689th Meeting of Senate

Wednesday, April 21, 2021 at 3 p.m.
Remote participation MS TEAMS-
Click here to join the meeting
Or call in (audio only)
(888) 862-4985, 906144997# Canada (Toll-free)
Phone Conference ID: 906 144 997#

A G E N D A

Approx. Timing	#	Agenda Item	Action
3:00	1.	Call to Order	
3:01	2.	Approval of the Agenda (including consent items)	Approval
3:02	3.	Business Arising from the Minutes	
ACTION ITEMS			
3:05	4.	Reports of Standing Committees	
	4.1	Research and Scholarship Policy Committee	**DECISION**
	4.2	Information Technology and Infrastructure Committee	**DECISION**
	4.3	Planning, Priorities and Budget Advisory Committee	**DECISION**
DISCUSSION ITEMS			
3:45	5.	Report of the Chair	Information
3:55	6.	Report of the President and Vice-Chancellor	Information
4:05		*****Senate Break*****	
4:15	7.	Report of the Provost and Vice-President, Academic	Information
4:25	8.	Report of the Vice-President, Research	Information
4:35	9.	Two Row Council – oral update	Information
	10.	Generative Discussion – N/A	
4:40	11.	Other Business	
4:45	12.	IN CAMERA – Report of the Provost and Vice-President, Academic*	Information
5:00	13.	Adjournment	
CONSENT ITEMS			
	14.	Minutes	
	14.1	688th Meeting of Senate held on March 24, 2021	Approval
	15.	Communications – Letter to Senate	Information
	16.	Report of the Academic Colleague	Information
	17.	Report of the Actions of the Board of Trustees – N/A	Information
	18.	Reports of Standing Committees	
	18.1	Academic Review Committee*	**DECISION**
	18.2	Undergraduate Program Committee	**DECISION**
	18.3	Graduate Studies Committee	Information
	18.4	Teaching and Learning Policy Committee	Information
	18.5	Governance Committee	Information
	18.6	Undergraduate Student Affairs Committee – N/A	

*Material on Senate SharePoint IN CAMERA

To: Chabriol Colebatch, University Secretary &
General Counsel, Brock University

From: Michael Ashton, Chair
Research and Scholarship Policy Committee

Date: April 13, 2021

Report to Senate 689, April 21, 2021

ACTION ITEM

1. Amendment to FHB III: C. 2.2.5 – Appointment of REB Members, Vice-Chairs, Chairs, and Appeals Board Members

MOVED (Ashton/)

THAT Senate approve the proposed changes to FHB III:C.2.2.5.c Appointment of REB Members, Vice Chairs, Chairs, and Appeal Board Members as indicated (strikeouts indicate deletion):

2.2.5. Appointment of REB Members, Vice Chairs, Chairs, and Appeal Board members

a) The REB shall follow its own established guidelines and procedures to propose candidate names for REB members, REB Vice-Chairs, and REB Chairs, and for all members of the Appeal Board, to the Research and Scholarship Policy Committee of Senate.

b) The Research and Scholarship Policy Committee shall recommend members, Vice-Chair and Chair of the REBs, and members of the Appeal Board, to Senate.

~~*c) The VPR and/or delegates shall be recused from any part of a Research and Scholarship Policy Committee meeting where appointment recommendations are discussed or decided.*~~

Rationale: Section 2.2.5.c) is not relevant to the current process of the Research Ethics Board (REB) committee appointments. There is no real or perceived conflict of interest for the Vice-President Research as this Office no longer appoints REB members.

CONSENT ITEMS – INFORMATION

2. In keeping with FBH 3:C, Article 2.2.5(a) noted in item #1 above, the REB has drafted some detailed guidelines and procedures for appointing REB members, REB Vice-Chairs, and REB Chairs. When finalized and received by the Committee, the relevant document will be distributed as information to Senate.

3. The Committee received from the Provost and the Vice-President Research a report addressing various concerns raised by the Committee regarding institutional Memoranda of Understanding (MOUs). The Provost will later propose some corresponding additions to the Faculty Handbook.

4. The Committee received an update from its working group that will develop the University's research data management strategy. The Tri-Agency Research Data Management Policy has now been released by the federal government, which means that the University will be required to complete its own institutional strategy by March 1, 2023, and to post the strategy and notify the agencies.

Report to Research & Scholarship Policy Committee

INFORMATION ITEM

TOPIC: MOUs

April 7, 2021

Lynn Wells, Provost & Vice-President, Academic
Tim Kenyon, Vice-President, Research

PURPOSE

- The purpose of this report is to address a set of concerns raised in the Research and Scholarship Policy Committee with respect to institutional Memoranda of Understanding ('MOUs').

BACKGROUND

- At the February 24, 2021 meeting of the Research and Scholarship Policy Committee, the Committee raised some questions regarding the University's processes and practices for institutional MOUs, including:
    - Whether MOUs entered into by the University could be made public;
    - How 'community partnerships' or 'international collaborations' are selected and approved and whether there are any organizations with whom the University would choose not to enter into an MOU;
    - What Senate's purview should be with respect to such agreements; and
    - How to ensure Senate's role does not impede or interfere with the academic freedom of faculty and professional librarians with respect to research and teaching.
- Following the meeting, the Provost engaged with the Vice-President, Research, Government and Community Relations, Brock International and the University Secretariat to explore and confirm ways of responding to the questions raised. A summary of the agreed upon response is set out below.

SUMMARY

Concern	Response
Transparency	• All MOUs entered into through Government & Community Relations and Brock International are already listed on their respective webpages.

Concern	Response
	• Where feasible, Brock will make available to the University community the full text of future MOUs. In accordance with FIPPA legislation, components of MOUs that reveal a trade secret or scientific, technical, commercial, financial or labour relations information of third parties, which have been supplied in confidence, may be held but would be available to an appropriate Committee of Senate and/or the Board. • Brock's MOU template will be made available online as well.
MOU processes & decisions	• Administrative processes and general principles for entering into MOUs shall be formalized and posted online. • A large number of MOUs are established through the action of individual faculty members or Faculties on the basis of academic and/or research imperatives. Administrative processes and general principles established should not aim to unduly impede these initiatives.
Senate's role and jurisdiction	• MOUs will comply with all applicable Senate policies and will not purport to give approval for any matter that requires Senate approval. This is current practice and assures that matters such as approval of new programs or research centres and institutes remain the responsibility of Senate. • The institutional MOU template will include a provision stipulating that any activities to be undertaken pursuant to the MOU are subject to the applicable requirements of the parties' governing bodies. • Any Senator who has a concern that an institutional MOU has not followed appropriate processes or is ill-advised is encouraged to raise the matter with the University Secretariat, who will direct the inquiry accordingly. If the Senator continues to have a concern, and the matter falls with the purview of a Senate committee or Senate, it may be brought to the attention of the applicable Senate committee or Senate.
Academic freedom	• All University policies and collective agreement provisions, including those concerning academic freedom, will be followed in the negotiation and implementation of MOUs.

NEXT STEPS

- The Provost and Vice-President, Academic and the Vice-President, Research, will work on implementing the measures described above, with regular updates provided to Senate.

To: Chabriol Colebatch, University Secretary & General Counsel, Brock University

From: Tim Ribaric
Chair, Information, Technology, and Infrastructure Committee

Date: April 13, 2021

Report to Senate 689, April 21, 2021

ACTION ITEM

1. **Hyflex Classrooms**

   MOVED (Ribaric/)

   THAT Senate endorse in principle, the introduction of Hyflex Classrooms as outlined in this document.

CONSENT ITEMS - INFORMATION

2. In March the Committee heard details about the proposed Engineering department and provided a statement of support for its creation and is looking forward to continued work on this initiative.

3. In April the Committee spent time discussing the report circulated from Two Row council, "Lighting the Fire: Experiences of Indigenous Faculty in Ontario University" and has devised some next steps for how the committee can follow up on calls of action outlined in the report.

HyFlex Classroom – For Information
Senate IT & I Committee – Meeting March 30th

HyFlex courses are not a new concept in the post-secondary sector. HyFlex courses can be defined as:

"Courses are those where students have the choice to attend learning on campus (in a classroom) or online, typically through real-time broadcast of classes via the internet. Online and on-campus students should be intentionally integrated to the learning environment through online interactions and engagement with synchronous learning opportunities (i.e., lectures, discussions). Where a student, in a hyflex course chooses to attend online, they should not be required to come to a physical location for any aspect of the course."

HyFlex classrooms have been identified as a way to support teaching and learning in the current environment and will provide a lasting legacy for Brock. At present, Brock does not have rooms that would allow for a HyFlex delivery. Several faculty members have inquired about HyFlex options and would be willing to teach in this model. Therefore, the following project has been designed to develop five classrooms that will support a HyFlex course. Once the technology is procured an extensive process of outreach and training for interested faculty will be designed and implemented to support the HyFlex course model.

- Cost for one room is $15,000 – Total cost for 5 rooms = $75,000
- Rooms to be equipped as HyFlex – TH 259, 258, 257, 256, 255
- These are flat classroom with the normal capacity for 60 (Rm 255, 256, 257), 77 (Rm 258) and 59 (Rm 259) students.
- Procurement of equipment will take approximately one month and it is essential to beginning now to ensure supply is available, as many other Canadian universities are also looking to scale up their Hyflex capacities for the Fall.
- Set-up of the rooms will take approximately 2 weeks.

In addition to the needs for HyFlex technology, these specific classrooms have also been previously designated as requiring modernization. Assessments are currently underway to determine the extent of the renovations required. If these can be completed together with the inclusion of the HyFlex technology by August 2021, then they will be completed simultaneously. If the renovations will not be able to be completed by this time, then the HyFlex will be installed in a way that is functional but also removable in the future for the renovations to take place.

SENATE

TO: Chabriol Colebatch
University Secretary & General Legal Counsel

FROM: Professor David Hutchison
Chair, Senate Planning, Priorities &
Budget Advisory Committee

DATE: April 13, 2021

Report to Senate 689, April 21, 2021

ACTION ITEM

1. 2021-22 Budget

MOVED (Hutchison/)

THAT PP&BAC recommends to Senate that the 2021-22 Budget is consistent with the academic policy of the University

2021-22 Budget Presentation (Updated for April 21 Senate Meeting)

Note: The following budget summary, which details the main points in budget presentations to PP&BAC, was drafted by Josh Tonnos, Associate Vice-President, Financial Services and reviewed by David Hutchison, Chair of PP&BAC for inclusion in this PP&BAC report.

Rationale

- The 2021-22 draft budget plan was developed under the following guiding principles:
  - Address our budget reality and find a balance between new revenue generation and expense reduction.
  - Human resource management including recruiting internally to minimize job loss.
  - Budget must be consistent with the academic policy of the University.
  - Continue advancing and investing in the institution's strategic priorities.
  - Student focus.
  - Target returning to hybrid instruction next Fall, respecting the health and well-being of the community.

- Administration, in consultation with the Board of Trustees, Senate Committees and the University community, developed a 2021-22 budget guidance strategy to achieve a balanced budget plan for 2021-22. This is a marked achievement recognizing Brock's $51 million revenue loss (15 per cent of total revenue) in 2020-21 and a $30 million revenue shortfall identified at the commencement of the budget planning phase for 2021-22.

Key Background

- Initial estimates pegged the 2021-22 fiscal year to have a $30.3 million funding shortfall.
- A mitigation strategy was developed through a comprehensive consultation process which included unit level guidance expense reductions of 8.8 per cent, central budget mitigation strategies, and in-year mitigation targets.
- Three townhalls were held throughout the year to provide opportunities for community engagement on the budget process.
- On March 23, 2021, the Senior Academic Leadership Team (SALT) passed a motion in support of the draft budget.
- On March 30, 2021, the Planning Priorities and Budget Advisory Committee of Senate (PP&BAC) passed a motion in support of the draft budget.
- A total of seven budget consultation meetings were held with PP&BAC and five with SALT between September 2020 and March 2021.
- Financial Services met with all units of the University in support of unit level budget development.
- The presentation, included in Senate's package, summarizes the 2021-22 budget, strategic investments and key risks.

Implications

- The proposed 2021-22 budget includes a $2.48 million in-year mitigation target, representing less than 1 per cent of the budget, as well as an organizational review savings target of $1.0 million with work currently underway on this initiative.
- This budget plan was a historic challenge to prepare following:
    - the 10 per cent reduction in domestic tuition in 2019-20 and tuition rates held flat at these levels going into 2020-21 and 2021-22,
    - a $51 million revenue shortfall in 2020-21 due to the impacts of the global pandemic and,
    - another $30 million estimated mitigation for 2021-22 at the commencement of the budget development phase.
- The combined mitigation target of $3.48 million compares to a mitigation target of $2.65 million in the 2020-21 budget, which subsequently grew to $51 million as reported in Financial Services 2020-21 Trimester Two report due to the global pandemic.
- Salient to the draft 2021-22 budget is the strategic reserve fund of $1.8 million set aside and unencumbered to fund in-year strategic priorities, and if needed provide added budget flexibility for mitigation. This reserve represents 0.5 per cent of revenue, short of the Fiscal Framework target of 1 per cent; however,

given the significant impacts of the global pandemic on revenues it should be recognized that having this reserve at 50 per cent is a notable achievement.

Next Steps

- The budget plan remains conservative for a reopening of the campus for Fall 2021 with a potential revenue upside should public health measures improve significantly into the fall; however, our operations remain flexible to adapt to the possible continuation of pandemic related public health restrictions.
- The 2021-22 budget includes new investments to support strategic enrolment growth with additional resources for developing and enhancing: Engineering, Continuing Education, campus renewal and deferred maintenance, Indigenization with an additional four faculty positions and capital project allotments, enhanced student awards and financial aid envelopes to minimize financial barriers, no reductions in faculty count overall, continuation of internally funded research grants and funding to support a revised model for research business development and commercialization of intellectual property, and budgets for continued support of all academic, research and support programs at Brock.
- Enrolment remains the greatest concern to long-term sustainability as Brock requires over 1% enrolment growth to cover inflation costs. New programs and new intake channels are needed to address this risk. In support of this, the budget provides for strategic enrolment enhancements.

INFORMATION

2. Proposal to establish a Department of Engineering

The PP&BAC Committee discussed the attached Academic Plan for the Establishment of a New Academic Unit which proposes to establish a Department of Engineering at Brock University. Dr. Greg Finn, Special Advisor to the President, was in attendance to answer questions and communicate the committee's feedback to the Academic Advisory Committee on Engineering which he chairs. The proposal will also be vetted by other Senate committees, including the IT&I Committee.

It was noted that the primary revenue stream for the new department and its associated programs will be tuition fees (both domestic and international). The University is optimistic that the engineering programs the department establishes (through the ARC process) will meet the enrolment targets outlined in Appendix 1 of the proposal. With reference to the proposal (p. 6), Greg Finn noted that "between 2007 and 2016, there was a 98 percent increase in applications for undergraduate engineering programs [across the province]. This compares with a 23 percent overall increase in total applications across all programs to Ontario universities over the same period."

There was a discussion as to how new engineering programs at the undergraduate and graduate levels will complement newly proposed and existing programs in other academic units. Greg emphasized the interdisciplinary nature of the engineering programs that are planned and the potential for intra-university partnerships beyond the Faculty of Math and Sciences where the new department will be housed.

Concerns were raised regarding the lack of diversity in existing engineering programs. Greg Finn and Lynn Wells assured the committee that diversity will be a priority both in terms of faculty hires and the student population. For example, plans are underway to work with Robyn Bourgeois, Vice-Provost Indigenous Engagement, regarding incentives to attract Indigenous students.

There was a question as to the payback date at which time the new department's costs to the University in the early years will have been recouped. It is anticipated that the department will generate a profit for the university beginning in 2025-26 as noted in Appendix 1. A member suggested clarifying Appendix 1 to indicate that there will be a steady state number of faculty (13) as of 2028-2029.

There was a query re. the ambitious plans for new facilities as detailed in the proposal. Greg Finn noted that there are early long-term plans for a new engineering building to accommodate the facility requirements as the engineering programs grow in size. Lynn Wells indicated that the University hopes to draw on potential government infrastructure funding. Discussions with external stakeholders regarding public and private (in-kind) funding support are ongoing.

PP&BAC expressed general support for the proposal from a budgetary perspective.

3. The committee received Trimester 2 Financial Update and Forecast.

Brock University

DRAFT

2021-22 BUDGET REPORT

Including key performance metrics

SENATE COMMITTEE:

DRAFT 2021-22 Budget

- April 21, 2021 -

Motion Senior Academic Leadership Team

Whereas the 2021-22 Budget was developed through consultation in setting budget guidance with the University community, and resulted in a budget that supports the Institutional Strategic Plan and the academic priorities of the Faculties, balanced with fiscal responsibility:

Therefore, the Senior Academic Leadership Team recommends to the Senate Planning, Priorities, and Budget Advisory Committee that the 2021-22 Budget is consistent with the academic policy of the University.

PP&BAC Motion

That the Senate Planning, Priorities, and Budget Advisory Committee recommend to Senate that the 2021-22 Budget is consistent with the academic policy of the University.

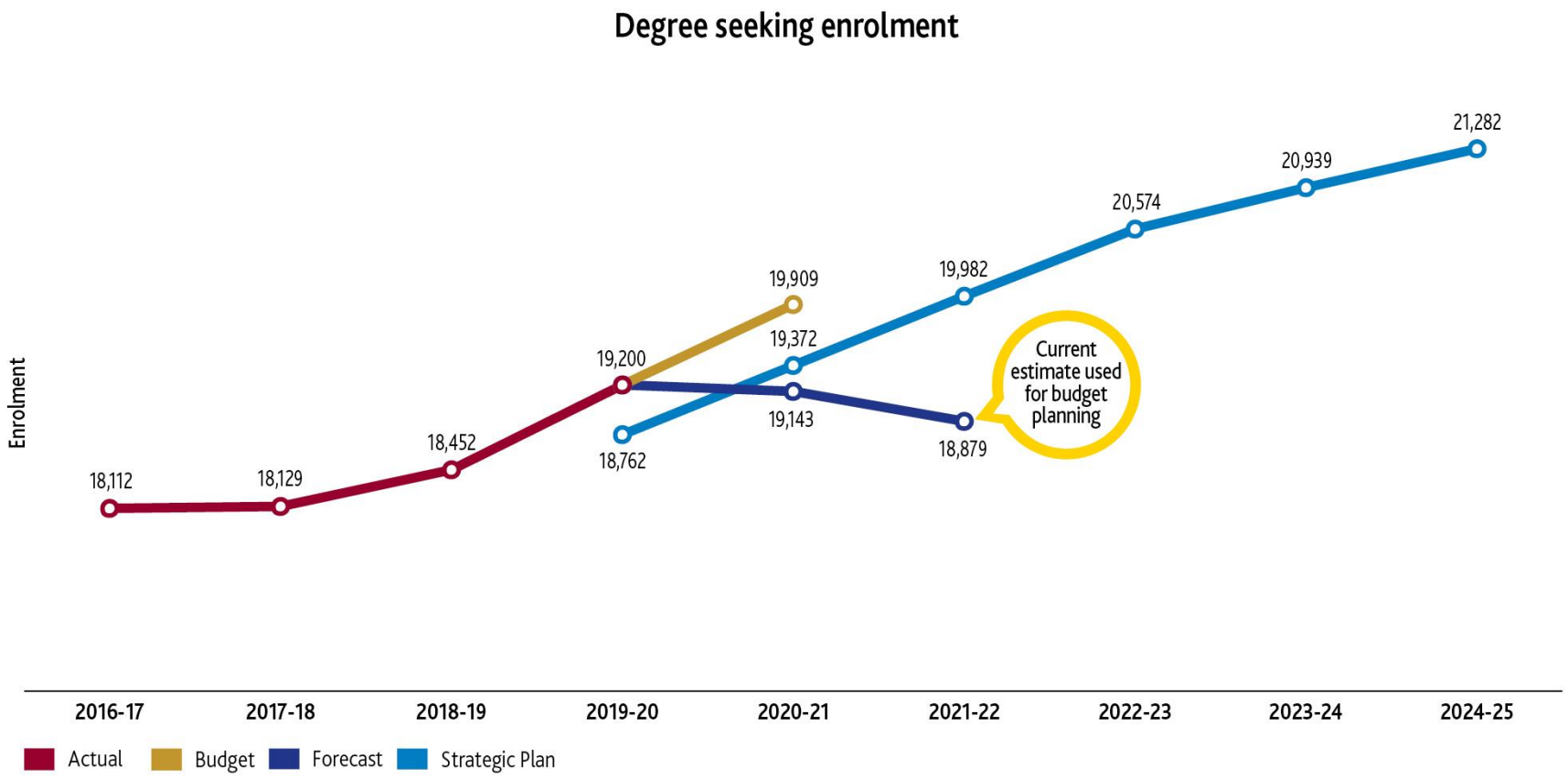
Motion

That the Senate recommend to the Board of Trustees that the 2021-22 Budget is consistent with the academic policy of the University.

Budget Process

- Budget guidance developed and finalized through consultation
- PPBAC Consultation
  - ✓ September 15, 2020 - Budget development process and timing
  - ✓ October 20, 2020 - Budget guidance, tuition fees and scholarship budget, 2020-21 Trimester 1 Forecast
  - ✓ November 17, 2020 – Capital budget, budget update
  - ✓ January 26, 2021 – Draft submitted budget update
  - ✓ February 23, 2021 – Draft budget update and 2020-21 T2 Forecast update
  - ✓ March 23, 2021 – presentation of draft budget
  - ✓ March 30, 2021 – passed motion in favour of 2021-22 draft budget
- Consultation with Senior Academic Leadership Team (SALT) (5 meetings)
- Townhall held November 6, 2020
- Non-academic budget developers submitted first draft budgets December 14, 2020
- Academic budget developers submitted first draft budgets January 11, 2021
- Townhall held February 5, 2021
- Senior Academic Leadership Team (SALT) motion passed in support of the 2021-22 draft budget March 23, 2021
- Townhall held March 26, 2021

Degree-seeking enrolment



2021-22 Draft Budget Financial Overview

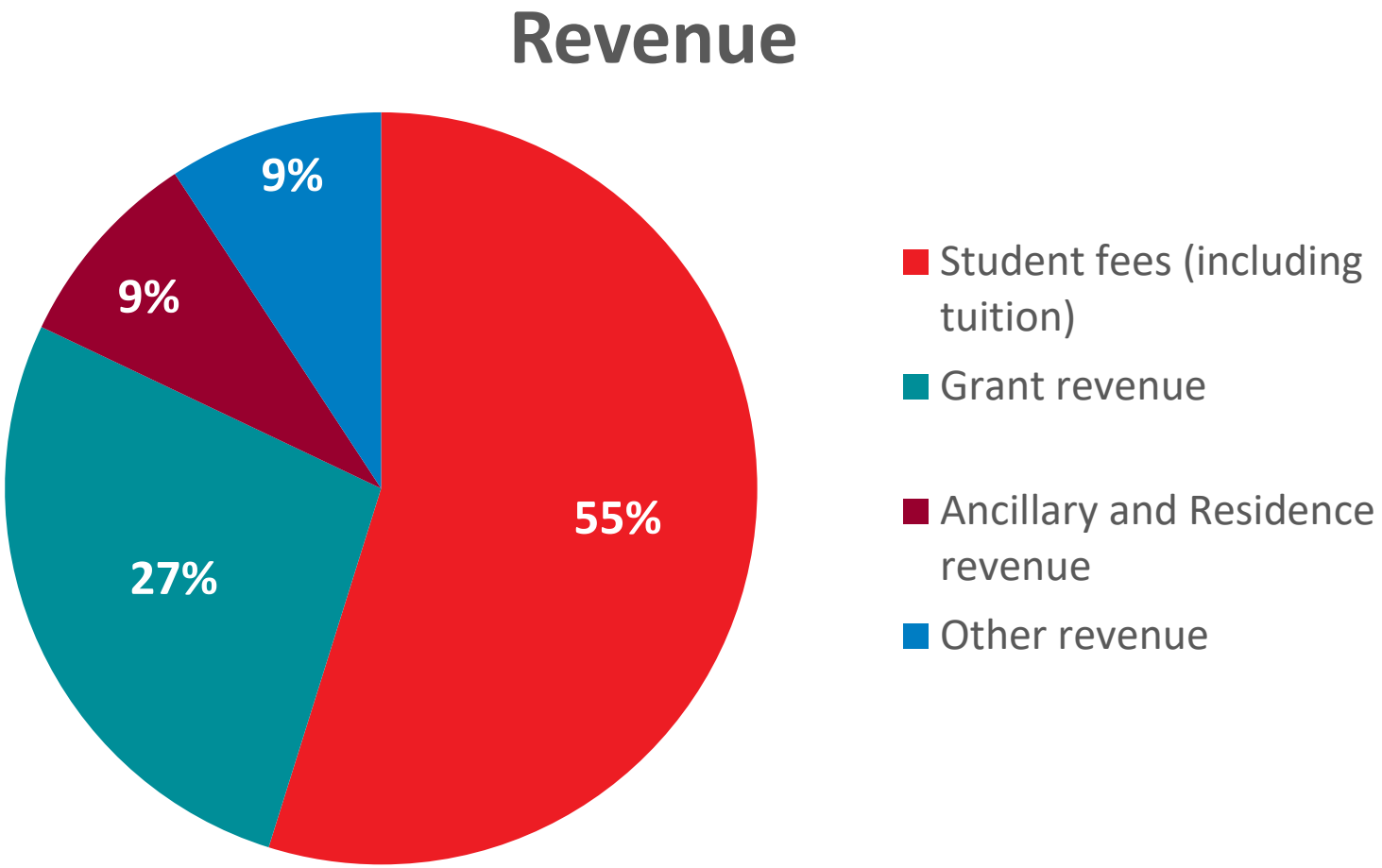
Brock University

2021-22 Budget

($000s)	2021-22 Budget	2020-21 Budget	2019-20 Actuals
Revenue			
Student fees	**196,563**	200,202	185,078
Grant revenue	**97,612**	97,288	96,788
Internal chargebacks	**9,044**	8,621	8,484
Inter-fund revenue	**6,838**	7,042	4,920
Other revenue	**48,410**	54,899	51,707
Total revenue	**358,467**	**368,052**	**346,977**
Operating expenses			
Personnel costs	**(233,001)**	(238,613)	(220,419)
Inter-fund revenue	**(26,610)**	(25,773)	(25,900)
Other operating costs	**(102,335)**	(106,313)	(93,000)
Total operating costs	**(361,946)**	**(370,699)**	**(339,319)**
Organizational review savings (Lane 3)	**1,000**		
Remaining in-year Mitigation	**2,479**	2,647	
Funding surplus	**-**	**-**	**7,658**

Brock University

2021-22 Budget - Revenue

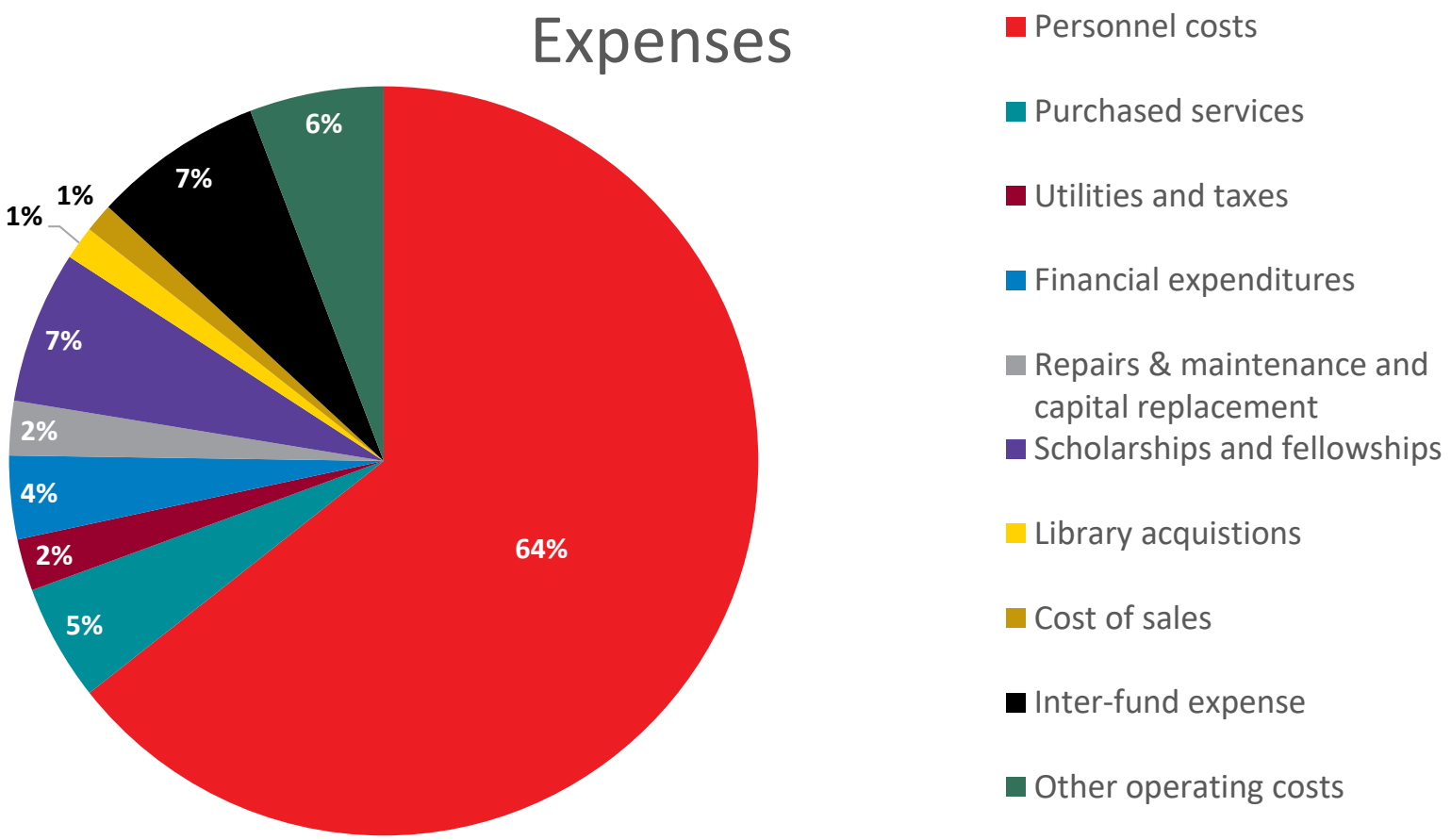


Revenue

($000's)	2021-22 Budget	2020-21 Budget	2020-21 T2 Forecast	Variance 2021-22 Budget vs 2020-21 Budget		Variance 2021-22 Budget vs 2020-21 T2 Forecast	
				$	%	$	%
Tuition	186,039	189,383	178,751	*(3,344)*	*-1.8%*	*7,288*	*4.1%*
Fee revenue	10,524	10,819	7,760	*(295)*	*-2.7%*	*2,764*	*35.6%*
MCU operating grants	89,014	90,126	90,322	*(1,112)*	*-1.2%*	*(1,308)*	*-1.4%*
Other MCU and specific purpose grants	8,598	7,162	8,830	*1,436*	*20.1%*	*(232)*	*-2.6%*
Ancillary and residence revenue	31,178	37,368	8,672	*(6,190)*	*-16.6%*	*22,506*	*259.5%*
Investment income	1,866	1,849	2,599	*17*	*0.9%*	*(733)*	*-28.2%*
Sales and services	12,720	15,682	9,157	*(2,962)*	*-18.9%*	*3,563*	*38.9%*
Internal chargebacks	9,044	8,621	3,006	*423*	*4.9%*	*6,038*	*200.9%*
Inter-fund revenue	6,838	7,042	7,532	*(204)*	*-2.9%*	*(694)*	*-9.2%*
Asset sale revenue	2,646	-	-	*2,646*		*2,646*	
Total Revenue	**358,467**	**368,052**	**316,629**	***(9,585)***	***-2.6%***	***41,838***	***13.2%***

Brock University

2021-22 Budget - Expenses



Brock University

Expenses

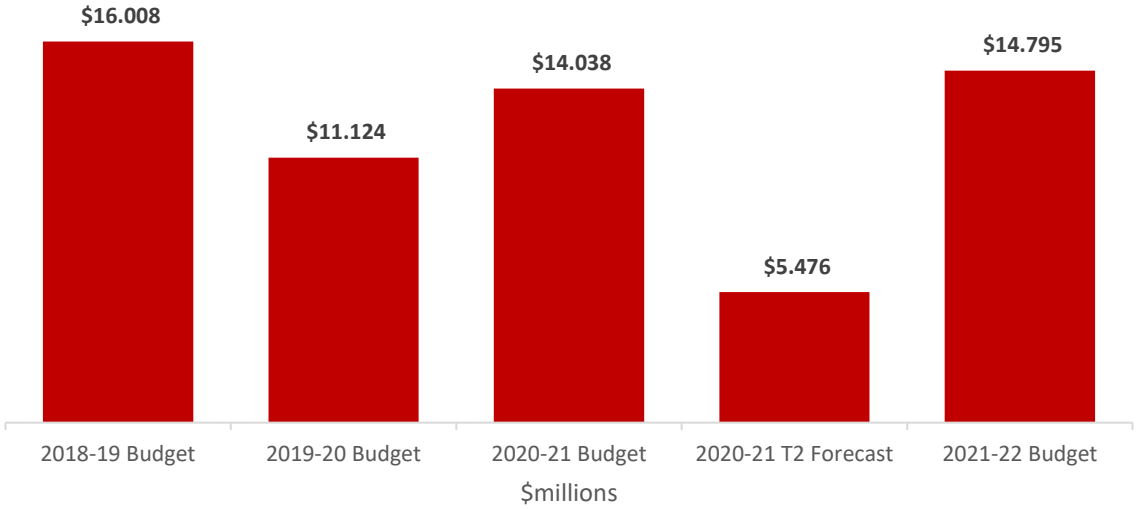
($000's)	2021-22 Budget	2020-21 Budget	2020-21 T2 Forecast	Variance 2021-22 Budget vs 2020-21 Budget		Variance 2021-22 Budget vs 2020-21 T2 Forecast	
				$	%	$	%
Personnel costs	**233,001**	**238,613**	**219,004**	**(5,612)**	**-2.4%**	**13,997**	**6.4%**
Purchased services	18,172	20,355	16,297	(2,183)	-10.7%	1,875	11.5%
Utilities and taxes	8,107	8,403	5,843	(296)	-3.5%	2,264	38.7%
Financial expenditures	13,019	11,378	11,213	1,641	14.4%	1,806	16.1%
Repairs & maintenance and capital replacement	8,500	9,424	7,515	(924)	-9.8%	985	13.1%
Scholarships and fellowships	23,845	20,304	21,068	3,541	17.4%	2,777	13.2%
Library acquisitions	5,222	5,121	5,125	101	2.0%	97	1.9%
Cost of sales	4,513	5,476	3,818	(963)	-17.6%	695	18.2%
Inter-fund expense (transfers to internally & externally restricted reserves)	26,610	25,773	15,759	837	3.2%	10,851	68.9%
Other operating costs	20,957	25,852	10,124	(4,895)	-18.9%	10,833	107.0%
Total operating costs	**361,946**	**370,699**	**315,766**	**(8,753)**	**-2.4%**	**46,180**	**14.6%**

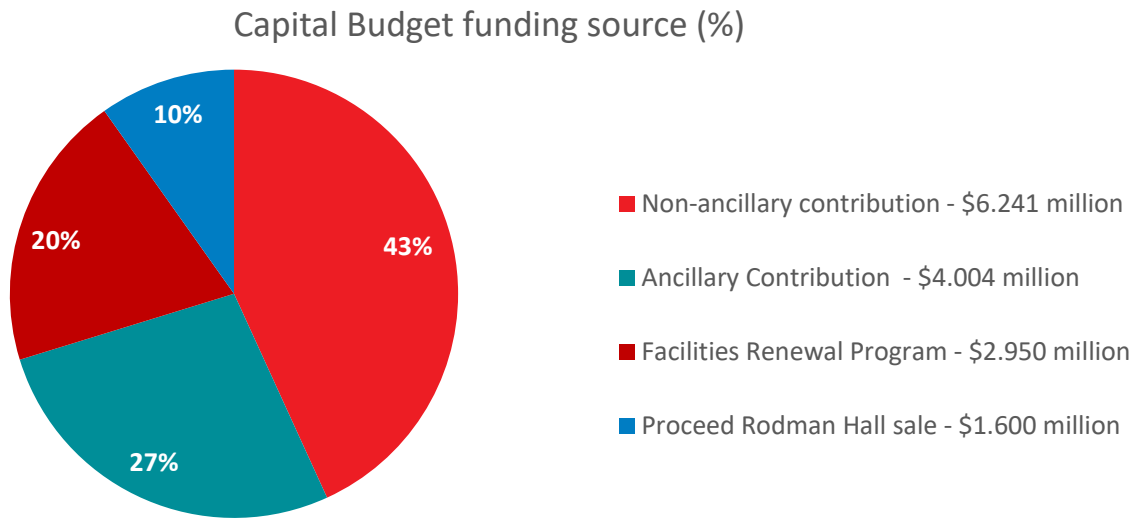
Brock University

Scholarships, bursaries and student awards

($000s)	2021-22 Budget	2020-21 Budget	$	%
Undergraduate				
Budgeted centrally	12,634	10,214	2,420	24%
Less: Grant-funded portion	(182)	(182)	-	0%
Budgeted in other units	111	103	8	8%
Tuition waivers	1,283	1,283	-	0%
Total Undergraduate (before endowments)	**13,846**	**11,418**	2,428	21%
Endowments	1,955	1,890	65	3%
Total Undergraduate (after endowments)	**15,801**	**13,308**	2,493	19%
Graduate				
Budgeted centrally	9,387	8,301	1,086	13%
Less: Grant-funded portion	(686)	(700)	14	2%
Budgeted in other units	236	209	27	13%
Tuition waivers	194	194	-	0%
Total Graduate (before endowments)	**9,131**	**8,004**	1,127	14%
Endowments	565	542	23	4%
Total Graduate (after endowments)	**9,696**	**8,546**	1,150	13%

Capital and related projects budget





Budgeted FTEs – year over year

Employee Group	Draft 2021-22 Budget	2020-21 Budget	Variance
Admin/Professional	690.8	721.1	(30.3)
BUFA Faculty/Librarians	551.9	549.7	2.2
BUFA LTA	55.1	57.3	(2.2)
CUPE 1295 FT	126.3	127.0	(0.7)
CUPE 2220	-	1.8	(1.8)
CUPE 4207 Unit 2	3.0	4.0	(1.0)
CUPE 4207 Unit 3	3.0	22.7	(19.7)
IATSE	3.8	3.8	-
OSSTF	147.1	155.4	(8.3)
Senior Administrative Council (SAC)	28.0	29.8	(1.8)
Total	**1,608.9**	**1,672.5**	**(63.5)**

Brock University

Faculty & Librarian FTE positions in Budget

The following shows the 2020-21 budgeted faculty & librarian FTEs vs the 2021-22 budgeted faculty & librarian FTEs

FTE represents 12 months full-time. Example, if individual is planned to retire mid-year they count for 0.5 FTE.

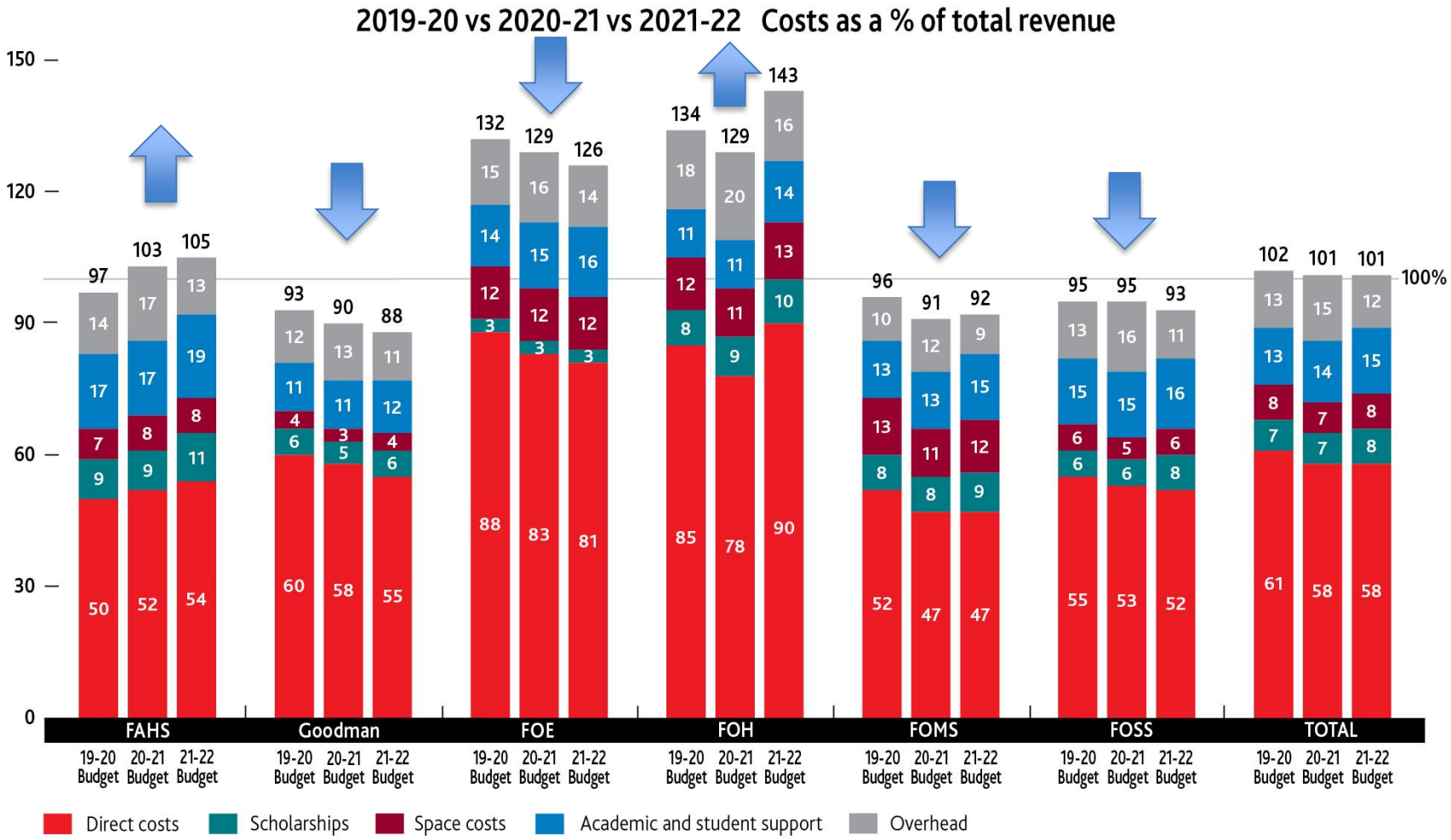
	Applied Health Science	Goodman	Education	Humanities	Math & Science	Social Science	Library	Total*
2020-21 Budget								
FTE - Faculty	92.4	84.2	42.3	89.4	69.3	152.5	17.6	549.7
FTE - LTA/ILTA Faculty	7.3	14.0	12.8	5.0	4.0	12.2	2.0	57.3
Total 2020-21 Budgeted FTE's	**99.7**	**98.2**	**55.1**	**94.4**	**73.3**	**164.7**	**19.6**	**607.0**
2021-22 Budgeted FTE's								
FTE - Faculty	90.0	80.0	44.4	93.3	71.4	153.3	18.5	551.9
FTE - LTA/ILTA Faculty	9.3	14.0	12.5	3.5	4.0	10.8	1.0	55.1
Total 2021-22 Budgeted FTE's	**99.3**	**94.0**	**56.9**	**96.8**	**75.4**	**164.1**	**19.5**	**607.0**
Variance								
FTE - Faculty	**(2.4)**	**(4.2)**	**2.1**	**3.9**	**2.1**	**0.8**	**0.9**	**2.2**
FTE - LTA/ILTA Faculty	**2.0**	**0.0**	**(0.3)**	**(1.5)**	**0.0**	**(1.4)**	**(1.0)**	**(2.2)**
Total Variance	**(0.4)**	**(4.2)**	**1.8**	**2.4**	**2.1**	**(0.6)**	**(0.1)**	**0.0**

*The 2020-21 Budget includes 2 positions that are not within a Faculty/Library (Engineering and Graduate Studies). The 2021-22 Budget includes 1 positions that is not within a Faculty/Library (Graduate Studies).

Brock University

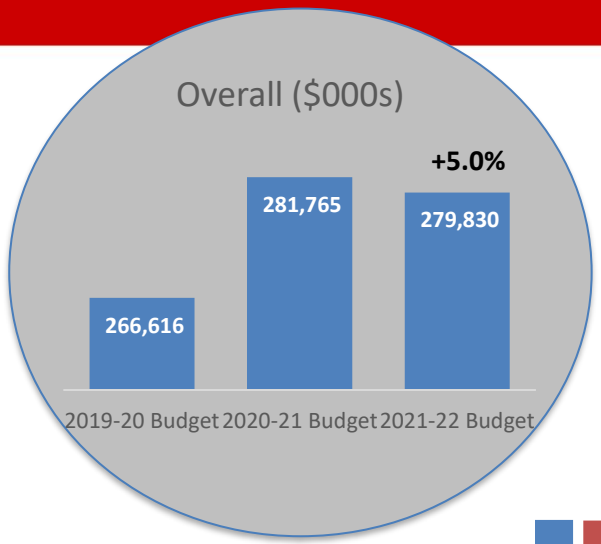
Revenue and Expense Allocation Model

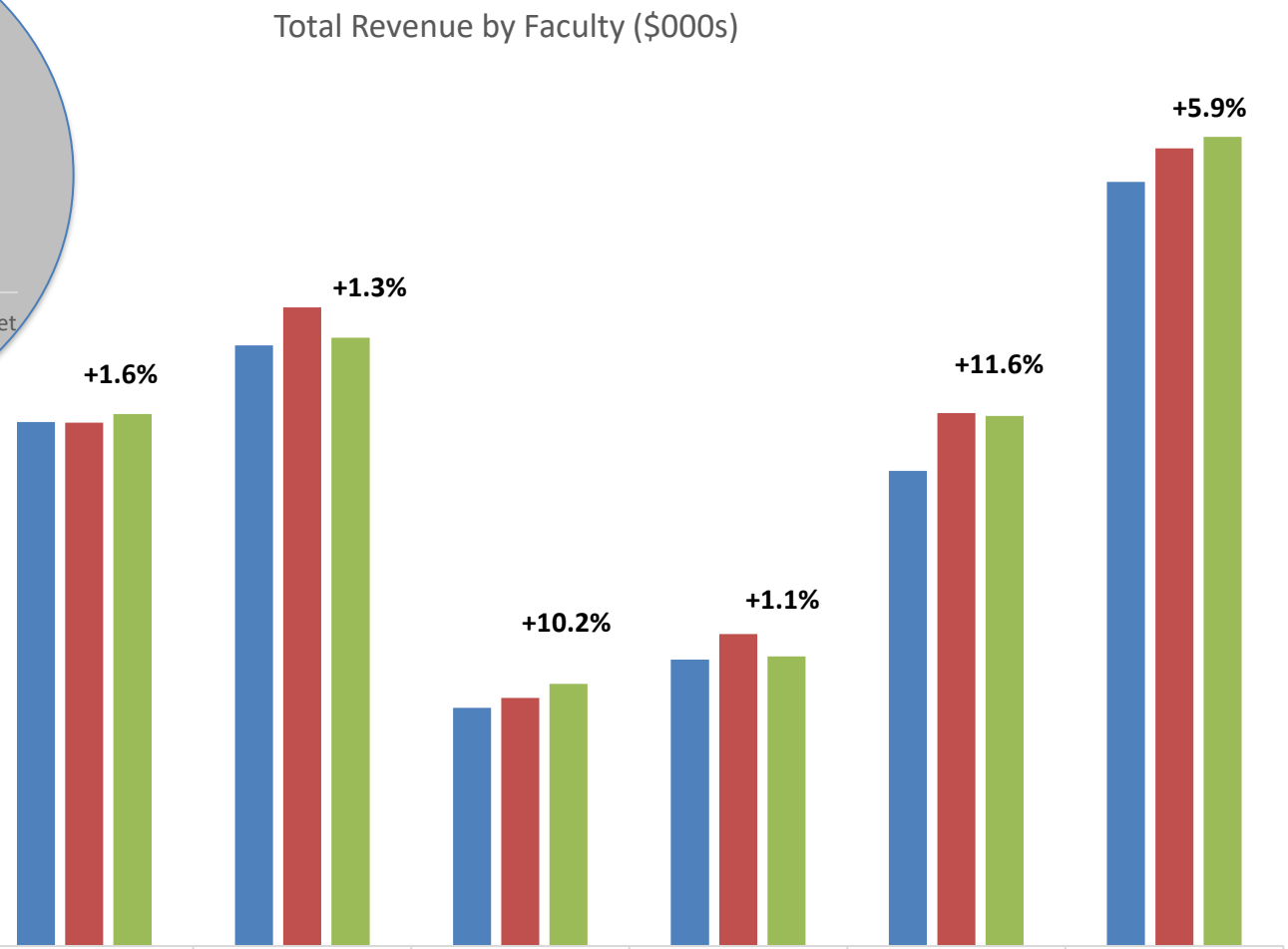
Revenue and expense allocation model
Costs as a % of Revenue – year over year



Brock University

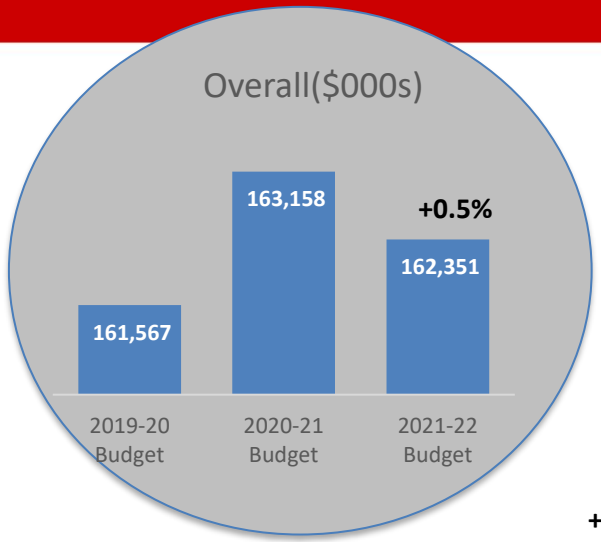
Total revenue allocation

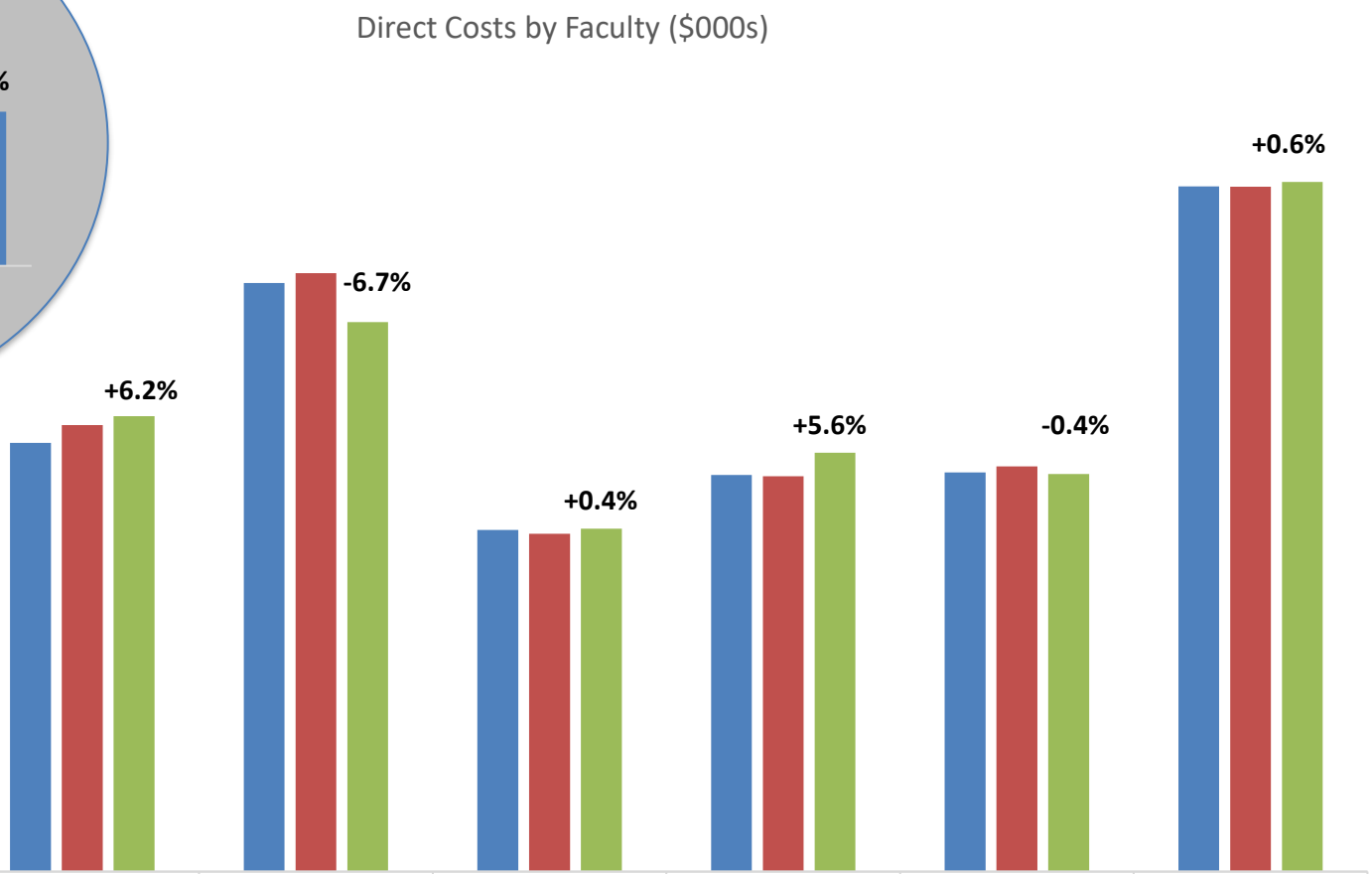




	FAHS	Goodman	FOE	FOH	FOMS	FOSS
2019-20 Budget	48,357	55,437	21,978	26,440	43,858	70,546
2020-21 Budget	48,302	58,949	22,908	28,788	49,182	73,636
2021-22 Budget	49,110	56,152	24,209	26,738	48,929	74,692

Direct Costs

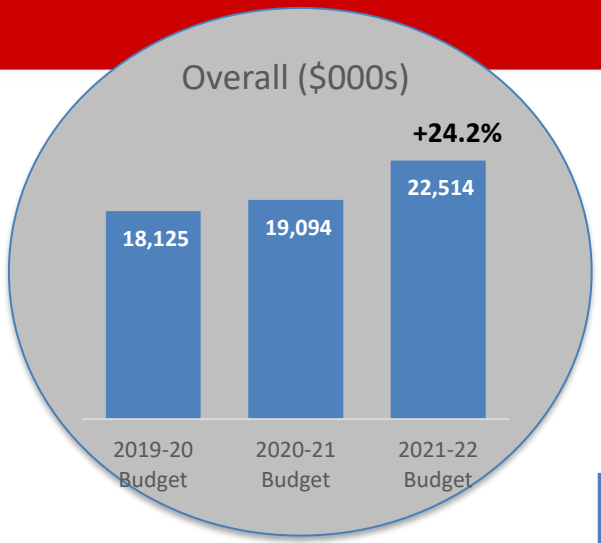


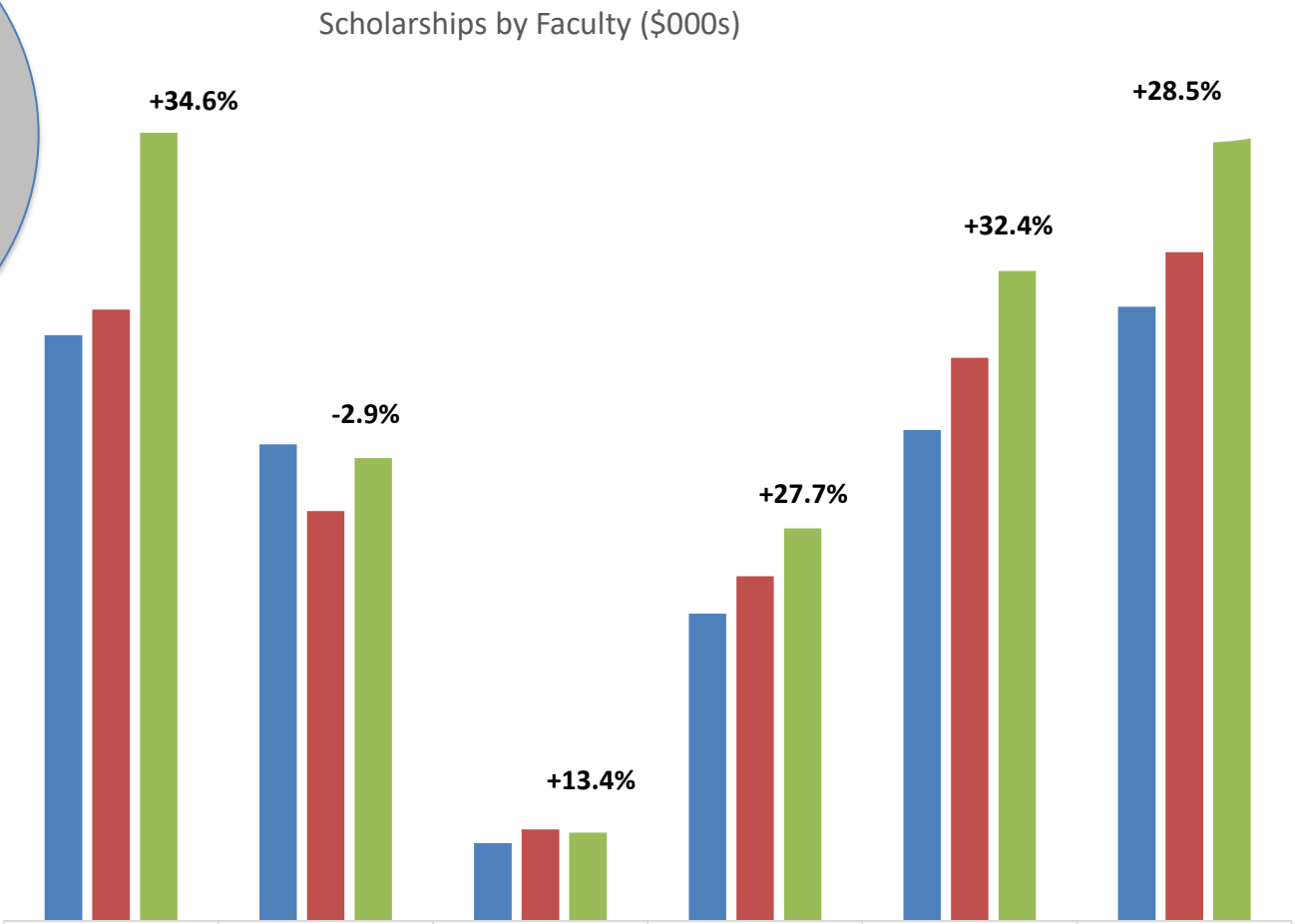


	FAHS	Goodman	FOE	FOH	FOMS*	FOSS
2019-20 Budget	24,394	33,488	19,435	22,556	22,714	38,980
2020-21 Budget	25,396	34,046	19,222	22,495	23,045	38,954
2021-22 Budget	25,907	31,258	19,514	23,825	22,620	39,227

*In 2021-22 Budget Science Store and Technical Services are not included in this total

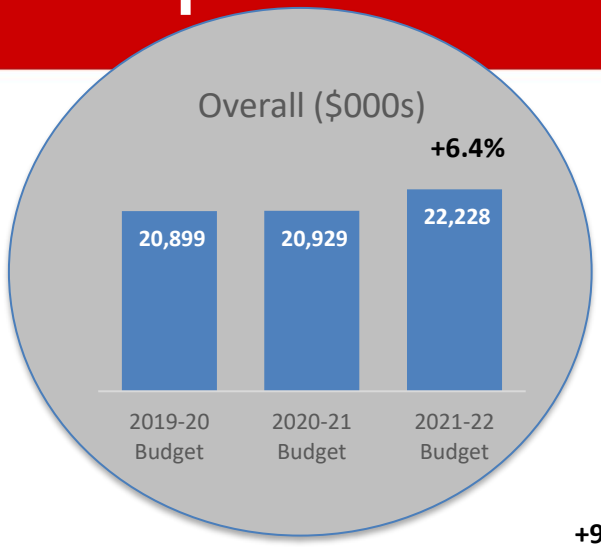
Scholarships

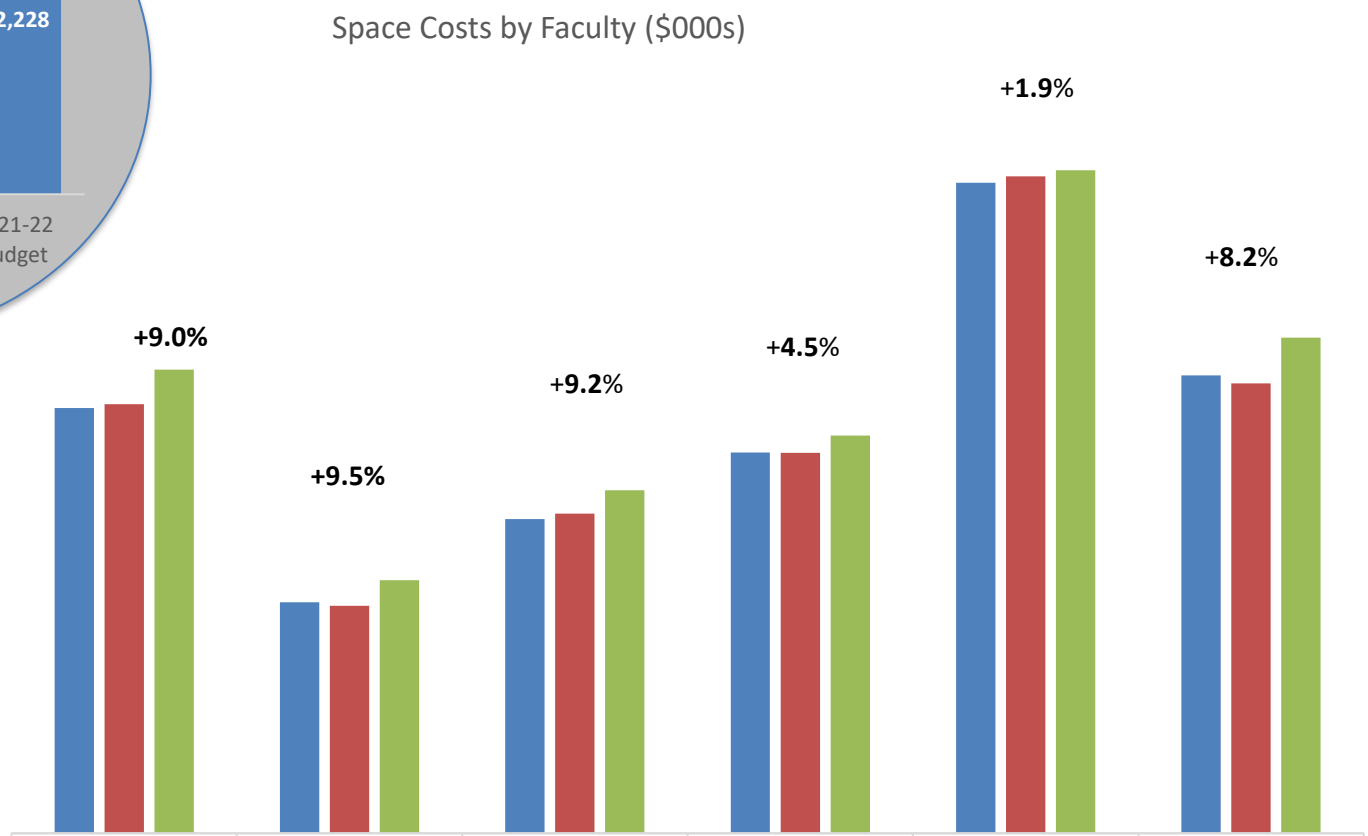




	FAHS	Goodman	FOE	FOH	FOMS	FOSS
2019-20 Budget	4,159	3,384	554	2,182	3,486	4,360
2020-21 Budget	4,339	2,910	651	2,448	3,999	4,747
2021-22 Budget	5,596	3,286	628	2,787	4,614	5,603

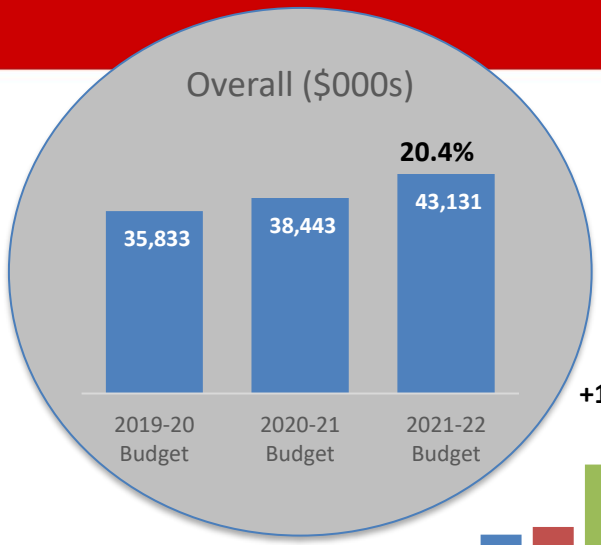
Space Costs



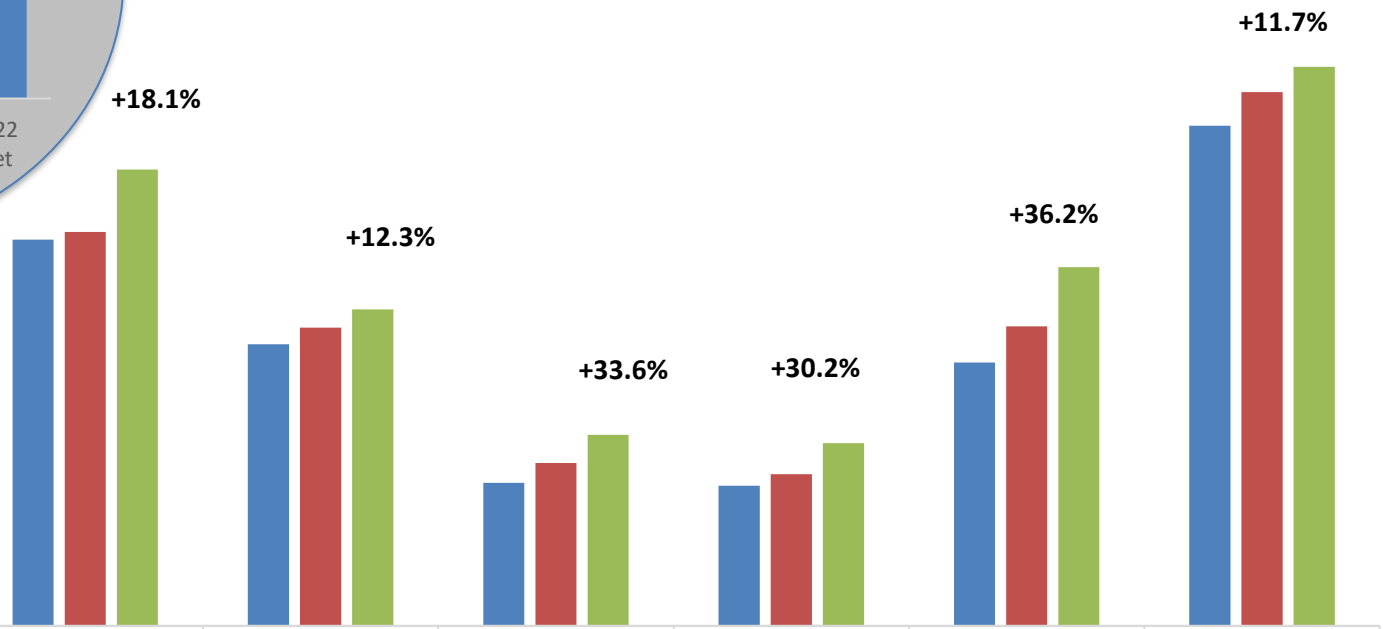


	FAHS	Goodman	FOE	FOH	FOMS	FOSS
2019-20 Budget	3,614	1,963	2,669	3,234	5,528	3,891
2020-21 Budget	3,646	1,932	2,715	3,232	5,581	3,823
2021-22 Budget	3,939	2,150	2,915	3,380	5,633	4,211

Academic & Student Support



Academic and Student Support by Faculty ($000s)

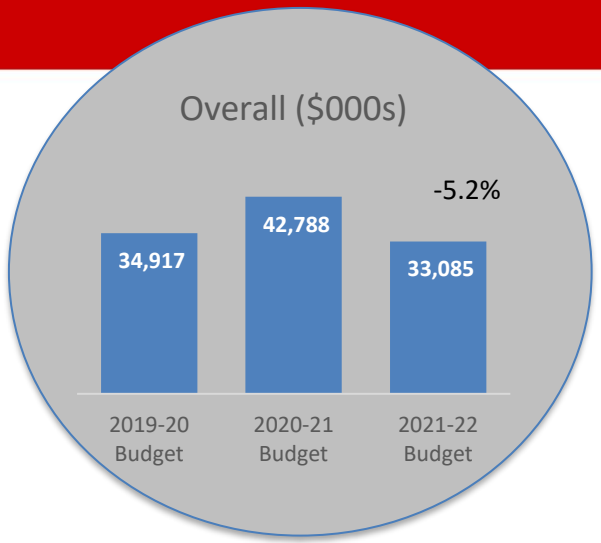


	FAHS	Goodman	FOE	FOH	FOMS	FOSS
2019-20 Budget	8,073	5,885	2,989	2,931	5,502	10,453
2020-21 Budget	8,231	6,231	3,401	3,169	6,259	11,152
2021-22 Budget	9,538	6,611	3,992	3,816	7,494	11,680

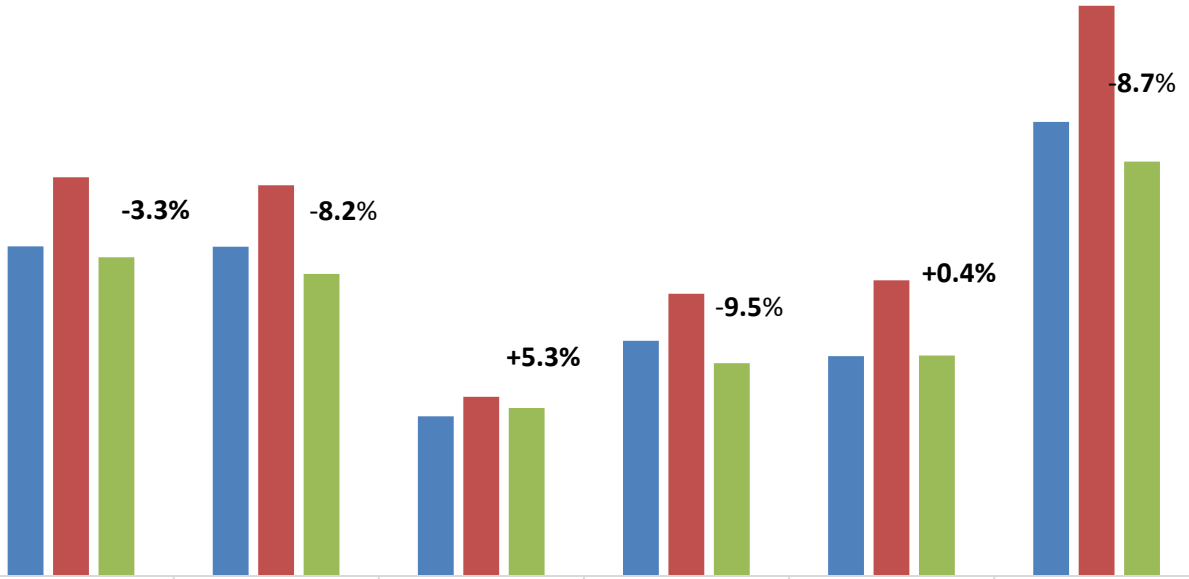
Includes Research Services, Faculty of Graduate Studies, Library, Centre for Pedagogical Innovation, Office of the Registrar, Aboriginal Student Services, Student Wellness and Accessibility, Student Life and Success, Brock International, Co-op, Career and Experiential Education, Brock Sports and Recreations and in 2021-22 Budget Science Stores and Technical Services.

Brock University

Overhead



Overhead by Faculty ($000s)



	FAHS	Goodman	FOE	FOH	FOMS	FOSS
2019-20 Budget	6,660	6,657	3,227	4,753	4,441	9,179
2020-21 Budget	8,058	7,900	3,622	5,705	5,975	11,528
2021-22 Budget	6,440	6,109	3,396	4,303	4,459	8,378

Includes Senior Academic and Administrative Team, Information Technology Services, Financial Services, Human Resources, Marketing and Communications, Development and Alumni Relations, Human Rights and Equity Services, University Secretariat, Office of Government Relations, Institutional Analysis and Planning, Internal Audit and Risk Management, Ancillary Operations and Residence, Capital and University Global.

Brock University

Motion

That the Senate recommend to the Board of Trustees that the 2021-22 Budget is consistent with the academic policy of the University.

Questions/Comments

Brock University

Appendix

2021-22 Academic Budget Presentations

Faculty of Applied Health Sciences

Budgetary support for programs, research, students and strategic plan (highlights & changes):

- Total 2021/2022 FAHS budget similar to 2020/2021 budget
- 3 ILTA renewals, 3 LTA replacements for faculty on LTD (support program delivery & growth)
- 1 Tenure Track replacement for internal Tier 2 CRC appointment & 1 New Tier 1 CRC candidate appointment (support for research & graduate/undergraduate students)
- 1 New ILTA appointment to support growth of MPH & MPH/MBA programs
- Maintaining support for FAHS experiential education, laboratory, clinical and tutorial experiences for students
- Maintaining range and total undergraduate and graduate courses for sufficient student selection, course/program completion and enrollment enhancement (Fall, Winter & Spring/Summer)
- Maintain appropriate TA support for course delivery, instructor support and graduate student financial support requirements
- Maintain faculty research support including; funding for grant applications, research equipment maintenance/renewal, BUFA contractual research & unscheduled teaching course releases and continuation of FAHS Senior Research Fellowships
- Maintain initiatives related to Brock and FAHS strategic plan priorities including; student health, academic guidance, new program development, indigenization initiatives, student recruitment and others

Faculty of Applied Health Sciences

Budgetary reductions/deferrals & consequences:

- Strategic reductions to travel, departmental/decanal expenses, professional development and equipment purchases
- Pro-rating salaries of new appointments/hires to July 1
- Delay in replacing a retired staff-laboratory demonstrator position (retired Dec. 31,2020- replacement Sept. 1, 2021)
- Two retirement/resignation faculty replacement (SPMA & NURS) positions deferred to 2022/2023 -will impact program delivery (SPMA) and new program initiation (BN/MN)
- Three new growth TT faculty positions and one staff position to support newly started programs (MAG & MPK) and transformation of BPH coop to a three-term cycle deferred to 2022/2023 -will impact program delivery, program transformation and student recruitment
- FAHS continues to have (by far) the highest student/faculty ratios at Brock-impacts course sizes and student experience

Faculty of Education

The Faculty of Education's (FOE) budget for FY 2021-22 includes measures to increase revenues to offset instructional costs associated with increased numbers of concurrent education students entering the final 2 years of teacher education as well as growth in other programs. The FOE budget addressed areas that need strategic investments to retain students during the 2020-21 academic year.

The project FOE budget for FY 2021-22 is ~$272k under guidance.

Amongst the mitigation measures are:

- Change in MPCE and M.Ed. (ISP) tuition from Department to Global
  - Impact $2,418k in loss revenue to FOE
- Increased course fees introduced in 20-21 and continued to 21-22(Practicum for Teacher Candidates)
  - ~$400k (Offsets Associate Teacher and Faculty Advisor travel costs)
  - Increases support for practicum/experiential education placements (directly related to SMA3 and Strategic Plan)
- Teacher Education: additional 81 students for 2021-22
  - Flow through in concurrent teacher education (2017 intake)
  - Addresses market demand
  - Retains consecutive teacher education enrollments at traditional levels
  - Net revenues (excluding grant): $64k
- Adult education: additional 593 course enrolments
  - Increased class size
  - Additional 6 sections for Open Access course
  - Net revenues (excluding grant) to FOE: $312k
- Continuing Teacher Education: additional 415 course enrolments
  - Addresses strong market demand (new courses supported by Ministry of Education – Math, Autism, etc.)
  - Net revenues (excluding grant) to FOE: $324k

Brock University

Faculty of Education

Strategic investments

Students:

- Introduced new (FOE) scholarships for selected international students who successfully complete online courses -- Total costs: $15k (Retention initiative)
- Additional scholarships for ISPs and PHD students for extra financial support. Total costs: $11k
- Total student support (includes scholarships) investment $89k

Academic:

- Open Access: additional 6 course sections with teaching costs of $59k
- Micro-credentials: new initiatives: online symposium, Future ready skills, Classroom Conversations $21k
- Additional faculty hire: Indigenous Educational Studies program director, or equivalent, $101k (10 months)

Research:

- Strategic initiatives $15k
- Conference support for faculty $15k
- Research and Development awards $20k
- Research workshops and writing institutes $22k

Budget mitigation

Students/Academic/Research:

- Reduction of Marketing and Advertising which supports student recruitment activities $16k vs 19-20 actual
- Reduction of Travel $62k vs 19-20 actual
- Reduction of staff positions/vacancies $44k
- Reduction of revenue and costs for Continuing Teacher Education China and International Summer Schools due to the pandemic. Net <$55k>

Brock University

Faculty of Education

- Risks
  - International student recruitment (impact of COVID 19)
    - Greater uncertainties due to visa/travel delays and vaccination requirements
    - Negative impact on attraction and retention
    - Requirement to offer course sections for different entry points (increased PT teaching)
  - Increased course fees in FY2020-21 (continued in FY2021-22)
    - Impact on accessibility and affordability
    - Negative reactions by students, parents
    - Inconsistencies across programs and courses
  - Decreased marketing and advertising budget
    - Negatively affects FOE ability to target student recruitment (e.g., Open Access & Micro-credentials)

Faculty of Humanities
PPBAC 2021

Travel

Many Humanities disciplines rely on travel – for excavations, archives and museum research, exhibitions and performances. Current and anticipated restrictions on travel, both COVID-related and budgetary, are hampering the research of faculty members and graduate students.

Because of restrictions on travel, some faculty members are postponing sabbaticals until travel is possible. The resultant reduction in part-time teaching does not balance against the increase in salary and benefits paid out.

Brock University

Faculty of Humanities

Equipment

Equipment for both teaching and research requires regular upkeep and replacement, and budgetary pressures will slow down the process.

-The Interactive Arts & Science (IASC) and GAME programmes require specialized computer stations to allow students to do their work and prepare for future work in the field, and keeping up-to-date is crucial for their progress.

-digital media equipment is used in research, teaching, and individual student projects in both IASC and the Visual Arts programmes. Digital media is a fast growing area of teaching that we should strive to support as well as possible.

- the teaching and research equipment originally purchased for the MIWSFPA is reaching the end of its useful life, since the opening of the facility is more than 5 years past. Attention to maintenance and replacement is necessary.

An additional pressure point for equipment has been added by COVID-19 restrictions: some instructors, TAs, and staff have difficulties getting access to technology, or even wifi capability, to do their work remotely. We've been scrambling for many months to keep these members going.

Faculty of Humanities

Temporary Teaching Budget

Reductions to teaching supports have been necessary. The guiding principles have been
- equity across the Faculty in the provision of teaching supports
- as little impact as possible on course delivery

Making sure the situation is known well in advance allows instructors to plan their courses for 2021-22 accordingly.

Faculty of Humanities

Humanities Research Institute

COVID-19 restrictions on travel and gatherings have had a significant impact on activities usually funded by the Humanities Research Institute (HRI). Often funds are awarded for research travel, conferences and colloquia, or graduate student conference travel. All of these are off the table at this time, so much less money has been awarded in 2020-21.

The assumption that we will have something approaching the previous normal has driven our budget planning for 2021-22: we hope to be able to fund gatherings, research travel, and student conference participation.

The HRI, as the engine to support and promote Humanities research and creative activity, is crucial to the success of our scholars, and we are committed to maintaining it.

Dean's Discretionary Fund

The money available in the Dean's Discretionary Fund was originally allocated to competitive funding to support 1) Research projects and equipment; 2) special events, especially conferences and speakers; and 3) hiring students, especially as research assistants.

In 2020, as a response to the Covid-19 shift to remote teaching, a portion of the DDF was used to hire technical assistance within the units of the FoH, as well as to create the SAKAI Squad: a team of students trained to assist instructors in creating and using SAKAI tools for teaching.

Faculty of Humanities

New Initiatives

Working Remotely

Remote teaching, research, and other work has been very difficult for many people in FoH. What we do is so often directly tied to human contact and interaction. And yet, members of the Faculty – faculty, part-time instructors, staff, TAs, and students, have risen admirably to the challenges.

- our members are using the digital tools available to teach as well as possible during this remote experience, while maintaining the human touch that means so much

-instructors gave a great deal of thought to re-arranging their paedagogy, considering what and how to teach, and what and how to assess

- for example: the work of the Music and Dramatic Arts departments has been very impressive. Music runs concerts electronically, and DART has been doing productions with all players in different spaces – some in different countries.

Faculty of Humanities

Certificates and Microcredentials

Humanities units have responded enthusiastically to the call to create certificates and other microcredentials, and we are keen to work with MarComm and Recruitment to promote these.

- waiting to see how certificate students and enrolments are calculated in the budget model

-certificates and microcredentials will indeed increase enrolments and thus help with budgets, but there's a greater value: they open up the University and the possibilities of further education to people who may not have considered it as an option for them.

Faculty of Math and Sciences

Budget Highlight

- Diversify our student population through international recruitment efforts such as going to international universities to promote FMS offerings
- Continue to provide FMS students with experiential learning opportunities in the classroom, lab and field -$120,000 budgeted to fund departments' equipment for teaching and student research
- Strengthen our outreach through community partnerships and generate interest in the Faculty of Math and Science by sharing key messages and information through various forms of communication (social media, newsletter, etc.)
- Strategic use of resources to maintain relatively lean part-time teaching budget, despite continuing increases in course enrollment
- Hiring delays in 20-21 which resulted in budget saving of **$1.3 M** by 20-21 forecast are impacting to 21-22 budget
- Hiring of 3 Faculty replacements (2 Computer Sciences delayed hiring and 1 Biology for retirement placement)
- Hiring of 4 Faculty for growth (3 Engineering, 1 Physics/Engineering)

Faculty of Math and Sciences

Aspirational Points

- Technical Services and Science Store were each given a separate budget guidance, that are higher than last year's budget, to support University wide academic and research needs.

Pain Points

- Dean's Strategic Fund which was planned to support both academic teaching and research of **$1.66M** are frozen for 20-21, although committed amount are secured for 20-21. Many longer-term plans couldn't proceed, such as international student recruitment and retention, Computer Science department hardware upgrade, etc.

- TA hours are further reduced to 59K hours for 21/22 from 66K hours in 20/21 due to budget mitigation. However, there are demands in TA hours due to pandemic (large volume of e-mails and small lab sizes, etc.)

- # of Sabbatical and faculty member on leave increases, which result in Sessional Instructor cost increased by $82K.

Goodman School of Business

2021/22 Operating Budget Impacts to Academic Activities - Expenses:

Deferral of unfilled full-time positions ($1.1M reduction)

- Faculty positions $891K; staff positions $255K
- Impacts:
  - Deferred faculty will generate workload strain on remaining faculty, affecting research output and classroom experience for students and faculty. We will not satisfy accreditation requirements with the diminished faculty complement.

Marketing budget reduced to 2019/20 level ($162K reduction)

- Impact:
  - GSB presence will be affected leading to diminished awareness of our programs and brand both locally and abroad, affecting registrations, and ranking.

Goodman School of Business

2021/22 Operating Budget Impacts to Academic Activities - Expenses:

Travel budget reduced to 50% of 2019/20 actual spend ($70K reduction)

- Impact:
  - Reductions focused on staff travel

Deferral of Courtyard tables and chairs ($90K reduction)

- Impact:
  - GSB new Courtyard outdoor furnishings on loan during Walker Family Complex expansion project (now complete) temporary furniture on loan from other parts of the university is being explored.

Deferral of Interior Branding of renovated spaces- final phase ($50K reduction)

- Impact:
  - Building brand incomplete.

Goodman School of Business

2021/22 Operating Budget Impacts to Academic Activities - Administration:

Initiative: movement of International Student Pathway tuition to the Global operating budget, allowing for automation of a high volume of tuition assessments

Outcome: more timely financial information and improved focus on core tasks and services that support academic activities within GSB Graduate Programs

Brock University

Faculty of Social Sciences

Strategic Initiatives /New Program Development

* Ph.D. in Sustainability – Approved for 2021 start.

*BA Honours Forensic Psychology and Criminal Justice– Approved for 2021 start. First year intake 40 students. Budget increase of **$174k** including 0.83 additional staff support

*Development of micro certificates and micro credentials – in the pipeline

*Student Fellowships (Graduate and Undergraduate) maintained at $**100K**

*Council for Research in Social Science awards maintained to actuals at **$70K**

*Strategic course offerings in Spring/Summer to assist students progress to graduation, fulfill context requirements, attract non-traditional learners and support continuing education **$684 K**

Faculty of Social Sciences

- Tenure-track and Limited Term positions and renewals focusing on priority and growth areas.
    - TT CHYS
    - TT Indigenous
    - LTA renewals in Applied Disability Studies
    - LTA Critical Criminology
    * LTA Labour Studies
- Risk is securing additional resources required for costs that will be incurred next year for new programs coming into play

Faculty of Social Sciences

A. BUDGET DEVELOPMENT PROCESS

*Initial Fall 2020 meetings with thirteen units to share guidance for reductions and revenue increases

*Part-time Budgets and Proposed Course offerings of units submitted to Dean's Office Nov 2020

*Dean's office assesses submissions, drawing on data such as course enrolments over past three years, proposed FTE changes, proposed Spring/Summer offerings , and prepares recommendations for reductions.

*Second round of meetings with units (Chair/Director and admin staff involved in budget development) to further assess part-time budget submission and discuss proposed reductions.

*Third round – units respond by making the recommended reductions, providing rationales for why reductions cannot be made (e.g., course required for student progression, new program development) or proposing alternative reductions.

Faculty of Social Sciences

OUTCOME PART-TIME BUDGET REDUCTIONS

Submitted to Finance/Provost Jan 13, 2021

*Reduction of 15 % in PT budget compared to original submission – Savings of $ 810,732

*Varied reductions across all units totaling 10% of PT budget from 2020/2021 to 2021/2022 for year-over-year reductions of $ 566,128.

B. **NON-SALARY OPERATING BUDGET REDUCTIONS**

*Initial Reduction of 8.2 % overall in Non-Salary lines from 2020/2021 to 2021/2022 for year over year savings of $ 107,251

Faculty of Social Sciences

C. **FURTHER REDUCTIONS**

Submitted to Finance/Provost – Feb 11, 2021

*SALARY SAVINGS

Redeployment 1.0 FTE and Hiring Rate Differential $80,811

*PART-TIME TEACHING SAVINGS

Additional review of part-time teaching budget resulting in savings of $9,537

*Operating Expenses

Further reduced by an additional $8,900

Travel and Marketing/Communication Budget reduced $84,746

Faculty of Social Sciences

COMMENTS /IMPACT

*Budgeting ‘conservatively’ based on expected course enrolment, while ensuring that we do not want to cap course enrolments and are able to provide required added resources (open up additional seminars for eg) if enrolment demands warrant it. Be flexible to add/subtract resources as required.

*Travel reductions – risk of faculty travel costs exceeding BUFA obligations to provide 750 for travel assistance per year.

*Reduction in marketing/communication - risk of not providing adequate support to market new programs.

*Costs for new programs are minimal for 2021/2022 budget year but will require additional faculty lines the following year.

- One BUFA retirement this year, compared to 17 last year, so unable to generate savings based on salary differentials for faculty renewal.

Faculty of Graduate Studies: **Highlights**

Operating:

- Professional Development Coordinator
  - support academic & career development via workshops and partnering with other service units
  - Signature PD events
- Digital Recruitment Co-Ordinator
  - work on virtual opportunities, such as social media platforms, virtual fairs, program showcases, etc.
- Increased communications
  - Newsletters: students, GPDs and GPAs; Website; Town Halls
- Student travel funding used for fees associated with virtual conferences.

Fellowship:

- Fellowship funding-levels maintained at previous year's levels.
  - Slight increase in average required for Dean's Excellence Scholarships (87%).
- Overall budget increase to support extra term funding for research-based students whose progress has been disrupted due to Covid-19.
- First Horizon Scholarships awarded
  - 20 students from under-represented groups
  - Over 100 applications

Faculty of Graduate Studies: Risks

- Staff changeovers
- Concerns continue around admissions for upcoming year --- particularly, international
- Delays in progress
  - Numbers continue to increase in terms of Leaves, Final Stage Status, Inactive Terms
  - Extra Term Funding
- Bursaries
  - Increased demand

Faculty of Graduate Studies: **Mitigation**

- Creating efficiencies
  - Cross-training staff for various roles
  - Shift to Virtual Supports
  - Automating Tasks
    - Offer Letters
  - Training opportunities for Grad Program Admins
  - Creative recruitment and marketing opportunities
- Working with stakeholders to set enrolment targets and create new pathways for students.
- Examining the use of accommodations to evaluate uptake and potential extension/adaptation/of supports for students.

Brock University Library

Library Acquisitions & Information Infrastructure

- The Acquisitions budget increases annually by 2% to cover inflation. We also rec'd an additional transfer of funds ($80K) from Goodman to administer the Bloomberg subscription. This brings the 2021/22 Acquisitions budget to $5.22M.

- Brock Library joined HathiTrust Digital Library, a platform with 17+ million digitized items. This service also provides us with digital access to approx. 1/3 of Brock's print collection during COVID-19. The collection also opens up possibilities for text mining. (=$8K)

- In 2021, we are upgrading the Brock Digital Repository to a cloud-based platform. The upgrade will improve stability and provide additional features. (=$20K)

Brock University Library

Library Operations

- Maintaining librarian complement (20 FTE). Vacancies to be filled:
  - GIS/Data Librarian (search in progress)
  - Head, Collection Services Dept
  - Head, Research Lifecycle Dept (as of Sept 2021)

- Impacts of Mitigation
  - Staff reduced from 37 -> 32 (5 unfilled positions due to retirements, resignations, promotions)
  - Shorter opening hours in 2021/21 in Map Data & GIS Library, Makerspace, and Digital Scholarship Lab
  - Reduced travel & prof development budget
  - Reduced budget for technology refresh, furniture, equipment

Budget for Research Enterprise ($000s)

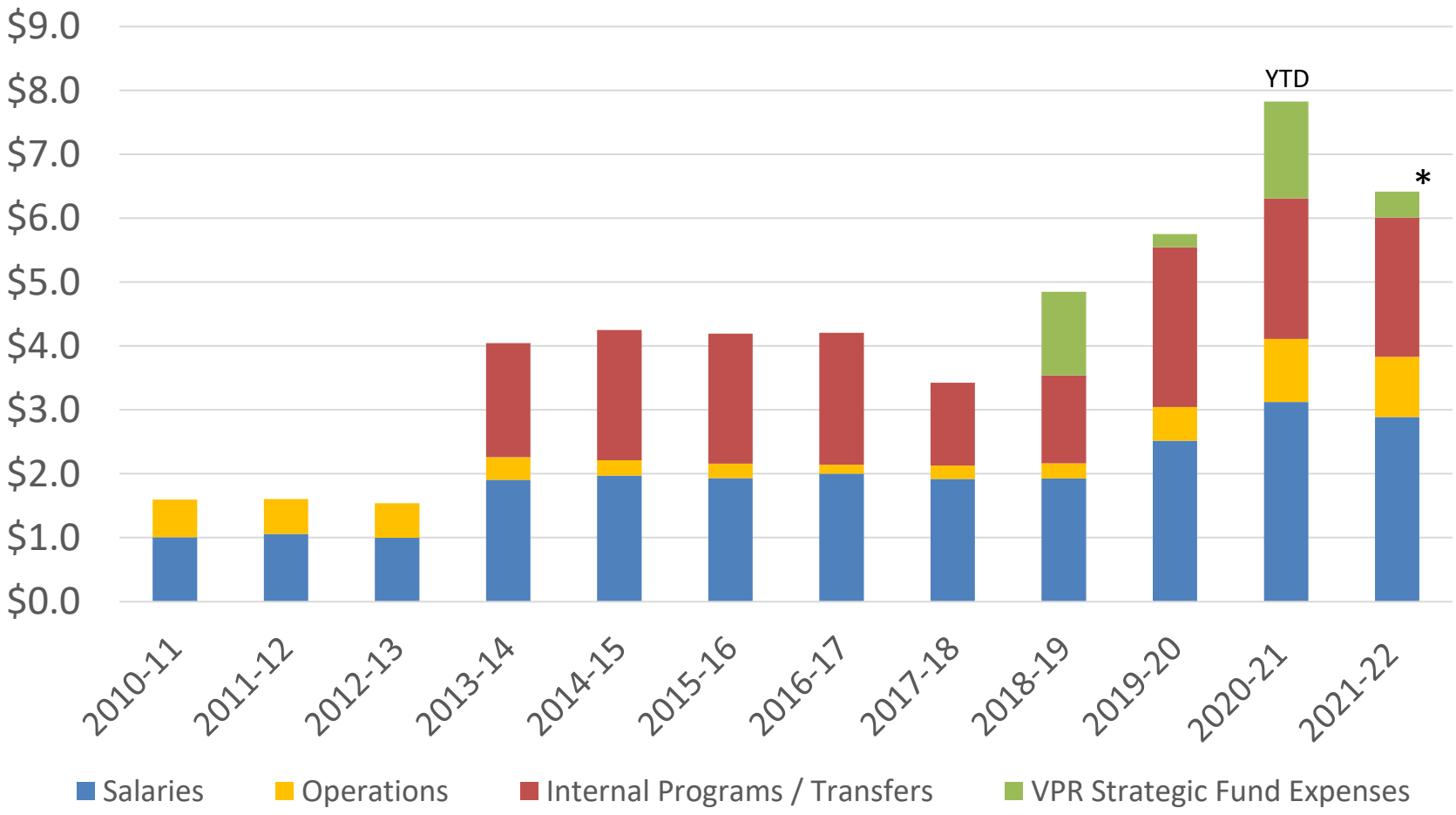
Grant funding in the 2021-22 submitted draft budget	($000s)
VPR Research Excellence – Research Initiative Award	255
VPR Research Excellence – Canada Games	50
VPR Research Excellence – Application Support	40
VPR Research Excellence – Equipment Support	150
VPR Research Excellence – Indigenous Research	30
VPR Research Excellence – Matching Funds	125
Chancellors Chair	40
Match of Minds Grants	250
Student Industrial Internship Program (In Development)	30
Distinguished / Early Career Research Awards*	8*
Total Grant Funding	**978**

*Does not include matching contributions to the program from BUFA

Operating Cost Budget for Research Enterprise (2021-22)	3,121
Personnel Budget for Research Enterprise (2021-22)	2,888

Brock University

Annual Budget Allocation and Strategic Fund Expenses
Vice-President Research - 2010 to 2022 (in $M)



* VPR Strategic Fund values in 2021-22 are estimated planned expenditures

Brock University

Key Budget Highlights - Research Enterprise

- Upward trend in revenue from Research Support Fund and overhead on contract research enables greater investment in operations and granting programs
- Additional investment in internal granting programs such as the RIA, VPR Equipment Support, and the Indigenous Research Grant
- Investments to add staff capacity to research enterprise units while eliminating vacant positions that are no longer necessary
- Resources to support a revised model for research business development and commercialization of IP

2021-22 Other Budget Investments

In $000's

- Indigenous support in the budget
  - Budget for Vice-Provost Indigenous Engagement $357
  - Aboriginal Student Services $369
  - Tecumseh Centre Budget $90
  - Undergraduate Aboriginal Studies & B.Ed $245
  - 4 new Faculty Indigenous positions
  - Scholarships for Indigenous student $83
- Continuing investment in engineering including 4 Faculty positions $672
- Increase in Library acquisitions $181

2021-22 Other Budget Investments cont.

In $000's

- Increase in Undergraduate Scholarships $2,370 (Note: $1,215 per Fiscal Framework – incremental $1,155 due to renewals as a result of Senate decision for pass with no grade)
- Increase in Graduate Fellowships $1,134 (Note: $999 per Fiscal Framework – incremental $135 due to additional fellowship renewals due to COVID)
- Investment in Continuing Education $200
- Investment in Academic Integrity supports $128
- Strategic/discretionary funds $1,792

Revenue and Expense Allocation Model 2021-22 Draft Budget

Full Revenue & Expense Allocation model - 2021-22 Budget							
In $000s	Applied Health Sciences	Goodman School of Business	Education	Humanities	Mathematics & Science	Social Sciences	Total
Revenue							
Global tuition by service teaching (undergraduate)	19,564	26,745	10,269	17,192	34,433	46,294	154,497
Global tuition by service teaching (graduate)	2,576	3,570	1,343	509	1,931	3,382	13,311
ISP Tuition	-	12,676	2,419	-	231	-	15,326
Direct revenue	140	936	1,858	587	331	320	4,172
Grant	26,340	12,194	8,245	8,325	11,254	24,073	90,431
Research Support Fund grant revenue	490	31	75	125	749	623	2,093
Total revenue	**49,110**	**56,152**	**24,209**	**26,738**	**48,929**	**74,692**	**279,830**
Contribution Margins							
Direct on-going personnel costs	21,022	24,046	13,327	19,801	18,804	32,607	129,607
Direct temporary personnel costs	3,992	3,805	5,234	3,255	2,965	5,522	24,773
Direct operating costs	893	3,407	953	769	851	1,098	7,971
Contribution Margin (before scholarships & bursaries)	***23,203***	***24,894***	***4,695***	***2,913***	***26,309***	***35,465***	***117,479***
Scholarships, bursaries and fellowships	5,596	3,286	628	2,787	4,614	5,603	22,514
Contribution Margin (after scholarships & bursaries)	***17,607***	***21,608***	***4,067***	***126***	***21,695***	***29,862***	***94,965***
Space Costs							
Space Costs	3,939	2,150	2,915	3,380	5,633	4,211	22,228
Net Contribution (after space costs)	***13,668***	***19,458***	***1,152***	***(3,254)***	***16,062***	***25,651***	***72,737***

Brock University

Revenue and Expense Allocation Model
2021-22 Draft Budget

Full Revenue & Expense Allocation model - 2021-22 Budget							
In $000s	Applied Health Sciences	Goodman School of Business	Education	Humanities	Mathematics & Science	Social Sciences	Total
Net Contribution (after space costs)	***13,668***	***19,458***	***1,152***	***(3,254)***	***16,062***	***25,651***	***72,737***
Academic & Student Specific Support Units							
Research Services; Technical Services & Science Stores (1)	1,684	108	210	360	3,069	1,815	7,246
Faculty of Graduate Studies	195	437	207	46	116	306	1,307
Library	3,012	2,392	1,410	1,363	1,703	3,776	13,656
Centre for Pedagogical Innovation	226	180	107	103	128	283	1,027
Student Specific (2)	4,421	3,494	2,058	1,944	2,478	5,500	19,895
Net contribution (before overhead allocations)	4,130	12,847	(2,840)	(7,070)	8,568	13,971	29,606
Overhead Allocations							
Shared Services (3)	5,665	5,464	2,997	3,661	3,689	7,401	28,877
Ancillary operations and Residence contribution	(505)	(400)	(236)	(222)	(283)	(628)	(2,274)
Capital	1,371	1,093	649	625	785	1,718	6,241
University Global	(91)	(48)	(14)	239	268	(113)	241
Net contribution	**(2,310)**	**6,738**	**(6,236)**	**(11,373)**	**4,109**	**5,593**	**(3,479)**

(1) Excludes Research Support Fund grant revenue

(2) Student Specific' includes the Office of the Registrar, Aboriginal Student Services, Student Wellness and Accessibility, Student Life and Success, Brock International, Co-op, Career and Experiential Education, Brock Sports and Recreation and Residence Life.

(3) Shared Services includes Senior Academic and Administrative Team, Information Technology Services, Financial Services, Human Resources, Marketing and Communications, Development and Alumni Relations, Human Rights and Equity Services, University Secretariat, Office of Government Relations, Institutional Analysis and Planning, and Internal Audit and University Risk Management.

Brock University

Trending – actual student headcount to budgeted Faculty FTE (by Faculty)

	Applied Health Science	Goodman School of Business	Faculty of Education	Faculty of Humanities	Faculty of Math & Science	Faculty of Social Science	Total
2021-22							
Budget Student headcount (Faculty of Major)	4,293	3,394	2,000	1,890	2,408	5,343	19,328
Budgeted Faculty FTE	99.3	94.0	56.9	96.8	75.4	164.1	586.5
Budget Student Headcount by Budgeted Faculty FTE	**43**	**36**	**35**	**20**	**32**	**33**	**33**
2020-21							
T2 Forecast Student headcount (Faculty of Major)	4,412	3,436	1,850	1,885	2,443	5,543	19,569
Budgeted Faculty FTE	99.7	98.2	55.1	94.4	73.3	164.7	585.4
T2 Forecast Student Headcount by Budgeted Faculty FTE	**44**	**35**	**34**	**20**	**33**	**34**	**33**
2019-20							
Actual Student headcount (Faculty of Major)	4,168	3,597	1,769	1,879	2,474	5,827	19,714
Budgeted Faculty FTE	97.1	101	58.7	94.5	71.7	163.5	586.5
Actual Student Headcount by Budgeted Faculty FTE	**43**	**36**	**30**	**20**	**35**	**36**	**34**
2018-19							
Actual Student headcount (Faculty of Major)	4,121	3,576	1,728	1,724	2,230	5,625	19,004
Budgeted Faculty FTE	90.7	98.9	57.5	94.9	74.8	157.7	574.5
Actual Student Headcount by Budgeted Faculty FTE	**45**	**36**	**30**	**18**	**30**	**36**	**33**
2017-18							
Actual Student headcount (Faculty of Major)	3,836	3,501	1,699	1,809	2,115	5,765	18,725
Budgeted Faculty FTE	88.2	96.4	56.6	92.4	73.3	156.2	563.1
Actual Student Headcount by Budgeted Faculty FTE	**43**	**36**	**30**	**20**	**29**	**37**	**33**

Note: Student headcount figures exclude 'No Faculty' (i.e. auditing & non-degree) enrolment and Faculty FTEs exclude Librarians.

All In Student Headcount by Faculty

Faculty	2021-22 Budget			2020-21 T2 Forecast			2021-22 Budget vs 2020-21 Budget
	Domestic	International	Total	Domestic	International	Total	
Faculty of Applied Health Science	4,125	168	4,293	4,237	175	4,412	(119)
Goodman School of Business	2,302	1,092	3,394	2,368	1,068	3,436	(42)
Faculty of Education	1,874	126	2,000	1,778	72	1,850	150
Faculty of Humanities	1,796	94	1,890	1,798	87	1,885	5
Faculty of Mathematics and Science	1,878	530	2,408	1,969	474	2,443	(35)
Faculty of Social Science	4,695	648	5,343	4,906	637	5,543	(200)
No Faculty	100	0	100	97	2	99	1
Total headcount	**16,770**	**2,658**	**19,428**	**17,153**	**2,515**	**19,668**	**(240)**

Brock University

Degree-seeking Student Headcount by Faculty

Faculty	2021-22 Budget			2020-21 T2 Forecast			2021-22 Budget vs 2020-21 Budget	2021-22 Strategic Plan	2021-22 Budget vs Strategic Plan
	Domestic	International	Total	Domestic	International	Total			
Faculty of Applied Health Science	4,125	168	4,293	4,237	175	4,412	(119)	4,596	(303)
Goodman School of Business	2,301	1,052	3,353	2,368	1,038	3,406	(53)	3,607	(254)
Faculty of Education	1,558	91	1,649	1,459	52	1,511	138	1,444	205
Faculty of Humanities	1,796	94	1,890	1,797	87	1,884	6	1,888	2
Faculty of Mathematics and Science	1,869	530	2,399	1,965	473	2,438	(39)	2,458	(59)
Faculty of Social Science	4,668	627	5,295	4,876	616	5,492	(197)	5,989	(694)
Total headcount	**16,317**	**2,562**	**18,879**	**16,702**	**2,441**	**19,143**	**(264)**	**19,982**	**(1,103)**

Brock University

Brock University

2020-21 TRIMESTER 2 FORECAST

September 1, 2020 to December 31, 2020

Executive summary

At the completion of the second trimester of 2020-21 Brock is projecting a fiscal year-end with a funding surplus of $0.9 million. This is an extraordinary outcome given the impacts of the global pandemic which resulted in revenues decreasing by more than $50 million compared to the budget that was prepared prior to the pandemic. More than half of the revenue loss is attributed to Ancillary Services following public health guidelines restricting access to campus. To put this impact into perspective, total Ancillary Services revenue is forecast at less than one quarter of their pre-pandemic budget. The second largest variance in revenue is attributed to lower enrolment offset by above average student retention rates. Student fees are forecast $13.7 million below the pre-pandemic budget or a 7 per cent shortfall.

Our all-in headcount enrolment is forecast at 96 per cent of our pre-pandemic budget or 19,668 students. Compared to the Institutional Strategic Plan our degree-seeking enrolment is forecasted to fall short by 229 students. Offsetting this shortfall was the position of strength in which Brock began the year. Brock recorded enrolment in 2019-20 exceeding our Institutional Strategic Enrolment Plan by 2.3 per cent or 438 students.

At Trimester one a plan to mitigate the significant revenue shortfall was developed. Strict hiring controls with a savings target of $19.2 million, or an 8 per cent reduction in personnel costs was identified. As of this forecast, the target has been exceeded with $19.6 million savings anticipated. In addition, $25.3 million in non-personnel operating expenditures have been mitigated with the balance of mitigation being a deferral and re-prioritization of capital expenditures of $9.3 million. Also included in the trimester one mitigation plan was the use of our strategic reserves. With the success to date of mitigating costs and improving student retention, the updated trimester two forecast does not require the use of these reserves to fund operations. This is a significant achievement as our prior year savings for strategic purposes will flow into the upcoming 2021-22 fiscal year unencumbered and be available to support our strategic priorities and recovery from the global pandemic.

Salient to the significant expense reductions to mitigate our considerable and immediate revenue reductions are our courageous faculty and staff who quickly pivoted to online learning and student services to continue to support our students. While we experienced strong cost containment in response to the global pandemic, we recognize that Brock maintained its commitment to students with $21.1 million in student scholarships and fellowships being spent which exceeds the pre-pandemic budget by $0.8 million. Other key areas where spending will exceed or meet the pre-pandemic budget plans in support of Brock's strategic priorities include: Human Rights and Equity Services, Student Life and Success, and Research Services.

While we celebrate in the successes to date, there is a recognition that our future fiscal environment remains challenging. With 60 per cent of university revenue subject to no rate inflation, balancing our operations requires investments in new programs with new net positive contributions to maintain our existing operations. The next few years will be challenging, that said, with the strategic plan as our lighthouse, our budget plans will endeavor to chart a sustainable pandemic recovery while remaining flexible to invest in areas of growth. Input and recommendations for future budget decisions are encouraged and may be emailed to **budgetreport@brocku.ca**

CONTENTS

This report contains certain forward-looking information. In preparing the Trimester 2 Report, certain assumptions and estimates were necessary. They are based on information available to management at the time of preparing the forecast. Users are cautioned that actual results may vary.

Throughout the text in this report, financial values have been rounded to the nearest thousand unless otherwise stated.

On the cover
From left, Katrina Carbonara, Robert Crozier and Sophie Hamstra all met the rigorous requirements to fast-track into Brock's PhD in Applied Health Sciences.

Photo collage on page 3
STUDENTS: Brock University has retained its No. 1 ranking for student mental health support.
COMMUNITY: Future Vineland winery to support Brock students and community. In photo: Spouses Liz (BA '12) and Robert Harold (OEVC '20), along with Tracey Schenck (MA '16) and her husband Joe Schenck are endeavoring to add a boutique winery to their Hanck Vineyards property in Vineland.
PATHWAYS: A new specialization in Leadership, Diversity, Community and Culture allows incoming students in Applied Disability Studies to meet personal goals in a welcoming environment. Stock photo courtesy Disability:IN.
PARTNERSHIPS: Brock University made its long-time collaboration with the Niagara Workforce Planning Board (NWPB) official by signing a Memorandum of Understanding (MOU) Tuesday, Sept. 22.

Financial results

The following table illustrates the Trimester 2 forecast for the University compared to budget. The information is presented on a funding basis, which represents committed cash, and based on the audited financial statements prepared in accordance with accounting standards for not for-profit organizations (NFPS). A reconciliation of the two presentations, for the 2020-21 forecast, can be found starting on **page 22 – 23**. Please note that certain reclassifications were made to the 2020-21 budget as compared to the figures presented in the 2020-21 Budget Report, noting the changes did not impact the net budget. All reclassifications will be fully reconciled in the future 2021-22 Budget Report.

Figure 1: **Funding and NFPS budget and forecast**

($000s)	Funding			NFPS		
	2020-21 Forecast	2020-21 Budget	Difference better/(worse)	2020-21 Forecast	2020-21 Budget	Difference better/(worse)
Revenue						
Student fees	**186,511**	200,202	**(13,691)**	**187,016**	200,642	**(13,626)**
Grant revenue	**99,152**	97,288	**1,864**	**96,199**	95,823	**376**
Internal chargebacks	**3,006**	8,621	**(5,615)**			**-**
Inter-fund revenue	**7,532**	7,042	**490**			**-**
Research revenue			**-**	**13,034**	13,253	**(219)**
Other revenue	**20,428**	54,899	**(34,471)**	**34,750**	66,330	**(31,580)**
Total revenue	**316,629**	**368,052**	**(51,423)**	**330,999**	**376,048**	**(45,049)**
Operating costs						
Personnel costs	**(219,004)**	(238,613)	**19,609**	**(221,796)**	(241,611)	**19,815**
Inter-fund expenses	**(15,759)**	(25,773)	**10,014**			**-**
Other operating costs	**(81,003)**	(106,313)	**25,310**	**(112,042)**	(131,106)	**19,064**
Total operating costs	**(315,766)**	**(370,699)**	**54,933**	**(333,838)**	**(372,717)**	**38,879**
Mitigation target		2,647	**(2,647)**			**-**
Surplus/(deficit)	**863**	**-**	**863**	**(2,839)**	**3,331**	**(6,170)**

SEPT. 01, 2020: The Faculty of Education and the Landscape of Nations 360° Indigenous Education Initiative (LON 360°) have committed to collaborate on initiatives to advance Indigenous subject matter across the Niagara region.

Taking a closer look at some of the numbers

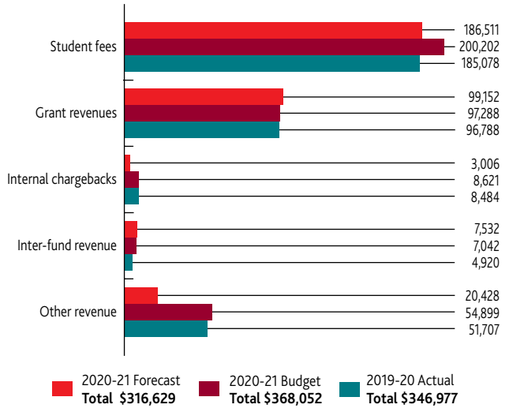
Overview

The 2020-21 Trimester 2 forecast shows a funding surplus of $0.9 million versus the balanced 2020-21 budget, which was after the $2.6 million mitigation target to be found in-year. This is an amazing outcome given the impacts of the global pandemic on the University resulting in a reduction in revenue by more than $50 million compared to budget. This surplus is driven by mitigation strategies that resulted in personnel saving forecasted to be $19.6 million under budget as well as operating costs and inter-fund expenses being forecasted below budget by $25.3 million and $10.0 million respectively. These savings are offset by a revenue forecast showing a shortfall of $51.4 million below budget. These variances are more fully described in the following sections of this report.

Review of overall revenue

More than half of the revenue loss as compared to the budget is attributed to Ancillary Services in the amount of $28.7 million following public health guidelines restricting access to campus. The second largest variance in revenue is attributed to lower than anticipated enrolment offset by above average student retention rates resulting in student fees forecast to be $13.7 million below the pre-pandemic budget plan, or a 7 per cent shortfall. Grant revenue is forecasted to increase from budget by $1.9 million, internal chargebacks are forecasting lower than budget by $5.6 million, inter-fund revenue is forecast higher than budget by $0.5 million and other revenue (excluding ancillary) is forecast lower by $5.8 million. Student fee revenues and grant revenues are discussed in the tuition and enrolment section and the operating grant section on the following pages. As mentioned above, the lower than budgeted other revenue was driven by Ancillary Services. The largest driver of this variance related to Residence revenues which is forecasting a revenue shortfall of $17.7 million. The other units in Ancillary Services are forecasting revenue shortfalls as follows, Campus Store $2.4 million, Conference Services $1.0 million, Dining/Hospitality Services $3.6 million, and Parking Services of $3.9 million. Investment income, which is forecasted to be $0.75 million higher than budget, is more fully described in the Treasury section of this report. Sales and service revenue is forecast to be lower than budget by $6.0 million, driven by lower than budgeted revenue of $3.6 million in Brock Sports and Recreation mainly due to the cancellation of summer camps, instructional and after school programs.

Figure 2: **Revenue** ($ millions)



Also contributing to the sales and services shortfall is consulting/service revenue forecasted to be lower than budget by $0.4 million, Ontario University Application fee revenue forecast to be $0.3 million lower than budget and various other revenue sources that were not able to be met because of the pandemic. Inter-fund revenue is forecasted at $7.5 million, $0.5 million higher than budget. It should be noted that the trimester one mitigation plan included the use $10.1 million of our limited reserves to mitigate our projected deficit. With the success to date on mitigating costs and improving student retention, the updated trimester two forecast does not require the use of strategic reserves to fund operations.

SEPT. 2, 2020: As part of its plan to achieve more modern facilities in the Hamilton-Burlington-Oakville corridor, Brock University has now sold the site that has been its Hamilton campus for the past 20 years.

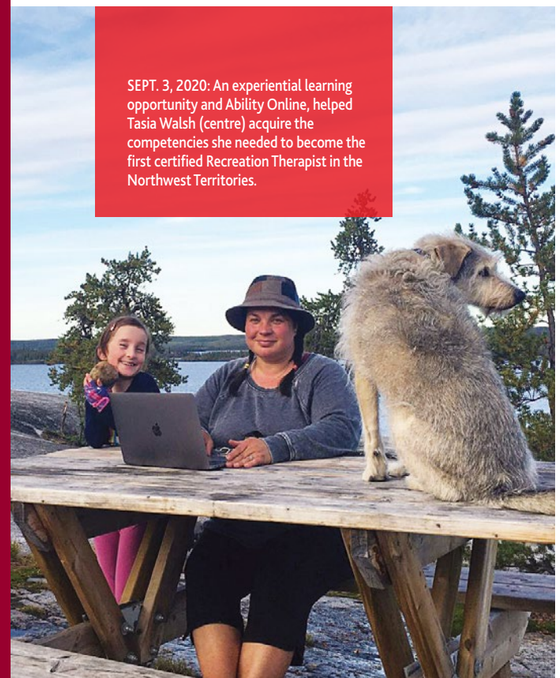
Tuition and enrolment

As detailed in Figure 3, students fees are forecast $13.7 million below the pre-pandemic budget.

Figure 3: **Tuition by reporting unit**

($000s)	2020-21 Forecast	2020-21 Budget	Difference better/(worse)	Listed below
Total tuition revenue in University Global	**164,148**	**165,935**	**(1,787)**	(1)
Tuition revenue budgeted in respective departments				
Professional Masters Preparation Certificate (Business) (PMPC)	**562**	563	(1)	(2)
International Masters Business Administration (IMBA)	**9,376**	12,318	(2,942)	(2)
International Master of Professional Accounting (IMPAcc)	**1,113**	1,826	(713)	(2)
Masters Preparation Certificate in Education (MPCE)	**145**	485	(340)	(3)
International Masters of Education (MEd)	**435**	1,802	(1,367)	(3)
International Master of Science in Materials Physics (MSc)	**231**	317	(86)	(4)
Total international student programs (ISP)s	**11,862**	**17,311**	**(5,449)**	
Continuing Teacher Education – Additional Qualifications (AQ)	**1,018**	711	307	(3)
Adult Education	**650**	974	(324)	(3)
Indigenous Education Programs		37	(37)	(3)
Intensive and short term English Language Programs (IELP & SELP)	**1,073**	4,415	(3,342)	(5)
Total other self-funded programs	**2,741**	**6,137**	**(3,396)**	
Tuition revenue in respective departments	**14,603**	**23,448**	**(8,845)**	
Total tuition revenue	**178,751**	**189,383**	**(10,632)**	
Fee revenue	**7,760**	**10,819**	**(3,059)**	
Total student fees	**186,511**	**200,202**	**(13,691)**	

Departments the tuition revenue is reported in: (1) University Global; (2) Goodman School of Business; (3) Faculty of Education; (4) Faculty of Mathematics and Science; (5) Brock International.



SEPT. 3, 2020: An experiential learning opportunity and Ability Online, helped Tasia Walsh (centre) acquire the competencies she needed to become the first certified Recreation Therapist in the Northwest Territories.

Non-tuition fee revenue, mainly representing student ancillary fees, are forecast $3.1 million lower than budget as a result of lower enrolment as well as certain fees not being fully charged to students during the year due to reduced access to campus. International student program (ISP) tuition is forecasted to be $5.4 million below budget, driven by lower enrolment in most of the ISP programs with the majority of the losses in the Goodman School of Business International Master Business Administration (IMBA) and International Masters of Professional Accounting (IMPAcc) programs, and the Faculty of Education International Master of Education (MEd) program. Other self-funded program revenue is forecasted lower than budget by $3.4 million, driven by lower English as a second language program revenue.

Despite the pandemic causing the majority of the universities' programs having to be taught online this year, global tuition is forecasted to be lower than budget by only $1.8 million or 1.1 per cent (see Figure 5). This forecast is significantly better than was projected as part of the trimester one forecast which forecasted global tuition to be lower than budget by 7.6 per cent. Although overall enrolment was lower than set out in the pre-pandemic budget, our spring/summer session realized strong growth over 2019-20, with a gain of almost $3.0 million. In addition, above average retention rates also assisted in offsetting the lower intake figures experienced. As evidence of the success of our online teaching platform, as detailed in Figure 5, global international tuition is forecast to exceed budget by $1.0 million. This increase is offset by lower than budgeted domestic tuition of $2.4 million, mainly as a result of lower first-year intake figures. Overall, enrolment is forecasted to come in at 96 per cent of the pre-pandemic budget at 19,668 students as shown in Figure 6.

Note: Although Figure 5 details global tuition by Faculty of major, the revenue and expense allocation model reports tuition based on where students take their courses (i.e. teaching Faculty). The revenue and expense allocation model is presented for year-end results within the Annual Report.

Figure 4: **Global tuition billings by session** ($ millions)

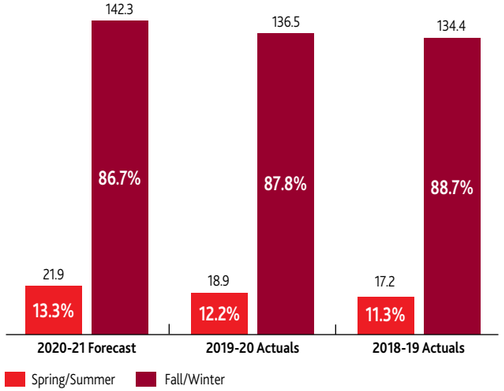


Figure 4 above, details global tuition by session – spring/summer and fall/winter for the forecast and the past two years.

Figure 5: **Tuition revenue budgeted in University Global**[1]

($000s)	2020-21 Actuals as of Jan. 13, 2021	2020-21 Budget	Difference better/ (worse)
Undergraduate – domestic			
Faculty of Applied Health Sciences	**23,954**	23,526	428
Goodman School of Business	**18,323**	20,029	(1,706)
Faculty of Education	**7,574**	7,367	207
Faculty of Humanities	**10,312**	10,234	78
Faculty of Mathematics and Science	**12,526**	13,281	(755)
Faculty of Social Sciences	**27,279**	27,518	(239)
Other[2]	**229**	199	30
Total undergraduate – domestic	**100,197**	**102,154**	**(1,957)**
Graduate – domestic			
Faculty of Applied Health Sciences	**2,226**	2,076	150
Goodman School of Business	**1,491**	1,747	(256)
Faculty of Education	**1,026**	1,317	(291)
Faculty of Humanities	**361**	443	(82)
Faculty of Mathematics and Science	**680**	650	30
Faculty of Social Sciences	**2,709**	2,677	32
Total graduate – domestic	**8,493**	**8,910**	**(417)**
Total domestic	**108,690**	**111,064**	**(2,374)**
Undergraduate – international			
Faculty of Applied Health Sciences	**4,483**	4,149	334
Goodman School of Business	**16,065**	14,423	1,642
Faculty of Education	**178**	121	57
Faculty of Humanities	**2,081**	2,048	33
Faculty of Mathematics and Science	**11,393**	11,435	(42)
Faculty of Social Sciences	**16,597**	17,537	(940)
Other[2]	**51**	13	38
Total undergraduate – international	**50,848**	**49,726**	**1,122**
Graduate – international			
Faculty of Applied Health Sciences	**300**	198	102
Goodman School of Business	**2,171**	1,767	404
Faculty of Education	**376**	215	161
Faculty of Humanities	**142**	225	(83)
Faculty of Mathematics and Science	**1,242**	1,537	(295)
Faculty of Social Sciences	**745**	1,203	(458)
Total graduate – international	**4,976**	**5,145**	**(169)**
Total international	**55,824**	**54,871**	**953**
Subtotal	**164,514**	**165,935**	**(1,421)**
Forecasted change to April 30, 2021	**(366)**		(366)
Total tuition revenue in University Global	**164,148**	**165,935**	**(1,787)**

(1) Figures based on Faculty of major.
(2) Includes letters of permission, non-degree students and auditors.

SEPT. 14, 2020: Left: Didi Mukendi (BKin '14) and Eric Mukendi (BBA '07) are paying it forward by generously donating $30,000 to the Brock-Niagara Centre for Health and Well-Being on behalf of their company, C6 Medical, after receiving support from the Centre for years.

SEPT. 16, 2020: Right: The Canada Games Council and the 2021 Canada Games Host Society announced that they have decided to postpone the 2021 Canada Summer Games until the summer of 2022 due to the ongoing COVID-19 pandemic.

Figures 6 and 7 detail all-in headcount enrolment. All-in enrolment represents degree-seeking students, non-degree students, auditors, and those pursuing additional qualifications and certificates, including ISP programs, not budgeted in Global. Brock's enrolment forecast of 19,668 represents a 0.6 per cent decrease as compared to prior year 2019-20 enrolment and a 4.2 per cent decrease compared to the 2020-21 pre-pandemic budget.

Figure 6: **All in student headcount by type**[1]

Type	2020-21 Forecast	2020-21 Budget	Difference – better/(worse) #	Difference – better/(worse) %	2019-20 Actual	Difference – better/(worse) #	Difference – better/(worse) %
Undergraduate – domestic	15,845	16,337	(492)	(3.0%)	15,970	(125)	(0.8%)
Undergraduate – international	1,857	1,990	(133)	(6.7%)	1,819	38	2.1%
Graduate – domestic	1,308	1,347	(39)	(2.9%)	1,235	73	5.9%
Graduate – international	658	848	(190)	(22.4%)	772	(114)	(14.8%)
Total	**19,668**	**20,522**	**(854)**	**(4.2%)**	**19,796**	**(128)**	**(0.6%)**

Figure 7: **All in student headcount by Faculty**[1]

Faculty	2020-21 Forecast			2020-21 Budget			Difference – better/(worse)	
	Domestic	International	Total	Domestic	International	Total	#	%
Faculty of Applied Health Sciences	4,237	175	4,412	4,073	163	4,236	176	4.2%
Goodman School of Business	2,368	1,068	3,436	2,574	1,133	3,707	(271)	(7.3%)
Faculty of Education	1,778	72	1,850	1,852	96	1,948	(98)	(5.0%)
Faculty of Humanities	1,798	87	1,885	1,812	90	1,902	(17)	(0.9%)
Faculty of Mathematics and Science	1,969	474	2,443	2,153	532	2,685	(242)	(9.0%)
Faculty of Social Science	4,906	637	5,543	5,121	823	5,944	(401)	(6.7%)
No Faculty	97	2	99	100		100	(1)	(1.0%)
Total headcount	**17,153**	**2,515**	**19,668**	**17,685**	**2,837**	**20,522**	**(854)**	**(4.2%)**

*Note: the enrolment forecast used for the 2020-21 budget and forecast is 'all-in' and includes letter of permissions, non-degree students, auditors, additional qualifications, and certificates. These are excluded in the 'degree-seeking only' enrolment as presented by the Office of the Registrar.

Operating grants

Figure 8: **General operating grants**

($000s)	2020-21 Forecast	2020-21 Budget	2019-20 Actual
Operating Grants			
Core Operating Grant	**70,076**	70,076	81,743
Differentiation Grant Envelope	**18,925**	18,925	6,045
International Student Recovery	**(1,844)**	(1,844)	(1,705)
Nursing Grant	**2,648**	2,969	2,679
Total operating grants	**89,806**	**90,126**	**88,762**
Specific purpose grants	**9,347**	**7,162**	**8,026**
Total grant revenue	**99,152**	**97,288**	**96,788**

Figure 8 above details grant revenue. Most of the Ministry of Colleges & Universities (MCU) operating grants are forecasted to be consistent with budget, with the exception of the nursing grant which is expected to be below budget by $0.3 million. The MCU has confirmed that the Strategic Mandate Agreement 2020-25 (SMA3) metrics for performance-based funding will be delayed until 2021-22. Therefore, there is no anticipated change in the larger Differentiation Envelope. The increase in the specific purpose grants is mainly due to the Facilities Renewal Program Funds (FRP) grant which is forecast to be $1.5 million higher than budget, based on an announcement from the MCU in 2020-21 and it is anticipated this funding will remain for 2021-22.

SEPT. 29, 2020: More than 3,100 students, including more than 2,000 first-year students, have taken part in the new BU101 academic skills program led by A-Z Learning Services in the fall. In photo: A-Z Learning Services Manager Maggie Whitfield working remotely.

OCT. 13, 2020: The Goodman COVID-19 Student Emergency Fund was recently established by the Business Students' Association (BSA) to support Goodman undergraduate students struggling financially because of the pandemic.

Review of overall costs

Personnel costs

Our people are what make everything possible at our University. Figure 9 below illustrates personnel costs in aggregate by personnel group. Overall personnel costs are expected to be under budget by $19.6 million, $0.4 million better than the mitigation plan that was developed with strict hiring controls with a savings target of $19.2 million. Savings were realized in both ongoing and temporary personnel groups. Ongoing personnel is forecasted to realize savings of $13.2 million. Temporary personnel savings are forecast at $6.4 million.

Figure 9: **Personnel costs by group**

Personnel Group [1] ($000s)	2020-21 Forecast			2020-21 Budget	Difference better/ (worse)	2019-20 Actual
	Salary/Wage	Benefits	Total personnel costs			
Faculty and Professional Librarians	88,808	20,162	**108,970**	113,011	4,041	106,836
Admin/Professional	43,489	12,052	**55,541**	61,881	6,340	54,310
OSSTF	7,484	2,380	**9,864**	10,637	773	9,790
CUPE 1295 FT	6,418	2,378	**8,796**	9,399	603	9,550
SAC	5,972	1,114	**7,086**	7,444	358	6,631
Other ongoing personnel	1,080	330	**1,410**	2,516	1,106	2,277
Total ongoing personnel	**153,251**	**38,416**	**191,667**	**204,888**	**13,221**	**189,394**
CUPE 4207 – Unit 1	15,014	1,645	**16,659**	17,691	1,032	16,141
Other temporary personnel	10,001	677	**10,678**	16,034	5,356	14,884
Total temporary personnel	**25,015**	**2,322**	**27,337**	**33,725**	**6,388**	**31,025**
Total personnel	**178,266**	**40,738**	**219,004**	**238,613**	**19,609**	**220,419**

(1) **Faculty and Professional Librarians** – BUFA members, Associate Deans, Associate Vice-Presidents of Research and Associate Librarian; **Admin/Professional** – ongoing administrative/professional and exempt staff; **OSSTF** – support and technical staff; **CUPE 1295 FT** – full-time maintenance, trades and custodial staff; **SAC** – Senior Administrative Council; **Other ongoing** – CUPE 4207-2, CUPE 4207-3, CUPE 2220 & IATSE; **CUPE 4207 - Unit 1** – instructors, teaching assistants, lab demonstrators, course co-ordinators and marker/graders; **Other temporary** – all other part-time teaching and non-teaching positions and stipend transfers.

OCT. 16, 2020: Hilary Pearson was installed as Brock University's ninth Chancellor during Virtual Fall Convocation.

OCT. 21, 2020: Robyn Bourgeois, an Associate Professor from the Faculty of Social Sciences, has accepted the role of Acting Vice-Provost, Indigenous Engagement.

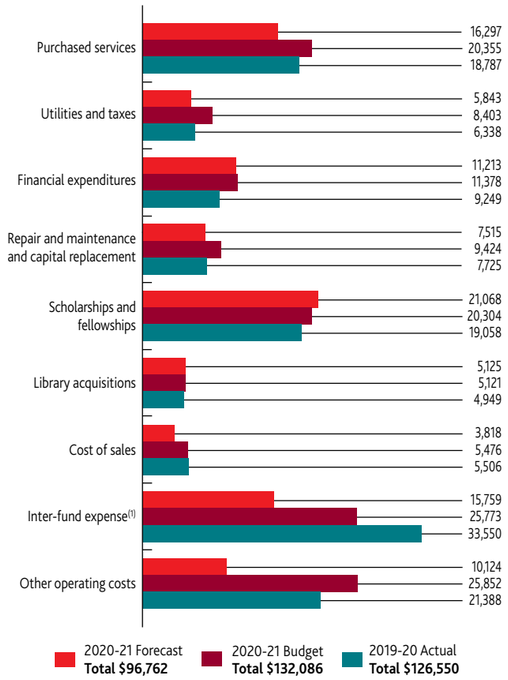
Operating costs

Operating costs are forecasted to be $96.8 million as compared to a budget of $132.1 million. This $35.3 million positive variance is due to a comprehensive plan to mitigate the large revenue losses as a result of the global pandemic. Figure 10 shows a comparison of forecasted operating expenses to the 2020-21 budget and 2019-20 actuals.

Inter-fund expenses are forecasted to be $10.0 million lower than budget. The majority of this decline is due to the pandemic mitigation plan related to the deferral and re-prioritizations of capital expenditure of $9.3 million.

Operating costs other than inter-fund expenses are forecast $25.3 million lower than budget. Saving were realized throughout the operating expenses with significant savings in travel, purchased services, utilities, repair and maintenance and capital replacement costs and cost of sales related to the Campus Store. While we experienced strong cost containment in response to the global pandemic, we recognize that Brock maintained its commitment to students with $21.1 million in student scholarships and fellowships being spent which exceeds the pre-pandemic budget by $0.8 million.

Figure 10: **Operating costs** ($millions)



*2019-20 Actual inter-fund expenses include discretionary appropriations in the amount of $7,650.

Unit and budget forecasts

Figure 11 on the following pages detail the funding by responsibility centre for the forecast and budget, grouped into one of the following categories: Teaching Faculties, Academic Support, Student Specific, Ancillary, Shared Services, Space and Global. Please note that Figure 11 includes certain reclassifications to the 2020-21 budget as compared to the figures presented in the 2020-21 Budget Report. All reclassifications will be fully reconciled in the future 2021-22 Budget Report, noting the changes did not impact the net reported budget.

Although most units experienced significant cost restraints, some key areas where spending will exceed or meet the pre-pandemic budget plans in support of Brock's strategic priorities include areas such as: Human Rights and Equity Services, Student Life and Success, and Research Services.

Funding budget by responsibility centre

Figure 11 details the funding budget by responsibility centre, where all personnel costs, operating costs and revenue have been grouped by their responsibility centre, which in turn are grouped into one of the following categories: Teaching Faculties, Academic Support, Student Specific, Ancillary, Shared Services, Space and Global.

Figure 11: **Funding budget by responsibility centre**

($000s)	2020-21 Forecast				2020-21 Budget				Difference of "Net" amounts
	Revenue	Personnel costs	Non-personnel costs	Net	Revenue	Personnel costs	Non-personnel costs	Net	
Teaching Faculties									
Faculty of Applied Health Sciences	168	(23,023)	(694)	**(23,549)**	325	(24,858)	(994)	**(25,527)**	1,978
Goodman School of Business	11,729	(27,903)	(2,571)	**(18,745)**	15,865	(29,356)	(5,081)	**(18,572)**	(173)
Faculty of Education	2,468	(17,228)	(665)	**(15,425)**	4,295	(18,310)	(1,209)	**(15,224)**	(201)
Faculty of Humanities	547	(22,274)	(654)	**(22,381)**	625	(22,117)	(843)	**(22,335)**	(46)
Faculty of Mathematics and Science	628	(21,160)	(860)	**(21,392)**	719	(22,455)	(963)	**(22,699)**	1,307
Faculty of Social Sciences	370	(37,727)	(898)	**(38,255)**	384	(38,394)	(1,310)	**(39,320)**	1,065
Total Teaching Faculties	**15,910**	**(149,315)**	**(6,342)**	**(139,747)**	**22,213**	**(155,490)**	**(10,400)**	**(143,677)**	**3,930**
Academic Support									
Faculty of Graduate Studies	512	(1,358)	(133)	**(979)**	462	(1,350)	(173)	**(1,061)**	82
Library	304	(4,925)	(5,597)	**(10,218)**	172	(5,622)	(5,656)	**(11,106)**	888
Research Services	2,677	(1,864)	(3,889)	**(3,076)**	2,628	(2,320)	(3,020)	**(2,712)**	(364)
Centre for Pedagogical Innovation	262	(929)	(285)	**(952)**	283	(1,071)	(193)	**(981)**	29
Total Academic Support	**3,755**	**(9,076)**	**(9,904)**	**(15,225)**	**3,545**	**(10,363)**	**(9,042)**	**(15,860)**	**635**
Student Specific									
The Office of the Registrar	2,292	(4,511)	(1,044)	**(3,263)**	2,417	(5,168)	(1,233)	**(3,984)**	721
Aboriginal Student Services	358	(287)	(88)	**(17)**	359	(294)	(68)	**(3)**	(14)
Student Life and Success	368	(1,710)	(148)	**(1,490)**	587	(1,715)	(294)	**(1,422)**	(68)
Student Wellness and Accessibility	2,851	(3,225)	(1,298)	**(1,672)**	3,022	(3,400)	(1,375)	**(1,753)**	81
Brock International	1,253	(3,255)	(1,647)	**(3,649)**	5,742	(5,029)	(2,941)	**(2,228)**	(1,421)
Co-op, Career and Experiential Education	2,518	(3,714)	(380)	**(1,576)**	2,704	(3,674)	(602)	**(1,572)**	(4)
Residence Life		(742)	(85)	**(827)**	5	(1,523)	(234)	**(1,752)**	925
Brock Sports and Recreation	3,152	(3,397)	(535)	**(780)**	8,099	(5,557)	(3,940)	**(1,398)**	618
Total Student Specific	**12,792**	**(20,841)**	**(5,225)**	**(13,274)**	**22,935**	**(26,360)**	**(10,687)**	**(14,112)**	**838**
Ancillary									
Ancillary Operations	5,356	(2,469)	(5,432)	**(2,545)**	16,742	(3,287)	(9,684)	**3,771**	(6,316)
Department of Residence Operations	3,467	(1,784)	(10,633)	**(8,950)**	21,471	(2,144)	(14,799)	**4,528**	(13,478)
Total Ancillary	**8,823**	**(4,253)**	**(16,065)**	**(11,495)**	**38,213**	**(5,431)**	**(24,483)**	**8,299**	**(19,794)**

Figure 11 continued

($000s)	2020-21 Forecast				2020-21 Budget				Difference of "Net" amounts
	Revenue	Personnel costs	Non-personnel costs	Net	Revenue	Personnel costs	Non-personnel costs	Net	
Shared Services									
Senior Academic and Administration Team[1]	47	(3,722)	(401)	**(4,076)**	193	(4,867)	(974)	**(5,648)**	1,572
Information Technology Services	413	(5,573)	(2,004)	**(7,164)**	459	(6,328)	(2,213)	**(8,082)**	918
Financial Services	388	(2,994)	(742)	**(3,348)**	494	(3,332)	(742)	**(3,580)**	232
Human Resources	207	(3,448)	(647)	**(3,888)**	207	(3,727)	(769)	**(4,289)**	401
Marketing and Communications	511	(1,597)	(1,387)	**(2,473)**	1,448	(1,670)	(1,851)	**(2,073)**	(400)
Development and Alumni Relations	592	(1,112)	(487)	**(1,007)**	611	(1,692)	(476)	**(1,557)**	550
Human Rights and Equity Services	657	(974)	(1,049)	**(1,366)**	474	(950)	(873)	**(1,349)**	(17)
University Secretariat		(814)	(30)	**(844)**	5	(843)	(95)	**(933)**	89
Office of Government Relations		(452)	(124)	**(576)**	77	(560)	(120)	**(603)**	27
Institutional Analysis	3	(289)	(23)	**(309)**		(378)	(23)	**(401)**	92
Internal Audit and University Risk Management		(380)	(24)	**(404)**		(382)	(34)	**(416)**	12
Total Shared Services	**2,818**	**(21,355)**	**(6,918)**	**(25,455)**	**3,968**	**(24,729)**	**(8,170)**	**(28,931)**	**3,476**
Space									
Facilities Management	462	(11,700)	(3,327)	**(14,565)**	815	(12,549)	(3,794)	**(15,528)**	963
Campus Security Services	120	(1,522)	(1,064)	**(2,466)**	154	(1,548)	(1,208)	**(2,602)**	136
Campus Development and Community Agreements	371	(50)	(1,316)	**(995)**	447	(260)	(1,645)	**(1,458)**	463
Utilities, Taxes and Insurance	1,972		(8,326)	**(6,354)**	2,425		(10,348)	**(7,923)**	1,569
Financing	2,365		(7,955)	**(5,590)**	3,706		(9,296)	**(5,590)**	-
Total Space	**5,290**	**(13,272)**	**(21,988)**	**(29,970)**	**7,547**	**(14,357)**	**(26,291)**	**(33,101)**	**3,131**
Global									
Scholarships, Bursaries and Fellowships	3,405		(23,012)	**(19,607)**	3,330		(22,425)	**(19,095)**	(512)
Capital	3,253		(5,475)	**(2,222)**	4,711		(14,038)	**(9,327)**	7,105
University Global	260,583	(892)	(1,833)	**257,858**	261,590	(1,883)	(6,550)	**253,157**	4,701
Total Global	**267,241**	**(892)**	**(30,320)**	**236,029**	**269,631**	**(1,883)**	**(43,013)**	**224,735**	**11,294**
Total University	**316,629**	**(219,004)**	**(96,762)**	**863**	**368,052**	**(238,613)**	**(132,086)**	**(2,647)**	**3,510**

(1) Includes the following: the offices of the President; the Vice-President, Administration; the Provost and Vice-President, Academic; the Vice-President, Research; the Vice-Provost and Associate Vice President, Academic; Vice-Provost, Students; the Vice-Provost, Strategic Partnerships and International; the Vice-Provost, Indigenous; the Associate Vice-President Advancement and External Relations as well as the operating costs of the Board of Trustees and Senate.

Treasury

Operating fund investment scorecard

The Government of Canada ten-year bond yield was 0.7 per cent at Dec. 31, 2020 (1.7 per cent at Dec. 31, 2019). This compares to the yield on the operating investment portfolio of 1.22 per cent with an average duration of 8 months (2.46 per cent yield and 8-month average duration at the same time last year). Scotiabank prime rate was 2.45 per cent on Dec. 31, 2020 (3.95 per cent at the same time last year). Yield on cash balances and short-term investments is linked to the prime rate, prime minus 165 basis points on cash, and prime minus 150 basis points on the 30 day hold investment account. Yields have dropped significantly on guaranteed investment certificates (GICs) where the rate on a 10-year GIC now compares to the rates we are receiving on the 30 day hold investment account; therefore, proceeds of matured GICs are currently being held in the 30 day hold account until rates improve. A summary of investment holdings as of Dec. 31, 2020 is shown in Figure 15. Figure 13 outlines monthly investment income performance compared to 2019-20. As detailed in Figure 12, operating investments have achieved 87 per cent of budget as we reach 67 per cent of the way through the fiscal year. The current forecast has operating investment income, not including the sinking fund, exceeding budget.

The sinking fund outperformed during the first eight months of fiscal 2020-21 generating an annualized 18.73 per cent gain (8.28 per cent loss at the same time last year). Short-term volatility is common and expected with this fund. We continue to support this fund as a long-term investment strategy to fund the 2045 payout of the University's $93 million debenture and the employee future benefits reserve. The fund requires a 5 per cent annual rate of return to achieve its goal and this rate of return is aligned with the asset mix and skill of the fund manager. A new sinking fund will be established as planned in 2021-22 to provide repayment proceeds for the $125 million series B debenture issued in 2020.

Figure 12: **Summary investment income – Operating Funds**

($000s) Unless otherwise stated	2020-21 Actuals to Dec. 31	2020-21 Budget	2019-20 Actuals	% of Budget achieved
Operating investment income	1,303	1,500	2,571	87%
Sinking fund	1,068	349	237	306%
Employee future benefits reserve	795		176	NA
Investment income	**3,166**	**1,849**	**2,984**	**171%**

OCT. 28, 2020: CCOVI to co-lead $6.2-million national research program supporting clean plant program for grapevines. In photo: Brock University Senior Scientist Sudarsana Poojari is leading the academic team.

Figure 13: **Cumulative monthly investment income performance 2019-20 vs. 2020-21** ($000s)

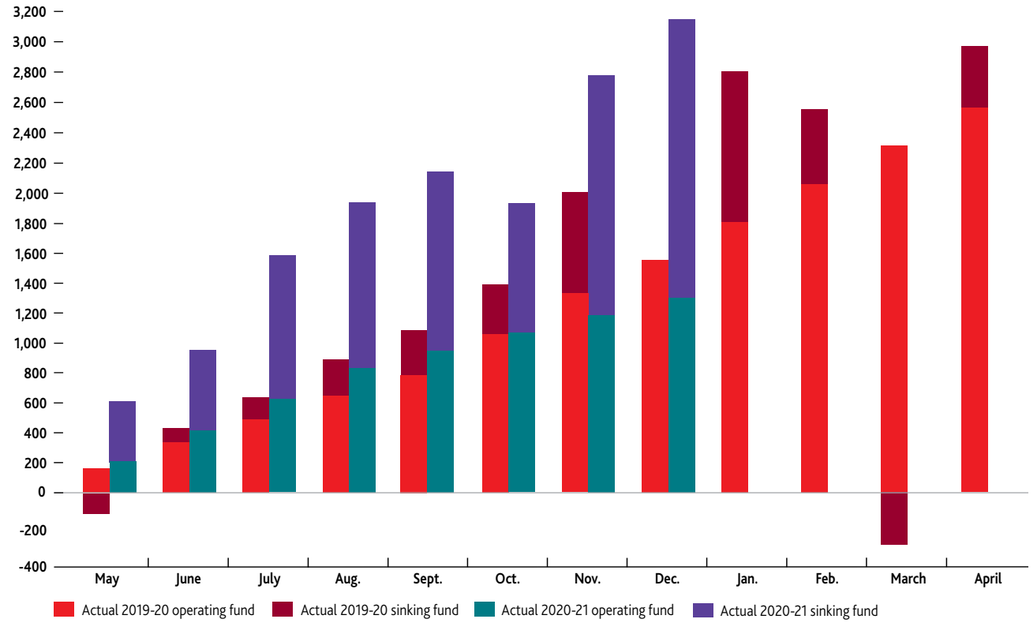
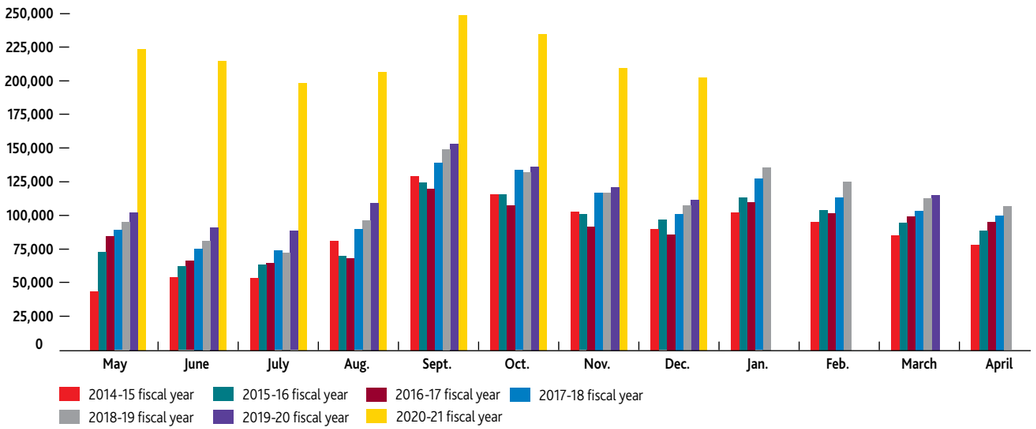


Figure 14: **Monthly cash flow – historical trend month-end balances** ($000s)



NOV. 9, 2020: Associate Professor of Health Sciences Adam MacNeil and Professor of Biology Fiona Hunter were awarded $200,000 in funding from the Canada Foundation for Innovation (CFI) to purchase equipment that will enable their team to research how humans react to coronavirus and a possible therapy to treat infection.

Figure 15: **Summary of investment holdings**

($000s) Unless otherwise stated	Market Value as at Dec. 31, 2020	Annualized rate of return	Fees	Net annualized rate of return
Scotiabank				
General account ($20 million average minimum balance)	47,750	0.80%	0.00%	0.80%
30 day GIC	60,000	0.95%	0.00%	0.95%
8 Month GIC	6,300	1.20%	0.00%	1.20%
9 Month GIC	6,300	1.25%	0.00%	1.25%
10 Month GIC	6,000	1.30%	0.00%	1.30%
11 Month GIC	3,500	1.35%	0.00%	1.35%
12 Month GIC	10,500	1.40%	0.00%	1.40%
14 Month GIC	8,300	1.56%	0.00%	1.56%
2 Year GIC	7,200	1.95%	0.00%	1.95%
2 Year GIC	17,300	1.50%	0.00%	1.50%
3 Year GIC	5,000	3.08%	0.00%	3.08%
3 Year GIC	2,500	2.65%	0.00%	2.65%
Total for account	**180,650**	**1.18%**	**0.00%**	**1.18%**
BMO Nesbitt Burns				
Savings Account	30	0.75%	0.05%	0.70%
2 Year GIC	1,000	2.60%	0.05%	2.55%
Total for Account	**1,030**	**2.55%**	**0.05%**	**2.50%**
TD Waterhouse				
2 Year GIC	5,712	2.47%	0.00%	2.47%
Total for account	**5,712**	**2.47%**	**0.00%**	**2.47%**
Mawer – balanced fund				
Sinking fund	8,675			
Employee future benefits reserve	6,457			
Total for account	**15,132**	**18.73%**	**0.25%**	**18.48%**
Portfolio consolidated total	**202,524**	**2.53%**	**0.02%**	**2.52%**

Our debt

Figure 16 details the current and projected external debt of the University.

Figure 16: **Outstanding debt**

($000s) (unless otherwise noted)	Actual				Budget	Forecast			
	April 30, 2017	April 30, 2018	April 30, 2019	April 30, 2020	April 30, 2021	April 30, 2022	April 30, 2023	April 30, 2024	April 30, 2025
Bond	93,000	93,000	93,000	93,000	**93,000**	93,000	93,000	93,000	93,000
Cairns building	24,863	24,109	23,319	22,491	**21,623**	20,714			
Residence	15,215	14,333	13,385	12,366	**11,271**	10,095	8,831	7,473	6,014
Marilyn I. Walker School of Fine and Performing Arts (MIWSFPA)	15,960	15,240	14,520						
Ancillary/Residence student experience projects				14,400	**139,400**	139,400	139,400	139,400	125,000
Total debt	**149,038**	**146,682**	**144,224**	**142,257**	**265,294**	**263,209**	**241,231**	**239,873**	**224,014**
Total student FFTE [1] [2]	**20,086**	**20,303**	**20,548**	**21,597**	**21,435**	**21,435**	**21,435**	**21,435**	**21,435**
Total debt/FFTE (in dollars)[1]	**$7,420**	**$7,225**	**$7,019**	**$6,587**	**$12,377**	**$12,279**	**$11,254**	**$11,191**	**$10,451**
Debt reduction strategy									
Sinking fund	6,413	6,696	7,370	7,607	**7,319**	7,685	8,069	8,473	9,301
Sinking fund – Ancillary/Residence					**1,903**	3,848	5,833	7,846	11,260
Debt repayment reserve	2,895	4,457	6,753	384	**1,884**	3,384		1,500	3,000
M. Walker donation – MIWSFPA	5,326	5,470	5,617						
Other donations – MIWSFPA	717	851	932						
Total assets for debt reduction	**15,351**	**17,474**	**20,672**	**7,991**	**11,106**	**14,917**	**13,902**	**17,819**	**23,561**
Net debt	**133,687**	**129,208**	**123,552**	**134,266**	**254,188**	**248,292**	**227,329**	**222,054**	**200,453**
Net debt/FFTE (in dollars)[1]	**$6,656**	**$6,364**	**$6,013**	**$6,217**	**$11,859**	**$11,583**	**$10,606**	**$10,359**	**$9,352**

(1) Fiscal full-time enrolment (FFTE). For a definition, refer to page 88 of the 2020-21 Budget Report.
(2) Given the impact of the pandemic, the enrolment forecast is being revised. The forecast highlighted above is shown as flat to approximate calculation for debt per FFTE; however, results will change once forecast is completed.

At the beginning of this fiscal year Brock secured a series B debenture of $125 million 3.03 per cent interest 40-year bullet, with the proceeds covering capital needs and refinancing of upcoming debt maturities. This series B debenture is in addition to the 2005 series A debenture offering with proceeds of $93 million. This debenture strategy has been implemented to take advantage of historically low interest rates.

In 2020 as part of the University issuing its Series B $125 million debenture, DBRS Morningstar reconfirmed Brock's current credit rating of "A (high)", with Stable trends. On Feb. 1, 2021, the university presented its financial results, strategic plan updates and financial forecast to DBRS Morningstar as part of its annual review of Brock's performance. At the time of writing this report, the results of DBRS Morningstar's credit rating update are not known; however, representatives of DBRS Morningstar advised that a material change in the University's enrolment forecast following the impacts of the global pandemic will weight negatively on the rating review. Included in the $125 million bond proceeds is the capital costs for the Zone Fitness Expansion. This capital project is funded from the proceeds of this bond, and the student fees estimated at $7.4 million will be invested into a sinking fund. The investment income earned on the sinking fund would be expected to exceed the estimated borrowing costs over the 40-year term; thus, further contribute to the repayment of the bond principal. Salient to this strategy is that the estimated $7.4 million in student fees collected over the upcoming five years could grow to $23.3 million or $45.2 million by 2060 with annualized rates of return of 3.5 per cent or 5.2 per cent respectively. The sinking fund repayment strategy for this bond includes operating budget contributions from Ancillary Operations beginning 2021-22 in addition to the Zone Fitness expansion fee. The existing sinking fund for the Series A Debenture issued in 2005 continues to grow ahead of schedule due to strong investment returns. The existing sinking fund requires operating budget contributions to begin 2024-25 and accelerating in 2028-29 with the debt cost for the Sunlife Residence Loan being repurposed into the sinking fund when it is fully repaid.

Figure 17: **Long-term debt**

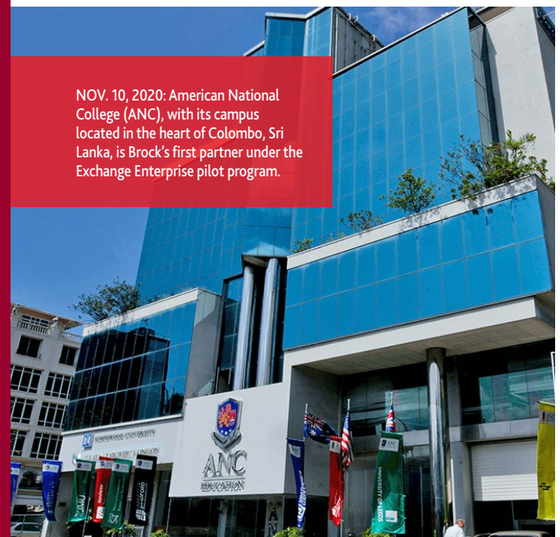
	Interest rate	Payment terms	Date to be paid in full	Annual payment ($000s)
Earp/Lowenberger – Residence	7.200%	Monthly blended payments of principal and interest of $162,443.70.	October 2028	1,949
Cairns Building	4.690%	Monthly blended payments of principal and interest of $158,668.10. Interest rate swap on $28 million. Payment based on 25 year amortization.	July 2037	1,904
Student experience projects	2.490%	Interest only payments until June 2024.	June 2024	359
Student experience projects – line of credit	Bankers Acceptance + 45 basis points	Due on demand	NA	NA
Debenture payable (bullet)	4.967%	Interest payable semi-annually $2,309,655.	December 2045	4,619
Debenture payable (bullet)	3.033%	Interest payable semi-annually $1,895,625.	May 2060	3,791

Debt retirement assets

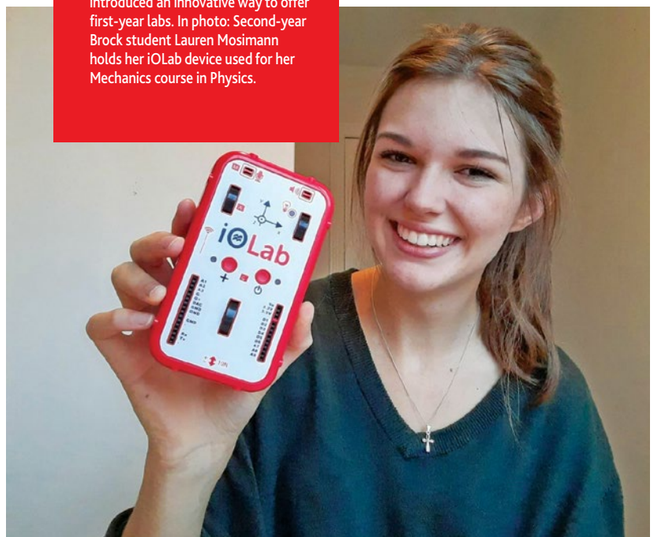
	Required rate of return	Payment terms	Date to be paid in full	Annual payment ($000s)
Sinking fund investment	5.000%	Policy requires Brock to annually review sinking fund investment performance and required contributions.	December 2045	As per Fiscal Framework
Sinking fund investment	5.200%	Policy requires Brock to annually review sinking fund investment performance and required contributions.	May 2060	As per Fiscal Framework
Debt reduction reserve	N/A	Annual contribution ($1,022 in 2017-18 as per fiscal framework) to an internally restricted reserve for debt repayment initially approved by the Board of Trustees on March 12, 2015.	N/A	As per Fiscal Framework

Figure 18: **Debt metrics**

	Published range current credit rating	2019-20 Fiscal year	2018-19 Fiscal year
Fiscal full-time equivalent (FFTE)		21,441	20,548
Total long-term debt/FFTE ($)	10.000 – 15.000	6,635	7,019
Interest coverage ratio	1.3 times to 2.5 times	4.64 times	4.97 times
Surplus-to-revenue	0% to 1% (5 year average)	3.3%	4.5%



NOV. 10, 2020: American National College (ANC), with its campus located in the heart of Colombo, Sri Lanka, is Brock's first partner under the Exchange Enterprise pilot program.



NOV. 11, 2020: Brock University's Department of Physics has introduced an innovative way to offer first-year labs. In photo: Second-year Brock student Lauren Mosimann holds her iOLab device used for her Mechanics course in Physics.

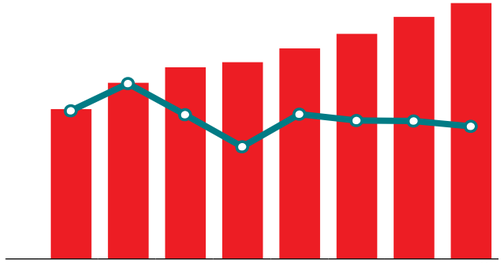
NOV. 13, 2020: David Sharron, Head of Brock's Archives and Special Collections, looks over historical documents from the Alexander Hamilton collection recently donated to the University. Valued at just under $350,000, the collection includes about 2,500 pieces.

Pension

The actuarial valuation on the pension plan was recently updated as at Jan 1, 2020, indicating the plan was 98 per cent funded on a going-concern basis (96 per cent as at July 1, 2017) and 106 per cent on a solvency basis (105 per cent as at July 1, 2017). The going concern deficit improved from $17.9 million in 2017 to $12.7 million in 2020 mainly due to strong investment returns, offset by new legislation to fund a provision for adverse deviation (Pfad) which is a requirement for all single employer sponsored pension plans. This requirement to fund a Pfad is not applicable for jointly sponsored pension plans. The University sector is currently working on developing a jointly sponsored pension plan with Guelph, Queen's and the University of Toronto leading the process. The University Pension Plan (UPP) became operational Jan. 1, 2020 with a planned date of July 1, 2021 to fully transition the legacy pension plans of the three founding institutions into the new UPP. It is anticipated that the UPP will become open to new member institutions thereafter. The pension plan returns exceeded the required 6 per cent rate of return over the last three years to drive an improved funded position. This will result in a $0.4 million annual savings in pension plan payments that are required to amortize the going concern deficit. Increased diversification of plan assets into infrastructure and real estate assets over the past three years have contributed to the strong investment performance. Overall, employee annual contributions into the pension plan represent $8.0 million and Brock's annual contributions represent $16.0 million. Brock currently funds the pension at a 2.0:1.0 ratio employer to employee.

The investment returns and investment balance for the last eight years are detailed in Figure 19. Additional information on the pension plan may be found at **brocku.ca/about/university-financials/#auditedpension-statements**

Figure 19: **Pension Plan as of June 30 pension year end** ($000s)



	2013	2014	2015	2016	2017	2018	2019	2020[1]
Assets	341,391	402,252	438,141	449,900	481,842	515,539	554,757	586,691
Gross return	11.1%	16.7%	10.3%	3.7%	10.4%	9.1%	9.0%	7.9%

(1) Represents the 12 month period ended Dec. 31, 2020.

NOV. 18, 2020: Franklin-Luther with her dog, Layla, after successfully defending her dissertation. She is the first student in Canada to complete a PhD in Child and Youth Studies.

NOV. 19, 2020: A group of second-year students at Brock foster literacy and support mental health. In photo: Brock Political Science student Annilea Purser shows a booklet of community letters of appreciation collected by BookWorm to show gratitude for health-care workers.

NOV. 24, 2020: Abdul Rahimi, Director of Goodman Group, and Himani Dureja, Vice-President, Education and Professional Development for Supply Chain Canada, Ontario Institute, engage in a virtual high-five in celebration of a one-year partnership to offer cybersecurity courses.

Capital and related projects

University infrastructure investment is ongoing as we invest in new and current space and technology to support and improve the student, academic and research experience. There are currently 42 open projects related to Facilities Management, 9 Residence and Ancillary, and 33 Information Technology Services. Figure 21 illustrates the activity to Dec. 31, 2020 with respect to the type and dollar amount of projects. As already discussed in this report, as part of the mitigation strategy for 2020-21 $9.3 million of capital projects were deferred and re-prioritized. All projects were reviewed and those projects that were not yet started or just in the planning phase were deferred. Only projects with external funding, legislative or safety requirements were allowed to continue during fiscal 2020-21. Projects already under construction or almost complete were not deferred as they would not generate savings for the University.

Figure 20: **Status of Capital Projects as of Dec. 31, 2020**

	Facilities Management	Residence and ancillary services	Information Technology Services
Open projects as of April 30, 2020	58	18	34
Projects opened to Dec. 31, 2020	6		1
Projects closed/completed to Dec. 31, 2020	(22)	(9)	(2)
Remaining projects open Dec. 31, 2020	**42**	**9**	**33**

Figure 21: **Capital and related project summary**

Project type ($000s)	Revenue/funding [1]	Spending to Dec. 31, 2020	Remaining to spend
Facilities Management (FM)			
AODA* Projects	387	(266)	121
Above surface/sub surface utilities, drainage, roads, parking lots, sidewalks	1,000	(619)	381
Adaptations/renovations and major renewal projects	1,824	(1,193)	631
Audits and studies	1,136	(848)	288
Buildings	1,449	(1,266)	183
Energy conservation and demand management	861	(250)	611
Major capital projects	57,331	(47,775)	9,556
New construction and replacement (under $1 million)	250	(232)	18
FM – surplus/(deficit)	1,606		1,606
Total Facilities Management projects	**65,844**	**(52,449)**	**13,395**
Residence and ancillary			
Above surface/sub surface utilities, drainage, roads, parking lots, sidewalks	5,808	(3,622)	2,186
Adaptations/renovations and major renewal projects	14,651	(12,247)	2,404
Buildings	87,607	(47,089)	40,518
Residence and ancillary – surplus/(deficit)	1,604		1,604
Total residence and ancillary	**109,670**	**(62,958)**	**46,712**
Information Technology Services (IT)			
Enterprise software projects	8,848	(6,846)	2,002
Hardware evergreening projects	1,106	(308)	798
Hardware growth projects	396	(290)	106
IT infrastructure projects	576	(65)	511
ITS – surplus/(deficit)	42		42
Total Information Technology Services projects	**10,968**	**(7,509)**	**3,459**
Total capital and related projects	**186,482**	**(122,916)**	**63,566**

* AODA – Accessibility for Ontarians with Disabilities.
(1) Funding revenue represents total expected funding and cash received. This amount is not reflective of all funding received to date.

Trimester 2 and remaining year activity

Brock University uses trimester reporting to match financial reporting with the inherent timing of the operations of Brock. Figure 22 details the in-year activity and forecast on a funding basis for Trimester 2.

Figure 22: **Funding in-year activity and forecast**

($000s)	2019-20 Funding actual	2020-21 Funding budget	Activity from May 1 to Dec. 31	Forecast for Jan. 1 to April 30	2020-21 Funding Forecast @ Dec. 31
Revenue					
Student fees	185,078	200,202	184,826	1,685	186,511
Grant revenue	96,788	97,288	62,613	36,539	99,152
Internal chargebacks	8,484	8,621	1,078	1,928	3,006
Inter-fund revenue	4,920	7,042	2,019	5,513	7,532
Other revenue	51,707	54,899	12,337	8,091	20,428
Total revenues	**346,977**	**368,052**	**262,873**	**53,756**	**316,629**
Operating costs					
Personnel costs	(220,419)	(238,613)	(137,332)	(81,672)	(219,004)
Inter-fund expenses	(25,900)	(25,773)	(7,465)	(8,294)	(15,759)
Other operating costs	(93,000)	(106,313)	(51,889)	(29,114)	(81,003)
Total operating costs	**(339,319)**	**(370,699)**	**(196,686)**	**(119,080)**	**(315,766)**
Mitigation target		**2,647**			
Funding surplus/(deficit) before discretionary appropriations	**7,658**		**66,187**	**(65,324)**	**863**
Discretionary appropriations	**(7,650)**				
Funding surplus/(deficit) after discretionary appropriations	**8**		**66,187**	**(65,324)**	**863**

Funding forecast presented in accordance with NFPS

Throughout this report financial information has been reported on a funding basis (sometimes referred to as committed cash basis). Figures 23 and 24 detail the entries and reclassifications required to convert the funding budget to be in accordance with the Canadian accounting standards for not-for-profit organizations (NFPS).

Please refer to page 90 and 91 of the 2020-21 Budget Report for detailed explanations of all the adjustments, reclassifications and eliminations. Overall these adjustments, reclassifications and eliminations for the 2020-21 forecast were consistently applied with those of the 2020-21 budget. The following details the changes made to each adjustment (see Figure 24): Forecasts were updated for #1 course fees, #3 research spending, #4 amortization, #5 endowment & trust spending, #8 capital purchases, #9 capital and infrastructure project reserves spending and #10 post-retirement benefits; #2 was updated to the 2020-21 forecast for the Facilities Renewal Program funds; and lastly adjustment #6 was added representing the portion of the gain on sale of the Hamilton campus that will be recognized in 2020-21.

Figure 23: **Reconciliation of NFPS forecast**

($000s)	2020-21 NFPS budget	2020-21 Funding forecast	NFPS adjustments	Notes	Eliminate inter-fund transfers	Eliminate internal chargebacks	2020-21 NFPS forecast
Revenue							
Student fees	200,642	186,511	505	1			187,016
Grant revenue	95,823	99,152	(2,953)	2			96,199
Internal Chargebacks		3,006				(3,006)	
Inter-fund revenue		7,532			(7,532)		
Research revenue	13,253		13,034	3			13,034
Other revenue	66,330	20,428	14,322	4-6			34,750
Total revenue	**376,048**	**316,629**	**24,908**		**(7,532)**	**(3,006)**	**330,999**
Personnel costs	(241,611)	(219,004)	(2,792)	3,9-11			(221,796)
Inter-fund expenses		(15,759)	(1,628)	3,5	17,387		
Operating costs	(131,106)	(81,003)	(34,045)	1, 3-5,7-9		3,006	(112,042)
Total costs	**(372,717)**	**(315,766)**	**(38,465)**		**17,387**	**3,006**	**(333,838)**
Funding surplus/ (deficit)	**3,331**	**863**	**(13,557)**		**9,855**	**-**	**(2,839)**

Figure 24: **Adjustments**

Note	Reconciliation of NFPS adjustments ($000s)	
1	Course fee revenue	505
2	Capital grants	(2,953)
3	Research, including fellowships	13,034
4	Amortization of deferred capital contributions	8,387
5	Endowment & Trust Spending	3,901
6	Gain on sale of asset	2,034
	Total revenue adjustments	**24,908**
3	Research spending – personnel	(3,414)
3	Research spending – operating costs	(9,620)
4	Amortization of capital assets	(23,269)
5	Endowment & Trust Spending	(3,901)
1	Course fee spending	(505)
7	Principal payments	1,963
8	Capital purchases	1,375
9	Capital and infrastructure project reserves spending – personnel	(598)
9	Capital and infrastructure project reserves spending – operating	(1,716)
10	Post-retirement benefits	(730)
11	Pension	1,950
	Total costs adjustments	**(38,465)**

Reserves and strategic funds

Figure 25 outlines reserves that have been established for research, faculty professional development and strategic initiatives with internal funding. In total, Brock has $23.5 million in internal research, professional development and strategic initiative support dollars for faculty and other units, including the President, Provost and Vice-President, Academic and Vice-President, Research and Faculty Deans as at Dec. 31, 2020. Included in the trimester one mitigation plan was the use of a portion of these limited reserves to mitigate our projected deficit. With the success to date on mitigating costs and improving student retention, the updated trimester two forecast does not require the use of strategic reserves to fund operations.

Figure 25: **Balances by Faculty as of Dec. 31, 2020**

($000s)	Operating project accounts	Research funds with no external obligations	Start-up funds	PER and accountable allowance accounts	Strategic Fund[1]	Total
Faculty of Applied Health Sciences	364	1,062	1,031	637	716	**3,810**
Goodman School of Business	777	55		530	1,312	**2,674**
Faculty of Education	75	104	89	411	55	**734**
Faculty of Humanities	198	115	25	498	161	**997**
Faculty of Mathematics and Science	610	223	358	676	2,202	**4,069**
Faculty of Social Sciences	698	932	1,044	990	969	**4,633**
Library		2		73		**75**
Other Units	575	280		91	5,606	**6,552**
Total	**3,297**	**2,773**	**2,547**	**3,906**	**11,021**	**23,544**

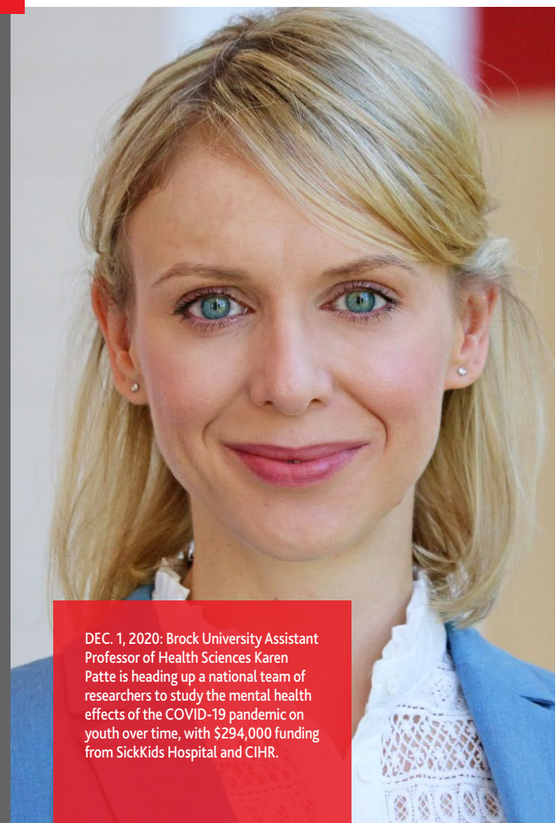
(1) Allocated through the Revenue and Expense Allocation model.

Appendix 1

Multi-year financial results on a funding basis

Figure 26

($000s)	2020-21 Forecast	2020-21 Budget	2019-20 Actual	2018-19 Actual	2017-18 Actual
Revenue					
Student fees	**186,511**	200,202	185,078	178,067	167,446
Grant revenue	**99,152**	97,288	96,788	97,927	97,371
Internal chargebacks	**3,006**	8,621	8,484	10,055	9,426
Inter-fund revenue	**7,532**	7,042	4,920	6,712	3,239
Other revenue	**20,428**	54,899	51,707	51,333	48,600
Total revenue	**316,629**	**368,052**	**346,977**	**344,094**	**326,082**
Operating costs					
Personnel costs	**(219,004)**	(238,613)	(220,419)	(212,647)	(205,233)
Inter-fund expenses	**(15,759)**	(25,773)	(25,900)	(29,950)	(23,288)
Other operating costs	**(81,003)**	(106,313)	(93,000)	(94,993)	(92,419)
Total operating costs	**(315,766)**	**(370,699)**	**(339,319)**	**(337,590)**	**(320,940)**
Mitigation target		**2,647**			
Funding surplus/(deficit) before discretionary appropriations	**863**		**7,658**	**6,504**	**5,142**
Discretionary appropriations		**-**	**(7,650)**	**(6,475)**	**(5,132)**
Funding surplus/(deficit) after discretionary appropriations	**863**	**-**	**8**	**29**	**10**



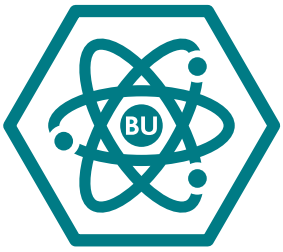
DEC. 1, 2020: Brock University Assistant Professor of Health Sciences Karen Patte is heading up a national team of researchers to study the mental health effects of the COVID-19 pandemic on youth over time, with $294,000 funding from SickKids Hospital and CIHR.

DEC. 16, 2020: Brock University Assistant Professor of Kinesiology Val Fajardo has been named Canada Research Chair in Tissue Remodelling and Plasticity throughout the Lifespan. Fajardo studies how muscles change in form and function over the course of a lifetime.

DEC. 9, 2020: CCOVI Senior Lab Instructor Steven Trussler, who will be the certified instructor for CCOVI's new Foundations in Winemaking course, takes a sample of finished wine from a carboy using a wine thief.

INSTITUTIONAL STRATEGIC PRIORITIES

Student Experience



Research

Community Engagement

Inclusivity

Brock University
Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
905 688 5550

budgetreport@brocku.ca

brocku.ca/finance

To: Chabriol Colebatch, University Secretariat

From: Don Cyr, Senate Chair

Date: April 15th 2021

Re: **Chair's Report to Senate 689**

On behalf of myself and the Vice Chair of Senate, welcome to the 689th Meeting of Senate. Classes for D3 have ended and the completion and grading of exams are in progress. Congratulations on another term under challenging circumstances.

The COU academic colleagues report is in consent section of the Agenda and refers to the April 1st meeting that included a meeting with executive heads.

There have been a couple of recent studies that I think may be of value going forward in terms of the microcredential/microcertificate front.

HEQCO has released some preliminary information with respect to a continuing larger study they are engaged in with the *Business and Higher Education Roundtable* (BHER) https://www.bher.ca/

The focus of the study is with respect to the lack of awareness or understanding of what microcredentials are, potentially hindering their effectiveness.

"We surveyed 2,000 Canadian adults and 201 employers; the findings from both surveys, which were part of a broader research project, highlight an awareness gap about what microcredentials are and who they serve. This isn't just a problem for postsecondary institutions trying to attract students, it's a problem for the Ontarians who could be benefiting from emerging opportunities for upskilling."
https://heqco.ca/janice-deakin-julia-colyar-jackie-pichette-microcredentials-short-focused-learning-that-responds-to-emerging-demands/

The report suggests a common definition for microcredentials that is rather broad. There are also some interesting preliminary statistics on the extent of online delivery with respect to current offerings of microcredentials. The full report is yet to come.

A report on microcredentials has also been released by *Colleges and Institutes Canada* (CICan)

https://brock.ca1.qualtrics.com/jfe/form/SV_ezgzUYndyaj57h4?Q_DL=BLFoDwP1DkN5lJl_ezgzUYndyaj57h4_MLRP_1YUO8EDosCb6d4q&Q_CHL=gl

"*The environmental scan showed a great interest in microcredentials across Canada and a degree of agreement on their purpose, characteristics and value. It also showed that 56% of responding colleges are offering microcredentials either online, in-person, or both, and that 33% are planning to or interested in doing so in the near future. This is not entirely new for colleges and institutes who have always been key providers of continuing education, including a variety of short programs and certificates, even if they were not called microcredentials. But as lifelong learning increasingly becomes the norm, we are seeing an increasing demand for more flexible pathways and credential types for learners*."

Somewhat related is a study out of Statistics Canada on the pattern of enrollment in College programs of students that have already obtained an undergraduate degree. It has always struck me that this is an area that universities could be doing more in, for students who have recently completed a degree. The topic perhaps has some relationship to microcredentials.
https://www150.statcan.gc.ca/n1/daily-quotidien/210408/dq210408b-eng.htm

The study (2010 – 2018) focuses on students completing a college program in Canada, after previously obtaining a university degree. Across Canada 14% had previously completed a university degree of some level (Bachelors, Masters, PhD), with Ontario and BC at the highest at 12%.The most common college fields of study of recent college graduates with a prior bachelor's degree were business, management and public administration (28%); health and related fields (24%); and social and behavioural sciences and law (18%).The study also reports statistics on the college programs taken depending upon age, whether the program related to their prior university degree, and possible motivation.

All this begs the question of whether this is a potential market for course based post graduate diplomas/certificates and the like that have the potential to be laddered into a Masters degree. Although we often think of the market for microcredentials as individuals returning for skills development after being in the workforce, there would appear to be a healthy market in terms of the student that has recently completed a degree.

Colleges are already well out of the starting gate in this area. I wonder if the university sector will lose time attempting to specify/define/standardize microcredentials. Although my marketing and entrepreneurship colleagues are more adept in this area, the concept of *Learn Startup* has gained traction in recent years. Start with a minimum viable product, continually test the market (student outcomes) and quickly make improvements going forward.

Office of the President

Brock University
Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
brocku.ca

President's Report to Senate - April 21, 2021

1. From April 2 to April 6, nearly 7,000 seniors received their first COVID vaccination on our campus. The vaccination clinic, which was organized and delivered by Niagara Public Health and required the coordination and participation of dozens of Brock staff, is an important step in helping to mitigate the health impacts of the pandemic and in bringing it to an eventual end. With each municipality in the Niagara Region having now announced its local vaccination sites, Brock will play in critical role serving the residents of both St Catharines and Thorold. As such, the vaccination clinic over the Easter long weekend is only the first of several that will be held over the spring and summer. I want to thank all Brock staff who participated in the event, giving up their days off and the long weekend to help Brock engage and serve its local community. Community members have expressed their appreciation for the role Brock is playing in supporting the region.

2. I would also like to commend our staff in operations, residence life, student health, and other related units who directly helped the university respond to and address the COVID-19 outbreak in our residences. With dozens of students affected and dozens more required to self-isolate, this unexpected event has put significant stress on our community. With students now recovering safely and the pace of new cases considerably slowed, we can begin to return slowly to campus operations within the confines of the current provincial stay-at-home order. It has been Brock's first outbreak and reflects some of the broader concerns about case numbers facing many settings across the province as reflected by and precipitating the province's recent lockdown orders.

3. I would also like to congratulate the winners of the 2021 Brock Surgite awards, which are presented each spring to student leaders who have made significant contributions to the University and/or broader community. This year's winners, who the Provost and I had an opportunity to virtually meet with, are yet another testament to the strength and commitment of our students and to their engagement with the local community beyond their studies, especially in this difficult year. The winners included: Azaan Adnan, Harroop Ahuja, Kristen Bott, Natasha Campbell, Rebekah Feld, Fitriya Mohamed Hussein, Bill Huynh, Lisa Mochrie, Nicholas Printup and Grayson Wadsworth-Hayes.

4. On March 19, 2021 Brock received an investment of $7.9 million from the Province of Ontario through the Postsecondary Education Support Fund to help institutions address the financial impacts of COVID-19. Brock received the most funding out of any university under this $106.4 million Fund that only went to select institutions. The funding will assist Brock's financial stability as well as address important institutional priorities that would have been otherwise postponed.

In addition to the Postsecondary Education Support Fund, the Province of Ontario announced in Budget 2021 other measures for the postsecondary sector. Measures include the Ontario Jobs Training Tax Credit for individuals to upskill during the pandemic, new funding for virtual learning, and re-announcements for OSAP eligibility expansion for micro-credentials and mental health support.

5. Brock was proud to virtually host the inaugural *1834 Fellowship Policy Forum*, which welcomed 40 fellows (aged 18-25) from Ontario, Quebec and Alberta for three days of online engagement. The Forum included participation from Prime Minister Justin Trudeau, MP Chris Bittle, MP Greg Fergus. In addition to several Brock University faculty and staff, including Dr. Kate Bezanson and Dr. Charles Conteh. The 1834 Fellowship program aims to assist in closing the gap in supporting Black Canadians in leadership positions and their capacity to contribute to the betterment of Canada and the forum was a culmination of the year-long Fellowship for the inaugural group, and an introduction for the 2021-22 cohort. Working with Operation Black Vote Canada to build the next generation of leaders, the weekend included learning about the rich black history here in Niagara (i.e., Harriet Tubman and the Salem Chapel), panel discussions, featured guest speakers and Fellow policy presentations. The Office of Government and Community Relations was instrumental in supporting the engagement and success of the Forum.

   Additional external activities and speaking engagements included hosting a *Community Leaders Dialogue on "Building Back Better",* in conjunction with the McConnell Foundation, on Brock's role in the local social and economic recovery; giving closing remarks at the *BIPOC Faculty of Applied Health Sciences Town Hall* organized by the Brock Physicians for Human Rights Brock (student) Chapter; and serving as a panelist for the *Canadian Women Economists Committee Panel on Race and Ethnic Origin.*

6. I continue to work with other university presidents through the Council of Ontario Universities and serve as the Chair of the Government and Community Relations Committee. The Chair of Senate, Dr. Don Cyr, also serves on the Government and Community Relations Committee and he too participated in the recent Academic Colleagues and Executive Heads meeting of COU. The key consideration of the Committee relates to the role of universities in contemporary society in relations to government and community relations as well as how universities can ensure they effectively communicate their value-proposition and contributions. It was emphasized that while advocating to government at the provincial and national levels were important, a significant component of government and community relations is local. It was therefore incumbent on individual universities to forge meaningful relations with local stakeholders. It was also emphasized that these relations were defined not simply by the overall institutional efforts, but rather the individual relations established by faculty and staff through their volunteerism and public relations at a local level which were imperative. It was further noted that how we communicate to parents and community members was ultimately defining when it comes to government and community relations in a similar manner to our engagement with students and other stakeholders.

7. The University has continued its efforts to enhance the student experience for their future return to campus. These efforts have recently included the opening of the students' physical and athletic facilities –Zone II, which was done in conjunction with the leadership of BUSU President, Asad Jalib, and GSA President Christopher Yendt. We are also currently completing the renovation of Decew Residence and the building of Residence 8. These residences will provide modern and additional on-

campus accommodations for our students. Additionally, these residences will support our community relations efforts to manage the impact on local communities (e.g., Thorold and St. Catharines) and moderate the impact on affordable housing from student enrolment growth approved through strategic planning. At steady state operations, these new residences will be budget neutral to positive.

8. Advancement & External Relations continues its efforts to secure new gifts to the University in support of our students, faculty and staff. Recent activities have included the establishment of a new scholarship in the Faculty of Education, support for student financial literacy and a donation to enhance our Horizon Graduate Student Scholarship program. The University's research enterprise has also been the beneficiary of a sizable gift-in-kind that will help support ongoing work in the Cool Climate Oenology and Viticulture Institute (CCOVI). These gifts are soon to be announced and celebrated publicly.

   The Alumni Relations team is building a hybrid plan for Homecoming 2021 in September given the uncertainty around the ability to host large social gatherings. The plan includes a number of virtual reunions and other programming that will encourage participation either online or in person (where allowed). Additionally, the next issue of SURGITE magazine is in production with a cover story highlighting the exceptional work of Dr. Mariek Schmidt, as part of the team overseeing the Perseverance Mars Rover voyage.

9. On March 26, we held Brock's third budget town hall of the academic year, which presented financial results for Trimester 2 of 2020-21 and laid out the budget for 2021-22. We continue to project that, thanks to the hard work of all members of our community, the University will succeed in balancing its budget for 2020-21. While the outlook for 2021-22 remains challenging, with enrolments continuing to lag behind pre-pandemic levels, we presented a balanced budget to PPBAC for its endorsement in March. This budget will now be going forward to the Board for final approval at the beginning of May.

Sincerely,

Dr. Gervan Fearon
President and Vice-Chancellor

Office of the Provost and
Vice-President, Academic

Brock University
Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada

provost@brocku.ca

Provost's Report to Senate – April 21, 2021

Dear colleagues,

On February 23, I released draft principles to guide academic planning for the Fall 2021 term. The document defines three potential scenarios that align with the Brock Stages of Re-Opening and lists the preparations the University is undertaking for each scenario. It also reiterates that academic planning is rightly within the purview of academic departments and Faculties and emphasizes Brock's commitment to be "as open as possible" in the Fall, with the intention of welcoming our students back to campus.

I have spent the last month consulting on the document, speaking with students, staff, faculty members and librarians to understand their concerns. I spoke with academic leaders, including Deans, Associate Deans and Chairs. I met with the Presidents of the Brock Undergraduate Students' Union and the Graduate Students' Association, as well as with union leaders on campus. I presented to Senate and to its committees, and I invited feedback from all members of Senate. I want to thank every member of our community who took the time to engage with the document and share their thoughts. I would like to reflect on some of the comments I heard from the community during the consultation process.

One of our greatest challenges as the Fall term approaches will be in managing our own anxiety and that of those around us. COVID has turned our lives upside down for the last year. Yet as strange as this new way of living may seem, we have slowly become accustomed to it. The prospect of returning to campus thus rightly makes some people nervous. But with the promise of near-universal immunization over the next few months, the pandemic will end and we must learn to resume living in most respects as we did before – for the sake of our own mental health and for that of our students, to restore the post-secondary experience students expect from us, and for the financial well-being of our University. We will approach the coming academic year with optimism supported by careful planning and confidence in our ability to navigate this new transition as a community.

The University remains committed to ensuring that the campus is safe, as it has been throughout the pandemic. The public health guidelines that may exist come September will be in place on our campus, as they have been throughout the pandemic. Processes are already in place through Human Resources for those who might wish to seek medical accommodations on health-related grounds.

Similarly, it is important to emphasize the critical role that the academic planning process will play in preparing for the Fall. I strongly believe that, as in normal times, the subject matter experts are best positioned to rule on matters of scheduling and mode of delivery. The public health measures brought on by the pandemic have forced us to think about mode of delivery a bit differently this past year, and as we look forward to the Fall term we will monitor the situation continuously and work with Deans and their academic units to consider shifting course delivery as needed. We also know that some instructors have developed new ways of teaching they would like to continue in the future. These requests should be discussed with department

Chairs as part of the academic planning process. In all of our planning, we should keep our priorities focused on the transformational experience we have promised to our students.

I heard many questions in consultation about vaccinations, specifically about whether the University would require students, staff and faculty members to be vaccinated before attending campus. This question has significant legal implications and has been the topic of much conversation across universities and colleges in the sector. At present there is no clear answer to this question. As we have been doing over the last year, we will continue to make informed decisions by seeking expert advice and partnering with other institutions in our sector to share information and key considerations. I will provide more information if we decide to revisit the issue at a later date.

Finally, I was often asked when the University would decide "for certain" the format for Fall instruction. Brock is sending a strong message to members of its community and to prospective students that we plan to be ready to return to campus in the Fall. Nor is Brock alone in this position. All of Ontario's universities and most colleges have made similar commitments. Even the District School Board of Niagara announced plans to return exclusively to in-school education in September. I believe that a return to campus is a realistic objective, and one that I trust will become increasingly so in the coming months as the rate of vaccination increases. By June 15, we should be in a position to finalize our plans for the Fall, with the understanding that we will always be prepared to react to any changes to the public health situation should they arise.

Thank you again for your engagement and valuable feedback in recent weeks. I will continue to provide regular updates as the Fall term approaches and, as always, I am happy to discuss preparations with any member of the Brock community.

Update on external reviews of administrative units

Earlier this year, Brock launched a number of reviews of the structure and operations of several administrative units. The topics have been wide-ranging, including academic advising, student services, sports and recreation, marketing and communications, and IT services. While motivated in part by the financial imperatives of COVID, the primary consideration is to ensure that these units are structured in a way that will ensure appropriate contact and collaboration in cognate areas around the University, as well as maximize the service level standards being provided to internal stakeholders, including academic units.

Most of these reviews are in their very early days, with contracts only recently awarded and work soon to get underway. Appropriate consultation will of course be a part of these processes. One notable exception is the review of Brock International, which began in September and concluded recently in March. The work of the review included extensive engagement and consultation with academic units, including Deans and academic advisors, as well as with Senate via its Chair. I want to thank Professor Camille Rutherford, who worked with our external partner to coordinate the review and who is now implementing the recommendations of the review.

Extension of the Dean of the Faculty of Education

Professor Michael Owen's first term as Dean of the Faculty of Education is scheduled to end on July 31, 2022. Professor Owen has indicated that he will not stand for re-appointment for a second term. He is interested, however, in a one-year extension to his term, a proposal that the President and I both support.

As a result, I have led a process under section 4 of the Faculty Handbook to finalize an extension. Following consultation with faculty members in the Faculty of Education via the Leadership Committee in Education, I am pleased to do so today. I trust you will join me in thanking Professor Owen for his work so far and for his continued commitment to Brock for the next two years.

Update on the program viability review process

As I have described in past meetings, I have been leading a program viability review process under FHB 3.C.15. As this section was only recently introduced, this is the first time the process is being led.

In the first step of the process, programs identified for review were asked to submit a report to the Provost addressing the viability criteria. The deadline for these reports passed in early April. I will now be striking a Provostial Committee to review the reports and make a recommendation to ARC on the future of the programs identified. ARC's recommendation would then come to Senate for final approval.

Sincerely,

Professor Lynn Wells
Provost & Vice-President, Academic

Office of the Vice-President Research

Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
T 905-688-5550 x4315
F 905-688-0748

brocku.ca

April 14, 2021

Report to Senate #689

With the warmer weather and sunshine of spring buoying spirits, it is a pleasure to share some information items about the research enterprise. One comment I would share in particular bears on the final item listed below.

I received a lot of enthusiastic feedback regarding Brock's involvement with Birds Canada and the Motus Network from colleagues whose research touches on biology and wildlife in a wide range of ways. The idea for this collaboration came from an unsolicited suggestion offered via email by a retired Brock professor. This is a great illustration both of the significance of the extended community of Brock researchers, and of the continued contributions that retired colleagues make to the research enterprise.

1. Portage to NDRIO
As of April 1, 2021, the Portage Network of research support platforms, tools, and training opportunities has been folded into NDRIO. Portage was developed and managed in partnership with the Canadian Association of Research Libraries.

2. Research Security Policy Statement
On March 24, 2021, the Ministry of Innovation, Science, and Economic Development (ISED) released an updated policy statement on research security, jointly with the Ministries of Public Safety and Health. The statement reiterates much of the policy statement of the previous September.

3. Some recent outreach and representation activities
- Ontario Council for University Research Executive: Jan. 14, Feb. 4, Mar. 4, Apr. 1
- Ontario Council for University Research: Jan. 21, Feb. 25, Mar. 25
- Special OCUR/COU meetings: IP Working Group Jan. 26; Tri-Council Heads to discuss EDI/COVID Feb. 16; Secretariat for Responsible Conduct of Research Feb. 25
- Economic Development Office, Niagara Region Mar. 22
- Economic Development Office, City of Burlington Mar. 23
- McConnell Foundation Community Dialogue, "Building Back Stronger" Mar. 31

4. Responsible Conduct of Research report
Under Brock University's Responsible Conduct of Research Policy, a breach is defined as any action that is determined to be inconsistent with the expectations for responsible conduct of research as outlined in the Policy.

Intent and impact are not relevant in determining the existence of a breach, so this is a category that includes many trivial and inadvertent cases. Intent and impact are considered in determining the appropriate recourse to an identified breach. Breaches that

are committed knowingly, and those which have a significant impact on the public or the research community will attract the most serious recourses.

For example, even though each of the following would be considered a breach, omitting one publication on a CV or failing to cite one reference in a grant application is treated very differently than intentionally falsifying or fabricating research data, or recruiting human participants without disclosing the risks to which they will be exposed.

Brock University responds to inadvertent minor breaches through non-disciplinary educative action (e.g., reminders about policy requirements or redirection to educational resources). Intent and seriousness of a breach would affect any disciplinary action to be taken by the University.

Calendar year	RCR allegations received	RCR breaches confirmed	Breaches resulting in educative action	Breaches resulting in disciplinary action
2018	9	6	6	0
2019	5	3	3	0
2020	5	4	4	0

5. Insight Grant results
Specific results remain embargoed, but I can share that Brock researchers received seven SSHRC Insight Grants in the 2020/21 round, with awards totaling roughly $900,000. I look forward to sharing further details when the results are made public.

6. Provincial lockdown
In response to provincial lockdown measures, the University has returned to a hybrid version of Pandemic Level Brock 1. Virtually all ongoing research access authorizations have remained active under this approach, in light of the existing safety protocols under which they were approved.

7. Motus network
Brock's scientific collaboration with Birds Canada, providing infrastructure support for the Motus wildlife tracking network, has now been confirmed and finalized. A tracking antenna array will be installed on the roof of the Plaza building.

Tim Kenyon, PhD
Vice President, Research

Brock University

Senate

(Circulated prior to approval)

MINUTES OF MEETING #688 (2020-2021)

SENATE

MARCH 24, 2021 at 3:00 P.M.

REMOTE PARTICIPATION VIA MICROSOFT TEAMS

PRESENT: *Chair*: Senator Don Cyr, *Vice-Chair*: Senator Larry Savage

Ex-Officio Members: Senators Ejaz Ahmed, Gary Comerford, Suzanne Curtin, Gervan Fearon, Andrew Gaudes, Geraldine Jones, Tim Kenyon, Anna Lathrop, Ingrid Makus, Carol Merriam, Michael Owen, Brian Power, Rafay Rehan, Mark Robertson, Camille Rutherford, Peter Tiidus, Lynn Wells, Thomas Winger

Elected Members: Senators James Allard, Mark Arthur, Michael Ashton, Kate Bezanson, Irene Blayer, Christene Carpenter-Cleland, Dipanjan Chatterjee, Rosemary Condillac, Jens Coorssen, Andrew Dane, Tim Dun, Joan Dundas, Fayez Elayan, Melanie Extance, Bareket Falk, Amy Friend, Jennifer Good, Omer Gul, Nicholas Hauck, Yasmine Hejazi, David Hutchison, Ben Johnson, Kelli-an Lawrance, Kelly Lockwood, Catherine Longboat, Francine McCarthy, Richard Mitchell, Tim Murphy, Roberto Nickel, Wendell Noel, Beatrice Ombuki-Berman, Dawn Prentice, Unyong Pyo, Tim Ribaric, Ian Ritchie, Moksh Sharma, Kirsty Spence, Carole Stewart, Tek Thongpapanl, Francine Vachon, Michelle Webber, Murray Wickett, Jannelle Yoon

REGRETS: Senators Michael Bidochka, Robyn Bourgeois, Andrew Bunke, Michèle-Elise Burnette, James O'Brien, Hilary Pearson, Rob Welch, Christopher Yendt

RESOURCE: Chabriol Colebatch (University Secretary and General Legal Counsel), Margaret Thompson (Associate Secretary to the University), Natasha Devos (Assistant Secretary to the University)

ALSO PRESENT: Other members of the Brock University community.

1. Welcome and Call to Order

The Chair called the meeting to order and provided a land acknowledgement.

2. Approval of the Agenda

The Chair referred members to the agenda, including consent items, and confirmed there were no items to be lifted from the consent portion.

MOVED (Elayan/Coorssen)

THAT the agenda, including consent items, be approved.

CARRIED

3. Business Arising from the Minutes

There was no business arising from the minutes.

4. Reports of Standing Committees and Special Committees

4.1 Teaching and Learning Policy Committee

[The Report of the Teaching and Learning Policy Committee dated March 16, 2021 was posted with the meeting materials.]

Senator Stewart, Chair of the Teaching and Learning Policy Committee, presented the report.

a) Amendment to FHB III A: 11.2.2 (i) Minimum Academic Requirements

MOVED (Carpenter-Cleland/Blayer)

THAT Senate approve the amendment to FHB III A: 11.2.2 (i) Minimum Academic Requirements (strikeout indicates deletion, highlight indicates insertion):

11.2.2 (i) Minimum Academic Requirements

Alternative to Academic Suspension: Students placed on academic suspension may be offered an alternative to academic suspension. Participating students will continue on academic probation, be required to take a mandatory non-credit support course and be restricted to a maximum of three credits. Students must successfully complete the non-credit support course, as well as attain a minimum 60 percent overall average once three credits have been attempted. Students who do not meet these requirements will be placed on academic suspension for a minimum of one year. This alternative to academic suspension may ~~not~~ be repeated one time.

CARRIED

Senator Stewart encouraged faculty members to complete the survey distributed by the Teaching Innovations Working Group which seeks feedback on their experiences related to online teaching. An email reminder will be sent to the Deans to distribute within their Faculties.

4.2 Information Technology and Infrastructure Committee

[The Report of the Undergraduate Program Committee dated March 16, 2021 was posted with the meeting materials.]

Senator Ribaric, Chair of the Information Technology and Infrastructure Committee, presented the report.

a) Learning Management System (LMS)

MOVED (Ribaric/Owen)

THAT Senate approve that the acquisition of a new Learning Management System (LMS) or a significant upgrade to the existing system is consistent with the University's Strategic Plan for academic computing and communications.

Senate engaged in a comprehensive discussion regarding the motion. It was noted that the wording of the motion is consistent with the process as outlined in Faculty Handbook 3:C.5.5.2 (c). Next steps include the completion of a needs assessment which will require broad consultation to determine whether a learning management system is needed at the University, the current system requires an upgrade, or a different model should be implemented.

Following the discussion, the Chair confirmed that Senate was prepared to consider the vote on the motion.

CARRIED

b) Terms of Reference – Resource Selection Team

The Provost then referred Senate to the membership of the Resource Selection Team and suggested the "Faculty representative, Senate" with a "Faculty / Professional Librarian representative, BUFA".

MOVED (Wells/Webber)

THAT Senate endorse that the membership of the Resource Selection Team be amended to replace "Faculty representative, Senate" with a "Faculty / Professional Librarian representative, BUFA".

CARRIED

4.3 Research and Scholarship Policy Committee

[The Report of the Research and Scholarship Policy Committee dated March 17, 2021 was posted with the meeting materials.]

Senator Ashton, Chair of the Research and Scholarship Policy Committee, presented the report.

a) Changes to the Youth Sports Research Centre

MOVED (Ashton/Tiidus)

THAT Senate approve the changes to the Youth Sports Research Centre as outlined in the Report.

CARRIED

5. Report of the Chair

The Chair announced that the extended call for nominations for the Senate Election resulted in nine nominations for the five seats available so the election will proceed with ballots being issued to the electorate on Friday.

The Chair also welcomed Senator Deng who was recently appointed to Senate due to a resignation.

6. Report of the President and Vice-Chancellor

[The President's Report to Senate dated March 24, 2021 was posted with the meeting materials.]

The President presented the Report and provided highlights for the information of Senate. He expanded on the recent announcement that Brock will be a mass vaccination site in the Niagara region and he and the Associate Vice-President, Advancement and External Relations responded to questions raised regarding safety protocols.

7. Report of the Provost and Vice-President, Academic

[The Report of the Provost and Vice-President, Academic, dated March 24, 2021 was posted with the meeting materials.]

The Provost presented the Report and provided highlights for the information of Senate. She congratulated the Dean of Humanities and University Librarian on their recent reappointments and thanked the Advisory Committee members and Senators for their contributions to that process.

During the discussion on the Report, the Provost was requested to consider including BUFA representation on the Fall Semester Planning Committee. The Provost will consider the request and report back to Senate.

a) Amendments to FHB 3.C.15 on the Program Viability Review Process

MOVED (Wells/Power)

THAT the following amendments to FHB 3:C.15 be approved (highlight indicates insertion, strikeout indicates deletion):

15. PROGRAM REVIEW AND DISCONTINUATION

15.1 UNDERGRADUATE AND MASTERS DEGREE PROGRAM VIABILITY REVIEW

…

15.1.2 Each year, with the release of the November 1 enrolment data, the Provost will report to Senate the list of programs identified to undergo a viability review. The program will be asked by the Provost to submit a report to the Provostial Committee addressing the viability criteria. Upon consideration of

the report, the Provostial Committee will make a recommendation to ARC on whether to discontinue the program. If ARC and Senate approves a recommendation to discontinue the program, the program will submit a termination plan to ARC (IQAP 6.1).

…

15.1.7 Certificates and micro-certificates shall be excluded from the program viability review process.

CARRIED

8. Report of the Vice-President, Research

[The Report of the Vice-President, Research, dated March 17, 2021 was posted with the meeting materials.]

The Vice-President, Research, presented the Report and provided highlights for the information of Senate. The Vice-President congratulated a number of Brock faculty members and students in their recent accomplishments in the field of research.

At the invitation of the Chair, the University Librarian and Vice-Provost and Dean, Graduate Studies, provided oral updates on matters related to the Tri-agency's new research data management policy and a new funding opportunity for graduate students, respectively.

9. Two Row Council

The Provost and Vice-President, Academic, provided an oral update on the activities of the Two Row Council from the meeting held on February 22, 2021. Matters considered included, but were not limited to: discussion on tweets by anonymous Twitter account; consultation on the future of the Tecumseh Centre, consultation on the white pine tree, teaching lodge from NPAAMB (Niagara Peninsula Aboriginal Area Management Board), and nominations to the Two Row Council.

10. Generative Discussion – N/A

11. Other Business

There were no items of other business.

The Chair noted that a motion was required to move in camera to consider the following confidential items:

12. Governance Committee - In Camera

Only Senators and those invited staff remained for the closed session.

On a motion by Senator Coorsen, seconded by Senator Elayan and carried, the Senate moved in camera at 4:28 p.m.

******

[During closed session, Senate considered confidential matters related to Honorary Degree Nominations – March 2021.]

Senate resumed open session at 4:32 p.m.

13. Adjournment

The meeting adjourned at 4:32 p.m.

CONSENT ITEMS

The following items were received and/or approved by consent:

14. Minutes of Previous Meeting
[The Minutes of the 687th meeting of Senate held on February 10, 2021 were posted with the meeting materials.]

Senate approved the Minutes of the 687th meeting held on February 10, 2021 by consent.

15. Communications
[A Media Release from the University of Alberta dated March 10, 2021 was posted with the meeting materials.]

Senate received the Media Release by consent.

16. Report of the Academic Colleague
[The Report of the Academic Colleague dated March 14, 2021 was posted with the meeting materials.]

Senate received the Report by consent.

17. Report of the Actions of the Board of Trustees
[The report of the Actions of the Board of Trustees from the meeting of the Board held on March 4, 2021 was posted with the meeting materials.]

Senate received the Report by consent.

18. Reports of Standing Committees

18.1 Academic Review Committee
[The Report of the Academic Review Committee dated March 16, 2021 was posted with the meeting materials.]

Senate approved the following motions by consent:

THAT the Final Assessment Report for the cyclical review of the MA in Social Justice and Equity Studies program in the Faculty of Social Sciences be approved.

THAT the Four-Year Report on the cyclical review of the graduate and undergraduate programs in English Language and Literature be approved.

18.2 Undergraduate Program Committee

[The Report of the Undergraduate Program Committee dated March 9, 2021 was posted with the meeting materials.]

Senate approved the following motions by consent:

THAT the Senate approve the introduction of a micro-certificate in Human Rights at Work to the 2021-2022 Labour Studies Academic Calendar as outlined in Appendix 1 to the Report.

THAT the Senate approve the introduction of a pass program in Medieval and Renaissance Studies to the 2021-2022 Academic Calendar as outlined in Appendix 2 to the Report.

THAT the Senate approve the addition of HIST 4P07 – Topics in Religious Studies to the 2021-2022 Department of History course bank as outlined in Appendix 3 to the Report.

THAT the Senate approve the Department of Recreation and Leisure Studies and Centennial College Leisure Service Program draft pathway agreement as outlined in Appendix 4 to the Report.

THAT the Senate approve the Introduction of Micro-certificate in Choral/Vocal Music to the 2021-2022 Department of Music Academic Calendar as outlined in Appendix 5 to the Report.

THAT the Senate approve the Introduction of Micro-certificate in Instrumental Music to the 2021-2022 Department of Music Academic Calendar as outlined in Appendix 5 to the Report.

THAT the Senate approve the Introduction of Micro-certificate in Music Making/Music Thinking to the 2021-2022 Department of Music Academic Calendar as outlined in Appendix 5 to the Report.

THAT the Senate approve WRDS 3P15 be cross listed as GAME 3P15 and homed in the Department of English Language and Literature as outlined in Appendix 6 to the Report.

THAT the Senate approve the revision to MUSI 3P55 (also offered as DART 3P55 and ENGL 3P55) pre-requisite as outlined in Appendix 7.

THAT the Senate approve the revision to the Minor in Africana Studies to include MARS 3Q63 as a course option and revision to SOCI 2P00, 3P35 and 4P22 to include a course note as outlined in Appendix 8 to the Report.

THAT the Senate approve the revision of CHYS 1F90 course restriction as outlined in Appendix 9 to the Report.

THAT the Senate approve the introduction of the micro-certificate in Gender Justice and the Art of Activism in the Department of Women's and Gender Studies in the 2021-2022 academic calendar as outlined in Appendix 10 to the Report.

THAT the Senate approve the addition of WGST 2Q91 (also offered as ENGL 2Q91) Black Women Writing Resistance in the 2021-2022 course bank.as outlined in Appendix 11 to the Report.

THAT the Senate approve the addition of WGST 2Q96 (also offered as COMM 2Q96, FILM 2Q96, PCUL 2Q96, VISA 2Q96) Art of Activism: Sexuality to Racial Justice in the 2021-2022 course bank as outlined in Appendix 12 to the Report.

THAT the Senate approve the renumbering of LING 3P51 to LING 2P51 in the 2021-2022 Applied Linguistics course bank as outlined in Appendix 13 to the Report.

THAT the Senate approve the renumbering of LING 2P53 to LING 3P53 in the 2021-2022 Applied Linguistics course bank as outlined in Appendix 14 to the Report.

THAT the Senate approve the addition of IASC 3P15 in the Year 3 Bachelor of Arts in Game Design program requirements as a course option in the 2021-2022 academic calendar as outlined in Appendix 15 to the Report.

THAT the Senate approve the revision of the Certificate in Ethics and Certificate in Pre-law to replace PHIL 2Q90 and 2Q91 as outlined in Appendix 16 to the Report.

THAT the Senate approve the addition of a program note in the Public Health calendar and referenced in Year 3 in the 2021-2022 academic calendar as outlined in Appendix 17 to the Report.

THAT the Senate approve the revision of SPMA 1P93 course format to include the addition of a seminar in the 2021-2022 academic calendar as outlined in Appendix 18 to the Report.

THAT the Senate approve the revision of VISA 3Q91 (also offered as STAC 3Q91) course title, description and note be revised and added in the 2021-2022 academic calendar as outlined in Appendix 19 to the Report.

THAT the Senate approve the draft articulation agreement between Brock University Oenology and Viticulture and Okanagan College as outlined in Appendix 20 to the Report.

THAT the Senate approve the removal of the expired Visual Arts and Sheridan College articulation agreement from the Academic Calendar as outlined in Appendix 21 to the Report.

18.3 Graduate Studies Committee

[The Report of the Graduate Studies Committee dated March 24, 2021 was posted with the meeting materials.]

Senate approved the following motions by consent:

THAT Senate approve the 2021-2022 Graduate Calendar changes as outlined in Appendix 1 to the Report.

THAT Senate approve the addition of KINE 5P15 to the Master of Professional Kinesiology Program in the 2021-2022 Graduate Calendar, as outlined in the Report.

THAT the Senate approve the calendar changes associated with the Major Modification to the SSAS Program - Scheme C for the 2021-2022 Graduate Calendar as outlined in Appendix 2 to the Report.

18.4 Governance Committee

[The Report of the Governance Committee dated March 24, 2021 was posted with the meeting materials.]

Senate received the Report by consent.

18.5 Undergraduate Student Affairs Committee

[The Report of the Undergraduate Student Affairs Committee dated March 16, 2021 was posted with the meeting materials.]

Senate received the Report by consent.

18.6 Planning, Priorities and Budget Advisory Committee

[The Report of the Planning, Priorities and Budget Advisory Committee dated March 16, 2021 was posted with the meeting materials.]

Senate received the Report by consent.

19. Faculty of Education Early Diploma Release and IN CAMERA – Early Diploma Release

[The Report from the University Registrar and Associate Vice-President, Enrolment Services dated March 8, 2021 was posted with the meeting materials.]

Senate approved the following motion by consent:

THAT in order to qualify Brock's concurrent education students for Temporary Certification of Qualification and Registration with the Ontario College of Teachers, Senate approve the early issue of undergraduate degree diplomas on March 31, 2021 for eligible Year 6 students currently enrolled and actively registered in Concurrent Education.

In addition, Senate approved a confidential motion regarding early diploma release by consent.

Centre for Canadian Studies
Faculty of Humanities

Brock University
Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
T 905 688 5550 x4029
Brocku.ca

25 March 2021

To the Chair of Senate

I am writing to request Senate investigate the overly burdensome reportage expectations placed on academic units by administrative units.

Several years ago when I was chair of Senate's Research and Scholarship Policy committee, we received a request from the transdisciplinary research institutes concerned about the burden of reporting that was being placed on those units. Even a brief glance at the requests for reports from several sectors in the university (VP Academic, VP Research, and others) found that many of these units were being expected to put hundreds of person hours into reporting, often providing the type of information that is already provided in other documentation such as faculty annual reports. Such resource redirection meant funds intended for research was used to write reports. The outcome of the investigation was, to my recollection, a slightly diminished reporting expectation of these units, and a better use of data such as those provided in faculty reports.

One phenomenon that was revealed in this investigation was the tendency to those who requested the reports to ask for more information than they intended to use, and to ask for information that was available elsewhere (such as in faculty annual reports). The research work of the institutes was a lesser priority than the information gathering aspirations of senior administration. Reports that were considered necessary to gauge a research units' efficiency thus reduced the unit's efficiency in achieving its core goal, which was pursuing research excellence, because time and funds were diverted from research to meeting the demands of the administration. One research center reported spending thousands of dollars on administrative support to gather the data and draft the reports for various administrative units demanding this information, money that could have been used to do research.

In his classic book *Medical Nemesis*, Ivan Illich uses the term "Specific Counterproductivity" to characterize the phenomenon of a system set up to achieve one goal but that results in the opposite. In the example above, senior administration requests intended to ensure that research is being done well actually reduced research intensity. In *The Careless Society,* John McKnight expands Illich's definitions, referring to illness-creating health systems, crime-producing criminal justice systems, and stupefying education as the outcomes of administration that loses sight of their main goals, and becomes more interested, in the words of Illich, in "an accounting of cost-efficiency."

Recently most faculty members have seen their work constrained by the priorities of administration. Those of us who have been at Brock for more than five years can lament the change in the annual report form from what was essentially an enhanced CV that the faculty member could update throughout the year, to an online form with a series of drop-down menus and limited field information that the faculty member can only update when the site on mybrocku.ca is "opened" by admin each year.

It is a perfect example of specific counterproductivity. When completing information on publications, for example, a faculty member needs to spend much more time filling in each field in order to ensure that it meets the data-mining expectation of administration. As a result, the more work a researcher has done, the more information they need to input, and the less time they have to do the essential work of researching and knowledge translation because they have to spend an inordinate amount of time ensuring their annual report meets the needs of administration. (Personally, I gave up. With dozens of media contacts each year, I just write "See my CV for details." Less obstinate, untenured colleagues may be unwilling to do this). As a result, a document that is intended to gauge productivity in effect reduces it. It is specifically counterproductive.

The recent demand from small academic units to justify their existence through submitting a "Viability report" has the potential to do the same thing from a teaching standpoint. At the busiest time of the year, in the middle of a semester during a pandemic shutdown when senior admin is asking teaching units to determine what the next year will look like, how many courses will be on-line versus in person, develop recruitment plans for the unique on-line context, and to set out their budgets for the following year, small units that have been identified as potentially struggling to attract students are now burdened with the expectation, in the course of six weeks, to draft a report that in effect justifies their existence.

(Note, the original report required from the Provost's office gave units four weeks. The deadline was pushed back in response to a request that this report deadline be delayed until after the semester had ended in order to enable programs to complete the crucial work of teaching and planning. The new deadline does not do this: it just pushes the deadline to the busiest time of the year, when final essays and assignments are due. That is an issue for another time but indicates again the emphasis upon administrative priorities rather than those of teaching, learning, and research).

Key elements of this report include asking how the unit is relevant to the university's strategic plan, and how the unit is relevant to the expectations of society. These are big questions. The result is that the targeted small units with limited resources have been spending inordinate amounts of time and people hours to answer complex questions in a short time. One director suggested a radical solution: that a conversation would be better than a formal report, but this was not an option. I hope there will be an opportunity to discuss the usefulness and appropriateness of these viability reports at some future point, but the current request is about the administrative focus on excessive reportage across the university.

I restate, then, my request that the Senate undertake a comprehensive review of the reporting requirements that are being made of academic units with an eye to considering how necessary they are and streamlining the process. In my view, the mission of Brock University is to facilitate excellence in research, teaching, and learning—this simple mandate permeates all strategic plans. Anything that gets in the way of that must be scrutinized and made as minimally intrusive as possible. When administrators ask for new reports, or create new complicated systems to gather that information, they should ask themselves "how will this affect the research, teaching, and learning that is at the core of

every university's mandate?" and "is there a way to do this that is minimally intrusive?" Because faculty members are not here to cater to the whims of administration; administration is here to make sure that research, teaching, and learning can take place in the most effective way possible. Burdening us with reports does not do this.

Persistent, time-consuming, and redundant reports are inefficient and counterproductive, and any good they might do must be balanced against potential harms. Currently this does not seem to be being done.

Sincerely

Dan Malleck, PhD
Director, Centre for Canadian Studies
Associate Professor, Health Sciences

To: Chabriol Colebatch, University Secretariat

From: Don Cyr, Academic Colleague

Date: April 12th, 2021

Re: Academic Colleagues Meeting – March 24th and April 1st 2021: Report to Senate

---

A ZOOM meeting of the Academic Colleagues (ACs) was held on the morning of March 24th and on Tuesday April 1st, 2021. On April 1st the ACs also met for approximately one hour with the Executive Heads (EHs) as part of the annual Council Meeting.

Wednesday, March 24th 9:00 AM – 12:00 pm

This meeting of the ACs represented a time to decide and reflect upon several topics that they would set for discussion with the EHs during the annual meeting of the COU. The general topic was one of *Planning for the Post Pandemic University* – what to consider in the short and longer term. Unfortunately, I was only able to attend for half of the three hour meeting, due to teaching commitments.

Thursday, April 1st, 9:00 – 11:30

The morning of the April 1st was in preparation for the meeting with the EHs in the early afternoon. The main purpose was to review the four discussion topics the ACs had decided upon (Attached: Equity Diversity and Inclusion; Online and Blended Learning; Student Mental Health; Accessibility). ACs were selected to introduce each topic for discussion.

The ACs also received a COU update (attached) which outlined sector wide enrollment statistics, as well as various items identified in the provincial budget relating to the university and college sector.

As indicated in the agenda, various reports by ACs were also presented – some verbally or short written summaries. I have not attached these but they are available. They are simply the report of the ACs that are members of different COU committees. Such meetings are generally not that frequent.

Thursday April 1st, 12:15 – 1:30 PM Council Meeting

Once a year the ACs meet with the EHs as part of the larger annual Council Meeting. As noted, the joint meeting is approximately one hour in length and the ACs suggest topics for group discussion in advance. Hence the general topic of *Planning for the Post Pandemic University* as noted above.

Part of the meeting also includes miscellaneous reports by EH's with respect to COU committees they may have chaired.

The subtopics determined by the ACs were then introduced. Unfortunately, these introductions were a bit lengthy, shortening the time for roundtable discussion. Some discussion took place but generally, it was one of recognition that these would be important issues going forward for all universities.

Next Academic Colleagues Meeting

Next meetings: May 11, 2021, 6-8 pm and May 12, 2021, 9-12 pm

COU Staff Update to Academic Colleagues – April 1, 2021

Fall 2020 Enrolment

Overall total Fall full-time enrolment increased by 2.1% across the sector. There were, however, strong differences across the sector, level of study and immigration status.

Undergraduate

Total undergraduate enrolment increased by 2.3%—with domestic increasing by 1.7% and international by 5.3%.

Domestic undergraduate

Growth in domestic undergraduate enrolment is primarily due to the sector experiencing the highest transition rates in at least the last 10 years. We also know that there has been an increase in the number of students moving from part-time to full-time studies and students in three-year programs continuing to complete a four-year degree. Enrolment in the summer, which is not included in these numbers was also significantly higher than in previous years.

International undergraduate

Growth in international undergraduate enrolment was not due to higher transitions but by flow-through enrolment. Over the last 6 years, international enrolment has increased by between 9% and 18%. Fall 2020 transition rates at their lowest in the past 6 years.

Graduate enrolment

Graduate enrolment increased by 1.4%, with domestic increasing by 3.6% and international decreasing by 3.7%. The drop in international enrolment was at the master's level, which experienced an 8.1% decrease in enrolment. Doctoral enrolment increased by 8.7%.

Budget

Budget 2021 centers on two key pillars: Protecting People's Health and Protecting Our Economy. The Budget focuses on "defeating COVID-19" through a series of actions and increases COVID-19-related funding to $51 billion over four years.

The ministry did not provide detailed information about funding for universities and colleges. COU has reached out to the ministry and is waiting for a response.

There were also no announcements related to tuition.

COVID-19 Relief Funding (re-announcement)

On March 19, government announced $106.4 million for COVID-19 funding for PSE "directed to those institutions facing the greatest financial impacts from COVID and [taking] into account size and relative financial health/availability of resources."

Ontario Jobs Training Tax Credit

The Budget announced the temporary Ontario Jobs Training Tax Credit to help individuals aged 25 to 65 upskill as a response to the pandemic. This temporary, refundable tax credit applies to the 2021 tax year and applies to individuals earning an income of between $10,000 and approximately $150,000. The credit is designed to cover 50% of eligible tuition and course fees (e.g. ancillary fees and charges, examination fees) from an eligible educational institution (e.g. university, college) up to a maximum of $2,000.

Mitac internships (re-announcement)

On March 10, the government announced an investment of $39.5 million to help Mitacs create up to 8,000 paid innovative research internships and upskilling opportunities for postsecondary students

Digital Learning and Micro-credentials

Budget 2021 announced a new investment of $21.4 million ($10.7 million in each of 2021-22 and 2022-23) toward the Virtual Learning Strategy. This builds on the previously announced $50 million in funding available to PSE institutions through eCampusOntario (December 11, 2020)

Budget 2021 announced a new $2 million allocation for a platform that will support the Virtual Learning Passport, building on and integrated with the micro-credential and Virtual Learning Strategy. The platform will be designed to issue digital credentials for life-long learners.

On March 18, the government confirmed the expansion of the Ontario Student Assistance Program (OSAP) to include nearly 600 micro-credential programs. This follows the previous announcement of a $59.5 million investment over three years in a micro-credential strategy as part of the government's overall virtual learning strategy.

Mental Health

The Budget re-announced funding of $7 million to help increase access to mental health and addiction services for postsecondary students during COVID-19 that was announced on February 9, 2021.

This funding builds on the $19.25 million investment announced in October 2020 to support mental health supports for postsecondary students in 2020–21, an increase of $3.25 million over last year. This one-time funding will provide services to those studying on campus or virtually and is expected to focus on the needs of vulnerable and diverse groups, such as Indigenous students, LGBTQ+ students and students with disabilities.

The budget announced that Ontario is providing additional funding of $175 million in 2021–22 as part of the investment of $3.8 billion over 10 years to develop and implement a comprehensive and connected mental health and addictions strategy.

Capital & Facilities Renewal

The Budget announced $493 million over three years for postsecondary facilities renewal building on the Budget 2020 facilities renewal announcement.

$90 million in funding was announced to support the College Equipment Renewal Fund (CERF) and a new universities' Training Equipment Renewal Fund (TERF).

This new funding for universities is $30 million over three years ($10 million per year) and will be application-based with expanded project eligibility.

While MCU is not yet in a position to confirm institutional allocations to COU members for 2022-23 or 2023-34 for the FRP envelope, over the three years, universities are expected to receive approximately 64.4%of the envelope, which is an increase compared to the share allocated to universities in 2020.

Intellectual Property (IP)

The Budget stated that the government is working with universities, colleges and research institutes to clarify the commercialization mandates of postsecondary institutions with the objective of ensuring that IP generated through taxpayer-funded research will have social and economic benefits for Ontario. MCU has communicated to COU that they are currently planning consultations on this item in the spring and more information will be available shortly.

Government announced a new investment of $1.5 million in funding to support the Special Implementation Team on Intellectual Property. This funding will support the advancement of web-based IP curriculum, as well the development of a centralized Ontario resource and creation of a robust IP policy to help protect home- grown ideas and prioritize commercialization to drive Ontario's innovation ecosystem.

Shared in the lock-up, but not reflected in the budget document, is that the government will provide $6.16 million in funding over two years ($3.16 million in 2021-22 and $3 million in 2022-23) to develop an Ontario Health Data Platform IP Policy, which will create rapid access pathways to data for researchers. The government has committed to working closely with the sector on development and implementation.

Other Research Items

The Budget announced a $56.4 million investment over the next four years to create the Ontario Vehicle Innovation Network (OVIN). OVIN will accelerate the development of electric, connected and autonomous vehicles by fostering collaboration and partnerships between small and medium-sized enterprises (SMEs), academia, the auto industry and battery sector.

College Investments

The government is investing $121 million to support almost 9,000 personal support workers (PSWs), including $115 million to train up to 8,200 PSWs through publicly funded colleges.

In February 2021, the government announced an investment of $4.1 million for eight training projects, including in regions hardest hit by the pandemic, to support the training of 373 new PSWs. The government also provided up to $2.4 million through a pilot scholarship program to fund the training costs of up to 300 students for PSW positions in the Ottawa area.

Colleges (but not universities) are included along with community organizations and training providers in the $60.8 million to upgrade internet and digital infrastructure under employment and training supports.

Digital Main Street Platform

The government is investing an additional $10 million in the Digital Main Street platform for 2021-22. This follows an initial $57 million investment announced in June 2020 in partnership with the federal government. This platform is designed to help SMEs in Ontario improve their online presence and achieve digital transformation. To date, this platform has hired over 600 students to work on projects with independent businesses. These investments will generate up to 1,400 new jobs for students and recent graduates.

Invest Ontario

The Budget announced a $400 million investment over four years to create the Invest Ontario Fund, which will support Invest Ontario, the new provincial agency focused on promoting the province as a key investment destination, and encourage investments in the advanced manufacturing, technology and life sciences sectors. The agency will provide expertise and customizable investor services to support investment opportunities, such as available financial assistance, talent support, advisory supports and concierge services. One of the objectives of Invest Ontario is to leverage "the expertise of the business community, regional partners and other levels of government to inform the Corporation and the Minister on investment priorities and to enhance co-ordination with regional partners on investment opportunities in Ontario," where regional partners are postsecondary institutions.

Anti-Racism and Anti-Hate Grant

Ontario is investing $1.6 million over two years to support the Anti-Racism and Anti-Hate Grant program, which will support community-based anti-racism initiatives focusing on anti-Black racism, anti-Indigenous racism, anti-Semitism and Islamophobia.

Employment and training support

The Budget announced an investment of an additional $614.3 million for 2020-21 and 2021-22 to provide targeted employment and training supports. This includes up to:

- $85.0 million to support the Skills Development Fund to help training and employment organizations assist workers during the province's economic recovery.
- $117.3 million to assist women, racialized individuals, Indigenous peoples, youth and people with disabilities who are facing the highest rates of unemployment during the pandemic.
- $157.2 million to provide workers in the hardest-hit sectors with career counselling and urgent training to find new careers and good jobs.
- $60.8 million to upgrade and expand high-speed internet and other digital infrastructure.
- $194 million to support Ontario workers with additional employment and training programs.

AC Discussion Topic for COU Council Meeting, April 1st 2021
Planning for the post-pandemic university

This past year has been a huge challenge for all members of universities: students, faculty members, staff, and administrators. As we look forward to returning to campus in September 2021 (with some limitations and restrictions still in place) and a return to 'normal' in September 2022, the Academic Colleagues have been discussing how we incorporate the pandemic experience into short-term and longer-term planning. We have centred our discussion on two general questions related to four themes:

- What have we learnt from the past year and how we can apply those lessons in the future?
- What can we do to ensure that we provide better and more inclusive learning experiences and support for our students?

1) Equity, Diversity, and Inclusion

All universities are committed to the principles of equity, diversity, and inclusion. As we return to campus, we must do so in ways that incorporate and facilitate anti-oppressive and inclusive practices. Doing so effectively will require the collection of data to support anti-oppressive and inclusive practices.

- How can universities ensure that the return to campus does not re-inscribe inequalities?
- How do we incorporate anti-racism practices as we welcome back students to our campuses, especially Asian, Black, and international students?
- How will universities ensure the collection of appropriate data?

2) Online and Blended Learning

The online environment, including synchronous, asynchronous and blended learning, affords advantages, such as flexibility and versatility. These may increase access for many students, although it may decrease access for others. Rethinking the use of space on campus and the supports for online and in-person learning, especially human resources, is essential and will need 3-5 years to fully develop the resources and infrastructure. There are real problems with academic integrity, workload for both faculty and students, and cost that must be addressed.

- What is the appropriate balance between in-person, blended, and online learning (both synchronous and asynchronous)? Pedagogically, what teaching and learning is best done in person or through blended or online instruction?
- How will universities invest in online and blended learning (technology and people) to make it truly effective, while supporting students and avoiding re-inscribing inequalities?
- How can universities address the access issues associated with online and blended learning and provide appropriate support to students?

3) Student Mental Health

Given the disproportionate impact of the pandemic on youth and early adults and the culture shock that will be experienced by new and returning students, universities must address student mental health by developing best practices, creating equitable policies, and providing students a degree of control over their learning and workload.

- How do we support student mental health in a still evolving context to ensure student success?

- How do we maintain academic integrity and high-quality learning experiences while ensuring that we provide students (who may also be Covid survivors) compassion, flexibility, and realistic expectations?
- What lessons have we learnt from the pandemic experience to better support student mental health and to ensure that we centre student mental health in our teaching, mentoring, and academic regulations?

4) Accessibility

Universities are committed to access, particularly for traditionally underrepresented students, and the pandemic has had both positive and negative impacts on accessibility.

- What are the bridging needs for students whose learning has been interrupted by the pandemic and who is responsible for remediating? The university? The instructor? The program/faculty?
- How do we ensure adequate preparation for second-entry programs (e.g., medical or law school)? How do we ensure that access to second-entry programs is not negatively affected by the pandemic?

TO: Chabriol Colebatch, Secretary to the University and General Counsel
Brock University

FROM: Brian Power
Vice-Chair, Senate Academic Review Committee

DATE: Apr 13, 2021

REPORT TO SENATE 689, April 21, 2021

ACTION ITEMS (N/A)

DISCUSSION ITEMS (N/A)

CONSENT ITEMS – FOR APPROVAL

1. **PhD in Intelligent Systems and Data Science - New Program Proposal**

   THAT the Program Proposal Brief for the PhD in Intelligent Systems and Data Science, to be offered by the Departments of Computer Science and Mathematics and Statistics, be approved for submission to the Quality Council.

   Rationale: ARC has considered a Program Proposal Brief for a PhD in Intelligent Systems and Data Science, to be offered by the Departments of Computer Science and Mathematics and Statistics, and herewith submits the proposal (see Appendix A Volumes I and II) for the approval of Senate. Revisions to the Program Proposal Brief as a result of the external review are tracked on the document. Please note that confidential materials related to the external review of the program have been made available via the Brock Senators confidential materials folder.

2. **Applied Disability Studies - Four-Year Report**

   THAT the Four-Year Report on the cyclical review of the graduate programs in the Department of Applied Disability Studies be approved.

Rationale: ARC has considered the Four-Year Implementation Report on the cyclical review of the graduate programs in the Department of Applied Disability Studies and herewith submits the Report (see Appendix B) for the approval of Senate.

3. MA in Psychology – Major Modification

That the Request for Major Modification, to modify the admissions requirements to omit the thesis (or equivalent) requirement for the MA in Psychology, be approved.

Rationale: ARC has considered the proposed major modification to the MA in Psychology program and herewith submits the Request (see Appendix C) for the approval of Senate.

4. BSc (Honours) Biological Sciences – Major Modification

That the Request for Major Modification, to add a co-op option to the BSc (Honours) Biological Sciences, be approved.

Rationale: ARC has considered the proposed major modification to the MA in Psychology program and herewith submits the Request (see Appendix D) for the approval of Senate.

CONSENT ITEMS – FOR INFORMATION (N/A)

New Graduate Program Proposal Brief

for the

Ph.D. in Intelligent Systems and Data Science

Proponent's Contact Information (1)		*Proponent's Contact Information (2)*	
Name:	Beatrice Ombuki-Berman	*Name:*	Henryk Fuks
Title:	Professor and Graduate Program Director	*Title:*	Professor and Graduate Program Director
Unit:	Computer Science	*Unit:*	Mathematics and Statistics
E-mail:	bombuki@brocku.ca	*E-mail:*	hfuks@brocku.ca

General Information

Name of Proposed Program:	Intelligent Systems and Data Science	
Unit Offering Program:	(i) Computer Science; (ii) Mathematics and Statistics	
Degree Designation upon Graduation:	Ph.D.	
Proposed Start Date:	September 2021	
Estimated Annual Intake and Steady State Enrollment:	Intake: 5	Steady State: 20
Submission Date:	(original) May 2019; (current submission) April 12, 2021	

Commented [BR1]: Deleted June 11, 2020

Table of Contents

APPENDICES (Part 2)

1: Unit Background

1.1: Introduction and Background

Introduce the program being proposed; clearly articulate the program goals and objectives; describe the development process, identifying participants and their involvement in developing the PPB.

We dedicate this proposal to Dr Babak Farzad.

(This program proposal brief is the result of the efforts of multiple authors over many years: Michael Winter, Brian Ross, and Beatrice Ombuki-Berman from the Department of Computer Science; Babak Farzad, Omar Kihel, Henryk Fuks, and Stephen Anco from the Department of Mathematics and Statistics; and R. De Grande, Y. Li, and N. Ezzati-Jivan from Computer Science for their contributions.)

The Department of Computer Science and Department of Mathematics and Statistics propose a new thesis-based degree entitled Ph.D. in Intelligent Systems and Data Science (ISDS). The jointly designed program targets the need for highly qualified scientists to tackle challenges in artificial intelligence & machine learning, integrated smart systems, modern software systems, statistical/mathematical modelling & analytics, and big data infrastructure. Graduates will proceed to research careers in academia, industry, government, and the community.

The research activities in both departments have reached a state in which a Ph.D. program is overdue and highly desirable. Over the past decade, the M.Sc. in Computer Science and M.Sc. in Mathematics and Statistics have been very successful, with high application, enrolment, and graduation rates. Faculty in the Department of Mathematics and Statistics have actively supervised Ph.D. students in the Ph.D. Physics program at Brock. There has been long-active collaboration in bioinformatics research between the Computer Science and Biological Sciences departments, which has resulted recently in the search for a joint tier II CRC in Bioinformatics/Computational Biology. Faculty members in Computer Science organize an active research group, the Bio-Inspired Computational Intelligence Group (BICIG), which has had over 50 alumni, including 7 who obtained Ph.D.'s after leaving Brock.

The Ph.D. in Intelligent Systems and Data Science is unique in many ways:

- The degree title and focus areas (discussed below) are distinct throughout Ontario and Canada. Although similar research topics are found at departments elsewhere, no institution currently advertises a doctoral degree with this distinct integrated theme. The novelty of the program should attract many students, receive substantial research funding, nourish both departments' undergraduate programs, and significantly contribute to local and national needs.
- This interdisciplinary degree directly acknowledges the fundamental and intrinsic relationship between computer science, mathematics, and statistics. For example, mathematics and statistics provide formal discourse and theoretical justifications in intelligent data analytics, empirical computer science, and formal software development. Computer science provides advances in artificial intelligence algorithms, learning systems, software engineering, and computing technologies. Thus, this program encourages the strengthening of every student's mathematical, statistical, and programming abilities.
- The degree strives to foster a cohesive interdisciplinary program, and community of students. The program structure requires students to take courses from both host departments, as well as study together in ISDS 7P75 Ph.D. Seminar and ISDS 5N01 Scientific Writing courses (Section

3.1.1). Students with these foundational and comprehensive skills will be better able to contribute scientific and technical advancements in their research fields.

- The ~~comprehensive~~ qualifying examination requires students to write a research grant application, similar to that used for NSERC DGS. This experience will give students unique training in grant preparation.
- The degree is intended to be relevant in the short-term, as well into the foreseeable future. Firstly, it builds upon the research expertise of faculty in both host departments, who collectively have considerable research experience in mathematical and statistical modelling, computational intelligence, machine learning, formal systems, algorithms, distributed systems, and bioinformatics. Future hires will broaden and strengthen the research topics undertaken. Secondly, it acknowledges contemporary needs in a software-based, data-driven economy. A next-generation system often combines three key components: data, intelligence, and computing. Students enrolled in this program can receive training in all three components. Finally, the degree is intended to be dynamic and "future proof" and adaptable to unforeseen future developments in technology, thus enjoying long-term relevancy. For example, the term "intelligent systems" is specifically used instead of "artificial intelligence". Intelligent systems encompass a wider scope of fields than AI [1] (unfortunately, "artificial intelligence" has obtained a parochial definition by the media in recent years). The program considers artificial intelligence in its broader historical context, where AI involves multiple paradigms and technologies suitable to different kinds of problems, now and in the future. Similarly, data science is a nascent field, and the term is treated as an umbrella for both currently understood uses, and future directions and themes.
- The Ph.D. has the potential to work alongside Brock's future engineering programs. All the areas of research focus may be fertile areas of collaborative research between the Ph.D. faculty and future engineering faculty and students.
- The program gives students the opportunity to gain experience in the development and application of advanced AI algorithms, complex software systems, data analytics tools, and statistical models. The program permits application of these technologies in a broad range of interdisciplinary domains, for example, optimization, bioinformatics, health care, engineering & design, operations & management, manufacturing, climate, energy, and many others. The implementation of this program will help Niagara, Ontario, and Canada establish and maintain advantage and competency in the market and economy

The Ph.D. in Intelligent Systems and Data Science will prepare students for leading careers in academia and industry. A unique and differentiating feature of the program is that graduates of the program will have the opportunity to obtain a deep understanding of a broad selection of topics in intelligent systems and data science. They will focus their doctoral research on an area requiring the development of new scientific methods to solve complex, challenging problems. Each student will be a recognized member of the scientific community who is familiar with common research practices, such as the publication and review process, the grant application procedures, scientific event organization, and work in collaborative research environments.

Based on our vision and expertise, the following gives a non-exhaustive list of research areas of focus for the program:

1. Artificial Intelligence

- Computational intelligence: evolutionary computation, particle swarm optimization, neural networks, bio-inspired algorithms.
- Machine learning: deep learning, reinforcement learning.

- Knowledge representation & reasoning: logic, fuzzy systems, formal reasoning.
- Applications: optimization, bioinformatics.

While machine power-assisted human hands in previous industrial revolutions, machine intelligence leverages the human brain in all sectors in the new tide of technical revolution [2]. The Department of Computer Science has a long history of research in topics of artificial intelligence. The Ph.D. will advance graduate research in paradigms such as evolutionary computation, particle swarm optimization, neural networks, machine learning, knowledge representation & reasoning, and others. Our philosophy is that artificial intelligence is not a monolithic field, but rather, a broad and general domain that includes many varied technologies and paradigms. The choice of technique to use is determined by the problem to be solved, and many problems often use of multiple techniques together. Examples of the diverse problems studied in AI research are many. The solution of critical real-world problems in scheduling and resource allocation has benefitted from the use of computational intelligence [3]. Complex bioinformatics and health-informatics problems have been the subject of AI research for years [4]. Evolutionary computation has successfully solved or synthesized complex systems at a level that competes with - or exceeds - human capabilities [5]. Machine learning using deep neural networks [6] and deep reinforcement learning [7] have shown exciting breakthroughs in recent ~~years, and~~years and is attracting increased attention from industry. Formal knowledge representation and reasoning, for example, logic and fuzzy systems, is a classic area of AI that is applicable to a wide number of domains [8]. We firmly believe that these and many other paradigms in AI will be critical to solving many diverse problems in science and industry, now and in the future.

2. Smart Systems

- Software systems.
- Network & complex networks.
- Internet of things.
- High-performance computing.

Smart Systems expand on the challenges related to highly complex systems commonly involved in diverse sectors of modern society that increasingly depend upon reliable software systems. General examples include intelligent and reliable software design, engineering, testing, and debugging. The design and validation of software systems through information and environmental modelling, with the possible application of (semi-)automated AI-based tools, is an active area of interest. The use of relational and fuzzy methods, principled system design, and formal algorithm development are research strengths of the faculty. Lately, there is a need for new methodologies for the design and analysis of complex systems for smart city, grid, home, health, and transportation. This focus area tightly aligns with future R&D investments of the Government of Canada, which is committed to supporting transport and mobility innovations [9]. The efficient and reliable interconnect protocols in complex networks such as 5G and Vehicular Networks [10], and the Internet-of-Things (IoT), are areas of active research. In concert with contemporary communication and interaction paradigms, the Communications Research Centre (CRC) pointed out concerns in terms of IoT and impending spectrum ~~crunch, and~~crunch and has invested in a Big Data Analytics Centre [11], and this is a promising source of future funding for Ph.D. research.

3. Data Science

- Statistical modelling.
- Data visualization & interpretation.

- Bioinformatics, computational biology, and health informatics.
- Ethics, privacy & trust in big data systems.

Data science is the "child of statistics and computer science" [12], requiring new thinking and methodologies to process and analyze big sets of data from science, engineering, social studies, and industry for prediction, discovery, and interpretation tasks. Essentially, data science integrates three key components: statistical thinking & modelling, computational technologies & resources, and human judgement & multidisciplinary knowledge. Faculty from the Department of Mathematics and Statistics have a considerable research expertise in topics of data science and analytics. There are unprecedented opportunities for building useful bioinformatics models and tools driven by the wealth of genomic and clinical data to tackle various health challenges [13]. For example, current faculty research is exploring the application of computational statistics in neuroscience [14]. Also, there are social implications and ethical concerns regarding the use of data science and intelligent systems that must be considered, and research activities should likewise promote justice and fairness (this applies to all the research focus areas in this program) [15].

4. Mathematical methods of complex systems

- Applied optimization (discrete and continuous, applications to networks)
- Cellular automata
- Coding theory
- Computational statistics
- Complex networks and graphs
- Cryptography
- Game theory (algorithmic and fundamental)
- Nonlinear dynamical systems

A complex system is typically characterized as being composed of a large number of elements whose interactions are nonlinear. Systems of this type often exhibit hierarchical organization with variety of intercommunicating functional layers. The interactions of the system components lead to high-level emergent properties which are not apparent at the lower levels.

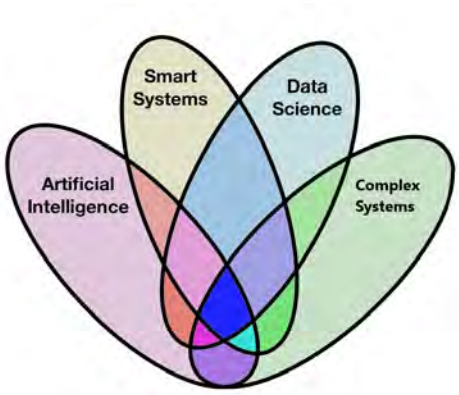
The Department of Mathematics and Statistics had developed a substantial expertise in mathematical methods which are used in the study of complex systems. This includes expertise in nonlinear dynamics and nonlinear differential equations, theory and applications of discrete, spatially extended dynamical systems such as cellular automata, discrete and continuous optimization, methods of graph theory and complex networks, applications of game theory in modeling and analysis complex systems, methods of computational statistics, and also expertise in diverse areas of pure and applied mathematics which, even if ~~the~~they are directly related to the above, serve as foundations of other methods. Some selected topics of current research directly related to complex systems conducted by members of the Department of Mathematics and Statistics are described below.

H. Fukś research interests are concentrated on the theory and applications of cellular automata, which are often viewed as a paradigm of a complex system of locally interacting components. His research is related to both the forward problem (given the topology and the interaction rule, predict the behaviour of the complex system [20]) and the inverse problem (given the observed behaviour of the system, describe its topology and its dynamical rule). The inverse problem is also known as complexity engineering, that is, devising a complex system which will perform some useful task, such as solving a concrete computational problem [21].

Convex and non-convex optimization methods are increasingly used in big-data optimization. In particular, non-convex large-scale optimization problems have found a wide range of applications in many engineering domains. The design and the analysis of large complex systems present several challenges to classical approaches based on convex analysis and necessitate the development of new optimization models and algorithms (see [16, 17]). The approach initiated in [18] appears to be promising for handling optimization problems whereby non-regularity of objectives and constraints, restrictions, incomplete or wrong evaluation of constraint functions, or the increase in the number of decision variables will alter the topology of the system. The results obtained are also currently being used to study the stability of equilibria for cooperative or non-cooperative large games, where perturbations of initial data create non-convexities yielding the failure of descent methods due to the homology of the underlying domains.

T. Wolf used optimization via genetic algorithms and heuristic methods to devise methods for solving life-and-death problems in the game of Go [19]. H. Ben-El-Mechaiekh has research interests and expertise in aspects of optimization, more precisely in the theory of variational inequalities and their applications. One of his recent papers lays the foundations for the analysis of nonlinear systems of inequalities in the absence of convexity [18].

Mathematical methods of complex systems listed above are strongly linked to the first three research areas of the proposal, namely to artificial intelligence (through nonlinearity, neural networks, optimization, computational statistics), to smart systems (through networks and graphs), and to data science (through computational statistics). Moreover, in a broader sense, all areas of Intelligent Systems and Data Science research rely on mathematical and statistical methods, and students enrolled in the proposed Ph.D. program will have access to experts in such methods in the Department of Mathematics and Statistics.



In summary, the research focus areas encompassed in the Ph.D. in Intelligent Systems and Data Science are not independent silos of research. Rather, the fields intersect one another in important and impactful ways, and students will have the opportunity to conduct research that fosters application of interdisciplinary methodologies and technologies. Of significance is that the research focus areas are adaptable to future unforeseen scientific advances. Thus, we have defined a dynamic

graduate program that will meet the present and future career needs of graduates, in both academia and industry, for many years to come.

References:

[1] G. Sheppard. "Intelligent Systems: The Big Picture", Research-Technology Management, pp.46-51, July-August 2019.

[2] J. Stajic, R. Stone, G. Chin, B. Wible. "Rise of the machines", Science, 349(6245):248-249, 2015.

[3] G. Church. "The maths problem that could bring the world to a halt", BBC, June ~~9~~9, 2019, https://www.bbc.com/future/article/20190606-the-maths-problem-that-modern-life-depends-on. Last accessed 23/02/2020.

[4] "IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology", http://cibcb.org. Last accessed 23/02/2020.

[5] "Human-Competitive Awards 2004-present", https://www.human-competitive.org/awards. Last accessed 24/02/2020.

[6] Y. LeCun, Y. Bengio, G. Hinton. "Deep learning", Nature, 521: 436-444.

[7] Y. Li. "Deep reinforcement learning: An overview", arXiv Preprint, arXiv:1701.07274, 2017.

[8] "International Conference in Relational and Algebraic Methods in Computer Science", https://link.springer.com/conference/ramics. Last accessed 24/02/2020.

[8] E. Jackson, J. Hughes, M. Daley, M. Winter. "An Algebraic Generalization for Graph and Tensor-Based Neural Networks", IEEE International Conference on Computational Intelligence in Bioinformatics and Computational Biology, 2017.

[9] Transport Canada. "Summary of the roundtable on Digital Innovation and Integration for 21st Century Transport and Mobility", Intelligent Transportation System World Congress 2017. October 2017. https://www.tc.gc.ca/eng/intelligent-transportation-system-world-congress-2017-summary-roundtable-digital-innovation-integration-21st-century-transport-mobility.html. Last accessed 24/02/2020.

[10] C. Huang, A. F. Molisch, R. He, R. Wang, P. Tang and Z. Zhong. "Machine-Learning-Based Data Processing Techniques for Vehicle-to-Vehicle Channel Modelling," IEEE Communications Magazine, vol. 57, no. 11, pp. 109-115, November 2019.

[11] Communications Research Centre. "CRC's Grand Challenges", https://www.ic.gc.ca/eic/site/069.nsf/eng/h_00046.html. Last accessed 24/02/2020.

[12] D.M. Blei and P. Smyth. "Science and data science". Proceedings of the National Academy of Sciences: 114(33): 8689–8692, 2017.

[13] E. Bender. "Big data in biomedicine", Nature, 527(7576_supp):S1-S19, 2015.

[14] W. Marshall, H. Kim, S.I. Walker, G. Tononi, L. Albantakis. "How causal analysis can reveal autonomy in models of biological systems". Philosophical Transactions of the Royal Society: A, 375:20160358, 2017.

[15] E. Gibney. "The battle to embed ethics in AI research", Nature, 577:609, 2020.

[16] A. Nedić, J-S Pang, G. Scutari, and Y. Sun. "Multi-agent Optimization", Lecture Notes in Mathematics, Springer International Publishing, 2014.

[17] A. Emrouznejad *et al.,* Eds., "Big Data Optimization: Recent Developments and Challenges", Studies in Big Data, Springer International Publishing, 2016.

[18] A. Latif and H. Ben-El-Mechaiekh. "Topological fixed point theory and applications to variational inequalities", Fixed Point Theory and Applications, Springer Open Access 84, 2015.

[19] M. Pratola and T. Wolf. "Optimizing GoTools' Search Heuristics using Genetic Algorithms", ICGA Journal 26, no 1, pp. 28-49, 2003.

[20] H. Fukś. "Orbits of Bernoulli measures in cellular automata". In R.A. Meyers, editor, Encyclopedia of Complexity and Systems Science, pages 1--19. Springer, Berlin, Heidelberg, 2017.

[21] H. Fukś. "Solving two-dimensional density classification problem with two probabilistic cellular automata". Journal of Cellular Automata, 10(1--2):149--160, 2015.

1.2: Consistency with the University's Mission and Academic Plan (IQAP 3.5.1)

Provide:

1. *A description of how the program is consistent with the mission, aims, objectives and existing strengths of the University;*
2. *An explanation of how the proposed program fits with the University's current program offerings and a demonstration of the University's capacity to deliver the proposed program;*
3. *Evidence that the proposal is consistent with the government's strategic directions (e.g., enrolment caps); and*
4. *Additional or re-allocated resources that will be required for the proposed program. A more detailed description of the resource requirements for the proposed program will be presented in Section 5.*

The proposed program aligns very well with a number of the strategic priorities and goals listed in the Brock University Institutional Strategic Plan 2018-2025, as detailed below. (Page numbers refer to the strategic plan document).

Build research capacity across the university (p.19)

Both the Department of Computer Science and Department of Mathematics and Statistics have a long history of research excellence, measured by factors such as publications, graduate student supervision, Tri-council research grants, and other government and industrial grants. The departments' respective M.Sc. programs have the highest application numbers and graduation rates in the Faculty of Mathematics and Sciences. The success of both departments' master's programs is evidence that it is time to launch a similarly successful Ph.D. program.

The Ph.D. in Intelligent Systems and Data Science is specifically designed to be an applied graduate program. Research in the Computer Science Department is highly applied, which is demonstrated by its strengths in algorithms, systems, software development, and computational intelligence. High performance computing, cryptography, network analysis and most areas in statistics are among the application-oriented research fields in the Mathematics and Statistics Department's research.

Enhance transdisciplinary research and high-impact research practices (Goal, p.20)

The program is inherently transdisciplinary, as it is being supported by two separate departments (Computer Science, and Mathematics and Statistics). Many of the research topics will permit research collaboration between these host departments and other units, for example, Biology, Earth Science, Physics, Business, and others. This has already been demonstrated by the current undergraduate and graduate programs, with examples of research collaborations in courses and thesis work ranging from

Biology, Earth Science, History, Psychology, Neuroscience, and Philosophy. As an example, an incomplete list of prior collaborations are as follows:

- Graduate theses within Earth Science using computational intelligence.
- Graduate students have taken courses in Biology and worked on Gene matching.
- Graduate thesis in Physics involving computer algebra and differential equations.
- Graduate thesis providing a mathematical model for Gibson's affordances (Psychology).
- Undergraduate project in Neuroscience/Biology.
- Undergraduate projects in History/Digital Humanities.
- Undergraduate theses in Physics.
- (near future) Undergraduate projects in Game Programming (with Humanities and Niagara College).

A research-intensive Ph.D. program will surely expand and intensify those collaborations. The number of participating faculty members from other departments is another indication that a significant number of theses will have multidisciplinary components.

Nurture a culture of research and creative excellence (Goal, p.19), and build awareness of Brock as a centre of research excellence (Goal, p.20)

The Ph.D. integrates with current and future research initiatives in both departments Faculty members participate in the Brock Institute for Scientific Computation (BISC), and the Department of Computer Science has started planning for a Centre of Intelligent Systems. The Department of Biological Sciences and Department of Computer Science are currently searching for a joint tier II CRC in Bioinformatics/Computational Biology. The Department of Mathematics and Statistics, Department of Computer Science, and Faculty of Business, are in advanced preparation of a B.Sc. in Data Science and Analytics. Computer science faculty have run an active Bio-Inspired Computational Intelligence Group over many years. Finally, Brock is heavily investing time and resources into future engineering programs. All of the above have the potential to interact with, and contribute to, the Ph.D. program.

Besides conducting a wide range of doctoral-level research led by faculty in both host departments, the Ph.D. program will be particularly effective in promoting the internationalization of research conducted at Brock University. Since the host departments' M.Sc. programs were established in 2006, approximately 130 students have graduated from the two programs. Approximately half the students have been international students from countries such as Bangladesh, Iran, Pakistan, China, Ghana, and India, showing the importance of internationalization within the programs.

In addition to the regular students, the Computer Science department hosted one exchange student from Technical University Ilmenau (Germany, in 2008), 3 students from Kobe University (Japan, 2017-2018), and six students from University of Pretoria (South Africa) since 2011. In Mathematics and Statistics, exchange students include four from Ufa State Technical University (Russia), one from Firat University (Turkey), two from China, two from Universite d'Oran (Algeria), and 3 from USTHB Algiers (Algeria). Further exchanges or stays at foreign universities or research laboratories are planned for the future. However, these endeavours are always limited by the short period of time that is available in an M.Sc. program. We expect a similar distribution of domestic and international students for the Ph.D. program as we already experience in the M.Sc. programs. In addition, due to the longer period of study for a Ph.D. student, it will become more feasible for them to spend some time at a foreign university or research laboratory. The multiple international connections of our faculty will additionally provide opportunities for this kind of exchange.

Deliver high-quality programs that meet the interest and needs of students (Goal, p.17)

These days, mathematical and computational solutions to problems are needed in almost every area of academia, business, and everyday life. The proposal for a new Ph.D. program in Intelligent Systems and Data Science addresses a societal need for highly qualified scientists with this problem-solving expertise, particularly in industry, government, research, and technology. The Ph.D. in Intelligent Systems and Data Science is in a sense an unusual degree. Most Ph.D. degrees are best suited towards academic careers. This degree is equally, if not more suitable, towards careers in business and industry. The significant technical complexities of modern industry, and their need for solutions requiring expertise in intelligent systems and data science in particular, as well as statistics, mathematics, and computing in general, justify the demand for such a high-level degree. We will further expand on the topic of emerging societal need in Section 8.

1.3: Alignment with the Strategic Mandate Agreement

Provide a description of how the proposed program is consistent with the program areas of strength or growth included in the current SMA.

Brock University's Strategic Mandate Agreement v.2 explicitly prioritizes the Ph.D. in Computer Science as a strategically important new graduate program [1]. Since that time, the Ph.D. has further evolved into the joint program offered by the Department of Computer Science and Department of Mathematics and Statistics. The proposed program strongly supports the strategic priorities listed in the SMA 2 in many ways.

Technology Development

The Ph.D. in Intelligent Systems and Data Science directly and firmly supports the Brock SMA 2's identified strength in technology development. Of particular note are recent news articles that outline the Federal government's strategic funding of research in artificial intelligence, data science, and smart systems technologies in Canada (e.g. [2],[3], [4], [5], [6]). Several faculty members (Wolf, Ombuki-Berman, Houghten, Ross, Li) are active in areas of AI, and in particular, computational intelligence. Smart systems, distributed systems, parallel algorithms, and software testing is studied (de Grande, Qiu, Ezzati-Jivan). Research in formal knowledge representation and reasoning is pursued by (Winter). Two faculty members (Marshall, Xu) work in the areas of optimization techniques for active learning and computational algorithms for big data. Other faculty (Marshall Houghten, Ombuki-Berman, Fuks, Ross, Li) do research related to data science, for example, complex networks, bio-networks, and feature extraction. The Department of Computer Science is planning the creation of a Centre of Intelligent Systems, and the Ph.D. program is a valuable aspect of the Centre. Other expertise from both departments covers a wide range of research areas, ranging from scientific computation, statistical and mathematical modelling, formal reasoning, algorithms, software engineering, and many others.

Research Excellence and Impact, and Transdisciplinary Research

One of the highlighted themes of Brock's differentiation as part of the past and future SMAs is its strength in transdisciplinary research. The proposed Ph.D. will promote Brock's efforts in transdisciplinary research into critically important areas, namely development of quantitative methods to solve complex problems in intelligent systems and data science. The potential for such transdisciplinary program is evident when one examines past and current faculty research collaborations, which include other faculty in Biology, Earth Sciences, Physics, Digital Humanities, Philosophy, and others. In addition, the M.Sc. degrees in both departments have been highly transdisciplinary in nature, with applications involving a wide range of topics outside the respective

departments. The Ph.D. also creates opportunities for collaborative research in a number of research aspirations of Brock, including but not limited to:

- Gaming
- Bioinformatics and Health Informatics
- Interactive Arts and Science
- Centre of Neuroscience
- Centre for Business Analytics
- Brock Research and Innovation Centre
- Brock Institute for Scientific Computation (BISC)

Innovation, Economic Development, and Community Engagement

A modern economy cannot ignore technology for its future well-being. This requires training future generations of scientists, with expertise in intelligent systems and data science. Training highly skilled experts in information technology is critically important for the future economy of Canada, as well as the Niagara area. For example:

- Technology is identified as being the fastest growing economic sector in Canada. [7]
- The Canadian Chamber of Commerce states that Canada must focus its efforts in innovation and technological development, for the good of its future economy. [8]

[1] Strategic Mandate Agreement (2017-2020), https://brocku.ca/vp-academic/wp-content/uploads/sites/65/SMA-2-April-18.docx, and Appendix, https://brocku.ca/vp-academic/wp-content/uploads/sites/65/SMA-Appendix-Brock-University-April-19.xlsx?x21735.

[2] "Canada funds $125 million Pan-Canadian Artificial Intelligence Strategy", http://www.newswire.ca/news-releases/canada-funds-125-million-pan-canadian-artificial-intelligence-strategy-616876434.html. Last accessed 24/02/2020.

[3] "Federal budget 2017: Ottawa aims to make Canada digital leader with AI strategy, support for fintech", http://business.financialpost.com/fp-tech-desk/federal-budget-2017-ottawa-aims-to-make-canada-digital-leader-with-ai-strategy-support-for-fintech-entrepreneurs . Last accessed 24/02/2020.

[4] Transport Canada. "Summary of the roundtable on Digital Innovation and Integration for 21st Century Transport and Mobility", Intelligent Transportation System World Congress 2017. October 2017. https://www.tc.gc.ca/eng/intelligent-transportation-system-world-congress-2017-summary-roundtable-digital-innovation-integration-21st-century-transport-mobility.html. Last accessed 24/02/2020.

[5] Canada's Digital Charter in Action: A Plan by Canadians, for Canadians https://www.ic.gc.ca/eic/site/062.nsf/eng/h_00109.html . Last accessed 24/02/2020.

[6] Positioning Canada to Lead in a Digital- and Data-driven Economy: Discussion Paper https://www.ic.gc.ca/eic/site/084.nsf/eng/00007.html . Last accessed 24/02/2020.

[7] "Technology Industry is Canada's Fastest Growing Economic Sector", https://www.mentorworks.ca/blog/market-trends/technology-industry-in-canada-2016/. Last accessed 24/02/2020.

[8] "Moving Canada's Economy Forward with Technology", http://www.chamber.ca/media/news-releases/151006-moving-canadas-economy-forward-with-technology/ . Last accessed 24/02/2020.

1.4: Appropriateness of Degree Nomenclature (IQAP 3.5.1)

Indicate the specific degree to be awarded upon completion of the program, ~~e.g.~~e.g., MA, M.Sc., ~~Ph.D.~~Ph.D. Indicate the program name to be included with the degree, ~~e.g.~~e.g., MA in Applied Health Sciences.

Ph.D. in Intelligent Systems and Data Science.

1.5: Fields in a Graduate Program (if applicable) (IQAP 3.5.14)

The inclusion of fields within a graduate program is optional. If a graduate program wishes to have the Quality Council endorse fields, clearly identify the fields below.

None.

2: Degree Level Expectations and Learning Outcomes

This section provides information on the degree level expectations (DLEs) and learning outcomes of the proposed program.

Brock DLEs and Faculty DLEs (where available) are included in Table 2.1. Both the overall program and the individual courses are assessed against these DLEs in terms of learning outcomes. The curricular content, admission requirements, mode of delivery, bases of evaluation of student performance, commitment of resources and overall quality of any academic program and its component courses are all related to its learning outcomes.

Proponents are advised that a curriculum map that links course learning outcomes to articulated program learning outcomes mapped to the DLEs shall be included in the PPB. As part of this process, proponents must also document and demonstrate the methods by which the performance level of students, based on the learning outcomes, will be assessed by the program.

Under the following headings, the proponents will provide a description of the program's learning outcomes and their consistency with Brock's and the Faculty's mission and degree level expectations [IQAP 3.5.1]. This will include an explanation of the ways in which the program assesses the extent to which students have achieved those outcomes.

2.1: Course Learning Outcomes (CLOs) (IQAP 3.5.1)

Course learning outcomes, which support the program learning outcomes, are reported in copies of Table A.1 for each course in the proposed program. Completed copies of Table A.1 are to be included in Appendix A.
Provide comments on the range, variety and rationale of the course learning outcomes. Course learning outcomes will be summarized to the program level, with the latter reported in Table 2.1 in the next section.

The learning outcomes of courses eligible for graduate-level credit are in Appendix A. All the courses use typical pedagogical methods for knowledge delivery and assessment. Lectures are the main means by which most students are exposed to course content. Assessment methods are typically assignments, tests, class seminars/presentations, and projects. In some graduate courses, projects are particularly stressed, as they permit students to independently apply course material towards creatively solving a non-trivial problem.

2.2: Program Learning Outcomes (PLOs) (IQAP 3.5.1)

Table 2.1 presents the program learning outcomes linked to the Brock and Faculty DLEs.
Address the clarity and appropriateness of the program requirements and associated learning outcomes in meeting the University's graduate DLEs.

Table 2.1 is successfully adopted by all doctoral programs at Brock University. The university-wide GDLEs (column one) address the most germane qualities associated with doctoral-level studies: depth, breadth, level of application, and limits of knowledge; research and scholarship, along with associated practices; professional autonomy and capacity; and communication skills. All the CLOS in Appendix A address many of the PLOs in Table 2.1. The ~~comprehensive~~ qualifying examination, research publications, thesis defense, and other associated program requirements complete the coverage of the GDLEs. Thesis research is undoubtedly the most important aspect of a Ph.D. program, and is likewise the cornerstone of the proposed Ph.D. degree.

2.3: Assessment of Teaching and Learning (IQAP 3.5.6)

Table 2.2 presents the program learning outcomes mapped to the modes of delivery and the methods of assessment for the proposed program.
a) With reference to Table 2.1 - 2.2, document the appropriateness of the proposed methods of assessment of the student achievement of the intended program learning outcomes and degree level expectations.
Include a numbered list of all assessment methods employed in the program(s). [IQAP 3.5.6].

Generally, the methods of assessment follow the same structure as already established for the host departments' M.Sc. programs. These methods fall into two categories:

(i) Courses: Courses employ a wide range of assessment methods. The most frequent methods are formal test, quizzes, and written/programming assignments. These are traditional methods of assessment, usually involving solving computational, mathematical, and statistical problems in a controlled environment (tests and quizzes) or outside of the classroom (written assignments). We believe that these methods are very effective to measure depth and breadth of knowledge, as well as the level of application of knowledge. Moreover, they are indispensable in evaluating written communication skills specific to computer science, mathematics, and statistics, such as analyze or implement an algorithmic solution to a problem, or the ability to justify steps in calculations and proofs.

Computer science courses often use a term project, which involves independent research by the student. Depending upon the course, the project may involve implementing a system using some principles discussed in the ~~course, or~~course or undertaking empirical experimentation. Projects usually are assessed by the instructor by grading a written report, which often takes the form of a scientific paper.

In addition to test, assignments, and projects, some kind of oral assessment is used in the majority of courses. This may involve a formal presentation or seminar delivered by the student, or in mathematics and statistics, informal discussion at the blackboard. These assessment methods complement tests and written assignments. We find them very useful not only in evaluating communication skills, but also in determining students' facility with problem solving, abstraction and logical reasoning, as well as in evaluating the depth of their knowledge of the subject.

Following the Brock guidelines, the course outline of each course specifies the method of assessment, dates, and relative weights of evaluation items. Course outlines are made available to the students in the first week of classes. A graduate student has to achieve a grade of at least 70% in order to receive credit for the course. At the end of each course, students will normally have the opportunity to provide feedback on the course content and instructor by completing a course evaluation. These course evaluations will follow the standard procedures, as outlined in the departments' procedures.

(ii) Supervision and Supervisory Committee: After a student has finished the required courses a supervisory committee is established following the guidelines outlined in the Graduate Program Handbook (see Appendix A). The supervisory committee consists of the supervisor and two additional faculty members. The supervisor, with the support of the supervisory committee, provides guidance and instruction in the research activities of the student. In addition, they are the main contributor in the ongoing evaluation process during the research work of the student. They monitor the student's progress and performance on a regular basis. The progress of the student will be documented by a written progress report twice a year.

Numbered list of all assessment methods:

1. Lectures
2. Assignments
3. Projects
4. Seminars
5. Labs
6. Supervision/individual guidance
7. Self study
8. Thesis proposal/NSERC application

b) Outline the plan for documenting and demonstrating the level of performance of students, and the consistency of the plan with the University's statement of its degree level expectations.

The program will conduct an exit survey of all students when they graduate from their studies. In addition, the program plans to keep track of graduates through their first 5 years after graduating. During the 4th or 5th year after graduation, we will send each graduate a short survey, querying her or him on their opinions of their Ph.D. experience in the program. We feel that it takes a number of years before graduates will have a balanced and knowledgeable opinion of their Ph.D. experience, especially regarding its value in obtaining suitable employment. Topics on the survey will include the perceived value of their graduate education, its usefulness in their subsequent career paths, and opinions on the strengths, weaknesses, and improvements to the program. The feedback from the survey will be collected by the GPDs in each ~~department, and~~department and will be studied and evaluated by the respective graduate committees. The departments will discuss possible revisions when changes seem worthy of consideration.

2.4: Program Curriculum Map (IQAP 3.5.1)

Table 2.3 presents a curriculum map that links the program learning outcomes with the methods of assessment employed and the degree of implementation for each course in the program. Based on the curriculum map provide an analysis of and describe plans to address duplication, gaps and areas for improvement in the program.

Table 2.3 (found at the end of this document) maps program learning outcomes to the curriculum. Since the Ph.D. program does not devote excessive time to courses, there is minimal "progression" (the colour coding for "Degree of Implementation"). Rather, the course requirements offer a breadth of knowledge. On the other hand, the Scientific Writing course, Ph.D. Seminar, and Ph.D. Thesis (bottom of table) illustrate a clearer progression. The Scientific Writing course introduces scientific authorship, which can be applied throughout the other courses, and especially the Ph.D. examination/thesis. The Ph.D. thesis itself is the canonical means by which a doctoral candidate proves mastery over scientific research and scholarship, as pursued during the degree.

2.5: Modes of Delivery (IQAP 3.5.5)

Discuss the formats (lecture, seminar, independent research, projects, etc.) by which the program will be delivered and the appropriateness of the proposed delivery mode(s) in meeting the program's intended learning outcomes and Graduate Degree Level Expectations (GDLEs). The Proponents will discuss the methods of delivery (face to face, online, blended, independent study, etc.) to be employed in delivering the program content and the rationale for the various delivery methods to be used.

Table 2.2 provides a mapping of the different ways that students will demonstrate their knowledge, and the different ways students will be assessed during their study, in relation to the modes of delivery, the learning outcomes of the program, and Brock's GDLEs. Notice that the distribution between the different components may vary due to different course selections and/or different styles in supervision. However, a base line is established through the program requirements in terms of number of courses, ~~comprehensive~~ qualifying examination, thesis preparation, and defense.

A significant number of courses require, as part of student evaluation, presentation of a project or of a significant independent assignment/project, as shown in Table 2.2. This is critically important in graduate education, as it permits students to independently apply their expertise to non-trivial problems in computer science, mathematics, and statistics. Nevertheless, the most intensive area of student engagement and inquiry-based learning is the mandatory Ph.D. thesis (ISDS 7F90), which involves successful passing of the qualifying~~comprehensive~~ examination, as well as defense.

Due to the small graduate student/faculty ratio for the program, students will always enjoy a high level of interaction with their supervisors and instructors.

Table 2.1: Doctoral Degree - Mapping Program Outcomes to Graduate Degree Learning Expectations

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Faculty specific GDLES** *A graduate of the Faculty of Mathematics and Science will be able to demonstrate:*	**Program Outcomes aligned with GDLES** *At the end of this program, the successful student will be able to demonstrate:*
1. Depth and Breadth of Knowledge A thorough understanding of a substantial body of knowledge that is at the forefront of their academic discipline or area of professional practice including, where appropriate, relevant knowledge outside the field and/or discipline.	A thorough understanding of a substantial body of knowledge in science, technology, or mathematics, that is at the forefront of their academic discipline or area of professional practice including, where appropriate, relevant knowledge outside the field and/or discipline.	1a. A systematic understanding of the field; 1b. Wide knowledge in the major areas of the discipline; 1c. Mastery of the appropriate skills and methods of research; 1d. Relevant knowledge in areas of application outside of the field;
2. Research and Scholarship **a)** The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen circumstances; **b)** The ability to make informed judgments on complex issues in specialist fields, sometimes requiring new methods; **c)** The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.	a) The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of science, technology, or mathematics, and to adjust the research design or methodology in the light of unforeseen problems; b) The ability to make informed judgments on complex issues in specialist fields in science, technology or mathematics, sometimes requiring new methods; and c) The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.	2a. Ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity; 2b. Capacity for critical analysis, evaluation and synthesis of new and complex ideas; 2c. Capability to participate actively in his/her academic community by communicating with peers, the larger scholarly community and with society in general about their areas of expertise; 2d. Ability to contribute to his/her specific field of study through original and substantial research that led to an international refereed publication;
3. Level of application of knowledge The capacity to a) undertake pure and/or applied research at an advanced level; and b) contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.	The capacity to a) undertake pure and/or applied research in science, technology or mathematics at an advanced level; and b) contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.	3a. Recognition as expert in the area of research that his/her thesis addresses; 3b. The ability to organize and carry out complex research on an individual basis; 3c. Ability to reason at a level of abstraction that is appropriate; 3d. Ability to make use of a range of existing theories, techniques and tools relevant to their field of research; 3e. Ability to refine existing techniques and/or develop new techniques in the process of solving a complex research problem;

Table 2.1: Doctoral Degree - Mapping Program Outcomes to Graduate Degree Learning Expectations

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Faculty specific GDLES** *A graduate of the Faculty of Mathematics and Science will be able to demonstrate:*	**Program Outcomes aligned with GDLES** *At the end of this program, the successful student will be able to demonstrate:*
		3f. Ability to find new research projects within their field of interest;
4. Professional capacity/autonomy **a)** The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations; **b)** The intellectual independence to be academically and professionally engaged and current; **c)** The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; **d)** The ability to evaluate the broader implications of applying knowledge to particular contexts.	a) The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations; b) The intellectual independence to be academically and professionally engaged and current; c) The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and d) The ability to evaluate the broader implications of applying knowledge to particular contexts.	4a. Awareness of the publication process in peer-reviewed outlets, and be able to select an appropriate outlet for articles reporting on his/her research work; 4b. Ability to create a small network of research collaborators; 4c. Ability to contribute to a long-term collaborative research project; 4d. Ability to establish his/her own research program; 4e. Ability to craft a promising application for significant funding; 4f. Ability to implement a career as an independent researcher and/or professional in academia and/or industry;
5. Level of communications skills The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively**.**	The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.	5a. Ability to communicate effectively and professionally both in speaking and writing with experts and the general audience; 5b. Knowledge of issues related to ethical conduct in science, and be able to engage in discussions on this topic both with their peers and the general public in an informed and reasoned fashion; 5c. Ability to select appropriate tools and software to analyze and communicate data and his/her results; 5d. Ability to work with other researchers including non-Computer Scientists on a project of common interest; 5e. Expertise at finding information that is relevant to his/her research work;
6. Awareness of the limits of knowledge	An appreciation of the limitations of one's own work and discipline, of the complexity of	6a. Awareness of the limitations of his area of expertise in theory and praxis;

Table 2.1: Doctoral Degree - Mapping Program Outcomes to Graduate Degree Learning Expectations

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Faculty specific GDLES** *A graduate of the Faculty of Mathematics and Science will be able to demonstrate:*	**Program Outcomes aligned with GDLES** *At the end of this program, the successful student will be able to demonstrate:*
An appreciation of the limitations of one's own work and discipline, of the complexity of knowledge, and of the potential contributions of other interpretations, methods, and disciplines.	knowledge in science, technology or mathematics, and of the potential contributions of other interpretations, methods, and disciplines.	6b. Awareness of potential contributions of other interpretations, methods, and disciplines.

Table 2.2: Doctoral Degree - Mapping Program Outcomes to Modes of Delivery and Methods of Assessment

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Program GDLES/Learning Outcomes** *A the end of this program, the successful student will:*	**Modes of Delivery**	**Assessment Methods** *Students can demonstrate their knowledge/ are assessed through the following methods:*
1. Depth and Breadth of Knowledge A thorough understanding of a substantial body of knowledge that is at the forefront of their academic discipline or area of professional practice including, where appropriate, relevant knowledge outside the field and/or discipline.	1a. Demonstrate a systematic understanding of the field; 1b. Demonstrate wide knowledge in the major areas of the discipline; 1c. Demonstrate mastery of the appropriate skills and methods of research; 1d. Show relevant knowledge in areas of application outside of the field;	1. Lectures (a, b, c) 2. Assignments (a, b, c) 3. Projects (a, b, c, d) 4. Seminars (a, b, c, d) 5. Labs (a, b, c) 6. Supervision/Individual Guidance (a, b, c, d) 7. Self Study (a, b, c, d)	• Participation (1, 4) • Tests/Exams (1, 2, 4, 5) • Assignments (1, 2, 4, 5, 7) • Projects (1, 2, 3, 6, 7) • Essay/Research Paper (1, 2, 3, 4, 6, 7) • Thesis (4, 6, 7) • Oral Presentation (3, 4, 6, 7) • Qualifying~~Comprehensive~~ Examination (1, 2, 3, 4, 5, 6, 7) • Peer Review (3, 4)
2. Research and Scholarship a) The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen circumstances; b) The ability to make informed judgments on complex issues in specialist fields, sometimes requiring new methods; c) The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.	2a. Be able to conceive, design, implement and adapt a substantial process of research with scholarly integrity; 2b. Demonstrate capacity for critical analysis, evaluation and synthesis of new and complex ideas; 2c. Is capable to participate actively in his/her academic community by communicating with peers, the larger scholarly community and with society in general about their areas of expertise; 2d. Have made a contribution to his/her specific field of study through original and substantial research that led to an international refereed publication;	1. Lectures (a, b, c) 2. Assignments (a, b) 3. Projects (a, b, c, d) 4. Seminars (a, b, c) 5. Labs (a, b) 6. Supervision/Individual Guidance (a, b, c, d) 7. Self Study (a, b, d) 8. Thesis Proposal/NSERC application (a, b, c, d)	• Participation (1, 4, 5) • Assignments (1, 2, 4, 5) • Projects (1, 2, 3, 4, 5) • Essay/Research Paper (1, 2, 3, 6, 7, 8) • Thesis (6, 7, 8) • Oral Presentation (4, 8) • Peer Review (3, 4, 8)

Table 2.2: Doctoral Degree - Mapping Program Outcomes to Modes of Delivery and Methods of Assessment

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Program GDLES/Learning Outcomes** *A the end of this program, the successful student will:*	**Modes of Delivery**	**Assessment Methods** *Students can demonstrate their knowledge/ are assessed through the following methods:*
3.Level of application of knowledge The capacity to a) undertake pure and/or applied research at an advanced level; and b) contribute to the development of academic or professional skills, techniques, tools approaches, and/or materials.	3a. Be a recognized expert in the area of research that his/her thesis addresses; 3b. Have demonstrated the ability to organize and carry out complex research on an individual basis; 3c. Be able to reason at a level of abstraction that is appropriate; 3d. Be able to make use of a range of existing theories, techniques and tools relevant to their field of research; 3e. Be able to refine existing techniques and/or develop new techniques in the process of solving a complex research problem; 3f. Be able to find new research projects within their field of interest;	4. Seminars (a, b, c, d, e, f) 6. Supervision/Individual Guidance (a, b, c, d, e, f) 7. Self Study (a, b, c, d, e, f) 8. Thesis proposal/NSERC application (a, b, c, d, e, f)	• Thesis (6, 7, 8) • Publication (6, 7, 8) • Peer Review (4, 8) • Oral Presentation (4, 8)
4.Professional capacity/autonomy a) The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations; b) The intellectual independence to be academically and professionally engaged and current; c) The ethical behaviour consistent with academic integrity and the use of	4a. Be aware of the publication process in peer-reviewed outlets, and be able to select an appropriate outlet for articles reporting on his/her research work; 4b. Be able to create a small network of research collaborators; 4c. Be able to contribute to a long-term collaborative research project; 4d. Be able to establish his/her own research program;	1. Lectures (a, f) 2. Assignments (c, d, f) 3. Projects (b, c, d, f) 4. Seminars (e, f) 6. Supervision/Individual Guidance (a, b, c, d, e, f) 7. Self Study (a, b, c, d, e, f) 8. Thesis Proposal/NSERC application (a, b, c, d, e, f)	• ~~Comprehensive~~ Qualifying Examination (1, 2, 3, 8) • Thesis (6, 7, 8) • Publication (6, 7) • Peer Review (3, 4, 8)

Table 2.2: Doctoral Degree - Mapping Program Outcomes to Modes of Delivery and Methods of Assessment

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Program GDLES/Learning Outcomes** *A the end of this program, the successful student will:*	**Modes of Delivery**	**Assessment Methods** *Students can demonstrate their knowledge/ are assessed through the following methods:*
appropriate guidelines and procedures for responsible conduct of research d) The ability to evaluate the broader implications of applying knowledge to particular contexts.	4e. Have demonstrated the ability to craft a promising application for significant funding; 4f. Be able to implement a career as an independent researcher and/or professional in academia and/or industry;		
5. Level of communications skills The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.	5a. Communicate effectively and professionally both in speaking and writing with experts and the general audience; 5b. Be well informed of issues related to ethical conduct in science, and be able to engage in discussions on this topic both with their peers and the general public in an informed and reasoned fashion; 5c. Be able to select appropriate tools and software to analyze and communicate data and his/her results; 5d. Be able to work with other researchers including non-Computer Scientists on a project of common interest; 5e. Be experts at finding information that is relevant to his/her research work;	1. Lectures (b, c, e) 2. Assignments (a, b, c, e) 3. Projects (a, b, c, e) 4. Seminars (a, b, c, d, e) 6. Supervision/Individual Guidance (a, b, c, e) 7. Self Study (b, c, e) 8. Thesis Proposal/NSERC Application (a, b, c, d, e)	• Participation (1, 4) • Oral Presentation (4) • Thesis (4, 6, 7, 8) • Publication (6, 7) • Essay/Research Paper (2, 3, 6, 7)
6. Awareness of the limits of knowledge An appreciation of the limitations of one's own work and discipline, of the complexity of knowledge, and of the potential contributions	6a. Be aware of the limitations of his area of expertise in theory and praxis; 6b. Be aware of potential contributions of other interpretations, methods, and disciplines.	1. Lectures (a, b) 4. Seminars (a, b) 6. Supervision/Individual Guidance (a, b) 7. Self Study (a, b)	• Thesis (6, 7, 8) • Publication (6, 7, 8) • Peer Review (4, 8) • Oral Presentation (4, 8)

Table 2.2: Doctoral Degree - Mapping Program Outcomes to Modes of Delivery and Methods of Assessment

Program: Ph.D. in Intelligent Systems and Data Science

Brock University GDLEs *A graduate of Brock University will be able to demonstrate:*	**Program GDLES/Learning Outcomes** *A the end of this program, the successful student will:*	**Modes of Delivery**	**Assessment Methods** *Students can demonstrate their knowledge/ are assessed through the following methods:*
of other interpretations, methods, and disciplines.		8. Thesis Proposal/NSERC Application (a, b)	

Note:

- Column 2 is taken from Table 1.1 column 3.
- Letters in blue in column 3 index GDLES/learning outcomes in column 2.
- Numbers in red in column 4 index modes of delivery in column 3.

3: The Program

3.1: Program Structure, Curriculum and Governance (IQAP 3.5.3)

3.1.1: Program Structure

Describe the program structure and include a breakdown of courses on a year-by-year or semester-by-semester basis. Explain how the proposed structure achieves the program learning outcomes and degree level expectations. In describing the structure, the Proponent will address the total number of credits or courses necessary for completion. Provide clear rationale for the program length that ensures that the program requirements can be reasonably completed within the proposed time period.

The program will normally follow a three-stage procedure. First, students will take courses in the graduate program. Then they will complete a ~~comprehensive~~ qualifying examination. Students will then perform their doctoral thesis research, ~~-~~and write and defend their thesis. The details of the program are as follows.

Course Requirements

Students holding an M.Sc. or transferring from an M.Sc. program must complete a total of 6 half-credit courses (this includes any transfer credits undertaken during M.Sc. studies for option (b) students). Students entering directly from undergraduate program must complete 8 half-credit courses. Courses selection is done in consultation with the supervisor, who is identified during admission. Course selection is primarily overseen by the supervisor, and is regulated by the following points:

- Required courses for all students: ISDS 7P75 Ph.D. Seminar and ISDS 5N01 Scientific Writing (normally taken together in the same term, see also Section 3.1 and 4.2).
- All other courses must be COSC/MATH half-credit courses at the 5(alpha)00 or above level.
- With respect to the COSC/MATH courses selected, students supervised by faculty in the Computer Science Department must take at least one graduate course in Mathematics or Statistics. Similarly, students supervised by faculty from the Mathematics and Statistics Department must take at least one graduate course in Computer Science. This requirement supports the interdisciplinary nature of the degree. Each department will ensure that a course appropriate to students with both computer science and mathematics/statistics backgrounds is offered every year.
- Exceptions to the above regulations must be approved by the student's supervisor and the Graduate Program Committee.

Qualifying~~Comprehensive~~ Examination

After all course requirements have been completed, but within the first 24 months of the program, all students must successfully complete a ~~comprehensive~~ qualifying examination. Prior to the exam, the student must submit a written proposal of research in the form of an NSERC PGS D grant application or, in the case of students planning a career in industry, a MITACS grant application or other industry appropriate funding source grant application. The student will be guided by the supervisor and the supervisory committee while preparing this application. The examination committee consists of the supervisory committee, and one additional faculty member from the program. The additional faculty member and one member of the supervisory committee will each provide a topic different from the student's research area together with sufficient study material at least 3 months prior to the examination. The examination will start with a presentation by the student about his/her research, followed by questions from the examination committee about this

research. The examination concludes with questions about the topics provided by the two members of the examination committee. The examination can be repeated once within four months.

Thesis and Thesis Defense

Before the thesis (ISDS 7F90) is submitted for defense, parts of the thesis have to be published in, or submitted to, a peer-reviewed international journal or conference. The supervisory committee will decide whether a thesis is ready for defense. The examination committee is chaired by the Dean of Graduate Studies or designate, and consists of the supervisory committee, an internal examiner (from outside the graduate program but within Brock University), and an external examiner. The defense is open and will start with a presentation by the student about his/her research, followed by questions from the examination committee.

The following table summarizes the structure of the program by providing a typical timeline of events during the stay in the program depending on the chosen option of entry.

Typical Timelines

		Option a Regular Entry	Option b Transfer from M.Sc. program	Option c Direct Entry with Bachelor's degree
Year 0			Study in the M.Sc. program	
Year 1	Fall	2-3 half-credit courses	2-3 half-credit courses	3 half-credit courses
	Winter	2-3 half-credit courses	2-3 half-credit courses	3 half-credit courses
	Summer	0-1 half-credit course Preparation Comp. Exam Research work/thesis	0-1 half-credit course Preparation Comp. Exam Research work/thesis	2 half-credit ~~course~~courses Preparation Comp. Exam Research work/thesis
Year 2	Fall	Preparation Comp. Exam Research work/thesis	Preparation Comp. Exam Research work/thesis	Preparation Comp. Exam Research work/thesis
	Winter	~~Comprehensive~~ Qualifying Exam Research work/thesis	Qualifying~~Comprehensive~~ Exam Research work/thesis	Qualifying~~Comprehensive~~ Exam Research work/thesis
	Summer	Research work/thesis	Research work/thesis	Research work/thesis
Year 3	(entire)	Research work/thesis	Research work/thesis	Research work/thesis
Year 4	Fall	Research work/thesis	Research work/thesis	Research work/thesis
	Winter	Research work/thesis	Research work/thesis	Research work/thesis
	Summer	Defense	Defense	Defense

3.1.2: Courses and Curriculum

Define the program length and provide a clear rationale that addresses the ability of students to complete the program requirements within the proposed time period. Clearly indicate required or core and elective courses for the program. Describe the contribution of any capstone experience to the program and the connection to the learning outcomes.

Length of Study

For full-time students entering the Ph.D. program with options (a) and (c) in 3.1.1, the program is normally a 12 term or four-year program. For M.Sc. students transferring into the Ph.D. program (option b), the program is normally a 15 term or five-year program, which includes the time spent in the master's program. Full-time students must complete all degree requirements within 6 years from the date of first registration. Part-time students must complete all degree requirements within 8 years from the date of first registration.

The course offerings are based on the current offerings in the graduate programs. The determination of Core or Elective courses will be determined by the supervisor. The courses are listed in Table 3.1. New courses will be added to the course bank as new tenure-track faculty are hired. The following courses are compulsory in the program, and will be added to the course bank:

- ISDS 5N01 – Scientific Writing
- ISDS 7P75 – Ph.D. Seminar

ISDS 5N01 will be taught by instructors from Brock Student Development Centre. The remaining courses are electives. The student may select from any course in the course bank, under the advice and approval of the student's supervisor. The host departments' contributions to the course bank cover the following major research areas of computer science, mathematics, and statistics:

- *Artificial intelligence*: COSC 5P71, COSC 5P72, COSC 5P73, COSC 5P74, COSC 5P77, COSC 5P78
- *Data Science*: COSC 5P08, COSC 5P76
- *Systems*: COSC 5P06, COSC 5P07, COSC 5P72, COSC 5P73
- *Formal methods*: COSC 5P02, COSC 5P03, COSC 5P05
- *Algorithms*: COSC 5P01, COSC 5P04
- *Methods of applied mathematics, differential equations and dynamical systems*: MATH 5P20, MATH 5P30, MATH 5P60, MATH 5P09, MATH 5P31, MATH 5P64
- *Statistical methods*: MATH 5P81, MATH 5P82, MATH 5P83, MATH 5P84, MATH 5P85, MATH 5P86, MATH 5P87, MATH 5P88
- *Graph and game theory*: MATH 5P35, MATH 5P36

In addition to the above, students can select courses from other areas of mathematics, including algebra and number theory (MATH 5P10, MATH 5P15, MATH 5P50, MATH 5P92), functional analysis and topology (MATH 5P40, MATH 5P70) and technology in math education (MATH 5P96).

Table 3.1: Summary of course information for Program in Ph.D. in Intelligent Systems and Data Science.

Course No.	Course Name	Core or Elective	Contact hrs/wk	Delivery Mode
ISDS 5N01	Scientific Writing	C	4	Seminars

ISDS 7P75	Ph.D. Seminar	C	4	Lec
COSC 5P01	Coding Theory	E	4	Lec/seminars
COSC 5P02	Logic in Computer Science	E	4	Lec/seminars
COSC 5P03	Universal Algebra in Computer Science	E	4	Lec/seminars
COSC 5P04	Parallel Algorithms	E	4	Lec/seminars
COSC 5P05	Introduction to the Lambda Calculus	E	4	Lec/seminars
COSC 5P06	Principles of Mobile Cloud Computing	E	4	Lec/seminars
COSC 5P07	Fundamentals of Parallel and Distributed Systems	E	4	Lec/seminars
COSC 5P08	Algorithms for Data Science	E	4	Lec/seminars
COSC 5P71	Genetic Programming	E	4	Lec/seminars
COSC 5P72	Robot Control Architectures	E	4	Lec/seminars
COSC 5P73	Computer Vision	E	4	Lec/seminars
COSC 5P74	Evolutionary Computation	E	4	Lec/seminars
COSC 5P75	Directed Reading	E	4	Lec/seminars
COSC 5P76	Non-invasive Data Analysis	E	4	Lec/seminars
COSC 5P77	Recent Advances in Computational Intelligence	E	4	Lec/seminars
COSC 5P78	Machine Learning	E	4	Lec/seminars
MATH 5P10	Groups, Rings, and Group Rings	E	4	Lec/seminars
MATH 5P35	Graph Theory	E	4	Lec/seminars
MATH 5P50	Algebraic Number Theory	E	4	Lec/seminars
MATH 5P66	Matrix Groups and Linear Representations	E	4	Lec/seminars
MATH 5P20	Computational Methods for Algebraic and Differential Systems	E	4	Lec/seminars
MATH 5P30	Dynamical Systems	E	4	Lec/seminars
MATH 5P40	Functional Analysis	E	4	Lec/seminars
MATH 5P60	Partial Differential Equations	E	4	Lec/seminars
MATH 5P09	Solitons	E	4	Lec/seminars
MATH 5P15	Algebraic Coding Theory	E	4	Lec/seminars

MATH 5P31	Ergodicity, Entropy and Chaos	E	4	Lec/seminars
MATH 5P36	Algorithmic Game Theory	E	4	Lec/seminars
MATH 5P41	Nonlinear Functional Analysis	E	4	Lec/seminars
MATH 5P64	Differential Geometry and Mathematical Physics	E	4	Lec/seminars
MATH 5P70	Topology	E	4	Lec/seminars
MATH 5P92	Cryptography	E	4	Lec/seminars
MATH 5P96	Technology and Mathematics Education	E	4	Lec/seminars
MATH 5P81	Sampling Theory	E	4	Lec/seminars
MATH 5P82	Nonparametric Statistics	E	4	Lec/seminars
MATH 5P83	Linear Models	E	4	Lec/seminars
MATH 5P84	Time Series Analysis and Stochastic Processes	E	4	Lec/seminars
MATH 5P85	Mathematical Statistical Inference	E	4	Lec/seminars
MATH 5P86	Multivariate Statistics	E	4	Lec/seminars
MATH 5P87	Computational Statistics	E	4	Lec/seminars
MATH 5P88	Advanced Statistics	E	4	Lec/seminars
MATH 5P89	Computational Methods for Generalized Linear Models	E	4	Lec/seminars

3.1.3: Program Options

Include possible options available for program completion, ~~e.g.~~e.g., full time vs part time, course based, MRP, dissertation, practicum, fast track, research requirements, etc.

The program normally accepts only full-time students. A part-time option will only be available in exceptional cases. An admission of a student with part-time status can only be based on option a) (Section 3.1.1, "holds M.Sc degree"), and requires the approval of the graduate committee of the relevant department. The student and the potential supervisor must outline the exceptional circumstances that require part-time status for the particular student.

In addition to the admission criteria in Section 4.1, a faculty supervisor must be identified and specified at admission. According to the specified supervisor's home department, applications will be reviewed by the Department of Computer Science or Department of Mathematics and Statistics. The Faculty of Graduate Studies administers standard admissions procedure for all graduate programs at Brock. For example, international students will be required to provide proof of English language proficiency as specified by the Faculty of Graduate Studies.

Exit Strategy: Students who decide to withdraw from the program before completing it can obtain a *Type 1 Graduate Diploma in Intelligent Systems and Data Science*, providing that they pass (minimum 70B) the following 5 half-credit:

- Interdisciplinary seminar ISDS 7P75
- Scientific writing course ISDS 5N01
- One graduate course in mathematics/statistics and 2 graduate courses in computer science or one graduate course in computer science and 2 graduate courses in mathematics/statistics.

3.1.4: Progression Requirements

Provide a description of the progression requirements for continuation in the program.

Progress requirements for remaining in the program are as follows:

- Students must obtain a minimum of 70B in a course to receive graduate credit in their course work (year 1).
- Students must pass the ~~comprehensive~~ qualifying examination to proceed with thesis research (end of year 2).
- Students must write up portion(s) of the thesis research and submit it to a suitable peer-reviewed national/international journal or conference as felt appropriate by the supervisor. The written paper will be initially approved by the student's supervisor, who is normally a second author on the manuscript. This will happen before the thesis defense commences. Actual acceptance for publication is desirable, and will likely happen in most cases, but is not a requirement for satisfying the degree requirements.
- Students must successfully pass the thesis defense (end of degree).

3.1.5: Governance

Describe the governance model to be established for oversight and monitoring of the program from an administrative and academic perspective. Document both University and program specific regulations. Examples or copies of related documents are to be included in Appendix C.

The Program Committee for the program follows article 16A in the Collective Agreement. In particular, the Program Commitee comprises all faculty members who teach in the program (16A.02a), as well as invitees whom the Program Committee wishes to invite to participate (16A.02c).

Commented [BR2]: Added.

Governance of the program will be jointly shared between the Department of Computer Science and the Department of Mathematics and Statistics. Each department will be responsible for the administration of the students being supervised by their respective faculty members. Administration of these responsibilities will primarily involve each department's respective graduate program director and graduate ~~studies committee, and~~studies committee and will follow the department procedures set by each unit. Such responsibilities may include:

- Determining the suitability of entrance requirements by applicants to the program and concentration during the application process.
- Faculty selection of students for supervision, and approval of these students by the department's graduate studies committee.
- Overseeing resource allocation from the department for the students (office space, hardware resources, teaching assistantships, conference funding....).
- Monitoring the progress of students with respect to satisfying the requirements of the program.

Both departments support the above model. The division of administrative duties ensures the independence of each department, which is necessary since both departments already have independent departmental governance. Decisions made at admission, supervisory committee oversight of qualifying~~comprehensive~~ examinations and thesis research progress, funding (TA contracts, supervisor research stipends), and department resource allocation (office space, hardware allocation, conference funding, etc.) will remain under the control of each department. Of course, aspects requiring co-operation will be discussed between the departments, with the goal of fairly allocating shared resources (e.g., graduate funding quota allocation by the Faculty and Graduate Studies, etc.).

Even though there will be split administrative responsibilities for the program, it is important to note that there are fundamentally shared goals and interests between the departments for the degree, which is the main motivation for the establishment of this transdisciplinary degree in the first place. Students from both departments will follow the high-level guidelines for the Ph.D., and hence share the same fundamental experience. Students are required to take graduate courses offered by both ~~departments, and~~departments and will take ISDS 7P75/5N01 together. There are also ample opportunities for close interaction between the departments. For example, the course bank is open to all students, and the selection and admittance to courses will be determined by supervisors and instructors according to individual student experience and abilities, as well as thesis topic requirements. Faculty in both departments may participate in thesis supervisory committees for all students, as deemed appropriate by supervisors. There are also possibilities for collaborative research between the departments.

Other administrative offices at Brock will be involved in administration of the Ph.D.:

(i) The Faculty of Mathematics and Science: This office is involved in various aspects of Ph.D. programs, such as teaching assistantship budgets for each unit, resource allocations for each unit, and other issues. Typically, the Faculty of M&S Associate Dean for Graduate Studies is the main administrator involved, who works under the direction of the Dean.

(ii) The Faculty of Graduate Studies: This office is responsible for implementing admissions for graduate programs, recording course grades and degree requirements, allocating funding and scholarships, overseeing University regulations for graduate programs, and organizing defences for Ph.D. students.

3.2: Program Content

3.2.1: Current State of the Discipline *(IQAP 3.5.4)*

Describe how the proposed curriculum of the program is positioned relative to the current state of the discipline or area of study.

The proposed curriculum is well-positioned with respect to the discipline. Important courses in intelligent systems and data science will be regularly offered. One of its main strengths is its wide scope, due to the rich assortment of courses and research expertise contributed by faculty from multiple disciplines – mathematics, statistics, and computer science. Hence the program is also ~~flexible, and~~flexible and will accommodate many different research interests and thesis trajectories which will naturally arise, given that two distinct departments are hosting the degree. The opportunity for students to select from such a wide selection of courses makes the program stand out from other programs that are homed in a single department, and whose curricula are consequently narrower in breadth. The scientific writing course (ISDS 5N01) is also unique.

3.2.2: Uniqueness of Innovations of the Program *(IQAP 3.5.4)*
Identify and describe any unique curriculum, innovations or creative components that contribute to the program and the achievement of its learning outcomes.

The program features two unique innovations. Both features were created in order to distinguish this program from other Ph.D. programs in the province. They combine research and learning components with professional development.

(i) ISDS 7P75/ISDS 5N01: The ISDS 7P75 seminar course will normally be taken together with the ISDS 5N01 scientific writing course. This provides a unique learning environment by combining scientific work with appropriate writing techniques in one experience. The student will get a research topic together with sufficient reading material from the supervisor. While studying the material the student will attend the mandatory sessions of the scientific writing course. The summary for the seminar course in the form of a scientific paper or other appropriate format and the final presentation will be prepared by the student with support of the instructors from Brock's A-Z Learning Services and the supervisor. This combined learning experience aligns very well with the Graduate Degree Learning Expectation "5. Level of communications skills" and Program Outcomes (Table 2.1: 2c, 5(a,b,e)).

(ii) Qualifying~~Comprehensive~~ Examination: The particular focus on writing grant applications as part of the qualifying~~comprehensive~~ examination is an innovation of this program. All students are required to propose their research topic in the form of a 5-page grant proposal, following the organization of an~~n~~ NSERC Discovery Grant or MITACS grant application. The application is prepared in consultation with and guided by the supervisor and the supervisory committee. This process aligns very well with the Graduate Degree Learning Expectation "4. Professional capacity/autonomy" and the Program Outcomes Table 2.1: 1a, 2(a,c), 3f, 4(d,e,f), 5a). As already mentioned above, a secondary outcome is that the student can actually submit a competitive grant application.

Formatted: Underline

3.2.3: Experiential Learning *(IQAP 3.5.11)*
If the proposed program will contain an experiential learning component provide a description of the component, including:
a) Requirements, credits, length;
b) Integration/relation of this experience within the program of study;
c) Who is responsible for arranging the experiential learning component;
d) What placement opportunities exist for students; and,
e) Where experiential education is a program requirement, provide evidence that all students can be accommodated.

Not applicable.

3.2.4: Research Requirements *(IQAP 3.5.4)*
For research-focused graduate programs, clearly indicate the nature and suitability of the major research requirements toward degree completion.

There are two means for determining whether the thesis research has reached a suitable level of quality to satisfy the degree requirements. First, the supervisory committee will decide whether a thesis is ready for defense. The primary committee member to make this determination is the

supervisor, since she or he has been the most involved with the student for the duration of studies. Second, before the thesis is submitted for defense, portion(s) of the thesis have to be published in, or submitted to, a national/international peer-reviewed journal or conference. (Acceptance for publication is not required.)

3.2.5: Distribution of Graduate Courses *(IQAP 3.5.4)*

For new graduate programs provide clear evidence that each student in the program will be required to take a minimum of two-thirds of the course requirements from among graduate level courses.

All the course requirements listed in 3.1.1 are graduate level (5Pxx and above) courses.

A draft copy of the calendar entry for the proposed program should be included as Appendix D

4: Admissions and Enrollments

4.1: Admission Requirements (IQAP 3.5.2)

Clearly define the admission requirements for the proposed program. Proponents will address the appropriateness of the program's admission requirements for the learning outcomes established for completion of the program. Describe pathways to entry and how applications will be adjudicated.

Students may enter the program via one of the following paths:

a) Direct: An M.Sc. in computer science, mathematics, statistics, or a closely related discipline, with a minimum 80% overall average from an accredited institution. The appropriateness of the M.Sc.'s field of study will be assessed primarily by a potential supervisor and the graduate program committee, who will determine whether the applicant has the background necessary to commence with Ph.D. research in the chosen area.

b) Transfer: Students currently in one of the M.Sc. programs of the host departments may apply to transfer into the Ph.D. program after one year of study if they have completed the required number of courses in their program with an average of at least 80%, have shown significant research progress and/or potential as determined by their supervisory committee and graduate program committee, and have the support of a faculty member who is willing to supervise and fund the student for Ph.D. studies.

c) Exceptional: In very exceptional cases, students may be admitted into the Ph.D. program with a four-year honours Bachelor's degree, or the equivalent, with an overall average of at least an 85%. These students must demonstrate high research potential adjudicated by the graduate program committee, and have the support of a faculty member willing to supervise and fund the student for Ph.D. studies.

Throughout the above, the main factor in determining the final admission of a student is the approval of a faculty member willing to supervise the ~~student, and~~student and contribute research funding. The assignment of a supervisor is required at the beginning of the admission process. Faculty members peruse applicant ~~files, and~~files and make decisions on whom they would like to admit under their supervision. The supervisory loads of faculty are decided by the faculty members themselves, who may use a number of factors in making their decisions (~~e.g.~~e.g., number of students, available grant money). Faculty are also personally responsible for deciding the balance of M.Sc. and Ph.D. students under their individual supervision. (This contrasts to the procedure of some larger institutions, in which students can select a suitable supervisor long after admission, and possibly even after courses have been taken.)

4.2: Alternative or Additional Requirements

Describe any alternative or additional requirements for admission into a graduate, second-entry or undergraduate program, such as minimum grade point average, additional language requirements or portfolios. Describe how the program will assess and recognize prior work or learning experience (if applicable).

Not applicable.

4.3: Enrollment Projections

The Department/Centre, in consultation with Institutional Analysis and Planning and the relevant Dean(s), is to provide the projected annual intake and enrollments for the program, including the desired level of steady state enrollment and how many years will be required to reach steady state levels.

The projected enrollment of the program is based on following observations:

a) The Ph.D. program will follow an apprenticeship model, which is a common approach to post-graduate education in scientific and mathematical disciplines. This model is based on a close learning and research relationship between the student and the faculty supervisor. After completing the course work of the program, the student will work closely with the supervisor on all aspects of the thesis and potential publications. The supervisor will normally provide additional funding for the student in terms of a research fellowship. This model requires a significant commitment of time and funding by the faculty supervisor, and as a consequence, it limits the number of students that a faculty member is able to supervise.

b) Both host departments will experience significant faculty turnover due to retirements during the coming. New faculty members with recently established research programs and funding will increase the capacity of the program over time. Two retirements in the Computer Science Department have been replaced as of 2020, 2 additional replacement positions have been approved for 2020/21, and that department's strategic hiring plan counts on an additional growth 3 hires during the next 3 years. The other unit (Mathematics and Statistics) had two retirements in ~~July 2019, and~~July 2019 and may have 2 additional retirements in the coming years. Therefore, for the calculation of the projected enrollment, we have assumed one faculty replacement every year starting in 2021.

Table 4.1: Projected Intake and Enrollments for Graduate Program

PROJECTED INTAKE AND ENROLLMENTS Doctoral Program		
Year	Intake	Total Enrollment
2021/22	5	5
2022/23	5	10
2023/24	5	15
2024/25	5	20
2025/26	5	20
2026/27	5	20

Provide comment on enrollment projections.
The projected enrollment of the program over the first 6 years is provided in Table 4.1. The initial and long-term intake of 5 Ph.D. students per year is based upon the projections given in the SMA 2 document. Between the two departments, we estimate that an intake of 5 students per year is reasonable, especially given that new research-active faculty will be hired to replace retirements in the coming years, and hopefully additional faculty will be hired to increase faculty numbers. In 4 years, an estimated steady-state enrollment of 20 Ph.D. students should arise, which will be sustained as students complete their program in 4-year time spans.

5: Resources

*In the following sections the Proponents will address the planned utilization of **existing** and **new** resources in support of the proposed program. Specifically, the proponents are to address the human (faculty and staff), physical (office, teaching and research space), financial, library, technology (ITS and CPI), Co-op and experiential learning, etc., resources required.*

Where new or additional resources are required to deliver the proposed program, the Proponents will document the results of consultation with the appropriate University office/unit, (~~e.g.~~ e.g., the relevant Dean(s), Library, ITS, etc.) in the appropriate section(s) below, including any institutional commitments to provide these new resources.

5.1: Resources for All Programs *(IQAP 3.5.9)*

5.1.1: Existing Resources *In the context of the proposed program indicate the planned utilization of any existing human, physical, fiscal and all other existing resources in the delivery of the program.*
The host departments sustain very successful undergraduate and graduate programs with the resources currently available. The departments are able to offer the necessary number of courses for both programs. The equipment and other resources in terms of servers, computer labs, library support etc. are good. The contingent of potential supervisors is strong enough to maintain consistently two of the largest M.Sc. programs in the Faculty of Mathematics and Science. Course Offerings The new program will introduce two new courses (ISDS 7P75 Ph.D. Seminar, ISDS 5N01 Scientific Writing). New faculty hires will naturally result in updates and growth of the graduate course bank. Teaching appointments by the Dean (including part-time instructors) will help the departments maintain their undergraduate offerings. Computers (i) As mentioned earlier, each department is responsible for resources required by students studying under supervisors from that department. Each Ph.D. student is allocated a PC in their office space if required (many students use their personal laptops). Department servers, computer labs, and a research cluster funded by faculty grants, can be used for more demanding computing tasks. (ii) Brock is a full member of the SHARCnet consortium, and therefore graduate students have access to high performance clusters.

To summarize the analysis of resources required to establish the new program and sustain undergraduate and graduate programs in both departments:

- Instructional support from Brock's A-Z Learning Services for the ISDS 7P75/ISDS 5N01 scientific writing course.
- Replacement tenure-track faculty members for retirements.
- Two growth tenure-track positions (one per host department) to support Ph.D.
- Sessional instructors to help maintain undergraduate course offerings when required.

5.1.2: Faculty Complement

Provide evidence of the participation of a sufficient number of faculty/instructors who are competent to teach and/or supervise in the program. When describing the faculty complement include the contributions of full-time faculty, sessional instructors, adjunct appointments, professional/clinicians, etc. to the proposed program. Requests for any new faculty positions and the general area of expertise required for the program should be clearly identified along with the rationale for the positions reported.

Tables 5.1, 5.2 and 5.3 providing data on the existing faculty resources to be utilized in support of the proposed program. The CVs of all faculty/instructors contributing to the program are found in Appendix E.

The current faculty numbers in the host departments is sufficient to support the basic requirements of the Ph.D. Current graduate course offerings that support the M.Sc. programs will be used for Ph.D. course requirements. Since the Ph.D. course requirements are fulfilled in the first 2 years of study, there will be sufficient offerings of graduate courses in both departments to satisfy the Ph.D.

At the suggestion and support of the Dean, two growth tenure-track appointments will be requested, in order to enrich and expand the success of the Ph.D. program. Each department will request a tenure-track faculty appointment to support the Ph.D. The appointments' research area will solidify the research themes of the Ph.D. Although the exact research directions are open, one promising research area is *computational modelling*, which directly supports the stated theme of "Intelligent Systems and Data Science." However, expertise in any of the focus areas are possible research fields for new appointments. A formal application for these appointments will commence immediately after the Ph.D. is given final approval.

Another area of strategic importance to the long-term success of the program is data science, including machine learning and AI. Currently, there is only a single faculty member (Marshall) in the Department of Mathematics and Statistics working in data science. The Mathematics and Statistics Department's hiring plan prioritizes two positions (replacements for retirements occurring July 1, 2019) in data science and computational statistics with emphasis on "big data". Filling these two positions will be essential for the program to have the capacity to cover the important new field of data science.

As mentioned elsewhere in the proposal, the Department of Mathematics and Statistics lost three positions in the last two years, two of them in mathematics and one in statistics. Current hiring plan calls for replacement of these positions with two positions in statistics/data science and one in financial mathematics. This means that the Department will effectively lose some expertise in mathematics. In order to make the proposed Ph.D. program successful, this missing expertise in mathematics will have to be addressed, preferably by future hiring of another faculty in mathematics. Moreover, since we hope to expand the proposed Ph.D. program in the future to include data science, strong mathematical foundation will definitely be essential, further justifying this need.

Similarly, the Department of Computer Science is experiencing four retirements from 2018-2020. Two retirements have been replaced, and two hires to replace the remaining positions has been approved for 2020. The Department was directed to dedicate one of the new replacements towards a proposed B.Sc. in Data Science and Analytics. This diverges from the Department's strategic hiring plan, in which the data science position was to be a new "growth" position to support this new program. Therefore, the Department is counting upon new growth position(s) in the coming years in order to support core undergraduate programs, the new BSc in Data Science, the growing M.Sc. program, and this new Ph.D. program. In particular, growth positions will enable the department to expand into important areas of computer science research (data bases, machine learning, security, and many others), and reach a critical mass for research activity in these areas.

a) Instructor Qualifications and Teaching Assignments within the Unit

Complete Table 5.1. Comment on the instructor qualifications and teaching assignments.

Table 5.1 shows the teaching assignments and student supervisions undertaken by faculty in both departments, both at the undergraduate and graduate levels. Most faculty are tenured, with one assistant professor in Computer Science in the tenure track stream, and another faculty member is a non-tenure stream instructional limited term appointment (ILTA). Three new tenure-track assistant professors are not included in the table, as they are new hires. Teaching loads vary according to each department's workload standards, as well as overload teaching voluntarily taken by faculty members. Undergraduate and graduate supervision is also voluntarily assumed by faculty, who may use a number of factors in determining supervision loads (student numbers, research grants for RA assistantships, etc.).

b) Contributions by Instructors to Other Units
Complete Table 5.2. Comment on the contribution of instructors in the program(s) to other units.

Dr. Winter has a long-standing relationship with the IASC and associated undergraduate Game program. This will not negatively impact his involvement in the Ph.D. (it has not affected his participation in the COSC M.Sc., as he is one of the most active graduate supervisors).

c) Contributions by Instructors from Other Units
Complete Table 5.3. Comment on the contribution of instructors from other units to the program.

Dr. Liang has collaborated with members of the Department of Computer Science on bioinformatics-related research.

d) Document the role of adjunct and part-time faculty in the delivery of the program.

Dr. Joseph Brown (U Innopolis, Russia) and Dr. James Hughes (St. Francis-Xavier University, Antigonish) are adjunct assistant professors in the Department of Computer Science. All are involved in M.Sc. supervision and examination. All adjunct professors are welcome to contribute to the Ph.D. program in terms of co-supervision and examination.

e) Clearly identify and provide the rationale for any new faculty positions required to deliver the program. Include the results of consultation with the relevant Dean(s).

Repeating discussion from 4.3 above, both host departments will experience significant faculty turnover due to retirements during the next 2-10 years. Computer Science will have 4 retirements within the next 2 years (of which three replacement positions have already been approved), and an additional 2 retirements within the following 6 years. Mathematics and Statistics will have two retirement in July 2019, one faculty passed away in December 2018, and 2 other faculty members will

soon reach the retirement age. However, no upcoming replacements are currently confirmed, and the actual timeline for any future replacements cannot be predicted. Therefore, we assumed at least one faculty replacement every year starting in 2020.

(Repeating from 5.1.2 above): At the suggestion and support of the Dean, both departments each will request new joint tenure-track faculty appointment which will directly support the Ph.D. program. The two new appointments' research areas will solidify the research themes of the Ph.D. Although the exact research directions are open, one promising research area is “Computational Modelling”, which directly addresses the stated theme of “Intelligent Systems and Data Science.” Other research areas are those listed in the focus areas in Section 1.1. A formal application for these appointments will commence immediately after the Ph.D. is given final approval.

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	**Area of Expertise**	**Academic Year**	**Terminal Degree**	**Rank***	**Tenure of Tenure Stream**	**Start Date**	**Undergraduate**	**Graduate**	**Undergrad/Grad combined**	**Core or Participating**	**Undergraduate Thesis**	**Major Research Paper**	**Gradate Thesis (Masters)**	**Graduate Thesis - Doctoral**	**Grad Committee Membership**	**Post-Doctoral Fellows**	
Computer Science																	
Robson De Grande	Networking and Distributed Computing	17/18	Ph.D.	AT	T	2017	2	0		C							
Ivo Düntsch	Formal Methods	17/18	Habilitation	EM	T	2002				C							retired
		14-17		F	T					C							sick leave
Earl Foxwell		17/18	M.Sc.	ILTA	-	2010	10			P							
		16/17		ILTA	-		10			P							
		15/16		ILTA	-		9			P							
		14/15		ILTA	-		9			P							
		13/14		ILTA	-		8			P							

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	**Area of Expertise**	**Academic Year**	**Terminal Degree**	**Rank***	**Tenure of Tenure Stream**	**Start Date**	**Undergraduate**	**Graduate**	**Undergrad/Grad combined**	**Core or Participating**	**Undergraduate Thesis**	**Major Research Paper**	**Gradate Thesis (Masters)**	**Graduate Thesis - Doctoral**	**Grad Committee Membership**	**Post-Doctoral Fellows**	
Sheridan Houghten	Combinatorial optimization	17/18	Ph.D.	F	T	1999	2	1		C	2		5		3		
		16/17		F	T		1			C	1		5		2		sabbatical (0.5 year)
		15/16		F	T		2	1		C	1		5		4		
		14/15		F	T					C	1		6		6		chair (0.5 year), sabbatical (0.5 year)
		13/14		F	T		1			C	1		5		5		chair
David Hughes	Programming languages	17/18	Ph.D.	AC	T	1978	3			C	3						lead author, cyclic review
		16/17		AC	T		3			C	3						courseware development
		15/16		AC	T		4			C	2						
		14/15		AC	T		3			C	4						chair (0.5 year)

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		13/14		AC	T		2			C	2						sabbatical
Beatrice Ombuki-Berman	Computational intelligence	17/18	Ph.D.	F	T	2001	2	1		C	3	1	4	2	6		Ph.D. supervisions at U. Pretoria (SA)
		16/17		F	T		3			C			2	2	4		Graduate Pgm. Dir.
		15/16		F	T		2			C			2	1	3		
		14/15		AC	T					C			2	1	3		sabbatical
		13/14		AC	T		2			C			3		5		
Ke Qiu	Parallel and distributed computing	17/18	Ph.D.	F	T	2004	2			C			2		5		chair
		16/17		F	T		2			C			2		2		chair
		15/16		F	T		2			C			2		2		chair
		14/15		F	T		1			C			2		2		sabbatical (0.5 year)

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		13/14		F	T		2	1		C			3		5		
Brian Ross	Computational intelligence	17/18	Ph.D.	F	T	1992	1			C	2		6		6		sabbatical (0.5 year)
		16/17		F	T		1	1		C	2		5		4		Graduate Pgm. Dir.
		15/16		F	T		1	1		C	2		6		7		Graduate Pgm. Dir.
		14/15		F	T		1	1		C			5		4		Graduate Pgm. Dir.
		13/14		F	T		2	1		C			5		4		
Michael Winter	Formal methods	17/18	Habilitation	F	T	2003	6	3		C	2	2	4		1		
		16/17		F	T		3	3		C	3		5		2		sabbatical (0.5 year)
		15/16		F	T		5	2		C	1		3		4		
		14/15		F	T		4	3		C	3		3		6		
		13/14		F	T		4	2		C	2		2		5		

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	**Area of Expertise**	**Academic Year**	**Terminal Degree**	**Rank***	**Tenure of Tenure Stream**	**Start Date**	**Undergraduate**	**Graduate**	**Undergrad/Grad combined**	**Core or Participating**	**Undergraduate Thesis**	**Major Research Paper**	**Gradate Thesis (Masters)**	**Graduate Thesis - Doctoral**	**Grad Committee Membership**	**Post-Doctoral Fellows**	
Mathematics and Statistics																	
Stephen Anco	Differential equations, integrability, mathematical physics	17/18	Ph.D	F	T	1999	0	0	1	C	0	2		0		1	Chair 0.5 course reduction (Self Study)
		16/17		F	T		0	1	0		0	2		0		1	Chair o. 5 course reduction (excess unscheduled teaching)
		15/16		F	T		3	0	0		1	2		1		0	GPD
		14/15		F	T		2	1	1		1	1		1		1	
		13/14		F	T		0	0	0		2	1		1		0	Sabbatical (1 year)

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
Hichem Ben-El-Mechaiekh	Nonlinear analysis	17/18	Ph.D	F	T	1988	0	1		C							Administrative leave (0.5 year)) 0.5 course reduction (Data Science Proposal)
		16/17		F	T		2										Associate Dean (half teaching load)
		15/16		F	T		2										Associate Dean (half teaching load)
		14/15		F	T		1	1				1					Associate Dean (half teaching load)

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		13/14		F	T		2	0	0							1	Administrative Leave (0.5 year)
Chantal Buteau	Didactic of mathematics	17/18	Ph.D	F	T	2004	4	0	0	C	1	2					
		16/17		F	T		3	0	1		1	2					
		15/16		F	T		3	0	1			2					
		14/15		F	T		0	0	0			5					Sabbatical leave
		13/14		F	T		3	0	1		1	4					
Henryk Fukś	Discrete dynamical systems, cellular automata	17/18	Ph.D	F	T	2000	3	0	1	C	1	2					
		16/17		F	T		3	1	0		1	2			1		

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		15/16		F	T		2	0	0			2	1		1		Sabbatical (0.5 year)
		14/15		F	T		2	1	0			1	3				GPD
		13/14		F	T		2	0	0			3	3				GPD,
Mei Ling Huang[1]	Statistical inference theory and methods	17/18	Ph.D	F	T	1991	2	0	2	C	1	3	3		3		
		16/17		F	T		2	1	0		2	1	3		3	1	Sabbatical (0.5 year)
		15/16		F	T		2	0	2			1	1		1	1	
		14/15		F	T		2	0	2			3	3		3	1	
		13/14		F	T		1	0	1			1	1		1		Sabbatical (0.5)

1 Retiring in July 2019

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
Omar Kihel	Number Theory, Algebra, Arithmetic Geometry and Cryptography.	17/18	Ph.D	F	T	2002	1	0	1	C		3	5				Special Course Release (0.5 year) GPD
		16/17		F	T		2	1	1		4	3	1				
		15/16		F	T		3	0	1		2	2	2				
		14/15		F	T		2	1	1		1	3	2				
		13/14		F	T		1	0	1		1	3	2				Sabbatical (0.5 year)
Yuanlin Li	Groups, rings and group rings	17/18	Ph.D	F	T	2001	2	1	0	C		2				1	Medical Reduction (0.5 year)
		16/17		F	T		2	0	0			1					Medical Leave (0.5)
		15/16		F	T		1	1	0			1			1	1	Sabbatical (0.5)

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		14/15		F	T		4	0	0		1	2			1		
		13/14		F	T		3	1	0		1	1	1		1		
Alexandre Odesskii	Mathematical physics	17/18	Ph.D	F	T	2008	2	1	1	C	1	1					
		16/17		F	T		3	0	1			1					
		15/16		F	T		4	0	0			1					
		14/15		F	T		4	0	0								
		13/14		F	T												Sabbatical (1 year)
Jan Vrbik	Classical mechanics, probability and statistics	17/18	Ph.D	F	T	1982	3	1	0	C	1	1	2		3		
		16/17		F	T		2	2	0			3	1		2		
		15/16		F	T		2	1	1			2			1		
		14/15		F	T		2	2	0			4	1		2		

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
		13/14		F	T		2	2	0		1	6	1		2		
Thomas Wolf	Integrability, Computer Algebra, General Relativity	17/18	Ph.D	F	T	2001	3	0	0	C							0.5 course reduction (Math Camp)
		16/17		F	T		1	1	0								
		15/16		F	T		1	1	0								Chair
		14/15		F	T		1	1	0								Chair
		13/14		F	T		2	1	0								Chair
Xiaojian Xu	Statistical models and inference	17/18	Ph.D	F	T	2006	2	2	0	C		2					
		16/17		F	T		1	1	0			1.5					Sabbatical (0.5 year)
		15/16		F	T		2	2	0			2					
		14/15		F	T		2	2	0			2.5					

Table 5.1: Instructor Qualifications and Teaching Assignments Within the Program (Current + past four years)

	Demographics						Courses			Supervisions							Comments
Instructor Name	Area of Expertise	Academic Year	Terminal Degree	Rank*	Tenure of Tenure Stream	Start Date	Undergraduate	Graduate	Undergrad/Grad combined	Core or Participating	Undergraduate Thesis	Major Research Paper	Gradate Thesis (Masters)	Graduate Thesis - Doctoral	Grad Committee Membership	Post-Doctoral Fellows	
Xiaojian Xu		13/14		F	T		2	2	0		1	1.5	1				

*F = Professor, AC = Associate, AT = Assistant, EM = Emeritus, AD = Adjunct, IN = Instructor, etc.

Table 5.2: Contributions by Instructors to Other Programs (Current + past four years)

		Year	Other Unit	Courses		Supervisions							
Instructor Name	**Area of Expertise**	**Academic year**	**Other Program**	**Undergraduate**	**Graduate**	**Core or Participating**	**Undergraduate Thesis**	**Major Research Paper**	**Graduate Thesis - Masters**	**Graduate Thesis - Doctoral**	**Grad Committee Member**	**Post-Doctoral Fellow**	**Comments**
Michael Winter	Theory	17/18	IASC (Interactive Arts and Science)	1.5		C							
Michael Winter	Theory	16/17	IASC	1	0.5	C		1					
Michael Winter	Theory	15/16	IASC	1		C							
Michael Winter	Theory	14/15	IASC	1		C		1					
Michael Winter	Theory	13/14	IASC	1		C							

Table 5.3: Contributions by Instructors from Other Program (Current + past four years)

		Year	Other Unit	Courses		Supervisions							
Instructor Name	Area of Expertise	Academic year	Other Program	Undergraduate	Graduate	Core or Participating	Undergraduate Thesis	Major Research Paper	Graduate Thesis - Masters	Graduate Thesis - Doctoral	Grad Committee Member	Post-Doctoral Fellow	Comments
Ping Liang		17/18	Biology			P	1						Co-supervisor
Ping Liang		16/17	Biology			P	1						Co-supervisor
Ping Liang		15/16	Biology			P							
Ping Liang		14/15	Biology			P							
Ping Liang		13/14	Biology			P							

5.1.3: Staff Complement

Indicate the availability of sufficient staff (technical and administrative) to support the proposed program, providing information on permanent staff that will have teaching responsibilities (Table 5.4) and all administrative staff (Table 5.5), directly associated with the program.
Requests for any new staff positions required for the program should be clearly identified and the rationale for the positions reported.

Table 5.4: Permanent Staff with Teaching Responsibilities Associated with the Program (Current + past four years)

Name	Academic Year	Start Date	Position	Contribution
Dave Bockus (COSC)	2013-18	1990	Lecturer	Teaching undergraduate courses as part of load.
Cale Fairchild (COSC)	2013-18	1999	Network & Systems Adminstrator	Maintains department network (hw, sw). Teaches undergraduate courses on overload.
Poling Bork (COSC)	2013-18	2001	Senior Lab Demonstrator/Coordinator/ Mentor	Supervision of graduate TAs, 1st year support, undergraduate mentor
Dorothy Levay (MATH)	2013-18	1991	Instructor/Manager of Academic Support	Supervision of graduate TA's, teaches undergraduate courses
Mark Willoughby (MATH)	2013-18	2015	Online Course Developer/Administrator	Teaching and administering undergraduate online courses

Table 5.5: All other Administrative Support Staff directly associated with the Program (Current + past four years)

Name	Academic Year	Start Date	Position	Comment
Donna Phelps (COSC)	2013-18	2005	Administrative Assistant	General administration, undergraduate and graduate.
Christine Keith (COSC)	2013-18	2015	Student Support Coordinator	Undergraduate program planning and support.
Margaret Thomson (MATH)	2013-18	2005	Administrative Assistant	General administration, undergraduate and graduate.
Neil Marshall (MATH)	2013-18	2014	Mathematics Development Programs Coordinator	Administers undergraduate help center

Comment on the adequacy of the staff complement to support delivery of the proposed program.

The staff is adequate for current needs. However, in the Department of Mathematics and Statistics, the administrative assistant is unable to take on additional duties.

Clearly identify and provide the rationale for any new staff positions required to support delivery of the program. Include the results of consultation with the relevant Dean(s).

Not applicable.

5.1.4: Fiscal Resources

With respect to financial resources, Proponents will provide a business plan for the proposed program for the first five (5) years of operation that includes the utilization of existing resources and clearly identifies required new resources. (Table 5.6 is in development and will be posted when ready.)

Table 5.6 (end of proposal document) gives an estimated budget for the program. The table presumes an even split between domestic and international students. Total expenses are not filled in, as there should be no significant additional expenses for the new program on top of the current expenses for the M.Sc. programs in both departments. Since there will be fewer M.Sc. supervisions for faculty supervising Ph.D. students, associated costs will naturally balance for both departments.

The financing of the program is dependent upon two factors:

(i) Continued delivery of undergraduate programs: This will require replacements of retiring faculty, ILTA hires, and possibly overload stipends. However, since the M.Sc. programs in both departments will continue, the addition of the Ph.D. program should not place any additional strain on the department's budget or resources. It will be natural for M.Sc. enrollments to reduce somewhat, since faculty members will need to divert funding towards Ph.D. students; but this should not negatively impact the successful delivery of graduate programs in both departments.

(ii) Financial support of new Ph.D. students: (See Section 5.2.2 for more details) Again, this does not impact either department's budget directly. Graduate support is dependent upon graduate fellowships from the Faculty of Graduate Studies, teaching assistantships that are granted to the department from the Dean's office, and research assistantships that are funded from supervisor's research grants. All these funds are currently involved in delivery of the master's program (as well as support for the undergraduate program, with respect to TA funding). The addition of the Ph.D. program will not impact these funds greatly with respect to the department budget. The quota of Ph.D. positions will define the number of fellowships available, and supervisor's budgeting of the research grant expenses will determine the number of students a faculty member can support. RA stipends amounts for graduate students are determined by faculty members.

5.1.5: Space

Provide evidence that adequate physical space (office, teaching space, research, etc.) exists to accommodate participants (faculty, staff and students) in the program.

Identify and provide the rationale for any new space required for the program. Evidence that the Proponents have consulted with the University Committee on Space regarding the program's space requirements must be included.

(i) Computer Science: Office space is made available to all full-time graduate students. Three rooms (J212, J214, J333) are used for M.Sc. students in their first year, and other rooms (J201, J210, J215, J216) for M.Sc. students in their second year. J201, J215, and J216 will be ~~be~~ prioritized for full-time Ph.D. students when the program commences. The department has converted a large room (J333) into a graduate computer laboratory.

(ii) Mathematics and Statistics: Mathematics and Statistics: Office space is provided for all full-time graduate students. Currently, students are occupying room D321, which actually consists of a large room with desk spaces for 22 students, and a smaller room with 3 desks (used by long-term visitors and postdocs). There is also another small room which is used as kitchen, with refrigerator, microwave, etc. Current graduate enrolment is 22 students, thus there is no space for additional students. If the combined enrolment of MSc and PhD exceeds 22, the Department will need support from the Faculty of Mathematics and Science and the University administration to acquire more space.

5.1.6: Support Services

Provide evidence that there are adequate support services (library, information technology, CPI, Co-op, etc.) for both teaching and research, to sustain the quality of scholarship and research activity produced by graduates. Evidence for such support services will document consultation and include a report, from all appropriate units, detailing the impact of the proposed program on existing resources.

For each specific support service, identify and provide the rationale for any new resources required to support delivery of the program.

Library

Provide information about the library holdings, availability of and access to the library resources relevant to support the proposed program.

Please see Appendix G.

Clearly identify and provide the rationale for any new library resources required to support delivery of the program. Include evidence of consultation with the Library.

Not applicable.

Information Technology Services (ITS)

Provide information regarding the hardware, software/internet, audio-visual, and other ITS resources relevant to support delivery of the proposed program.

(i) Computer Science: The department budgets for, and maintains, their own computer hardware used in their programs. Individual faculty members purchase specialized hardware and software from their own research funds when necessary. Faculty have also contributed towards a Linux-based research cluster which, although aging, is still useful for many computing needs. Replacement of the cluster is being pursued at this time. Maintenance performed by their Network and Systems Administrator (Cale Fairchild) will be adequate for the department's future requirements of the new Ph.D. program.

(ii) Mathematics and Statistics: The department uses ITS support for maintaining computer hardware of individual faculty. ITS also helps to maintain the hardware and software located in the faculty lab and in the graduate student office (desktop operating systems, user/network access as well as relevant desktop software). The department does not have a dedicated computer technician or a support person. University IT services provide a basic level of support, but in some areas (especially regarding support of Linux) it is not sufficient. The department does not expect a significant increase in demand for support services due to the proposed Ph.D. program.

Clearly identify and provide the rationale for any new ITS resources required to support delivery of the program. Include evidence of the consultation with ITS.

None required.

Co-op, Career and Experiential Education (CCEE)
Provide information regarding the CCEE resource implications for existing resources relevant to support delivery of the proposed program.

Not applicable.

Clearly identify and provide the rationale for any new CCEE resources required to deliver the program. Include evidence of the consultation with CCEE.

Not applicable.

Additional Resources
Provide information regarding additional resources relevant to support delivery of the proposed program.

Not required.

Clearly identify and provide the rationale for any additional resources required to deliver the program. Include evidence of the consultation where appropriate.

Not required.

5.2: Resources for Graduate Programs (IQAP 3.5.10)

5.2.1: Faculty Expertise

Provide evidence that faculty have the current and relevant research or professional/clinical expertise needed to sustain the program, promote innovation and foster an appropriate intellectual climate. Reference may be made to Sections 5.1 and 6 which deal with the faculty complement and the intellectual contributions, respectively, of the faculty.

Table 5.1 shows that the faculty are maintaining undergraduate and graduate programs in their discipline, in terms of curricula delivery and student supervision. In particular, the high number of graduate student supervisions indicates that there is a rich intellectual environment for graduate studies, which will bode very favourably for the new Ph.D. program. Table 6.1 shows that they are active in publishing their research, and Table 6.2 indicates successes in research grant awards. All these factors prove that there is an active intellectual and scholarly environment conducive to hosting the new Ph.D. program.

5.2.2: Financial Assistance (where appropriate)

Provide evidence that financial assistance for students will be sufficient to ensure adequate quality and numbers of students.

The funding for full-time students consists of the following components. The Faculty of Graduate Studies provides a Graduate Fellowship to each student. International students receive an International Tuition Fellowship in addition. All graduate students are guaranteed a quota of TA hours during each year of their study. Last but not least, supervisors can provide a Research Fellowship to each of their students (the exact amount of support can vary).

In 2018/19, full-time Brock Ph.D. students receive $21576 (domestic) and $31576 (international) as base funding packages for each of 4 years of study. It will also be normal to have supervisors contribute an amount towards a Research Fellowship, which varies between $1000-$10,000 throughout the university. Currently, M.Sc. students receive a $5000-$6000/year fellowship from supervisors, and so a value of $8000/year for Ph.D. students may be reasonable.

5.2.3: Supervisory Loads

Address how supervisory loads will be distributed across the faculty delivering the program.

Graduate student supervision is always a voluntary decision by faculty ~~members, and~~members and is never assigned as part of workload. Faculty members are personally responsible for managing and balancing their supervisory duties. Students' quota will initially be divided evenly between two departments, subject to mutually acceptable small adjustments if the application pool in a given year requires it.

The distribution and the compensation for extra teaching and for supervision will follow each department's workload plans, Brock University rules, and BUFA Agreements.

5.2.4: Status of Faculty

Address how the qualifications and appointment status of faculty, who will provide instruction and supervision, will be evaluated and monitored.

All tenure-track and tenured faculty members may instruct graduate courses and supervise graduate students. Tenure-track/tenured faculty normally hold a Ph.D. or the equivalent (determined during initial appointment).

New graduate supervisors will be mentored by more senior faculty. New supervisors will be encouraged to first supervise M.Sc. students, before committing to Ph.D. supervision. Successful M.Sc. supervision of a few students will indicate that a new faculty member is capable of proceeding to graduate supervision.

There is no provision in the Collective Agreement to monitor and evaluate established faculty members. It should be noted that this has not been necessary for the M.Sc. programs in both departments. The Faculty Handbook states, "Supervisors should be sufficiently familiar with the area of research, or be willing to gain such familiarity, to ensure adequate student guidance is provided." It is the professional responsibility of all faculty members to adhere to this basic tenet.

6: Quality and Other Indicators (IQAP 3.5.12)

6.1: Quality of the Faculty

Provide appropriate indicators (e.g., qualifications, research, innovation and scholarly record) that document evidence of the quality of the faculty. The expertise of the faculty will be documented through the completion and inclusion of: Table 6.1 - Intellectual Contributions; Table 6.2 - External Research Grants and Contracts; ~~and,~~ and Table 6.3 - Internal Research Grants and Contracts.

Comment on how the expertise and quality of faculty, as judged by the intellectual contributions and research grants and contracts received, contribute to the success of the proposed program.

The faculty members of the Ph.D. program are experts in their research field. Indicators of the quality of the faculty are provided by academic research and scholarly achievements. We selected the following indicators to measure research and scholar productivity:

- Regular Teaching: undergraduate and graduate courses
- Supervisions: undergraduate and graduate supervision, supervisory committee duties
- Publications: Books, chapters in books, articles in peer-reviewed journals and conferences
- Internal grants and awards: funding/award received through internal adjudication at Brock University
- External Grants: NSERC funding and other major granting agencies
- Other Significant Work: invited presentations, editorial and refereeing duties.

The most important information for each faculty member is summarized in Table 6.1. More detailed information is provided by the Curriculum Vitae of each faculty member in Appendix E.

Table 6.1: Intellectual Contributions (Past Eight Years, 2010/11 to 2017/18)

Faculty Name	A. Publication of books and monographs	B. Contributions to edited books	C. Papers in peer refereed journals	D. Peer reviewed abstracts	E. Papers delivered at conferences and professional meetings	F. Contributions to panels, workshops, and clinics	G. Invited Presentations	H. Consulting (government, related professionals and agencies)	I. Preparation of instructional, clinical, curriculum or policy materials for such agencies	J. Editorial and refereeing duties	K. Creation, performance, direction, programming, design and staging of creative works for the public	L. Curation of juried exhibitions	M. Festivals and competitions adjudicated, master classes offered	N. Professional residencies	O. Development of software, hardware or equipment	P. Scholarly contributions to pedagogy	Q. Other scholarly contributions to agencies, communities, governments or organizations	R. Other publications (non-refereed) with significant public impact
Computer Science																		
De Grande, Robson	1		14		34		8			12								
Ezzati-Jivan, Naser			11	6	12	10	10	2	2	8		4	1		4			
Houghten, Sheridan		1	9		25*	15	1			50+								2
Hughes, David	2														1	3		
Li, Yifeng	1	1	18	5	30	3	5	5 yrs	5 yrs	38					7	1	5 yrs	1
Ombuki-Berman, Beatrice		3	7	3	25		7			40+					1		4	
Qiu, Ke		1	40		14					40								
Ross, Brian		3	5		18					50+								
Winter, Michael	1		14		14					2								

Table 6.1: Intellectual Contributions (Past Eight Years, 2010/11 to 2017/18)

Faculty Name	A. Publication of books and monographs	B. Contributions to edited books	C. Papers in peer refereed journals	D. Peer reviewed abstracts	E. Papers delivered at conferences and professional meetings	F. Contributions to panels, workshops, and clinics	G. Invited Presentations	H. Consulting (government, related professionals and agencies)	I. Preparation of instructional, clinical, curriculum or policy materials for such agencies	J. Editorial and refereeing duties	K. Creation, performance, direction, programming, design and staging of creative works for the public	L. Curation of juried exhibitions	M. Festivals and competitions adjudicated, master classes offered	N. Professional residencies	O. Development of software, hardware or equipment	P. Scholarly contributions to pedagogy	Q. Other scholarly contributions to agencies, communities, governments or organizations	R. Other publications (non-refereed) with significant public impact
Mathematics and Statistics																		
Anco, Stephen		1	33		7	39	6											
Ben-El-Mechaiekh, Hichem		5	11		14		14		1	50+								
Buteau, Chantal		1	19	1	24	6	5			15+					1	12		
Fukś, Henryk		11	15		14		1			24+							5	
Huang[2], Mei Ling			16		24		8	20		20+							6	
Kihel, Omar			20				28											
Li, Yuanlin		1	41		62		5											
Marshall, William			13			2	2			9					1			
Odesskii, Alexandre			16				11											

2 Retiring in July 2019

Table 6.1: Intellectual Contributions (Past Eight Years, 2010/11 to 2017/18)

Faculty Name	A. Publication of books and monographs	B. Contributions to edited books	C. Papers in peer refereed journals	D. Peer reviewed abstracts	E. Papers delivered at conferences and professional meetings	F. Contributions to panels, workshops, and clinics	G. Invited Presentations	H. Consulting (government, related professionals and agencies)	I. Preparation of instructional, clinical, curriculum or policy materials for such agencies	J. Editorial and refereeing duties	K. Creation, performance, direction, programming, design and staging of creative works for the public	L. Curation of juried exhibitions	M. Festivals and competitions adjudicated, master classes offered	N. Professional residencies	O. Development of software, hardware or equipment	P. Scholarly contributions to pedagogy	Q. Other scholarly contributions to agencies, communities, governments or organizations	R. Other publications (non-refereed) with significant public impact
Vrbik, Jan			34															
Wolf, Thomas		1	14		49		1								4		3	
Xu, Xiaojian		1	15		24		11	6		20+								

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
Computer Science															
De Grande, Robson	17/18					1	28,000							28,000	28,000
Ivo Düntsch	12/13					1	20,000							20,000	
	11/12					1	20,000							20,000	

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
Houghten, Sheridan	17/18					1	20,000							20,000	
	16/17					1	20,000							20,000	
	15/16					1	20,000							20,000	
	14/15					1	20,000							20,000	
	13/14					1	15,000							15,000	
	12/13					1	15,000							15,000	
	11/12					1	15,000							15,000	
	10/11					1	15,000							15,000	140,000
Ombuki-Berman, Beatrice	17/18	2					10,000							10,000	
	16/17	1					10,000							10,000	
	12/13										31,250			31,250	
	11/12										50,000			50,000	
	10/11						12,000				12,000			12,000	123,250
Qiu, Ke	17/18					1	10,000							10,000	
	16/17					1	10,000							10,000	
	15/16					1	18,000							18,000	
	14/15					1	18,000							18,000	
	13/14					1	18,000							18,000	
	12/13					1	18,000							18,000	

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
	11/12					1	18,000							18,000	110,000
Ross, Brian	17/18					1	22,000							22,000	
	16/17					1	22,000							22,000	
	15/16					1	14,000							14,000	
	14/15					1	14,000							14,000	
	13/14					1	14,000							14,000	
	12/13					1	14,000							14,000	
	11/12					1	14,000							14,000	
	10/11					1	12,700							12,700	126,700
Winter, Michael	17/18					2	119,740							119,740	
	16/17					1	14,000							14,000	
	15/16					2	18,500					2	49,999	68,499	
	14/15					1	14,000							14,000	
	13/14					1	14,000							14,000	
	12/13					1	23,000							23,000	
	11/12					1	23,000							23,000	
	10/11					1	23,000							23,000	299,239
Mathematics and Statistics															
Anco, Stephen	17/18					1	18,000							18,000	

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
	16/17					1	18,000							18,000	
	15/16					1	18,000							18,000	
	14/15					1	18,000							18,000	
	13/14					1	18,000							18,000	
	12/13					1	18,000							18,000	
	11/12					1	18,000							18,000	
	10/11					1	18,000							18,000	144,000
Buteau, Chantal	08/09							2	18,400					18,400	
	07/08							2	18,400					18,400	36,800
Farzad[3], Babak	17/18					1	15,000							15,000	
	16/17					1	15,000							15,000	
	15/16					1	15,000							15,000	
	14/15					1	15,000							15,000	
	13/14					1	15,000							15,000	
	12/13					1	17,000							17,000	
	11/12					1	17,000							17,000	
	10/11					1	17,000							17,000	126,000

3 Passed away in December 2018

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
Fukś, Henryk	17/18					1	11,000							11,000	
	16/17					1	11,000							11,000	
	15/16					1	11,000							11,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12000							12,000	
	11/12					1	12,000							12,000	
	10/11					1	12,000							12,000	93,000
Huang[4], Mei Ling	17/18					1	11,000							11,000	
	16/17					1	11,000							11,000	
	15/16					1	11,000							11,000	
	14/15					1	11,000							11,000	
	13/14					1	15,000							15,000	
	12/13					1	15,000							15,000	
	11/12					1	15,000							15,000	
	10/11					1	15,000							15,000	104,000
Kihel, Omar	17/18					1	14,000							14,000	

4 Retiring in July 2018

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
	16/17					1	12,000							12,000	
	15/16					1	12,000							12,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12,000							12,000	
	11/12					1	1,0000							1,0000	
	10/11					1	6,000							6,000	9,0000
Li, Yuanlin	17/18					1	14,000							14,000	
	16/17					1	12,000							12,000	
	15/16					1	12,000							12,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12,000							12,000	
	11/12					1	10,000							10,000	
	10/11					1	10,000							10,000	94,000
Odesskii, Alexandre	17/18					1	14,000							14,000	
	16/17					1	14,000							14,000	
	15/16					1	14,000							14,000	
	14/15					1	14,000							14,000	
	13/14					1	14,000							14,000	

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
	12/13					1	14,000							14,000	
	11/12					1	14,000							14,000	
	10/11					1	14,000							14,000	112,000
Wolf, Thomas	17/18					1	24,000							24,000	
	16/17					1	12,000							12,000	
	15/16					1	12,000							12,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12,000							12,000	
	11/12					1	17,000							17,000	
	10/11					1	17,000							17,000	118,000
Xu, Xiaojian	17/18					1	11,000							11,000	
	16/17					1	11,000							11,000	
	15/16					1	11,000							11,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12,000							12,000	
	11/12					1	12,000							12,000	
	10/11					1	12,000							12,000	93,000

Table 6.2: Research Grants and Contracts – External Sources (past eight years)

Name	Year	CFI		CIHR		NSERC		SSHRC		Other Major Granting Agencies		Other Grants & Contracts		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
Yuen[5], John	16/17					1	12,000							12,000	
	15/16					1	12,000							12,000	
	14/15					1	12,000							12,000	
	13/14					1	12,000							12,000	
	12/13					1	12,000							12,000	
	11/12					1	16,000							16,000	
	10/11					1	16,000							16,000	92000

5 Resigned in 2017

Table 6.3: Research Grants and Contracts – Internal Sources (past eight years)

Instructor Name	Year	BUAF		CIHR Internal		SSRC Internal		Dean/Faculty		Department		Other		Year Total	Individual Total
		#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount		
Chantal Buteau	16/17					2	4,500							4,500	
Chantal Buteau	14/15					2	4,250							4,250	
Chantal Buteau	13/14					1	2,000							2,000	10,750
Mei Ling Huang	16/17											1	5,000	5,000	5,000
Ping Liang	10/11	1	4,000											4,000	

6.2: Faculty Expertise Linked to the Program Structure

With reference to the program structure outlined in Section 3 explain how the faculty expertise will contribute to ensuring the intellectual quality of the student experience.

The program and curriculum discussed in Section 3 is a product of the faculty's technical expertise in the fields of mathematics, statistics, and computer science. Some courses contain foundational content of the field, while others are specialty courses directly arising from faculty research expertise. The success of both departments' master's programs, which use most of these courses, provides a strong foundation for a high-quality Ph.D. program. The new ISDS 7P75/ISDS 5N01 Scientific writing and Seminar courses will further enhance the quality of the curriculum. (5N01 has been delivered to the Department of Chemistry program for many years.)

7: Student Demand (IQAP 3.5.7)

Provide evidence of the existence of a population of potential students to whom this program would be of interest by providing data documenting the demand for the new degree/program on the part of potential students including:

a) The origin of the student demand (local, regional, domestic and/or international);

Since the introduction of the M.Sc. program in Computer Science, and M.Sc. in Mathematics and Statistics, there has been a large pool of potential applicants for a Ph.D. program. History shows that there has always been more eligible applicants than the capacity of the programs. International applicants usually comprise the majority of applications.

Faculty members in both departments regularly receive queries from interested applicants about Ph.D. studies. In addition, over the life of the M.Sc. programs, many students have continued onto Ph.D. programs at the following universities. There is roughly an equal distribution of students from Computer Science and Mathematics & Statistics in this list.

- Dalhousie University (2)
- Simon Fraser University (2)
- Concordia University (2)
- York University (1)
- University of Saskatchewan (1)
- University of Toronto (1)
- McMaster University (2)
- Queen's University (3)
- Ryerson University (1)
- University of Ontario Institute of Technology (1)
- Carleton University (1)
- University of Guelph (3)
- University of Waterloo (2)
- University of Victoria (1)
- Laval University (1)
- Memorial University (1)
- University of Ottawa (1)
- University of Central Florida (2)
- University of Cadiz (Spain) (1)
- Central Michigan University (1)
- Izmir Institution of Technology (Turkey) (1)

b) Evidence of basis for the projected five (5) year enrollment presented in Section 4.3;

Evidence that supports our enrollment projections includes the following:

- High application rates to the M.Sc. programs in Mathematics and Statistics, and Computer Science (see Table 7.1).
- High numbers of registrations in both M.Sc. programs (the highest in the Faculty of Mathematics and Science).
- Frequent email queries about Ph.D. studies at Brock in our departments. Although statistics have not been tabulated, anecdotally, faculty members easily receive at least 5 queries a year regarding Ph.D. supervision.
- A number of M.Sc. graduates carry on Ph.D. studies at other institutions (see above list). It is reasonable to expect that some of them would have remained at Brock, should a Ph.D. program had been available.

c) Expected duration for the student demand;

Interest in graduate studies in mathematics, statistics, and computer science, has not abated in the last decade, and there is no reason to expect any reduction of interest in the coming years. The press interest in topics such as big data and artificial intelligence supports the view that interest will be active for the foreseeable future. (Please see Section 8.0 below for detailed discussions on this topic).

d) Evidence of the level of professional interest, if applicable and,

Not applicable.

e) For new graduate programs only, a list of the undergraduate or master's programs from which students may be drawn.

The main programs from which we expect most Ph.D. applicants to have previously studied are M.Sc. degrees in Mathematics, Statistics, and Computer Science. There is the possibility for applicants with closely related backgrounds to be considered (Data Analytics, and Computer Engineering, to name a few). Naturally, the student's prior background and experience will determine the concentration for their Ph.D. studies, as well as the direction of their Ph.D. research.

In past years, Brock M.Sc. graduates in both Mathematics and Statistics, and Computer Science, have lamented the fact that they could not continue their doctoral studies at Brock. A quick survey of current M.Sc. students in Computer Science found that 3 students would be interested in staying for Ph.D. studies at Brock, if such a program were available. This interest of our students is important for admitting Canadian students into the ~~program, and~~program and sustaining a continuation in research topics. It also speaks to the high quality and satisfaction the students had during their master's studies. In summary we expect to have a large pool of applicants for the new program, with potentially a higher percentage of domestic students.

NOTE: The Ministry of Advanced Education and Skills Development will consider enrollment in competing and comparable programs at other institutions when evaluating potential demand for the proposed program.

8: Societal Need (IQAP 3.5.8)

Provide evidence of a societal need for students who have successfully completed the proposed program. Proponents will describe the demand for graduates of the proposed degree/major on the part of society by addressing the following:

a) Various dimensions of societal need for graduates (socio-cultural, economic, scientific, technological, etc.), with examples of career paths for graduates;

The economic importance of information technology skills was addressed earlier. Nowadays, mathematics, statistics, computer science, data science, artificial intelligence, and information technology skills are needed in almost every area of work and personal life. The proposed Ph.D. in Intelligent Systems and Data Science addresses an acute societal need for highly qualified scientists with expertise in these fields, particularly by employers in industry, government, research, and technology. Some evidence of the need for such Ph.D.'s is the following:

- The online magazine Slate states that a science Ph.D. in general is "not a waste of time". Even though universities produce more Ph.D.s than faculty positions available, the article argues that the unemployment rate among Ph.D. holder is extremely low; 1.7 percent in the US in 2012. [1]
- Fortune Magazine's 2016 List of Best 15 Graduate Degrees for Jobs lists Ph.D. in Computer Science at #3, and Ph.D. in Mathematics at #8. [2]
- Online career site Find Your Calling ranks a doctorate in fields related to Computer & Information Research Science as the ninth best doctoral-level job for 2016. [3]
- The Independent (UK)'s list of best jobs of 2016 gives the following rankings: data scientist (#1), statistician (#2), mathematician (#6), and software engineer (#7). [4]
- The Globe and Mail discusses Canada's need for new Ph.D.s. [5]
- In Grad School Hub's "10 Best Doctoral Degrees by Salary", #3 is Computer Science, and #10 is Statistics. [6]
- The TFE Times list of highest paying Ph.D. degrees lists computer science (#3), statistics (#10) and mathematics (#22) [7].

The high need for graduates with degrees in computer science, mathematics, statistics, and information technology degrees is borne out by the experience of our departments' graduate students and their careers after graduating from Brock. The proposed Ph.D. in Intelligent Systems and Data Science will address the urgent need for scientists having these skills in industry and elsewhere.

[1] "Is a Science Ph.D. a Waste of Time?", D. Lametti, Slate magazine (2012), https://slate.com/technology/2012/08/what-is-the-value-of-a-science-phd-is-graduate-school-worth-the-effort.html. Retrieved 25/02/2020.

[2] "Best ~~And~~and Worst Graduate Degrees For Jobs in 2016", Fortune Magazine (2016), http://fortune.com/2016/03/21/best-worst-graduate-degrees-jobs-2016/. Retrieved 25/02/2020.

[3] "Best Doctoral-Level Jobs for 2016", G. Burrow, Find Your Calling (2016), http://blog.findyourcalling.com/best-doctoral-level-jobs-for-2016/. Last accessed 12/12/2017.

[4] "Revealed: the best (and worst) jobs of 2016", S. Osborne, The Independent (2016), http://www.independent.co.uk/news/business/news/what-are-the-best-jobs-and-the-worst-a6985376.html. Last accessed 25/02/2020.

[5] "Few academic jobs, but Canada's need for Ph.D.s grows", B. Herbert-Copley, The Globe and Mail (2013). https://www.theglobeandmail.com/news/national/education/few-academic-jobs-but-canadas-need-for-phds-grows/article12219592/. Last accessed 25/02/2020.

[6] "10 Best Doctoral Degrees by Salary", Grad School Hub (2017), http://www.gradschoolhub.com/lists/best-doctoral-degrees-by-salary/. Last accessed 25/02/2020.

[7] "26 Highest Paying Ph.D Degrees, TFE Times (2017), https://tfetimes.com/15-ph-d-degrees-thatll-make-you-filthy-rich/. Last accessed 25/02/2020.

b) Geographic scope of the societal need for graduates (local, regional provincial, national, international); and,

The importance of computer science, mathematics, statistics, and STEM fields in general, is not bounded by geographic borders, but is internationally important. The internet has disrupted the historical importance of geographic locations as it pertains to technology, industry, and the world economy.

c) Duration of the societal need;

Automation and technology are changing the jobs that will be available in society in the near future. This evolution in technology is profoundly important to Canada's, and the world's, future economy, and has been termed the Fourth Industrial Revolution [1]. The future need for scientists with knowledge in intelligent systems and data science, and having the mathematical, statistical, and computational skills for design and analysis, is critical for Canada. The US Bureau of Labor Statistics supports the claim that STEM jobs (science, technology, engineering, mathematics) will see a growth of more than 9 million between 2012 and 2022 [2]. Similar forecasts are seen for Canada [3-7].

[1] "The Fourth Industrial Revolution: what it means, how to respond", Klaus Schwab, World Economic Forum (2016), https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/. Last accessed 25/02/2020.

[2] "STEM 101: Intro to tomorrow's jobs", Dennis Vilorio, Occupational Outlook Quarterly, Spring 2014, www.bls.gov/ooq. Last accessed 25/02/2020.

[3] "Jobs of the Future", https://canada2067.ca/en/articles/jobs-of-the-future/. Last accessed 25/02/2020.

[4] "Where the jobs will be in Canada over the next 10 years", https://careers.workopolis.com/advice/where-the-jobs-will-be-in-canada-over-the-next-10-years/. Last accessed 25/02/2020.

[5] "Growing STEM: Careers abound in science, technology, engineering and mathematics", Adrienne Martin, eco ~~canada~~Canada (2014), http://www.eco.ca/blog/growing-stem-careers-abound-in-science-technology-engineering-and-mathematics/. Last accessed 25/02/2020.

[6] "Some Assembly Required: STEM Skills and Canada's Economic Productivity", Expert Panel on STEM Skills for the Future (2015), https://cca-reports.ca/wp-content/uploads/2018/10/STEMExecSummEn.pdf. Last accessed 25/02/2020.

[7] "Future-proof: Preparing young Canadians for the future of work", Creig Lamb and Sarah Doyle, Brookfield Institute (2017). https://brookfieldinstitute.ca/report/future-proof-preparing-young-canadians-for-the-future-of-work/. Last accessed 25/02/2020.

Evidence in support of the above may include:

a) *The probable availability of positions upon graduation (e.g., include external letters of support from potential employers or governmental agencies). Describe and document career opportunities including non-academic positions for graduate degrees;*

The many news articles and reports cited above and elsewhere provide ample evidence that the STEM skills and scientific expertise obtained with the Ph.D. in Intelligent Systems and Data Science are recognized as being critically important to Canada's current and future economy.

b) *In the case of professional programs, an assessment of the congruence of the proposed program with the regulatory requirements of the profession;*

Not applicable.

c) Employment rates for graduates of existing and related programs; and

On February 25, 2020, the Canadian job site indeed.com listed 501 jobs for Ph.D. in Computer Science, 172 for Ph.D. in Mathematics, and 205 for Ph.D. in Statistics. Many jobs specified a choice between these fields. There are also 2037 jobs (not necessarily Ph.D. level) for AI, and 902 for data science.

The National Science Foundation (USA) performed a Survey of Doctorate Recipients (2013), which shows an employment rate of 97.7% for Ph.D. in Computer Science, and 96.4% for Ph.D. in Mathematics/Statistics.

d) Employment outlook based on federal, provincial or sector reports, where available.

See citations listed in Section 8(a) and 8(b).

NOTE: The Ministry of Advanced Education and Skills Development may consider other sources of information related to societal and labour market need in evaluating the potential societal need for the proposed program.

9: Qualification for Public Funding (IQAP 3.5.13)

In providing the information in this section, proponents will consider:

a) Differences between the proposed program and existing comparator programs, including innovative and distinguishing aspects of the proposed program;

The proposed Ph.D. in Intelligent Systems and Data Science is unique in Ontario and Canada. The degree title and program structure acknowledge the important relationships between these disciplines and research focus areas in contemporary scientific research. The degree also focusses on the strong demand in industry for Ph.D. holders with expertise in these fields. The program is broad enough in scope to permit participation by researchers in both ~~departments, and~~departments and encourages future collaboration between faculty. The program is also "future proof", in that it is not too narrowly specialized on specific research topics whose trendiness and popularity may diminish in the near future. For example, artificial intelligence had a surge of media and industry attention in the 1980's, which quickly subsided until the 2010's; and multimedia was a hot area in the 1990's, but the term is now an anachronism.

Before proceeding with a comparative discussion, 2 graduate programs should first be mentioned. Neither of these programs will be discussed in detail.

- The University of Waterloo has a Masters of Data Science and Artificial Intelligence. This is a ~~1 year~~1-year course-based professional graduate degree. This degree does not compete in depth to our ~~Ph.D., because~~Ph.D., because it is not research-based, is an MSc-level degree, and concentrates on narrower topics of AI than ours.

- The University of Quebec at Montreal has a *Doctorat en Informatique Cognitive* (Ph.D. in Artificial Intelligence). This program ~~patially~~partially aligns with our Ph.D., although our program is wider in scope, given that ours is in *intelligent systems* and not specific topics in artificial intelligence, and also includes data science. Since AI is a broad field of research, there is room for many specialist AI graduate programs, especially given the interest and need for such expertise.

Below are Ontario Ph.D. programs that share some superficially similar aspects to the Ph.D. in Intelligent Systems and Data Science. The main characteristics of similarity is that these comparator programs superficially appear to involve mathematics, statistics, and/or computer science. Closer examination of these programs, however, shows that the programs are distinctly different in direction and content to our proposed Ph.D.

A summary comparison of degree requirements between our Ph.D. and these programs, as well as a selection of others in Ontario and Canada, is given in Table 9.1.

1. *Ryerson University - Ph.D. in Mathematical Modelling and Methods*

This is a program of the Department of Mathematics at Ryerson. The degree specializes in 3 distinct fields: (i) Discrete Mathematics and Networks; (ii) Financial Mathematics; and (iii) Biomathematics and Fluids. The research program is dedicated to topics in these fields, and therefore the scope of research is much narrower than our Ph.D. Although both our Ph.D. and Ryerson's stress modelling, their Ph.D. is exclusively mathematics-orientated, and computational aspects are not promoted as a major theme of the program.

In terms of curriculum, Ryerson's program offers 4 core courses (in mathematics and statistics), and 12 elective courses. Electives range from topics courses, to courses in the areas of the degree speciality fields. Only one course (computational complexity) is specifically computer science oriented. This contrasts to our course bank of 39 courses in topics in mathematics, statistics, and computer science, as well as scientific writing.

2. *UOIT: Ph.D. in Modelling and Computational Science*

Similar to our program, UOIT's Ph.D. acknowledges the roles of mathematical modelling and computation in problem solving. A key difference between their program and ours, however, is that their program is exclusively directed towards applications of scientific computation. Consequently, their program is advertised as focussing in two specific application areas: Computational Physical Science and Scientific Computing. Their listed research areas are thus applications of scientific computation. Although some of these topics might be studied in our program (depending on faculty expertise and collaborative contacts), our degree is not dedicated to scientific computation. Our research directions have a different direction and scope than theirs.

~~UOIT list 5 core courses and 22 electives,~~UOIT list 5 core courses and 22 electives compared to our course bank of 39 courses. Their courses are focussed in modelling, analysis, computational methods (numerical analysis, Monte Carlo), and topics courses in areas of scientific computation. Our course bank has a wider range of courses in theoretical topics, especially in mathematical methods.

3. U Guelph: Ph.D. in Computational Science

This is an interdisciplinary Ph.D. involving faculty members from various departments, including computer science, economics, engineering, English, geography, history, integrative biology, mathematics and statistics, pathobiology, psychology, and veterinary medicine. Their Ph.D. is

focussed on applying computational methods to solve interdisciplinary problems in the sciences and humanities. Although this is an important aspect of our Ph.D., our degree highlights intelligent systems and data science, and our program involves faculty with computational, mathematical, and statistical backgrounds.

Their course requirements state that students should take one or more courses in the interdisciplinary area related to their thesis research. This may include "Computational Study Modules" (online tutorials) to upgrade their computing knowledge. Otherwise, there is no specified course bank for their degree. Therefore, their degree is based on interdisciplinary research topics in terms of course work than ours. In addition, it seems that applicants to their program can have diverse academic backgrounds, with limited backgrounds in mathematics, statistics, and computer science. Mathematical methods are not stressed in their program whatsoever.

Appendix H lists Ph.D. programs in Ontario that refer to the terms (or variants): computer science, mathematics, or statistics.

b) Comments from other institutions regarding the proposed new program. Note: MAESD will seek input from other institutions regarding any new program proposals;

Not applicable, since comparators above are distinct to our Ph.D..

c) Comments regarding health-related programs from the Ministry of Health and Long Term Care, if applicable;

Not applicable.

d) Comments from other relevant stakeholders, as required; and

Not applicable.

e) Comment on the impact of any proposed experiential learning components within the proposed program on experiential learning programs at other institutions, if applicable.

Not applicable.

Table 9.1: Comparison with other Ph.D. Programs

University	Field	Course Requirements	~~Comprehensive~~ Qualifying Examination	Thesis Proposal	Other
Brock University (proposed program)	Intelligent Systems and Data Science	• 4 COSC/MATH courses • ISDS 7P75 • ISDS 5N01	• Thesis proposal in form of a NSERC application • Defense • Oral Examination (breadth requirement)		• submission for publication
Ontario					
University of Guelph	Computational Science	• Research methodology course • other courses (determined by committee)	• Qualifying examination	• 2 seminars	
University of Ontario Institute of Technology	Modelling and Computational Science	⇨ 3 courses for breadth ⇨ Professional skills course	• Written proposal and oral candidacy exam	• Written thesis proposal	
Ryerson University	Mathematical Modelling and Methods	• 3 courses	• Written and oral candidacy exam	• No information	
McMaster University	Computer Science	• 4 courses	• Examination of graduate level understanding of the undergraduate computer science material • Defense of thesis proposal		
University of Ottawa	Computer Science	• 3 courses	• Written and oral examination	• Written thesis proposal • Defense	• 2 seminars
University of Toronto	Mathematics	• 6 courses (can include courses taken in the M.Sc. program)	• 3 exams (breadth)	• Presentation of preliminary results	• Thesis seminar • Department and University thesis defenses

University of Waterloo	Applied Mathematics	• 4 courses	• Written comprehensive exam	• written proposal and seminar	• teach one undergraduate course (or seminar series if no course available)
Western University	Statistics	• 8 courses	• written qualifying exam (basic knowledge)	• proposal defence	• seminar (department, or conference)
York University	Statistics	• 5 courses	• 3 comprehensive exams (breadth)	• no information	
	Canada				
Dalhousie University	Computer Science	• 2 courses (previously 4 courses)	• Internal review of the directed research project to date • Defense		
University of British Columbia	Computer Science	• 5 courses breadth ⇨ 3 courses in research area	• Research project presented in writing and orally	• Defense	
University of Alberta	Mathematics and Statistics	• 6 courses	• Candidacy exam		
Simon Fraser University	Applied and Computational Mathematics	• 8 courses (with breadth reqts)	• Oral exam on research area	• written Ph.D. proposal	
University of Manitoba	Statistics	⇨ 4 courses	• qualifying exam (breadth?) • candidacy exam (research?)		
McGill University	Mathematics and Statistics	• 12 courses	• 2 written papers for comprehensive exam • oral exam of 2 advanced topics (different from written topics)		

10: Information Required by the Ministry for the Approval of New Programs

In addition to the above information required in the IQAP to satisfy the requirements of the Quality Assurance Framework, for the purposes of funding (~~i.e.~~ i.e., grant allocation) for new programs the Ministry of Advanced Education and Skills Development (MAESD) requires that institutions specifically address the following in their request for program approval.

Describe how the proposed program is consistent with an area of strength and/or area of growth identified in the (SMA). If not aligned, describe how the program is consistent with the mission, aims, objectives and existing strengths of Brock.

A detailed discussion of relationship of proposal to SMA 2 was discussed in Section 1.3. To summarize that discussion, the Ph.D. aligns with three components of the SMA 2:

(i) Strategic Areas of Program Strength and Expansion (SMA2, p.22): The Ph.D. program directly falls under the category of "Scientific and Technological Applications", which is listed both as an area of strength and area of expansion. The Ph.D. will allow Brock to expand its research directions into branches of science identified as being critical to the local, national and world economy, by allowing advanced graduate research in intelligent systems and data science. Currently, there are no doctoral-level programs at Brock that offer such research directions.

(ii) Research Excellence and Impact (SMA2, p.13): The Department of Computer Science and Department of Mathematics and Statistics have a long history of research accomplishments, evident in their research productivity, as well as highly successful M.Sc. programs. The Ph.D. program will elevate this research to a level it deserves.

(iii) Innovation, Economic Development, and Community Engagement (SMA2, p.16): As mentioned in Section 1.3, the research undertaken in the Ph.D. embraces topics that are identified as critical to the future economy of Canada. Much of this research will have great potential in commercial and industrial applications, both in local start-up companies, as well as larger international corporations with high name recognition.

The proposed Ph.D. also aligns with the following strategic priorities/goals in the Brock University Institutional Strategic Plan 2018-2025:

- Offer a transformational and accessible academic and university experience:
  - Deliver high-quality programs that meet the interests and needs of students.
  - Develop programs that meet labour market and societal needs.
- Build research capacity across the university:
  - Nurture a culture of research excellence.
  - Invest in research infrastructure and support to ensure sustainable and accessible research services.
  - Enhance transdisciplinary research and high-impact research practices.
- Support regional economic, social, and cultural vitality (by) increasing access to programs that are in high demand that will increase the employability of graduates.

Explain how the proposed program fits with Brock's current program offerings and the University's capacity to deliver the proposed program.

Brock does not have any Ph.D. program in the areas of Computer Science, Mathematics, or Statistics. The proposed Ph.D. fills a void in the current graduate offerings at Brock, and the integration of the research from the host departments further strengthens and enriches the research direction of this Ph.D. Given the critical importance of STEM fields in modern society and the global economy, the

lack of a doctoral degree in these fields at Brock is serious, and an anomaly for a modern comprehensive university.

As discussed in previous sections, both departments have the resources to deliver the program with minimal extra resource requirements.

Provide at least two (2) examples of both institutional and sector comparator programs (including program name, university, and most recent tuition fee exclusive of additional fees) used to set the proposed tuition fee.

Comparators may be similar credentials, similar programs or programs with similar cost structures. The Ministry prefers tuition comparators in Ontario, and then in Canada, if Ontario comparators are not available. If no comparators are available for tuition fee setting, please provide the rationale.

Justify the reasoning for the proposed tuition; if higher than comparators, describe how the impact on accessibility will be mitigated.

Program Comparators – Brock University

Program Name	Tuition fee for the program's full academic year, as defined by the institution	Academic year	Tuition fees: how it is charged (per year/ session/course /credit)	Number of semesters covered by tuition noted in column 2	Number of units of study covered by tuition noted in column 2	Number of semesters for program completion	Number of units of study for program completion
Biological Sciences	$9084.72 (dom), $23504.49 (intl)	2018/19	Flat fee per year	3	n/a (flat fee/year)	12	2
Chemistry	$9084.72 (dom), $23504.49 (intl)	2018/19	Flat fee per year	3	n/a (flat fee/year)	12	7

Program Comparators - Sector (only the program, institution names, and tuition fees are mandatory)

Program Name	Institution Name	Tuition fee for the program's full academic year, as defined by the institution	Tuition fees: how it is charged (per year/ session/course /credit)– if known.	Tuition year	Number of semesters covered by tuition noted in column 1	Number of units of study covered by tuition noted in column 1	Number of semesters for program completion	Number of units of study for program completion
Modelling and Computational Science	UOIT	$8,421.46 (dom),	Flat fee per year	2018/19	3	n/a	12	3

		$18,421.78 (intl)						
Computational Science	U. Guelph	$7768 (dom), $18732 (intl)	Flat fee per year	2018/19	3	n/a	9	1

Commentary:

List comparator programs both at Brock and other Ontario institutions, with particular reference to universities in the region; document how any duplicative similarities with existing programs at the University and other post-secondary institutions are justified; document that the program has consulted with other regional universities regarding the establishment of a similar program where the existing program is a recognized area of differentiation or leadership for the institution or where the proposed program requires substantial new investment in faculty, infrastructure, or experiential/entrepreneurial learning outside the regular learning environment.

A detailed discussion of comparator programs is in Section 9.0 (a). Although the three comparator programs (Ryerson, UOIT, Guelph) are closest to our program, as computation and modelling are involved to varying degrees in these programs. However, the title and the focus areas of our programs are distinct from these existing programs. To summarize the earlier discussion:

(i) Ryerson U., Ph.D. in Mathematical Modelling and Methods: This is exclusively hosted by the Department of Mathematics and is directed towards 3 distinct topics: discrete mathematics and networks; financial mathematics; and biomathematics and fluids. It is therefore does not focus on any areas on data science and intelligent systems and does not include computer science methods as a partner field to their mathematical methods.

(ii) UOIT, Ph.D. in Modelling and Computational Science: This program has some superficial similarities to ours. However, it is entirely focused on two distinct fields: computational physical science, and scientific computations. It therefore does not consider research in fundamental topics in data science & analytics, mathematical & statistical modelling, artificial intelligence, optimization, smart systems, and high-performance computing in the host departments at Brock.

(iii) Guelph, Ph.D. in Computational Science: This is a multidisciplinary Ph.D. involving faculty from a wide array of different fields, from English to History to veterinary medicine and others. It is essentially a degree in computational methods for solving interdisciplinary programs. Although our Ph.D. will also consider this aspect, our program is founded in mathematical/statistical modelling and computer science technologies. Our degree therefore intrinsically highlights theories and applications in big data, machine intelligence, and systems design, and consequently, students are firmly founded in coursework, ~~comprehensive~~ qualifying examinations, and thesis research in these areas. Guelph's degree is much broader in its interdisciplinary philosophy and scope, and less focused on foundational data science, artificial intelligence, and systems disciplines as ours.

Comment on any differences between the proposed program and comparators (number of credits/courses, structure, etc.).

Please see 3.2.2 and 9.0 for a detailed discussion of differences regard program structure between our program and others. To summarize that discussion, the Ph.D. program follows the same structure as most Ph.D. program in mathematics, statistics and computer science in Ontario and Canada:

(i) Course component: Students entering the program with a M.Sc. degree must take 6 courses. Two of these courses are prescribed (ISDS 7P75 Ph.D. Seminar, and ISDS 5N01 Scientific Writing). Other

programs require between 3 to 12 courses. Compulsory course(s) in research methodology or professional skills are sometimes required.

(ii) ~~Comprehensive~~ Qualifying examination: Our program requires a qualifying ~~comprehensive~~ examination~~,~~ that includ~~es~~ing ~~a unique assessment in~~ writing a research grant~~. Other programs have comprehensive examinations, as well as written and oral qualifying examinations for the thesis~~ proposal that describes the candidate's doctoral research topic, as well as an oral presentation and examination of the proposal.

(iii) Thesis research: All programs involve thesis research, submission, and defence. Our program uniquely requires students to submit thesis research for publication at a peer-reviewed conference/journal. (Although publication is not required, it is desirable).

Table 2.3: Doctoral Curriculum

Ph.D. in Modeling with Mathematics and Applied Computing

	Degree Level Expectation Headings==>	Depth and Breadth of Knowledge				Knowledge of Methodologies				Application of Knowledge						Professional Capacity/Autonomy						Level of Communication Skills					Awareness of Limits of Knowledge	
	Program Learning Outcomes==>	LO1a	LO1b	LO1c	LO1d	LO2a	LO2b	LO2c	LO2d	LO3a	LO3b	LO3c	LO3d	LO3e	LO3f	LO4a	LO4b	LO4c	LO4d	LO4e	LO4f	LO5a	LO5b	LO5c	LO5d	LO5e	LO6a	LO6b
Course No.	Course Title																											
COSC 5P01	Coding Theory	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4	2,3,4,7	7			3,4	3,4	3,4	3,4								3,4,7	3,4,7	3,4,8		3,4	3,4,7	7
COSC 5P02	Logic in Computer Science	2	2	2	2	2	2				2	2	2	2								2	2	2			2	2
COSC 5P03	Universal Algebra for Computer Science	2	2	2	2	2	2				2	2	2	2								2	2	2			2	2
COSC 5P04	Parallel Algorithms	4,7	4,7	4,7	4,7	4,7	4,7	7			4,7	4,7	4,7	4,7								4,7	7	7		4	4,7	4,7
COSC 5P05	Introduction to Lambda Calculus	2	2	2	2	2	2				2	2	2	2								2	2	2			2	2
COSC 5P06	Principles of Mobile Cloud Computing	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10				2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10								2,3,4,7,10	2,3,4,7,10	2,3,4,7,10		2,3,4,7,10	2,3,4,7,10	2,3,4,7,10
COSC 5P07	Fundamentals of Parallel and Distributed Syste	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10				2,3,4,7,10	2,3,4,7,10	2,3,4,7,10	2,3,4,7,10														
COSC 5P08	Data Science	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5	2,3,4,5,7	7			3,4,5	3,4,5	3,4,5	3,4,5														
COSC 5P71	Genetic Programming	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5	2,3,4,5,7	7			3,4,5	3,4,5	3,4,5	3,4,5								3,4,5,7	3,4,5,7	3,4,5,8		3,4	3,4,5,7	7
COSC 5P72	Robot Control Architectures																											
COSC 5P73	Computer Vision and Visual Learning	3,4	3,4	3,4	3,4	3,4	3,4				3,4	3,4	3,4	3,4								3,4	3,4	3,5		3,4	3,4	
COSC 5P74	Evolutionary Computation	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5	2,3,4,5,7	7			3,4,5	3,4,5	3,4,5	3,4,5								3,4,5,7	3,4,5,7	3,4,5,8		3,4	3,4,5,7	7
COSC 5P75	Directed Reading	4,5	4,5		4,5						4,5	4,5	4,5	4,5	4,5							4,5	4,5	4,6		4	4,5	
COSC 5P76	Non-invasive Data Analysis	2	2	2	2	2	2				2		2	2								2	2	3		3	2	2
COSC 5P77	Recent Advances in Computational Intelligence	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5	2,3,4,5,7	7			3,4,5	3,4,5	3,4,5	3,4,5														
COSXC 5P78	Machine Learning	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	2,3,4,5	2,3,4,5,7	7			3,4,5	3,4,5	3,4,5	3,4,5														
MATH5P09	Solitons and Nonlinear Wave equations	1, 2, 7, 12	1, 2, 7, 12	1, 2, 7, 12	1	2	1, 2, 12	1, 2, 3, 12			2, 12	2, 12	2, 12	2, 12								1, 2, 3, 12		1, 2, 3, 12	1, 2	12	1, 12	1, 12
MATH 5P10	Modern Algebra	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	3, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7, 8			2, 3, 4, 7	2, 3, 4, 7	2, 3, 7	2, 3, 4, 7								2, 3, 4, 7, 8		2, 3, 4, 7, 8	2, 3, 7	8	3	3
MATH 5P11	Advanced Algebraic Stuctures	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	3, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7, 8			2, 3, 4, 7	2, 3, 4, 7	2, 3, 7	2, 3, 4, 7								2, 3, 4, 7, 8		2, 3, 4, 7, 8	2, 3, 7	8	3	3
MATH 5P20	Computational Methods for Algebraic and Diffe	1, 3	1, 3	1, 3		3	1, 3, 4	1, 3			1, 3, 4	1, 3, 4	4	1, 3, 4								1, 3		1, 3	3, 4	3	3, 4	3, 4
MATH 5P21	High Performance Computing	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P30	Dynamical Systems	2, 3, 4	2, 3, 4	2, 3, 4	3, 4	2, 3, 4	2, 3, 4, 7	2, 3, 4, 7			2, 3, 4	2, 3, 4	3, 4	2, 3, 4								1, 2, 3, 4, 7		1, 2, 3, 4, 7	3, 4, 7	4	3, 4	3, 4
MATH 5P31	Ergodicity, Entropy and Chaos	2, 3, 4	2, 3, 4	2, 3, 4	3, 4	2, 3, 4	2, 3, 4, 7	2, 3, 4, 7			2, 3, 4	2, 3, 4	3, 4	2, 3, 4								1, 2, 3, 4, 7		1, 2, 3, 4, 7	3, 4, 7	4	3, 4	3, 4
MATH 5P35	Graph Theory	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7			1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7								1, 2, 3, 4, 7		1, 2, 3, 4, 7	1, 3, 4, 7	4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7
MATH 5P36	Algorithmic Game Theory	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P40	Functional Analysis	2, 3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 7, 12	3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 7, 12			2, 3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 7, 12								2, 3, 4, 7, 12		2, 3, 4, 7, 12	3, 4, 7, 12	2, 3, 4, 7, 12	2, 3, 4, 12	2, 3, 4, 12
MATH 5P41	Nonlinear Functional Analysis	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P50	Algebraic Number Theory	2, 3, 7	2, 3, 7	2, 3, 7	7	2, 3, 7	2, 3, 7	2, 3, 7			2, 3, 7	2, 3, 7	2, 3, 7	2, 3, 7								2, 3, 7		2, 3, 7	7		2, 3, 7	2, 3, 7
MATH 5P60	Partial Differential Equations	1, 2, 7, 12	1, 2, 7, 12	1, 2, 7, 12	1	2	1, 2, 12	1, 2, 3, 12			2, 12	2, 12	2, 12	2, 12								1, 2, 3, 12		1, 2, 3, 12	1, 2	12	1, 12	1, 12
MATH 5P64	Differential Geometry and Mathematical Physi	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P66	Matrix groups and linear representations	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	3, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7, 8			2, 3, 4, 7	2, 3, 4, 7	2, 3, 7	2, 3, 4, 7								2, 3, 4, 7, 8		2, 3, 4, 7, 8	2, 3, 7	8	3	3
MATH 5P69	Introduction to Scientific Computing	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P70	Topology	2, 3, 4, 12	2, 3, 4, 12	2, 3, 4, 12	3, 4, 12	2, 3, 4, 12	2, 3, 4, 12	2, 3, 4, 12			2, 3, 4, 12	2, 3, 4, 12	2, 3, 4, 12	2, 3, 4, 12								2, 3, 4, 12		2, 3, 4, 12	3, 4, 12	2, 3, 4, 12	2, 3, 4, 12	2, 3, 4, 12
MATH 5P81	Sampling Theory	1, 2, 3, 4, 7, 10	1, 2, 3, 4, 7, 10	1, 2, 3, 4, 7, 10	10	1, 3, 5, 7, 10	1, 2, 3, 4, 5, 7, 10	7, 10			1, 3, 5, 7, 10	1, 3, 5, 7, 10	1, 3, 5, 7, 10	1, 3, 5, 7, 10								1, 2, 3, 7, 10		1, 2, 3, 7, 10	7, 10	10	1, 10	1, 10
MATH 5P82	Nonparametric Statistics	1, 2, 3, 4, 7, 10	1, 2, 3, 4, 7, 10	1, 2, 3, 4, 7, 10	10	1, 3, 5, 7, 10	1, 2, 3, 4, 5, 7, 10	7, 10			1, 3, 5, 7, 10	1, 3, 5, 7, 10	1, 3, 5, 7, 10	1, 3, 5, 7, 10								1, 2, 3, 7, 10		1, 2, 3, 7, 10	7, 10	10	1, 10	1, 10
MATH 5P83	Linear Models	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3			1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3								1, 2, 3		1, 2, 3	1, 2, 3	1, 3	1, 2, 3	1, 2, 3
MATH 5P84	Time Series Analysis and Stochastic Processes	2, 3, 4	2, 3, 4	2, 3, 4		3, 4	2, 3, 4	2, 3, 4			2, 3, 4	2, 3, 4	2	3, 4								2, 3, 4		2, 3, 4	3, 4		3, 4	3, 4
MATH 5P85	Mathematical Statistical Inference	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3			2, 3, 4	2, 3, 4	2, 3	2, 3, 4								2, 3		2, 3	2, 3, 4	2, 3	2, 3	2, 3
MATH 5P86	Multivariate Statistics	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3			1, 2, 3	1, 2, 3	1, 3	1, 2, 3								1, 2, 3		1, 2, 3	1, 2, 3	1, 3	1, 2, 3	1, 2, 3
MATH 5P87	Computational Statistics	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7, 11	1, 2, 3, 4, 7			1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7								1, 2, 3, 4, 7, 11		1, 2, 3, 4, 7, 11	1, 2, 3, 4, 7, 11	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7
MATH 5P88	Advanced Statistics	2, 3, 4	2, 3, 4	2, 3, 4		2, 3, 4	2, 3, 4	2, 3, 4			2, 3, 4	2, 3, 4		2, 3, 4								2, 3, 4		2, 3, 4	2, 3, 4		3, 4	3, 4
MATH 5P89	Computational methods for generalized linear models																											
MATH 5P92	Cryptography and Number Theory	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MATH 5P96	Technology and Mathematics Education	1,2,3	1,2,3	1,2,3		1,2,3	1,2,3	1,2,3			1,2,3	1,2,3	1,2,3	1,2,3								1,2,3		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
MMAC 5N01	Scientific Writing							1, 2, 3, 5, 7, 9														1, 2, 3, 5, 7, 9				1, 2, 3, 5, 7, 9		
MMAC 7P90	Ph.D. Thesis	**1,5,6,7**	**1,5,6,7**	**1,5,6,7**	**1,5,6,7**	**5,6**	**5,6**	**1,6,7,8**	**5,6,9**	**5,6,7,9**	**5,6,7,9**	**5,6,7,9**	**5,6,7,9**	**5,6,7,9**	**5,6,7,9**	**5,6,9**	**5,6**	**5,6,9**	**5,6**	**5,6,8,9**	**5,6,7,9**	**1,5,6,7,8,9**	**1,5,6,7,8,9**	**5,6,9**	**1,5,6,9**	**5,6,9**	**5,6,7,8,9**	**5,6,7,8,9**
MMAC 7P75	Ph.D. Seminar	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**			**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**				**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**	**1,7,8**		**1,7,8**	**1,7,8**	**1,7,8**

Degree of Implementation:

Introduced
Reinforced
Mastered

Numbered list of all assessment methods

1. Participation: courses, department seminars, thesis defenses
2. Tests, Exams
3. Assignments
4. Projects
5. Essay/Research paper writing
6. Thesis
7. Oral presentations
8. Comprehensive examination
9. Peer review
10. Case studies
11. Self or peer evaluation
12. Reading annotated lecture notes

Table 5.6: Proposed Budget for Ph.D. in Intelligent Systems and Data Science					
	Year 1 Forecast	Year 2 Forecast	Year 3 Forecast	Year 4 Forecast	Year 5 Forecast
Insert Academic Year ==>	2020	2021	2022	2023	2024
ENROLLMENT (Headcount)					
Intake	4	4	2	2	4
Returning Students Year 2		4	4	2	2
Returning Students Year 3			4	4	2
Returning Students Year 4				4	4
Returning Students Year 5					
Total Enrollment	4	8	10	12	12
Domestic vs International Enrollment					
Domestic	2	4	5	6	6
International	2	4	5	6	6
Total Enrollment	4	8	10	12	12
Annualized Tuition Rate					
Domestic Tuition	$8,176.23	$8,176.23	$8,176.23	$8,176.23	$8,176.23
International Tuition	$25,754.49	$25,754.49	$25,754.49	$25,754.49	$25,754.49
REVENUE					
Domestic					
Tuition	$16,352.46	$32,704.92	$40,881.15	$49,057.38	$49,057.38
Ancillary Fees	$2,083.28	$4,166.56	$5,208.20	$6,249.84	$6,249.84
Total Domestic	$18,435.74	$36,871.48	$46,089.35	$55,307.22	$55,307.22
International					
Tuition	$51,508.98	$103,017.96	$128,772.45	$154,526.94	$154,526.94
Ancillary Fees	$3,355.28	$6,710.56	$8,388.20	$10,065.84	$10,065.84
Total International	$54,864.26	$109,728.52	$137,160.65	$164,592.78	$164,592.78
Revenue					
Tuition Revenue	$67,861.44	$135,722.88	$169,653.60	$203,584.32	$203,584.32
Ancillary Revenue	$5,438.56	$10,877.12	$13,596.40	$16,315.68	$16,315.68
Special Purpose Funding (if applicable)					
TOTAL REVENUE	$73,300.00	$146,600.00	$183,250.00	$219,900.00	$219,900.00
EXPENSES					
New Faculty Positions (Number)					
Salaries (salary rate*number)					
Benefits (17% of salary)	$0.00	$0.00	$0.00	$0.00	$0.00
New Staff Positions (Number)					
Salaries (salary rate*number)					
Benefits (23% of salary)					
Stipends (Number)					
Salaries (salary rate * number)					
Benefits (XX% of Salary)					
TOTAL STAFFING COSTS	$0.00	$0.00	$0.00	$0.00	$0.00
ITS Costs					
Library Costs					
Operating Costs					
Equipment (new and replacement)					
Marketing					
Scholarships and Bursaries	$106,304.00	$212,608.00	$265,760.00	$318,912.00	$318,912.00
Experiential Education					
Indirect Costs (RATE?)					
Other Expenses					
TOTAL EXPENSES	$106,304.00	$212,608.00	$265,760.00	$318,912.00	$318,912.00
GROSS REVENUE	-$33,004.00	-$66,008.00	-$82,510.00	-$99,012.00	-$99,012.00
Weighted Grant Units					
To be Negiotiatied					

Appendix A

Course Level Learning Outcomes

Course: COSC 4P03

Course Calendar Description:
Advanced Algorithms

Classical and evolving problems and algorithms in Computer Science. Topics include classical design and analysis techniques, cryptography, combinatorics.

Lectures, seminar, 3 hours per week.
Prerequisite(s): COSC 3P03 (minimum 60 percent) or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Identify when dynamic programming can and should be used; develop dynamic programming algorithms.	Lectures	Assignments, Test	
Identify when greedy algorithms can produce optimal solutions; develop greedy algorithms for such situations.	Lectures	Assignments, Test	
Use and develop combinatorial algorithms to search for, generate, and/or enumerate a variety of combinatorial structures.	Lectures	Assignments, Test	

Understand the fundamentals of cryptography (including public-key cryptography); understand and apply basic cryptanalysis techniques.	Lectures	Assignments, Test	
Explain and/or develop advanced algorithms for difficult problems.	Lectures; independent reading	Project, Class Presentation	

Course: Cosc 4P13

Course Calendar Description: Operating Systems: Design and Implementation

Design and implementation of UNIX and other operating systems. Topics include process and thread management, interprocess communication, synchronization and scheduling, multiprocessing, device drivers, kernel memory management, distributed and advanced file systems and STREAMS (knowledge of C assumed).

Lectures, lab, 4 hours per week.

Prerequisite(s): COSC 2P13 (minimum 60 percent) or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Install and manage a unix operating system	Lab	Lab completion	Develop better and comprehensive labs
Understand the internal process and scheduling mechanisms. Understand and trace kernel procedure invocation and parameter passing at kernel level.	Lecture Lab	Lab completion Unit Tests	Develop better and comprehensive labs
File structure and security, access rights.	Lecture	Unit tests	Develop better and comprehensive labs

Device mounts and driver, interrupt handers	lecture	Lab completion Unit test	Develop better and comprehensive labs
Memory management, VM paging and security policies. Resource mgmt.	Lecture Lab	Lab completion Unit Test	Develop better and comprehensive labs

Course: COSC 4P14

Course Calendar Description:
Computer Networks

Advanced topics in computer networking, including computer network security, wireless and high-speed networking, computer network management and performance evaluation.

Lectures, lab, 4 hours per week.

Prerequisite(s): COSC 2P13 (minimum 60 percent) or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Describe layers of internet stack	lectures	assignments	
Describe, and be able to reproduce the behaviour of, multiple common Application Layer protocols	lectures, labs	assignments, labs, lab exercises	
Use a 'penetration testing' operating system to find and exploit glaring vulnerabilities in networks/systems	lectures, labs, lab exercises	labs, lab exercises	
Employ multiple cryptographic schemes/tools for signing, authenticating, encrypting, and decrypting communications	lectures, labs, lab exercises	assignments, labs, lab exercises	

Effect low-level communications via socket programming and low-level tools	lectures, labs, lab exercises	assignments, labs, lab exercises	
Describe and reproduce multiple approaches for monitoring or intercepting communications, including MitM attacks	lectures, labs	lab exercises, assignments	
Create tools to connect to existing APIs for data retrieval, as well as web scraping	lectures, labs	assignments	
Describe the operation of, and common concerns with, wireless communications	lectures	assignments	

Course: COSC 4P41

Course Calendar Description:
Functional Programming

Introduction to functional programming using the languages Haskell. Topics include all data types, type inference, pattern-matching, recursion, polymorphism, higher-order functions, lazy vs eager evaluation, modules and monads.

Lectures, 3 hours per week.

Prerequisite(s): three and one-half COSC credits or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the principles of functional programming	lecture		
Understand and apply the principles of recursion	lecture, exercise questions	tests	
Understand and apply the principles of data type implementation in a functional programming language	lecture, exercise questions	tests	
Understand and apply the principle of functions as first-order entities	lecture, exercise questions	tests	
Understand and apply polymorphism and overloading	lecture, exercise questions	tests	
Understand and apply action based programming in a strongly	Lecture, exercise questions	tests	

typed functional environment using monads			
Learn to formally reason about programs in a functional language	lecture		

Course: COSC 4P42

Course Calendar Description:
Formal Methods in Software Engineering

Specification and correctness of software. Topics include algebraic specifications, semantics of programming languages, Hoare/dynamic logic, specification languages, program transformation.

Lectures/lab/tutorial, 4 hours per week.
Prerequisite(s): three and one-half COSC credits and MATH 1P67 or permission of the instructor.

Prerequisite(s): three and one-half COSC credits or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the challenge of developing correct software	lecture		
Understand and apply the principles of logical reasoning in first-order logic	lecture, exercise questions	tests	
Understand and apply the principle of induction using well-founded relations	lecture, exercise questions	tests	
Learn formal approaches to semantics of programming languages	lecture		
Understand and apply the Hoare calculus for program correctness	lecture, exercise questions	tests	
Understand and apply abstract data types using algebraic specifications	lecture, exercise questions	tests	

Learn to reason formally about algebraic specifications and their implementation	Lecture, exercise questions	tests	

Course: COSC 4P61

Course Calendar Description:

Theory of Computation

(also offered as MATH 4P61)
Regular languages and finite state machines: deterministic and non-deterministic machines, Kleene's theorem, the pumping lemma, Myhill-Nerode Theorem and decidable questions. Context-free languages: generation by context-free grammars and acceptance by pushdown automata, pumping lemma, closure properties, decidability. Turing machines: recursively enumerable languages, universal Turing machines, halting problem and other undecidable questions.

Lectures, 3 hours per week.

Restriction: open to COSC (single or combined), BCB, CAST, CNET, GAMP and NEUR Neurocomputing stream majors.

Prerequisite(s): MATH 1P67.

Note: MATH students may take this course with permission of the Mathematics Department.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Discuss the concept of finite state machines and design a deterministic finite state machine to accept a specified language.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Generate a regular expression to represent a specified language.	lectures, textbooks, assignments,	assignments, midterm, final exam	

Show equivalence among finite state machines, regular expressions, and regular grammars.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Design a context-free grammar to represent a specified language.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Design a push-down machine for a context-free language.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Show equivalence between PDAs and CFLs	lectures, textbooks, assignments,	assignments, midterm, final exam	
Understand what a Turing machine is and the Chruch-Turing Thesis	lectures, textbooks, assignments,	assignments, midterm, final exam	
Know classifications of four types of languages and the machines corresponding to each family of languages, Chomsky hierarchy.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Have basic knowledge of countable and uncountable sets.	lectures, textbooks, assignments,	assignments, midterm, final exam	
Know the decision problems for languages and how they are related to problems to be solved and that there are decision problems that are not recursively enumerable.	lectures, textbooks, assignments,	assignments, midterm, final exam	

Explain why the halting problem has no algorithmic solution.	lectures, textbooks, assignments	assignments, midterm, final exam	

Course: COSC 4P75

Course Calendar Description:
Compiler Construction

Topics include lexical, syntactic and semantic analysis of high-level languages; symbol table organization; code generation and optimization.

Lectures, 3 hours per week.

Prerequisite(s): COSC 2P03 (minimum 60 percent), 2P05 (minimum 60 percent) and 2P12 (minimum 60 percent) or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Describe the compilation process and its phases	lecture		
Explain and apply the principles of language translation including lexical, syntactic and semantic analysis and code generation	lecture	project	
Describe and implement one technique for error-recovery in each of syntactic and semantic analysis	lecture	project	
Develop a compiler for a small Java-like language using recursive descent parsing	lecture, project	project	
Apply object-oriented techniques to a single-person, large-scale project	lecture, project	project	

Apply coding/documentation standards in project development		project	
Apply appropriate testing techniques in project development		project	

Course: COSC 4P76 Machine Learning

Course Calendar Description:

Fundamental machine learning techniques with emphasis on using these techniques to design and implement small practical learning systems. Topics include learning as a search, inductive bias, concept learning, computational learning, explanation-based learning and reinforcement learning.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand what is a well-defined machine-learning problem? Understand concept learning, learning from examples, the idea of hypothesis space, version spaces and candidate elimination algorithms. Understand other machine learning fundamentals such as theoretical limitations of machine learning,	Lectures	Test	
Appreciate the idea of evaluating hypotheses. Differentiate between sample and true errors, learn different probability distributions and how to compare different learning algorithms, training, testing and validation techniques, dimensionality reduction	Lectures, assignments, tutorials.	Test, assignments.	

techniques such as principal component analysis			
Be exposed to, understand, design, develop and apply various supervised learning models such as decision trees, neural networks, support vector machines using well-known bench-mark data and real-world applications.	Lectures, assignments, project, seminars	Term test, seminar presentation, assignments, term project.	
Understand, design, develop and apply various unsupervised learning paradigms such as k-means and variants, vector quantization, self-organizing feature maps etc.	Lectures, assignments, seminar/project	Term test, seminar presentation, assignments, term project	
Understand and apply instance based learning; k-nearest neighbor for classification and regression, case based learning	Lectures, assignments, seminar/project	Term test, seminar presentation, assignments, term project	
Understand and apply the fundamentals of reinforcement	Lectures, assignments, seminar/project, project		

learning and applications of Q-learning		Term test, seminar presentation, assignments, term project	
Understand and apply the fundamentals of Bayesian learning: understand basics of probability theory, Bayes Theorem, various Bayesian algorithms; their roles and weakness/strengths	Lectures, assignments, project	Assignments, tests, project	
Apply and have an appreciation of statistical analysis and machine learning software packages and applications of machine learning techniques, be able to choose and apply an appropriate learning algorithm to real-world applications,	Lectures, seminars, tutorials, assignments, project	Assignments, project	
Survey, understand, examine and apply a range of other topics in machine learning including deep learning, evolutionary learning, etc.	Lectures, assignments, invited talks, class seminars, project	Assignments, seminar presentation, test, term projects.	

Understand, design, develop and apply machine learning algorithms to various real- world applications including game development, data clustering and classification, face & character recognition, image processing, stock market prediction, etc.	Lectures, assignments, project, invited talks	Assignments, term test, term projects.	

Course: COSC 4P78

Course Calendar Description:
Robotics

Computer control aspects of robots focusing on behaviour-based robot control architectures. Topics include robot components and subsystems, sensors and perception, object location and manipulation, mobile robot navigation, task planning, control architectures, adaptive and social behaviour.

Lectures, 3 hours per week; lab, 1 hour per week.

Prerequisite(s): COSC 3P71 (minimum 60 percent) or permission of the instructor.
Note: PHYS 1P91 and 1P92 are recommended.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Evaluation situations to devise sensor suites suitable to the assigned tasks	lecture, self study	assignments, final test	
Construct microcontroller board and robot from low-level electronic components	labs, project	labs, project	Funding for pre-made robots would allow for more complex tasks
Program agents to perform various tasks, based on perceived inputs	labs, project	labs, project	(See above)
Describe multiple control architectures and agent models	lecture, self study	assignments, final test	
Describe and/or use multiple communication mechanisms, both intra-robot and inter-robot	lecture, lab, self study	labs, assignment, final test	

Either research and explain an advanced topic concerning robotics or machine vision in a formal style, or develop a more advanced robotic agent or software	project	project	

Course: COSC 4P80 Artificial Neural Networks

Course Calendar Description:

Practical problem solving using artificial neural networks. Supervised learning, single- and multilayer feed-forward networks and backpropagation and refinements; recurrent neural networks; Hopfield networks and Boltzmann machines. Unsupervised learning, competitive learning, Kohonen map and self-organizing feature maps.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand and apply the fundamentals of neural network models: McCulloch-Pitts model, multilayer perceptron, associative memory, radial basis function, etc.	Lectures, assignment.	Assignment, term test.	
Understand and apply supervised learning algorithms especially variants of back propagation algorithms and unsupervised learning including self-organizing feature maps learning etc.,	Lectures, assignments.	Assignments, term test, term project.	
Survey and apply a range of advanced topics in neural computation including deep learning, and evolving neural networks.	Lectures, assignments, invited talks, class seminars.	Assignments, seminar presentation, test, term projects.	

Understand, design and apply neural networks to various real-world applications including classification, character recognition, image processing, clustering, stock market prediction, etc.	Lectures, assignments, project, invited talks	Assignments, term test, term projects.	
Exposure to statistical analysis, experimental design and implementation of neural networks software libraries using AI programming, and use of existing neural networks and deep learning libraries.	Lectures, tutorials, assignments, project	Assignments, term projects.	
Exposure to recent and other miscellaneous topics in neural computation including real-world applications	Lectures, class seminars, project.	Class seminars, student selected term project.	

Course: COSC 4P81 AI Programming

Course Calendar Description:

developing computer applications for AI problem solving. The course will explore different topics in AI software systems, and examine how different programming languages and paradigms can suit particular AI problem domains. Introductions to different AI languages (Prolog, Lisp, Python) will be briefly overviewed. However, the focus will be their use in AI problem solving, rather than to give comprehensive treatments of the languages.

Lectures, 3 hours per week.

Prerequisite(s): three and one-half COSC credits or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand and apply the fundamentals of logic programming and the Prolog language, including appolications in expert systems and natural language processing.	Lectures, assignment.	Assignment, project.	
Understand and apply the fundamentals of functional language and the LISP programming language, and example applications in symbolic processing.	Lectures, assignment.	Assignment, project.	
Understand and apply Python programming, and applications in machine learning systems.	Lectures, assignment.	Assignment, project.	
Understand and apply Java programming in a genetic programming system, and use it towards problem solving.	Lectures, assignment.	Assignment, project.	

Course: COSC 4P87 Foundations of Reasoning under Uncertainty

Course Calendar Description:

Uncertain reasoning is based on both deductive and inductive methods. Exploration of formal foundations of both streams. Formal systems such as propositional modal logics and grammars, models of probability, Bayesian reasoning, fuzzy sets, rough sets, concept lattices and knowledge structures.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Discuss the presence and role of uncertainty in data modelling.	Lectures, exercises	Class test, oral examination	
Discuss and apply problem solving strategies.	Lectures, exercises	Class test, oral examination	
Exemplify the parts of a formal system, provide interpretations for a formal system and formally prove simple theorems.	Lectures, exercises	Class test, oral examination	
Describe the aims, components and tools of the rough set model, and its statistical assumptions.	Lectures, exercises	Class test, oral examination	
Name reasons for uncertainty and explain their consequences.	Lectures, exercises	Class test, oral examination	

State and exemplify the basic properties of a probability function, random variables, and expectation	Lectures, exercises	Class test, oral examination	
Explain and discuss important principles of reasoning under uncertainty such as the principle of indifference, Occam's razor, and randomness.		Class test, oral examination	
Describe the philosophy of Bayes theory and name some of its advantages and problems.	Lectures, exercises	Class test, oral examination	
Use Bayes rules to determine prior probabilities from posterior probabilities, and find the odds of events.	Lectures, exercises	Class test, oral examination	

Course: COSC 4P98 Topics in Computer Media and Digital Audio

Course Calendar Description:
Fractals, digital audio fundamentals, Fourier analysis, MIDI, computer composition, music and sound processing and user interfaces. Programming assignments may use C, Java, Supercollider and Csound.

Lectures, 3 hours per week.

Prerequisite(s): three and one-half COSC credits or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the fundamentals of acoustic audio and its digital representation, sampling, and signal processing.	Lectures, assignment.	Assignment, term test.	
Understand Fourier representation of audio, including Fourier Series and Discrete Fourier Transformation.	Lectures, assignment.	Assignment, term test.	
Survey a range of diverse audio synthesis techniques, including additive, subtractive, and granular synthesis.	Lectures, assignment.	Assignment, term test, optional project.	
Understand the basics of MIDI, as well as computer music programming environments such as CSound**.**	Lectures, assignment.	Assignment, term test.	

Exposure to essential ideas of commercial SDK toolkits for audio programming (e.g. VST)	Lectures, optional assignment.	Optional assignment, term test, optional project.	
Exposure to miscellaneous relevant topics in digital audio, including computer composition, fractal composition, AI and music, visualization, and others.	Lectures, class seminar, optional project.	Class seminar, term test, optional project.	

Course: COSC 5P01

Course Calendar Description:
Coding Theory

The main concepts, problems and applications related to error-correcting codes. Different classes of codes and their properties. Emphasis on algorithms relating to codes, examination of algorithms for encoding and decoding, together with algorithms that may be used in computer searches for specific classes of codes.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Explain and prove basic properties relating to linear and non-linear codes.	Lectures	Assignments, Test	
Encode and decode codes using a variety of methods.	Lectures	Assignments, Test	
Create and use codes using a variety of methods.	Lectures	Assignments, Test	
Explain advanced problems and concepts relating to codes; develop algorithms for such problems	Lectures, independent reading	Class Presentation, Project	

Course: COSC 5P02

Course Calendar Description:
Logic in Computer Science

A thorough introduction to mathematical logic, covering the following topics: propositional and first-order logic; soundness, completeness, and compactness of first-order logic; first-order theories; undecidability and Gödel's incompleteness theorem; and an introduction to other logics such as intuitionistic and modal logics. Furthermore, the course stresses the application of logic to various areas of computer science such as computability, programming languages, program specification and verification.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the different components of a logic	lecture		
Understand and apply the principles of logical reasoning in propositional logic	lecture, exercise questions	tests	
Prove correctness, completeness and decidability of propositional logic	lecture	exam	
Understand limitations of propositional logic	lecture		
Understand and apply the principles of logical reasoning in first-order logic	lecture, exercise questions	tests	
Prove correctness and completeness of first-order logic	lecture	exam	
Understand limitations of first-order logic	lecture		

Understand and apply the principles of logical reasoning in modal logics	lecture, exercise questions	tests	
Understand limitations of first-order logic	lecture		
Determine applications of modal logics in Computer Science	lecture		

Author:
Course: COSC 5P03 Universal Algebra for Computer Science

Course Calendar Description:

The study of the concepts and constructs of Universal Algebra, such as products, subalgebras, homomorphic images and congruences, term algebras, free algebras, its connections with Logic and Model Theory, decidability issues, lattices and relation algebras, and applications in Computer Science such as Type Theory, Specification, Complexity Theory, Uncertainty Management and others.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the basic concepts of universal algebra and its relation to topics in computer science.	Lectures	Class test, oral examination	
Understand and work with binary relations and their operators	Lectures, exercises	Class test, oral examination	
Understand and apply the basic operations on algebras (taking of subalgebras, direct products, homomorphic images)	Lectures, exercises	Class test, oral examination	
Explain the homomorphism theorems	Lectures	Class test, oral examination	

Understand and explain the concept of free algebras and their properties	Lectures	Class test, oral examination	
Understand the role of universal algebra in equational logic	Lectures	Class test, oral examination	
Know the definitions and basic properties of various classes of algebras such as lattices, Kleene algebras, relation algebras etc.	Lectures	Class test, oral examination	

Course: COSC 5P04

Course Calendar Description:

Parallel Algorithms

Introduction to parallel processing, various parallel computational models including both shared-memory and distributed-memory models, speed-up, cost, design and analysis of parallel algorithms and data structures for a variety of problems in searching, sorting, graph theory, computational geometry, strings, and numerical computation; brief introduction to parallel complexity.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Explain what parallel/distributed computing.	lectures, seminars, projects	seminar presentations, projects	
Know different models of parallel computation, shared memory vs distributed memory (interconnection networks).	lectures, seminars, projects	seminar presentations, projects	
Analyze parallel algorithms and explain cost, efficiency, and speed-up.	lectures, seminars, projects	seminar presentations, projects	

Design parallel divide-and-conquer algorithms	lectures, seminars, projects	seminar presentations, projects	
Be familiar with some well known algorithms for sorting, searching, graph problems.	lectures, seminars, projects	seminar presentations, projects	
Be able to design and analyze parallel algorithms for various models of PRAM and interconnection networks.	lectures, seminars, projects	seminar presentations, projects	

Course: COSC 5P05

Course Calendar Description:
Introduction to Lambda Calculus

Introduction to typed and untyped lambda calculi and their semantics. Syntax of the lambda calculus, conversion, fixed points, reduction, Church-Rosser theorem, representation of recursive functions, lambda models. Category theory, cartesian closed categories and categorical models of lambda calculus.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the syntax and semantics of the simply typed lambda calculus	lecture, exercise questions	tests	
Understand and apply reduction systems	lecture, exercise questions	tests	
Understand the principles of category theory	lecture, exercise questions	tests	
Learn categorical semantics of the simply typed lambda calculus	lecture, exercise questions	tests	
Understand the semantic problems of recursion and recursively defined data types	lecture, exercise questions	tests	
Understand the syntax and semantics of the untyped lambda calculus	lecture, exercise questions	tests	
Understand the syntax and semantics of typed lambda calculi with recursion	lecture, exercise questions	tests	

Understand the syntax and reduction system of the second-order lambda calculus	lecture		

Course: COSC 5P07 Fundamentals of Parallel and Distributed Algorithms

Course Calendar Description:
This course is intended to present fundamentals of parallel and distributed simulations to graduate students. These simulations evolved from military-oriented applications in the 1960s to sophisticated frameworks, producing the basic concepts for all simulators, such as multiplayer online role-playing games, as well as virtual environments in manufacturing, emergency management, education, and medical fields. The course requires a background knowledge on programming, data structures, and distributed systems for understanding the concepts behind simulation execution control algorithms. The topics of the course will describe the optimistic and conservative synchronization strategies for coordinating discrete-event distributed simulations, as well as their involved features and limitations; the course will also cover the current frameworks and challenges in the area, as well as new, widely used paradigms.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Explain parallel/distributed computing.	lectures, seminars, projects	seminar presentations, projects	
Know different models of parallel computation, shared memory vs distributed memory (interconnection networks).	lectures, seminars, projects	seminar presentations, projects	
	lectures, seminars, projects	seminar presentations, projects	

Analyze parallel algorithms and explain cost, efficiency, and speed-up.			
Design parallel divide-and-conquer algorithms	lectures, seminars, projects	seminar presentations, projects	
Be familiar with some well known algorithms for sorting, searching, graph problems.	lectures, seminars, projects	seminar presentations, projects	
Be able to design and analyze parallel algorithms for various models of PRAM and interconnection networks.	lectures, seminars, projects	seminar presentations, projects	

Author: Beatrice Ombuki-Berman
Course: COSC 5P08 Data Science

Course Calendar Description:
Provides students with fundamentals in data science including algorithms and tools/techniques in data science. A hands-on group term project focusing on a real-world applied data set/industry problem will form a major component of this course.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand fundamental concepts in data science and associated algorithms.	Lectures, assignments, project.	Assignments, project, test.	
Applications of techniques for data science, including an understanding of appropriateness of algorithms towards different problems paradigms.	Lectures, assignments, project	Assignments, project, test	
Understand how to design and implement empirical experiments using data science techniques, and how to write, analyze, and write up the results in a formal, scientifically rigorous manner.	Lectures, assignments, project	Assignments, project	

Author: Brian Ross
Course: COSC 5P71 Genetic Programming

Course Calendar Description:

The synthesis of computer programs using evolutionary computation. The study of different representations, including tree, linear, grammatical. Theoretical analyses, including the effects of operators, representations, fitness landscapes. Practical applications in problem solving, decision making, classification, computer vision, design.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand fundamental concepts behind Koza's tree-based genetic programming, including evolutionary algorithm, tree representation, GP language design, and basic application of GP to problems.	Lectures, assignments, project.	Assignments, project, test.	
Understand advanced GP representations, such as strong typing, ADFs, linear GP, developmental GP, and grammatical GP.	Lectures, assignments, project	Assignments, project, test	
Understand advanced problem solving techniques for GP, such as diversity strategies, parallelism, and multi-objective evaluation.	Lectures, assignments, project.	Assignments, project, test	

Understand the computational and problem-solving limitations of GP, and the ideas behind the No Free Lunch theorem.	Lectures	Test	
Understand how to design and implement empirical experiments using GP, and how to write, analyze, and write up the results in a formal, scientifically rigorous manner.	Lectures, assignments, project	Assignments, project	
Ability to independently peruse the scientific literature on a GP topic of interest.	Seminar, project	Seminar, project	

Course: COSC 5P73: Computer Vision and Visual Computer Learning

Course Calendar Description: Introduction to computer vision and pattern classification. The problems of WHAT and WHERE. The issue of knowledge representation and performance. Knowledge consolidation models. The concept of recursive (i.e. evolutionary) computer learning. Visual learning. Guided learning from infallible and fallible experts. Autonomous learning and experimentation. Analysis of HPC architectures conducive to visual computer learning.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Write scene segmentation apps	Lectures, assignments, two-person project	Evaluation of assignments, two-person project	Better student background prep in physics (optics)
Write object classification and recognition apps	Lectures, assignments, two-person project	Evaluation of assignments, two-person project	Better student background prep in physics (optics)

Course: COSC 5P74 Evolutionary Computation

Course Calendar Description:

Study of basic concepts of evolutionary algorithms (EAs) from a theoretical and application viewpoint. This includes genetic algorithms, evolutionary strategies, genetic programming, problem representation, genetic operations, overall control, theory of EAs and various examples of important applications. Includes related bio-inspired sub-areas such as swarm intelligence, and evolutionary robotics.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand fundamental concepts of different evolutionary algorithms (with an emphasis on genetic algorithm), such as representations, genetic operators, evaluation strategies, search space analysis, design and practical applications. Compare evolutionary algorithms with swarm intelligence algorithms.	Lectures, assignments, project	Assignments, test, project presentations	
Understand and apply different representation strategies, genetic operators and selection schemes. Applications.	Lectures, assignments, project	Assignments, test, project	
Understand and apply advanced problem-solving topics such as multi-objective strategies, hybrid strategies, niching and speciation	Lectures, assignments, project	Assignments, tests, project and presentations	

and co-evolution with applications			
Understand the challenges and uses of evolutionary computation in dynamic optimization	Lectures, assignments, project	Assignments, tests, project and presentations	
Understand theoretical foundations of search space analysis and its implication for efficient genetic design	Lectures	Tests	
Understand and apply fundamental concepts from swarm intelligence focusing on ant systems and particle swarm optimization, comparisons with evolutionary algorithms. Real-world applications	Lectures, assignments, seminar, project	Assignments, term test, project.	
Understand the design, empirical experimentation using GAs, Ants systems and PSO, technical writing of results and discussions	Lectures, assignments, project	Assignments, project, seminar presentation.	
Other advanced topics of interest: search space analyses, neural – evolutionary systems,	Seminar, project	Seminar presentation, term test, project	

deep evolving neural networks, genetic programming, evolutionary robotics, swarm robotics, etc.			

Author:
Course: COSC 5P76 Non-invasive Data Analysis

Course Calendar Description:

A study of data analysis using information from the given data based on the rough set data model. Includes an overview of the data modeling process, principles of probability, non-parametric significance testing, data filtering and discretization, model selection, rule validation, case studies

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Know and explain various approaches to data modelling.	Lectures, exercises	Class test, oral examination	
Know and explain the basic difference between quantitative and qualitative data analysis.	Lectures, exercises	Class test, oral examination	
Know, explain, and give examples for the basic constructs of rough set data analysis (RSDA) such as equivalence relations, information systems, rules, reducts, etc.	Lectures, exercises	Class test, oral examination	
Find and interpret the approximation quality of a set of attributes with respect to a decision attribute.	Lectures, exercises	Class test, oral examination	

Apply randomization methods to obtain the significance of rules.	Lectures, exercises	Class test, oral examination	
Know and discuss model selection within the rough set model	Lectures, exercises	Class test, oral examination	
Read and understand literature and give a seminar on a topic related to the course, e.g. further RSDA methods, formal concept analysis, modal operators in qualitative data analysis, knowledge spaces	Reading	Seminar	

Author: Brian Ross
Course: COSC 5P77 Recent Advances in Computational Intelligence

Course Calendar Description:

A course on computational intelligence paradigms focusing on swarm intelligence, evolutionary computation, and neural networks including recent advances in deep neural networks. Applications to machine learning, optimization and data science. This is a guided seminar style based graduate course targeting recent advances in the field.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand fundamental concepts in computational intelligence algorithms.	Lectures, assignments, project.	Assignments, project, test.	
Applications of computational intelligence algorithms, including an understanding of appropriateness of algorithms towards different problems paradigms.	Lectures, assignments, project	Assignments, project, test	
Understand how to design and implement empirical experiments using computational intelligence, and how to write, analyze, and write up the results in a formal, scientifically rigorous manner.	Lectures, assignments, project	Assignments, project	

Author: Beatrice Ombuki-Berman
Course: COSC 5P78 Machine Learning

Course Calendar Description:

A graduate level Artificial intelligence course on machine leaning. Introduces theoretical foundations and machine learning systems, algorithms and applications. Supervised, unsupervised leaning and statistical models, among others will be covered. Students will learn tools and the methods and principles for handling real-world data sets and data science applications. Research methodologies, seminar presentations and an applied term project will be conducted.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand fundamental concepts in machine learning algorithms.	Lectures, assignments, project.	Assignments, project, test.	
Applications of machine learningalgorithms, including an understanding of appropriateness of algorithms towards different problems paradigms.	Lectures, assignments, project	Assignments, project, test	
Understand how to design and implement empirical experiments using machine learning, and how to write, analyze, and write up the results in a formal, scientifically rigorous manner.	Lectures, assignments, project	Assignments, project	

Course: COSC 5V90

Course Calendar Description:
Functional Programming and Interactive Theorem Proving

Introduction to the dependently typed functional programming language of Coq as well as its formal language for mathematical definitions and theorems. Introduction to higher-order logic, interactive theorem proving. Development of verified software using the Coq system.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*	**Strategy for Improvement**
Understand the principles of functional programming and interactive theorem proving	lecture		
Understand the duality of proofs and programs	lecture		
Learn to use the Coq Interactive Theorem Prover	lecture, exercise questions	tests	
Understand and apply formal reasoning to program development in a functional programming language	lecture, exercise questions	tests	
Understand and apply algebraic reasoning in an Interactive Theorem Prover	lecture, exercise questions	tests	
Develop and verify a software solution in Coq	lecture, exercise questions	tests	

Table A.1
Course Learning Outcomes

Course: MATH 5P09: Solitons and Nonlinear Wave Equations

Course Calendar Description: **Introduction to solitons: Linear and nonlinear travelling waves. Nonlinear evolution equations (Korteweg de Vries, nonlinear Schrodinger, sine-Gordon). Soliton solutions and their interaction properties. Lax pairs, inverse scattering, zero-curvature equations and Backlund transformations, Hamiltonian structures, conservation laws..**

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Know examples of linear dispersive wave equations and some physical applications. Find and understand dispersion relation.	Lectures, assignments	Assignments, midterm
Understand and find travelling wave solutions of linear and nonlinear evolution equations.	Lectures, assignments, computer lab	Assignments, midterm
Know examples of nonlinear dispersive wave equations and some physical applications.	Lectures, assignments	Assignments, midterm
Understand solitons versus solitary waves; describe main distinguishing features of solitons and their interactions for KdV equation; understand basic aspects of integrability.	Lectures, assignments, course webpages	Assignments, midterm, final project
Understand basic conservation laws of KdV and mKdV equations; Miura transformation.	Lectures, assignments	Assignments, midterm
Understand and apply auto-Backlund transformation and nonlinear superposition of KdV equation.	Lectures, assignments, computer lab	Assignments, midterm, final project

Table A.1
Course Learning Outcomes

Understand properties of 2-soliton solution of KdV equation; position shift formula.	Lectures, assignments, course webpages	Assignments, midterm, final project
Understand Lax pair and its derivation from Miura transformation for KdV equation; formulation of Lax pair as a zero-curvature equation.	Lectures, assignments	Assignments, midterm, final project
Understand inverse scattering transform (IST); eigenfunctions; scattering states and bound states; spectrum and isospectral property; construction of KdV solutions from scattering data.	Lectures, assignments, computer lab	Assignments, midterm
Apply IST to find multi-soliton solutions of KdV equation; properties of multi-solitions; position shifts.	Lectures, assignments, course webpages	Assignments
Derive conservation laws of KdV equation from Lax pair; properties of higher conservation laws.	Lectures, assignments	Assignments
Understand basic aspects of theory of conservation laws for wave equations; main physical examples: mass, momentum, energy.	Lectures, assignments	Assignments
Understand Hamiltonian structure of KdV equation and basic aspects of bi-Hamiltonian theory; connection between Hamiltonians and symmetries.	Lectures, assignments	Assignments
Present a derivation of travelling wave solutions or solitons or Lax pair or auto-Backlund transformation for an integrable evolution equation; implement in a Maple worksheet.	Computer lab	Final project and presentation

Table A.1
Course Learning Outcomes

Course: MATH 5P10: Course Name: Groups, Rings, and Group Rings

Course Calendar Description: Advanced group theory and ring theory, such as group actions, p-groups and Sylow subgroups, solvable and nilpotent groups, finiteness conditions in rings, semisimplicity, the Wedderburn-Artin theorem. Introduction to group rings, such as unit groups, augmentation ideals, several important types of units, and the isomorphism problem..

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand some advanced topics in group theory, such as the isomorphism theorems, symmetric groups and G-sets, the Sylow theorems, subnormal and normal series, solvable and nilpotent groups.	Lectures, assignments	Assignments, midterm test.
Understand basic and some important concepts in ring theory, such as ideals, factorization in commutative rings, rings of quotients and localization, rings of polynomials. Artinian and Noetherian rings, semi-simple rings.	Lectures, assignments	Assignments, midterm test, research projects.
Understand Basic concepts in Modules, such as homs and exact sequences, free modules, projective and injective modules, tensor products, modules over PID.	Lectures, assignments.	Assignments, midterm test, research projects.
Understand some basic concepts in group rings, such as augmentation ideals, several important units: bicyclic units and Bass cyclic units, Clean group rings.	Lectures, assignments. Presentations in class	Assignments, research projects.

Table A.1
Course Learning Outcomes

Course: MATH 5P30: Dynamical Systems

Course Calendar Description: Introduction to dynamical systems and their applications in mathematical modeling. Linear flows, local theory of nonlinear flows, linearization theorems, stable manifold theorem. Global theory: limit sets and attractors, Poincare´-Bendixson theorem. Structural stability and bifurcations of vector fields. Low dimensional phenomena in discrete dynamics. Chaotic dynamics: routes to chaos, characterization of chaos and strange attractors.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand basic types of linear flows, the notion of invariant subspaces, method of determining the nature of the linear flow by finding the Jordan form of the matrix defining the given dynamical system/	Lectures, assignments	Assignments, midterm test
Understand two fundamental theorems of local theory of dynamical systems: stable manifold theorem and Hartman-Grobman linearization theorem	Lectures, in-class demonstrations of computer experiments	Assignments, midterm test, final project/take-home exam
Find linearizing homeomorphism and approximate equation of stable and unstable manifolds for a given dynamical system	Lectures, assignments, use of provided Maple software	Assignments, midterm test, final project/ take-home exam
Analyze dynamics on center manifold for a given dynamical system	Lectures, assignments	Assignments, midterm test, final project/ take-home exam
Understand the notions of alpha and omega limit sets, attractor, attracting set, and limit cycles of various types	Lectures, assignments	Assignments, midterm test, final project/ take-home exam

Table A.1
Course Learning Outcomes

Know examples of limit cycles in the natural world and their technological applications (biological oscillations, electronic circuits, chemical reactions, etc.)	Lectures, videos shown in class, computer experiments shown in class, use of provided Maple software	final project/ take-home exam
Be able to prove that limit cycle exists/does not exists in a given dynamical system (Bendixson criterion, Poincare-Bendixson theorem)	Lectures, assignments	Assignments, final project/take-home exam
Understand the notion of a bifurcation of a vector field and know basic types of bifurcations occurring in commonly encountered dynamical systems and models	Lectures, assignments	Assignments, final project/take-home exam
Understand the classical (Devaney) definition of chaos for discrete maps and for continuous systems (via Poincare map).	Lectures, assignments, in-class computer experiments	Assignments, final project/take-home exam
Know standard examples of chaotic systems and chaotic attractors, as well as their basic properties	Lectures, in-class computer experiments	Final project/take-home exam

Table A.1
Course Learning Outcomes

Course: MATH 5P31: Ergodicity, Entropy and Chaos

Course Calendar Description: **Introduction to ergodic theory, invariant measures, Birkhoff ergodic theorem. The first return formula, Kac's lemma, recurrence theorems. Entropy, coding maps, Shannon-McMillian Breiman theorem. Chaos, predictability, Lyapunov exponent, speed of divergence, Pesin theorem. Ergodicity, entropy and chaos in shift dynamical systems and cellular automata.**

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand the construction of counting measure from orbits of one-dimensional maps. Understand invariance of a measure with respect to a map.	Lecture, assignment, labs using Maple, in-class computer demonstration	Assignments and tests
Write Frobenius-Perron equation for measure density of simple dynamical maps: Bernoulli map, mod 1 map, tent map, piecewise linear maps in interval [0,1], etc. Be able to iterate measure densities numerically (using Maple).	Lecture, assignment, labs using Maple	Assignments and tests
Understand the notion of ergodicity using simple maps as example. Understand Birkhoff ergodic theorem in the context of one-dimensional maps.	Lecture, assignment, labs using Maple, computer demonstration	Assignments and tests
Understand the notion of the first return and various recurrence theorems.	Lecture, assignment, computer and video demonstrations of recurrence	Assignments and tests
Understand the notion of partition, union of partitions, and generating partitions by a map. Understand the notion of entropy of a transformation as well as entropy of an alphabet. Know how to compute entropies of simple maps.	Lecture, labs using Maple	Assignments and tests

Table A.1
Course Learning Outcomes

Know the meaning and applications of Shannon-McMillian Breiman theorem.	Lecture	Assignments and tests
Know the classical (Devaney's) definition of chaos and the meaning of transitivity, sensitivity, and density of periodic points. Know examples of chaotic maps. Understand the meaning of Lyapunov exponent and its relationship to sensitivity.	Lecture, labs using Maple	Assignments and tests
Know what cellular automaton is, and understand how elementary rules are constructed. Understand why the shift map is chaotic.	Lecture, labs using Maple	Assignments and tests

Table A.1
Course Learning Outcomes

Course: MATH 5P40: Functional Analysis

Course Calendar Description: The basic theory of Hilbert spaces, including the Projection Theorem, the Riesz Representation Theorem and the weak topology; weak derivatives, Sobolev spaces and the Sobolev Imbedding Theorem; the variational formulation of boundary value problems for ordinary and partial differential equations, the Lax-Milgram Lemma and its applications; the finite element method.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Demonstrate an understanding of the fundamental concepts and the main examples of inner product and Hilbert spaces and state the main theorems (Bessel, Parseval, Riesz-Fisher, Best Approximation and Projection on Closed Convex Subsets, Riesz -Fréchet, Lax-Milgram Theorems). Develop an understanding of the weak topology	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Determine if a norm derives from an inner product. Show orthogonality for a finite or infinite set of vectors (functions) and construct orthonormal bases using the Gram-Schmidt orthogonalization process. Compute the Fourier coefficients for a given element in an inner product space with an orthonormal basis. Determine the orthogonal decomposition of vectors in a Hilbert space. Determine the projection of a vector onto a closed convex set. Show that a sequence converges weakly. Explain the difference between strong and weak convergence of sequences in Hilbert spaces. State and prove the Stampacchia Theorem	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project

Table A.1
Course Learning Outcomes

Demonstrate an understanding of the motivation for considering the Sobolev space $H^1((0,1))$ for the solvability of boundary value problems in dimension 1. Demonstrate an understanding of the spaces $W^{1,p}((0,1))$ and their properties (completeness, reflexivity, separability, etc.). Demonstrate a knowledge of the main Sobolev imbedding theorems ($W^{1,p}$ into L^∞, $W^{1,p}$ into L^q, $W^{1,p}$ into C) Demonstrate an understanding of the space $W_0^{1,p}$ including stating the Poincaré inequality and the Trace Theorem.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Write the weak (variational) formulation of a Dirichlet boundary value problem, prove the existence of weak solutions and determine the regularity of weak solutions. State and prove the Maximum principle for a non-homogeneous Dirichlet problem.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Demonstrate an understanding of the Ritz and Galerkin methods for elliptic problems including the formulation and well-posedness of approximating schemes and the convergence of discrete solutions.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project

Table A.1
Course Learning Outcomes

Course: MATH 5P41: Nonlinear Functional Analysis

Course Calendar Description: Topological fixed-point theory with applications to dynamical systems and optimization. Topics include the theorems of Brouwer, Borsuk, Schauder-Tychnoff, and Kakutani as well as the Knaster-Kuratowski-Mazurkiewicz principle. Applications of these landmark results to the solvability and qualitative analysis of dynamical systems as well as convex and non-convex optimization are discussed.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Develop and understanding of the role of fixed point theory for the solvability of nonlinear analysis problems (differential equations, optimization and critical point theory, game theory, etc.).	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
State and proof the Banach Contraction Principle. and use it to prove the existence of solutions to initial value problems. Analyze the dynamical nature of a fixed point (attracting, repelling, neutral) study the behavior of the orbits of dynamical systems.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
State and prove the fixed point theorems of Brouwer and Schauder and use them to establish the solvability of initial or boundary value problems.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Develop a basic proficiency with set-valued analysis (notions of semi-continuity, differentiability for set-valued maps). State and proof the Theorems of Kakutani and Ky Fan and understand their crucial role for the existence of equilibria for generalized games and abstract economies as well for the well-posedness of convex and non-convex minimization problems.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project

Course: MATH 5P50: Algebraic Number Theory

Course Calendar Description: An introduction to algebraic aspects of number theory. Topics include the general theory of factorization of ideals in Dedekind domains and number fields, Kummer's theory on lifting of prime ideals in extension fields, factorization of prime ideals in Galois extensions, local fields, the proof of Hensel's lemma, arithmetic of global fields

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand advanced topics about number fields and number rings.	Lectures, assignments	Assignments, midterm test
Understand the theory of factorization of ideals in Dedeking domains and some calculations using Kummer's theory on lifting of prime ideals in fields extension and the application of Dedekind' theorem.	Lectures, assignments	Assignments, midterm test and presentation
Find prime decomposition in Galois extensions.	Lectures, assignments	Assignments, midterm test
Understand the theory of local fields and the proof of Hensel's lemma.	Lectures, assignments	Assignments, midterm test
Understand the notion of the ideal class group as well as the notion of unit group and the application of Dirichlet's unit theorem.	Lectures, assignments	Assignments, midterm test, final project/ take-home exam

Table A.1
Course Learning Outcomes

Course: MATH 5P60: Course Name

Course Calendar Description: **Review of linear and nonlinear equations in two variables. Existence and uniqueness theory, fundamental solutions, initial/boundary-value formulas for the heat equation, wave equation, Laplace equation in multi-dimensions. Exact solution techniques for 1st and 2nd order linear and nonlinear equations. Analysis of solutions, variational formulations, conservation laws, Noether's theorem.**

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Recognize the four basic types of linear PDEs in two variables; know some of their nonlinear generalizations and physical applications.	Lectures, assignments	Assignments, midterm
Know the solution of the transport equation in multi-dimensions; understand existence, uniqueness, regularity of the solution. Find and understand some conserved integrals.	Lectures, assignments	Assignments, midterm, final exam
Know the solution of the heat/diffusion equation in multi-dimensions by convolution with the fundamental solution; understand existence, uniqueness, regularity, dispersion and decay of the solution. Understand conserved heat/mass integral.	Lectures, assignments	Assignments, midterm, final exam
Know the solution of the wave equation in multi-dimensions by convolution with the fundamental solution; understand existence, uniqueness, regularity of the solution.	Lectures, assignments	Assignments, midterm, final exam
Understand light cones, Huygen's principle, support set, conserved energy integral. Explain the different properties of wave propagation in one, two, three dimensions.	Lectures, assignments	Assignments, midterm, final exam

Table A.1
Course Learning Outcomes

Know the polynomial, Laurent polynomial, and eigenfunction solutions of the Laplace equation in multi-dimensions. Know the fundamental solution and its application to Green's functions for solving boundary value problems.	Lectures, assignments	Assignments, midterm, final exam
Understand spherical means, mean-value theorem, Liouville's theorem, and other global properties of harmonic functions.	Lectures, assignments	Assignments, final exam
Know the method of characteristics for solving a 1st order PDE in multi-dimensions. Find the general solution of a given 1st order PDE.	Lectures, assignments	Assignments, final exam
Know the method of power series for solving 1st order and 2nd order PDEs in multi-dimensions. Understand convergence, analyticity, and Cauchy-Kovalevskya theorem. Find the power series solution of a given PDE.	Lectures, assignments	Assignments, final exam
Know the technique of mapping (change of variables) by point, contact, nonlocal transformations for solving some linear and nonlinear PDEs.	Lectures, assignments	Assignments, final exam
Know the method of Fourier transforms for solving the initial-value problem for linear, higher-order, time-evolution PDEs in multi-dimensions. Find the initial-value solution of a given PDE.	Lectures, assignments	Assignments, final exam
Know index notation and geometrical notation for scalars, vectors, matrices, and tensors in n-dimensions. Know how to calculate in index notation. Understand rectangle and spherical coordinates in n-dimensions.	Lectures, assignments	Assignments, midterm, final exam
Present a derivation of a solution of a PDE or a proof of a property of a PDE in a mathematically clear and proper way.	Lectures	Presentation of an answer to a question on the final exam

Table A.1
Course Learning Outcomes

Course: MATH 5P66: Matrix groups and linear representations

Course Calendar Description: Abelian groups, permutation groups, rotation groups. Representations of discrete and continuous groups by linear transformations (matrices). General properties and constructions of group representations. Representations of specific groups. Lie groups and Lie algebras. Applications in various areas of Mathematics, including invariant theory and group algebras, and Theoretical Physics, including crystallography and symmetries in quantum systems.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Identify isomorphism class of given abelian group, represent a given permutation as a wiring diagram, find its cycles decomposition and represent it as a product of transpositions.	Lectures, assignments	Assignments, midterm test, final exam
Understand relationship between Lie groups and Lie algebras including rotation groups and use this relationship to find continuous symmetries of a given object.	Lectures, assignments	Assignments, midterm test, final exam
Find all irreducible representations of abelian groups, permutation groups. Write basis, dimension, matrix elements of representation of permutation groups in terms of Young diagrams.	Lectures, assignments	Assignments, midterm test, final exam
Understand relationship between representations of Lie groups and Lie algebras. Find all irreducible representations of rotation groups.	Lectures, assignments	Assignments, midterm test, final exam
Find decomposition into irreducible representations using characters theory. Find tensor product of given irreducible representations.	Lectures, assignments	Assignments, midterm test, final exam

Table A.1
Course Learning Outcomes

Course: MATH 5P70: Topology

Course Calendar Description: An introduction to point set topology concepts and principles: topological spaces, metric spaces, product and quotient topologies, compactness, connectedness, continuity of mapping between topological spaces, completeness of metric spaces, countability and separation axioms, metrizability, Baire spaces and dimension theory.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Demonstrate an understanding of the fundamental types of about topological spaces including metric, subspace, product and quotient topologies and the various separation properties (Hausdorff, regularity, complete regularity, and normality).	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Demonstrate a knowledge and an understanding of the main concepts of topology: compactness and paracompactness, normal spaces, connectedness and path-connectedness, continuity of mappings between topological space, countability axioms, separation axioms, Baire spaces.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Demonstrate an understanding of the main theorems of Topology: Bolzano-Weierstrass Theorem, Cantor Theorem, invariance of compactness and connectedness under continuity, Uryshon Metrization Theorem, Tietze Extension Theorem, Tychonoff Theorem, Ascoli Theorem, the Baire category Theorem.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project
Demonstrate an understanding of the Fundamental Group including covering spaces, the fundamental group of a circle, the fundamental group pf the n-sphere.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project

Table A.1
Course Learning Outcomes

Prove the Brouwer fixed point theorem, prove the Fundamental Theorem of Algebra. Prove the Borsuk-Ulam Theorem.	Attending lectures Complete assigned readings Complete course assignments Submit and present an end of term project	Home Assignments Term tests End of term project

MATH 5P81 SAMPLING THEORY

1. Depth and Breadth of Knowledge

Motivate students to learn sampling theory by using many examples of its applications in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines. Help students to understand the concepts, theorems and methods of sampling theory, and how to deal with efficiency and precision of estimates in real world practice. Develop students' thinking abilities about new ideas of sampling. Develop students' sampling survey allocation abilities. Develop students' computational skills using calculator and computer software. Develop Students communication skills.

2. Knowledge of Methodologies

COURSE CONTENT

Motivate students to learn sampling theory and its applications.

- **a.** *Introduce the **history** of sampling theory dealing with efficiency and precision of estimates.*
- **b.** *Introduce the **significant impact** of sampling theory in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines, and give many examples of its real world practice.*
- **c.** *Introduce recent developments of sampling theory and its **future** in the 21st Century.*

Assist students to understand the following sampling concepts, theorems and techniques.

- ***a. Simple Random Sampling*** *(Weeks 1,2)*
  - *(1) Sample random sampling, characteristics of population and sample.*
  - *(2) Estimators of population mean and variance and their expected values and variances.*
  - *(3) Random sample with replacement.*
  - *(4) Selection of a random sample.*
- ***b. Sampling Proportion*** *(Week 3)*
  - *(1) Estimation of a proportion and its expected value and variance.*
  - *(2) Exact and Approximate Confidence intervals for a population proportion.*
- ***c. Estimation of Sample Size*** *(Week 4)*
  - *(1) Sample sizes for estimating a population mean using a given tolerance limit and a risk.*
  - *(2) Sample sizes for estimating a population proportion using a given tolerance limit and a risk.*
  - *(3) Sample sizes determination using a given cost function or a loss function*
- ***d. Stratified Random Sampling*** *(Weeks 5, 6, 7)*
  - *(1) Stratified random sample; stratified random sample mean and its expected value and variance.*
  - *(2) Stratified estimator of population proportion and its expected value and variance.*
  - *(3) Optimal allocation of sample sizes.*
  - *(4) Comparison of precision of the estimators for population mean and proportion by using stratified random sampling or simple random sampling.*
- ***e. Ratio Estimators*** *(Weeks 8, 9)*
  - *(1) Population ratio and sample ratio.*
  - *(2) Ratio estimators for population mean, total and their expected values, variances and biases.*
  - *(3) Ratio estimators in stratified random sampling: combined and separated methods.*
  - *(4) Comparisons of precision of the five estimators studied for estimating a population mean.*

f. Regression Estimators *(Weeks 10, 11)*

(1) Population linear regression and sample linear regression.

(2) Linear regression estimators for population mean, population total and their expected values, variances and biases.

(3) Regression estimators in stratified random sampling: combined and separated methods.

(4) Comparisons of precision of the eight estimators studied for estimating a population mean.

g. Systematic Sampling and Cluster Sampling *(Week 12)*

(1) Systematic Sampling, systematic random sample mean and its expected value and variance.

(2) Cluster Sampling, cluster random sample mean and its expected value and variance.

(3) Comparisons of precision of the ten estimators studied for estimating a population mean.

h. Sampling Errors and Others *(Week 12)*

Develop students' thinking abilities about new ideas of sampling.

a. *Discuss how sampling models and techniques above were developed.*

b. *Encourage students to discuss new ideas of sampling.*

Develop students' sampling survey abilities by using the knowledge above

a. Assignments: *Let students use sampling skills to solve problems and prove basic theoretical problems.*

b. Case Studies *(one week)**: See Section 3.*

ROLE OF TECHNOLOGY

Develop students' computational skills using computer software.

Computer Lab: *Use SAS, MAPLE or EXCEL to run the sampling techniques for the assignments and case studies.*

MINIMAL SKILLS

Students are expected to perform the mathematical proofs and computational skills (by calculator and SAS or MAPLE) on the following topics:

- *Selection of a random sample with replacement and a simple random sample (random sample without replacement).*
- *Estimators of population mean, variance, proportion and their expected values and variances by using a simple random sample.*
- *Optimal sample size for a simple random sample.*
- *Estimators of population mean, variance proportion and their expected values and variances by using a stratified random sample.*
- *Optimal allocation of sample sizes for a stratified random sample. Neyman allocation.*
- *Estimator of population mean by using ratio estimators, regression estimators of a simple random sample or a stratified random sample.*
- *Estimator of population mean by using systematic random sampling, and cluster random sampling.*
- *Comparisons of the precision of the ten estimators studied of population mean.*
- *Sampling survey techniques.*

Textbook *(suggested):* **Sampling Techniques,** *W. Cochran, third edition, John Wiley, New York, 1997.*
Prerequisite: *Math 2P82.*
Lecture & Tutorial Hours*: Lectures, 3 hours per week, Lab (or Tutorial), 1 hour per week*

3. Application of Knowledge

For developing students' sampling survey application abilities by using the knowledge in Section 2, students perform <u>Case Studies</u> *(one week)**:** Let students design (in groups or individually) realistic and useful sampling projects. Require the students to identify any simplifying assumptions and to determine sample sizes then collect raw data, and finally compare the precision of estimates to give an optimal design of the sampling survey. The outline is as follows:*

(1) Main methods and analysis (50%)

a. Statement of a survey problem *(a practical and useful problem).*

b. Objective of the survey.

c. Sampling methods: <u>Note:</u> (i) A real data collection must be performed.
(ii) A pilot survey may be required.

- ***Population (****units, characteristics: Mean, total, proportion, etc****.);***
- ***Sample Factors (****units and frame, questionnaire, precision, cost function****);***
- ***Sampling methods:***
  - ***(i) Simple random sampling (****sample size estimated, normality test is needed****)***
  - ***(ii) Stratified random sampling (****proportional allocated****)***
  - ***(iii) Stratified random sampling (****Neyman allocated****)***
- ***Data table.***

d. Analysis:

- ***Estimations (****for population mean, total or proportion****) by using three sampling methods;***
- ***Compare the precision of the estimations;***
- ***Conclusions of the survey.***

(2) Organization and creativity (10%)

(3) Talk (10%)

(4) Asking and answering questions (10%)

(5) Report (20%)

Report format: Title, names, abstract, key words, text, references
(*SAS program and output should be attached****)***

(6) Students and teacher evaluate for each study project.

4. Communication Skills

In Case Studies (Section 3), students work in groups to discuss, present, evaluate and write reports.

5. Awareness of Limits of Knowledge

The knowledge in Math 4P81 consists of basic sampling theory and techniques. The limitations are:

a) Models are basic.
b) Mathematical derivations are basic.
c) Applications are limited.

6. Autonomy and Professional Capacity

a) The knowledge of methodologies in this course will lead to further studies of advance sampling survey theory and methodologies.
b) The knowledge of methodologies in this course may apply to other disciplines and real-world problems. The course provides basic sampling theory and skills for a professional statistician.
c) A base course for the "Knowledge and Ability Test for Mathematical Statistics Test" of Statistics Canada.
d) A core course for the Associate Statisticians Accreditation of the Statistical Society of Canada.

MATH 5P82 NONPARAMETRIC STATISTICS

1. Depth and Breadth of Knowledge

Motivate students to learn nonparametric statistics by using many examples of its applications in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines. Help students to understand the concepts, theorems and methods of nonparametric statistics, and how to deal with statistical inference for non-normal populations or distribution-free populations in real world practice. Develop students' thinking abilities about new ideas of nonparametric statistics. Develop students' problem solving abilities. Develop students' computational skills using calculator and computer software. Develop student communication skills.

2. Knowledge of Methodologies

COURSE CONTENT

Motivate students to learn nonparametric statistics and its applications.

a. *Introduce the* ***history*** *of nonparametric statistics dealing with statistical inference for non-normal population or distribution-free population.*
b. *Introduce the* ***significant impact*** *of nonparametric statistics in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines, and give many examples of its real world practice.*
c. *Introduce recent developments of nonparametric statistics and its* ***future*** *in the 21st Century.*

Assist students to understand the following concepts, theorems and techniques.

a. ***Review statistical inference*** *(Weeks 1/2)*
   (1) Estimation.
   (2) Hypothesis testing; power of a test; unbiased test; significance level.

b. ***Binomial Tests – using binomial distribution and its approximation*** *(Weeks 1, 2, 3)*
   (1) Binomial test and confidence interval for probability: Theorems and examples.
   (2) Point estimation, hypothesis testing and confidence interval for population quantiles (discrete and continuous cases): Order Statistics, theorems and examples.
   (3) Tolerance limits: Theorem and examples.

c. ***Contingency Tables – using multinomial distribution and its approximation*** *(Weeks 4, 5, 6)*
   (1) 2 x 2 *contingence tables: method and theorem.*
   (2) r x c *contingence tables: chi-square tests for differences of probability or independence.*
   (3) Exact and approximate distributions of r x c *contingence tables with fixed or random margins.*
   (4) Median test.
   (5) Chi-square goodness-of-fit test.
   (6) Cochran's test and McNemar's test.

d. ***Rank Tests - using rank distribution and its approximation*** *(Weeks 7, 8, 9, 10, 11)*
   (1) The Mann-Whitney test for two independent samples: Theorems, methods and Examples.
   (2) The Kruskal-Wallis test for several independent samples: Theorems, methods and examples.
   (3) Measures of rank correlation: Spearman's Rho and Kendall's Tau.
   (4) Nonparametric linear regression method: Test for slop and confidence interval for slop.
   (5) The Wilcoxon signed ranks test for one-sample matched-pairs case: Theorems, method and examples.

(6) The Friedman test and Quade test for several related samples case: Theorems, methods and examples.

e. ***Statistics of the Kolmogorov-Smirnov type*** *(Week 12)*
   (1) The Kolmogorov goodness-of-fit test.
   (2) The Lilliefors test and the Shapiro-Wilk test for normality.
   (3) The Smirnov test on two independent samples.

Develop students' thinking abilities about new ideas of nonparametric statistics.

a. *Discuss how nonparametric statistics methods above were developed.*
b. *Encourage students to discuss new ideas of nonparametric statistics***.**

Develop students' nonparametric statistics inference abilities by using the knowledge above

a. ***Assignments:*** *Let students use nonparametric statistics skills to solve problems and prove basic theoretical problems.*
b. ***Case Studies*** *(one week)****: See Section 3.***

ROLE OF TECHNOLOGY

Develop students' computational skills using computer software.

Computer Lab: *Use SAS, MAPLE or EXCEL to run the nonparemetric statistical methods above for the assignments and case studies.*

MINIMAL SKILL SET

Students are expected to perform the mathematical proofs and computational skills (by calculator and SAS or MAPLE) on the following topics:

- *Binomial test.*
- *Order statistics for confidence interval and tolerance limits.*
- *Estimation and hypothesis test on a population quantile: discrete and continuous cases.*
- *The* r x c *contingence tables: chi-square tests for differences of probability or independence.*
- *Exact and approximate distributions of* r x c *contingence tables with fixed or random margins.*
- *Median test.*
- *The Chi-square goodness-of-fit test.*
- *The Cochran's test and McNemar's test.*
- *The Mann-Whitney test for two independent samples.*
- *The Kruskal-Wallis test for several independent samples.*
- *Measures of rank correlation: Spearman's Rho and Kendall's Tau.*
- *Nonparametric linear regression method: Test for slop and confidence interval for slop by using Spearman's Rho and Kendall's Tau.*
- *The Wilcoxon signed ranks test for one-sample matched-pairs case.*
- *The Friedman test and Quade test for several related samples case.*
- *The Kolmogorov goodness-of-fit test, the Lilliefors test and the Shapiro-Wilk test for normality.*
- *The Smirnov test on two independent samples.*

Textbook *(suggested):* **Practical Nonparametric Statistics,** *W. J. Conover, third edition, John Wiley & Sons, New York, 1999.*

Prerequisite: *Math 2P82.*

Lecture & Tutorial Hours: Lectures, 3 hours per week, Lab (or Tutorial), 1 hour per week.

3. Application of Knowledge

For developing students' nonparametric statistics inference application abilities by using the knowledge in Section 2, students perform <u>Case Studies</u> *(one week)**:** Let students design (in groups or individually) realistic and useful projects which deal with non-normal populations. Require the students to identify any simplifying assumptions on the population, collect raw data and perform statistical inference. The outline is as follows:*

(1) Main methods and analysis (50%)

a. Statement of a problem; *(Give a set of non-normal data, and a practical and useful problem)*

b. Test data for normality; *(Use Kolmogorov-Smirnov test, and use SAS check)*

c. Data table;

d. Use nonparametric methods to analyze data;

<u>ANOVA:</u>	**<u>REGRESSION</u>**
• *Hypothesis tests;*	• *Least squares estimation;*
• *Multiple comparisons;*	• *Hypothesis test for slope;*
• *Confidence intervals*	• *Confidence interval for slope.*

e. Use parametric methods to analyze data;

<u>ANOVA:</u>	**<u>REGRESSION</u>**
• *Hypothesis tests;*	• *Least squares estimation;*
• *Multiple comparisons;*	• *Hypothesis test for slope;*
• *Confidence intervals.*	• *Confidence interval for slope.*

f. Compare the results in (e) and (d).

(2) Summary (10%)

- *"Parametric and Nonparametric Methods in the Case Study"*
  (Give comparisons of assumptions, H_0 , Test statistics, power, C.I., etc.)

(3) Talk, Organization and creativity (10%)

(4) Asking and answering questions (10%)

(5) Report (20%).

Report format: Title, names, abstract, key words, text, references.
(*SAS program and output should be attached**)***

(6) Students and teacher evaluate for each study project.

4. Communication Skills

In Case Studies (Section 3), students work in groups to discuss, present, evaluate and write reports.

5. Awareness of Limits of Knowledge

The knowledge in Math 4P82 consists of basic nonparametric statistics theory and methods. The limitations are:

a) Models are basic.
b) Mathematical derivations are basic.
c) Applications are limited.

6. Autonomy and Professional Capacity

a) The knowledge of methodologies in this course will lead to further studies of advance nonparametric statistics inference methodologies.
b) The knowledge of methodologies in this course may apply to other disciplines and real-world problems. The course provides basic nonparametric statistics theory and skills for a professional statistician.

c) A base course for the “Knowledge and Ability Test for Mathematical Statistics Test” of Statistics Canada.
d) A core course for the Associate Statisticians Accreditation of the Statistical Society of Canada.
e) A possible base course for the Examinations of the Society of Actuaries.

Table A.1
Course Learning Outcomes

Course: MATH 5P83: Linear Models

Course Calendar Description: Classical linear model, generalized inverse matrix, distribution and quadratic forms, regression model, nested classification and classification with interaction, covariance analysis, variance components, binary data, polynomial data, log linear model, linear logit models, generalized linear model, conditional likelihoods, quasi-likelihoods, estimating equations, and computational techniques.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand and be able to derive Gauss-Markov Theorem, be able to apply the analytic form of ordinary and generalized least squares estimators, and be able to apply maximum likelihood estimation for the coefficient vector and variance components for any general linear regression model (GLRM).	Lectures, assignments	Assignments and midterm test
Understand and derives BLUE and BQUE for GLRMs. Understand the derivation of the tests and conference regions for any subset/linear combinations of the coefficient vector in any GLRM.	Lectures, assignments	Assignments, midterm test, and final exam
Understand and be able to derive the estimators for multiple regression with random repressors.	Lectures, assignments, demonstration in class (using Splus codes)	Assignments, midterm test, and final exam
Understand how ANOVA models related to general linear models; understand estimability, testability, and parameterization. Be able to derive the general solutions for balance and unbalanced ANOVA models.	Lectures, assignments	Assignments, and final exam
Understand and apply ANCOVA models, be able to derive the estimators for the ANCOVA parameters. Understand random effects and mixed effects models. Understand how a generalized linear model can be viewed as extended GLMs, and how a nonlinear models can be approximated to GLMs.	Lectures, assignments	Assignments, and final exam

Table A.1
Course Learning Outcomes

Course: MATH 5P84: Course Name

Course Calendar Description: Course calendar entry comes here.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand and work with Normal distribution, including its univariate, bivariate and multivariate version.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
The PDF of the empirical correlation coefficient and the corresponding Fisher approximation.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Related conditional and marginal distributions; partial correlation.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Autoregressive, moving-average and ARMA(p,q) models as examples of time series. Finding correlograms and spectral density.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Estimating spectral density; lag and kernel windowing, Bartlett, Parzen and Tukey schemes for smoothing empirical densities.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Finding asymptotic formulas for the variance of estimators of various parameters of time-series models.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.

Table A.1
Course Learning Outcomes

Course: MATH 5P86: Multivariate Statistics

Course Calendar Description: Theory of multivariate statistics, matrix algebra and random vector, sample geometry and random sampling, multivariate normal distribution, inference about means, covariance matrix, generalized Hotelling's T-square distribution, sample covariance and sample generalized variance, Wishart distribution, general hypothesis testing, analysis of variance and linear regression model, principle components, factor analysis, covariance analysis, canonical correlation analysis, discrimination and classification, and cluster analysis.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand and be able to perform the following four pre-treatments for multivariate data analysis: assessments of multivariate normal distribution (MND); outlier detection; transformation skill to MND; treatment for missing data using EM algorithm.	Lectures, assignments	Assignments, TD data homework project, and midterm test
Understand the derivation of the tests using likelihood ratio method and be able to well-perform MANOVA, profile analysis, and tests for homoscedasticity.	Lectures, assignments	Assignments, midterm test, and final exam
Understand the differences between principle component analysis and factor analysis (FA), and be able to well-perform FA, including four methods for estimating the loadings, two methods of factor score estimation, orthogonal and oblique rotations, varimax criterion, as well as criteria/test for determining the proper number of factors.	Lectures, assignments, demonstration in class (using Splus codes)	Assignments, midterm test, and final exam
Understand cluster analysis techniques, similarity measurements, three hierarchical clustering methods, and non-hierarchical clustering method of K-means.	Lectures, assignments	Assignments, midterm test, and final exam

Table A.1
Course Learning Outcomes

Course: MATH 5P87: Computational Statistics

Course Calendar Description:

An introduction to the theory and techniques in computational statistics. Topics include classification techniques, discriminant analysis, resampling methods, linear model selection and regularization, nonlinear regression, tree-based methods, support vector machines, and unsupervised learning. Computations will be done in R.

Prerequisite(s): MATH 3P82 and MATH 3P86 (or their equivalences), or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Know how to use classification techniques, discriminant analysis, and resampling methods.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Understand and use linear model selection and regularization, nonlinear regression	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Understand and use in practical applications: tree-based methods, support vector machines, and unsupervised learning	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.

Table A.1
Course Learning Outcomes

Course: MATH 5P88: Advanced Statistics

Course Calendar Description: Course calendar entry comes here.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Generating random numbers from various univariate distributions, both discreate and continuous.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Generating random independent samples from multivariate distributions; Metropolis sampling.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Finite Abelian groups; additive and multiplicative groups of mod(n); generating random numbers from continuous uniform distribution.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Moment-generating, characteristic and cumulant-generating functions; inverse Fourier transform.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Extending Central Limit Theorem to Edgeworth-series approximation. Asymptotic formulas for the mean, variance, skewness and kurtosis of various sample statistics.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Bivariate and multivariate extension of Edgeworth approximation; special case of maximum-likelihood estimators.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.

Table A.1
Course Learning Outcomes

Course: MATH 5P89: Computational methods for generalized linear models (proposed course)

Course Calendar Description: Generalized linear models: logistic regression, log-linear (Poisson) regression, linear mixed effect models, generalized linear mixed effect models, hierarchical Bayes models; Computational methods: iteratively reweighted least squares, expectation-maximization, restricted maximum likelihood, genetic algorithms; Selected additional topics: survival models, methods for inference (bootstrap, permutation tests), generalized additive models. Computations will be done in R. Prerequisite(s): MATH 5P83 and 5P87 (or the equivalences), or permission of the instructor.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand and know how to use in practice the generalized linear models: logistic regression, log-linear (Poisson) regression, linear mixed effect models, generalized linear mixed effect models, hierarchical Bayes models;	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Understand and use computational methods: iteratively reweighted least squares, expectation-maximization, restricted maximum likelihood, genetic algorithms;	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.
Understand and use selected additional models and methods, including survival models, methods for inference (bootstrap, permutation tests), generalized additive models.	Attending classes, working out assignment questions and studying for the final exam. Maple programming used extensively.	Successfully completing the corresponding assignment and answering questions of the final exam.

Course: MATH 5P92: Cryptography and Number Theory

Course Calendar Description: Topics may include RSA cryptosystems, ElGamal cryptosystem, algorithms for discrete logarithmic problem, elliptic curves, computing point multiples on elliptic curves, primality testing and factoring algorithms

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Understand basic concepts in number theory, congruences modulo n, the Chinese Remainder Theorem, quick computations of inverses and huge powers modulo n.	Lectures, MAPLE lab and assignments.	Assignments, midterm test
Understand primality testing and do some applications	Lectures, MAPLE lab and assignments.	Assignments, midterm test
Understand the concept of public cryptography, the Diffie Hellman key exchange, the RSA cryptosystem in detail as well as attacking RSA. Be able to work with other public cryptosystems.	Lectures, MAPLE lab and assignments.	Assignments, midterm test
Understand quadratic reciprocity and the application of Euler's criterion to primality testing.	Lectures, MAPLE lab and assignments.	Assignments, midterm test
Understand the notion of finite fields and basic notion of the theory of elliptic curves and applications into cryptography.	Lectures, MAPLE lab and assignments.	Assignments, midterm test and presentation

Table A.1
Course Learning Outcomes

Course: MATH 5P96: Technology and Mathematics Education

Course Calendar Description: Topics may include contemporary research concerning digital technologies, such as computer algebra systems and Web 2.0, in learning and teaching mathematics; design of educational tools using VB.NET, HTML, Geometer's Sketchpad, Maple, Flash, etc.; critical appraisal of interactive learning objects in mathematics education.

Note: taught in conjunction with MATH 4P96.

Learning Outcome *A student will be able to:*	**Learning Activity/Experience** *A student will learn this by:*	**Assessment** *Achievement of this outcome will be demonstrated by:*
Outline and understand the history of digital technology integration in mathematics education (internationally, nationally, and provincially)	Lecture	Indirectly through weekly activity reports and reflection on related didactical issues; final exam
Understand the effect on mathematics curriculum and learning of technology integration	Lab sessions involving a problem solving by use of diverse technologies, activity report and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project
Understand the limitations, constraints, and benefits of formal (in-class & at-home) evaluations of students' mathematics understanding when digital technology is involved/allowed	Lecture, lab sessions, activity report on the analysis and design of evaluations and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project
Understand the affordances and constraints of using dynamic geometry software (e.g. GeoGebra) for the learning and teaching of geometry; Use GeoGebra for basic mathematics problem solving and illustration	Lecture, lab session, activity report and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project
Understand the role, potential, and constraints of 1) simulation technology for the learning of probability and statistics concepts and 2) using digital technology (e.g. Fathom, Excel, etc.) to conduct statistical work.	Lecture, lab session, activity report and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project

Table A.1
Course Learning Outcomes

Understand key aspects, benefits, and constraints of learning mathematics with programming (or more broadly, computational thinking); understand the recent trends in educational reforms; use basic Scratch programming in Scratch	Lecture, lab session, activity report and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project
Understand key characteristics of, and identify mathematics video games supporting the players' development of mathematical thinking (i.e., not only 'rote' practice)	Lecture, lab session, activity report on the selection and analysis of math video games and reflection on related didactical issues	Activity report and reflection; final exam; and possibly individual project

Appendix B

Course Outlines

Brock University
Department of Computer Science
COSC 4P03 – Advanced Algorithms
Winter 2018

Instructor: Sheridan Houghten, J313

Prerequisite:
COSC 3P03 (minimum 60%).

Course Description: This course examines classical and evolving problems and algorithms in Computer Science.

Textbook: There is no required textbook for this course. We will use selected chapters from the following books, on reserve in the library:

- Introduction to Algorithms, 3rd edition, T.H.Cormen, C.E.Leiserson, R.L.Rivest and C. Stein, McGraw Hill, 2009 (CLRS).
- Combinatorial Algorithms: Generation, Enumeration and Search, D.L.Kreher and D.R.Stinson, CRC Press, 1999 (KS).
- Cryptography: Theory and Practice, 3rd edition, D.R.Stinson, CRC Press, 2006.

We will refer to other sources as required, including:

- The Algorithm Design Manual, S.S.Skiena, Springer-Verlag, 1998/2008.
- The Art of Computer Programming, Volume 4, D.E.Knuth, Addison-Wesley, 2005: fascicles 0 (Combinatorial Algorithms), 2 (Tuples and Permutations), 4 (Trees) and 5 (Combinatorial Generation).

Mark Distribution:

- Assignments: 1x15% and 2x10%
- Term Test: 25%
- Project/Term Paper: 35%
- Participation: 5%

Tentative Outline: *(Subject to change; additional reading may be required)*

- Introduction/Review; Growth of Functions (ch. 3, CLRS)
- Dynamic Programming (ch. 15, CLRS)
- Greedy Algorithms (ch.16, CLRS)
- Approximation Algorithms (ch.35, CLRS)
- Intro to Combinatorial Structures and Algorithms (ch.1, KS)
- Combinatorial Generation (ch.2, KS)
- Backtracking Algorithms (ch.4, KS)
- Heuristic Searches (ch.5, KS)
- Classical Cryptography (ch.1, Stinson)
- Cryptographic Theory (ch.2, Stinson)
- Block Ciphers (ch.3, Stinson)
- Public-Key Cryptography (ch.5-6, Stinson)
- Optional Topics, including but not limited to: Ranking and Unranking, Information Theory, DNA Computing.

Important Dates:

– Last date for withdrawal without academic penalty: Friday, March 9th, 2018.
– Last date to receive notification of at least 15% of final grade: Friday, March 2nd, 2018.

Course Policies:

Illness: If you miss a test or assignment due to illness, you must submit a student medical certificate (`http://www.cosc.brocku.ca/forms/medical`) *within 3 days of the illness*, at the main office in the Computer Science department.

Plagiarism: The department views plagiarism as a serious issue. Students may visit `http://www.cosc.brocku.ca/about/policies/plagiarism` to view the department's policies on plagiarism.

Term Test: The term test will be given during **class** time, on a preannounced date.

Term Paper/Project: Students have the option of either writing a term paper or doing a project (with appropriate documentation) on an advanced topic related to algorithms. Students must obtain approval for the topic from the instructor. All projects and term papers must be presented to the class.

The term paper and project documentation must be submitted electronically to a plagiarism detection site. Information on how to do this will be given in the term paper/project guidelines.

Participation: Students will receive the full 5% participation marks if they attend ***all*** of the project/term paper presentations given by fellow students.

Assignments:

- All assignments must be completed *individually*.
- Due dates for assignments will be printed on the assignment text. Assignments will be accepted up to 3 days late with a one-time penalty of 25%. Generally it is to your advantage to hand in assignments on time, even if incomplete. You are strongly encouraged to do hand all assignments in on time.
- *Assignments must be submitted both as hard copies AND electronically.*
- Hard copies of all assignments must be submitted in the 4P03 assignment box, in an envelope with an attached, signed cover page. To generate the cover page, visit `http://www.cosc.brocku.ca/forms/cover`.
- Electronic submission is for the purposes of plagiarism detection using `MOSS`. To submit electronically, create a directory on Sandcastle containing all files for the assignment, and run the script `submit4p03a` from this directory.

COSC 4P13

Operating Systems Design and Implementation
Course Outline

Sept. - Dec. 2015

Instructor	Office Hours	Extension	Lecture Time & Place
Dave Bockus	J324 M-F 9:30 - 4:30	x3281	T - 11:00 to 12:30 Th241 R - 10:00-11:30 WH207

A study involving the working of a modern operationg system

Design and implementation of UNIX and other operating systems. Topics include process and thread management, interprocess communication, synchronization and scheduling, multiprocessing, device drivers, kernel memory management, distributed and advanced file systems and STREAMS (knowledge of C assumed).

Lectures, 3 hours per week. (see notes)

Prerequisites: COSC 2P12 (minimum 60 percent), 2P13 (minimum 60 percent) and 2P91 (minimum 60 percent).

The lecture component will focus on fundamentals concerning the design and implementation of aspects concerning a variety of topics in a broad sense. The lab component will focus on practical immersion into a modern operating system, primarily FreeBSD. Students will be expected to complete a variety of labs concerning BSD, attaining experience on a Unix operating system.

Text Book

The following Text is recommended, since a vast majority of topics will be choosen from it. It is the students responsibility to aquire a copy, electronic or otherwise. Google the ISBN and order from the supplier which best suits your price range.

The Design and Implementation of FreeBSD operations system (2nd Ed.) Marshall Kirk Mckusick, George V. Neville-Neil, Robert N.M. Watson. (ISBN 978-0-321-96897-5)

MARKING SCHEME:

1. Quiz (4 x 5%, held in class TBA - or when you least expect it.) (See Note 1)
2. Weekly Assignments and Readings (30%, expect 4 to 6, mini assignments) (See Note 2)
3. Practical Lab (50%) (See Note 3)

Notes:

1. Quizes will be no more the 20min in length and will serve as a refresher for the previous week(s) lecture and assignment material. Quiz material may be taken from lectures or the assigned readings.

2. Mini assignments will follow assigned captures to be read from the text or other sources. It is expected that students complete the readings and the accompanying questions, as assigned from the end of the chapters.

3. Students will be given a modern PC (Dell Optiplex 990). FreeBSD will be installed and maintained by the individual. One 1 1/2 hr. lab period will be used for supervised instruction. Additional time on the computers may be needed and it is expected that students us out of class/lab time to complete tasks as required. At the end/(start of following) week, the instructor will inventory students progress, which will count toward the Practical Lab Mark.

4. The purpose of this course is to impart skills requisite to operating system design and implementation. It is therefore imperative that all students attend labs and complete the work as required. Assessment is largely based on the instructors subjective view on student participation.

5. It is strongly suggested that students with a laptop, bring these to lab, to serve as a reference source (Google will be your friend).

6. Plagiarism is frownd upon and will not be tolerated. End of chapter assignments are expected to be the work of individuals. Lab work may be collaborated on.

Course Schedule

Week	Date	Chapt.	Lecture Topic	Lab Topic
1	Sept. 10	1-2	Intro - Design and Overview of BSD	
2	Sept. 17	3 - 4	Kernel Service & Process Mgmt.	
3	Sept. 24	4 - 5	Process Mgmt & Security	
4	Oct.1	6	Memory Management	
5	Oct. 8	6	Memory Management	
6	Oct. 22	7 - 8	I/O & Devices	
7	Oct. 29	8	Devices	
8	Nov. 5	9 - 10	File systems	
9	Nov. 12	10-11	File systems & Network Filesystems	
10	Nov. 19	12	Interprocess Communications	
11	Nov. 26	13-14	Network-Layer Protocols	
12	Dec. 3	14-15	Transport-Layer and Boot Process	
.* Subject to change				

Previous Page

Brock University - COSC 4P14 - Computer Networks - Fall 2017-18

Instructor: Earl Foxwell
email: efoxwell@brocku.ca
Classes: Wednesdays & Fridays, 3:30–5:00pm, WH208

This course provides an overview of the underlying mechanisms supporting modern day networking, with a focus on the TCP/IP Internet Stack, as well as application protocols utilizing it. Concepts will be introduced in lectures, and reinforced in assignments. Practical knowledge will be gained through labs and exercises. A broad range of topics will be covered, including low-level communications; socket programming; wireless considerations; and security-related issues such as authentication, encryption, and common forms of attack.

Course Materials:

Textbook: Computer Networking: a top-down approach, J.F. Kurose, K.W. Ross
Network Security Essentials, William Stalling, Prentice Hall

Evaluation:

Labs: 5×4=**20%**
Lab Exercises: 4×5=**20%**
Assignments: 3×20=**60%**
Note: You are only eligible to receive credit for labs and lab exercises when you attend. Repeated absence may result in losing lab priviledges.
i.e. Ditching your lab partner will not be beneficial to your grade.

Additional Notes:

- If contacting your instructor via email, please include "COSC 4P14" in the subject line.
- All official correspondence for this course will be sent to your Brock email address. Please check this account regularly.
- Please read the department's policy on medical notes on the COSC home page. Other reasons may be used for granting extensions or other accommodations, at the instructor's discretion, but only if the instructor is contacted *in advance* of due dates.
- Plagiarism is a serious offense and will be treated accordingly. Phrase-matching software, such as MOSS, will be applied to compare submissions. For more information, please see http://www.cosc.brocku.ca/about/policies/plagiarism for details.
- As part of Brock University's commitment to a respectful work and learning environment, the university will make every reasonable effort to accommodate all members of the university community with disabilities. If you require academic accommodations related to a permanent disability to participate in this course, you are encouraged to contact the Student Development Centre Services for Students with Disabilities (4th Floor Schmon Tower ext. 3240) and also to discuss these accommodations with the instructor.
- November 7th is the last day for voluntary withdrawal without academic penalty. At least 15% of your final grade will be available by November 3rd.

COSC 4P41
Course Outline

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 10:00am - noon, email: mwinter@brocku.ca

Calendar description

Introduction to functional programming using the languages Haskell. Topics include all data types, type inference, pattern-matching, recursion, polymorphism, higher-order functions, lazy vs eager evaluation, modules and monads.

Course Outline

Week	Date	Book / Chapter	Topics
1	Jan 04/08	[1] 1 - 3	Introduction to Functional Programming
2	Jan 11/15	[1] 4 - 5	Recursion and Data Types
3	Jan 18/22	[1] 6 - 7	Lists
4	Jan 25/29	[1] 9 - 10	Patterns of Computation and Functions as Values
5	Feb 01/05	[1] 12 - 13	Overloading, Type Classes and Type Checking
6	Feb 08/12	[1] 14 - 15	Algebraic Types
7	Feb 22/26*	[1] 16	Abstract Data Types
8	Feb 29/Mar 04	[1] 17	Lazy Evaluation
9	Mar 07/11	[1] 18	Programming with Actions
10	Mar 14/18	[1] 8, 14.7 & 17.9	Reasoning about Programs
11	Mar 21/28**	[1] 8, 14.7 & 17.9	Reasoning about Programs II
12	Apr 01/04	[2] 7	Language extensions, Review

* Feb 15-19 is Reading Week.
** Mar 25 is Good Friday. Make-up on Apr 04.

Texts

[1] (required) *Haskell, The Craft of Functional Programming*, 3rd edition, S. Thompson, *Addison - Wesley* (2011), ISBN 0-201-88295-7
[2] (recommended) The Haskell 2010 Report, Simon Marlow, online.
[3] (recommended) Real World Haskell, Bryan O'Sullivan, John Goerzen, Don Steward, *O'Reilly* (2009), ISBN 978-0-596-51498-3
[4] (recommended) *The Haskell School of Expression*, P. Hudak, *Cambridge University Press* (2000), ISBN 0-521-64408-9

Links

- Haskell homepage
- GHC/GHCi Haskell Compiler and interpreter
- Introduction to Haskell (online)
- The Haskell API Search Engine
- Web site for the book: Haskell, The Craft of Functional Programming

---

COSC Home Page
COSC 4P41 Home Page

COSC 4P41
Course Procedures

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 10:00am - noon, email: mwinter@brocku.ca

Marking Scheme

Lab Test 1	20%
Lab Test 2	20%
Lab Test 3	20%
Final Lab Exam	40%

Important Dates

Tests & Exam

Lab Test 1	February 01	2:00pm - 3:30pm
Lab Test 2	February 29	2:00pm - 3:30pm
Lab Test 3	March 21	2:00pm - 3:30pm
Lab Exam	April 06	10am-noon (D205)

Notes

- A mark of at least 40% on the final exam is required to achieve a passing grade in this course.
- Consideration regarding illness for test dates will **only** be considered if accompanied with the completed Departmental Medical Excuse form.
- Academic misconduct is a serious offence. The principle of academic integrity, particularly of doing one's own work, documenting properly (including use of quotation marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students should consult Section VII, 'Academic Misconduct", in the "Academic Regulations and University Polices entry in the Undergraduate Calendar, available at brocku.ca/webcal to view a fuller description of prohibited actions, and the procedures and penalties.

COSC Home Page
COSC 4P41 Home Page

COSC 4P42
Course Outline

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri 9:00am - 11:00am, email: mwinter@brocku.ca

Calendar description

Course Outline

Week	Lecture Dates	Lecture Topic	Lab Date	Lab Topic
1	Sep 07, 12	Introduction	Sep 08	No lab
2	Sep 14, 19	First-order logic - Syntax and Semantics	Sep 15	Introduction to Coq, Natural Deduction (propositional logic) in Coq
3	Sep 21, 26	First-order logic - Natural Deduction	Sep 22	Natural Deduction (first-order logic) in Coq
4	Sep 28, Oct 03	First-order logic - Soundness of Natural Deduction	Sep 29	Test 1
5*	Oct 05, 17	Introduction of the Programming Logic IMP and Hoare Logic	Oct 06	Natural number and induction in Coq
6	Oct 19, 24	Programming Language IMP - Syntax and Operational Semantics	Oct 20	Hoare logic in Coq
7	Oct 26, 31	Programming Language IMP - Hoare Logic	Oct 27	Test 2
8	Nov 02, 07	Programming Language IMP - Soundness of Hoare logic	Nov 03	IHoare logic in Coq
9	Nov 09, 14	Algebraic Specifications - Motivation, Syntax and Semantics	Nov 10	Hoare logic (lists and pseudo-pointers) in Coq
10	Nov 16, 21	Algebraic Specifications - Homomorphisms, Initial and Terminal Models	Nov 17	Test 3
11	Nov 23, 28	Algebraic Specifications - Homomorphisms, Initial and Terminal Models	Nov 24	Hoare logic (lists and pseudo-pointers) in Coq
12	Nov 30, Dec 05	Selected topics, Review	Dec 01	Theories and Hoare Logic in Coq

* October 09-13 is Reading Week, no classes.

Supplemental Texts

- *The Formal Semantics of Programming Languages: An Introduction*, G. Winskel, *The MIT Press* (1993), ISBN 0-262-23169-7 (hc), 0-262-73103-7 (pb)
- *The Design of Well-Structured and Correct Programs*, S. Alagic & M.A. Arbib, *Springer-Verlag* (1978), ISBN 0-387-90299-6
- *Fundamentals of Algebraic Specifications 1: Equations and Initial Semantics*, H. Ehrig & B. Mahr, *Springer-Verlag* (1985), ISBN 0-387-13718-1
- *Logic in Computer Science*, *2nd edition*, M. Huth & M. Ryan, *Cambridge University Press* (2004), ISBN 0-521-54310-X

COSC Home Page
COSC 4P42 Home Page

COSC 4P42
Course Procedures

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri 9:00am - 11:00am, email: mwinter@brocku.ca

Marking Scheme

Test 1 (Sep 29)	20%
Test 2 (Oct 27)	20%
Test 3 (Nov 17)	20%
Final Exam (Dec 06)	40%

Important Dates

Test	Length	Date/Time
1	60 mins	Sep 29 (11:00am-noon) D205
2	60 mins	Oct 27 (11:00am-noon) D205
3	60 mins	Nov 17 (11:00am-noon) D205
Exam	90 mins	Dec 06 (09:15am-10:45am) D205

All tests and the exam will be held in D205.

Notes

- A mark of at least 40% on the final exam is required to achieve a passing grade in this course.
- Consideration regarding illness for assignment submission or test dates will **only** be considered if accompanied with the completed Departmental Medical Excuse form.

COSC Home Page
COSC 4P42 Home Page

MATH 4P61: Theory of Computation

- Instructor: Ke Qiu
- Time and Location: Tu and Th., 5:00-6:30 PM,TH 245
- Office: J306
- Office Hours: TBA and by appointment.

General Objectives

Introductions to formal languages, automata, and their relation, and theory of computation. In particular, we will cover the following topics:

preliminaries: induction, proofs, sets, countability, Cantor's theorem, technique of diagonalization;

regular sets, languages, and their closure properties, regular, grammars, and finite state machines;

context free languages and their closure properties, context-free grammars, push-down automata, normal forms;

Turing machines and general introduction to computations: recursive and recursively enumerable languages, (un)decidability, etc.

The Chomsky Hierarchy: relations between different classes of languages.

Recommended Textbook

Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, 3rd ed., Rajeev Motwani, and Jeffrey Ullman, Addison-Wesley Publishing Company. A useful link to the book: http://infolab.stanford.edu/~ullman/ialc.html.

The first edition of this book is a classic and one of the best among the many books on this subject.

For both the midterm and the final exam, a cheat sheet is allowed. For the ultimate cheat sheet in theoretical computer science, see here.

Homework

Assignments are to be handed in by 5:00 PM on the due date specified. Late assignment will be accepted up to one day with a penalty of 50%.

You may discuss assignments with your fellow students. But, please remember not to share solutions. The work you submit must be your own. When submitting an assignment, please follow the general rules for computer science students. Specifically, a standard computer science cover page should be included.

Assignment	Out Date	Due Date	Solutions

Marking Scheme (tentative)

There will be one midterm (Oct. 26 in class) and a final exam.

Assignments (4)	25%
Midterm	25%
Final	50%

Cheating

Cheating and plagiarism as defined in the Academic Integrity section of the Calendar is strictly prohibited. Some forms of cheating are:

1. copying someone else's answer (including from the internet);
2. stealing, borrowing, or lending a program listing;
3. fabricating program output

Cheating in any form will not be tolerated and will be dealt with severely. The penalty is given as follows: Let n be the total mark for an assignment/exam, your mark for this assignment/exam will be -n. A second offence will result in a failing grade for the course. In both cases, the incident will be reported to the department and the registrar's office.

Course Description

COSC 4P75 is an introduction to compilation and the art of compiler construction. The primary objective is that the student, upon successful completion of the course, be able to craft a compiler for a Java-like language. Students will develop a complete working compiler for a small Java-like language using recursive-descent parsing.

Course Website

`https://lms.brocku.ca/portal/site/COSC4P75D02FW2015MAIN/`

Instructor

Dave Hughes, J312, x3516, dhughes@brocku.ca

Textbook

none

Software

Students may use any Java development environment they choose as long as it can produce a java .jar file executable from the command line. Generated code will be tested using the Jamal interpreter.

Course Learning Outcomes

Upon successful completion of this course, students will be able to:

- Describe the compilation process and its phases
- Explain the principles of language translation including lexical, syntactic and semantic analysis and code generation
- Describe one technique for error-recovery in each of syntactic and semantic analysis.
- Develop a compiler for a small Java-like language using recursive descent parsing
- Apply object-oriented techniques to a single-person, large-scale project
- Apply coding/documentation standards in project development
- Apply Intellectual Property rights in project development
- Apply appropriate testing techniques in project development

Marking Scheme

Lexical Analysis	Oct. 19 @ 12:00 noon	20%
Syntactic Analysis	Nov. 16 @ 12:00 noon	30%
Semantic Analysis	Dec. 10 @ 12:00 noon	30%
Code Generation	Jan 18, **2016** @ 12:00 noon	20%

Notes

- As part of Brock University's commitment to a respectful work and learning environment, the University will make every reasonable effort to accommodate all members of the University community with disabilities. If you require academic accommodations related to a permanent disability to participate in this course, you are encouraged to contact the Student Development Centre Services for Students with Disabilities (4th Floor Schmon Tower ext. 3240) and also to discuss these accommodations(s) with the professor/instructor.
- Assignments will be available on-line and are due at the times specified above. Late assignments will only be accepted upon pre-approval by the instructor and may be subject to a penalty.
- Assignments are submitted electronically to the course drop box and on paper to the instructor (or designate) and are returned in class.
- Assignments will be carefully examined regarding plagiarism. Cases of suspected plagiarism will be dealt with according to the University regulations and Departmental procedures. MOSS (Measure Of Software Similarity) may be used to electronically compare assignments for the purpose of detection and prevention.
- Consideration regarding illness in assignment submission will only be provided if accompanied with the completed Departmental Medical Excuse form (available on the COSC website). Forms must be submitted within 3 working days of return from illness.
- Nov. 10th is the last day for voluntary withdrawal without academic penalty, 15% of the final grade will be available to students by Nov. 3.
- **Note that assignment 4 is due at the beginning of the winter term. Students should recognize that this may have impact on their studies in winter term.**

Lecture Schedule

Date	Topics
Sept 10, 15	Introduction, compilation, syntax & semantics, compiler organization
Sept 16, 22	Lexical analysis
Sept 23, 29, Oct 1, 6	Syntactic Analysis
Oct 8, 20[1], 22, 27, 29, Nov 3	Semantic Analysis
Nov 5, 10, 12, 17, 19, 24[2]	Code Generation

[1] Mid-term break is Oct. 12-16

[2] The final weeks are reserved for project development

Machine Learning
(COSC 4P76)

Brock University, Department of Computer Science

Instructor: Beatrice Ombuki-Berman Office:J307, x3494, office hrs: Thu.: 1:00 - 2:00 pm E-mail:bombuki@brocku.ca

Prerequisites:

COSC 3P71 (minimum 60 percent) or permission of the instructor

Course Description

This course is designed for advanced undergraduate students who have basic knowledge about artificial intelligence. The primary objective of this course is to introduce and study some basic principles, techniques, and applications of a variety of learning models. Some of the areas we will cover in this course include learning as search, concept learning, inductive inference of decision trees, artificial neural networks, genetic algorithms, bayesian learning, computational learning, and reinforcement learning. The emphasis of the course is on teaching the fundamentals, and not on providing a mastery of specific commercially available software tools or programming environments. Written and programming assignments are used to help clarify basic concepts. The student will learn research skills applicable to other fields of computer science. Each student will be expected to understand and present a selected current machine learning research paper and complete a term project.

Evaluation

- **Assignments (2) (30%)**
- **Test (15%)**
- **Seminar(20 %)**
- **Term project (25%)**
- **Participation in Class, Tutorials and Seminars (10%)**

Notes

No end of term examination is scheduled for this course.

COSC 4P76 Tentative Teaching Syllabus

• Introduction - What is machine learning? - Why machine learning? - Classification and machine learn?	• Instance based Learning - k-Nearest Neighbor - Radial basis functions - Case-based reasoning
• Concept Learning - concept space, instance space, hypothesis space, ... - inductive bias	• Decision Tree Learning - representation - ID3 - C4.5
• Ensemble Learning - Bagging, Boosting, Classifer dependency, ... - inductive bias	• Ensemble Clsssification
• Artificial Neural Nets - perceptrons - multilayer networks - backpropagation -self-organizing feature maps -evolving neural networks	• Evaluating Hypotheses
• Computational Learning - PAC learning - the VC dimension	• Bayesian Learning - Bayes Theorem - Bayes Optimal Classifier
• Reinforcement Learning - Q learnin	• Rule based learning

Brock University - COSC 4P78 - Robotics - Winter Term, 2018

Instructor: Earl Foxwell
email: efoxwell@brocku.ca
Classes: Mondays 1900-2200 in **TH241**

This course will provide an introduction to robotics, including design, control, sensors and perception, and capabilities and limitations.

Course Materials:

Reference Materials:
Introduction to AI Robotics, Robin, R. Murphy, The MIT Press, 2000
The Robotics Primer, Mataric, 2007

Evaluation:

Labs:	32%
Assignments (2):	20%
Project:	20%
Final Test:	28%

The final test will be written in-class, on March 19th.
Note: to receive a credit for the course, you must meet the following criteria:

- A final grade of at least 40% on the final test
- A final grade of at least 40% on the project
- You must miss **no more** than **one** (1) lab

Course Topics:

- Introduction
- Sensors
- Effectors and Actuators
- Navigation and Path Planning
- Control Systems
- Agents and Multiple Agents

Project:

Students will complete a project. Students are strongly encouraged to consult with the course instructor prior to beginning work on their projects. Additional details will be provided on the course website.

Additional Notes:

- Any physical submissions will only be graded if they include a signed, valid cover page stapled to the front. See the COSC home page to generate a cover page with barcode.
- Please read the department's policy on medical notes on the COSC home page. Other reasons may be used for granting extensions or other accommodations, at the instructor's discretion, but only if the instructor is contacted *in advance* of assignment due dates.
- All assignments will have a firm due date. Late dates will not be assigned, and late submissions will not be accepted.

- Electronic submission of assignments will be required, and programs will be carefully examined for plagiarism. Plagiarism is a serious offense and will be treated accordingly. See http://www.cosc.brocku.ca/about/policies/plagiarism for details.
- As part of Brock University's commitment to a respectful work and learning environment, the university will make every reasonable effort to accommodate all members of the university community with disabilities. If you require academic accommodations related to a permanent disability to participate in this course, you are encouraged to contact the Student Development Centre Services for Students with Disabilities (4th Floor Schmon Tower ext. 3240) and also to discuss these accommodations with the instructor.
- March 9th is the last day for voluntary withdrawal without academic penalty. 15% of the final grades will be available to students by March 2nd.

COSC 4P80 Artificial Neural Network: Outline

Department of Computer Science Brock University

Instructor: Beatrice M.Ombuki-Berman Office:J307, office hrs: TBAS (or appointment) E-mail:bombuki@brocku.ca Teaching Assistant: TBA E-mail:TBA

Course Description

The goal of this course is to introduce students to practical problem solving using a powerful class of AI model, artificial neural networks. We begin with a brief introduction of a loose analogy to the brain to give some idea of the parallel and distributed nature of neural networks. An overview of various neural network models will be carried out by discussing the underlying principles, model architectures, behaviours and learning algorithms. Supervised learning, single- and multilayer feed-forward networks and backpropagation and refinements; recurrent neural networks; Hopfield networks and Boltzmann machines. Unsupervised learning, competitive learning, Kohonen map and self-organizing feature maps. A range of applications will also be discussed. The student will learn research skills applicable to other fields of computer science. Each student will be expected to understand and present a selected current neural networks research paper and complete a term project.

Prerequisites:

Programming skills are assumed. Completion of COSC 3P71 Introduction to Artificial Intelligence is highly recommended. Familiarity with linear algebra, basic calculus, probability theory and statistics is expected. Where necessary, and if possible, some fundamental refreshers on some of these will be provided via tutorials.

Textbook & Assigned Reading : There will be no main text. Assigned reading will be available online and at the library's reserve reading desk. Various useful textbooks and journal articles will be used.

Evaluation

Assignments (2): 35%
Term Project: 25%
Seminars: 20%
Test: 15%
Participation: 5%

Note: Further details are found on the course web-page.

COSC 4P81 AI Programming

Optional texts:

1. *AI Application Programming* 2e, Tim Jones, Charles River Media (2005)
2. *Building Machine Learning Systems with Python*, W. Richert and L.P. Coehlo, Packt Pub, 2013.
3. Many free e-books on Prolog, Lisp, Expert systems.

Overview: This is a course in developing computer applications for AI problem solving. The course will explore different topics in AI software systems, and examine how different programming languages and paradigms can suit particular AI problem domains. Introductions to different AI languages (Prolog, Lisp, Python) will be briefly overviewed. However, the focus will be their use in AI problem solving, rather than to give comprehensive treatments of the languages.

Topics:

1. Logic programming
   - Logic programming and its roots in artificial intelligence.
   - Introduction to Prolog
   - Expert Systems and expert system shells.
   - Natural language processing.

2. Functional languages and symbolic programming
   - Introduction to LISP.
   - applications in symbolic processing

3. Python and machine learning
   - Introduction to Python.
   - Machine learning: Neural networks, Bayesian learning, kNN clustering

4. Genetic programming and Java
   - Overview of evolutionary algorithms, genetic programming.
   - Implementing a genetic programming system in ECJ and Java.

Evaluation:

- Assignments (4): 60%
- Final project: 40%

Comments:

- The project is a more comprehensive implementation involving an AI application. Students would be free to choose their topic and language. It might involve taking an assignment and significantly expanding its scope. Projects can be done in groups of 2.
- Late assignments are not accepted.

- Plagiarism detection software may be used on all submissions.

Ivo Düntsch http://www.cosc.brocku.ca/~duentsch/

Computer Science Department duentsch@brocku.ca

Brock University Ph: (+1) (905) 688 5550, ext 3090
St Catharines, Ontario, L2S 3A1 Fax: (+1) (905) 688 3255

Foundations of Reasoning under Uncertainty - 4P87

Objectives

On completion of this course you should be able to

- Demonstrate familiarity with
  - Basic issues of artifical intelligence and data modelling, including the possibilities and limits of quasi-intelligent systems,
  - Problem solving techniques,
  - Principles of probability and methods of uncertainty handling,
  - Formal foundations of knowledge representation and rule based systems.

Content

The course will cover the areas listed below; this is a tentative programme, and may be changed.

Topic 1	Data models
Topic 2	Strategies of problem solving a la Polya
Topic 3	Uncertainty and principles of probability
Topic 4	Bayesian reasoning
Topic 5	Formal systems and grammars
Topic 6	Propositional logics
Topic 7	Rough set data analysis and Knowledge structures

Course material

There will be no prescribed textbook. A full set of lecture notes will be made available.

ADMINISTRATIVE DETAILS

Lecture times and place:	Mon, Wed 12.30 - 14.00 MCA241, tentative schedule
Office hours:	By appointment
Assessment:	Two class tests (30% each) and a 30 min oral examination at the end of the course (40%) (tentative)

08/30/2015 12:47:21

Department of Computer Science
Faculty of Mathematics and Science

COSC 4P98 Topics in Computer Media and Digital Audio

Fall 2017

Instructor: *Brian Ross*
Email: *bross@brocku.ca*
Contact: *905 688 5550 ext 4284*

Lectures: Wednesday, Friday 8:00-9:30am, TH240

Course Prerequisites: three and one-half COSC credits or permission of instructor.

Description:

The course explores topics in computer media, with an emphasis on computer audio and music. Topics that may be covered include:

- Fundamentals of audio:
  - basics, sampling, signal processing
- Sound analysis:
  - Fourier series, FFT
- Audio synthesis:
  - waveform generation, granular synthesis
- Computer music and MIDI
- Music and audio programming languages:
  - CSound, Processing, Beads, Supercollider
- Commercial music and audio applications
  - VST programming
- Computer composition
- Noise and Fractals
- AI and Music
- Visualization
- Arduino, Raspberry pi, and interactive installations
- ???

I will present some fundamental topics in these areas. A portion of the course will be seminar-oriented, in which the class will have the opportunity to research and present their own selected topics.

This course will rely on **individual research** into topics of interest. You will need to make use of research resources to find information about topics for your assignments, seminar and project. This will include the Internet, the library's collection of books (paper, electronic), journals, conference proceedings, and resources elsewhere.

Seminars: The seminars are intended to give you experience in independent research, as well as presenting technical material to the class. Seminars will be 20-25 minutes in duration (including 3-5 minutes questions). Your seminar can be in any suitable topic in computer audio and media. A topic might be a research paper you discovered from a

journal or proceedings, a section or chapter from a book, or information from a web site. Please run your topic idea by me beforehand to make sure it is appropriate. A schedule of seminar topics will be maintained online. I encourage you to send me topic ideas that others might like to consider!

A web page or PDF/Powerpoint file with the details of your seminar will be required. This will be made available to the class. Seminars will be given during the final weeks of the term.

Project

- The project is in a topic in digital audio and computer media. Please have your project idea approved by me beforehand.
- The project requires an implementation and written report.
- You can work in groups of up to two on projects.
- The projects will be due at the end of the term in December.
- See the project description hand-out for details.

Term Test: A term test will be held in class near the end of the course, and before seminars begin. It will cover the lecture material.

Recommended Texts:

- *Who is Fourier? A Mathematical Adventure*, Trans. College of LEX, LRF, ISBN 0-9643594-0-8.
- Other recommended reading will be mentioned in class and listed on the web site.

Course Communications:

- http://www.cosc.brocku.ca/Offerings/4P98/
- Email communications will be sent to the course mailing list. Be sure to regularly check your Brock email for course news.

Evaluation:

- Assignments (3): 35%
- Project: 25%
- Term test: 20%
- Seminar: 15%
- Seminar participation: 5%

Late Submission Policy:

No late assignments will be accepted. Late penalty is 100%.

Relationship between attendance and grades:

As is usually the case in university courses, attendance in class correlates with a good grade in the course. If you must miss a lecture, you are expected to obtain the material and other information from the lecture from another student (not the professor!).

The participation grade is given for attending all the seminar dates in the final weeks of the course. The 5% is allocated over the dates (not including your own seminar day). Attendance will be taken during the seminars.

Important dates: (check the online University calendar for makeup days due to holidays)

Last date to withdraw without academic penalty:	Tuesday November 7, 2017
Date you will be notified of 15% of your course grade:	on or before Tuesday October 31, 2017

Academic Policies

Academic Integrity:
Academic misconduct is a serious offence. The principle of academic integrity, particularly of doing one's own work, documenting properly (including use of quotation marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students should consult Section VII, "Academic Misconduct", in the "Academic Regulations and University Polices" entry in the Undergraduate Calendar, available at http://brocku.ca/webcal to view a fuller description of prohibited actions, and the procedures and penalties.

Turnitin.com may be used on final project submissions. If you object to uploading your work to Turnitin.com for any reason, please notify me within the first 2 weeks of the term to discuss alternative submissions.

Moss (programming code plagiarism checker) may be used on assignments and projects.

Assignments are to be done individually. You are not permitted to collaborate or share code or algorithms; use and/or modify code created by others; use programs submitted for credit in other courses; or copy and/or modify code found online, even if it is advertised as open source code. Note that citing source code means it may not be plagiarized; however, you may not receive marks for the assignment or project, since it is not your own work.

Projects may be done in groups of up to two people. Group members are expected to contribute equally to course projects. Grades will be assigned accordingly.

If you find libraries that help with your assignment or project, please ask me before using them. Some libraries may not be permitted, especially if they perform the majority of the content of an assignment or project! You must cite the sources of all libraries and ideas used in your work.

Academic Accommodation Statement:

As part of Brock University's commitment to a respectful work and learning environment, the University will make every reasonable effort to accommodate all members of the university community with disabilities. If you require academic accommodations related to a documented disability to participate in this course, you are encouraged to contact Services for Students with Disabilities in the Student Development Centre (4th floor Schmon Tower, ex. 3240). You are also encouraged to discuss any accommodations with the instructor well in advance of due dates and scheduled assessments.

Academic Accommodation due to Religious Obligations:

Brock University acknowledges the pluralistic nature of the undergraduate and graduate communities such that accommodations will be made for students who, by reason of religious obligation, must miss an examination, test, assignment deadline, laboratory or other compulsory academic event. Students requesting academic accommodation on the basis of religious obligation should make a formal, written request to their instructor(s) for alternative dates and/or means of satisfying requirements.

Medical Exemption Policy:

The department's medical form can be found here: http://www.cosc.brocku.ca/forms/medical

Brock University
Department of Computer Science
COSC 5P01 – Coding Theory
Fall 2017

Instructor:

Sheridan Houghten, J313

Course Description:

This course examines concepts, problems and applications of error-correcting codes.

Textbook:

There is no required textbook for this course. We will use material from various books and other sources. The following books will be on reserve in the library:

- Introduction to the Theory of Error-Correcting Codes, Vera Pless, Wiley & Sons (several editions exist).
- Introduction to Coding Theory, Ron M. Roth, Cambridge University Press, 2006.
- Fundamentals of Error-Correcting Codes, W.Cary Huffman and Vera Pless, Cambridge University Press, 2003.

Note that a number of relevant electronic resources are also available from the library.

Mark Distribution:

- Assignments: 20%
- Class Presentation: 15%
- Exam (Oral): 30%
- Project: 35%

Tentative Outline:

- Introduction: communication, redundancy, codes, distance, encoding/decoding
- Distance metrics: Hamming, edit, insertion-deletion, etc.
- Linear codes: generator matrices, weight, syndrome decoding, sphere packing bound, dual codes, families of linear codes and their constructions.
- Non-linear codes: bounds, optimal codes, constructions to improve bounds, families and examples of non-linear codes.
- Searches for codes, including how equivalence can be used.
- Optional topics: exact topics and depth will be chosen according to student interest, but some of the following will be included: cyclic codes, BCH codes, LDPC codes, applications to bioinformatics, applications to complexity theory.

Important Dates:

- Last date for withdrawal without academic penalty: Tuesday November 7th, 2017.

Course Policies:

Illness: If you miss an assignment or other piece of work due to illness, you must submit a student medical certificate (http://www.cosc.brocku.ca/forms/medical) *within 3 days of the illness*, at the main office in the Computer Science department.

Plagiarism: The department views plagiarism as a serious issue. Students may visit http://www.cosc.brocku.ca/about/policies/plagiarism to view the department's policies on plagiarism. Plagiarism detection software may be used in this course.

Assignments:

- Assignments must be completed individually.
- Due dates for assignments will be printed on the assignment text. No late assignments will be accepted except in the case of extreme circumstances; see above course policy concerning illness.
- *Assignments must be submitted both as hard copies AND electronically.*
- Hard copies of all assignments must be submitted to the instructor in an envelope with an attached, signed cover page. To generate the cover page, visit http://www.cosc.brocku.ca/forms/cover.
- Instructions on electronic submission will be provided on the assignment text.

Class Presentations: All students will choose one advanced topic to teach to their fellow students. The student should plan to use an entire class (60-75 minutes) to teach this topic. The topic is to be chosen in consultation with the instructor. The class presentation schedule will be determined by the instructor according to topic.

Exam: The exam will cover all class material including presentations by students. It will be an oral exam to be booked on an individual basis, either on the last day of class or after classes are finished.

Project: Students will complete a project (which includes complete documentation) on an advanced topic related to coding theory. Topics must be approved by the instructor. Students must submit a written proposal to the instructor; the instructor will consider approval based on this written proposal. The project may extend the topic chosen by the student for their class presentation or may be on a different topic, as desired.

COSC 5P02
Course Outline

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 9:00am-11:00am, email: mwinter@brocku.ca

Calendar description

A thorough introduction to mathematical logic, covering the following topics: propositional and first-order logic; soundness, completeness, and compactness of first-order logic; first-order theories; undecidability and Gödel's incompleteness theorem; and an introduction to other logics such as intuitionistic and modal logics. Furthermore, the course stresses the application of logic to various areas of computer science such as computability, programming languages, program specification and verification.

Course Outline

Week	Date	Topics
1	Jan 09/11	Introduction, Propositional Logic **(no lab)**
2	Jan 16/17/18	Propositional Logic, Natural Deduction
3	Jan 23/24/25	Natural Deduction, Normal forms
4	Jan 30/31, Feb 01	First Order Logic, **(Test 1)**
5	Feb 06/07/08	First Order Logic, Natural Deduction
6	Feb 13/14/15	Natural Deduction, Intuitionistic Logic
7*	Feb 27/28, Mar 01	Decidability, Gödel's results, **(Test 2)**
8	Mar 06/07/08	Modal Logic
9	Mar 13/14/15	Modal Logic
10	Mar 20/21/22	Modal Logic, decidability, **(Test 3)**
11	Mar 27/28/29	Dynamic Logic
12	Apr 03/05	Program verification, review **(no lab)**

* February 19-February 23, 2018 is Reading Week, no classes.

Texts

- *Logic in Computer Science*, *2nd edition*, M. Huth & M. Ryan, *Cambridge University Press* (2004), ISBN 0-521-54310-X
- *Mathematical Introduction to Logic*, *2nd edition*, H.B. Enderton, *Academic Press* (2001), ISBN 0-12-238452-0
- *Logic for Mathematics and Computer Science*, S.N. Burris, *Pearson Education* (1998), ISBN 0-13-285974-2

COSC Home Page
COSC 5P02 Home Page

COSC 5P02
Course Procedures

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 9:00am-11:00am, email: mwinter@brocku.ca

Marking Scheme

Term Test 1	20%
Term Test 2	20%
Term Test 3	20%
Final Exam	40%

Important Dates

Term Test 1 (30 min): January 31, 2018 (in lab)

Term Test 2 (30 min): February 28, 2018 (in lab)

Term Test 3 (30 min): March 21, 2018 (in lab)

Final exam (oral, 45 min): Wednesday, April 11, 2018, schedule tba

Notes

- A mark of at least 40% on the final exam is required to achieve a passing grade in this course.
- Consideration regarding illness for assignment submission or test dates will **only** be considered if accompanied with the completed Departmental Medical Excuse form.

COSC Home Page
COSC 5P02 Home Page

Universal Algebra COSC 5P03

Ivo Düntsch

Course outline

As the name suggests, Universal Algebra is concerned with the properties of general algebraic systems. According to Whitehead's description which he coined in the late 19^{th} century,

> "Universal Algebra is the name applied to that calculus which symbolizes general operations, defined later, which are called Addition and Multiplication. There are certain general definitions which hold for any process of addition and others which hold for any process of multiplication. These are the general principles of any branch of Universal Algebra."

Constructs of Universal Algebra are at the basis of many areas of Computer Science, among which are Formal Methods, Type Theory, Specification, Complexity Theory, Computer algebra, Uncertainty Management and many more. Its equational formalisms are well suited for automated reasoning, and in the spirit and letter of the ACM's view that "The discipline of computing is the systematic study of algorithmic processing that describe and transform information"(2).

In this course, we will study the concepts and constructs of Universal Algebra, such as products, subalgebras, homomorphic images and congruences, term algebras, free algebras, its connections with Logic and Model Theory, decidability issues, lattices and relation algebras, and applications in Computer Science.

As a basic textbook we will use Burris' and Sankappanavar's "A Course in Universal Algebra" (1), which is available for download at

http://www.math.uwaterloo.ca/~snburris/htdocs/ualg.html.

This will be supplemented by further reading in special topics. As a teaching aid we may use the , Universal Algebra Calculator by R. Freese and E. Kiss.

Parallel Computation: Models and Algorithms
COSC 5P04, Winter 2014

Each student is to give a lecture and to do a project.

Lectures:

Each lecture is roughly 1 hour and 20 minutes long (with some flexibility). The objective is to present a topic lecture style so that the audiences have a good understanding of the materials presented. It is important to select a proper topic so that people can actually understand the presentation. To this end, it is better not to be too ambitious. Each lecture should be similar to what we do in each class. You can use slides if you so prefer. Please provide students with notes/slides before your lecture. The lectures take place in the last two to three weeks of the term.

Projects:

Each student is required to do a project and present your project which will take place at the end of the term or later. Each presentation will take roughly 45 minutes (35 minutes presentation plus a 10 minute question period). This will give you an opportunity to familiarize yourself with important stages in your research. A project report is also required. Your work can be one of the following:

(a) Do a major critical literature survey on one particular subject.
(b) Find a suitable problem and design your own parallel algorithm(s) to solve the problem.
(c) Others (please let me know beforehand).
Of course, (b) requires that you find and read one or more (major) paper first, namely, the (a) part. Ideally, original research, namely (b) is preferred. It is even better if you could combine your project with your MSc. research. For example, if you are doing string algorithms for some bioinformatics problems, it would be a good idea to consider topics related to parallel string algorithms. This could be a survey type of work or better yet, work that either improves previous results or a completely new work no one has done (e.g. parallelizing some sequential algorithm, or a parallel algorithm on a model no one has considered before).

Please discuss your project idea with me once you have decided on what to do for your project and before you actually start.

Your report should be similar to a journal or conference paper consisting of the following: title, abstract, literature review, main results, conclusion, and bibliography.

Potential Topics

1. Algorithms:

Parallel algorithms can be considered for all problems (sorting and searching, graph problems, string problems, optimization problems, problems in bioinformatics, numerical analysis, various data communication algorithms such as broadcasting, gossiping, generating combinatorial objects in parallel, number theoretic problems, etc.). You can also consider designing an algorithm to solve a problem and then implementing your algorithm on some parallel machines/systems, e.g. SHARCNET.

2. Properties of graphs/interconnection networks

Journals and Conferences:

Here is a list of important journals and conferences on parallel computing in general. You may also find papers from the reference section of parallel computation books. The list is by no means complete. There are **numerous** other journals and conferences that are either exclusively devoted to parallel processing or contain parallel processing content. You are free to find your papers from other sources (simply do an internet search)

Journals:

Journal of Parallel and Distributed Computing
Parallel Computing
IEEE Trans. on Parallel and Distributed Systems
IEEE Trans. on Computers
Information Processing Letters
Parallel Processing Letters
Journal of Interconnection Networks
Journal of Supercomputing
Networks
.....
To find a proper lecture/project topic, one possible way is to go to these journals' websites and check the current and past issues and see which subject interests you. Then download the articles. The reference sections of these papers should lead you to more papers on the subject. In addition, once you know the general area of your topic, do a search (e.g. Google Scholar) to get papers.

Conferences:

International Conference on Parallel Processing (ICPP)
ACM Symposium on Parallelism in Algorithms and Architectures (SPAA)
International Parallel and Distributed Processing Symposium (IPDPS)
International Symposium on Parallel Architectures, Algorithms, and Networks (I-SPAN)
International Conference on Parallel and Distributed Systems (ICPADS)
……

COSC 5P05
Course Outline

Instructor: Michael Winter, Office J323, Office J323, Office Hours: Tue 1:00pm-3:00pm & Wed, 9:00am - 11:00am, email: mwinter@brocku.ca

Calendar description

Introduction to typed and untyped lambda calculi and their semantics. Syntax of the lambda calculus, conversion, fixed points, reduction, Church-Rosser theorem, representation of recursive functions, lambda models. Category theory, cartesian closed categories and categorical models of lambda calculus.

Course Outline

Week	Date	Topics
1	Jan 06/08	Introduction, Simply typed λ-calculus with explicit pairs
2	Jan 13/15	Simply typed λ-calculus with explicit pairs, Confluence (Church-Rosser)
3	Jan 20/22	Categories, Morphisms
4	Jan 27/29	Constructions, Cartesian closed categories **(Test 1)**
5	Feb 03/05	Constructions, Functors and Adjunctions
6	Feb 10/12	Categorical semantics of the simply typed λ-calculus
7*	Feb 24/26	Variant types and recursion
8	Mar 03/05	Untyped λ-calculus **(Test 2)**
9	Mar 10/12	Recursive Domain Equations
10	Mar 17/19	Recursive Domain Equations (continued)
11	Mar 24/26	Algebras, primitive recursion and catamorphisms **(Test 3)**
12	Mar 31/Apr 02	Second order λ-calculus, Review

* Feb 16-20 is Reading Week, no classes.

Texts

- The main text book: *Categories, Types, and Structures*
- Additional Material on the lambda calculus: *Lambda Calculus*
- H. Barendregt: *Lambda Calculi with Types*

COSC Home Page
COSC 5P05 Home Page

COSC 5P05
Course Procedures

Instructor: Michael Winter, Office J323, Office Hours: Tue 1:00pm-3:00pm & Wed, 9:00am - 11:00am, email: mwinter@brocku.ca

Marking Scheme

Term Test 1	20%
Term Test 2	20%
Term Test 3	20%
Final Exam	40%

Important Dates

Term Test 1 (30 min): January 29, 2015 (in class)

Term Test 2 (30 min): March 05, 2015 (in class)

Term Test 3 (30 min): March 26, 2015 (in class)

Final exam (oral, 45 min): Wednesday, April 08, 2015, Schedule tba

Notes

- A mark of at least 40% on the final exam is required to achieve a passing grade in this course.
- Consideration regarding illness for assignment submission or test dates will **only** be considered if accompanied with the completed Departmental Medical Excuse form.

COSC Home Page
COSC 5P05 Home Page

COSC 5P71 – Genetic Programming

Instructor: Brian Ross
bross@brocku.ca
http://www.cosc.brocku.ca/Offerings/5P71/

Office: J319
Phone: 688-5550 ext. 4284

Objective: An introduction to genetic programming: evolutionary computation, principles, methodology, technologies, and applications.

Text: *A Field Guide to Genetic Programming* by R. Poli, W.B. Langdon, N. F. McPhee. ISBN 978-1-4092-0073-4. 2008.

- Download free PDF here: http://www.gp-field-guide.org.uk/

Reading: Assigned reading will be available online and at the library reserve reading desk. Many useful references are currently available at the reserve reading desk.

Evaluation:		
	Assignments (2):	30%
	Project:	40%
	Term test:	15%
	Seminar:	15%

Assignments: The assignments will give you practical experience in applying evolutionary techniques in problem solving. Assignments will require you to use an existing genetic programming package. Details about assignment requirements will be given with the first assignment handout.

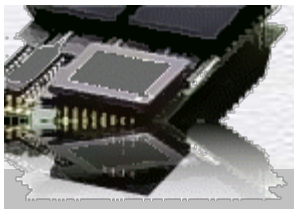
Late assignments: No lates accepted.

Seminars: Students will present a seminar on a topic in genetic programming. Although you can decide on your own topic, you should run it by me first. A list of broad topic areas is available online. When you have chosen a topic, please let me know, and give me any related papers you will be discussing. I will make it available to the class, preferably 1 week prior to your scheduled seminar.

Project: Please see the project handout for details. It will be due at the end of term (date TBA).

Other comments:

- All assignments must include a department cover page.
- Please be familiar with the department and university policies on plagiarism.
- Please read the department's policy on medical notes, found on the web.



Brock University
Department of Computer Science

COSC 5P73: Computer Vision

Winter 2017 Instructor: **Vlad Wojcik**

Assignments: 1 2 +Project

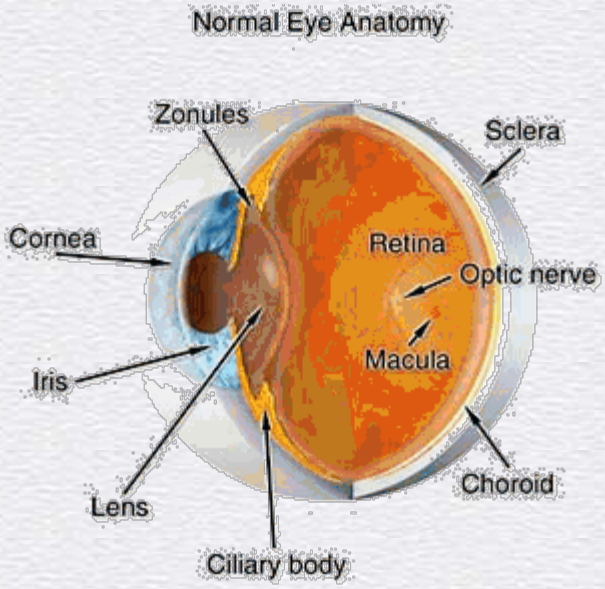
GOALS:

A branch of **Machine Learning**, Computer Vision aims at equipping computers with animal skills of vision, i.e. the ability to interpret perceived images in term of objects and their spatial and temporal relationships. This is a tall order, as full operational details of the animalian visual cortex remain poorly understood. Vigorous research continues in both directions.

Does it all seem like we are trying to teach a computer something we do not know well ourselves? You are right. Worse still: We already know that your **brain** can see things your eyes can't. Unbelievable? **Check this out**! Now, get this: overrules what your eyes see ... Check this **girl** out: Does she stand on her left or right leg? How does she rotate? Left or right? Are you sure ??

Sometimes the damage to a part of **visual cortex** leads to total or partial blindness; at other times some cognitive disorders emerge. Go figure!

COURSE TOPICS COVERED:



- **Basic optics**(a quick and dirty review)
- **Image formation and image models**
  Issues: Cameras, camera models, camera calibration, radiometry, light sources, shadows, shadings, colour.
- **Early vision: Just one image**
  Issues: Linear filters, edge detection, texture.
- **Early vision: Multiple images**
  Issues: Geometry of multiple views, stereopsis, affine and projective structures from motion.
- **Mid-level vision**
  Issues: Segmentation by clustering, by fitting a model. Segmentation and fitting using probabilistic methods. Tracking with linear dynamic models.
- **High-level vision: Geometric methods**
  Issues: Model-based vision, smooth surfaces and their outlines, aspect graphs,

range data.

- **High-level vision: Probabilistic and inferential methods**
  Issues: Finding templates using classifiers, recognition by relations between templates, geometric templates from spatial relations.

- **Applications**
  Issues: Searching image libraries, image-based rendering, etc.

RECOMMENDED READING:

- D.A. Forsyth, J. Ponce: **Computer Vision: A Modern Approach**, 2nd ed., Prentice-Hall 2003, ISBN 9780136085928.
- R.O. Duda, P.E. Hart, D.G. Stork: **Pattern Classification**, 2nd ed., J. Wiley & Sons 2001, ISBN 0-471-05669-3.

MORE READING:

1. **Mammalian Sensory Systems**.
2. **Cameras**.
3. **Colour**.
4. **Image Alignment (i.e. Registration)**.
5. **Issues in Scene / Image Segmentation**.
6. **The Hyperball Concept** plus **FAQ**.
7. **Audio Pattern Recognition and Learning**.
8. **Visual Pattern Recognition and Learning**.
9. **Computer Vision On-Line**: The Evolving, Distributed, Non-Proprietary Compendium.
10. **Computer Vision Handbook.**
11. D.H. Ballard, C.M. Brown: **Computer Vision.**
12. Intel Corp.: Open Source **Computer Vision Library**.
13. Partial list of **Computer Vision Industry**.
14. V. Wojcik, **Recursive Problem of Calibration of Expert Systems,** January 1998.
15. V. Wojcik, **The Structure of the Brain and of the Adaptive Computer Architectures,** January 1998.

MARKING SCHEME:

- Two assignments @ 15% each
- One mid-term test @ 30%
- One two-person project @ 40%

NOTES:

In case a given mark is perceived unjust or unclear by a student, s/he is encouraged to see the instructor to discuss the issue. Depending on the case s/he is able to make, a mark can be modified. The deadline to contact the instructor on these matters is one week after the mark has been issued. Marks not disputed within this period will be considered final.

PENALTIES:

Possible lateness in assignment submission is counted in days, each period of a day ending at 4 PM. The penalty for late submission of assignments is 25% up to three days (or a part of a day). After that period the penalty is 100%.

While honest cooperation between students is considered appropriate, the Department considers **plagiarism** a serious offense. For clarification on these issues you are directed to the statement of **Departmental Policies and Procedures**.

Instructor: Vlad Wojcik
Revised: Friday, 10-Feb-2017 11:05 PM

COSC 5P74 Evolutionary Computation

Department of Computer Science Brock University

Instructor: B.M.Ombuki-Berman Office:J307, office hrs: TBA E-mail:bombuki@brocku.ca

Objectives

To provide a broad introduction to the field of evolutionary algorithms (EAs) from both theoretical and application viewpoint. This includes genetic algorithms, evolutionary strategies, genetic programming, problem representation, genetic operations, overall control, theory of EAs and various examples of important applications. Includes related bio-inspired sub-areas such as swarm intelligence, evolutionary robotics and evolving neural networks. To teach and show students how these paradigms exploit biological processes in nature to solve problems from various application domains. The course is suitable for students preparing for research in evolutionary computation, as well as other students who want to apply evolutionary computation techniques (and related areas) to solve problems in their fields of study. Comparisons with other meta-heuristics are included depending on the application domain.

Assigned Reading:

There will be no main text. Assigned reading will be available online and at the library's reserve reading desk. Various useful textbooks and journal articles will be used.

Evaluation

Assignments (2-3): 30%
Term Project: 30%
Seminars: 20%
Test: 20%

Assignments:

The assignments are meant to augment the topics covered in class by providing you will practical applications of evolutionary computation strategies. All assignments are implementation based and hand-in will include a sciencific report based on the IEEE format. Unless otherwise stated by the instructor: all assignments must be done entirely on your own.

Late Submission Policy

No lates are accepted, except for medical reasons with valid medical report is submitted according to departmental policy.

Project:

The format and details of the end of term project are provided in class.

Seminars:

Each student will present a seminar on topics in evolutionary computation and related areas such as swarm intelligence and evolving neural networks. A list of suggested topics will be available, but you may choose a topic not on this list. As soon as you have chosen your topic, please let me know so that I announce it to the rest of the class. Furthermore, provide me with a copy of the paper you will be discussing a week prior to your seminar date so that I can avail to the rest of the class. Further details on seminars will be discussed in class.

Lecture Notes

Copies of some the lecture material will be available to you. However, not all the lectures will have electronic notes hence the students should be ready to take notes insides the lecture at any required time.

Further Comments

- All assignments and project must include a department cover page and should be submitted to me at the beginning of class.

- Please familiarize yourself on the department' policy on medical notes, found on the web.

- You also should be familiar with the department and university policies on plagiarism. Students are responsible for informing themselves about those standards before undertaking any academic work. Ignorance is not an acceptable defense and the penalties for academic dishonesty are severe.

- A variety of materials and announcements will be made available on the Class Home-page at http://www.cosc.brocku.ca/Offerings/5P74/. You are responsible for informing yourself on whatever information is posted there.

Ivo Düntsch

http://www.cosc.brocku.ca/~duentsch/

Computer Science Department

duentsch@brocku.ca

Brock University
St Catharines, Ontario, L2S 3A1

Ph: (+1) (905) 688 5550, ext 3090
Fax: (+1) (905) 688 3255

COSC 5P76 Winter 2015/16

Non-invasive data analysis

Objectives

On completion of this course a student should, among others,

- Know and explain various approaches to data modelling,
- Know and explain the difference between risk and uncertainty.
- Know and explain the basic difference between quantitative and qualitative data analysis,
- Know, explain, and give examples for the basic constructs of rough set data analysis (RSDA) such as equivalence relations, information systems, rules, reducts, etc.,
- Find and interpret the approximation quality of a set of attributes with respect to a decision attribute,
- Be able to give a seminar on a research topic in the course area.
- Additional material to be announced.

Course material

Main text: Rough set data analysis: A road to non-invasive knowledge discovery Study material will be made available on the resource page.

Administrative details

Lecture times and place:	Mon, Wed 13.30 - 14.00 ST105

Office hours:	By appointment.
Assessment:	To be determined.
Lecture Plan:	Tentative schedule

01/03/2016 10:38:51

COSC 5V90
Course Outline

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 9:00am - 11:00am, email: mwinter@brocku.ca

Course description

Introduction to the dependently typed functional programming language of Coq as well as its formal language for mathematical definitions and theorems. Introduction to higher-order logic, interactive theorem proving. Development of verified software using the Coq system.

Course Outline

Week	Date	Topics
1	Jan 09/11	Introduction, Principle of functional programming and interactive theorem proving
2	Jan 16/18	Functions as proofs, Proofs as functions
3	Jan 23/25	Coq basics
4	Jan 30, Feb 01	Programming in Coq I
5	Feb 06/08	Programming in Coq II, ~~**(Test 1)**~~
6	Feb 13/15	Verification of functional programs in Coq I, **(Test 1)**
7*	Feb 27, Mar 01	Verification of functional programs in Coq II
8	Mar 06/08	Verification of functional programs in Coq III
9	Mar 13/15	Algebraic theories in Coq I, **(Test 2)**
10	Mar 20/22	Algebraic theories in Coq II
11	Mar 27/29	Algebraic theories in Coq III
12	Apr 03/05	Further features of Coq, Review

* February 19-February 23, 2018 is Reading Week, no classes.

COSC Home Page
COSC 5V90 Home Page

COSC 5V90
Course Procedures

Instructor: Michael Winter, Office J323, Office Hours: Mon & Fri, 9:00am - 11:00am, email: mwinter@brocku.ca

Marking Scheme

Term Test 1	30%
Term Test 2	30%
Final Exam	40%

Important Dates

Term Test 1 (60 min): ~~February 08, 2018~~ February 13, 2018

Term Test 2 (60 min): March 15, 2018

Final exam (90 min): Tuesday, April 10, 2018, schedule tba

Notes

- A mark of at least 40% on the final exam is required to achieve a passing grade in this course.
- Consideration regarding illness for assignment submission or test dates will **only** be considered if accompanied with the completed Departmental Medical Excuse form.

COSC Home Page
COSC 5V90 Home Page

COURSE: Math/Phys 4P09/5P09 Solitons and Nonlinear Wave Equations

Time: T Fr 2-3:30pm TBA
Instructor: Prof. Stephen Anco
Office: J423 x3728 office hours by appointment

Recommended Reading: Drazin and Johnson, *Solitons: an introduction*

Webpage: lie.math.brocku.ca/∼sanco/solitons/index.php

Grading:
Homework (weekly) 40%
Midterm Quiz 15%
Seminar participation 15%
Final Exam OR Project and Presentation 30%

TOPICS:
Solitons and their properties.

1. Linear and nonlinear waves. Historical background on solitons. (Chapter 1)

2. Korteweg de Vries equation and other soliton equations. Traveling wave solutions. (Chapter 2)

3. Backlund transformations and nonlinear superposition. (Chapter 5)

4. Lax pairs and inverse scattering. (Chapter 5 and 6)

5. Zero curvature representation and the dressing method.

6. Conservation laws of soliton equations. (Chapter 5)

7. Hamiltonian formulation of wave equations. Bi-Hamiltonian structure of soliton equations.

8. Lagrangians and symmetries.

Lectures are based on the course notes provided in pdf format. You are responsible to:
(i) bring a printed copy of the notes with you to each lecture;
(ii) participate in the seminar discussion of the material in the notes during each lecture;
(iii) review this material yourself after each lecture.

You may discuss homework problems together but all of the solutions you submit must be your own work.

Late homework or missed midterm will be accepted only if you get approval prior to the due date.

MATHEMATICS 5P10 (Winter 2018)
Modern Algebra

Professor:	Dr. Yuanlin Li Room MC J422 Email: yli@brocku.ca Home Page: http://spartan.ac.brocku.ca/ ∼ yli/5P10/5p10f15.html
Lectures:	TR: 9:30 -11:00 am (J409)
Office Hours:	TR: 11:00 - 11:50 am or by appointment
Textbooks:	1. *An Introduction to the Theory of Groups*, 4th edition, by Joseph J. Rotman, Springer-Verlag, New York, Inc. 1995 (**corrected second printing 1999**) 2. *Algebra*, first edition, by Thomas W. Hungerford, Springer-Verlag, New York, Inc. 1974 3. *An Introduction to Group Rings*, first edition, by Cesar Polcino Milies and Sudarshan K. Sehgal, Kluwer Academic Publishers, Dordrecht, 2002
Prerequisite:	MATH 3P13
Marking Scheme:	Three Assignments: 40% Midterm Exam: 30% Course Project (regarded as the final exam): 30%
Course Content:	This course covers some basic topics (groups, rings, modules and group rings) in algebra. The details are as follows: 1. Topics in Groups: Groups and Homomorphisms, The Isomorphism Theorems, Symmetric Groups and G-sets, The Sylow Theorems, Subnormal and Normal Series, Solvable and Nilpotent groups, *Free groups. (Chapters 1-6 in Rotman's book) 2. Ring Theory: Rings and Homomorphisms, Ideals, Factorization in Commutative Rings, Rings of Quotients and Localization, Rings of Polynomials and Formal Power series. (Chapter 3 in Hungerford's book) 3. Modules: Modules, Homs and Exact Sequences, Free Modules and Vector Spaces, Projective and Injective Modules, Tensor Products, Modules over PID. (Chapter 4 in Hungerford's book) 4. Introduction to group rings. (Chapter 3 in Polcino Milies and Sehgal's book)

Course Project: This project will help you develop your research abilities. Students are expected to work on your own. Several topics will be given, and each student will choose a topic from the given list. No two individuals should choose the same topic. In order to complete the project, you will need to study reference books related to your chosen topic. Research papers and books can be found from the library, through an inter-library loan, through an internet search, or by using academic databases such as "mathscinet". More detailed instructions will be given in class. An outline of your project is due on Feb. 2, a draft copy (optional) is due on Mar. 23, and the final copy is due on Mar. 30. Each student will also be expected to give a presentation of its project. Your marks for the project will be based on both your final copy and your presentation.

Exams and Assignments:

Exam	Date	Mark
Midterm	Thursday, March. 8	30%
AS #	Due Date	Mark
1	Friday, Jan. 26	12%
2	Friday, Feb. 16	14%
3	Friday, Mar. 16	14%
Project	Due Date	Mark
Outline	Feb. 2	2%
Draft Copy	Mar. 23	optional
Final Copy	Mar. 30	20%
Presentation	Last week	8%

Notes:

(1) The Midterm exam will be 60 minutes long and held during the regular lecture time. There is no final exam and your research project will be regarded as the final exam.

(2) **This course also emphasizes good mathematical writing. Students will be expected to write their solutions to assignments using a very readable and logical mathematical style**. The assignments are due at 4 pm on the due dates. **No late assignments will be accepted**. The solution to each homework will be posted after the due date. Please attach a cover page to your assignment. This should bear (at the top) **your name, student number, course number and assignment number**. A sample cover page can be found in the **Course Home Page**.

(3) **Reading Week:** Feb. 19-23 (no classes).

MATHEMATICS 5P11 (Winter 2010)

An Introduction to Group Rings

Professor:	Dr. Yuanlin Li Room MC J422 Email: yli@brocku.ca Home Page: http://spartan.ac.brocku.ca/ ∼ yli/5P11/5p11w10.html
Classes:	Thursday: 1:00 - 4:00 pm (H313)
Office Hours:	Thursday 12:30 - 1:50; or by appointment
Textbook:	*An Introduction to Group Rings*, by C Polcino Milies and S. K. Sehgal, Kluwer Academic Publishers, Dordrecht, 2002
Marking Scheme:	Your final grade will be assigned based on the following: In class Presentations. Course Project or Report.
Course Content:	This course covers several fundamental topics in group rings and the details are listed below. Group rings and their unit groups; Augmentation and other ideals; Algebraic elements; Several important types of units; Isomorphism problem; Free groups of units, Integral group rings and group algebras.

Math 5P20: Computational Methods for Algebraic and Differential Systems

COURSE OBJECTIVES

The course covers the algebraic back ground and computer algebra applications of solving systems of polynomial algebraic and differential equations.

COURSE CONTENT

1. **Gröbner Bases**
   Monomials, polynomials, affine space, zero functions, affine varieties, parametrizations of affine varieties, ideals, GCD of polynomials and their properties, Euclidean algorithm, monomial orderings, standard orderings, leading monomials, division algorithm, monomial ideals, Dickson's Lemma, Hilbert Basis Theorem, ideal of leading terms, Gröbner bases, S-polynomials, Buchberger's Algorithm, special ideals, primary decompositions, properties of Gröbner bases, ideal quotients, syzygies, modules, implicitization of parametrically described varieties, minimal and reduce Gröbner basis, Gröbner bases in Singular and Maple, improving efficiency.

2. **Length Reduction of Systems of Equations**
   motivation, algorithm, vanishing multipliers, possibilities for speedup the order of pairings of equations, beneficial side effects

3. **Differential Gröbner Bases**
   derivative terms, differential rings, differential ideals, orderings on differential polynomials, differential Gröbner bases definition / theory / properties, S-polynomials, linear systems, Kolchin-Ritt Algorithm, GAC algorithm, DIFFGBASIS algorithm.

4. **Integration of Exact Differential Equations**
   motivation, the algorithm, non-integrability tests, termination, constants and functions of integration, a generalization,

5. **Combining the Computation of Gröbner bases with Integrations**
   conservation laws of SYZYGIES, integrations based on SYZYGIES, comparison with integrating exact DE, integrations based on curls of SYZYGIES, problems with redundancy and usefulness

TEXTBOOKS:
- David Cox, John Little Donal O'Shea: Ideals, Varieties, and Algorithms, Springer, 3rd Edition (if available, as the 2nd is full of typos).
- Gert-Martin Greuel, Gerhard Pfister: A Singular Introduction to Commutative Algebra, ISBN: 3540428976 Springer.
- Keith O. Geddes, Stephen R. Czapor, George Labahn. Algorithms for Computer Algebra. (October 1992) Kluwer Academic Pub; ISBN: 0-7923-9259-0
- T. Becker, V. Weispfennig: Gröbner Bases. A Combinatorial Approach to Commutative Algebra. Springer, New York, 1993.
- Teo Mora, Solving Polynomial Equation Systems I, Cambridge Univ Press, Brock library: QA 218 M64 2005
- Teo Mora, Solving Polynomial Equation Systems II, Cambridge Univ Press, Brock library: QA 218 M64 2005

LECTURES: Lectures: Mon 8:00 - 11:00 in room MC J409A

INSTRUCTOR: Prof. Thomas Wolf, office J413, Ext 3803, email: `twolf@brocku.ca`,
office hours: any time, e.g. Wed and Thu 1pm - 3pm.

GRADING: Assignments: 60%, 2 Term Tests each: 20%, Assignments handed in late will loose marks at a rate of 10% per day if the reason for delay was not discussed with the course organizer before. Submission of identical assignments will result in 0 marks for everyone involved. *It is a Brock regulation that the pass mark for an MSc course is 70% which applies to this course!*

NOTES: Teaching material will be provided through the web page
`http://lie.math.brocku.ca/twolf/htdocs/5P20/`
with user name: 5P20 and password: Groebner . Please send me an email from your most frequently read email account, so that I can add it to the course email list and email you about new material to download. Also, please let me know if the lecture time is ok with you or whether you need to move it.

Parallel Processing Architectures
CIS*6100 (W10)

High-Performance Computing
MCSC 6030G (W10)

High-Performance Computing
MATH 5P21 (W10)

Course Outline

General Information

Regular classes: January 11, 2010 to April 9, 2010
Final Exam: N/A

Instructors :	Deborah Stacey, School of Computer Science, University of Guelph [REYN 222 | x52250 | e-mail: dastacey@uoguelph.ca] David McCaughan, SHARCNET [REYN 210 | x56467 | e-mail: dbm@sharcnet.ca] William Gardner, School of Computer Science, University of Guelph [REYN 105 | x52696 | e-mail: wgardner@uoguelph.ca]	Luciano Buono, Faculty of Science, UOIT [(905) 721-3111 x2938 | e-mail: Pietro-Luciano.Buono@uoit.ca] Thomas Wolf, Dept. of Mathematics, Brock University [Math J413 | x3803 | e-mail: twolf@brocku.ca]
Advising :	by appointment (or see one of us after class)	
Lectures :	F 0900--1200 UoG: REYN 312 | UOIT: UA 4080 | Brock: MCF 313	
Discussion Forum :	UoG CIS Moodle Server	
Web Page :	http://www.usrlocal.ca/~dbm/teaching/CIS6100/	

Overview

This course is intended to provide current or prospective SHARCNET researchers from all disciplines with an opportunity to explore issues of parallel design and programming at considerably more depth than can be offered in a workshop style setting. Since courses such as this represent the front lines in training the next generation of HPC

specialists, we also strive to consider cutting edge and non-traditional parallel architectures to maximize the breadth of experience offered to the student. Although designed with SHARCNET users in mind, any student wih an adequate computational background is welcome to enroll.

Students entering this course are expected to have a good grasp of basic procedural programming in a language such as C or FORTRAN. A comfort level with C is particularly desirable as FORTRAN is not well supported in the emerging technologies (whereas C++ is becoming increasingly common) and the option to use the FORTRAN language may not always be available. This will serve as the base upon which we construct a working knowledge of parallel computing models as well as theoretical issues related to efficient parallel program design and implementation in both cluster and shared memory environments. Program development will be explored on local development clusters using the Message Passing Interface (MPI), POSIX threads, and other programming models germane to topics under consideration (Pilot, GP-GPU, Cell API, UPC, etc.).

The course will cover the following topics:

- Parallel computing architectures
- New programming models: Pilot parallel framework
- Parallel programming with MPI
- Thread-based parallelism
- New architectures: GP-GPU programming
- Design and performance analysis of parallel software
- Special topics (parallel complexity theory, MPI-2, etc.)

Evaluation

- Assignments : 60% (4 x 15%)
- Course Project: : 40%

Required Text

Barry Wilkinson and Michael Allen. *Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers (2e)*. Prentice Hall, 2005 (ISBN 0-13-140563-2).

Suggested References

William Gropp, Ewing Lusk and Anthony Skjellum. *Using MPI: Portable Parallel Programming with the Message-Passing Interface (2e)*. MIT Press, 1999.

Peter S. Pacheco. *Parallel Programming with MPI*. Morgan Kaufmann, 1997.

Bradford Nichols, Dick Buttlar, Jacqueline Proulx Farrell. *PThreads Programming: A POSIX Standard for Better Multiprocessing*. O'Reilly, 1996.

Raymond Greenlaw, H. James Hoover and Walter L. Ruzzo. *Limits to Parallel Computation: P-Completeness Theory*. Oxford Press, 1995.

Last Modified: 2010 / 10 / 07

Course Information

Math 5P30 Dynamical Systems Fall 2018

Instructor: Prof. Henryk Fukś (MCJ407)
Lectures: M W 9.30-11.00 MCJ404
Web site: Isaak/Sakai
Office hours: T 12.00-13.00, W 11.00-12.00

The goal of this course is to reach central results of both local and global theory of dynamical systems, as well as some results of bifurcation theory. Application will be stressed as much as possible.
Specific topics to be covered:
Introduction to dynamical systems. Top-down approach to mathematical modeling. Differential equations: flows, linearization, Hartman-Grobman theorem, central manifold theory, periodic orbits, limit sets, Poincare-Bendixson theory, local bifurcations of vector fields, influence of diffusion, introduction to spatial system.
Some additional topics may be covered depending on interests and background of participants.

Marking scheme:

- Four assignments, worth 12% each. 48%
- In-class midterm test, October 17 20%
- Final exam (take home) 32%

Text:

Perko, *Differential equations and Dynamical Systems*, Springer Verlag.
This text will be supplemented with lecture notes and handout.

Notes:

- All students are required to become familiar with Brock's Academic Integrity Policy available at Brock's web page
- The date for withdrawal without academic penalty is November 6, 2018. You will receive marks from the first two assignment before this date.
- Late assignments will normally not be accepted (except for documented medical reasons)

Course Information

Math 5P31 Ergodicity, Entropy and Chaos, Fall 2017

Instructor: Prof. Henryk Fukś (MCJ407, office hours M 13.00-14.00, Th 10.00-11.00)
Textbook: *Computational Ergodic Theory* by Geon Ho Choe.

Lectures: T Th 15.30-17.00 TH246
Lab/Tutorial: T 1000-1100 MCJ430

Topics: Introduction to ergodic theory, invariant measures, Birkhoff ergodic theorem. The first return formula, Kac's lemma, recurrence theorems. Entropy, coding maps, Shannon-McMillian Breiman theorem. Chaos, predictability, Lyapunov exponent, speed of divergence, Pesin theorem. Ergodicity, entropy and chaos in shift dynamical systems and cellular automata.

Marking scheme:

- Four assignments, worth 8% each. 32%
- Midterm test (October 24) 28%
- Final examination (take home) 40%

Note: you must obtain at least 30% on the final examination in order to pass the course.

Assignments will include computer algebra component. You will have access to Maple computer algebra system in your lab/tutorial.
Assignments are due on the following dates: September 22, October 20, November 10, December 1. Drop your assignment in the box across J434 , but *not later than on 12pm on the due date*.

IMPORTANT:

- All students are required to become familiar with Brock's Academic Integrity Policy available at Brock's web page
- The date for withdrawal without academic penalty is November 7, 2017. You will receive marks from the first two assignments and the midterm test before this date.
- Late assignments will not be accepted (except for documented medical reasons)

Course Information

MATH 5P35 - Graph Theory

Instructor

Babak Farzad (bäbăk fărzäd)
Office: MC J-424
Phone: (905) 688-5550 ext. 3145
e-mail: bfarzad@brocku.ca

Lectures

Mon, Wed 11:00 - 12:30 MC J-409

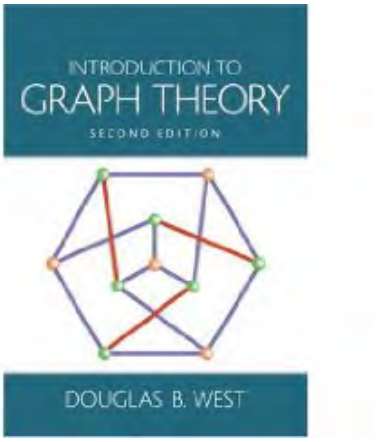
Office hours

Mon, Wed, Thu 14:10 - 15:00

You can also e-mail me to meet at a different time.

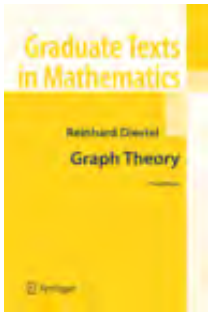
References and Textbooks

The official text for the course is
"Introduction to Graph Theory, 2/e", by Douglas B. West, Prentice Hall 2001.

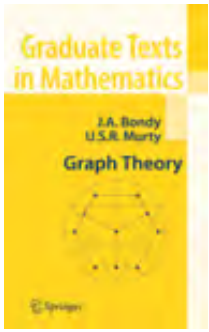


However, most of the content of the course can be found in any standard graph theory text (some notations might be different) including the following two:

"Graph Theory (Graduate Texts in Mathematics), 3/e", by Reinhard Diestel, Springer, 2006.
There is a free, searchable, and hyperlinked electronic edition, which may be downloaded for offline use.



"Graph Theory (Graduate Texts in Mathematics)", by J.A. Bondy and U.S.R Murty, Springer, 2008.



Grading Scheme

5 Assignments: 15% each
1 Project: 30%

Yes, I know 5 * 15 + 30 = 105

Assignments

Assignments are due by the beginning of the class on their due date. Solutions must be written clearly and neatly. An important aspect of the course is the clear presentation of solutions, which involves careful writing. You are encouraged to use LaTeX to write up your solutions. In particular. the last two assignments must be typed in LaTeX. Students can discuss assignment problems. Students should then write up clear and complete solutions on their own.

MATH 5P36 – Algorithmic Game Theory

Texts:
Algorithmic Game Theory by N. Nisan, T. Roughgarden, E. Tardos, and V. Vazirani
http://www.cambridge.org/journals/nisan/downloads/Nisan_Non-printable.pdf

Networks, Crowds and Markets by D. Easley and J. Kleinberg
http://www.cs.cornell.edu/home/kleinber/networks-book/

Multiagent Systems: Algorithmic, Game Theoretic and Logical Foundations by Y. Shoham and K. Leyton-Brown
http://www.masfoundations.org/download.html

Course grades:
assignments (30%)
presentations (40%)
project (30%)

Core Topics

- Introduction
  Nisan et al., Sections 1.1.1-1.3.5.
  Easley and Kleinberg, Chapter 6.

- Social Choice Theory: Arrow's Impossibility Theorem,
  The Gibbard-Satterthwaithe Theorem, Characterisation via Independence of Irrelevant Alternatives.
  Nisan et al., Sections 9.1-9.2.
  Easley and Kleinberg, Chapter 23.
  Shoham and Leyton-Brown, Chapter 9.

- Mechanism Design: VCG mechanisms. Mechanism Design: Applications; Combinatorial Auctions.
  Easley and Kleinberg, Chapter 9.
  Nisan et al., Section 9.3.
  Shoham and Leyton-Brown, Sections 10.3-10.4.3.

- Mechanism Design: Applications of VCG; Combinatorial Auctions; the Revelation Principle; Practical problems with VCG.
  Nisan et al., Section 9.3.5, 9.4
  Shoham and Leyton-Brown, Section 10.2 and Section 10.4.5.
  Thirteen reasons why the Vickrey-Clarke-Groves process is not practical M. Rothkopf.
  http://orforum.blog.informs.org/files/2007/04/rothkopf_article.pdf
  Nisan et al., Section 9.4.

- Mechanism Design: The Revenue Equivalence Theorem. Equilibria: Existence of Nash equilibria.
  Nisan et al., Section 9.6.
  Shoham and Leyton-Brown, Section 3.3.4.

- Equilibria: Lemke-Howson algorithm; Selfish Routing; Potential Functions and Pure NE.
  Nisan et al., Section 2.3.
  Shoham and Leyton-Brown, Section 4.2.2, 6.4
  Easley and Kleinberg, Chapter 8.

- Auctions: Sponsored Search Auctions. Online Auctions

Nisan et al., Sections 28.1-28.3 and 9.5.6.
Easley and Kleinberg, Chapter 15.

- Cooperative Game Theory: the Core and Market games; Nash Bargaining.

Shoham and Leyton-Brown, Section 12.2.2.
On market games by L. Shapey and M. Shubik.

Mathematics 5P40 (FALL 2017)
Functional Analysis

Professor: H. Ben-El-Mechaiekh
Room MC J419
Email: hmechaie@brocku.ca

Lectures: Reading Course

Marking Scheme:

4 Assignments @ 18% each:	72%
Course Project (Report + Presentation):	28%

Course Description: The basic theory of Hilbert spaces, including the Projection Theorem, the Riesz Representation Theorem and the weak topology; weak derivatives, Sobolev spaces and the Sobolev Imbedding Theorem; the variational formulation of boundary value problems for ordinary and partial differential equations, the Lax-Milgram Lemma and its applications; the finite element method.

Reference Texts (Public domain copies on Sakai

1) ***MH:*** *Functional Analysis – An Elementary Introduction,* By Markus Haase (Delft Institute of Applied Mathematics
2) ***HB :*** *Analyse Fonctionelle*, Haim Brézis, Dunod

Course Content:

- **MH Chapter 1** (Inner products, Orthogonality, The Trigonometric System),
- **MH Chapter 2** (The Cauchy-Schwarz Inequality and the Space l^2, Norms, Bounded Linear Mappings)
- **MH Chapter 5** (Cauchy Sequences and Completeness, Hilbert Spaces, Banach Spaces, Series in Banach Spaces and Hilbert Spaces)
- **MH Chapter 8 and HB Chapter V** (Best Approximations in Hilbert Spaces, Orthogonal Projections, Projection on a closed convex subset of a Hilbert space, Dual of a Hilbert Space, Abstract Fourier Expansions, The Theorems of Stampacchia, Lax Milgram and Riesz Fréchet)
- **MH Chapter 10 and HB Chapter VIII** (Weak Derivatives, The FTC, Sobolev Space $W^{1,p}$ (I), Sobolev Imbedding Theorem, Variational formulation of boundary value problems, the maximum principle,

Brock University

Winter 2012

MATH 5P50 Algebraic Number Theory

Lectures Monday:13:00-16:00 MCD301	

Instructor : Office : Phone : Email :	Omar Kihel J-425 905-688-5550 ext. 3295 okihel@brocku.ca
Home Page:	http://spartan.ac.brocku.ca/~okihel
Course description:	This course provides a reasonable coverage for a one semester graduate course. Topics include the general theory of factorization of ideals in Dedekind domains as well as in the number field case, some calculations using Kummer's theory on lifting of prime ideals in extension fields, factorization of prime ideals in Galois extensions, local fields, the arithmetic of global fields.
Textbook:	Number Fields by Marcus.
Prerequisites:	MATH 3P13

Mark Distribution:	Assignments 2: Test Presentation	40% 40% 20%

COURSE: Math 5P60 Partial Differential Equations

Instructor: Prof. Stephen Anco
Office: J423 x3728

Text: Evans, Partial Differential Equations

Grading:
Homework & Seminar (weekly) 50%
Midterm exam 15%
Final exam 25%
Presentation 10%

TOPICS:
1. Overview of PDE theory and examples of linear and nonlinear PDEs.

2. Basic types of linear PDEs: convective equation (2.1), heat equation (2.3), wave equation (2.4), Laplace equation (2.2); fundamental solutions ($*$) and integral representation formulas for Cauchy problems.

3. General solution of linear and nonlinear PDEs: 1st order PDEs and characteristics (3.1–3.2), power series (4.6), Fourier transform (4.3), mappings (4.4), eigenfunction series with boundary conditions ($*$).

4. Exact solution methods: separation of variables (4.1), similarity and group-invariant solutions (4.2$*$).

5. Variational formulations: Lagrangians (8.1), conservation laws and Noether's theorem ($*$), Hamiltonians ($*$), gradient flows ($*$).

Lectures are based on the course notes provided in pdf format. You have the responsibility to:
(i) bring a printed copy of the notes with you to each lecture;
(ii) participate in the seminar discussion of the material in the notes during each lecture;
(iii) review this material yourself after each lecture.

You may discuss homework problems together but all of the solutions you submit must be your own work. Late assignments will not be accepted.

COURSE: MATH 4P64/5P64 Introduction to Mathematical Physics

Time: Lecture M, W 12:30-14:00; Lab T 14:00-15:00 (starting Sep 20)
Instructor: Prof. Alexander Odesskii
Office: J432, email: aodesski@brocku.ca, ext. 3297

Grading:
Labs/Homework (weekly) 30 %
Midterm 20 %
Final exam 50 %

TOPICS:

Calculus of variations, least action principle in physics, symmetries and conservation laws, differential-geometric structures (differential form, vector field, Riemannian metric). Applications to physics: electro-magnetic field as a one-form, gravity as a pseudo-Riemannian metric. Introduction to mathematical ideas of quantum mechanics.

Notes:

(1) The Midterm exam will be 75 minutes long and held during the regular lecture time in your classroom. The final exam will be of 3 hours duration. **No make up midterm will be arranged.** If a student misses the midterm exam for a very good reason (proof required), the weight will be added to the final exam.

(2) The homeworks are due in the next labs. **No late homeworks will be accepted**. You must attach a cover page to your homework. This should bear (at the top) **your name, student number, course number and homework number**.

(3) **Plagiarism:** You may discuss the problems with other students; however, **the final submitted work must be your own.** Any evidence of copying will result in a mark of 0.

(4) **Withdrawal Date:** Friday, November 4, 2011 is the **last date** for withdrawal from the course **without academic penalty.**

COURSE: MATH 5P66/PHYS 5P66 Matrix groups and linear representations

Time: Lecture W F 1230-1400;
W: MCA241, F: MCJ404
Instructor: Prof. Alexander Odesskii
Office: J432, email: aodesski@brocku.ca, ext. 3297
TA: HamidReza Nayeri (hn15ir@brocku.ca)

Grading:
Labs/Homework (weekly) 20 %
Midterm 20 %
Oral presentation 10 %
Final exam 50 %

TOPICS:

Abelian groups, permutation groups, rotation groups. Representations of discrete and continuous groups by linear transformations (matrices). General properties and constructions of group representations. Representations of specific groups. Lie groups and Lie algebras.

Notes:

(1) The Midterm exam will be 75 minutes long and held during the regular lecture time in your classroom. The final exam will be of 3 hours duration. **No make up midterm will be arranged.** If a student misses the midterm exam for a very good reason (proof required), the weight will be added to the final exam.

(2) **No late homeworks will be accepted**. You must attach a cover page to your homework. This should bear (at the top) **your name, student number, course number and homework number**.

(3) **Plagiarism:** You may discuss the problems with other students; however, **the final submitted work must be your own.** Any evidence of copying will result in a mark of 0.

Physics Department

PHYS 5P10

Homework
Lectures
Marks
Calendar entry
Integrity

PHYS 4P10/5P10 - Introduction to Scientific Computing

Instructor: E. Sternin

Latest news

- MSc progress report template on overleaf.com
- Please submit your homework via email to edward dot sternin at brocku dot ca. Attach (do not include in the body of the message) *.m,*.c, Makefile *.ipynb etc. files as necessary. Make sure the comments contain your Brock email as the identifier of the author.
- Late homework submissions are penalized by a sinking cap of 15%/day, so assignments that are 2 days late cannot get a grade higher than 70, etc.
- Monitor your grades through the **Marks** link on the left.
- Lectures will be posted in Lectures, both as .ipynb notebooks and as [non-interactive] .html files, if you do not have jupyter installed.
- This course can be taken as PHYS 5P10 or MATH 5P69, and by undergraduates as PHYS 4P10. The courses will be differentiated by level-appropriate expectations in the preparation of reports and projects.
- Be sure to review this statement on academic integrity
- You are expected to prepare your homework and reports using LaTeX. It is available on all computers in Physics labs, and online at overleaf.com. In preparation for the lectures students are encouraged to open overleaf accounts. Some useful resources for writing reports are here, and will be reviewed in class.

Course outline

What Brock calendar entry says (slightly revised for the current calendar):

- Survey of computational methods and techniques commonly used in condensed matter physics research; graphing and visualization of data; elements of programming and programming style; use of subroutine libraries; common numerical tasks; symbolic computing systems. Case studies from various areas of computational physics. Discipline-specific scientific writing and preparation of documents and presentations.

What do I need to bring into the course?

- This course is a core course of the MSMP program, and is recommended to all Physics graduate students. Basic familiarity with Linux is assumed, and will be reviewed briefly.

Course Goals

- to develop a working knowledge of interactions with Linux OS
- to become proficient in experimental data graphing and numerical analysis
- to gain working knowledge of program development
- to become familiar with one or several interpreted programming environments, and to acquire basic scripting skills
- to become proficient in LaTeX and use it for scientific papers and presentations

Textbook

There is no formal textbook for the course. A number of online resources are available and can be used as reference material for the lectures. Some of these are:

- *Computational Physics* by Morten Hjorth-Jensen (a local copy)(a tar file of programs

from the text)
- » *Scientific Computing: An Introductory Survey* by Michael T. Heath
- » *A Survey of Computational Physics* by Rubin H. Landau, Manuel Jose Paez and Cristian C. Bordeianu (a local copy)
- » *Scientific Computing* by Jeffrey R. Chasnov (a local copy)
- » *Principles of Scientific Computing* by David Bindel and Jonathan Goodman (a local copy)
- » *An Introduction to Computer Simulation Methods Third Edition* by Harvey Gould, Jan Tobochnik, and Wolfgang Christian (a local copy)
- » *Numerical Recipies* by William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery
- » *Introduction to Programming with Fortran* by Ian Chivers and Jane Sleightholme (a local copy)
- » *Numerical Methods and Computing* by Ward Cheney and David Kincaid

This list will grow as the course progresses.

Grade composition

Component	% of the final mark	Notes
Homework	30%	Weekly problem sets in the first half of the course. Solutions should be submitted to the instructor during the lecture period on the due date. Late submissions are capped at -15% per day.
Projects	45%	Three (or four, time-permitting) extended projects in the second half of the course. Project papers in the form of a scientific journal submission, using Elsevier or *Can. J. Phys.* format.
Final presentation	25%	One of the three projects (selected at random) presented as a research seminar.

Topics to be covered

This is an approximate outline. Topics not on this list may get covered as time permits.

- » **A common toolbox**
  - » interacting with the OS; CLI vs GUI
  - » Linux as a collection of small tools + pipes between them
  - » the basics of programming: shell, C, scripting languages
  - » code development: edit, compile, run, make and Makefile structure, elementary debugging, linking to program libraries
  - » visualization with gnuplot and other graphing tools
- » **Numerical methods**
  - » Numerical differentiation: finite differences, interpolation, root finding
  - » Numerical integration: special functions and quadrature
  - » Solution of Ordinary Differential Equations: Euler-Cromer, Runge-Kutta
  - » Linear algebra: methods of solving systems of equations and eigenvalue problems
  - » Stochastic Methods:Random number generators, importance sampling, Molecular dynamics, Monte-Carlo techniques
- » **Case Studies/Projects**
  - » Least-squares problem: experimental noisy data, noise distribution and filtering, importance of baseline, assumption of Gaussian noise, chi-squared; classification of LS problems, regularization and selection of lambda. Test case: a spectrum of exponential relaxation rates
  - » Molecular modeling: protein database data, force fields, GROMACS simulation package. Test case: a lipid bilayer with cholesterol guests (T.Harroun)
  - » Models of solids: Ising model, magnetic moment, temperature, heat capacity, Metropolis' algorithm. Test case: magnetic transitions in an Ising lattice (B. Mitrovic/S. Bose)
  - » Image Analysis: filtering to remove noise, segmentation to isolate regions and

objects of interest, regional and spectral analysis to extract statistical data. Test case: spatial frequency distribution of a line image

1812 Sir Isaac Brock Way
St. Catharines, Ontario, L2S 3A1
Phone: +1.905.688-5550 ext.3412
Email: physics@brocku.ca
Fax: +1.905.984-4857
 Updated: 26-Mar-2018 10:59

Welcome to Math 5P70
Topology

Instructor: Professor B. Ralph (J428)

Course Text
Introduction to Topology, Adams and Franzosa

Topics
Topological Spaces; Interior, Boundary, Closure; Subspace, Quotient Space, Product Topology; Continuous Functions and Homeomorphisms; Metric Spaces; Connectedness; Compactness

Undergraduate Grading
There will be:

2 midterms	15% each
4 assignments	8 % each
Final Exam	38%

Graduate Grading
There will be:

2 midterms	10% each
4 assignments	6% each
Final Exam	36% (Extra Questions for Grad Students)
Final Presentation	20%

Tests and Labs

Tests, labs and presentations will be held in the Thursday 3-5 timeslot. Leave it open

Midterm Schedule
The midterms will be held in class on Thursday February 7th and March 14th.

Assignments
Assignments are due at the start of class on Jan. 31, Feb. 14, March 21and April 4. This course will emphasize good mathematical writing. Students will be expected to write solutions using a very readable and logical mathematical style.

Graduate Presentations and Submission
20 minute presentation followed by questions. Topics could be any of Chapters 10-14 of text or other approved topics. Choice of topics must be unique. Presentations will be given in the last 4 weeks of classes.

Fall 2017, Brock University

MATH 4P81/5P81 SAMPLING THEORY

Lecture Hours: M W 9:30 - 11:00 TH246
Lab Hours: W 13:00 - 14:00 MC J430

Prerequisites: MATH 2P82
Instructor: M. L. Huang, *mhuang@brocku.ca*
Office: MC J411. Office hour: Monday 13:00 – 14:00
Telephone: (905) 688-5550 Ext. 4255
Textbook: *Sampling Techniques,* Third edition. W. G. Cochran, John Wiley & Sons, New York, 1997.
T.A.: Jenny Tieu, *jt12cc@brocku.ca*

Topics, Schedule, Grades

Week	Date Fall 2017	Topics	Assignments No. To you Due %	Lab Time	Test %
1, 2 3	9/ 6 - 9/15 9/18 - 9/22	Chapters 1, 2	#1 Sept. 11 Sept. 25 *6%*	9/20 Lab#1	
4 5	9/25 - 9/29 10/ 2 - 10/ 6	Chapters 3, 4	#2 Sept. 27 Oct. 6 *6%* (12pm Prof. Office)	9/27 Lab#2	
6 7 8	10/16 -10/20 10/23 - 10/27 10/30 - 11/ 3	Chapter 5	#3 Oct. 4 Oct. 25 *6%*	10/ 4 Lab#3 10/18 Lab#4	Test *24%* November 8, J430 12:00-14:00 (Chapters 1-5)
9	11/ 6 - 11/10	Chapter 6	#4 Oct. 25 Nov. 24 *6%* (12:00 Prof. Office)		
10 11	11/13 - 11/17 11/20 - 11/24	Chapters 7,8,9	Case Study *12%* Give Outline: Oct. 25 Presentations: Nov. 20 Submission: Nov. 22	11/15 Lab J430 Prepare Case study	
12	11/27 - 12/ 1	Review			
	December	Final Exam	*40%*		

Note

1. **Mark distribution:** Test (1) *24%*
   Assignments (4) *24%*
   Case Study (1) *12%*
   Final Exam (1) *40%*
2. **A student must obtain *30%* of marks on the final examination to pass the course.**
3. **In general assignments are due lecture or lab. Instructor will give help, but late assignments will NOT be accepted (zero mark)**
4. **Test will be written in regular class time. NO make-up tests are provided for students who miss writing a test at the scheduled time.**
5. **Statistical packages SAS will be used for assignments in the labs. To labs, you should bring**
   (a) The code of SAS;
   (b) Your assignment.
6. **The purpose of the case study is to develop the student's abilities in statistical applications.**

(Note: graduate students will add theoretic studies in the test, exam and case studies) ***MATH 4P815P81***

SAMPLING THEORY

1. Depth and Breadth of Knowledge

Motivate students to learn sampling theory by using many examples of its applications in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines. Help students to understand the concepts, theorems and methods of sampling theory, and how to deal with efficiency and precision of estimates in real world practice. Develop students' thinking abilities about new ideas of sampling. Develop students' sampling survey allocation abilities. Develop students' computational skills using calculator and computer software. Develop Students communication skills.

2. Knowledge of Methodologies

COURSE CONTENT

Motivate students to learn sampling theory and its applications.

- **a.** *Introduce the **history** of sampling theory dealing with efficiency and precision of estimates.*
- **b.** *Introduce the **significant impact** of sampling theory in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines, and give many examples of its real world practice.*
- **c.** *Introduce recent developments of sampling theory and its **future** in the 21st Century.*

Assist students to understand the following sampling concepts, theorems and techniques.

- ***a. Simple Random Sampling*** *(Weeks 1,2)*
  - *(1) Sample random sampling, characteristics of population and sample.*
  - *(2) Estimators of population mean and variance and their expected values and variances.*
  - *(3) Random sample with replacement.*
  - *(4) Selection of a random sample.*
- ***b. Sampling Proportion*** *(Week 3)*
  - *(1) Estimation of a proportion and its expected value and variance.*
  - *(2) Exact and Approximate Confidence intervals for a population proportion.*
- ***c. Estimation of Sample Size*** *(Week 4)*
  - *(1) Sample sizes for estimating a population mean using a given tolerance limit and a risk.*
  - *(2) Sample sizes for estimating a population proportion using a given tolerance limit and a risk.*
  - *(3) Sample sizes determination using a given cost function or a loss function*
- ***d. Stratified Random Sampling*** *(Weeks 5, 6, 7)*
  - *(1) Stratified random sample; stratified random sample mean and its expected value and variance.*
  - *(2) Stratified estimator of population proportion and its expected value and variance.*
  - *(3) Optimal allocation of sample sizes.*
  - *(4) Comparison of precision of the estimators for population mean and proportion by using stratified random sampling or simple random sampling.*
- ***e. Ratio Estimators*** *(Weeks 8, 9)*
  - *(1) Population ratio and sample ratio.*
  - *(2) Ratio estimators for population mean, total and their expected values, variances and biases.*
  - *(3) Ratio estimators in stratified random sampling: combined and separated methods.*
  - *(4) Comparisons of precision of the five estimators studied for estimating a population mean.*
- ***f. Regression Estimators*** *(Weeks 10, 11)*
  - *(1) Population linear regression and sample linear regression.*

(2) Linear regression estimators for population mean, population total and their expected values, variances and biases.
(3) Regression estimators in stratified random sampling: combined and separated methods.
(4) Comparisons of precision of the eight estimators studied for estimating a population mean.

g. Systematic Sampling and Cluster Sampling *(Week 12)*
(1) Systematic Sampling, systematic random sample mean and its expected value and variance.
(2) Cluster Sampling, cluster random sample mean and its expected value and variance.
(3) Comparisons of precision of the ten estimators studied for estimating a population mean.

h. Sampling Errors and Others *(Week 12)*

Develop students' thinking abilities about new ideas of sampling.
a. *Discuss how sampling models and techniques above were developed.*
b. *Encourage students to discuss new ideas of sampling.*

Develop students' sampling survey abilities by using the knowledge above
a. Assignments: *Let students use sampling skills to solve problems and prove basic theoretical problems.*
b. Case Studies *(one week)**: See Section 3.*

ROLE OF TECHNOLOGY

Develop students' computational skills using computer software.
Computer Lab: *Use SAS, MAPLE or EXCEL to run the sampling techniques for the assignments and case studies.*

MINIMAL SKILLS

Students are expected to perform the mathematical proofs and computational skills (by calculator and SAS or MAPLE) on the following topics:

- *Selection of a random sample with replacement and a simple random sample (random sample without replacement).*
- *Estimators of population mean, variance, proportion and their expected values and variances by using a simple random sample.*
- *Optimal sample size for a simple random sample.*
- *Estimators of population mean, variance proportion and their expected values and variances by using a stratified random sample.*
- *Optimal allocation of sample sizes for a stratified random sample. Neyman allocation.*
- *Estimator of population mean by using ratio estimators, regression estimators of a simple random sample or a stratified random sample.*
- *Estimator of population mean by using systematic random sampling, and cluster random sampling.*
- *Comparisons of the precision of the ten estimators studied of population mean.*
- *Sampling survey techniques.*

Textbook *(suggested):* **Sampling Techniques,** *W. Cochran, third edition, John Wiley, New York, 1997.*
Prerequisite: *Math 2P82.*
Lecture & Tutorial Hours*: Lectures, 3 hours per week, Lab (or Tutorial), 1 hour per week*

3. Application of Knowledge

For developing students' sampling survey application abilities by using the knowledge in Section 2, students perform <u>Case Studies</u> *(one week)**: Let students design (in groups or individually) realistic and useful sampling projects. Require the students to identify any simplifying assumptions and to determine sample sizes*

then collect raw data, and finally compare the precision of estimates to give an optimal design of the sampling survey. The outline is as follows:

(1) Main methods and analysis (50%)

a. Statement of a survey problem *(a practical and useful problem).*

b. Objective of the survey.

c. Sampling methods: **Note:** **(i) A real data collection must be performed.**
(ii) A pilot survey may be required.

- ***Population (****units, characteristics: Mean, total, proportion, etc****.);***
- ***Sample Factors (****units and frame, questionnaire, precision, cost function****);***
- ***Sampling methods:***
  - ***(i) Simple random sampling (****sample size estimated, normality test is needed****)***
  - ***(ii) Stratified random sampling (****proportional allocated****)***
  - ***(iii) Stratified random sampling (****Neyman allocated****)***
- ***Data table.***

d. Analysis:

- ***Estimations (****for population mean, total or proportion****) by using three sampling methods;***
- ***Compare the precision of the estimations;***
- ***Conclusions of the survey.***

(2) Organization and creativity (10%)

(3) Talk (10%)

(4) Asking and answering questions (10%)

(5) Report (20%)

Report format: Title, names, abstract, key words, text, references
(*SAS program and output should be attached****)***

(6) Students and teacher evaluate for each study project.

4. Communication Skills

In Case Studies (Section 3), students work in groups to discuss, present, evaluate and write reports.

5. Awareness of Limits of Knowledge

The knowledge in Math 4P81 consists of basic sampling theory and techniques. The limitations are:

a) Models are basic.
b) Mathematical derivations are basic.
c) Applications are limited.

6. Autonomy and Professional Capacity

a) The knowledge of methodologies in this course will lead to further studies of advance sampling survey theory and methodologies.
b) The knowledge of methodologies in this course may apply to other disciplines and real-world problems. The course provides basic sampling theory and skills for a professional statistician.
c) A base course for the "Knowledge and Ability Test for Mathematical Statistics Test" of Statistics Canada.
d) A core course for the Associate Statisticians Accreditation of the Statistical Society of Canada.

Winter 2018, Brock University

MATH 4P82/5P82 NONPARAMETRIC STATISTICS

Lecture Hours: T TH 15:30 - 17:00 TH 240
Lab Hours: M 17:00 - 18:00 MC J430

Prerequisites: MATH 2P82
Instructor: M. L. Huang, *mhuang@brocku.ca*
Office: MC J411, Office hour: Monday 14:00 – 15:00
Telephone: (905)688-5550 Ext.4255
Textbook: *Practical Nonparametric Statistics, third* edition. W. J. Conover, John Wiley & Sons, New York, 1999.
T.A.: Jenny Tieu, *jt12cc@brocku.ca*

Topics, Schedule, Grades

Week	Date Winter 2018	Topics	Assignments No.	To you	Due	%	Lab Time	Test %
1 2 3	1/ 8 - 1/12 1/15 - 1/19 1/22 - 1/26	Chapter 1,2,3	#1	Jan. 9	Feb. 1	*6%*	1/22, Lab #1	
4 5 6	1/29 - 2/ 2 2/ 5 - 2/ 9 2/12 - 2/16	Chapter 4	#2	Feb. 1	Feb. 26 *(Labtime, 6pm)*	*6%*	1/29, Lab #2 2/12, Lab #3	
7 8 9	2/26 - 3/ 2 3/ 5 - 3/ 9 3/12 - 3/16	Chapter 5	#3 #4	Feb. 27 March 13	March 13 March 29	*6%* *6%*	2/26, Lab #4 3/19, Lab #5	Test *24%* March 5, J430 16:00 – 18:00 Chapters 1-4
10 11	3/19 - 3/23 3/26 - 4/ 1	Chapter 5, 6	Case Study Give Outline: March 6 Presentations: March 22 Submission: March 26				Prepare Case study Lab 3/19	*12%*
12	4/ 2 – 4/ 6	Review						
			Total *24%*					*36%*
	April	Final Exam	*40%*					

Note

1. **Mark distribution :** Test (1): *24%*
   Assignments (4) *24%*
   Case Study (1) *12%*
   Final Exam (1) *40%*
2. **Must obtain *30%* of marks on the final examination to pass the course.**
3. **In general assignments due class time. Instructor will give help, but late assignments will NOT be accepted (zero mark).**
4. **Test will be written in regular class time. NO make-up tests are provided for students who miss writing a test at the scheduled time.**
5. **Statistical packages SAS will be used for assignments in the labs. To labs, you should bring**
   (a) The code of SAS;
   (b) Your assignment.
6. **The purpose of the case study is to develop the student's abilities in statistical applications.**
   (Note: graduate students will add theoretic studies)

MATH 4P82/5P82 NONPARAMETRIC STATISTICS

1. Depth and Breadth of Knowledge

Motivate students to learn nonparametric statistics by using many examples of its applications in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines. Help students to understand the concepts, theorems and methods of nonparametric statistics, and how to deal with statistical inference for non-normal populations or distribution-free populations in real world practice. Develop students' thinking abilities about new ideas of nonparametric statistics. Develop students' problem solving abilities. Develop students' computational skills using calculator and computer software. Develop student communication skills.

2. Knowledge of Methodologies

COURSE CONTENT

Motivate students to learn nonparametric statistics and its applications.

a. *Introduce the* ***history*** *of nonparametric statistics dealing with statistical inference for non-normal population or distribution-free population****.***
b. *Introduce the* ***significant impact*** *of nonparametric statistics in Biology, Health Studies, Physics, Chemistry, Psychology, Economics, Business, Education, Engineering and other academic disciplines, and give many examples of its real world practice****.***
c. *Introduce recent developments of nonparametric statistics and its* ***future*** *in the 21st Century.*

Assist students to understand the following concepts, theorems and techniques.

a. ***Review statistical inference*** *(Weeks 1/2)*
   (1) Estimation.
   (2) Hypothesis testing; power of a test; unbiased test; significance level.

b. ***Binomial Tests – using binomial distribution and its approximation*** *(Weeks 1, 2, 3)*
   (1) Binomial test and confidence interval for probability: Theorems and examples.
   (2) Point estimation, hypothesis testing and confidence interval for population quantiles (discrete and continuous cases): Order Statistics, theorems and examples.
   (3) Tolerance limits: Theorem and examples.

c. ***Contingency Tables – using multinomial distribution and its approximation*** *(Weeks 4, 5, 6)*
   (1) 2 x 2 *contingence tables: method and theorem.*
   (2) r x c *contingence tables: chi-square tests for differences of probability or independence.*
   (3) Exact and approximate distributions of r x c *contingence tables with fixed or random margins.*
   (4) Median test.
   (5) Chi-square goodness-of-fit test.
   (6) Cochran's test and McNemar's test.

d. ***Rank Tests - using rank distribution and its approximation*** *(Weeks 7, 8, 9, 10, 11)*
   (1) The Mann-Whitney test for two independent samples: Theorems, methods and Examples.
   (2) The Kruskal-Wallis test for several independent samples: Theorems, methods and examples.
   (3) Measures of rank correlation: Spearman's Rho and Kendall's Tau.
   (4) Nonparametric linear regression method: Test for slop and confidence interval for slop.
   (5) The Wilcoxon signed ranks test for one-sample matched-pairs case: Theorems, method and examples.
   (6) The Friedman test and Quade test for several related samples case: Theorems, methods and examples.

e. ***Statistics of the Kolmogorov-Smirnov type*** *(Week 12)*

(1) The Kolmogorov goodness-of-fit test.
(2) The Lilliefors test and the Shapiro-Wilk test for normality.
(3) The Smirnov test on two independent samples.

Develop students' thinking abilities about new ideas of nonparametric statistics.

a. Discuss how nonparametric statistics methods above were developed.
b. *Encourage students to discuss new ideas of nonparametric statistics***.**

Develop students' nonparametric statistics inference abilities by using the knowledge above

a. ***Assignments:*** *Let students use nonparametric statistics skills to solve problems and prove basic theoretical problems.*
b. ***Case Studies*** *(one week)****: See Section 3.***

ROLE OF TECHNOLOGY

Develop students' computational skills using computer software.

Computer Lab: *Use SAS, MAPLE or EXCEL to run the nonparemetric statistical methods above for the assignments and case studies.*

MINIMAL SKILL SET

Students are expected to perform the mathematical proofs and computational skills (by calculator and SAS or MAPLE) on the following topics:

- *Binomial test.*
- *Order statistics for confidence interval and tolerance limits.*
- *Estimation and hypothesis test on a population quantile: discrete and continuous cases.*
- *The* r x c *contingence tables: chi-square tests for differences of probability or independence.*
- *Exact and approximate distributions of* r x c *contingence tables with fixed or random margins.*
- *Median test.*
- *The Chi-square goodness-of-fit test.*
- *The Cochran's test and McNemar's test.*
- *The Mann-Whitney test for two independent samples.*
- *The Kruskal-Wallis test for several independent samples.*
- *Measures of rank correlation: Spearman's Rho and Kendall's Tau.*
- *Nonparametric linear regression method: Test for slop and confidence interval for slop by using Spearman's Rho and Kendall's Tau.*
- *The Wilcoxon signed ranks test for one-sample matched-pairs case.*
- *The Friedman test and Quade test for several related samples case.*
- *The Kolmogorov goodness-of-fit test, the Lilliefors test and the Shapiro-Wilk test for normality.*
- *The Smirnov test on two independent samples.*

Textbook *(suggested):* **Practical Nonparametric Statistics,** *W. J. Conover, third edition, John Wiley & Sons, New York, 1999.*
Prerequisite: *Math 2P82.*
Lecture & Tutorial Hours: Lectures, 3 hours per week, Lab (or Tutorial), 1 hour per week.

3. Application of Knowledge

For developing students' nonparametric statistics inference application abilities by using the knowledge in Section 2, students perform <u>Case Studies</u> *(one week)****:*** *Let students design (in groups or individually) realistic and useful projects which deal with non-normal populations. Require the students to identify any*

simplifying assumptions on the population, collect raw data and perform statistical inference. The outline is as follows:

(1) Main methods and analysis (50%)

a. Statement of a problem; *(Give a set of non-normal data, and a practical and useful problem)*

b. Test data for normality; *(Use Kolmogorov-Smirnov test, and use SAS check)*

c. Data table;

d. Use nonparametric methods to analyze data;

ANOVA:	**REGRESSION**
• *Hypothesis tests;*	• *Least squares estimation;*
• *Multiple comparisons;*	• *Hypothesis test for slope;*
• *Confidence intervals*	• *Confidence interval for slope.*

e. Use parametric methods to analyze data;

ANOVA:	**REGRESSION**
• *Hypothesis tests;*	• *Least squares estimation;*
• *Multiple comparisons;*	• *Hypothesis test for slope;*
• *Confidence intervals.*	• *Confidence interval for slope.*

f. Compare the results in (e) and (d).

(2) Summary (10%)

- *"Parametric and Nonparametric Methods in the Case Study"*
  (Give comparisons of assumptions, H_0 , Test statistics, power, C.I., etc.)

(3) Talk, Organization and creativity (10%)

(4) Asking and answering questions (10%)

(5) Report (20%).

Report format: Title, names, abstract, key words, text, references.
(*SAS program and output should be attached)*

(6) Students and teacher evaluate for each study project.

4. Communication Skills

In Case Studies (Section 3), students work in groups to discuss, present, evaluate and write reports.

5. Awareness of Limits of Knowledge

The knowledge in Math 4P82 consists of basic nonparametric statistics theory and methods. The limitations are:

a) Models are basic.
b) Mathematical derivations are basic.
c) Applications are limited.

6. Autonomy and Professional Capacity

a) The knowledge of methodologies in this course will lead to further studies of advance nonparametric statistics inference methodologies.
b) The knowledge of methodologies in this course may apply to other disciplines and real-world problems. The course provides basic nonparametric statistics theory and skills for a professional statistician.
c) A base course for the "Knowledge and Ability Test for Mathematical Statistics Test" of Statistics Canada.
d) A core course for the Associate Statisticians Accreditation of the Statistical Society of Canada.

e) A possible base course for the Examinations of the Society of Actuaries.

Math5P83 Linear Models

Instructor: Xiaojian Xu, MCJ412. **e-mail**: xxu **at** brocku **dot** ca
Lectures: MCC400. Tuesdays and Thursdays: 3:30pm-5:00pm.
Office hours: Tuesdays 12:30pm-2:00pm and Fridays 2:30pm-4:00pm, or by appointment

Course web page: http://spartan.ac.brocku.ca/~xxu/5P83All.html
This page may contain the course outline, homework problems, data sets, announcements, and so on. Please check it on a regular basis.

Textbook: Linear Models in Statistics, Second Edition. Alvin Rencher. Wiley.

Prerequisite: This course discusses the mathematical and statistical theory behind the statistical techniques used for fitting models in which the expected relationship is expressed by a linear equation in the model parameters. The emphasis is on carefully laying down the foundations using vector space theory and principles of statistical inference. Students are expected to have had a course in Linear Algebra such as Math 2P12, as well as an advanced course in Applied Statistics such as MATH3P86.

Assessment:
Assignments: 40%; Midterm exam: 25%, TBA (Note: **no make-up exam will be arranged)**. If a student misses the test for a good reason (proof is required), the weight will be added to the final exam; Final exam: 35%, TBA. There are 4 assignments in total which are equally weighted. For written assignments, you are expected to comprehend what you are writing, not merely the answers. Assignments should be submitted before the beginning of class on the announced due date. **Late assignments will not be accepted**.

Course description:
http://www.brocku.ca/webcal/2017/graduate/MATH.html#MATH_5P83
Important dates:
https://brocku.ca/important-dates/graduate-studies/

Academic Integrity Policy: Academic misconduct is a serious offence. The principle of academic integrity, particularly of doing one's own work, documenting properly (including use of quotation marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students should consult Section XVII, "Academic Misconduct", in the "Academic Regulations and University Policies" entry in the Graduate Calendar, available at http://brocku.ca/webcal to view a fuller description of prohibited actions, and the procedures and penalties.

Outline of Topics:
- Introduction to linear models.
- Generalized inverses; derivatives of linear functions and quadratic forms.
- Random vectors and matrices; distribution of quadratic forms.
- Simple and multiple linear regressions.
- (Generalized) least squares, estimable functions, and the Gauss-Markov theorem.
- Hypothesis tests and confidence sets.
- Analysis of variance and analysis of covariance.
- Random effect, and mixed models.
- Generalized linear models.

MATH 5P84 – Time Series Analysis and Stochastic Processes
Course Outline

List of topics:

- Multivariate Normal distribution; marginal and conditional distribution; partial correlation coefficient
- Autoregressive and Moving Average models; stability analysis; serial correlation; correlogram; forecasting
- Parameter estimation; large-sample theory
- Spectral analysis; periodogram; filtering; smoothing a spectrum; spectral and lag windows

References:

1. Vrbik J, Vrbik P: Informal Introduction to Stochastic Processes with Maple (last chapter only), Springer, 2013
2. William W S Wei: Time Series Analysis (Univariate and multivariate methods), 2nd Edition, Pearson (Addison-Wesley), 2006
3. Peter J Brockwell, Richard A Davis: Introduction to Time Series and Forecasting, 2nd Edition, Springer text in Statistics, 2002

Marking scheme:

Weekly assignments:	60%
In-lab 3 hour final exam:	40%

Brock University

MATH 5P85, Winter 12-13

Mathematical Statistical Inference

Course Outline

Instructor:

Wai Kong (John) Yuen

Lectures:

T R 1230-1400 TH254 =20

Course Web page

There is a web page for this course which = contains the=20 course outline, homework problems, and solutions to exams. = Announcements=20 made in class will be posted there and will not be repeated in class. = The=20 address of this web page is: http://sparta= n.ac.brocku.ca/~wyuen/M5P85/main.html

Office hours:

T R 1400-15:30

Text:

Statistical Inference by George Casella and Roger L. = Berger, 2nd=20 Edition. We will quickly review Chapter 1-5 and study parts of Chapter = 6-10 in=20 detail.

References:

Useful graduate-level probability and mathematical=20 statistics books in the library are:

- Mathematical Statistics by Keith Knight=20
- Introduction to Mathematical Statistics by Robert V. Hogg, Joseph = W.=20 Mckean, Allen T. Craig, 6th edition=20
- An Introduction to Probability Theory and its Applications Vol II = by=20 William Feller=20
- A First Look at Rigorous Probability Theory by Jeffrey Rosenthal=20

Useful undergraduate-level probability and books in the = library=20 are:

- Mathematical Statistics with applications by Dennis D. Wackerly, = William=20 Mendenhall III, Richard L. Scheaffer=20
- John E. Freund's Mathematical Statistics with Applications by = Irwin=20 Miller, Marylees Miller=20
- Probability and Statistics : the science of uncertainty by Michael = J.=20 Evans and Jeffrey S. Rosenthal.=20
- An Introduction to Probability Theory and its Applications Vol I = by=20 William Feller=20
- Probability and Random Processes by Geoffrey Grimmett, David = Stirzaker=20
- and many others you can find in the library.

Grading:

- 30% Midterm exam (1 in-class midterm, Mar 5)=20
- 25% Assignments
  - There will be four assignments in total, with due dates being = Feb 1, Feb=20 15, Mar 15 and Apr 8 at 12:30pm.=20
  - You can discuss the assignments together but you MUST understand = and=20 write your own solutions.
- 45% Final exam

All students should become familiar with = Brock's=20 Academic Integrity Policy (http://www.brocku.ca/aca= demicintegrity/).=20

Course description:

Revision of probability theory, convergence = of=20 random variables, statistical models, sufficiency and ancillarity, point = estimation, likelihood theory, optimal estimation, Bayesian methods,=20 computational methods, minimum variance estimation, interval estimation = and=20 hypothesis testing, linear and generalized linear models, = goodness-of-fit for=20 discrete and continuous data, robustness, large sample theory, Bayesian=20 inference.=20

Missed exams:

There will be no make-up exam for missed in-class = exam.=20 Upon presentation of documentation of a valid excuse, the corresponding=20 percentage of the final mark

will be forwarded to the final exam. With = no=20 presentation of such documentation a grade of zero will be entered for = the=20 missed exam.

Important dates:

Add deadline: Thursday, January 17
Drop = deadline:=20 Friday, March 8

Math5P86 -- MULTIVARIATE STATISTICS

Instructor: Xiaojian Xu, MCJ412

Lectures: WH202, Mondays and Fridays 10:00am--11:30am

Office hours: MCJ412: Tuesdays and Wednesdays: 1:00pm--2:30pm.
e-mail: xxu **at** brocku **dot** ca

Course web page:
http://spartan.ac.brocku.ca/~xxu/5P86All.html
This page contains the course outline, homework problems, data sets, announcements, and so on. Please check it on a regular basis.

Text: Applied Multivariate Statistical Analysis; 6th edition; R.A. Johnson and D.W. Wichern; Prentice-Hall.

Prerequisite: Students will be expected to be familiar with the techniques of linear algebra (e.g. Math 2P12), mathematical statistics (e.g Math 2P82), and basics introduced in undergraduate course of multivariate analysis (e.g. Math 3P86). Some experience with the use of statistical softwares (e.g. S-plus) will be helpful.

Assessment:
Assignments: 40%.
Midterm exam: 25%, Oct. 20, Friday, 2017; WH202, 10:00am--11:30am.
No make up test will be arranged. If a student misses the test for a good reason (proof required), the weight will be added to the final exam.
Final exam: 35%, TBA.

Assignments: There are 4 assignments in total which are equally weighted. For written assignments, you are expected to comprehend what you are writing, not merely the answers. Assignments should be submitted before the beginning of class on the announced due date. **Late assignments will not be accepted**.

Course description:
http://www.brocku.ca/webcal/2017/graduate/math.html#MATH_5P86

Important dates:
https://brocku.ca/important-dates/graduate-studies/#fw-msc

Main topics (subject to change due to students' level of preparation):

1. REVIEW and INTRODUCTION

- Analysis techniques: Univariate v.s. Mulitivaraite
- Expectation and covariance of random vectors and matrices
- Definition and properties of multivariate normal distribution
- Estimation of mean and variance
- Assessing the assumption of multivariate normality
- Detecting outliers and cleaning data
- Transformations to near normality

2. ONE-SAMPLE INFERENCE FOR A MEAN VECTOR

- Inference about mean vectors when some observations are missing

- EM algorithm

3. INFERENCE ON MEAN VECTORS FOR TWO OR MORE SAMPLES

- Comparing several multivariate means: one-way MANOVA
- Profile analysis
- Testing for equality of covariance matrices
- Two-way MANOVA

4. FACTOR ANALYSIS

- Orthogonal factor models
- Estimation methods
- Factor scores

5. CLUSTER ANALYSIS

- Introduction to the problem
- Measures of similarity
- Hierarchical clustering
- Non hierarchical clustering

If time permits, we will also cover the following topics:

6. MULTIVARIATE LINEAR REGRESSION

7. CANONICAL CORRELATION ANALYSIS

Back to main page

Brock University

MATH 5P87 Fall 12-13

Probability and Measure Theory

Course Outline

Instructor:

Wai Kong (John) Yuen

Lectures:

MF 1400-1530 MCJ404

Course Web page

There is a web page for this course which contains the course outline, homework problems and solutions. Announcements made in class will be posted there and will not repeated in class. The address of this web page is: http://spartan.ac.brocku.ca/~wyuen/M5P87/main.html

Office hours:

TBA

Text:

Probability and Measure by Patrick Billingsley, Anniversary Edition. We shall cover selected topics from Chapter 1-4.

References:

Useful graduate-level probability books in the library are:

- A First Look at Rigorous Probability Theory by Jeffrey Rosenthal.
- A Course in Probability by K. L. Chung

- An Introduction to Probability Ttheory and its Applications Vol II by William Feller
- Probability and Measure Theory by Robert B. Ash
- Probability Theory by S.R.S. Varadhan
- A User's Guide to Measure Theoretic Probability by David Pollard

Useful undergraduate-level probability books in the library are:

- An Introduction to Probability Theory and its Applications Vol I by William Feller
- Probability and Statistics: the Science of Uncertainty by Michael J. Evans and Jeffrey S. Rosenthal.
- Probability and Random Processes by Geoffrey Grimmett, David Stirzaker
- and many others you can find in the library.

Grading:

- 5% Attendance
  - You are only allowed to miss a total of 3 lectures (arriving 30 minutes late is considered a missed lecture). Each additional missed lecture will cost 1% each.
- 10% Class Participation.
  - To obtain full credits, you need to attempt to answer questions during lectures, ask questions of your own and give good comments when appropriate.
- 45% Assignments
  - There will be three assignments in total, with due dates being Oct 5, Nov 9 and Dec 7 at 2pm.
  - You can discuss the assignments together but you MUST understand and write your own solutions.
- 40% Presentation
  - You will need to give a presentation of 30 mins on a topic of your choice, probably selected from the textbook.

All students should become familiar with Brock's Academic Integrity Policy (http://www.brocku.ca/academicintegrity/).

Course description:

An introduction to a rigorous treatment of probability theory using measure theory. Topics include probability measures, random variables, expectations, laws of large numbers, distributions and discrete Markov chains. Selected topics from weak convergence, characteristic functions and the Central Limit Theorem.

Important dates:

Add deadline: Monday, September 24, 2012.
Drop deadline: Friday, November 2, 2012.

MATH 5P88 – Advanced Statistics
Course Outline

- Generating random numbers from various distributions
- Monte Carlo techniques; Metropolis sampling
- Multiplicative and linear congruential generators of uniform random numbers
- Estimating distribution and probability density functions
- Large-sample theory applied to random independent samples
- Edgeworth-series expansion of a probability density function
- Computing cumulants of maximum-likelihood estimators
- Constructing 1/n -accurate approximation to a sampling distributions

Marking Scheme: Assignments 60%, Final Exam 40%

Brock University

Fall 2015

MATH 4P92/5P92 Topics in Number Theory

Lectures		Lab/Tutorial
Monday:	12:30-2:00	Monday: 2:00-3:00
Wednesday:	12:30-2:00	Room: MCJ202
Room:	TH246	

Instructor:	Omar Kihel
Office:	J-425
Phone:	905-688-5550 ext. 3295
Email:	okihel@brocku.ca
Home Page:	http://spartan.ac.brocku.ca/~okihel
Textbook:	There is no textbook. I will use different textbooks.
Topics to be covered:	Introduction, Elementary Number Theory, Applications to Cryptography, Elliptic Curves, Cryptography using Elliptic Curves.
Prerequisites:	MATH 1P11 or 1P12; one of MATH 2P12, 2P81, 2P92 (2P71), 3P12. Background that is useful for this course includes elementary number theory, algebra, probability, and combinatorics.

Mark Distribution:		
	Assignments (3 assignments)	15%
	Presentation	15%
	Test1 (October 5th, 2015)	35%
	Test2	35%

Comments: Late assignments will not be accepted. It is the responsibility of the student to check the course webpage.

Brock University

Winter 2011

MATH 5P94

Lectures Wednesday:15:30-17:00 MCD301	

Instructor : Office : Phone : Email :	Omar Kihel J-425 905-688-5550 ext. 3295 okihel@brocku.ca
Home Page: :	http://spartan.ac.brocku.ca/~okihel
Sep 28 Oct 5 Oct 12 Oct 19 Oct 26 Nov 2 Nov 9 Nov 16 Nov 23	Tariq Neil Majid Prof. Alexander Odesski Prof. Babak Farzad/ Prof. Chantal Buteau Prof. Chantal Buteau/ Prof. Babak Farzad Tariq Neil Majid

Mark Distribution:	Presentation 1 Presentation 2 Participation	40% 40% 20%

Mathematics 4/5P96 (Fall 2016)
Technology and Mathematics Education

Instructor: Dr. C. Buteau
Room MC J427
Email: cbuteau@brocku.ca

Lectures: Monday 13:00 - 15:00 in J404

Labs: Wednesday 12:00 - 14:00 in MC J430

Office Hours: Mo 11:00-12:00; Tu 9:45-10:45; Wed 14:00-15:00 (TBC) or by appointment

Course Objective

The main objective of this course is to develop an understanding and critical appraisal of mathematics teaching and learning with digital technology.

Course Description

Contemporary research concerning digital technologies, such as Computer Algebra Systems, Dynamic Geometry Software, online applets, Learning Objects, programming, and Wolfram Alpha, in learning and teaching mathematics. This includes topics such as the history of technology use in mathematics education, an international/national/provincial perspective on practices and research, digital technology use in assessment, implementation in the classroom, mathematics computer games, mathematics learning objects and online systems, technology in mathematical modeling*, technology use in probability & statistics, and dynamic geometry. Design of an educational tool.

* *if time permits.*

Grading

a) A presentation about a research paper (in teams of 3 – *individual for 5P96*): 8%
b) A final exam (in a computer lab): 35%**
c) An original project with presentation (in teams of 2– *individual for 5P96*): 22%
d) Lab participation (weeks 1-10): 15%
e) Weekly lab reports (weeks 1-10): 20%

** a minimum of 40% on the exam is required to pass the course.

Format for the original project and penalties

The original project consists of a technology-based mathematics educational tool together with a written report (19%), and a presentation (3%). The tool is to be put on a CD or USB that is clearly labeled with your name and ID. The CDs or USBs and written reports or the essay are to be put into ***8.5 x 11 inch envelopes*** also labeled with your name and ID. The sealed envelope is to be deposited on the due date and time: December 2 at 3:00pm (TBC). *Late final project (tool and written report or essay) will receive a mark of 0% for the tool and written report or essay component.*

Notes:

(1) Each student is expected to attend and participate in all the first 10 **weekly labs**. Participation grades in each lab will be based on the engagement in the mathematical activities and discussions. Participation at each lab session is worth of 1.5%. If a student misses a lab session for a good reason (proof required), the weight will be added to the final exam. ***No make up lab will be arranged***. Labs start on Wednesday September 7, 2016.

(2) **The lab reports**, each worth 2.5% for a total of 20%, are due at the beginning of the lab in the following week. Only the eight best reports (out of 10) will be recorded. The reports might contain parts done in team, as a such, the grading will then be comprised of an individual grade (for the individual section) and a team grade. If a student misses a lab, the team section of the lab report must then be completed individually. You must attach a cover page to your lab reports with: **course name and number, lab session name and number, your name(s), and student number(s)**. Your work must be one-sided only. A penalty of up to 5% might be deducted on your lab report if this format is not fully respected. There will be a **penalty of 20% for late report** and more than one day late (i.e., after Thursday 12:00) will result in 0%.

(3) The final exam will take place in a computer lab during the final exam period. **To pass the course** both a passing mark and a score of at least 40% on the final exam are required.

(4) The **project presentations** will take place during the last lecture day on December 5. If a student misses the presentation for a valid reason (proof required), the weight (3%) will be added to the final exam.

(5) The assignment of research papers and dates for the **presentation** will be assigned in the week of September 12. The presentation, in teams of 3, will be 12-15 minutes long. There will be presentations all along the term, with the first one on September 26 (TBC). The grading will consist of an individual grade and a team grade.

(6) **Use your Brock Email Address ONLY for all your electronic communication**. Be aware that emails not stemming from a Brock electronic address (hotmail, yahoo, gmail, ...) may NOT be responded to.

(7) **Plagiarism**: You may discuss the problems with other students. However, **the final submitted work must be your own (or from your own team for team work components)**. Any evidence of copying will result in a mark of 0.

(8) **Withdrawal Date**: Tuesday, 8 November, 2016 is the last date for withdrawal from the course without academic penalty.

Appendix C

Program Governance & Unit Rules and Regulations

Appendix C: Program Governance & Unit Rules and Regulations

C.1 General regulations

The authoritative source of regulations for the administration of the Ph.D. in Intelligent Systems and Data Science is the Faculty Handbook, and in particular Section 3B (Graduate Academic Regulations):
https://brocku.ca/university-secretariat/faculty-handbook/section-3/

Rules regarding the selection of Graduate Program Directors can be found in the current BUFA Agreement.

C.2 Program Governance

The Department of Computer Science and Department of Mathematics and Statistics will jointly govern the program. Joint governance implies the coordination of the program between the graduate program directors, chairs, and graduate program committees of each department, as well as the Dean's office and the Faculty of Graduate Studies.

Both departments have agreed upon the general requirements, rules, and regulations governing the program, as listed below in section C.3. Other administrative aspects of the program will be divided between the departments, primarily based upon the home department of the supervisor(s) of a student. For example, a (non-exhaustive) list of administrative duties that will be managed independently by each department includes the following:

- Selection of each department's graduate program director.
- Admission standards
- Selection of students by supervisors and departmental graduate program committees.
- Selection of thesis supervisory committees.
- Student office/lab allocation.
- Computer resource allocation and maintenance.
- TA management and funding.
- Course offerings, scheduling and timetabling.
- Comprehensive examination preparation, scheduling, assessment.
- Defense administration (with the Faculty of Graduate Studies)

Faculty from each department may be invited to participate in the Ph.D. administration of students from either department. Students may also take courses from the offerings of each department, subject to supervisor and instructor approval.

C.3 Rules and Regulations at the Unit Level

C.3.1 Entrance requirements

The program will normally follow a three-stage procedure. First, students will take courses in the graduate program. Then they will complete a comprehensive examination. Students will then perform their doctoral thesis research, and write and defend their thesis. The details of the program are as follows.

There are three ways in which students may be admitted, and these options will determine the duration of the program:

a) An MSc. in Computer Science, Mathematics, Statistics, or a closely related discipline with a minimum 80% overall average from an accredited institution.

b) Students currently in the M.Sc. program may apply to transfer into the Ph.D. program after one year of study if they have completed the required number of courses in their program with an average of at least 80% and have shown significant research progress as determined by their supervisory committee and graduate program committee.

c) In very exceptional cases, students may be admitted into the Ph.D. program with a four-year Honours Bachelor's degree, or the equivalent, with an overall average of at least an 85%. These students must demonstrate high research potential adjudicated by the graduate program committee.

C.3.2 Length of Study

For full-time students, the program is normally a 12 term or four-year program. For M.Sc. students transferring into the Ph.D. program (option b), the program is normally a 15 term or five-year program, which includes the time spent in the master's program. Full-time students must complete all degree requirements within 6 years from the date of first registration. Part-time students must complete all degree requirements within 8 years from the date of first registration.

C.3.3 Course Requirements

Students admitted through option (a) or (b) (C.3.1) must complete a total of 6 half-credit courses (this includes transfer credits undertaken during M.Sc. studies for option b students). Students entering under option (c) must complete a total of 8 half-credit courses. Courses selection is done in consultation with the supervisor, and is regulated by the following points:

- Required courses for all students: ISDS 7P75 Ph.D. Seminar and ISDS 5N01 Scientific Writing (normally taken together in the same term, see also Section 3.1 and 4.2).
- One half credit graduate course can be from a different department related to applications of modeling with mathematics or statistics, or applied computing, with the approval of the supervisor and course instructor.
- All other courses must be COSC/MATH half-credit courses at the 5(alpha)00 or above level.
- Exceptions to the above regulations have to be approved by the student's supervisor and the Graduate Program Committee.

The course offerings are based on the current offerings in the graduate programs in each department. The determination of Core or Elective courses will be determined by the supervisor. The courses are listed in the Graduate Calendar.

The following courses are compulsory in the program:

- ISDS 5N01 – Scientific Writing
- ISDS 7P75 – Ph.D. Seminar

ISDS 5N01 will be taught by instructors from Brock Student Development Centre.

The remaining courses are electives. The student may select from take any course in the course bank, under the advice and approval of the student's supervisor. The host departments' contributions to the course bank cover the following major research areas of computer science, mathematics, and statistics:

- *Formal methods*: COSC 5P02, COSC 5P03, COSC 5P05
- *Algorithms*: COSC 5P01, COSC 5P04, COSC 5P76
- *Computational intelligence*: COSC 5P71, COSC 5P74
- *Computer and Software Systems*: COSC 5P06, COSC 5P72, COSC 5P73
- *Methods of applied mathematics, differential equations and dynamical systems*: MATH 5P20, MATH 5P30, MATH 5P60, MATH 5P09, MATH 5P31, MATH 5P64
- *Statistical methods*: MATH 5P81, MATH 5P82MATH 5P82, MATH 5P83, MATH 5P84, MATH 5P85, MATH 5P86, MATH 5P87, MATH 5P88
- *Graph and game theory*: MATH 5P35, MATH 5P36

In addition to the above, students can select courses from other areas of mathematics, including algebra and number theory (MATH 5P10, MATH 5P10 60, MATH 5P10 66, MATH 5P10 15, MATH 5P10 92), functional analysis and topology (MATH 5P40, MATH 5P70) and technology in math education (MATH 5P96).

C.3.4 Comprehensive Examination

After all course requirements have been completed, but within the first 24 months of the program, all students must successfully complete a comprehensive examination. Prior to the exam, the student must submit a written proposal of research in the form of an NSERC grant application (PGS D). The student will be guided by the supervisor and the supervisory committee while preparing this application. The examination committee consists of a Graduate Program Director or designate, the supervisory committee, and one additional faculty member. The additional faculty member and one member of the supervisory committee will each provide a topic different from the student's research area together with sufficient study material at least 3 months prior to the examination. The examination will start with a presentation by the student about his/her research, followed by questions from the examination committee about this research. The examination concludes with questions about the topics provided by the two members of the examination committee. The examination can be repeated once within four months.

C.3.5 Submission for Publication, Thesis Submission, and Defense

Detailed regulations governing thesis formatting and Ph.D. defenses are found in the Faculty Handbook.

Before the thesis is submitted for defense parts of the thesis have to be published in, or at least have to be submitted to, an international journal or conference. The supervisory committee will decide whether a thesis is ready for defense. The examination committee is chaired by the Dean of Graduate Studies or designate, and consists of the supervisory committee, an internal examiner (from outside the graduate program but within Brock University), and an external examiner. The defense is open and will start with a presentation by the student about his/her research, followed by questions from the examination committee.

Computer Science

Departmental Procedures

Departmental Committee (Article 16)

Approved by department: 22/10/2018

Composition

The Departmental Committee comprises:

- all full-time faculty (BUFA members)
- 2 undergraduate student representatives (selected by the CSC annually with term length one year)
- 1 graduate student representative (overseen by the GPD with term length one year)
- full time staff
- others as approved by the full-time BUFA members

The Administrative Assistant shall serve as recording secretary.

Operation

The Departmental Committee shall operate in a manner consistent with Article 16 and Article 18 of the Collective Agreement between Brock University and Brock University Faculty Association 2017-2020. On questions of appointment, reappointment, promotion, tenure, leaves and election of chairs, only full time probationary and tenured BUFA members (henceforth referred to as the voting members) may vote, although all members of the Departmental Committee may take part in the discussion. Votes in the above matters shall be by secret ballot (16.03d).

For all departmental meetings and subcommittee meetings, the quorum is 50%+1 where for all votes in departmental meetings, the number of tenured and tenure-track faculty members should be no less than 50%+1 of the total number of attendees who are departmental committee members.

The departmental committee is to hold at least one meeting each term in the Fall and Winter. All minutes of the meetings will be made available.

Appointment of Chair (Article 27.03)

The department shall meet during the Fall term of the final year of a Chair's term to make a choice of a Chair for the subsequent year. Any tenured, full-time faculty member (BUFA) of the Department normally at the rank of Associate or above may declare themselves as a candidate or be nominated as a candidate. A candidate may refuse nomination or withdraw at any time. A Chair's term may be renewed. A renewal will be considered in the same manner as a vote for selection. After the candidate(s) have had an opportunity to provide information to the Committee and answer questions, they will be excused. After non-voting members have had an opportunity to be part of the discussions, they will also be excused from the meeting. The voting members will then vote, by secret ballot, for the choice of a Chair. The current chair will forward the result of the vote to the Dean.

Departmental Procedures

Appointment of Graduate Program Director (Article 16A)

Department of Computer Science

Approved by department22/10/2018

The department shall meet during the fall term of the third and final year of a GPD's term of service to make a choice of a GPD for the subsequent three years. Any tenured, full-time faculty member (BUFA) of the Department normally at the rank of Associate or above may declare themselves as a candidate or be nominated as a candidate. A candidate may refuse nomination or withdraw at any time. After the candidate(s) have had an opportunity to provide information to the Departmental Committee and answer questions, they will be excused. After non-voting members have had an opportunity to be part of the discussions, they will also be excused from the meeting. The voting members will then vote, by secret ballot, for the choice of a GPD. The chair will forward the result of the vote to the Dean.

Departmental Procedures

Procedures for Hiring, Reappointment, Tenure and Promotion, and Sabbatical leaves
Department of Computer Science
Brock University

Approved: 22/10/2018

The subcommittee for the hiring, reappointment, tenure and promotion, and sabbatical leaves consists of the tenured and tenure-track faculty members.

Hiring (Articles 19, 19.10 c, and 20.02.a.iii)

It is the responsibility of this Subcommittee to

- review the Department's Employment Equity Plan and propose amendments if necessary
- monitor the application of the Employment Equity Plan
- prepare a draft advertisement
- evaluate and respond to replies to the advertisement
- request further information and recommendations from the applicants
- make the dossiers of the applicants available to the departmental committee members (note that reference letters are only available to the BUFA members)
- prepare a short list of candidates to be invited for interviews:

  At the departmental committee meeting for the purpose of selecting the short list, everyone would have an opportunity to give their comments on the candidates to the Subcommittee. After non-voting members have had an opportunity to be part of the discussions, they will be excused from the meeting. The Subcommittee will continue discussions in this and subsequent Subcommittee meetings as required and then vote by secret ballot.
- submit the short list with all necessary files such as the Employment Equity Plan and candidates' CV's to the Dean and JCEE for approval
- arrange for interviews with the department and the Dean and BUFA
- make a hiring recommendation to the Dean.

Visits of short-listed candidates will be arranged so as to provide an opportunity for all members of the Department to meet them and/or attend a lecture or presentation. The candidate will present both a teaching and a research presentation. In scheduling the visit, the meeting with the BUFA Hiring Advice Committee member will be included.

Once the interview process is completed, discussions of the merits of the candidates shall take place *in camera* in meeting(s) of the Subcommittee. One of these meetings will include the

Departmental Committee at large, in which the Subcommittee can receive opinions and advice of all department members on the merits of the candidates. Minutes shall be kept of all such meetings. The Subcommittee will vote by secret ballot its recommendation regarding the appointment. After the hiring procedure is completed, copies of the approved minutes shall be filed in the office of the Dean.

The Chair shall forward the decision of the Subcommittee to the Dean (19.10.o), including a minority report should a minority viewpoint be expressed (19.10.p).

Specifically, all recommendations regarding the position to be filled, including any changes in the job description, shall be recorded, circulated to, and confirmed by the Department and forwarded to the Dean for approval.

The Chair shall write a report stating the recommendation of the Departmental Committee which accurately and fully represents the views of the Department and shall include a minority report, if a minority viewpoint has been expressed. The Chair will make the report available to the Departmental Committee for three (3) working days, during which time Subcommittee members may make suggestions for revision. After this period, and within one (1) week of the Department reaching a recommendation, the Chair/Director shall forward the recommendation and report to the appropriate Dean.

In the interest of openness and transparency, members will declare any relationship to the candidates. Conflict of interest will be handled according to Article 18. Discussions may ensue.

Reappointments (Article 19.12)

The application for reappointment will be made available to the Departmental Committee members (19.12.a.i). The Chair will consult with the members of the department. If no Subcommittee member views the reappointment as problematic, the Chair shall make a recommendation to reappoint to the Dean.

If a minority of at least two (19.12.a.i) Subcommittee members view the reappointment as problematic, they may request an email ballot of the Subcommittee members on the question of holding a reappointment review (19.12.a.i, 19.12.a.ii). If a majority believes a reappointment review should be held, the Chair will collect evidence of the member's performance and schedule a meeting of the Departmental Committee to discuss the issue. After the meeting, the candidate will be informed of the areas of concern and invited to present evidence at a subsequent meeting, accompanied by an academic colleague or a BUFA representative, to present evidence and answer questions. The member shall then be excused. After non-voting members have had an opportunity to be part of the discussions, they will also be excused from the meeting. The Subcommittee members will continue discussions as required and then vote by secret ballot on the reappointment recommendation. The Chair will forward the recommendation, result of the vote, and appropriate documentation to the Dean (19.12.a.iii).

Tenure and/or Promotions (Article 21)

A candidate may be nominated by a Department member or may apply on his/her own. A candidate may refuse nomination or withdraw at any time.

The candidate should seek advice of the BUFA Promotion and Tenure Advice Committee and will compile a dossier (21.09, 21.11). The Chair will check the completeness and accuracy of the dossier that will then be open to all members of the Department (21.14).

The candidate will propose a list of external referees which shall be distributed to all Subcommittee members via email (21.38.e). Should any member disagree with the list, a meeting will be held to discuss the list. Should no agreement on the list be forthcoming, the candidate and the Chair, on behalf of the department, will submit separate lists to the Dean. Otherwise the Chair shall submit the agreed list to the Dean.

The Chair will consult any faculty members on leave.

The Departmental Committee, meeting *in camera* without the candidate, will consider the application. After non-voting members have had an opportunity to be part of the discussions, they will be excused from the meeting. The Subcommittee members will continue discussions as required and then vote by secret ballot whether the tenure and/or promotion should be recommended (21.15).

If the department requires further information or is considering a negative recommendation, the Chair will inform the candidate of the specific questions or concerns and the candidate may respond in writing and/or attend a subsequent Departmental Committee meeting accompanied, if so desired, by a BUFA representative. The Departmental Committee will meet, *in camera*, a second time to consider the case. The candidate will be allowed to present information and answer questions and then shall be excused. After non-voting members have had an opportunity to be part of the discussions, they will also be excused from the meeting. The Subcommittee members will continue discussions as required and then vote by secret ballot (21.20).

The Chair will write a report stating the recommendation of the Subcommittee, the reasons for the recommendation, the recorded vote and the minority view, if any, and reasons for the minority view. The Chair will make the report available to the Departmental Committee for 10 working days, during which voting members may make suggestions for revision. After this period, the Chair will forward the recommendation and report to the candidate and the Dean (21.24).

Should the candidate be applying for both promotion and tenure, the questions will be treated as one issue (21.22).

Sabbatical Leaves (Article 34.03)

The applicant(s) will prepare and submit a dossier (34.03.d) to the Chair who will then make it available to the Department.

The Department will meet to consider the application(s) *in camera* without the applicant (34.03.e). After non-voting members have had an opportunity to be part of the discussions, they will be excused from the meeting. Should more information be required, or if a negative decision is being considered, the Chair will inform the applicant of the specific questions or concerns and the applicant may respond in writing and/or attend a subsequent Departmental Committee

meeting accompanied, if so desired, by a BUFA representative. The Departmental Committee will meet, *in camera*, a second time to consider the case. The applicant will be allowed to present information and answer questions and then shall be excused. After non-voting members have had an opportunity to be part of the discussions, they will also be excused from the meeting. The Subcommittee members will continue discussions as required and then vote by secret ballot (34.03.f).

The Chair will inform the applicant(s) and forward the supporting documentation and recommendation(s) to the University Subcommittee on Academic Leaves.

The departmental recommendation on sabbatical shall be on the basis of merit only. Should the number and timing of sabbaticals be problematic regarding departmental staffing, the Chair shall present the issues to the Dean. The Dean may negotiate a postponement (34.02.k) or delay (34.03.a) of a sabbatical with the applicant to meet the Department's needs.

Departmental Procedures

Approved by department: 22/10/2018

EMPLOYMENT EQUITY PLAN, Department of Computer Science

The Department is committed to hiring persons in academic positions based on merit, including demonstrated or potential ability in teaching, scholarly attainment and professional distinction (as per *Article 19.02* of the Collective Agreement). Recognizing all efforts should be made to ensure that designated groups, including women, Aboriginal peoples, members of visible minorities, people with disabilities, and lesbian, gay, bisexual, transgender, and queer (LGBTQ), are better represented in the Department and University as a whole, the following goals will inform the hiring process in the Department:

1. The Department seeks to achieve gender balance, as defined in *Article 20.01 (ii)*;

2. Any Department with more than 40% representation of women (i.e. women hold more than 40% of the probationary and tenured/permanent positions in the Department) will be deemed to have achieved a gender balance and, in this instance, the employment equity procedures in *Article 20* will apply to candidates from the other designated groups (i.e. Aboriginal peoples, members of minorities, people with disabilities, and lesbian, gay, bisexual, transgender, and queer (LGBTQ)).

3. In developing its curriculum and program requirements, the Department will consider their implications for attracting members of designated groups.

I. Advertisement

The Department will take the following steps during the hiring process, as elaborated in *Article 20.02 a. (i. - iii.)*:

1. Distribute a draft of the proposed advertisement to the Department for formal approval before external circulation;

2. Where possible, ensure that at least one member of the Department Selection Committee is from a designated group (or appointed one from outside of the Department with full voting rights).

In addition to the above, the Department will take the following steps with a view to eliminating barriers to employment of designated groups:

II. Recruitment

1. Advertise the position widely in a variety of media, including the Department website, the electronic list-serve for the discipline and related sub-fields , the Association website related to the discipline, Career Opportunities page at Brock, the Canadian Association of University

Teachers Bulletin, and University Affairs ;

2. Contact the Chairs of appropriate universities with a high number of PhDs, seeking them to encourage persons in designated groups to apply.

3. The following is included in the ad: "Candidates who wish to have their application considered as a member of one or more designated groups should fill out the Self-Identification Form available at https://brocku.ca/human-resources/wp-content/uploads/sites/81/SelfIdentificationForm.doc and include the completed form with their application." so that these forms will be part of the applications that will be reviewed.

III. Shortlisting

1. Consider carefully the applications of all self-identified persons from designated groups, according to the merit considerations spelled out in *Article 19.02*;

2. Candidates for probationary and tenured appointments are to be selected for the shortlist on the basis of the criteria in *Articles 19.02 (a), 19.02 (b) and 20* Employment Equity.

IV. Selection

In accordance with *Article 20.01(a) i*, recommend for appointment a person from a designated group, where that person is equally qualified as the best candidate, or is not substantially apart in qualifications from the best candidate.

V. Summary of Current Probationary and Tenured Members

A summary of the current number of probationary and tenured members in the Department, as well as the number of self-identified members of each designated group, is given below. Please note that one person is counted twice both as a woman and visible minority.

	Women	Visible Minorities	Aboriginal Peoples	People with Disabilities	LGBTQ	Total
Tenured (9)	2	2	0	0	0	4
Probationary (1)	0	0	0	0	0	0

VI. Equity Related Goals for Hiring

We aim to recommend a person from a designated group, provided that the person is equally qualified as the best candidate, or is not substantially apart in qualifications from the best candidate. In accordance with *Article 20.01(a) and (b)*, we will first

address the gender imbalance in the department, followed by the considerations of other designated groups.

Departmental Procedures

Procedures for Adjunct Appointments
Department of Computer Science
Brock University

Approved by department: 22/10/2018

An adjunct appointment is made on the recommendation of the department and must be approved by the Dean and the President.

Procedure for approval of an initial adjunct appointment

A person wishing to hold an adjunct appointment within the department will request the appointment by sending a letter to the chair of the department. This letter should indicate the reasons for the request and anticipated future contributions to the department, as well as any existing collaborations with members of the department and/or relationship to the department. The applicant should enclose a CV. The applicant will normally be invited to present a research seminar to the department.

The application will be circulated to the departmental committee. The department, meeting in camera, will consider the application. The voting members of the department will then vote, by secret ballot, on whether they wish to recommend an adjunct appointment. After the vote, the chair will forward the recommendation to the Dean's office.

The recommendation will include the following information, which is to have been discussed by the department:

- The effective dates of the appointment. This will normally be for 3 years, however a shorter term may be recommended if the department feels it is warranted.
- Rank.
- Specific duties and responsibilities.
- Special conditions, if any.

Procedure for renewal of an adjunct appointment

A person already holding an adjunct position within the department may wish to renew their appointment when the term expires. The procedures for renewal are the same as for the initial appointment, with the exception that the candidate should specify in their letter that the request is for renewal. Such a request should normally be made at least 2 months prior to the expiry of the appointment. If no such request is made then the appointment will lapse.

Departmental Procedures

Course Evaluation Procedures
(Articles 12.04.a.v, 12.07, 16.03.h)

Approved by department: 22/10/2018

1. Course evaluation instrument is approved by department committee and available both in a paper version and an online version.

2. The instructor informs the Administrative Assistant by the end of week eight if they are using the hard copy evaluation and will provide the course configuration (i.e. lecture, lab, tutorial, seminar), and the date on which the course evaluation is to be conducted. The Chair will send a timely reminder to instructors in regard of this matter.

3. Course evaluation is performed by either one of the following two methods:

    a. Paper system:
        - The course evaluation is performed in class normally during the last two weeks of term.
        - Instructor will ask another instructor or a volunteer from the class to conduct the evaluation. The instructor will not be present during the evaluation.
        - Volunteer oversees course evaluation, collects forms and returns forms to Administrative Assistant at the first available opportunity.

    b. Online system:
        - The online system will provide both restricted access (to the students registered in the course) and anonymity of respondent.
        - When the evaluation is prepared, the students are informed and reminded that the online evaluation is available for two weeks.

NOTE: The following Procedures apply to the hard copy course evaluations. The Centre for Pedagogical Innovation administers the current online evaluations,

4. The Administrative Assistant prepares the course evaluation packages including the appropriate question sets based on the course configuration and notifies the instructor when the evaluation is available.

5. The Administrative Assistant collates and prepares the comments for course evaluations.

6. For non-BUFA instructors, Administrative Assistant places course evaluation packages in Chair's mailbox and emails summary to the Chair.

7. For TAs/Lab Demonstrators, Administrative Assistant places the TA/Lab Demonstrator evaluation packages in the Senior Lab Demonstrator's mailbox and

emails the summary, if available, to the instructor, Senior Lab Demonstrator and Chair.

8. When instructor submits final marks, Administrative Assistant places the instructor course evaluation package in members' mailboxes (BUFA) and emails comments and data to the instructor (BUFA and non-BUFA). If a TA wishes to see their own evaluations they may see them after this time.

9. The Administrative Assistant deletes summaries and retains no copies of course evaluations or summaries in departmental files for BUFA members unless requested by the member in writing. The BUFA member is solely responsible for the archiving of course evaluations. Course evaluations for non-BUFA instructors are maintained in departmental files.

10. BUFA members will make the results of the course evaluations available to the Dean as part of the Performance Review process (12.07.d)

Department of Computer Science
Normal Workload Standard
2018/19
(Articles 24 and 21.06)

Approved by Department: 22/10/2018

Preface

Members are entitled to equitable workloads (Article 24.01) and have the right and responsibility to devote time to the three components of academic workload: Teaching, Research/Scholarly/Creative Activity and Service, normally in the ratio 40/40/20 (Article 24.03.a).

Various circumstances may lead to (24.03.b, 24.03.d, 24.04.b, 24.04.c, 24.05.b) workload redistributions or reductions. Workload redistribution is negotiated with the Dean and typically leads to a different ratio of workload components. Leaves, phased-in retirement, etc. generally lead to a reduced total workload measure but usually retain the same ratio for remaining workload components.

Certain positions (e.g. Chair) have teaching relief. This relief is partial compensation for additional administrative loads carried by these positions. The following list enumerates common teaching release, but is not intended to be exhaustive.

- Chair = Normally minimum 2 half course reduction in base scheduled teaching amount (Article 27.02.b).
- GPD = Normally minimum 1 half course reduction in base scheduled teaching amount (Article 27.02.c).

The Annual Workload Plan (AWP) defines the actual distribution (normally 40/40/20) and the total workload each of which may differ from the NWS (24.02.b, 24.04.bc) and/or exhibit minor variation year-to-year (24.05.b).

Teaching Commitment

Teaching activities include those described in Articles 24.02.a and 21.06.a. Teaching commitment normally consists of a maximum of 4 scheduled half courses (base scheduleded teaching amount, 24.04.a (iv)) plus a combination of the following, amounting to 4.5 half course equivalents of total teaching commitment:

- additional consideration for scheduled teaching factors including but not limited
- to extra contact hours, high enrollment and courses new to the instructor (24.04.c)
- supervision of graduate students (equivalent to 0.5 half-course per student)
- reading courses (equivalent to 0.20 half-course per student)
- supervision of projects:
- 4F90 (equivalent to 0.20 half-course per student)
- 3P99 or 2P99 (equivalent to 0.10 half-course per student)
- MSc supervisory committees (equivalent to 0.1 half-course per student, and not including student supervision)
- other teaching activities

If unscheduled teaching (including carryover from a previous year) equals or exceeds 1.5

half-course equivalents in a given year, scheduled teaching is normally reduced by a maximum of 1.0 half courses for that year.

Once teaching reductions have been taken into account, any additional unscheduled teaching (including carryover from a previous year) in excess of 0.5 half-course equivalents will be carried over to the subsequent year. Carryover is limited to 1.0 half-course equivalent.

Research/Scholarly/Creative/Professional Activity Commitment

All faculty members are normally expected to be active in research/scholarly/creative activity, make attempts to obtain funding (if relevant to their scholarly activity), and disseminate the results of their work.

Research/scholarly/creative and professional commitment normally consists of a combination of activities as described in Articles 24.02.b and 21.06.b amounting to 40% of total workload including, but not limited to:

- discovery-based research as evidenced by, inter alia, journal and conference publications
- applied research as evidenced by, inter alia, patents, industrial research/development contracts
- contributions to the discipline as evidenced by, inter alia, books, case studies, monographs, contributions to edited books, panels, workshops, clinics, editorial duties, refereeing duties
- software/hardware/equipment development as evidenced by, inter alia, commercial products, industrial contracts, tools in use in educational or other areas
- pedagogical development as evidenced by, inter alia, curriculum design, learning object development, books, case studies, monographs, contributions to edited books, panels, workshops, clinics, editorial duties, refereeing duties
- scholarly/professional contributions as evidenced by, *inter alia,* consultation with government, professional or related agencies; instructional, clinical, curriculum or policy development
- attempting to secure funding for research/scholarly or creative activities
- other activities appropriate to research/scholarship or creative work

It is understood that in the field of Computer Science a refereed conference publication is considered equivalent to a refereed journal publication.

Service Commitment

All faculty members are normally expected to participate in service activities, which include those described in Articles 24.02.c and 21.06.c. Service commitment normally consists of membership in the Departmental Committee and a combination of other activities, amounting to 20% of total workload, including but not limited to:

- union/Senate/university committees
- faculty/department committees
- departmental responsibility
- professional service
- community service
- other service activities

Approved: March 14, 2018
Revised: October 15, 2018

Department of Mathematics and Statistics

Rules of Procedure for the Academic Year 2018/2019

I. Departmental Assembly

1. The Departmental Assembly shall operate in a manner consistent with Article 16 of the Collective Agreement.

2. The Departmental Assembly comprises:

(1) all full-time faculty members;
(2) the staff instructor, the Online Course Developer/Administrator, and the Mathematics Development Programs Coordinator;
(3) ILTA members (if any).

All members listed in (2) shall have full voting rights, except as limited by the restrictions of Sections 16.02 (a) and (c) and 16.03 (b), (c) and (d), and also limited to exclude all matters of academic program policy and direction and all hiring/promotion of faculty.

3. The Department Chair shall be elected by a majority vote of the Departmental Assembly in accordance with Article 27.03 of the Collective Agreement. Normally the Chair serves for three years.

4. The Department Chair or his/her delegate chairs the Departmental Assembly meetings; the administrative assistant takes minutes.

5. The Departmental Assembly shall meet at least once in each of the fall and winter terms. Additional meetings will be at the call of the Chair or by the call of at least two members of the Assembly.

6. The Department Chair shall give all members at least seven days advance notice of the date called for a meeting, unless the Departmental Assembly agrees unanimously to an earlier date. All major items normally shall be communicated at least four days before the meeting.

7. Meetings shall be scheduled during business hours when all members are free from teaching duties and other university service duties. If this is not possible, then meetings shall be scheduled outside of business hours at days/times approved by a Department email vote.

8. A meeting shall be cancelled if a majority of full-time faculty members are not present (excluding any members on sabbatical).

II. Procedures for Departmental Votes

1. Votes shall normally be held during Assembly meetings. Members not in attendance for a vote, including any members on sabbatical, shall be allowed to cast a ballot within a week.

2. Votes on any important business shall be conducted by secret ballot. Any voting member of the Departmental Assembly may call for a secret ballot on any vote. The administrative assistant shall collect and count the ballots. The ballots shall be tallied and recorded only after all ballots, including any cast by absent members, are received by the administrative assistant, or after one week from the day of the vote.

3. Email votes are permissible for routine or minor business or if an urgent deadline arises. Members will be given a clear deadline (with a reasonable period of time) for submission of a vote. All votes will be tallied and counted by the administrative assistant. Any member may call for a regular vote in place of an email vote.

4. A vote passes if and only if a majority of the Departmental Assembly voting members (specified under I.2) vote “yes” or “in favour”. Any member on sabbatical who does not opt out of a vote is included as a voting member when counting if a majority has been obtained. Sabbatical members can opt out of any vote by notifying the Departmental

Chair. For votes on important business, the Department Chair shall send a reminder message to all absent sabbatical members.

5. Exceptional requests by any individual member of the Departmental Assembly will be resolved by the following procedures:

(1) the member will prepare a short written document if necessary, containing only facts relevant to the request;
(2) the member will be given time to speak about the request in a meeting of the Departmental Assembly;
(3) without the member present, the request will be discussed and a vote taken if necessary;
(4) normally any request will be approved only by establishing reasonable criteria that apply to all similar members of the Departmental Assembly (rather than just to a specific individual).

III. Procedures and Criteria for Promotion and Granting of Tenure

1. The Department shall operate in accordance with Article 21 of the Collective Agreement, including all procedures and criteria.

2. Votes on Promotions and Tenure shall be conducted using the wording:

(1) “The Department recommends … be granted Promotion to Full Professor”; or
(2) “The Department recommends … be granted Tenure and Promotion to Associate Professor”.

3. If the vote on an application for Tenure does not pass, then in accordance with Articles 21.15 and 21.66, a second vote shall be held using the wording:

"The Department recommends an extension of the probationary period for … year(s)", where the period cannot exceed two years for a first probation and one year for a second probation.

IV. Procedures for Annual Performance Review and Teaching Evaluations

1. Faculty members are responsible to submit an annual report to the Department Chair. Numerical summary pages of a member's teaching evaluations shall be submitted directly to the Dean.

2. To comply with Article 27.01(o) of the Collective Agreement, the Department Chair shall advise the Dean on performance review of faculty members solely at the Dean's request and based solely on criteria established by the Departmental Assembly.

[Note: The department will need to decide on "criteria" for performance review. Until this is done, the default criteria will be "past practice".]

3. Course evaluations for each faculty member and each staff instructor shall be kept private from other members and from administrative staff, including the Department Chair. The administrative assistant shall receive and distribute all course evaluations.

V. Procedures for Scheduling of Teaching Assignments & Course Offerings

1. In preparing the Department's Annual Workload Plan, the Department shall use the following procedures for assigning teaching and offering courses:

(1) The Department Chair shall circulate the Department's Course Offering Schedule, after consultation with the Department on the offering of upper year courses and consultation with the Graduate Program Director on the offering of graduate courses.
(2) The Department Chair shall ask each faculty member and staff instructor for preferences for his/her own teaching assignment.
(3) The Department Chair shall prepare and circulate a preliminary teaching deployment that adheres to (1) and (2).
(4) Any unresolved disputes that may arise between faculty members or staff instructors or with the Department Chair regarding a member's own teaching assignment shall be settled in consultation with the Office of Human

Rights and Equity Services or with the Dean.
(5) Enrollment minimums and procedures for cancellation of low enrollment courses are specified in Appendix 1.
(6) The final teaching deployment, and any subsequent changes to it, shall be passed by a Departmental vote.
(7) The membership continues until membership reassignment is approved by the departmental committee for the following academic year or until the member resigns.

VI. Committee Procedures

1. Departmental committees shall be struck, restructured, or disbanded only by a Departmental vote.

2. The Department Chair or any other member of the Departmental Assembly may propose striking, restructuring, or disbanding a committee.

3. Membership in all Departmental committees and Faculty of Mathematics & Science committees shall be established annually by the following procedures:

(1) The Department Chair shall ask each member for preferences of which committee(s) the member will serve on, consistent with the Department's Normal Workload Standard.
(2) Each of the five program concentrations (Applied Mathematics, Mathematics Education, MICA, Pure Mathematics, Statistics) shall form a standing committee.
(3) Major committees shall include, if at all possible, one representative from each of the five program concentrations.
(4) The Department Chair shall prepare and circulate a preliminary committee membership list that adheres to (1), (2), (3).
(5) Any unresolved disputes that may arise between faculty members or other assembly members or with the Chair regarding a member's own committee assignment(s) shall be settled in consultation with the Office of Human Rights and Equity Services or with the Dean.
(6) The final committee membership list shall be passed by a Departmental vote.

4. No one shall chair the same Departmental committee for more than three consecutive years.

5. No one shall serve on the same Departmental committee for more than three consecutive years, except for standing members as listed in the Normal Department Workload Standard and except for extraordinary circumstances.

6. Each Departmental committee shall elect its own committee chair.

7. Committee meetings are called by the committee chair or by any two committee members, with at least seven days advance notice unless the committee unanimously agrees to an earlier date.

8. Meetings shall be scheduled during business hours when all members are free from teaching duties and other committee meetings and university service duties.

9. A meeting shall be cancelled if a majority of members are not present.

10. Committee votes shall normally be held during committee meetings. Members not in attendance for a vote shall be allowed to cast a ballot within a reasonable period of time. Any member may call for a secret ballot on any vote.

11. Email votes are permissible for routine or minor business or if an urgent deadline arises. Members will be given a clear deadline (with a reasonable period of time) for submission of a vote.

12. A vote passes if and only if a majority of the committee members vote “yes” or “in favour” (including any absent members).

VII. Procedures of Conduct for the Departmental Assembly and Departmental Committees

1. The complete agenda (except for minor "Other Business") for a meeting shall be distributed to all members at

least two business days ahead of the meeting.

2. The first item on the agenda shall be approval of the agenda. The chair shall call for changes/additions/objections and the final agenda shall be approved by either unanimous consent or a vote if called by the chair or any member. Absent members are not entitled to vote on the agenda.

3. Minutes of previous meetings shall be typed and circulated to all members by the administrative assistant, or a delegated member, within a reasonable period of time. Minor corrections to the minutes shall be conducted by email. Minutes normally do not require approval, however, any member may call for a vote on approval of the minutes.

4. Votes on major business shall be placed on the agenda only in advance or by unanimous consent of all members during the meeting. Votes on routine and minor business can be added/deleted from the agenda by a motion during the meeting.

5. Motions can be tabled by any voting member in attendance at a meeting. Once a motion is on the table, the chair shall call for a discussion. Votes on any important business require a motion to be tabled.

6. A motion must be seconded by a voting member before it can be put to a vote. The chair shall allow equal time for every interested member to speak before the vote is called.

7. Members shall speak one at a time, by raising a hand and waiting for the chair to give the floor to the member. Members shall address only the agenda items under discussion. Any member can call a point of order if any rule is not being followed in a meeting.

8. The role of the chair of a committee shall be primarily to:

(1) provide all information/documents relevant to the agenda items;
(2) guide the discussion and seek consensus among members whenever possible;
(3) give the floor to members in the order in which they raise a hand to speak;
(4) ensure that the agenda is followed and that every member has an equal chance to speak.

9. The chair may speak as an equal departmental colleague to state an opinion on the business under discussion.

10. All members shall act collegially and not raise their voices or create a hostile atmosphere. Any member, including the chair, who engages in uncollegial behaviour shall be dismissed from the meeting.

VIII. Duties and Role of the Departmental Chair

1. Administration Duties:

(1) supervise the administrative assistant, including year-end job performance evaluation;
(2) evaluate staff members;
(3) review Departmental Budget (annually and as needed) with the administrative assistant and the Dean's budget officer.

2. Signing Authority:

(1) course grades;
(2) Change/Add Majors forms (prepared by the administrative assistant);
(3) course substitutions (forms prepared by the administrative assistant);
(4) Transfer Credits and Letter of Permission (forms prepared by the administrative assistant);
(5) Degree Audit Reports (prepared by the administrative assistant);
(6) email accounts for Part-Time Instructors and Visiting Scholars (inputted by the administrative assistant);
(7) Standing Review forms and Approve Continuance in Program forms (prepared by the administrative assistant);
(8) CUPE TA/Part-Time Instructor Job Postings (inputted by Dorothy);
(9) CUPE Allocation of Hours Forms for TAs (prepared by Dorothy);
(10) TA/Part-Time Instructor Contracts (inputted by the administrative assistant);

(12) special requests by Faculty for travel or conference funds;
(13) departmental expenses/expenditures (forms prepared by the administrative assistant);
(14) APC submission forms for graduate and undergraduate calendar (inputted by the administrative assistant).

3. Major Responsibilities:

(1) attend Dean's meeting of Chairs & Directors;
(2) report Departmental motions, concerns, questions to the Dean;
(3) communicate the Dean's instructions and tasks or concerns to the Department Assembly;
(4) advocate for quality and integrity of the Department's programs in meetings with the Dean and the University administration;
(5) reply to inquiries from the Dean's Office, Human Resources, and the University administration (routine inquiries including phone messages are handled by the administrative assistant);
(6) convene and facilitate Departmental meetings;
(7) make sure all Department business is conducted transparently, collegially, and democratically;
(8) make sure all procedures for sabbatical and promotion and tenure applications are conducted according to the Collective Agreement;
(9) facilitate passing the Annual Workload Plan including the list of Departmental/University Committees and membership;
(10) oversee changes/amendments to the Departmental Rules of Procedure and the
Normal Workload Standards proposed by the Departmental Assembly;
(11) bring any major expenditures or major budget items to the Departmental Assembly for discussion and approval;
(12) adjudicate student complaints and cases of academic misconduct by students;
(13) help resolve disputes among Department members;
(14) assist Human Resources and the Dean with resolving CUPE grievances and handling administrative problems with Part-Time instructors.

4. Committee Roles:

(1) chairs Departmental hiring committees for administrative staff members; normally shall not serve as chair of any other major Departmental committee;
(2) may serve on other Departmental/University committees.

IX. Duties and Role of the Service Course Coordinator

(a) Principles of Coordination

i) Collegiality: all decisions concerning the course's delivery are made after consultation with, call for input from, and timely approval of all instructors and adhere to the recommendations and curriculum set by the Service Course Committee and Curriculum Committee.
ii) Fairness: No section shall be favoured by the choice of assigned work or access to information pertaining to testing.
iii) Transparency: The coordinator will ensure that all matters pertaining to the course will be presented in an open and transparent way to all instructors and that they are provided with a forum in which to discuss all the issues that arise.
iv) Efficiency: It is expected that the course coordinator will optimize the flow of materials and ideas in such a way as to be a real benefit to both teachers and students.

(b) Responsibilities: The Course Coordinator is responsible for the effective and smooth running of the course. This includes

i) Administering the online section of the course.
ii) Chairing the meetings of instructors.
iii) Communicating with the Manager, Academic Support and the Mathematics Development Programs Coordinator on matters related to the course.
iv) Supporting students.

v) Establishing grading and marking schemes for both versions of the test, and distributing these to the TAs.
vi) Submitting final exam scantrons to ITS for grading, receiving the results afterwards and importing into Gradebook.

(c) Duties:

i) Calling meetings of the instructors and setting the meeting agendas.
ii) Creating a schedule of assignments.
iii) Organizing students into appropriately sized drop-boxes, rotating the TAs through different drop-boxes for each assignment, posting final versions of each assignment on all course Sakai pages, as well as releasing assignment solutions when applicable.
iv) Writing solutions for both versions of the test and posting to Sakai.

(d) Duties (cannot be overridden):

i) Ensuring that all course materials seen by students use correct English and standard mathematical language and terminology.
ii) Entering student information, assisting with technical difficulties and ensuring con tent correctness.
iii) Providing assignment extensions for all students if/when required, and downloading grades and importing into Gradebook.
iv) Preparing drafts and final versions of review material to all sections in Sakai.
v) Making sure deadlines are respected.
vi) Resolving grading issues and ensuring that grades are entered correctly.
vii) Handling all requests for test accommodation due to medical illness or extenuating circumstances. This involves collecting, reviewing and approving medical certificates, booking a room for the secondary test sitting, and emailing students to confirm room location.
viii) Handling all interactions with SSWD/SAS, including inputting test/exam information onto the OASIS system, and receiving/redistributing to the TA's all test/exams written with SSWD.
ix) Posting general announcements regarding test information (such as room assignments, relevant chapters, etc.), and any other information to be circulated to the entire class.
x) Collating all the questions received from the instructors and generating the pdf file of assignments, term tests and final exam.
xi) For term tests, if a secondary term test sitting was required (due to medical illness or other accommodations), the Course Coordinator is responsible for creating an alternate version of the term test.

(e) Duties (cannot be overridden after consultation with and approval by the Service Course Committee):

i) Creation of WeBWorK assignments.
ii) Selecting the textbook for the next session/year (after consultation with the Chair of the Service Course Committee who will consult a member of either the Statistics or Mathematics Committee).
iii) Reviewing all submitted questions for content, level of difficulty, appropriate language and notation, etc; selecting questions to put on the test, and/or creating questions to cover missing content or unsatisfactory questions; creating a second version of the test.

(f) Course Outline & Syllabus: Before the start of the course, the Course Coordinator will call a meeting with all instructors to unanimously agree on a schedule of assignments & tests, which must be approved by the Service Course Committee. It must contain:

i) The textbook(s) (if any).
ii) A detailed table of contents with a corresponding timetable and corresponding textbook(s) sections.
iii) Instructions and guidelines (e.g. penalties for late work, formats for submitted work, format and expectations for labs and tutorials, disclaimer on plagiarism, etc.)

(g) Content of Assigned Work: The Course Coordinator shall abide by the following guidelines:

i) Each instructor will be required to prepare one or more assignments for the course, proportional to the number of sections being taught. At the first course meeting, instructors will choose the assignment(s) for which they will be responsible.
ii) An assignment draft must be available for all instructors to review at least 3 days prior to the assignment being posted to Sakai. If an instructor fails to send comments, it will be assumed that the instructor approves of the draft. Once a final version has been established, the assignment must be posted by the Coordinator a minimum of 10 days prior to its due date.
iii) No work shall be assigned to students without being approved by all instructors who have responded to the Course Coordinator's invitations for input and approval. Under no circumstances will an instructor be asked to agree to any kind of assessment that they have not been invited to review. This assumes a reasonable amount of assigned work material to be reviewed prior to selection and publication.
iv) The Course Coordinator will invite questions from instructors for each test and the final exam.
v) The final examination will contain a selection of questions from each instructor.
vi) The Course Coordinator will set a deadline for submission of changes to the final exam after which no changes can be made. Instructors must then unanimously agree on the final version that is to be sent for printing.

Appendix 1. Procedures & options for low-enrollment courses

The Dean establishes the minimal acceptable enrollment for various categories of courses in a given academic year. Such requirement shall be followed:

(1) When the Annual Workload Plan is prepared, Department members who request to teach a course that may get an enrollment (based on projections/estimates from previous years) below the minimum will be notified by the Departmental Chair. If necessary, these courses will be listed and circulated to the whole Department by the Departmental Chair before the final AWP is put to a vote.

(2) Once the enrollment period for courses is nearing a close, the Departmental Chair will notify any Department members whose upcoming courses have enrollment below the minimum.

(3) If a course does not have the minimum enrollment, then the Department member scheduled to teach that course will be notified and must choose one the following options:
(a) teach a TBA course for the coming term;
(b) teach a TBA course for the next term or spring term;
(c) negotiate with the Dean to teach an extra course in the following year.
The only way a department member could avoid the options (a), (b), (c) is by voluntarily going to a 5-3 load in advance by teaching an extra course and then postponing the reduced load as a cushion for a future year.

(4) If a student is in need of a course for fulfilling degree requirements, but the course is not run either as a regular course or a reading course, then the Departmental Chair (in the case of an undergrad student) or the GPD (in the case of a grad student) will authorize a substitution in the courses needed for the student to complete a degree.

(5) The Department will put in place a 2-year schedule of course offerings, both undergrad and grad, where courses will be divided into three categories: (I) runs every year; (II) runs in alternate years; (III) runs occasionally (at least once every 3-5 years) based on student demand or other considerations. This schedule will be revised as needed when the AWP is prepared and will be made available on the Department website to assist students with planning their course schedules and completing degree requirements.

Appendix 2. Procedures regarding departmental documents

(1) All department documents must be circulated after final approval and should be available from the administrative assistant for any member of the department to access.

(2) All department documents must show a date of last revision and a date of last approval.

Appendix 3. Coordination of Multi-Section Courses

1. Service courses Math 1P97 and Math 1P98 will follow the coordinated administration of the Service Course Coordinator.

2. Any instructor (part-time, staff, faculty) who wishes to teach a section of service courses Math 1P97 and/or 1P98 agrees to follow the coordinated administration of the Service Course Coordinator. The instructor shall agree, by signature, that he/she has been informed of and will respect all matters that are explicitly listed in the Service Course Coordinator's duties (d, e).

Appendix 4. Miscellaneous Procedures

1. Accommodation of Visitors:

The department is happy to accommodate visitors subject to availability of space and resources. Departmental office space, email access, access to department's computers, etc. will be provided only to visitors who meet at least one of the following criteria:
(a) the visitor is actively working on research with a faculty member in the department;
(b) the visitor will be teaching a course as approved by the department at the time of the invitation;
(c) the visitor has some institutional connection with Brock through the visitor's home institution (e.g. scholar exchange program, VIS program).

2. Student Surveys in Courses:

(1) In any service course and any regular course taught by a part-time instructor, if complaints arise or other evidence of a problem emerges, then the department has a right to intervene by conducting a survey or suggesting changes to the grading pattern. This applies to any instructor: faculty member, staff member, or part-time.

(2) If necessary, CPI can be consulted regarding survey questions, and the Associate Dean Undergraduate Programs can be consulted regarding changes to grading pattern. Both the instructor and the department have to approve both the questions on a survey and/or changes to a grading pattern.

3. Policies on Misconduct and Medical Notes in Courses:

For all courses, the Course Outline and Syllabus must include a reference to the Brock Policies on Academic Misconduct and Medical Notes. Instructors cannot make changes to those policies without prior consent of the Department and the Associate Dean for Undergraduate Studies.

Appendix D

Draft Calendar Entry

Intelligent Systems and Data Science

Ph.D. in Intelligent Systems and Data Science

Dean
S.Ejaz Ahmed
Faculty of Mathematics and Science

Associate Dean
Cheryl McCormick
Faculty of Mathematics and Science

Core Faculty

Professors
S. Ejaz Ahmed (Mathematics and Statistics), Stephen Anco (Mathematics and Statistics), Hichem Ben-El-Mechaiekh (Mathematics and Statistics), Henryk Fuks (Mathematics and Statistics), Sheridan Houghten (Computer Science), Mei Ling Huang (Mathematics and Statistics), Omar Kihel (Mathematics and Statistics), Yuanlin Li (Mathematics and Statistics), Alexander Odesskii (Mathematics and Statistics), Beatrice Ombuki-Berman (Computer Science), Ke Qiu (Computer Science), Brian Ross (Computer Science), Jan Vrbik (Mathematics and Statistics), Michael Winter (Computer Science), Thomas Wolf (Mathematics and Statistics)

Associate Professors
Chantal Buteau (Mathematics and Statistics), David Hughes (Computer Science), Xiaojian Xu (Mathematics and Statistics)

Assistant Professors
Robson De Grande (Computer Science), Naser Ezzati-Jivan (Computer Science), Yifeng Li (Computer Science), William Marshal (Mathematics and Statistics)

Professors Emeriti
Howard Bell (Mathematics and Statistics), Ivo Düntsch (Computer Science), Ronald Kerman (Mathematics and Statistics), Eric Muller (Mathematics and Statistics

Participating Graduate Faculty

Associate Professors
Ping Liang (Biological Sciences)

Adjunct Professors
Joseph Brown, James Hughes

Graduate Program Directors
Beatrice Ombuki-Berman (COSC)
bombuki@brocku.ca

Henryk Fuks (MATH)
hfuks@brocku.ca

Administrative Assistant (COSC)
Donna Phelps
905-688-5550, extension 3513
Mackenzie Chown J314
donna.phelps@brocku.ca

Administrative Assistant (MATH)
Margaret Thomson
905-688-5550, extension 3300
Mackenzie Chown J415
mathadmin@brocku.ca

Program Description

The Department of Computer Science and Department of Mathematics and Statistics offers a program leading to the Doctor of Intelligent Systems and Data Science (PhD) degree. The program offers a strong research theme into the complementary roles of intelligent systems and data science, and their role in solving complex real-world applications. Graduate research topics may be conducted in a number of broad areas, including artificial intelligence, smart systems, and data science. Please see department web pages for a listing of faculty and their specific research interests.

Admission Requirements

There are three ways in which students may be admitted: (i) An M.Sc. in Computer Science, Mathematics, Statistics, or a closely related discipline with a minimum 80% overall average from an accredited institution. (ii) Students currently in the M.Sc. program may apply to transfer into the Ph.D. program after one year of study if they have completed the required number of courses in their program with an average of at least 80% and have shown significant research progress as determined by their supervisory committee and graduate program committee. (iii) In very exceptional cases, students may be admitted into the Ph.D. program with a four-year Honours Bachelor's degree, or the equivalent, with an overall average of at least an 85%. These students must demonstrate high research potential adjudicated by the graduate program committee.

The Graduate Admissions Committee will review all applications and recommend admission for a limited number of suitable candidates.

Part-time study is available.

Degree Requirements

All candidates must fulfil course requirements, a comprehensive examination, and thesis requirements.

Course Requirements: Students admitted through option (i) or (ii) must complete a total of 6 half-credit courses; students using option (iii) must complete a total of 8 half-credit courses. Courses selection is done in consultation with the supervisor. Required courses for all students: ISDS 7P75 Ph.D. Seminar and ISDS 5N01 Scientific Writing (normally taken together in the same term). One half credit graduate course can be from a different department related to applications of modeling with mathematics or statistics, or applied computing, with the approval of the supervisor and course instructor. All other courses must be COSC/MATH half-credit courses at the 5(alpha)00 or above level.

Comprehensive Examination: After all course requirements have been completed, but within the first 24 months of the program, all students must successfully complete a comprehensive examination. Prior to the exam, the student must submit a written proposal of research in the form of an NSERC grant application (PGS D). The student will be guided by the supervisor and the supervisory committee while preparing this application. The examination committee consists of a Graduate Program Director or designate, the supervisory committee, and one additional faculty member. The additional faculty member and one member of the supervisory committee will each provide a topic different from the student's research area together with sufficient study material at least 3 months prior to the examination. The examination will start with a presentation by the student about his/her research, followed by questions from the examination committee about this research. The examination concludes with questions about the topics provided by the two members of the examination committee. The examination can be repeated once within four months.

Thesis and Thesis Defense: Before the thesis is submitted for defense parts of the thesis have to be published in, or at least have to be submitted to, an international journal or conference. The supervisory committee will decide whether a thesis is ready for defense. The examination committee is chaired by the Dean of Graduate Studies or designate, and consists of the supervisory committee, an internal examiner (from outside the graduate program but within Brock University), and an external examiner. The defense is open and will start with a presentation by the student about his/her research, followed by questions from the examination committee.

Facilities

A campus-wide fiber optic network links all of the university's academic computing facilities. The departments' computers form an integral part of this resource. All faculty and graduate students are provided with an account on the departmental and/or university servers. Most computers on campus can be accessed from microcomputers in any of the laboratories.

Brock is also a full member of the SHARCnet consortium with access to all its high performance clusters of powerful workstations.

In addition to three servers, the departments maintain several PC based labs and UNIX workstations for teaching and research.

Course Descriptions

Note that not all courses are offered in every session. Refer to the applicable timetable for details

Students must check to ensure that prerequisites are met. Students may be deregistered, at the request of the instructor, from any course for which prerequisites and/or restrictions have not been met.

ISDS 5N01
Scientific Writing
The organizational and stylistic skills of writing and referencing a scientific document. Examples from the various literature forms such as primary journals, reviews, reports, and theses, as well as presentations and seminars. Database use and reference citation, and use of figures and graphs to illustrate data.
Note: Normally taken in conjunction with ISDS 7P75.

ISDS 7P75
PhD Seminar
The preparation of a thesis proposal, including a written document and public presentation. Successful completion will indicate a student is adequately prepared to commence thesis research.
Note: Normally taken in conjunction with ISDS 5N01

ISDS 7F90
PhD Research and Thesis
Original theoretical and/or experimental research and thesis. An external examiner will participate in the final thesis defence to evaluate the student's performance in this course.

COSC 5P01
Coding Theory
The main concepts, problems and applications related to error-correcting codes. Different classes of codes and their properties. Emphasis on algorithms relating to codes, examination of algorithms for encoding and decoding, together with algorithms that may be used in computer searches for specific classes of codes.

COSC 5P02
Logic in Computer Science
A thorough introduction to mathematical logic, covering the following topics: propositional and first-order logic; soundness, completeness, and compactness of first-order logic; first-order theories; undecidability and

Gödel's incompleteness theorem; and an introduction to other logics such as intuitionistic and modal logics. Furthermore, the course stresses the application of logic to various areas of computer science such as computability, programming languages, program specification and verification.

COSC 5P03
Universal Algebra for Computer Science
The study of the concepts and constructs of Universal Algebra, such as products, subalgebras, homomorphic images and congruences, term algebras, free algebras, its connections with Logic and Model Theory, decidability issues, lattices and relation algebras, and applications in Computer Science such as Type Theory, Specification, Complexity Theory, Uncertainty Management and others.

COSC 5P04
Parallel Algorithms
Introduction to parallel processing, various parallel computational models including both shared-memory and distributed-memory models, speed-up, cost, design and analysis of parallel algorithms and data structures for a variety of problems in searching, sorting, graph theory, computational geometry, strings, and numerical computation; brief introduction to parallel complexity.

COSC 5P05
Introduction to Lambda Calculus
Introduction to typed and untyped lambda calculi and their semantics. Syntax of the lambda calculus, conversion, fixed points, reduction, Church-Rosser theorem, representation of recursive functions, lambda models. Category theory, cartesian closed categories and categorical models of lambda calculus.

COSC 5P06
Principles of Mobile Cloud Computing
Fundamentals supporting Mobile Cloud Computing, including task offloading, connectivity of mobile networks, and remote storage. Study of the basics and recent research advancements on principles of mobile computing, distributed applications and services, Cloud computing and virtualization, management and use of resources offered by Cloud service providers, computation offloading and thin-client computing, and application scenarios and selected use cases.

COSC 5P71
Genetic Programming
The synthesis of computer programs using evolutionary computation. The study of different representations, including tree, linear, grammatical. Theoretical analyses, including the effects of operators, representations, fitness landscapes. Practical applications in problem solving, decision making, classification, computer vision, design.

COSC 5P72
Robot Control Architectures
Survey of approaches to control in single and multi-robot systems. Examination and study of different mobile robot control architectures, including deliberative, reactive and hybrid with focus on the issues of resolving the fundamental conflict between thinking and acting, i.e., high-level deliberation and real-time control. Other relevant topics including communication techniques in multirobot systems and safety characteristics of the studied control architectures.

COSC 5P73
Computer Vision and Visual Computer Learning
Introduction to computer vision and pattern classification. The problems of WHAT and WHERE. The issue of knowledge representation and performance. Knowledge consolidation models. The concept of recursive (i.e. evolutionary) computer learning. Visual learning. Guided learning from infallible and fallible experts. Autonomous learning and experimentation. Analysis of HPC architectures conducive to visual computer learning.

COSC 5P74
Evolutionary Computation
Study of basic concepts of evolutionary algorithms (EAs) from a theoretical and application viewpoint. This includes genetic algorithms, evolutionary strategies, genetic programming, problem representation, genetic operations, overall control, theory of EAs and various examples of important applications. Includes related bio-inspired sub-areas such as swarm intelligence, and evolutionary robotics.

COSC 5P75
Directed Reading
A reading course designed for the individual student and subject to final approval by the department graduate committee. Usually offered by the student's thesis supervisor but may also be offered by other faculty members after consultation with the supervisor.

COSC 5P76
Non-invasive Data Analysis
A study of data analysis using information from the given data based on the rough set data model. Includes an overview of the data modeling process, principles of probability, non-parametric significance testing, data filtering and discretization, model selection, rule validation, case studies.

COSC 5V90-5V99
Selected Topics in Computer Science
Various advanced topics in computer science offered by faculty members.

MATH 5P09
Solitons and Nonlinear Wave Equations
(also offered as PHYS 5P09)
Introduction to solitons: Linear and nonlinear travelling waves. Nonlinear evolution equations (Korteweg de Vries, nonlinear Schrodinger, sine-Gordon). Soliton solutions and their interaction properties. Lax pairs, inverse scattering, zero-curvature equations and Backlund transformations, Hamiltonian structures, conservation laws. Note: taught in conjunction with MATH 4P09.

MATH 5P10
Groups, Rings, and Groups Rings
Advanced group theory and ring theory, such as group actions, p-groups and Sylow subgroups, solvable and nilpotent groups, finiteness conditions in rings, semisimplicity, the Wedderburn-Artin theorem. Introduction to group rings, such as unit groups, augmentation ideals, several important types of units, and the isomorphism problem.

MATH 5P11
Advanced Algebraic Structures
Topics may include: Algebraic coding theory; Combinatorial group theory; Advanced structures in ring theory. Note: Taught in conjunction with either 4P11 or 4P13

MATH 5P20
Computational Methods for Algebraic and Differential Systems
(also offered as PHYS 5P20)
Computer algebra applications of solving polynomial systems of algebraic and differential systems of equations are covered, including the necessary algebraic background. Polynomials and ideals, Groebner bases, affine varieties, solving by elimination, Groebner basis conversion, solving equations by resultants, differential algebra, differential Groebner bases.

MATH 5P21
High Performance Computing

Parallel computing architectures, new programming models, pilot parallel framework, parallel programming with MPI, thread-based parallelism, and a final project regarding the application of parallel computing to a mathematical problem.
Note: Students entering this course are expected to have a good grasp of basic procedural programming in a language such as C or FORTRAN.

MATH 5P30
Dynamical Systems
(also offered as PHYS 5P68)
Introduction to dynamical systems and their applications in mathematical modeling. Linear flows, local theory of nonlinear flows, linearization theorems, stable manifold theorem. Global theory: limit sets and attractors, Poincare´-Bendixson theorem. Structural stability and bifurcations of vector fields. Low dimensional phenomena in discrete dynamics. Chaotic dynamics: routes to chaos, characterization of chaos and strange attractors.

MATH 5P31
Ergodicity, Entropy and Chaos
Introduction to ergodic theory, invariant measures, Birkhoff ergodic theorem. The first return formula, Kac's lemma, recurrence theorems. Entropy, coding maps, Shannon-McMillian Breiman theorem. Chaos, predictability, Lyapunov exponent, speed of divergence, Pesin theorem. Ergodicity, entropy and chaos in shift dynamical systems and cellular automata.

MATH 5P35
Graph Theory
Basic definitions, paths and cycles, connectivity, trees and forests, bipartite graphs, Eulerian graphs; Matchings in bipartite graphs and in general graphs; Planar graphs, Euler's formula and Kuratowski's theorem. Graph colourings, Brooks' and Vizing's theorem and colouring of planar graphs; Network flows, Min-Max Theorem.

MATH 5P36
Algorithmic Game Theory
Basic definitions, games, strategies, costs and payoffs, equilibria, cooperative games; Complexity of finding Nash equilibria; Mechanism design; Combinatorial auctions; Profit maximization in mechanism design; Cost sharing; Online mechanisms; Inefficiency of equilibria; Selfish routing; Network formation games; Potential function method; The price of anarchy; Sponsored search auctions.

MATH 5P40
Functional Analysis
The basic theory of Hilbert spaces, including the Projection Theorem, the Riesz Representation Theorem and the weak topology; weak derivatives, Sobolev spaces and the Sobolev Imbedding Theorem; the variational formulation of boundary value problems for ordinary and partial differential equations, the Lax-Milgram Lemma and its applications; the finite element method.

MATH 5P41
Nonlinear Functional Analysis
Topological fixed point theory with applications to dynamical systems and optimization. Topics include the theorems of Brouwer, Borsuk, Schauder-Tychnoff, and Kakutani as well as the Knaster-Kuratowski-Mazurkiewicz principle. Applications of these landmark results to the solvability and qualitative analysis of dynamical systems as well as convex and non-convex optimization are discussed.

MATH 5P50
Algebraic Number Theory
An introduction to algebraic aspects of number theory. Topics include the general theory of factorization of ideals in Dedekind domains and number fields, Kummer's theory on lifting of prime ideals in extension fields, factorization of prime ideals in Galois extensions, local fields, the proof of Hensel's lemma, arithmetic of global fields.

MATH 5P60
Partial Differential Equations
(also offered as PHYS 5P60)
Review of linear and nonlinear equations in two variables. Existence and uniqueness theory, fundamental solutions, initial/boundary-value formulas for the heat equation, wave equation, Laplace equation in multi-dimensions. Exact solution techniques for 1st and 2nd order linear and nonlinear equations. Analysis of solutions, variational formulations, conservation laws, Noether's theorem.

MATH 5P64
Differential Geometry and Mathematical Physics
(also offered as PHYS 5P64)
Topics may include: Lagrangian and Hamiltonian mechanics, field theory, differential geometric structures, Lie groups and Lie algebras, G-bundles, manifolds, introduction to algebraic topology. Applications to theoretical physics.

MATH 5P66
Matrix groups and linear representations
(also offered as PHYS 5P66)
Abelian groups, permutation groups, rotation groups. Representations of discrete and continuous groups by linear transformations (matrices). General properties and constructions of group representations. Representations of specific groups. Lie groups and Lie algebras. Applications in various areas of Mathematics, including invariant theory and group algebras, and Theoretical Physics, including crystallography and symmetries in quantum systems.

MATH 5P69
Introduction to Scientific Computing
(also offered as PHYS 5P10)
Survey of computational methods and techniques commonly used in condensed matter physics research; use of common subroutine libraries; symbolic computing systems; case studies from various areas of computational science; an independent- study term project. Use of graphing and visualization software. Numerical differentiation and integration. Use of special functions. Monte Carlo and molecular dynamics simulation of structure, energetic and thermodynamic properties of metallic, semiconducting and ionic solids and nanoparticles.

MATH 5P70
Topology
An introduction to point set topology concepts and principles. Metric spaces; topological spaces; continuity, compactness; connectedness; countability and separation axioms; metrizability; completeness; Baire spaces.

MATH 5P81
Sampling Theory
Theory of finite population sampling; simple random sampling; sampling proportion; estimation of sample size; Stratified sampling; optimal allocation of sample sizes; ratio estimators; regression estimators; systematic and cluster sampling; multi-stage sampling; error in surveys; computational techniques and computer packages, and related topics. Case studies.
Note: taught in conjunction with MATH 4P81.

MATH 5P82
Nonparametric Statistics
Order statistics; rank tests and statistics; methods based on the binomial distribution; contingency tables; Kolmogorov-Smirnov statistics; nonparametric analysis of variance; nonparametric regression; comparisons with parametric methods.Computational techniques and use of SAS, Maple or other statistical packages, Case Studies.
Note: taught in conjunction with MATH 4P82.

MATH 5P83
Linear Models
Classical linear model, generalized inverse matrix, distribution and quadratic forms, regression model, nested classification and classification with interaction, covariance analysis, variance components, binary data, polynomial data, log linear model, linear logit models, generalized linear model, conditional likelihoods, quasi-likelihoods, estimating equations, computational techniques and related topics.
Prerequisite(s): MATH 3P86 (or equivalent) or permission of the instructor.

MATH 5P84
Time Series Analysis and Stochastic Processes
Time series, trend, seasonality and error, theory of stationary processes, spectral theory, Box-Jenkins methods, theory of prediction, inference and forecasting. ARMA and ARIMA processes, vector time series models, state space models, Markov processes, renewal process, martingales, Brownian motion, diffusion processes, branching processes, queueing theory, stochastic models, computational techniques and related topics.
Note: Math 5P84 has been approved by the VEE (Validation by Education Experience) Administration Committee of the Society of Actuaries. To receive VEE credit, candidates will need a grade of 70 or better.

MATH 5P85
Mathematical Statistical Inference
Revision of probability theory, convergence of random variables, statistical models, sufficiency and ancillarity, point estimation, likelihood theory, optimal estimation, Bayesian methods, computational methods, minimum variance estimation, interval estimation and hypothesis testing, linear and generalized linear models, goodness-of-fit for discrete and continuous data, robustness, large sample theory, Bayesian inference.

MATH 5P86
Multivariate Statistics
Theory of multivariate statistics, matrix algebra and random vector, sample geometry and random sampling, multivariate normal distribution, inference about means, covariance matrix, generalized Hotelling's T-square distribution, sample covariance and sample generalized variance, Wishart distribution, general hypothesis testing, analysis of variance and linear regression model, principle components, factor analysis, covariance analysis, canonical correlation analysis, discrimination and classification, cluster analysis and related topics.
Prerequisite(s): MATH 3P86 (or equivalent) or permission of the instructor.

MATH 5P87
Probability and Measure Theory
An introduction to a rigorous treatment of probability theory using measure theory. Topics include probability measures, random variables, expectations, laws of large numbers, distributions and discrete Markov chains. Selected topics from weak convergence, characteristic functions and the Central Limit Theorem.

MATH 5P88
Advanced Statistics
Topics may vary year to year. Advanced methods and theory in statistical inference, survival analysis, risk analysis, sampling techniques, bootstrapping, Jackknife, generalized linear models, mixed models, modern computational statistics, quality control, life data modeling, biostatistics, multivariate analysis, time series analysis and related topics.

MATH 5P92
Cryptography and Number Theory
Topics may include RSA cryptosystems, ElGamal cryptosystem, algorithms for discrete logarithmic problem, elliptic curves, computing point multiples on elliptic curves, primality testing and factoring algorithms.
Note: taught in conjunction with MATH 4P92.

MATH 5P95
Statistics Seminar

Independent study and presentation of major research papers in areas of specialization.
Note: this course will be evaluated as Credit/No-Credit.

MATH 5P96
Technology and Mathematics Education
Topics may include contemporary research concerning digital technologies, such as computer algebra systems and Web 2.0, in learning and teaching mathematics; design of educational tools using VB.NET, HTML, Geometer's Sketchpad, Maple, Flash, etc.; critical appraisal of interactive learning objects in mathematics education.
Note: taught in conjunction with MATH 4P96.

MATH 5P99
Major Research Paper
Students will complete a survey paper on a topic chosen in consultation with a supervisor from one of the research areas of specialization.

MATH 5V75-5V79
Selected Topics in Mathematics and Statistics
An investigation of a specific area or group of related topics in mathematics or statistics.

Appendix E

Faculty CVs

Robson E. De Grande

Personal Information

Affiliation	Department of Computer Science, Brock University
Address	1812 Sir Isaac Brock Way – room MCJ 311, St. Catharines, ON, Canada
Nationality	Canadian Citizen and Brazilian Citizen
Phone	+1 (905) 688 5550 x3090
E-mail	rdegrande@brocku.ca
Web site	www.cosc.brocku.ca/~rdegrande/
LinkedIn	www.linkedin.com/in/robsondegrande

Research Interests

Large-Scale Distributed Systems
Cloud Computing and Networking
Performance Modeling and Simulation
Computer Networks
Vehicular Networks and Intelligent Transportation
Distributed Collaborative Virtual Simulation Systems
High Performance Computing

Formal Education

2007 - 2012 **PhD in Computer Science**, *University of Ottawa*, Ottawa, Canada,
Title: *Dynamic Load Balancing Schemes for Large-Scale HLA-based Simulations*
Supervisor: *Prof. Azzedine Boukerche*.
Areas: *Distributed Systems and Networks; High Performance Computing*

2005 - 2006 **MSc in Computer Science**, *Federal University of São Carlos*, São Carlos, Brazil,
Title: *A System Integrating Privacy Protection Techniques for Allowing Service Personalization*
"Sistema de Integração de Técnicas de Proteção de Privacidade que Permitem Personalização"
Supervisor: *Prof. Sérgio Donizette Zorzo*.
Areas: *Software Design; Distributed Systems and Networks; Privacy and Security*

2001 - 2004 **BSc in Computer Science**, *Federal University of São Carlos*, São Carlos, Brazil.

Professional Experience

2017 **Assistant Professor**, *Department of Computer Science*, St. Catharines, ON, Canada.

2016 - 2017 **Network Manager**, *NSERC CREATE TRANSIT Strategic Network*, Ottawa, Canada.
Manager of the NSERC TRANSIT (Training and Research in Advanced Network Systems for Intelligent Transportation).

2013 - 2016 **Network Manager**, *NSERC DIVA Strategic Research Network*, Ottawa, Canada.
Manager of the NSERC DIVA (Developing Next Generation Intelligent Vehicular Networks And Applications) Strategic Research Network.

2012 - 2013 **Postdoctoral Fellow and Research Associate**, *University of Ottawa*, Ottawa, Canada.

2007 - 2012 **Research Assistant**, *University of Ottawa*, Ottawa, Canada.

2005 - 2006 **Research Assistant**, *Federal University of Sao Carlos*, Sao Carlos, Brazil.

Industry

2007 - 2007 **Software Developer**, *Federal University of Sao Carlos*, Sao Carlos, Brazil.

2004 - 2005 **Software Developer**, *Aptor Software*, Sao Carlos, Brazil.

Honors and Awards

2012 **Best Paper Award**, *16th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications*.

2010 **Excellence Research Award**, *PARADISE Research Laboratory, Canada*.
Ph.D. Award granted to a Laboratory member with outstanding performance in the period of 2009-2010.

Mentoring and Training

Ph.D. Students

2013 - 2015 **Hengheng Xie**, *(completed)*.
Thesis: Towards a Distributed TCP Improvement through Individual Contention Control in Wireless Networks
Thesis Defence: July 2015

2013 - 2015 **Maram S. B. Younes**, *(completed)*.
Thesis: Efficient Fault Tolerant Distributed Path Recommendation Protocol for Vehicular Networks
Thesis Defence: January 2015

MSc Students

2014 - 2017 **Dan Liu**, *(completed)*.
Thesis: Enabling Interoperability for Large-Scale Distributed Systems through OCCI
Thesis Defence: November 2017

2014 - 2016 **Tao Zhang**, *(completed)*.
Thesis: Vehicular Cloud: Stochastic Analysis of Computing Resources in a Road Segment
Thesis Defence: June 2016

2014 - 2016 **Ali AlBuhussain**, *(completed)*.
Thesis: Design and Analysis of an Adjustable and Configurable Bio-inspired Heuristic Scheduling Technique for Cloud Based Systems
Thesis Defence: June 2016

2013 - 2015 **Torki Alghamdi**, *(completed)*.
Thesis: Enhancing Load Balancing Efficiency based on Migration Delay for Distributed Virtual Simulations
Thesis Defence: June 2015

2012 - 2014 **Shichao Guan**, *(completed)*.
Thesis: A Multi-layered Scheme for Distributed Simulations on Cloud Environments
Thesis Defence: December 2014

2012 - 2014 **Raed Alkharboush**, *(completed)*.
Thesis: Improved Prediction-based Dynamic Load Balancing Systems for HLA-Based Distributed Simulations
Thesis Defence: October 2014

Undergraduate Students

2016 - 2016 **Yuhan Lee**, *(completed)*.
Project: Intelligent Transportation System Models for Traffic Solutions in Urban Areas

2016 - 2016 **Haroun Benmeddour**, *(completed)*.
Project: Modelling 3D Road Scenarios for Intelligent Transportation Systems

2013 - 2013 **Aissa Hadj Mohamed**, *(completed)*.
Project: Ottawa Urban 3D Model for Realistic ITS Simulations

Publications

Books

[1] Rodolfo I. Meneguette, Robson E. De Grande, Antonio A. F. Loureiro. "Intelligent Transport System in Smart Cities: Aspects and Challenges of Vehicular Networks and Cloud," in Series: Urban Computing. Publisher: Springer. ISBN 978-3-319-93332-0. DOI 10.1007/978-3-319-93332-0. Pages 390. 2018.

Refereed Journals

[J15] A. Boukerche, S. Guan, and R. E. D. Grande, "A task-centric mobile cloud-based system to enable energy-aware efficient offloading," *IEEE Transactions on Sustainable Computing*, pp. 1–1, 2018. DOI: 10.1109/TSUSC.2018.2836314.

[J14] A. Boukerche and R. E. De Grande, "Vehicular cloud computing: Architectures, applications, and mobility," *Computer Networks*, vol. 135, pp. 171–189, 2018. DOI: https://doi.org/10.1016/j.comnet.2018.01.004.

[J13] T. Zhang, R. E. De Grande, and A. Boukerche, "Design and analysis of stochastic traffic flow models for vehicular clouds," *Ad Hoc Networks*, vol. 52, pp. 39–49, 2016. DOI: 10.1016/j.adhoc.2016.07.009.

[J12] R. E. De Grande, A. Boukerche, and R. Alkharboush, "Time series-oriented load prediction model and migration policies for distributed simulation systems," *IEEE Transactions on Parallel Distributed Systems*, vol. 28, no. 1, pp. 215–229, 2017. DOI: 10.1109/TPDS.2016.2552174.

[J11] R. E. De Grande, A. Boukerche, S. Guan, and N. Aljeri, "A modular distributed simulation-based architecture for intelligent transportation systems," *Concurrency and Computation: Practice and Experience*, vol. 28, no. 12, pp. 3409–3426, 2016. DOI: 10.1002/cpe.3801.

[J10] Y. Gu, A. Boukerche, and R. E. D. Grande, "Supporting multidimensional range queries in hierarchically distributed tree," *Concurrency and Computation: Practice and Experience*, vol. 28, no. 6, pp. 1848–1869, 2016. DOI: 10.1002/cpe.3160.

[J9] R. W. N. Pazzi, A. Boukerche, R. E. De Grande, and L. Mokdad, "A clustered trail-based data dissemination protocol for improving the lifetime of duty cycle enabled wireless sensor networks," *Wireless Networks*, vol. 23, no. 1, pp. 177–192, 2017. DOI: 10.1007/s11276-015-1089-7.

[J8] S. Guan, R. E. De Grande, and A. Boukerche, "A multi-layered scheme for distributed simulations on the cloud environment," *IEEE Transactions on Cloud Computing*, 2015. 10.1109/TCC.2015.2453945. DOI: 10.1109/TCC.2015.2453945.

[J7] A. Darehshoorzadeh, R. E. De Grande, and A. Boukerche, "Toward a comprehensive model for performance analysis of opportunistic routing in wireless mesh networks," *IEEE Transactions on Vehicular Technology*, vol. 65, no. 7, pp. 5424–5438, 2016. DOI: 10.1109/TVT.2015.2457680.

[J6] R. E. De Grande, A. Boukerche, and H. Ramadan, "Distributed re-arrangement scheme for balancing computational load and minimizing communication delays in hla-based simulations.," *Wiley Concurrency and Computation: Practice and Experience*, vol. 25, no. 5, pp. 626–648, 2013. DOI: 10.1002/cpe.1807.

[J5] R. E. De Grande, M. A. Almulla, and A. Boukerche, "Measuring and analyzing migration delay for the computational load balancing of distributed virtual simulations," *IEEE Transactions on Instrumentation and Measurement*, vol. 61, no. 12, pp. 3158–3174, 2012. DOI: 10.1109/TIM.2012.2205103.

[J4] R. E. De Grande, A. Boukerche, and H. Ramadan, "Decreasing communication latency through dynamic measurement, analysis, and partitioning for distributed virtual simulations," *IEEE Transactions on Instrumentation and Measurement*, vol. 60, no. 1, pp. 81–92, 2011. DOI: 10.1109/TIM.2010.2065730.

[J3] R. E. De Grande and A. Boukerche, "Dynamic balancing of communication and computation load for hla-based simulations on large-scale distributed systems.," *Elsevier Journal of Parallel Distributed Computing*, vol. 71, no. 1, pp. 40–52, 2011. DOI: 10.1016/j.jpdc.2010.04.001.

[J2] R. E. De Grande, A. Boukerche, and H. Ramadan, "Measuring communication delay for dynamic balancing strategies of distributed virtual simulations," *IEEE Transactions on Instrumentation and Measurement*, vol. 60, no. 11, pp. 3559–3569, 2011. DOI: 10.1109/TIM.2011.2161143.

[J1] E. E. Ajaltouni, M. Zhang, A. Boukerche, and R. E. D. Grande, "An adaptive dynamic load balancing technique for grid-based large scale distributed simulations.," *Journal of Interconnection Networks*, vol. 10, no. 4, pp. 391–419, 2009. DOI: 10.1142/S0219265909002637.

Refereed Conferences

[C34] F. Zhang, R. E. De Grande, and A. Boukerche, "Macroscopic interval-split free-flow model for vehicular cloud computing," *21st IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2017, pp. 107–114.

[C33] H. Zhijun, R. E. De Grande, and A. Boukerche, "Towards efficient data access in mobile cloud computing using pre-fetching and caching," *IEEE International Conference on Communications (ICC)*, 2017, pp. 1–6. DOI: 10.1109/ICC.2017.7997078.

[C32] H. Li, R. E. De Grande, and A. Boukerche, "An efficient CPP solution for resilience-oriented SDN controller deployment," *2017 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPS) Workshops*, 2017, pp. 540–549. DOI: 10.1109/IPDPSW.2017.161.

[C31] S. Guan, R. E. De Grande, and A. Boukerche, "A cloudlet-based task-centric offloading to enable energy-efficient mobile applications," *2017 IEEE Symposium on Computers and Communications (ISCC)*, 2017, pp. 564–569. DOI: 10.1109/ISCC.2017.8024588.

[C30] V. Soto, R. E. De Grande, and A. Boukerche, "REPRO: time-constrained data retrieval for edge offloading in vehicular clouds," *Proceedings of the 14th ACM Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, & Ubiquitous Networks (PE-WASUN)*, 2017, pp. 47–54. DOI: 10.1145/3134829.3134834.

[C29] D. Liu, R. E. De Grande, and A. Boukerche, "Towards the design of an interoperable multi-cloud distributed simulation system," *Proceedings of the 50th Annual Simulation Symposium (ANSS)*, 2017, 13:1–13:12.

[C28] R. I. Meneguette, A. Boukerche, and R. E. D. Grande, "SMART: an efficient resource search and management scheme for vehicular cloud-connected system," *IEEE Global Communications Conference (GLOBECOM)*, 2016, pp. 1–6. DOI: 10.1109/GLOCOM.2016.7842271.

[C27] A. AlBuhussain, R. E. De Grande, and A. Boukerche, "Elasticity based scheduling heuristic algorithm for cloud environments," *In Proceedings of the 20th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2016, pp. 1–8.

[C26] F. Zhang, R. E. De Grande, and A. Boukerche, "Accuracy analysis of short-term traffic flow prediction models for vehicular clouds," *In Proceedings of the 13th ACM Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, & Ubiquitous Networks (PE-WASUN)*, 2016, pp. 19–26. DOI: 10.1145/2989293.2989297.

[C25] S. Guan, R. E. De Grande, and A. Boukerche, "A novel energy efficient platform based model to enable mobile cloud applications," *In Proceedings of the 21st IEEE Symposium on Computers and Communication (ISCC)*, 2016, pp. 914–919. DOI: 10.1109/ISCC.2016.7543853.

[C24] S. Guan, R. E. De Grande, and A. Boukerche, "An hla-based cloud simulator for mobile cloud environments," *In Proceedings of the 20th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2016, pp. 128–135.

[C23] R. I. Meneguette, A. Boukerche, D. L. Guidoni, R. E. De Grande, A. A. F. Loureiro, and L. A. Villas, "A flow mobility management architecture based on proxy mobile ipv6 for vehicular networks," *In Proceedings of the 21st IEEE Symposium on Computers and Communication (ISCC)*, 2016, pp. 732–737. DOI: 10.1109/ISCC.2016.7543823.

[C22] A. AlBuhussain, R. E. De Grande, and A. Boukerche, "Performance analysis of bio-inspired scheduling algorithms for cloud environments," *In Proceedings of the IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, 2016, pp. 776–785. DOI: 10.1109/IPDPSW.2016.186.

[C21] H. Xie, R. E. De Grande, and A. Boukerche, "Cross layer optimization for routing based on link layer delay analysis," *In Proceedings of the IEEE International Conference on Communications (ICC)*, 2016, pp. 1–6. DOI: 10.1109/ICC.2016.7511233.

[C20] T. Zhang, R. E. De Grande, and A. Boukerche, "Urban traffic characterization for enabling vehicular clouds," *In Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC 2016)*, 2016, pp. 1–6. DOI: 10.1109/WCNC.2016.7564985.

[C19] T. Alghamdi, R. E. De Grande, and A. Boukerche, "Enhancing load balancing efficiency based on migration delay for distributed virtual simulations," *In Proceedings of the 19th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2015, pp. 33–40.

[C18] T. Zhang, R. E. De Grande, and A. Boukerche, "Vehicular cloud: Stochastic analysis of computing resources in a road segment," *In Proceedings of the 12th ACM Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks*, Cancun, Mexico, 2015, pp. 9–16. DOI: 10.1145/2810379.2810383.

[C17] A. Sianati, R. E. De Grande, and A. Boukerche, "Bundling communication messages in large scale cloud environments," *In Proceedings of the 20th IEEE Symposium on Computers and Communications (ISCC)*, 2015, pp. 244–251.

[C16] S. Guan, R. E. De Grande, and A. Boukerche, "Enabling hla-based simulations on cloud environments," *In Proceedings of the 19th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2015, pp. 112–119.

[C15] R. Alkharboush, R. E. De Grande, and A. Boukerche, "A genetic algorithm approach for adjusting time series based load prediction," *In Proceedings of the IEEE International Parallel and Distributed Processing Symposium Workshop (IPDPSW)*, 2015, pp. 292–298. DOI: 10.1109/IPDPSW.2015.96.

[C14] D. Liu, R. E. De Grande, and A. Boukerche, "An adaptive fault-tolerance scheme for distributed load balancing systems," *In Proceedings of the 48th ACM Annual Simulation Symposium Spring Simulation Multi-Conference*, 2015, pp. 116–123.

[C13] H. Xie, A. Boukerche, R. E. De Grande, and F. R. Yu, "Towards a distributed TCP improvement through individual contention control in wireless networks," *In Proceedings of the IEEE International Conference on Communications (ICC)*, 2015, pp. 5602–5607. DOI: 10.1109/ICC.2015.7249215.

[C12] M. B. Younes, A. Boukerche, R. E. De Grande, and H. Xie, "An efficient fault tolerant distributed path recommendation protocol for next generation of vehicular networks," *In Proceedings of the IEEE International Conference on Communications (ICC)*, 2015, pp. 5783–5788. DOI: 10.1109/ICC.2015.7249244.

[C11] R. Alkharboush, R. E. De Grande, and A. Boukerche, "Federate migration decision-making methods for hla-based distributed simulations," *In Proceedings of the 18th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications*, 2014, pp. 190–197.

[C10] S. Guan, R. E. De Grande, and A. Boukerche, "Real-time 3d visualization for distributed simulations of vanets," *In Proceedings of the 18th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications*, 2014, pp. 138–146.

[C9] R. Alkharboush, R. E. De Grande, and A. Boukerche, "Load Prediction in HLA-Based Distributed Simulation Using Holt's Variants," *In Proceedings of the 17th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications*, 2013, pp. 161–168. DOI: 10.1109/DS-RT.2013.25.

[C8] R. E. De Grande, M. Almulla, and A. Boukerche, "Autonomous Configuration Scheme in a Distributed Load Balancing System for HLA-Based Simulations," *In Proceedings of the 17th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2013, pp. 169–176. DOI: 10.1109/DS-RT.2013.26.

[C7] R. E. De Grande and A. Boukerche, "Migration Delay Awareness in a Self-Adaptive Balancing Scheme for HLA-Based Simulations," *In Proceedings of the 16th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2012, pp. 169–176. DOI: 10.1109/DS-RT.2012.33.

[C6] R. E. De Grande and A. Boukerche, "Dynamic load redistribution based on migration latency analysis for distributed virtual simulations," *In Proceedings of the IEEE International Workshop on Haptic Audio Visual Environments and Games (HAVE)*, 2011, pp. 88–93. DOI: 10.1109/HAVE.2011.6088397.

[C5] R. E. De Grande and A. Boukerche, "Predictive Dynamic Load Balancing for Large-Scale HLA-based Simulations," *In Proceedings of the 15th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2011, pp. 4–11. DOI: 10.1109/DS-RT.2011.17.

[C4] R. E. De Grande and A. Boukerche, "A dynamic, distributed, hierarchical load balancing for hla-based simulations on large-scale environments.," *In Proceedings of the 16th International Euro-Par Conference - Parallel Processing (Euro-Par - Part I)*, 2010, pp. 242–253. DOI: 10.1007/978-3-642-15277-1_23.

[C3] R. E. De Grande and A. Boukerche, "Self-Adaptive Dynamic Load Balancing for Large-Scale HLA-Based Simulations," *In Proceedings of the 14th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, 2010, pp. 14–21. DOI: 10.1109/DS-RT.2010.11.

[C2] R. E. De Grande and A. Boukerche, "Distributed dynamic balancing of communication load for large-scale hla-based simulations.," *In Proceedings of the 15th IEEE Symposium on Computers and Communications (ISCC)*, 2010, pp. 1109–1114. DOI: 10.1109/ISCC.2010.5546621.

[C1] R. E. De Grande and A. Boukerche, "A redistribution scheme centred on communication delay for distributed virtual simulations," *In Proceedings of the IEEE International Symposium on Haptic Audio-Visual Environments and Games (HAVE)*, 2010, pp. 1–6. DOI: 10.1109/HAVE.2010.5623959.

Tutorials

2014 **Modeling and Simulation of Vehicular Area Networks**,
17th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM).
Montreal, Canada

Invited Talks

2015 **Scheduling Tasks and Balancing Load in Cloud Environments**.
University Paris Descartes, France

2015 **Characterizing Urban Traffic for Vehicular Cloud Applications**.
University of Franche-Comte, France

2014 **Supporting Real-time Visualization of Large-scale VANet Simulations**.
Federal University of Ceara, Brazil

2014 **Dynamic Load Re-arrangement for Cloud Applications**.
University of Paris 13, France

2014 **A 3D Visualization Tool for VANet Distributed Simulations**.
UNICAMP, Brazil

2012 **Enabling Distributed Simulations on the Cloud**.
Federal University of Minas Gerais, Brazil

2013 **Access and Security Concerns in Large-Scale Distributed Systems over Grids**.
Federal University of Sao Carlos, Brazil

2011 **Load Balancing Schemes for Large-Scale Distributed Systems**.
Federal University of Sao Carlos, Brazil

Other Contributions

2018 **Special Session Co-Chair**, *22nd IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, Rome, Italy.

2017 **Technical Program Co-Chair**, *15th ACM International Symposium on Mobility Management and Wireless Access (MobiWac)*, Miami Beach, USA.

2017 **Poster Co-Chair**, *20th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Miami Beach, USA.

2017 **Special Session Co-Chair**, *21st IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, Rome, Italy.

2016 **Poster Chair**, *19th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Malta.

2016 **Technical Program Co-Chair**, *14th ACM International Symposium on Mobility Management and Wireless Access (MobiWac)*, Malta.

2016 **Special Session Co-Chair**, *20th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, London, UK.

2016 **Network Manager - Chair of the Organizing Committee**, *5th Annual NSERC DIVA Workshop*, Ottawa, Canada.

2015 **Poster Chair**, *18th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Cancun, Mexico.

2015 **Special Session Co-Chair**, *19th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, Xinhua, China.

2014 **Network Manager - Chair of the Organizing Committee**, *4th Annual NSERC DIVA Workshop*, Ottawa, Canada.

2014 **Network Manager - Chair of the Organizing Committee**, *2nd Canada-Brazil Intelligent Transportation Systems Workshop*, Fortaleza, Brazil.

2014 **Local Organizing Committee**, *17th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Montreal, Canada.

2014 **Technical Program Chair**, *4th ACM International Symposium on Design and Analysis of Intelligent Vehicular Networks and Applications (DIVANet)*, Montreal, Canada.

2014 **Network Manager - Chair of the Organizing Committee**, *1st Canada-Brazil Intelligent Transportation Systems Workshop*, Florianopolis, Brazil.

2013 **Special Session Co-Chair**, *17th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, Delft, The Netherlands.

2013 **Posters Co-Chair**, *16th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Barcelona, Spain.

2013 **Network Manager - Chair of the Organizing Committee**, *3rd Annual NSERC DIVA Workshop*, Ottawa, Canada.

2012 **Organizing Committee**, *2nd Annual NSERC DIVA Workshop*, Ottawa, Canada.

2011 **Organizing Committee**, *14th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, Miami Beach, USA.

2011 **Organizing Committee**, *1st Annual NSERC DIVA Workshop*, Ottawa, Canada.

Technical Program Committee Member

2015 - 2018 IEEE Symposium on Computers and Communications (ISCC)

2015 ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN)

2014 - 2018 ACM Annual Simulation Symposium (ANSS)

2014 - 2018 ACM International Symposium on Mobility Management and Wireless Access (MobiWac)

2014 - 2017 ACM International Symposium on QoS and Security for Wireless and Mobile Networks (Q2SWinet)

2013 - 2018 ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)

2013 - 2016 ACM International Symposium on Design and Analysis of Intelligent Vehicular Networks and Applications (DIVANet)

2011 ACM SIGSIM Conference on Principles and Advanced Discrete Simulations (PADS)

2011 - 2018 IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT)

Reviewing Activities

2016 - **IEEE Communications Letters**.

2015 - **ACM Transactions on Modeling and Computer Simulation (TOMACS)**.

2015 - **IEEE Transactions on Wireless Communications (TWC)**.

2015 - **Springer Wireless Networks (WINE)**.

2015 - **Elsevier Future Generation Computer Systems (FGCS)**.

2014 - **ACM Computing Surveys (CSUR)**.

2013 - **Elsevier Simulation Modelling Practice and Theory (SIMPAT)**.

2013 - **IEEE Transactions on Parallel and Distributed Systems (TPDS)**.

2012 - **Wiley Concurrency and Computation: Practice and Experience**.

2012 - **Journal of Simulation (JOS)**.

2011 - **IEEE Transactions on Instrumentation and Measurement (TIM)**.

2010 - **Elsevier Journal of Parallel and Distributed Computing (JPDC)**.

Editorial Service

2014 - 2015 **Elsevier Simulation Modelling Practice and Theory: Simulation in/of the Cloud**.
Co-Guest Editor with Prof. Gabriele D'Angelo (University of Bologna)

Languages

English Fluent

Portuguese Native Speaker

French Intermediate-Advanced

Spanish Intermediate

Skills and Expertise

Programming Languages	C++, C, ,C/C++ STL, C#, Java (including JSP and Servlets), Pascal, PHP, Lisp, Prolog, XUL, XML, MPI, LaTeX, UML, Python, JavaScript, Pearl, Shell Scripting
Databases	MySQL, PostgreSQL, Oracle SQL
Simulation	HLA, Discrete Event Simulation, Simulation Modeling and Analysis
Operating Systems	Linux, Linux server administration, Windows
Software Development	Eclipse, Unity3D, Vim, Git

Naser Ezzati-Jivan

Department of Computer Science
Brock University
NEzzati@brocku.ca
+1 (905) 688-5550 ext. 3520

RESEARCH INTERESTS

My research area is automated performance and security evaluation of large-scale cloud and distributed systems, currently focusing primarily on static and dynamic software analysis techniques towards improving software performance, software reliability, software maintenance, and software debugging.

ACADEMIC BACKGROUND

- **Assistant Professor** 2020-Present
  Computer Science Department, Brock University
- **Part-time Lecturer** 2018-Present
  Polytechnique Montreal
- **Research Associate** 2016-Present
  DORSAL Lab, Polytechnique Montreal
- **Postdoctoral Fellow** 2014-2016
  Polytechnique Montreal and Ericsson Canada
- **Ph.D. in Computer Engineering** 2010-2014
  Department of Computer and Software Engineering, University of Montreal, Canada
  Thesis: "Multi-level Trace Abstraction, Linking and Display"
  Supervisor: Prof. Michel Dagenais
- **M.Sc. in Computer Engineering, Software** 2000-2002
  Department of Software Engineering, University of Isfahan, Isfahan, Iran
  Thesis: "High-Performance Firewall Through an In-kernel Architecture"
- **B.Sc. in Computer Engineering, Software** 1996-2000
  Department of Computer Engineering, Sharif University of Technology, Tehran, Iran
  Thesis: "Secure File Transfer and Telnet Client Using SSH Protocol"

RESEARCH PROJECTS

- **Anomaly Detection and diagnosis with Machine Learning** ,

  2017-2018

  This ongoing project studies the problem of automated analysis, proposing new algorithms and data processing to reduce the manual intervention required to detect, diagnose and correct problems in the monitored systems.

- **Architecture for real-time and scalable system-level and cloud-level monitoring and analysis** ,

  2017-2018

  This ongoing project proposes a new architecture and algorithms to provide a hierarchical streaming framework for the control, monitoring, aggregation and analysis of tracing and debugging data.

- **Tracing and debugging support for advanced programming environments** ,

  2016-2017

  The focus of this research project was on providing specialised algorithms, analysis and views to support complex software environments, with a large number of parallel co-processor cores, a large cloud of physical nodes, and distributed applications with mobile code.

- **Performance analysis of MPI parallel applications** ,

  2016-2017

  The research proposes tools and techniques to collect performance data for an MPI Parallel Application, capture its behavioral model and construct a framework to analyze and visualize its full stack (user-space, kernel, driver and network) execution.

- **Study on cloud virtualization overheads** ,

  2015-2016

  The research proposes methods and views for analyzing the overheads introduced by virtualization and virtual machines co-location.

- **Distributed requests clustering for latency analysis** ,

  2015-2016

  The research presents an automatic analysis method that clusters requests, based on their response times, extracts and organizes their features in a tree-based data structure, and mines the association rules among the different groups of requests. This aims to analyse comparatively the groups of slow web and database requests to find the possible root-causes of their latency problems.

- **Modeling and analyzing real-time data streams** 2014-2015

  The research is on presenting an architecture with corresponding data structures and algorithms to process stream events, generate an adequate summary -detailed enough for recent data and succinct enough for old data- and organize them to enable an efficient multi-dimensional analysis, similar to database OLAP analyses.

- **Multilevel data abstraction and visualization** 2010-2014

  In this research, I proposed techniques to reduce execution trace size and complexity and generate several levels of abstract events, organize them in a hierarchy and visualize them at multiple levels. The main goal was to enable users to perform a top-down multi-scale analysis, to gain a better comprehension of the underlying system execution and to ease a comprehensive root-cause analysis.

- **Big Data in banking: data warehousing and data mining project, Iran's Mellat bank Research and Planning Center** 2006-2010

  The goal was the study concerning the adoption of Data Warehouse, Data Mining, and Data Analytic capabilities to enable bank organization to investigate and get deeper insight into customers data and perform improved decision makings.

SELECTED PUBLICATIONS

REFEREED JOURNAL PAPERS:

1. Didier Nadeau, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Efficient large scale heterogeneous debugging using dynamic tracing. *Elsevier Journal of Systems Architecture*, 2019. URL https://doi.org/10.1016/j.sysarc.2019.02.016

2. Hossein Abbasi, **Naser Ezzati-Jivan**, Martine Bellaiche, Chamseddine Talhi, and Michel R. Dagenais. Machine learning-based edos attack detection technique using execution trace analysis. *published in Springer Journal of Hardware and Systems Security*, 2019. doi: 10.1007/s41635-018-0061-2. URL https://doi.org/10.1007/s41635-018-0061-2

3. Fabien Reumont-Locke, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Efficient methods for trace analysis parallelization. *Springer International Journal of Parallel Programming*, 2019. doi: 10.1007/s10766-019-00631-4. URL https://doi.org/10.1007/s10766-019-00631-4

4. **Naser Ezzati-Jivan**, Houssem Daoud, and Michel R. Dagenais. Multi-level diagnosis of performance problems in distributed systems. *in-progress*, 2018a

5. **Naser Ezzati-Jivan** and Michel R. Dagenais. Multi-scale navigation of large trace data: A survey. *Concurrency and Computation: Practice and Experience*, 29(10):e4068–n/a, 2017. ISSN 1532-0634. doi: 10.1002/cpe.4068. URL http://dx.doi.org/10.1002/cpe.4068. e4068 cpe.4068

6. Adrien Verge, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Hardware-assisted software event tracing. *Concurrency and Computation: Practice and Experience*, 29(10):e4069–n/a, 2017. ISSN 1532-0634. doi: 10.1002/cpe.4069. URL http://dx.doi.org/10.1002/cpe.4069. e4069 cpe.4069

7. Florian Wininger, **Naser Ezzati-Jivan**, and Michel R. Dagenais. A declarative framework for stateful analysis of execution traces. *Software Quality Journal*, 25(1):201–229, March 2017. ISSN 0963-9314. doi: 10.1007/s11219-016-9311-0. URL https://doi.org/10.1007/s11219-016-9311-0

8. **Naser Ezzati-Jivan** and Michel R. Dagenais. Cube data model for multilevel statistics computation of live execution traces. *Concurrency and Computation: Practice and Experience*,

27(5):1069–1091, 2015. ISSN 1532-0634. doi: 10.1002/cpe.3272. URL http://dx.doi.org/10.1002/cpe.3272

9. **Naser Ezzati-Jivan** and Michel R. Dagenais. A framework to compute statistics of system parameters from very large trace files. *ACM SIGOPS Operating Systems Review*, 47(1):43–54, January 2013. ISSN 0163-5980. doi: 10.1145/2433140.2433151. URL http://doi.acm.org/10.1145/2433140.2433151

10. Alireza Shameli-Sendi, **Naser Ezzati-Jivan**, Masoume Jabbarifar, and Michel R. Dagenais. Intrusion response systems: Survey and taxonomy. *International Journal of Computer Science and Network*, 12(1):1, 2012. URL http://paper.ijcsns.org/07_book/201201/20120101.pdf

11. **Naser Ezzati-Jivan** and Michel R. Dagenais. A stateful approach to generate synthetic events from kernel traces. *Adv. Soft. Eng.*, 2012:6:6–6:6, January 2012. ISSN 1687-8655. doi: 10.1155/2012/140368. URL http://dx.doi.org/10.1155/2012/140368

12. Masoume Jabbarifar, Alireza Shameli Sendi, Alireza Sadighian, **Naser Ezzati-Jivan** , and Michel R. Dagenais. A reliable and efficient time synchronization protocol for heterogeneous wireless sensor network. *Wireless Sensor Network*, 2010:910–918, December 2010. ISSN 1687-8655. doi: 10.4236/wsn.2010.212109. URL http://dx.doi.org/10.4236/wsn.2010.212109

SUBMITTED JOURNAL PAPERS:

1. **Naser Ezzati-Jivan**, Wahab Hamou-Lhadj, and Michel R. Dagenais. Multilevel visualization of large execution traces. *in Progress*, 2019

2. Yves Junior bationo, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Cloud service performance diagnosis using multi-layer tracing. *submitted to Springer Journal of Cloud Computing*, 2019

3. **Naser Ezzati-Jivan** and Michel R. Dagenais. Fast label placement technique for multilevel visualization of execution traces. *in Progress*, 2019

4. Simon Delise, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Integrated modeling tool for indexing and analyzing state machine trace. *accepted with revisions in Science Publications*, 2019

5. Julien Desfossez, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Real-time linux kernel response time measurement. *in Progress*, 2019

6. Jean-Christian KOUAME, **Naser Ezzati-Jivan**, and Michel R. Dagenais. A data driven approach for pattern matching, filtering and analysis of execution traces. *in Progress*, 2019

REFEREED CONFERENCE PAPERS:

1. **Naser Ezzati-Jivan**, Genevieve Bastien, and Michel R. Dagenais. High latency cause detection using multilevel dynamic analysis. In *2018 Annual IEEE International Systems Conference (SysCon 2018)*, Jan 2018b. doi: 10.1109/SYSCON.2018.8369613. URL https://doi.org/10.1109/SYSCON.2018.8369613

2. Yves Junior bationo, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Efficient cloud tracing: From very high to very low level. In *2018 IEEE Cloud Summit 2018 (ICCE 2018)*, pages 1–6, Jan 2018. doi: 10.1109/ICCE.2018.8326353. URL https://doi.org/10.1109/ICCE.2018.8326353

3. Houssem Daoud, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Dynamic trace-based sampling algorithm for memory usage tracking of enterprise applications. In *2017 IEEE High Performance Extreme Computing Conference (HPEC 2017)*, pages 1–7, Sept 2017. doi: 10.1109/HPEC.2017.8091061. URL https://doi.org/10.1109/HPEC.2017.8091061

4. Cedric. Biancheri, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Multilayer virtualized systems analysis with kernel tracing. In *2016 IEEE 4th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW 2016)*, pages 1–6, Aug 2016. doi: 10.1109/W-FiCloud.2016.18. URL https://doi.org/10.1109/W-FiCloud.2016.18

5. Loic Prieur-Drevon, Raphael Beamonte, **Naser Ezzati-Jivan**, and Michel R. Dagenais. Enhanced state history tree (esht): A stateful data structure for analysis of highly parallel system traces. In *2016 IEEE International Congress on Big Data (BigData Congress 2016)*, pages 83–90, June 2016. doi: 10.1109/BigDataCongress.2016.19. URL https://doi.org/10.1109/BigDataCongress.2016.19

6. K. Kouame, **Naser Ezzati-Jivan**, and Michel R. Dagenais. A flexible data-driven approach for execution trace filtering. In *2015 IEEE International Congress on Big Data*, pages 698–703, June 2015. doi: 10.1109/BigDataCongress.2015.112. URL https://doi.org/10.1109/BigDataCongress.2015.112

7. **Naser Ezzati-Jivan** and Michel R. Dagenais. Multiscale navigation in large trace data. In *27th Annual IEEE Canadian Conference on Electrical and Computer Engineering, 2014*, pages 1–6, 2014. doi: 10.1109/CCECE.2014.6901019. URL http://dx.doi.org/10.1109/CCECE.2014.6901019

8. Alexandre Montplaisir, **Naser Ezzati-Jivan**, Florian Wininger, and Michel Dagenais. Efficient model to query and visualize the system states extracted from trace data. In Axel Legay and Saddek Bensalem, editors, *Runtime Verification*, volume 8174 of *Lecture Notes in Computer Science*, pages 219–234. Springer Berlin Heidelberg, 2013. ISBN 978-3-642-40786-4. URL http://dx.doi.org/10.1007/978-3-642-40787-1_13

9. **Naser Ezzati-Jivan**, Alireza. Shameli-Sendi, and Michel R. Dagenais. Multilevel label placement for execution trace events. In *26th Annual IEEE Canadian Conference on Electrical and Computer Engineering, 2013*, pages 1–6, 2013. doi: 10.1109/CCECE.2013.6567826. URL https://doi.org/10.1109/CCECE.2013.6567826

10. **Naser Ezzati-Jivan** and Michel R. Dagenais. An efficient analysis approach for multi-core system tracing data. In *Proceedings of the 16th International Conference on Software Engineering and Applications (SEA 2012)*, 2012. doi: 10.2316/P.2012.790-053. URL http://dx.doi.org/10.2316/P.2012.790-053

11. **Naser Ezzati-Jivan**, Alireza Shameli-Sendi, Naser Nematbakhsh, and Michel R. Dagenais. High performance internet connection filtering through an in-kernel architecture. In *2011 The Sixth International Conference on Internet Monitoring and Protection (ICIMP 2011)*, pages 32–37, March 2011. URL https://www.thinkmind.org/download.php?articleid=icimp_2011_2_30_30064

12. **Naser Ezzati-jivan**, Houshang Tavakoli, and Parisa Pasyar. Haram: moving toward formation of a national digital library in iran. In *2011 Proceedings of the International Conference on Digital Library Management ICDLM: Extending Benefits of Modern Technology to Public, Academic and Special Libraries, Kolkata, India*, pages 223–231, 2011

13. **Naser Ezzati-jivan**, Mahlagha Fazeli, and Khadije Sadat Yousefi. *New Approach for Automated Categorizing and Finding Similarities in Online Persian News*, pages 120–128. Springer Berlin Heidelberg, Berlin, Heidelberg, 2010. ISBN 978-3-642-16032-5. doi: 10.1007/978-3-642-16032-5_11. URL https://doi.org/10.1007/978-3-642-16032-5_11

PHD DISSERTATION:

1. **Naser Ezzati-Jivan**. *Multi-Level Trace Abstraction, Linking and Display*. PhD thesis, École Polytechnique de Montréal, 2014. URL http://publications.polymtl.ca/1402/

FUNDINGS

- Research associate in NSERC CRD Research Project Proposal
  Title: "Automated monitoring and debugging of large-scale many-core heterogeneous systems",
  Funded by: NSERC, Ericsson Canada, Ciena, Google Montreal, EfficiOS and Prompt
  Amount: over 1M C$
  Year: 2017.

- Research associate in NSERC CRD Research Project Proposal
  Title: "Software debugging and monitoring for heterogeneous many-core telecom systems",
  Funded by: NSERC, Ericsson Canada, EfficiOS and Prompt
  Amount: over 1M C$
  Year: 2014.

MOST RECENT TEACHING

- **Lecturer** 2020-Present

  Brock University

  Computer Systems (2p13)

- **Lecturer** 2018-Present

  Polytechnique Montreal University

  Doctoral Research Strategies in Engineering

OTHER PROFESSIONAL EXPERIENCE

- **Deputy Director of Research, Planning and Education** 2009-2010

  National Library of Iran

- **Directing Manager of the Digital Library and Resources Department** 2005-2009

  National Library of Iran

- **Head of Software Engineering Group** 2004-2005
  National Library of Iran
- **Project Manager for Data Warehouse and Data Mining Project** 2003-2004
  Mellat Bank of Iran
- **Software Developer and Analyzer** 2002-2004
  Digital Clone Company

LEADERSHIP ACTIVITIES

- Conference organizer for semi-annual DORSAL Progress Report Meetings, Polytechnique Montreal, 2014-2017
- Deputy Director and Directing Manager in National Library of Iran, 2005-2010
- Software Project Manager in National Digital Library Project, 2008-2010
- Software Project Manager in Bank Mellat Data Mining and Warehouse Project, 2004-2005
- Isfahan university team leader for the ACM International Collegiate Programming Contest (abbreviated as ACM-ICPC), 2001
- Founder and president of "Information Technology Magazine", Sharif University of Technology, Tehran, Iran, 1998-2000.

HONORS AND AWARDS

- Department Special Mention Award for Ph.D. Thesis, 2015.
- Ranked among the top 25 students out of 100,000 participants in National Level (Conquer) Examinations for M.Sc. program, 2000.
- Ranked among the top 45 students out of 400,000 participants in National Level (Conquer) Examinations for B.Sc. program, 1996.

LANGUAGES

- English: Fluent
- Farsi: Native
- Azeri: Native
- French: Beginner

RESIDENCY STATUS

- Citizen of Canada

REFERENCES

- **Prof. Michel R. Dagenais**

  Supervisor
  Department of Computer and Software Engineering, Polytechnique Montreal
  2900 Edouard Montpetit Blvd, Montreal, QC H3T 1J4, Canada

  phone: (514) 340-4711 Ext. 4029
  email: michel.dagenais@polymtl.ca

- **Prof. Wahab Hamou-Lhadj**

  Research Collaborator
  Department of Electrical and Computer Engineering, Concordia University
  1515 St. Catherine West, Montreal, QC H3G2W1, Canada

  phone: (514) 848-2424 Ext. 7949
  email: wahab.hamou-lhadj@concordia.ca

- **Prof. Juergen Dingel**

  Research Collaborator
  School of Computing, Queen's University
  723 Goodwin Hall Kingston, ON, K7L 2N8, Canada

  phone: (613) 533-3071
  email: dingel@cs.queensu.ca

- **Prof. Mohammad Mohebbi**

  Research Collaborator
  Computer Science Department, Appalachain State University
  287 Rivers St, Boone, NC 28608, USA

  phone: (706) 201 6404
  email: mohebbim@appstate.edu

  5Base Solution Architect, and Research

Earl Brendan Foxwell

500 Glenridge Ave.
St. Catharines, Ontario, Canada, L2S 3A1
efoxwell@brocku.ca
(905) 688-5550 x6125

Education

2009 Master of Science, Computer Science, Brock University.
Topic: Particle Swarm Optimization for Two-Connected Networks with Bounded Rings
Supervisor: Dr. Beatrice Ombuki-Berman

2006 Bachelor of Science (Hons.), Computer Science, Brock University.
First-class Standing

Employment

2010 - 2018 Lecturer, Computer Science Department, Brock University.
Courses: *Introduction to Computer Science*, *Introduction to Artificial Intelligence*, *Computer Organization & Assembly Language*, *Logic Programming*, *Introduction to Computer Networking*, *Data Structures and Abstraction*, *Advanced Data Structures & Algorithms*, *Artificial Neural Networks*, *Introduction to Operating Systems*, *Fluency with Technology*, *Robotics*, *Programming Languages and Object Orientation*, *Computer Networks*, *Programming in C++ with Applications*, *Introduction to Media Computation*, *Procedural Programming*, *Mobile Computing*.

2010 Sessional Instructor, Computer Science Department, Brock University.
Courses: *Logic Programming*, *Advanced Data Structures & Algorithms*.

2009 Teaching Assistant, Computer Science Department, Brock University.
Courses: *Personal Computers and Networks*, *Introduction to Artificial Intelligence*, *Machine Learning*, *Fluency with Technology*.
Tasks: Labs, marking, guest speaker, instructing lecture, proctoring.

2006 - 2009 Graduate Teaching Assistant, Computer Science Department, Brock University.
Courses: *Introduction to Computer Science*, *Data Structures and Abstraction*, *Introduction to Artificial Intelligence*, *Introduction to Media Computation*, *Personal Computers and Networks*, General Consulting.
Tasks: Tutorials, labs, marking, guest instruction, contributing to tests, proctoring.

2006 Marker, Computer Science Department, Brock University.
Course: *Computer Organization & Assembly Language*.

2004 Private tutor.
Course: *Theory of Computation*.

Academic Honours and Grants

2006 - 2008 Brock Graduate Fellowship.
2006 - 2008 Brock Research Fellowship.
2004 - 2005 Brock University, Faculty of Mathematics and Science, Deans List.

1999 3M Scholarship
1999 Brock University Entrance Scholarship

Awards and Distinctions

2015 - 2016 2015 Distinguished Teaching Award — Faculty of Mathematics and Science.

Skills and Experience

- ▷ Compiled languages
  - · C, Java: Efficient designs for research, advanced AI search techniques, mobile platform development, object orientation, OpenGL
- ▷ Scripting languages
  - · PHP, Python: Both client and server-side scripting, image generation and manipulation, basic media functionality and pygame
- ▷ Declarative languages
  - · Prolog: Predicate logic, definite clause grammars, constraint logic programming
  - · Lisp: Functional programming, lambda expressions
- ▷ Light database work
  - · mySQL, SQLite: Experience with web forum software, local data storage and PHP bindings
- ▷ Office and typesetting
  - · MS Office, LaTeX: Peer-reviewed research and thesis
- ▷ AI and Evolutionary Computation
  - · Bioinspired metaheuristics, discrete optimization, game trees
- ▷ Hardware repair and maintenance
  - · Assembly/disassembly
  - · Partitions, booting multiple operating systems
  - · Diagnostic and recovery utilities
- ▷ Personal Skills
  - · Ability to learn new skills and languages quickly
  - · Project planning skills, including designs for extensibility
  - · Excellent writing and editing skills

Publications and Workshops

- ▷ **Earl B. Foxwell**, Beatrice Ombuki-Berman, "Particle swarm optimisation for the design of two-connected networks with bounded rings", *International Journal of High Performance Systems Architecture*, vol. 1, no. 4, 2008, pp 220–230.
- ▷ **E.B. Foxwell**, B. Ombuki-Berman *Particle Swarm Optimization for the Design of Two-Connected Networks with Bounded Rings*, First International Workshop on Parallel Architectures and Bioinspired Algorithms, Toronto, Canada, October 25-29, 2008.

Academic Interests

- ▷ Evolutionary Computation
- ▷ Combinatorial Optimization

References

Available upon request.

SHERIDAN HOUGHTEN
Professor
Department of Computer Science
Brock University
St. Catharines, Ontario L2S 3A1
(905) 688 5550 ext. 4526
shoughten@brocku.ca

FORMAL EDUCATION

Ph.D., Concordia University, Computer Science, 1999

Master of Computer Science, Concordia University, Computer Science, 1993

Bachelor of Science, Concordia University, Mathematics and Science College, 1991

ACADEMIC POSITIONS HELD

2011-present:	Professor, Computer Science Brock University, St. Catharines, Ontario
2003-2011:	Associate Professor, Computer Science Brock University, St. Catharines, Ontario
1999-2003:	Assistant Professor, Computer Science Brock University, St. Catharines, Ontario
1998-1999:	Lecturer, Computer Science (limited-term) Concordia University, Montreal, Quebec
1995-1997:	Part-time Instructor, Computer Science, Concordia University Concordia University, Montreal, Quebec

CREATIVE AND SCHOLARLY ACTIVITIES

PUBLICATIONS

Refereed Journals:

P.E. Becker, M. Derka, S. Houghten and J. Ulrich, Build a Sporadic Group in Your Basement, *American Mathematical Monthly* 124, p. 291-305, 2017. **Awarded 2018 Halmos-Ford Award by the MAA (Mathematical Association of America).**

J.A. Hughes, S. Houghten and D. Ashlock, Restarting and recentering genetic algorithm variations for DNA fragment assembly: The necessity of a multi-strategy approach, *BioSystems* 150, p.35-45, 2016.

L. Plant and S. Houghten, Properties of Optimal and Near Optimal Edit Metric Error Correcting Codes, *Congressus Numerantium* 224, p.147-157, 2015.

J.A. Hughes, S. Houghten and D. Ashlock, Recentering and Restarting a Genetic Algorithm using a Generative Representation for an Ordered Gene Problem, *International Journal of Hybrid Intelligent Systems*, Vol.11, No.4, p.257-271, 2014.

G. Mallen-Fullerton, J.A. Hughes, S. Houghten and G. Fernandez-Anaya, Benchmark Data Sets for the DNA Fragment Assembly Problem, *International Journal of Bio-Inspired Computation*, Vol.5, No.6, p.384-394, 2013.

M. Derka, S. Houghten and P. Becker, A methodology for constructing the basis of a putative (72,36,16) extremal code for a given authomorphism group, *Congressus Numerantium* 212, p.173-193, 2012.

D. Ashlock, S. Houghten, J.A. Brown and and J. Orth, "On the Synthesis of DNA Error Correcting Codes", *BioSystems* 110, p.1-8, 2012.

P. Comte, S. Vassiliev, S. Houghten and D. Bruce, “Genetic Algorithm with Alternating Selection Pressure for Protein Sidechain Packing and pK(a) Prediction”, *BioSystems* 105, p.263-270, 2011.

J. Sun, S. Houghten and J. Ross, “Bounds on Edit Metric Codes with Combinatorial DNA Constraints”, *Congressus Numerantium* 204, p.65-92, 2010

Book Chapters:

J.A. Hughes, S. Houghten and D. Ashlock, Permutation Problems, Genetic Algorithms, and Dynamic Representations, book chapter for “Nature Inspired Computing and Optimization: Theory and Applications”, Springer book series on Modelling and Optimization in Science and Technology, p.123-149, 2017.

Refereed Conference Proceedings:

M. Dubé, S. Houghten and D. Ashlock, Parameter Selection for Modeling of Epidemic Networks, *2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 8 pages, 2018.

S. Houghten, T.K. Collins, J.A. Hughes and J.A. Brown, Edit Metric Decoding: Return of the Side Effect Machines, *2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 8 pages, 2018. **Awarded Best Paper.**

Y. Kazemi and S. Houghten, A Deep Learning Pipeline to Classify Different Stages of Alzheimer’s Disease from fMRI Data, *2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 8 pages, 2018.

A. Saunders, D. Ashlock and S. Houghten, Hierarchical Clustering and Tree Stability, *2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 8 pages, 2018.

D. Ashlock and S. Houghten, Hybridization and Ring Optimization for Larger Sets of Embeddable Biomarkers, *2017 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-8, 2017.

T.K. Collins, A. Zakirov, J.A. Brown and S. Houghten, Single-Objective and Multi-Objective Genetic Algorithms for Compression of Biological Networks, *2017 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-8, 2017.

J. Orth, S. Houghten and L. Tulloch, Evaluation of the Salmon Algorithm, *2017 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-8, 2017.

T. Ribaric and S. Houghten, Genetic Programming for Improved Cryptanalysis of Elliptic Curve Cryptosystems, *2017 IEEE Congress on Evolutionary Computation*, 419-426, 2017.

J.A. Brown, S. Houghten, T. Kennedy Collins and Q. Qu, Evolving Graph Compression using Similarity Measures for Bioinformatics Applications, *2016 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-6, 2016.

A. Entezari Heravi and S. Houghten, A Methodology for Disease-Gene Association using Centrality Measures, *2016 IEEE World Congress on Computational Intelligence*, 24-31, 2016.

D. Ashlock and S. Houghten, Lexicode Crossover for Embeddable Biomarkers, *2015 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-7, 2015.

A. Entezari Heravi, K. Tahmasebipour and S. Houghten, Evolutionary Computation for Disease Gene Association, *2015 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, 1-8, 2015.

M. Goodarzi, S. Houghten and P. Liang, Effect of Multi-K Contig Merging in de novo DNA Assembly, *2014 IEEE Conference on Bioinformatics and Bioengineering*, 355-361, 2014.

K. Tahmasebipour and S. Houghten, Disease-Gene Association using a Genetic Algorithm, *2014 IEEE Conference on Bioinformatics and Bioengineering*, 191-197, 2014.

C. Price, S. Houghten, S. Vassiliev and D. Bruce, Modeling Metal Protein Complexes from Experimental Extended X-ray Absorption Fine Structure using Evolutionary Algorithms, *2014 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, p.1-8, 2014.

J.A. Hughes, S. Houghten, G. Mallen-Fullerton and D. Ashlock, Recentering and Restarting Genetic Algorithm Variations for DNA Fragment Assembly, *2014 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology*, p.1-8, 2014. **Awarded Best Student Paper.**

J.A. Hughes, S. Houghten and D. Ashlock, Recentering, Reanchoring and Restarting an Evolutionary Algorithm, *5th World Congress on Nature and Biologically Inspired Computing*, IEEE, p.76-83, 2013.

J.A. Hughes, J. Brown, S. Houghten and D. Ashlock, Edit Metric Decoding: Representation Strikes Back, *IEEE Congress on Evolutionary Computation*, p.229-236, 2013.

Z. Li and S. Houghten, Searching for Optimal Deletion Correcting Codes: New Properties and Extensions of Tenengolts Codes, *12th IEEE International Conference on Computer and Information Technology (CIT 2012)*, p.647-654, 2012.

D.E. McCarney, S. Houghten and B.J. Ross, Evolutionary Approaches to the Generation of Optimal Error Correcting Codes, *Genetic and Evolutionary Computation Conference (GECCO 2012)*, ACM, p.1135-1142, 2012.

F. Alizadeh Noori and S. Houghten, A MultiObjective Algorithm with Side Effect Machines for Motif Discovery, *2012 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology*, p.275-282, 2012.

J.A. Brown, D. Ashlock, S. Houghten and J. Orth, "Autogeneration of Fractal Photographic Mosaic Images", *IEEE Congress on Evolutionary Computation*, June 2011.

J. Orth and S. Houghten, "Optimizing the Salmon Algorithm for the Construction of DNA Error-Correcting Codes", *2011 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology*, April 2011.

D. Ashlock and S. Houghten, "Ring Optimization of Edit Metric Codes in DNA", *ACM International Conference on Bioinformatics and Computational Biology 2010* (full paper).

J.A. Brown, S. Houghten and D. Ashlock, "Side Effect Machines for Quaternary Edit Metric Decoding", *2010 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology*, p.103-110, 2010.

Non-refereed Conference Proceedings:

T.K. Collins and S. Houghten, A Future Direction for the Disease Gene Association Problem, 2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology, Extended Abstract (2 pages), 2018.

P. Comte, S. Vassiliev, A. Mahmood, M.R. Gunner, D. Bruce and S. Houghten, "Conformational Sampling of Proteins for the Generation of Molecular Ensemble Distributions", *27th Annual Eastern Regional Photosynthesis Conference* – poster, 2010.

INVITED PRESENTATIONS

Evolutionary Algorithms for Bioinformatics: Disease-Gene Association, DNA Fragment Assembly and Protein Modeling, Missouri University of Science and Technology (joint IEEE-CIS and graduate seminar), December 2014.

GRANTS OBTAINED

NSERC Discovery Grant, $20000/yr, 2014-2019

NSERC Discovery Grant, $15000/yr, 2009-2014

EDITORIAL, REFEREEING AND TECHNICAL COMMITTEE DUTIES

Committee Member, IEEE Computational Intelligence Society Task Force on Ethical and Social Implications of Computational Intelligence, since 2017.

Committee Member, IEEE Computational Intelligence Society Bioinformatics and Bioengineering Technical Committee, 2010-present (vice-chair 2016).

Technical Co-Chair, 2018 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology.

Proceedings Chair, 2017 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology.

Program Committee Member, 2016 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology.

Program Committee Member: Optimization, Learning, and Decision-Making in Bioinformatics and Bioengineering, 2016 IEEE World Congress on Computational Intelligence.

General Chair, 2015 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology.

Co-Chair, Bioinformatics and Computational Biology Special Session, 2014 IEEE Congress on Evolutionary Computation.

Organizing Committee Member (special sessions chair): 2014 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology.

Co-Chair, Bioinformatics and Computational Biology Special Session, 2013 IEEE Congress on Evolutionary Computation.

Program Committee Member: Conference on Computational Intelligence Methods for Bioinformatics and Biostatistics, 2013.

Co-Chair, Bioinformatics Special Session, 2012 IEEE World Congress on Computational Intelligence.

Organizing Committee Member (technical co-chair): 2012 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology.

Organizing Committee Member (co-chair): Bioinformatics Special Session, 2011 IEEE Congress on Evolutionary Computation.

Program Committee Member: Canadian Conference on Computer Science and Software Engineering

Reviewer for the following Journals:

- Neurocomputing (Elsevier)
- IEEE Computational Intelligence Magazine
- IEEE Transactions on Computational Biology and Bioinformatics
- BioSystems (Elsevier)
- Discrete Mathematics (Elsevier)
- IEEE Transactions on Information Theory
- Journal of Combinatorial Mathematics and Combinatorial Computing

Reviewer for the following Conferences (each multiple times):

- IEEE World Conference on Computational Intelligence
- Computational Intelligence Methods for Bioinformatics and Biostatistics
- IEEE Congress on Evolutionary Computation
- Canadian Conference on Computer Science and Software Engineering
- IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology

TEACHING AND LEARNING ACTIVITIES

COURSES TAUGHT

2018:
Winter: COSC 3P32 (Introduction to Database Systems), COSC 4P03 (Advanced Algorithms)
2017:
Fall: COSC 5P01 (Coding Theory)
Winter: Sabbatical
2016:
Fall: COSC 2P03 (Advanced Data Structures)
Winter: COSC 3P32 (Introduction to Database Systems)
2015:
Fall: COSC 2P03 (Advanced Data Structures), COSC 5P01 (Coding Theory)
Winter: Sabbatical
2014:
Winter: COSC 2P32 (File and Database Systems)
2013:
Winter: COSC 2P32 (File and Database Systems)
2012:
Winter: COSC 5P01 (Coding Theory)
2011:
Winter: COSC 5P01 (Coding Theory)
2010:
Fall: COSC 2P03 (Advanced Data Structures)
Winter: COSC 4P03 (Advanced Algorithms), COSC 5P01 (Coding Theory)

GRADUATE SUPERVISIONS

Note: Our MSc program started in Fall 2006 and we do not yet have a PhD program.

Sharnendu Banik (currently in 1st year of MSc program)
Arvand Fazeli (currently in 1st year of MSc program)
Tyler Kennedy Collins (currently in 2nd year of MSc program)
Yaroslava Girilishena, MSc, 2017
Thesis: Complete Computational Sequence Characterization of Mobile Element Variations in the Human Genome using Meta-Personal Genome Data
Yosra Kazemi, MSc, 2017
Thesis: A Deep Learning Pipeline for Classifying Different Stages of Alzheimer's Disease from fMRI Data
Tim Ribaric, MSc, 2017
Thesis: Elliptic Curve Cryptography using Computational Intelligence
Veronica Suaste Morales, MSc, 2017
Thesis: Lossy Compression of Quality Values in Next-Generation Sequencing Data
Ashkan Entezari, MSc, 2015
Thesis: Disease-Gene Association using Genetic Programming
Mohammad Goodarzi, MSc, 2014
Thesis: New Contig Creation Algorithm for the de novo DNA Assembly Problem
James Hughes, MSc, 2014
Thesis: A Study of Ordered Gene Problems Featuring DNA Error Correction and DNA Fragment Assembly with a Variety of Heuristics, Genetic Algorithm Variations, and Dynamic Representations
Collin Price, MSc, 2014
Thesis: Modeling Metal Protein Complexes from Experimental Extended X-Ray Absorption Fine Structure using Computational Intelligence
Koosha Tahmasebipour, MSc, 2014
Thesis: Disease-Gene Association using a Genetic Algorithm
Farhad Alizadehnoori, MSc, 2012
Thesis: A Multi-Objective Genetic Algorithm with Side Effect Machines for Motif Discovery
Martin Derka, MSc, 2012
Thesis: A Generator Matrix Based Search for Extremal Self-Dual Binary Error-Correcting Codes
John Orth, MSc, 2012
Thesis: The Salmon Algorithm – a New Population Based Search Meta Heuristic
Zhiyuan Li, MSc, 2011
Thesis: Construction of 1-Deletion-Correcting Ternary Codes
Pascal Comte, MSc, 2010
Thesis: Bio-Inspired Optimization & Sampling Technique for Side-Chain Packing in MCCE

UNDERGRADUATE SUPERVISIONS

Jessica Graham (2018-present)
Igor Laskaev (2018-present)
Angelo Romualdo (2018-present)
Michael Dubé (2017-2018)
Lindsey Tulloch (2017)
Tyler Kennedy Collins (2016)
Christopher Thompson (2013-2015)
Taras Mychaskiw (2013-2014)
Lachlan Plant (2013-2014)
James Hughes (2012)
Daniel McCarney (2010-2011)
Samal Izekulova (2010-2011)
Jonathan Ross (2009-2010)

GRADUATE SUPERVISORY COMMITTEE MEMBER

Tanjil Fazle Rabbi (current Computer Science MSc student)
Michael Gircys (MSc, Computer Science, 2018)
Nafiseh Motevallibashi (MSc, Computer Science, 2017)
Mehrdad Arabpour (MSc, Computer Science, 2016)
Elham Salimi (MSc, Computer Science, 2016)
Keivan Noroozi (MSc, Computer Science, 2016)
Anthony Awuley (MSc, Computer Science, 2015)
Kelly Moylan (MSC, Computer Science, 2015)
Ethan Jackson (MSc, Computer Science, 2014)
Justin Chan (Computer Science MSc student until 2014)
Lily Zhang (MSc, Computer Science, 2014)
Mahdi Oraei Gholami (MSc, Computer Science, 2013)
Maryam Baniasadi (MSc, Computer Science, 2013)
Francis Atampore (MSc, Computer Science, 2012)
Adrian Harrington (MSc, Computer Science, 2012)
He Zhu (Computer Science MSc student until 2012)
Anwar Abdalbari (MSc, Computer Science, 2011)
Steven Bergen (MSc, Computer Science, 2011)
Darren Peters (MSc, Computer Science, 2011)
Prathap Siddavaatam (MSc, Computer Science, 2011)
Adam Lenarcic (MSc, Computer Science, 2011)
Robert Flack (MSc, Computer Science, 2010)
Bahar Aameri (MSc, Computer Science, 2010)
Si Zhang (MSc, Computer Science, 2010)

THESIS EXAMINATION COMMITTEE MEMBER (not including those already listed above)

Examiner, MSc Thesis, Ms. Amanda Saunders, Department of Integrative Biology, University of Guelph (2017).

External Examiner, MSc Thesis, Ms. Mahsa Daneshmandmehrabani, Department of Mathematics, Brock University (2017).

External Examiner, MSc Thesis, Ms. Arnoosh Golestanian, Department of Mathematics, Brock University (2015).

External Examiner, MSc Thesis, Mr. Jesse Larone, Department of Mathematics, Brock University (2014).

Internal External Examiner, PhD Thesis, Mr. Musa Ahmed, Department of Biological Sciences, Brock University (2014).

External Examiner, PhD Thesis, Mr. El Sayed Mahmoud, School of Computer Science, University of Guelph (2012).

External Examiner, MSc Thesis, Mr. Majid Karimi, Department of Mathematics, Brock University (2012).

UNIVERSITY AND COMMUNITY SERVICE

COMMITTEES:

Advisory Committee, Reappointment of Dean of Mathematics and Science, 2016
Internal Reviewer, Studies in Arts and Culture (IQAP), 2016
Computer Science Department Search Committee, 2015-2017
Advisory Committee, Appointment of Dean of Mathematics and Science, 2010/2011
Associate Deans Advisory Selection Committee, Faculty of Mathematics and Science, 2010
Computer Science Department Graduate Program Committee, 2009-present

ADMINISTRATIVE DUTIES:

Library Representative, Computer Science Department, 2016
Chair, Computer Science Department, 2011-2014
Graduate Program Director, Computer Science Department 2009-2011
Faculty Advisor, ACM Chapter, 2000-present
Coach for ACM Programming Contest, 1999-present

SERVICE DUTIES EXTERNAL TO BROCK:

Reviewer, NSERC Discovery Grant Applications, 2015-2017.

External Reviewer, Quality Assurance Review, Computer Science, University of Lethbridge, 2016.

External Reviewer, Administrative Review, School of Computer Science, University of Guelph, 2016.

External Reviewer, Promotion to Full Professor, Dr. Vivekanandan Kumar, School of Computing and Information Systems, Athabasca University, 2015.

External Reviewer, School of Computer Science, University of Guelph (IQAP), 2014.

External Reviewer, Mathematics and Computer Science Programs, Nipissing University (IQAP), 2013.

External Reviewer, Promotion to Full Professor, Dr. Alioune Ngom, School of Computer Science, University of Windsor, 2012.

COMMUNITY SERVICE:

Glynn A Green School Advisory Council, 2009-present

Curriculum Vitae

D.J.F. Hughes
Assoc. Professor
Dept. of Computer Science
Brock University

Education

B.Sc. (hons) (Computer Science):	1974	University of Manitoba
M.Sc. (Computer Science):	1975	University of Manitoba
Ph.D. (Computer Science):	1979	University of Manitoba

Doctoral Thesis:
"The Design of a Software Environment for the Development of Modular Systems"

Academic Appointments

Graduate Teaching Assistant,	University of Manitoba	1974–76
Part-time Lecturer,	University of Manitoba	1976–78
Assistant Professor,	Brock University	1978–84
Associate Professor,	Brock University	1984–date
Interim Chair	Dept. of Computer Science	Jan 1, 2015–June 30, 2015
Chair,	Dept. of Computer Science	2005–2011
	Brock University	1987–1990
Co-ordinator	Computing & Business Programme	1996–date
	Brock University	

Scholarly & Professional Activities

Academic and Professional Experience

Author:	- Jones & Bartlett Publishers, Sudbury, MA
Referee:	- INFOR Journal

Administrative Experience

Member	BUFA Executive	2009–2010
	BUFA Secretary	2009–2010
Member	Joint BUFA/Administration Committee on Salary Caps & Grids	2007–2011
Member	Research Board	2011–2013
Member	BUFA Hiring Advice Committee	2005–2011
Member	Senate Teaching & Learning Policy Committee	2017-2018
		2014–2015
Member	Senate Undergraduate Student Affairs Committee	2018-date
		2012–2013
Member	Senate TLPC/SA ad hoc Subcommittee on Spring/Summer Schedule	2014–2015

Member	Senate TLPC/SA ad hoc subcommittee on Context Courses	2014–2015
Member	Senate Spring/Summer Policy Sub-committee	2013
Member	Faculty Undergraduate Curriculum Review Committee	2011–date
Interim Chair	Dept. of Computer Science	Jan 1, 2015–June 30, 2015
Chair	Dept. of Computer Science	2005–2011
Coordinator	Computing & Business (BCB) Program	1996–date
Chair	Department Curriculum Committee	2011–date
Member	Department Curriculum Committee	2001–date
Member	Department Search Committee	2016–2017
	Department Calendar Representative	2011–date
	Department Undergraduate Student Advisor	2000–date
	Department Timetable Representative	2011–date
	Department Admissions Officer	2000–2015
Member	Working group on BA/BSc in Game Design/Programming	2008–2015
Member	FMS Data Science Program Working Group	2017-date
Lead Author	COSC Self Study, Cyclic Review	2017-date
Participant	ONCAT College University Pathways for Games Project	2012–2014
Member	Canadian Association for Computer Science (CACS/AIC)	2005–2011
Member	CACS/AIC Executive (representing Ontario)	2006–2012
Researcher	CACS/AIC Annual Survey	2010–2016

Courseware Development

Summer 2014-2017	Development of on-line version of COSC 1P02
Winter 2014:	Instructional Labs for COSC 1P03

Teaching Experience

Introduction to Computer Science (COSC 1P02: 17/18, 17/18 (online), 16/17, 15/16, 14/15, 13-14,…)
Data Structures & Abstraction (COSC 1P03: 17/18, 16/17, 15/16, 14/15, 12/13, 10/11,…)
Principles of Programming Languages (COSC 2P05 16/17, 15/16, COSC 3P05 14/15,…)
Procedural Programming (COSC 2P91: 12/13)
Mobile Computing (COSC 3V97: 13/14, 12/13)
Compiler Construction (COSC 4P75: 15/16, 11/12, 09/10,…)

Supervision of Undergraduate Honours Theses

Navjot Minhas	"Project Peer to Peer"	2010
Denis Ideler	UCOSP	2011
Ron Bond	"My Smart Hands"	2012
Chris Stinson	UCOSP	2012
Chris Conley	UCOSP	2013
Kevan Fisher	UCOSP	2014
James Grisdale	UCOSP	2014
Chris Kellendonk	UCOSP	2014
Jacub Subczynski	UCOSP	2014

Annuschka Bork	UCOSP	2015
Ryan Spring	UCOSP	2015
James Earle	UCOSP	2016
Riley Donaldson	UCOSP	2016
Bradley Kennedy	UCOSP	2016
Chang Ding	UCOSP	2017
Brock Jones	UCOSP	2017
Ronny Mondal	UCOSP	2017
Balaji Venkatesh	UCOSP	2017
Sarah Ann Childs	UCOSP	2018

Research/Pedagogical Grants

Ontario eCampus Open Textbook Initiative	2017-18	applied.
Brock University eLearning Initiative	2016/17	$7,000

Publications

Books Authored

Hughes, D.; *Introduction to Data Structures*; 2015; (manuscript and e-book) used in COSC 1P03 starting Winter 2015

Hughes, D.; *Introduction to Computer Science*; revised edition 2014; (manuscript and e-book) used in COSC 1P02 starting Fall 2014

Hughes, D.; *Introduction to Computer Science Part I*; (manuscript and e-book) used in COSC 1P02 (2012)

Yifeng Li

Assistant Professor, PhD:
Department of Computer Science, Brock University
Work Email: yli2@brocku.ca
Personal Email: yifeng.li.cn@gmail.com
Mailing Address: Room WJ322, Computer Science, 1812 Sir Isaac Brock Way, St. Catharines, ON L2S 3A1
Home Page 1: `https://www.cosc.brocku.ca/staff/li`
Home Page 2: `https://sites.google.com/view/yifengli`
Adjunct Professor:
School of Computer Science, University of Windsor

Education

1. Post-Doctoral Research Fellow, Centre for Molecular Medicine and Therapeutics (CMMT), University of British Columbia (UBC), 2013.10-2015.08 (Main Research Topic: Deep Machine Learning Methods for the Identification of *cis*-Regulatory Elements in Human Genome, Advisor: Dr. Wyeth Wasserman)
2. Ph.D. in computer science, School of Computer Science, University of Windsor (UWindsor), ON, Canada, 2009.09-2013.10. (Dissertation Title: Sparse Machine Learning Models in Bioinformatics, available online: `http://scholar.uwindsor.ca/etd/5023`, Advisor: Dr. Alioune Ngom and Dr. Luis Rueda)
3. Master's degree in computer science, School of Information, Shandong Institute of Light Industry (SDILI; now renamed as Qilu University of Technology), China, 2006-2009. (Thesis Title: Computational Intelligences for Mass Spectrometry Data Analysis, Advisor: Dr. Yihui Liu)
4. Bachelor's degree in computer science, School of Information, SDILI, China, 2002-2006.

Work Experiences

1. 2020.01 - present: Assistant Professor, Department of Computer Science, Brock University
2. 2015.8 - 2019.12: Research Officer, Digital Technologies Research Centre, National Research Council Canada

Awards, Grants, and Honours (Selected)

1. NRC Rising Star Award, Institutional/National, 2018.
2. NRC New Beginning Ideation Grant (20% success rate), Institutional, 2019-2020 (PI, CAD $50,000 + 20%time).
3. NRC-DT Award for Innovative & Interdisciplinary Research, Institutional, 2018.
4. Certificate of Excellence, Institutional, 2016.
5. NRC Ideation Game Changing Funds, Institutional/National, 2016 (Co-PI, CAD $641,594 for two years).
6. NSERC Postdoctoral Fellowship, National, 2015 (CAD $45,000/year).
7. Canada Governor General's Gold Medal, National, 2013-2014 (priceless).
8. RECOMB 2015 Travel Fellowship, 2015 (USD $1,000).
9. Alberta Innovates Centre for Machine Learning and Canadian Artificial Intelligence Association Travel Award for Canadian AI, 2013 (CAD $800).
10. IEEE BIBM Student Travel Award, 2012 (USD $600).
11. IEEE CIBCB Student Travel Grants, 2012 (USD $400).
12. Ontario Graduate Scholarship, UWindsor, 2012-2013 (CAD $15,000/year).
13. Ontario Graduate Scholarship, UWindsor, 2011-2012 (CAD $15,000/year).
14. Graduate Student Achievement Awards, UWindsor, April 2012.
15. Graduate Student Society Scholarship, UWindsor, 2010-2011 (CAD $500).
16. International Student Society Bursary Awards, May 2011, UWindsor (CAD $300).
17. IEEE Walter Karplus Summer Research Grant, 2010 (USD $3,800).
18. Graduate Student Achievement Awards, UWindsor, April 2010.
19. Doctoral Tuition Scholarships, UWindsor, 2009-2013 (CAD $6000/year).
20. Graduate Assistantship, UWindsor, 2009-2013 (CAD $5,000+/semester).

21. Research Assistantship, UWindsor, 2009-2013 (CAD $2,000/semester).
22. IEEE CIBCB Student Travel Grants, 2008 (USD $800).

Research Interests

1. **Bioinformatics & Health-Informatics:** I have a strong enthusiasm to apply machine learning and data mining models to bioinformatics (such as annotation of non-coding regions of the human genome, biomarker identification using next-generation/deep sequence data, systems biology, high-dimensional biological data analysis), and computational health-informatics (such as cancer research, personalized disease (including cancer and complex traits) diagnosis and treatment, drug design & repurposing, and (next-generation) intelligent and integrative health-informatics systems).
2. **Machine Learning:** I am very interested in the theoretical studies of the unification of neural networks and probabilistic graphical models, deep generative models, deep network learning, large-scale sparse matrix factorizations, sparse representations, disentangled representation learning, generalized and regularized linear models, kernel/nonlinear approaches, deep feature selection, as well as Bayesian learning and inference. I prefer to formulate and explain various machine learning models from a statistical perspective.
3. **Data Science:** Theories and applications of big data analytics, structured data modelling, and heterogeneous data integration for knowledge discovery and actionable decision making. Particularly interested in multi-view matrix factorizations, multi-modal deep learning models, data visualization, network science, knowledge representation, and knowledge learning from structured data.
4. **Artificial Intelligence:** In a long term, I am interested in artificial intelligence algorithms that are inspired by neuroscience and cognitive science. Particularly, computational modelling and realization of the five principles of cognition (perception-action cycle, memory, attention, intelligence and language) are my priorities. I am very interested in the merge of symbolic representation and distributed representation theories through capsule neural networks.
5. **Computational Intelligence:** Evolutionary computation and quantum computing for machine learning.
6. **Optimization:** Fast numerical optimization methods for large-scale machine learning and data mining models.

Leaderships and Activities

1. Sponsorship Chair for AI-CRV 2020 Conference (`http://www.ai-crv.org/2020/home`) in Ottawa.
2. Co-founder of the Ottawa-AI Alliance and co-organizer of the Ottawa-AI Workshop, Oct. 19, 2018. (`https://sites.google.com/view/ottawaaialliance`)
3. Organizer of the NRC-DT Computing Science Colloquium Series, since May 2018. (`https://nrc.canada.ca/en/corporate/events/computing-science-colloquium-series-nrc`)
4. Member of Canadian Artificial Intelligence Association (CAIAC) since 2013.
5. Member of Institute of Electrical and Electronics Engineers (IEEE) since 2008.
6. Assessor of Canada Foundation for Innovation (CFI), Build in Canada Innovation Program (BCIP), Western Innovation (WINN) Initiative, Mitacs Accelerate Grants, NSERC Collaborative Research & Development Grants.
7. Evaluator of the Creative Destruction Lab, University of Toronto.
8. Local Arrangements Chair of the 2016 IEEE World Congress on Computational Intelligence (WCCI), Vancouver.
9. Co-chair of the special session of Computational Intelligence in Genetic Regulatory Network under the umbrella of IEEE CIBCB 2013.
10. Co-chair of the special session of Computational Intelligence for Microarray Data Analysis under the umbrella of IEEE CIBCB 2012 and 2011.
11. Advertising committee chair of the BTC 2011 conference in University of Windsor.
12. Co-organizer of the 5th University of Windsor Computer Science Conference.
13. Judge of the 2014 Bioinformatics Retreat @ UBC Roboson Square.
14. Committee member of The International Association for Pattern Recognition Technical Committee 20: Pattern Recognition for Bioinformatics (IAPR TC-20: PRIB: `http://iaprtc20.mosuma.org/?q=node/2`)

15. Reviewer/PC member of NuerIPS 2016/17/18/19, ICML 2017/18/19, ICLR 2016/17/18/19/20, AISTATS 2016/17/18/19, AAAI 2020, IJCAI 2019, ACML 2019, WCCI 2016/18, BIBM 2015, ICCABS BMC Special Issues 2014, IEEE CEC 2009/10/11/18/19, SSCI 2014, PRIB 2014/13, IEEE CIBCB 2012/16/17, and Graduate Student Symposium under Canadian AI 2013, 2019 National Big Data Challenge, etc.
16. Reviewer of Briefings in Bioinformatics, Bioinformatics, BMC Bioinformatics, IEEE/ACM Transactions on Computational Biology and Bioinformatics, Journal of Bioinformatics and Computational Biology, IEEE Transactions on Neural Networks and Learning Systems, Neural Networks, Neurocomputing, Neural Computing and Applications, ACM Transactions on Knowledge Discovery from Data, Expert Systems with Applications, IEEE Transactions on Multimedia,IEEE Transactions on Systems, Man, and Cybernetics: Systems, PLOS ONE, PLOS Computational Biology, Scientific Reports, Science China: Life Science Journal, etc.
17. Associate Editor of BMC Bioinformatics (Machine Learning and Artificial Intelligence Section).

Publications

Dissertation

* [1] **Yifeng Li**, "Sparse machine learning models in bioinformatics," PhD Dissertation, School of Computer Science, University of Windsor, 334 pages, Oct. 2013. (thesis available: `http://scholar.uwindsor.ca/etd/5023/`)

Preparing, Submitted, and Revised Refereed Journal Papers:

* [1] Danny Salem, **Yifeng Li** (corresponding author), Pengcheng Xi, Miroslava Cuperlovic-Culf, Hilary Phenix, and Mads Kaern, "YeastNet: Deep learning enabled accurate segmentation of budding yeast cells in bright-field microscopy," *Bioinformatics*, under revision, Manuscript ID: BIOINF-2019-0569R1, 2019.

Published Refereed Journal Papers:

* [1] Lipu Wang, Qiang Li, Ziying Liu, Anu Surendra, Youlian Pan, **Yifeng Li**, L. Irina Zaharia, Therese Ouellet, and Pierre R. Fobert, "Integrated transcriptome and hormone profiling highlight the role of multiple phytohormone pathways in wheat resistance against fusarium head blight," *PLOS ONE*, vol. 13, no. 11, e0207036, 2018. (IF: 2.766)

[2] Genevieve L. Stein-O'Brien, Raman Arora, Aedin C. Culhane, Alexander V. Favorov, Lana X. Gamire, Casey S. Greene, Loyal A. Goff, **Yifeng Li**, Alioune Ngom, Michael F. Ochs, Yanxun Xu, and Elana J. Fertig, "Enter the matrix: factorization uncovers knowledge from omics," *Trends in Genetics*, vol. 34, no.10, 790-805, 2018. (IF: 10.556)

[3] **Yifeng Li**, Youlian Pan, and Ziying Liu, "Multi-class non-negative matrix factorization for comprehensive feature pattern discovery," *IEEE Transactions on Neural Networks and Learning Systems*, vol. 30, no. 2, 615-629, 2019. (IF: 7.982)

[4] **Yifeng Li**, Wenqiang Shi, and Wyeth W. Wasserman, "Genome-wide prediction of *cis*-regulatory regions using supervised deep learning methods," *BMC Bioinformatics*, no. 19, 202, 2018. (IF: 2.213)

[5] **Yifeng Li**, Francois Fauteux, Jinfeng Zou, Andre Nantel, Youlian Pan, "Personalized prediction of genes with tumor-causing somatic mutations based on multi-modal deep Boltzmann machine," *Neurocomputing*, vol. 324, 51-62, 2018. (IF: 3.241)

[6] **Yifeng Li**, Fang-Xiang Wu, and Alioune Ngom, "A Review on machine learning principles for multi-view biological data integration," *Briefings in Bioinformatics*, vol. 19, no. 2, 325-340, 2018. (IF: 6.302)

[7] Chih-Yu Chen, Wenqiang Shi, Bradley P. Balaton, Allison M. Matthews, **Yifeng Li**, David J. Arenillas, Anthony Mathelier, Masayoshi Itoh, Hideya Kawaji, Timo Lassmann, Yoshihide Hayashizaki, Piero Carninci, Alistair R.R. Forrest, Carolyn J. Brown, and Wyeth W. Wasserman, "A role for YY1 in sex-biased transcription revealed through X-linked promoter activity and allelic binding analyses," *Scientific Reports*, vol. 6, ID: 37324, 2016. (IF: 4.122)

[8] **Yifeng Li**, Chih-Yu Chen, and Wyeth W. Wasserman, "Deep feature selection: Theory and application to identify enhancers and promoters," *Journal of Computational Biology*, vol. 23, no. 5, 322-336, 2016. (IF: 1.191)

[9] **Yifeng Li**, Chih-Yu Chen, Alice M. Kaye, and Wyeth W. Wasserman, "The identification *cis*-regulatory elements: A review from a machine learning perspective," *BioSystems*, vol. 138, 6-17, 2015. (IF: 1.619)

[10] **Yifeng Li**, Haifen Chen, Jie Zheng, and Alioune Ngom, "The max-min high-order dynamic Bayesian network for learning gene regulatory networks with time-delayed regulations," *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, vol. 13, no. 4, 792-803, 2016. (IF: 2.428)

[11] **Yifeng Li**, B. John Oommen, Alioune Ngom, and Luis Rueda, "Pattern classification using a new border identification paradigm: The nearest border technique," *Neurocomputing*, vol. 157, 105-117, 2015. (IF: 3.241)

[12] **Yifeng Li** and Alioune Ngom, "Versatile sparse matrix factorization: Theory and applications," *Neurocomputing*, vol. 145, 23-29, 2014. (IF: 3.241)

[13] **Yifeng Li** and Alioune Ngom, "Sparse representation approaches for the classification of high-dimensional biological data," *BMC Systems Biology*, vol.7(S-4), pp. S6, 2013. (IF: 2.050)

[14] **Yifeng Li** and Alioune Ngom, "The non-negative matrix factorization toolbox for biological data mining," *BMC Source Code for Biology and Medicine*, vol. 8, pp. 10, 2013. (new journal, no IF yet)

[15] **Yifeng Li** and Alioune Ngom, "Non-negative least squares methods for the classification of high dimensional biological data," *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, vol. 10, no.2, pp. 447-456, 2013. (IF: 2.428)

[16] **Yifeng Li** and Alioune Ngom, "Classification approach based on non-negative least squares," *Neurocomputing*, vol. 118, pp. 41-57, 2013. (IF: 3.241)

[17] **Yifeng Li** and Yihui Liu, "Feature selection based on simulated annealing algorithm for high-resolution protein mass spectrometry data," *China Journal of Bioinformatics*, vol. 7, no.2, pp. 85-90, Jun. 2009. (Chinese)

[18] **Yifeng Li** and Yihui Liu, "Feature selection for protein mass spectrometry data based on genetic algorithm," *Computer Engineering*, vol. 35, no.19, pp. 192-194, Oct. 2009. (Chinese)

Book Chapters:

* [1] **Yifeng Li** and Alioune Ngom, "Mining gene-sample-time microarray data," Chapter 13 in Luis Rueda ed. *Microarray Image and Data Analysis: Theory and Practice*, CRC Press/Taylor & Francis, pp. 339-368, 2014.

Published Refereed Conference Proceedings:

* [1] Xiaoyan Li, Iluju Kiringa, Tet Yeap, Xiaodan Zhu, **Yifeng Li** (corresponding author), "Anomaly Detection Based on Unsupervised Disentangled Representation Learning in Combination with Manifold Learning," NeurIPS 2019 LIRE Workshop, Vancouver, Dec., 2019.

[2] **Yifeng Li** and Xiaodan Zhu, "Capsule generative models," *International Conference on Artificial Neural Networks*, Munich, Germany, Sep. 2019, pp. 281-295.

[3] Xiaoyan Li, Iluju Kiringa, Tet Yeap, Xiaodan Zhu, **Yifeng Li** (corresponding author), "Exploring deep anomaly detection methods based on capsule net," *ICML 2019 Workshop on Uncertainty and Robustness in Deep Learning*, Long Beach, USA, June, 2019.

[4] **Yifeng Li** and Xiaodan Zhu, "Capsule restricted Boltzmann machine," *NIPS 2018 Workshop on Bayesian Deep Learning*, Montreal, Canada, Dec., 2018.

[5] Yufei Feng, Xiaodan Zhu, **Yifeng Li**, Yuping Ruan, Michael Greenspan, "Learning capsule networks with images and text," *NIPS 2018 Workshop on Visually Grounded Interaction and Language*, Montreal, Canada, Dec., 2018.

[6] **Yifeng Li** and Xiaodan Zhu, "Exploring Helmholtz machine and deep belief net in the exponential family perspective," *ICML 2018 Workshop on Theoretical Foundations and Applications of Deep Generative Models*, Stockholm, Sweden, July, 2018.

[7] **Yifeng Li** and Xiaodan Zhu, "Exponential family restricted Boltzmann machines and annealed importance sampling," *International Joint Conference on Neural Networks (IJCNN)*, Rio, Brazil, July 2018, pp. 39-48.

[8] **Yifeng Li**, "Advances in multi-view matrix factorizations," *2016 International Joint Conference on Neural Networks (IJCNN)*, Vancouver, Canada, July 2016, pp. 3793-3800.

[9] **Yifeng Li** and Alioune Ngom, "Data integration in machine learning," *2015 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, Washington DC, Nov., 2015, pp. 1665-1671.

[10] **Yifeng Li**, Chih-Yu Chen, and Wyeth W. Wasserman, "Deep feature selection: Theory and application to identify enhancers and promoters," *2015 Annual International Conference on Research in Computational Molecular Biology (RECOMB)*, Warsaw, Poland, April, 2015, vol. LNCS 9029, pp. 205-217. (acceptance rate 21.20%)

[11] **Yifeng Li**, Richard Caron, and Alioune Ngom, "A decomposition method for large-scale sparse coding in representation learning," *International Joint Conference on Neural Networks (IJCNN)*, Beijing, China, 2014, pp. 3732-2738.

[12] **Yifeng Li**, B. John Oommen, Alioune Ngom, and Luis Rueda, "A new paradigm for pattern classification: Nearest border techniques," *26th Australasian Joint Conference on Artificial Intelligence*, New Zealand, Dec. 2013, vol. LNCS 8272, pp. 441-446.

[13] **Yifeng Li** and Alioune Ngom, "Versatile sparse matrix factorization and its applications in high-dimensional biological data analysis," *IAPR International Conference on Pattern Recognition in Bioinformatics (PRIB)*, Nice, June, 2013, LNBI 7986, pp. 91-101.

[14] Iman Rezaeian, **Yifeng Li**, Martin Crozier, Eran Andrechek, Alioune Ngom, Luis Rueda, and Lisa Porter, "Identifying informative genes for prediction of breast cancer subtypes," *IAPR International Conference on Pattern Recognition in Bioinformatics (PRIB)*, Nice, June, 2013, LNBI 7986, pp. 138-148.

[15] **Yifeng Li**, "Sparse representation for machine learning," *26th Canadian Conference on Artificial Intelligence (AI 2013)*, Regina, May, 2013, LNAI 7884, pp. 352-357.

[16] **Yifeng Li** and Alioune Ngom, "The max-min high-order dynamic Bayesian network learning for identifying gene regulatory networks from time-series microarray data," *IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB/SSCI)*, Singapore, Apr. 2013, pp. 83-90.

[17] **Yifeng Li** and Alioune Ngom, "Fast kernel sparse representation approaches for classification," *IEEE International Conference on Data Mining (ICDM)*, Brussels, Belgium, Dec. 2012, pp. 966-971. (acceptance rate 19.97%)

[18] **Yifeng Li** and Alioune Ngom, "Fast sparse representation approaches for the classification of high-dimensional biological data," *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, Philadelphia, PA, Oct. 2012, pp. 306-311. (acceptance rate 19.93%)

[19] **Yifeng Li** and Alioune Ngom, "Supervised dictionary learning via non-negative matrix factorization for classification," *International Conference on Machine Learning and Applications (ICMLA)*, Boca Raton, Florida, Dec. 2012, pp. 439-443.

[20] **Yifeng Li** and Alioune Ngom, "Diagnose the premalignant pancreatic cancer using high dimensional linear machine," *LNBI/LNCS: 2012 IAPR International Conference on Pattern Recognition in Bioinformatics (PRIB)*, LNBI 7632, pp. 198-209, 2012.

[21] **Yifeng Li**, Alioune Ngom, and Luis Rueda, "A framework of gene subset selection using multiobjective evolutionary algorithm," *LNBI/LNCS: 2012 IAPR International Conference on Pattern Recognition in Bioinformatics (PRIB)*, LNBI 7632, pp. 38-48, 2012.

[22] **Yifeng Li** and Alioune Ngom, "A new kernel non-negative matrix factorization and its application in microarray data analysis," *IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, San Diego, CA, May 2012, pp. 371-378.

[23] **Yifeng Li** and Alioune Ngom, "Classification of clinical gene-sample-time microarray expression data via tensor decomposition methods," *LNBI/LNCS: Selected Papers of 2010 International Meeting on Computational Intelligence Methods for Bioinfomatics and Biostatistics (CIBB)*, vol. 6685, pp. 275-286, 2011.

[24] **Yifeng Li** and Alioune Ngom, "Non-negative matrix and tensor factorization based classification of clinical microarray gene expression data," *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, Hong Kong, Dec. 2010, pp.438-443.

[25] **Yifeng Li**, Numanul Subhani, Alioune Ngom, and Luis Rueda, "Alignment-based versus variation-based transformation methods for clustering microarray time-series data," *ACM International Conference On Bioinformatics and Computational Biology (BCB)*, Niagara Falls, NY, Aug. 2010, pp.53-61.

[26] Numanul Subhani, **Yifeng Li**, Alioune Ngom, and Luis Rueda, "Alignment versus variation vector methods for clustering microarray time-series data," *IEEE Congress on Evolutionary Computation (CEC/WCCI)*, Barcelona, Spain, Jul. 2010, pp. 818-825.

[27] **Yifeng Li**, Alioune Ngom, and Luis Rueda, "Missing value imputation methods for gene-sample-time microarray data analysis," *IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, Montreal, Canada, May 2010, pp.183-189.

[28] **Yifeng Li**, Yihui Liu, and Li Bai, "Genetic algorithm based feature selection for mass spectrometry data," *IEEE International Conference on Bioinformatics and Bioengineering (BIBE)*, Athens, Greece, Oct. 2008, pp.85-90.

[29] **Yifeng Li** and Yihui Liu, "A Wrapper feature selection method based on simulated annealing algorithm for prostate protein mass spectrometry data," *IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, Sun Valley, Idaho, Sep. 2008, pp.195-200.

Software/Tutorials/Abstracts/Non-Refereed Papers/Technical Reports/Presentations:

* [1] **Yifeng Li**, "Deep learning for health data analytics," *Ottawa Heart Conference 2019: Big Data in Cardiovascular Disease*, invited talk, Ottawa, Canada, Apr.13, 2019.

[2] **Yifeng Li**, "Machine learning for text data analytics," *Treasury Board of Canada Secretariat and Canada School of Public Service*, invited talk, Ottawa, Canada, Mar. 8, 2019.

[3] **Yifeng Li**, "Generative machine learning models enabled intelligent data analytics," *Distinguished Speaker Seminar Series, Institute for Data Science, Carleton University*, invited talk, Ottawa, Canada, Jan. 21, 2019.

[4] **Yifeng Li**, Francois Fauteux, Jinfeng Zou, Andre Nantel and Youlian Pan, "Personalized prediction of genes with tumor-causing somatic mutations based on multi-modal deep Boltzmann machine," oral and poster at *The 18th International Biotechnology Symposium and Exhibition*, Montreal, Canada, Aug. 2018.

[5] **Yifeng Li**, Ziying Liu, Qiang Li, Ioannis Mavraganis, Liping Wang, Brian Fowler, Youlian Pan and Jitao Zou, "Computational discovery of molecular mechanisms in wheat cold resistance from RNA-seq data," poster at *The 3rd Canadian Wheat Symposium (CWS)*, Ottawa, Canada, Nov. 2016.

[6] **Yifeng Li**, "Multi-View Matrix Factorization Models for Integrative Data Analysis," ICT, NRC, Aug., 2016. Software Available at `https://github.com/yifeng-li/mvmf`

[7] **Yifeng Li**, "The identification of *cis*-regulatory elements: A review from the machine learning perspective," tutorial at *IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, Niagara Falls, Canada, Aug. 2015.

[8] **Yifeng Li**, "Deep feature selection: Theory and application to identify enhancers and promoters," invited colloquium at University of Windsor, Oct. 2014.

[9] **Yifeng Li**, "Deep learning for identifying *cis*-regulatory elements and other applications," CMMT, University of British Columbia, Oct. 2014. Software Available at `https://github.com/yifeng-li/DECRES`

[10] **Yifeng Li**, and Alioune Ngom, "Probabilistic graphical models toolbox in MATLAB," School of Computer Science, University of Windsor, May 2013. Software available at `https://sites.google.com/site/pgmtool`

[11] **Yifeng Li**, and Alioune Ngom, "Regularized linear models and kernels toolbox in MATLAB," School of Computer Science, University of Windsor, May 2013. Software available at `https://sites.google.com/site/rlmktool`

[12] **Yifeng Li** and Alioune Ngom, "The sparse representation MATLAB toolbox," School of Computer Science, University of Windsor, Oct. 2011. Software available at `https://sites.google.com/site/sparsereptool`

[13] **Yifeng Li**, Alioune Ngom, and Luis Rueda, "Spectral Clustering Toolbox," School of Computer Science, University of Windsor, 2010. Software available at `https://sites.google.com/site/speclust`

[14] **Yifeng Li** and Alioune Ngom, "The non-negative matrix factorization MATLAB toolbox," School of Computer Science, University of Windsor, Technical Report, No. 11-060, May 2011. Available at `https://sites.google.com/site/nmftool`

[15] Iman Rezaeian, **Yifeng Li**, Martin Crozier, Eran Andrechek, Alioune Ngom, Luis Rueda, and Lisa Porter, "Finding informative genes for the prediction of breast cancer types," *The 1st Windsor Cancer Research Group Conference*, Windsor, ON, Nov. 2012.

[16] **Yifeng Li** and Alioune Ngom, "Fast kernel sparse representation approach for classification," *The 6th University of Windsor Computer Science Conference*, Windsor, ON, Dec. 2012.

[17] **Yifeng Li** and Alioune Ngom, "Tensor decomposition methods for the classification of three-dimensional microarray data," *The 5th University of Windsor Computer Science Conference*, Windsor, ON, Apr. 2011.

[18] **Yifeng Li** and Alioune Ngom, "Non-negative matrix factorization: theory & applications to microarray gene expression analysis," *The 4th University of Windsor Computer Science Conference*, Windsor, ON, Apr. 2010.

[19] **Yifeng Li** and Alioune Ngom, "Non-negative matrix and tensor factorization methods for microarray data analysis," *Report to IEEE CIS Walter Karplus Research Grant 2010*, Nov. 2010, pp. 1-8. `http://cis.ieee.org/graduate-student-research-grants.html`

Teaching Experience

1. APCO 1P93 Applied Programming (in Python for Data Science), Instrutor (Winter2020).
2. 03-60-254 Data Structures & Algorithms (Lab Instructor Fall2012, Graduate Assistant Winter2012, Graduate Assistant Winter2010, Graduate Assistant Fall2010, Lab Instructor Summer2010).
3. 03-60-141 Introduction to Algorithms & Programming II (Lab Instructor Fall2011).
4. 03-60-256 Computer Architecture I: Digital Design (Graduate Assistant Fall2009).
5. 03-60-100 Key Concepts in Computer Science (Lab Instructor Summer2011).

Mentoring/Supervisory Experience

1. I supervise graduate students at the Department of Computer Science, Brock University.
2. I supervise students in research projects through the NRC Student Program.
3. I co-supervise student with Dr. Mads Kaern of the Ottawa Institute of Systems Biology, University of Ottawa.
4. As an Adjunct Professor, I collaborate with Dr. Ngom and Dr. Rueda in UWindsor to co-supervise graduate students in several bioinformatics projects.
5. I am supervising a PhD student (Ping Luo) with Dr. Fang-Xiang Wu in University of Saskatchewan for a project of computationally comparing different integrative machine learning methods for analysing multi-omics data.
6. I was the supervisor of two undergraduate researchers, in the Wasserman lab, on sequence data processing and machine learning through the UBC Work Learn Program.
7. I also served as machine learning mentor of PhD students in the Vancouver Bioinformatics program.

Research Experience

Position	Institution	Advisor & Subject	(Selected) Collaborator & Subject	Date
Research Officer	DT, NRC	data science, AI, machine learning, deep learning, bioinformatics, health-informatics	1. AI for Design and Scientific Discovery Program (DT, NRC) 2. Health Challenging Program (HHT, NRC) 3. Canadian Wheat Improvement Flagship Program (ACRD, NRC) 4. Cancer diagnosis (HHT, NRC) 5. Agriculture and Agri-Food Canada 6. Canada Food Inspection Agency 7. Health Canada 8. Dr. FangXiang Wu (UofSask, data integration) 9. Elana Fertig & Michael Ochs (Johns Hopkins Medicine, NMF for therapeutic response) 10. Xiaodan Zhu (NRC and Queen's) 11. Richard Naud (uOttawa) 12. Mads Kaern (uOttawa) 13. Anna Goldenberg (Sickkids, Vector Institute, UofT) 14. Joseph Emerson (IQC, Waterloo, Canada-UK Program)	2015.08-now
Post-Doc Fellow	CMMT, UBC	Dr. Wyeth Wasserman (deep machine learning methods for *cis*-regulatory elements prediction)	1. Dr. Elizabeth Simpson (regulatory landscape of PAX6 gene) 2. Dr. Carolyn J. Brown (X-chromosome inactivation) 3. Raymond Ng (deep learning, data science)	10/2013-08/2015
Research Assistant	Computer Science, UWindsor	Dr. Alioune Ngom and Dr. Luis Rueda (sparse machine learning models in bioinformatics: non-negative matrix factorization, sparse coding, sparse representation, tensor factorization, missing value estimation, regularized linear models, spectral clustering, high-order dynamic Bayesian networks, and probabilistic graphical models)	1. Dr. Lisa Porter (Biology, UWindsor, breast tumor subtyping) 2. Dr. Arturas Petronis (CAMH, U of T, ChIP-Chip data analysis in epigenomics) 3. Dr. John Oommen (CS, Carleton, novel nearest border methods for classification) 4. Dr. Richard Caron (Math & Stat, UWindsor, large scale optimization for sparse coding) 5. Dr. Jie Zheng (Computer Engineering, NTU, Singapore, gene regulatory network)	09/2009-10/2013
Research Assistant	Computer Science, SIDIL	Dr. Yihui Liu (Computational intelligences for mass spectrometry data analysis)	Li Bai (CS, U of Nottingham, UK) (genetic algorithm based feature selection for protein mass spectrometry data)	09/2006-07/2009

Beatrice M. Ombuki-Berman
Professor & Graduate Program Director
Department of Computer Science
Brock University, St. Catharines, Ontario, L2S 3A1
(905) 688 3494 ext. 3494 bombuki@brocku.ca

RESEARCH INTERESTS

- Artificial Intelligence: Swarm Intelligence, Evolutionary Computation, Neural Networks, Self-Adaptive Strategies.
- AI application: Challenging Optimization Problems (Large-scale optimization, Multi/many-objective optimization, Combinatorial optimization etc.), Complex Networks Modeling & Design, Network science
- Others: Machine learning (Evolving neural networks, evolving complex network systems)

FORMAL EDUCATION

- Ph.D., Intelligent Systems, Dept. Information Engineering, University of the Ryukyus, Japan, 2001.
- ME., Information Engineering, University of the Ryukyus, 1998.
- Japanese Language and Cultural Studies, Osaka U. of Foreign Studies, Certificate, 1995.
- BSc., Double Mathematics (Statistics and Mathematics) and Computer Science, Jomo Kenyatta University of Agriculture and Technology, Kenya, 1993.

ACADEMIC POSITIONS HELD

- Full Professor, Computer Science, Brock University, 2014–current.
- Graduate Supervisions (unpaid), Computer Science, U. Pretoria, 2015–current.
- Associate Professor, Computer Science, Brock University, 2005–2014.
- Assistant Professor, Computer Science, Brock University, 2001–2005.
- Special Graduate Faculty (unpaid), Computing and Information Science, University of Guelph, 2003–2005.
- Research and Teaching Assistant, Information Engineering, University of the Ryukyus, 1996—2001.
- Teaching Assistant, Math and Computer Sciences, Jomo Kenyatta University of Agriculture and Technology, 1993—1995.

ACADEMIC DISTINCTIONS and AWARDS

- Japanese Monbusho Government Scholarship, Masters programme & Ph.D. pro-

gramme, 1996–2001.
- Japanese Monbusho Government Scholarship for Research Student, 1995.

SCHOLARLY ACTIVITIES

- **Refereed Publications (Journals, Conference Proceedings and Book Chapter)**

1. K.R Harrison, **B. M Ombuki-Berman and** A.P Engelbrecht. "Gaussian-Valued Particle Swarm Optimization," *Eleventh International Conference on Swarm Intelligence, ANTS 2018, Accepted* June 2018.
2. J. Paterson and **B. M. Ombuki-Berman**. "Optimizing Scale-Free Network Robustness with the Great Deluge Algorithm," *The 31st International Conference on Industrial, Engineering & Other applications of Applied Intelligent Systems*, IEA-AIE 2018, *Accepted*, June 2018.
3. M. Ventresca, K. Harrison and **B. M. Ombuki-Berman**. "A Bi-Objective Critical Node Detection Problem," *European Journal of Operational Research*, 254 (3): 895-908, March 2018.
4. J. Douglas Harrison, A.P Engelbrecht and **B. M. Ombuki-Berman**. "Merging and Decomposition Variants of Cooperative Particle Swarm Optimization – New Algorithms for Large Scale Optimization Problems," 2nd International Conference on Intelligent Systems, Metaheuristics and Swarm Intelligence, March 2018.
5. J. Maltese, **B. M. Ombuki-Berman** and A. P. Engelbrecht. "A Scalability Study of Many-Objective Optimization Algorithms," *IEEE Transactions on Evolutionary Computation*, 22 (1) pp: 79-96, February 2018.
6. K.R Harrison, A.P Engelbrecht and **B. M. Ombuki-Berman**. "Optimal Parameter Regions and the Time Dependence of Control Parameter Values for the Particle Swarm Optimization Algorithm," *Swarm and Evolutionary Computation*, Elsevier, *In Press*, Available Online January 2018.
7. K.R Harrison, A.P Engelbrecht, and **B. M Ombuki-Berman**. "Self-Adaptive Particle Swarm Optimization: A review and Analysis of Convergence," in Press, *Swarm Intelligence*, Springer, Available online, November 2017.
8. Audrey Opoku-Amankwaar and **B.M Ombuki-Berman**. "An Age Layered Population Structure Genetic Algorithm for Multi-Depot Vehicle Routing." 2017 *IEEE Symposium Series on Computation Intelligence, pp.3403-3410*, November 2017.
9. K. R. Harrison, A. P. Engelbrecht, and **B. M. Ombuki-Berman**, An Adaptive Particle Swarm Optimization Algorithm Based on Optimal Parameter Regions, *2017 IEEE Symposium Series on Computational Intelligence* (SSCI 2017), pp. 1606–1613, IEEE, 2017.
10. K.R. Harrison, **B.M. Ombuki-Berman**, and A.P. Engelbrecht, Optimal Parameter Regions for Particle Swarm Optimization Algorithms, *2017 IEEE Congress on Evolutionary Computation* (CEC 2017), pp. 349–356, June 2017.
11. K.R Harrison A. P Engelbrecht, and **B.M Ombuki-Berman**. "Inertia Weight Control Strategies for Particle Swarm Optimization," *Swarm Intelligence* 10(4), pp. 267-305, Springer, December 2016.
12. K.R. Harrison, M. Ventresca and **B. M. Ombuki-Berman**. "A Meta-Analysis of

Centrality Measures for Comparing and Generating Complex Network Models," *Journal of Computational Science,* Elsevier, 17(1): 205-215, November 2016.

13. M. Medland, K. R. Harrison, and **B. M. Ombuki-Berman**. "Automatic Inference of Graph Models for Directed Complex Networks using Genetic Programming," *IEEE Congress on Evolutionary Computation,* CEC 2016, pp. 2337-2344, Vancouver, Canada, July 2016.
14. J. Maltese, **B. M. Ombuki-Berman**, and A. P. Engelbrecht. "Pareto-Based Many-Objective Optimization using Knee Points," *IEEE Congress on Evolutionary Computation*, CEC 2016, pp. 3678 - 3686, Vancouver, Canada, July 2016.
15. K. R. Harrison, A. P. Engelbrecht and **B.M. Ombuki-Berman**. "The Sad State of Self-Adaptive Particle Swarm Optimizers," IEEE Congress on Evolutionary Computation, CEC 2016, pp. 431-439, at 2016 *IEEE World Congress on Computational Intelligence*, Vancouver, Canada, July 2016.
16. K.R. Harrison, **B.M Ombuki-Berman**, and Andries P. Engelbrecht. "A Radius-Free Quantum Particle Swarm Optimization Technique for Dynamic Optimization Problems," *IEEE Congress on Evolutionary Computation*, CEC 2016, pp. 578-585, at 2016 IEEE World Congress on Computational Intelligence, Vancouver, Canada, July 2016.
17. K. R. Harrison, **B. Ombuki-Berman** and A. P. Engelbrecht. "The Effect of Probability Distributions on the Performance of Quantum Particle Swarm Optimization for Solving Dynamic Optimization Problems," *IEEE Symposium on Swarm Intelligence*, IEEE SIS 2015, pp. 242-250, Cape Town, Dec. 2015.
18. Justin Maltese, **Beatrice Ombuki-Berman** and Andries P. Engelbrecht. "Cooperative Vector Particle Swarm Optimization for Multi-Objective Optimization," *IEEE Symposium on Swarm Intelligence,* IEEE SIS 2015, pp. 1294- 1301, Cape Town, Dec. 2015.
19. Justin Maltese, **Beatrice Ombuki-Berman** and Andries P. Engelbrecht. "High-Dimensional Multi-Objective Optimization Using Co-operative Vector- Evaluated Particle Swarm Optimization with Random Variable Grouping," *IEEE Symposium on Swarm Intelligence*, IEEE SIS 2015, pp. 1302 - 1309, Cape Town, Dec. 2015.
20. Oleg Rybik, Ivo Duntsch and **Beatrice Ombuki-Berman**. A GA Approach for finding decision rules based on bireducts, Extended abstract, RST 2015, Warsaw, Poland, June 2015.
21. Ron Bond, Andries Engelbrecht and **Beatrice Ombuki-Berman**. "Evaluating Landscape Characteristics of Dynamic Benchmark Functions". CEC 2015, *IEEE Congress on Evolutionary Computation*, CEC 2015, pp. 187 - 195, Sendai, Japan, May 2015.
22. Derek Dibblee, Justin Maltese, **Beatrice Ombuki-Berman** and Andries Engelbrecht. "Vector-Evaluated Particle Swarm Optimization with Local Search". *IEEE Congress on Evolutionary Computation*, CEC 2015, pp. 1343 - 1350, Sendai, Japan, May 2015.
23. Kyle Harrison, Mario Ventresca and **Beatrice Ombuki-Berman**. "Investigating Fitness Measures for the Automatic Construction of Graph Models". *Lecture Notes in Computer Science*, 9028 pp:189-200, 2015 18th European Conference on the Applications of Evolutionary Computation, EvoCOMPLEX, Copenhagen, Denmark, April 2015.
24. Mario Ventresca, Kyle Harrison, and **Beatrice Ombuki-Berman**. "An Experimental Evaluation of Multi-Objective Evolutionary Algorithms for Detecting Critical Nodes in Complex Networks". *Lecture Notes in Computer Science*, 9028 pp:164-176,2015. 18th

European Conference on the Applications of Evolutionary Computation, EvoCOMPLEX, Copenhagen, Denmark, April 2015.

25. Michael Medland, Kyle Harrison and **Beatrice Ombuki-Berman**. "Demonstrating the Power of Object-Oriented Genetic Programming via the Inference of Graph Models for Complex Networks," *6th World Congress on Nature and Biologically Inspired Computing*, (NABIC 2014), pp. pp. 305-311, Portugal, August 2014.
26. M. Medland, K. Harrison and **B. Ombuki-Berman**. "Incorporating Expert Knowledge in Object-Oriented Genetic Programming," *Genetic and Evolutionary Computation Conference*, GECCO 2014, pp. 145 - 146, Vancouver, July 2014.
27. K. Harrison, **B. Ombuki-Berman** and A. Engelbrecht. "Dynamic Multi- Objective Opti. using Charged Vector Evaluated Particle Swarm Optimization," *IEEE Congress on Evol. Computation*, CEC 2014, pp. 1929 - 1936, Beijing, China, July 2014.
28. A. Bailey, M. Ventresca and **B. Ombuki-Berman**. "Genetic Programming for the Automatic Inference of Graph Models for Complex Networks," *IEEE Transactions on Evolutionary Computation*, Issue No. 99 (early access ref.), 18(3):405-419.
29. K. Harrison, **B. Ombuki-Berman** and A. Engelbrecht. "A Scalability Study of Multi-Objective Particle Swarm Optimizers," *IEEE Congress on Evolutionary Computation*, CEC 2013, pp. 189–197, Cancun´n, Mexico, June 2013.
30. A. Bailey, **B. Ombuki-Berman** and M. Ventresca. "Automatic Inference of Hierarchical Graph Models using Genetic Programming with an Application to Cortical Networks," *Genetic and Evolutionary Computation Conference*, GECCO 2013, pp. 893–900, Amsterdam, Netherlands, July 2013.
31. A. Bailey, **B. Ombuki-Berman** and S. Aseibola. "Discrete Particle Swarm Optimization for the Single Allocation Hub Location Problem," *2013 IEEE Symposium on Computational Intelligence in Production and Logistics Systems*, IEEE SSCI 2013, pp. 92–98, Singapore, April 2013.
32. N. Unger, **B. Ombuki-Berman** and A. P. Engelbrecht. "Cooperative PSO for Dynamic Environments," 2013 IEEE Symposium on Swarm Intelligence, IEEE SSCI 2013, pp. 172–179, Singapore, April 2013.
33. M. Ventresca, A. Runka and **B. Ombuki-Berman**. "Predicting GAs Performance on the Vehicle Routing Problem Using Information Theoretic Landscape Measures," 13th European Conference on Evolutionary Computation in Combinatorial Optimization, EvoCOP 2013, pp. 214–225, Vienna, Austria, April 2013.
34. K. Harrison, **B. Ombuki-Berman** and A.P. Engelbrecht. "Knowledge Transfer Strategies for Vector Evaluated PSO for Multi-Objective Optimization," Evolutionary Multi-Criterion Optimization, Lecture Notes in Computer Science, vol. 7811, no. 2013, pp. 171–184, March 2013.
35. A. Bailey, **B. Ombuki-Berman** and M. Ventresca. "Automatic Generation of Graph Models for Complex Networks by Genetic Programming," Genetic and Evolutionary Computation Conference, GECCO 2012, pp. 711–718, Philadelphia, USA, July 2012.
36. M. Naeem and **B. Ombuki-Berman**. "An Efficient Genetic Algorithm for the Uncapacitated Single Allocation Hub Location Problem," 2010 IEEE Congress on Evolutionary Computation, CEC 2010, pp. 941–948, Barcelona, Spain, July 18–23, 2010.

Submitted: K.R Harrison, **B. M. Ombuki-Berman** and A.P Engelbrecht. "A Parameter-free Particle Swarm Optimization Algorithm using Performance Classifiers," *Swarm and Evolutionary Computation*, Elsevier, *August* 2018.

On-going research projects:

Many-objective PSOs for optimization in Dynamic Search Spaces

A Comparative Study: Swarm Intelligence Algorithms for Large-Scale data clustering

PSO Fitness Landscape Analysis with Neutrality and Varying Gradient

Random Grouping and Factorization to Train Large Neural Networks using Cooperative PSO

General-Purpose Audio Tagging with Deep Learning Neural Network

Learning Neural Network Ensembles and Concept Drift

Other presentations and invited talks

1. B. Ombuki-Berman "Genetic programming for Evolving Directed Complex Networks," Invited Talk, Dept. Information Engineering, U. of The Ryukyus, Japan, August 2016
2. B. Ombuki- Berman "Handling Large-Scale Optimization Problems using PSOs," Invited Talk, Dept. Information Engineering, U. of The Ryukyus, Japan, August 2016
3. K. Harrison and B. Ombuki-Berman. "Dynamic Multi-Objective Optimization using Particle Swarms Inspired by Atomic Models," Second Brock-Kobe Bi- lateral Workshop on Scientific Computation, August 2013.
4. M. Medland and B. Ombuki-Berman. "Unravelling the Underlying Algorithmic Principles of Directed Complex Networks," Second Brock-Kobe Bilateral Workshop on Scientific Computation, August 2013.
5. K. Harrison, B. Ombuki-Berman and A.P. Engelbrecht. "Vector Evaluated PSO for Multi-Objective Optimization," Computational intelligence research group research day, Pretoria, South Africa, December 2012.
6. B. Ombuki-Berman, K. Klassen and A. Harrington. "Using Summed Ranks and Pareto Ranking to Design Outpatient Schedules," Canadian Operational Research Society Conference, Niagara Falls, Ontario, June 2012.
7. K. Klassen, B. Ombuki-Berman and A. Harrington. "Developing Appointment Schedules with Genetic Algorithms", Production and Operations Management Society Conference, Chicago, Illinois, April 2012.

RESEARCH FUNDING

1. NSERC Development Grant, $20,000, 2016 – 2018
2. Matching Funds (Brock), $12,000, 2016-2018
3. Match-of-Minds, Brock Internal Grant, $10,000, 2018
4. Match-of-Minds, Brock Internal Grant, $5, 000, 2017
5. Match-of-Minds, Brock Internal Grant, $5, 000, 2016
6. Ontario Centers of Excellence, $31 250, (OCE contribution $25,000 and AIRON $6250), 2013.
7. Federal Economic Development Agency for S. Ontario, $50, 000, 2011-2012
8. Natural Sciences and Engineering Research Council of Canada.
9. NSERC GRF, $8,000, 2011.
10. Natural Sciences and Engineering Research Council of Canada.
11. NSERC Discovery Grant, $60, 000 (or $12,000/year), 2006-2011.

Applied Research Via Industry Collaborations and Software Development

12. PI for Collaboration with Airon Group of Companies, Ontario: Intelligent Energy Analytics with Fault Detection for Facility Management, 2013.
13. PI Collaboration with SmartTeacher (St. Catharines) incorporated with Aseco Inc. (Oakville): A neural-network based bio-feedback response system, Math educational software, 2011-2012.

Editorial and External Grant Competitions Reviewer

1. Academic Editor, Complexity, Open Access Journal, May 2018- Ongoing
2. Associate Editor, IEEE Transactions on Emerging Topics on Computational Intelligence, Jan. – Dec. 2017.
3. Mitacs Accelerate Fellowship, 2018
4. NSERC Discovery Grant, 2015, 2012 and 2010 Competitions
5. NSERC Idea to Innovation Program 2007 Competitions
6. National Research Foundation of South Africa, 2016, 2007, 2005.

External Examiner for Graduate Theses outside Brock

1. Department of Computer Science, University of Windsor, ON, PhD Theses
2. Faculty of Engineering and Applied Science, University of Ontario Institute of Technology, MSc. Theses.
3. Department of Computer Science, University of Pretoria, S. Africa, PhD Thesis.

Event Administration

1. (Invited) Publicity Co-chair, IEEE 5th Intl. Conference on Soft Computing & Machine Intelligence, Conference, 2018/11 - 2018/11.
2. (Invited) Session Chair (Evolutionary Computation), The 31st International Conference on Industrial, Engineering & Other applications of Applied Intelligent Systems,

IEA-AIE 2018, Montreal, Canada, 2018.
3. (Invited) Session Chair, 2017 IEEE Symposium Series on Computational Intelligence, USA.
4. Organizer (Adaptive systems session): 2017 IEEE Symposium Series on Computational Intelligence, USA
5. (Invited) Session Chair, 2017, 2017 IEEE Congress in Evolutionary Computation, Spain.
6. (Invited) Publicity Co-chair, 2015 IEEE Symposium Series on Computational Intelligence, SA, The 16th European Conference on Evolutionary Computation in Combinatorial Optimization, EvoCop 2016, Portugal, 2016.
7. The 15th European Conference on Evolutionary Computation in Combinatorial Optimisation, EvoCop 2015, Copenhagen, 2015.
8. The 14th European Conference on Evolutionary Computation in Combinatorial Optimisation, EvoCoP 2014, Spain, 2014.
9. Swarm Intelligence, ANTS 2012, Belgium, 2012

Reviewer for the following Journals:

- IEEE Transactions on Evolutionary Computation
- IEEE Transactions on Systems, Man and Cybernetics: Part C on Applications and Reviews
- IEEE Transactions on Neural Networks and Learning
- Swarm and Evolutionary Computation
- Swarm Intelligence
- European Journal of Operations Research
- Computers and Operational Research
- Soft Computing
- Applied Soft Computing
- Applied Intelligence
- Applied Soft Computing
- Applied Mathematics and Computation
- Annals of Operations Research
- South African Journal of Computing
- Optimization Letters
- Operational Research
- Public Transport
- ACM Computing Surveys
- ACM Computing Reviews
- International Journal of Swarm Intelligence
- Connection Science
- Journal of Advanced Transportation
- Inverse Problems in Science & Engineering
- Journal of Information Science & Engineering
- IEEE Communications Letters

- Engineering Applications of Artificial Intelligence

Reviewer and Technical Program Committee Member for the following International Refereed Conferences:

1. The Genetic and Evolutionary Conference (GECCO)
2. European Conference on Evolutionary Computation in Combinatorial Optimization, EvoCOP
3. IEEE Congress on Evolutionary Computation (IEEE CEC)
4. IEEE Symposium Series on Computational Intelligence (IEEE SSCI)
5. International Symposium on Innovations in Intelligent Systems and Applications
6. IEEE Computational Intelligence and Security
7. International Conference on Evolutionary Computation, ICEC.
8. International Technical Conference on Circuits/Systems, Computers and Communications, ITC-CSCC.
9. IEEE International Conference on Systems, Man, and Cybernetics.

Curriculum Development

Co-chair Committee on Proposed Ph.D. in Modeling and Applied Computing, Brock University, July 2017 – Current
Committee Member and Department Rep., Proposed Interdisciplinary BSc & BA in Data Science, 2017
Committee Member, New MSc. Computer Science, Brock University, 2005-2005

DESIGNING OF NEW COURSES At BROCK U.

- COSC 5P74 Evolutionary Computation
- COSC 4P80 Artificial Neural Networks
- COSC 4P76 Machine Learning

Courses Taught

- COSC 3P71 Artificial Intelligence
- COSC 4P76 Machine Learning
- COSC 4P80 Artificial Neural Networks
- COSC 2P13 Computer Systems (previous: Operating Systems)
- COSC 1P03 Data Structures and Abstraction
- COSC 4P90 Honors project theses in AI
- COSC 5P74 Evolutionary Computation
- COSC 5P75 Directed Graduate Study, Swarm Intelligence
- COSC 5P75 Directed Graduate Study, Complex Networks
- COSC 5P75 Directed Graduate Study, Evolutionary Computation

- COSC 5P75 Directed Graduate Study, Pattern Classification
- COSC 5P75 Directed Study, Evolving neural networks
- COSC 5P90 Graduate thesis
- COSC 5F99 Graduate Project

STUDENT SUPERVISIONS GRADUATE SUPERVISIONS (2010-Current)

Note: Our MSc. program started in Fall 2006 and we do not yet have a PhD. program.

Summary:

- PhD Students (**2**, On-going, Co-supervision, University of Pretoria)
- MSc. On-going: **4**
- MSc. Completed: **16**
- GRADUATE SUPERVISORY COMMITTEE MEMBER: **20+**
- (Not including those already included above with my students)

Visiting International Internships Supervisions (Graduate Students)

- Kohei Yamamoto, Kobe University Japan, 2017-2018.
- Kengo Shimizu, Kobe University Japan, 2018-2019.

UNDERGRADUATE SUPERVISIONS – Last 8 Years only (honors theses or Funded Summer RAs)

- Honors Thesis: On-going: 3
- Honors Thesis: Completed: 16+
- Summer Research assistants: 9+

Ph.D. Thesis (The last 8 years only)

Bailey, Alex (PhD, In Progress), University of Pretoria, Thesis Title: "Evolving graph models for large-scale complex networks"

Harrison, Kyle (PhD, Submitted June 2018), University of Pretoria, Thesis Title: "Self-Adaptive PSOs"

MSc Thesis (The last 8 years only)

Crane, Tyler (Expected, 2020), (Topic TBA: Complex Networks Modeling & Genetic Programming)

Clark, Mitchell (Expected, 2020), (Topic on Swarm Intelligence, TBA)

Pawel, Jocko (Expected, 2020), (Topic on Evolving Deep learning, TBA)

Paterson, James (In Progress, Expected 2019), "Genetic Programming for Evolving graph models for complex networks"

McLean Reginald (In Progress, expected 2019), "A comparative Study of Swarm Intelligence techniques for Evolving Neural Networks"

Dzhumkaliev, Ruslan (In Progress, Expected December 2018). Project Title: "PSO Techniques for Multidimensional Data Clustering"

Douglas, Jay (In Progress, Expected September 2018). Thesis Title: "Cooperative PSOs for Large Scale Optimization"

Biswas, Sanjib (Completed, 2017). Thesis Title: "Multi-objective genetic algorithms for Multi-depot VRP with Time windows"

Opoku-Amankwaah, Audrey (Completed, 2017), Brock University Thesis Title: Age Layered Population Structure Genetic Algorithm for scheduling and optimization

Maltese, Justin (Completed, 2016). Thesis Title: "Many-objectives optimization using Knee-Based PSO and DE algorithms"

Rybkin, Oleg (Completed, 2016) , Brock University Thesis Title: "Genetic algorithms approach for finding rough sets decision rules"

Bond, Ron (Completed, 2014) , Brock University Thesis: "Dynamical landscape characterizations and niching algorithms"

Harrison, Kyle (Completed, 2014), Thesis Title: "Network Similarity Measures and Automatic Construction of Graph Models using Genetic Programming"

Medland, Michael (Completed, 2014), Thesis: "Graph Models for Directed Complex Networks via Object-Oriented Genetic Programming"

Asobiela, Stephen (Completed, 2013), Thesis Title: "Multi-Objective GAs for Allocation Hub Location Problems"

Iranzad, Arash (Completed, 2013), Thesis Title: "Image classifications using support vector machines"

Bailey, Alex (Completed, 2013), Thesis Title: "Using GP to construct graph models for

complex networks" Present Position: TBA

Edalatmanesh, Mahmood (Completed, 2013), Thesis Title: "Heuristics for the Critical Node Detection Problem Present Position"

Mofrad, Tanaby Z (Completed, 2010), Thesis Title: "Comparison of the Classification Ability of Hyperball Algorithms with Neural Networks"

Runka, Andrew (Completed, 2010), Thesis Title: "Genetic Programming for the RoboCup Rescue Simulation System"

Honors Thesis (The last 8 years only)

Titles not listed here

UNIVERSITY AND COMMUNITY SERVICE

DEPARTMENTAL SERVICE WORK

Graduate Program Director, 2017-2020, 2007–2008
Graduate Studies committee 2006 - current
Coordinator, Computer Science Honors thesis course projects, 2018-19, 2012
Coordinator, Department Seminar Series, 2018-19
Member, Curriculum committee, 2016-2018
Member
Department's new Graduate Programs Preparatory committee
Chair, Department Recruitment and Retention committee, 2008–2010
Hiring needs preparatory sub-committee, 2011–2012

FURTHER SERVICE WORK (Faculty/University)

University Senator, 2018-2021, 2012-2014
Representative, Math & Science Faculty Governance Senate Committee, 2018-19
Graduate Studies Senate Sub-Committee (BUFA observer), 2016 -19
Representative, Math & Science Faculty, Collective Agreement Negotiating Committee, 2016-17
Chair, Tenure and Promotions committee, Math & Science Faculty, 2015–2016

Member, Tenure and Promotions committee, Math & Science Faculty, 2012–2013

COMMUNITY SERVICE:

- Coach, St. Catharine's Jets Soccer Club, 2018.

- Volunteer, Wheatley School, 2011–2017.
- Volunteer, Broadway Lights Dance Studio, 2017-18.
- Brock Liaison Officer, Celebration of Ontario Women Comp. Scientists Conf.
- Coordinator, online silent auction Software & Organizing committee member −25 years Anniversary Gala, Wheatley School, 2011.
- Volunteer, Teacher Assistant, Parliament Oak Elementary School, 2009–2010

Ke Qiu

2010/11-2017/18

Department of Computer Science
Brock University
St. Catharines, ON, Canada, L2S 3A1
Tel: (905) 688-5550 ext. 5062
Fax: (905) 688-3255
kqiu@brocku.ca

Education

- 1988-1992 Ph.D., (Computing and Information Science), Queen's University, Kingston, Canada. The Star and Pancake Interconnection Networks: Properties and Algorithms.
- 1986-1988 MSc., (Applied Mathematics), University of California, Davis, CA, USA. Autonomous Land Vehicle Navigations: Obstacle Avoidance and Terrain Negotiation.
- 1983-1984 MSc., (Computer Science), University of California, Davis, CA, USA.
- 1978-1982 BSc., (Computer Science), Harbin Institute of Technology, Harbin, China.

Academic Positions Held

- 2012- Professor, Department of Computer Science, Brock University.
- 2004-2012 Associate Professor, Department of Computer Science, Brock University.
- 1999-2003 Associate Professor, Jodrey School of Computer Science, Acadia University (Visiting Professor, University of Texas, Arlington, 2001-2002 while on sabbatical)
- 1994-1999 Assistant Professor, Jodrey School of Computer Science, Acadia University.
- 1993-1994 Visiting Fellow to the Defence Research Establishment Valcartier (DND DREV), Quebec.
- 1992-1993 Post-Doc Fellow, Queen's University.

Creative and Scholarly Activities

Book Chapters

1. . E. Cheng, K. Qiu, and Z.Z. Shen, "Structural Properties of the Generalized Exchanged Hypercubes," Springer International Publishing Switzerland 2017, A. Adamatzky (ed.), *Emergent Computation, Emergence, Complexity and Computation*, 24, DOI 10.1007/978-3-319-46376-6_9

Refereed Journal Papers

1. W. Ding and K. Qiu, "A Quadratic Time Exact Algorithm for Continuous Connected 2-Facility Location Problem in Trees," *Journal of Combinatorial Optimization*, 2017. https://doi.org/10.1007/s10878-017-0213-2

2. E. Cheng, K. Qiu, and Z.Z. Shen, "On Diagnosability of Interconnection Networks," *International Journal of Unconventional Computing*, Vol. 13, No. 3, pp. 245-251, 2017.

3. E. Cheng, K. Noroozi, K. Qiu, and Z.Z. Shen, "Routing on the hypercube with Blocking/Faulty Nodes,' *Congressus Numerantium*, 229, pp. 75-85, 2017.

4. E. Cheng, K. Qiu, and Z.Z. Shen, "Diagnosability Problems of the Exchanged Hypercube and Its Generalization," *International Journal of Computer Mathematics*, Volume 2, Issue 2, pp. 39-52, 2017.

5. W. Ding and K. Qiu, "An FPTAS for Generalized Absolute 1-Center Problem in Vertex-Weighted Graphs," *Journal of Combinatorial Optimization*, Volume 34, Issue 4, pp. 1084-1095, Nov. 2017.

6. W. Ding and K. Qiu, "Incremental Single-Source Shortest Paths in Digraphs with Arbitrary Positive Arc Weights," *Theoretical Computer Science*, Vol. 674, No. 25, pp. 16-31, April, 2017.

7. E. Cheng, K. Qiu, and Z.Z. Shen, "On the Restricted Connectivity of the Arrangement Graph," *Journal of Supercomputing*, Volume 73, Issue 8, pp. 3669-3682, August 2017.

8. E. Cheng, K. Qiu, and Z.Z. Shen, "A Strong Connectivity Property of the Generalized Exchanged Hypercube," Dedicated to the memory of Levon H. Khachatrian, *Discrete Applied Mathematics*, Vol. 216, Part 3, pp. 529-536, Jan. 2017.

9. E. Cheng, K. Qiu, and Z.Z. Shen, "Length Two Path Centered Surface Areas of the (n, k)-Star Graph," *Information Sciences*, Vol. 332, 1, pp. 115-130, March 2016.

10. E. Cheng, K. Qiu, and Z.Z. Shen, "On the Conditional Diagnosability of Hyper-Butterfly Graphs and Related Networks," *Parallel Processing Letters*, Vol. 26, No. 1, 2016.

11. W. Ding and K. Qiu, "Approximating the Restricted 1-Center in Graphs," *Theoretical Computer Science*, available online, June 2016.

12. E. Cheng, K. Qiu, and Z.Z. Shen, "Connectivity Results of Complete Cubic Networks as Associated with Linearly Many Faults," *Journal of Interconnection Networks*, Vol. 15, Nos 1 & 2. accepted Sept. 2015.

13. E. Cheng, K. Qiu, and Z.Z. Shen, "Edge Centered Surface Area for the (n, k)-Star Graph," *Journal of Combinatorial Mathematics and Combinatorial Computing*, 94, pp. 237-260, 2015.

14. F. Zhang, K. Qiu, and J.S. Kim, "Hyper-star Graphs: Some Topological Properties and an Optimal Neighbourhood Broadcasting Algorithm," Special issue of *Concurrency and Computation: Practice and Experience*. 27, pp. 4186-4193, 2015.

15. E. Cheng, K. Qiu, and Z.Z. Shen, "Finding Edge-Centered Surface Areas for the (n, k)-Star Graph via First Principle," *Congressus Numerantium*, Vol 221, pp. 163-188, 2014.

16. E. Cheng, K. Qiu, and Z.Z. Shen, "On the Conditional Diagnosability of Matching Composition Networks," *Theoretical Computer Science*. Vol. 557, 6, pp. 101-114, Nov. 2014.

17. J.S. Kim, S.W. Kim, K. Qiu, and H.O. Lee, "Some Properties and Algorithms for the Hyper-Torus Network," *Journal of Supercomputing*, Vol. 69, Issue 1, pp. 121-138, July 2014.

18. E. Cheng, K. Qiu, and Z.Z. Shen, "Deriving Length Two Path Centered Surface Area for the Arrangement Graph: A Generating Function Approach," *Journal of Supercomputing*, 68, pp. 1241-1264, 2014.

19. E. Cheng, K. Qiu, and Z.Z. Shen, "On the Surface Areas of the Alternating Group Graph and the Split-Star Graph," *Ars Combinatoria*, 115, pp. 239-260, 2014.

20. E. Cheng, K. Qiu, and Z.Z. Shen, "Length Two Path Centered Surface Area for the Arrangement Graphs," em International Journal of Computer Mathematics, Vol. 91, No. 6, 1170-1189, 2014.

21. E. Cheng, K. Qiu, and Z.Z. Shen, "The Edge-Centered Surface Area of the Arrangement Graph," *Journal of Combinatorial Optimization*, 27, pp.49-64, 2014.

22. W. Ding and K. Qiu, "Algorithms for the Minimum Diameter Terminal Steiner Tree Problem," *Journal of Combinatorial Optimization*, Vol. 28, Issue 4, 837-853, Nov. 2014.

23. E. Cheng, K. Qiu, and Z.Z. Shen, "Length Two Path Centered Surface Area for the Bipartite Graphs," *Journal of Combinatorial Mathematics and Combinatorial Computing*, 90, pp. 223-239, 2014.

24. E. Cheng, K. Qiu, and Z.Z. Shen, "The Number of Shortest Paths in the (n, k)-Star Graphs," *Discrete Mathematics, Algorithms and Applications*, Vol. 6, No. 4, 2014.

25. E. Cheng, K. Qiu, and Z.Z. Shen, "A Faster Algorithm for Finding Disjoint Ordering of Sets," *International Journal of Networking and Computing*, Vol. 3, No. 2, pp. 182-191, July 2013.

26. E. Cheng, K. Qiu, and Z.Z. Shen, "On Disjoint Shortest Paths Routing in Interconnection Networks: A Case Study in the Star Graph," *Congressus Numerantium*, 216, pp. 157-180, 2013.

27. E. Cheng, J.W. Grossman, K. Qiu, and Z. Z. Shen, "The Number of Shortest Paths in the Arrangement Graph," *Information Sciences*, 240, pp. 191-204, 2013.

28. E. Cheng, K. Qiu, and Z.Z. Shen, "A Generating Function Approach to the Edge Surface Area of the Arrangement Graphs," *The Computer Journal*, Oxford University Press, Vol. 56 (7), pp. 871-881, 2013.

29. E. Cheng, L. Liptak, K. Qiu, and Z.Z. Shen, "Cyclic Vertex-Connectivity of Cayley Graphs Generated by Transposition Trees," *Graphs and Combinatorics*, Vol. 29, Issue 4, pp. 835-841, 2013.

30. E. Cheng, L. Liptak, K. Qiu, and Z.Z. Shen, "A Unified Approach to the Conditional Diagnosability of Interconnection Networks," *Journal of Interconnection Networks*, Vol. 13, Nos. 3 & 4, 2012.

31. D. Peters, X. Luo, K. Qiu, and P. Liang, "Speeding Up Large-Scale Next Generation Sequencing Data Analysis with pBWA," *Journal of Biocomputing*, accepted Dec. 2012.

32. E. Cheng, K. Qiu, and Z.Z. Shen, "Edge Centered Surface Areas of Bipartite Graphs," *Congressus Numerantium*, 211, pp. 185-196, 2012.

33. E. Cheng, L. Liptak, K. Qiu, and Z.Z. Shen, "On Deriving Conditional Diagnosability of Interconnection Networks," em Information Processing Letters, 112, pp. 674-677, 2012.

34. E. Cheng, K. Qiu, and Z Shen, "On the Surface Area of the Augmented Cubes," *Journal of Supercomputing*, 61 (3), pp. 856-868, 2012.

35. E. Cheng, K. Qiu, and Z.Z. Shen, "A Note on the Alternating Group Network," *Journal of Supercomputing*, Vol. 59, No. 1, pp. 246-248, 2012.

36. E. Cheng, K. Qiu, and Z. Shen, "On the Surface Areas and Average Distances of Meshes and Tori," *Parallel Processing Letters*, Vol. 21, No. 1, pp. 61-75, 2011.

37. E. Cheng, K. Qiu, and Z. Shen, "A Note on the Surface Area of the Cartesian Product Graphs," *Congressus Numerantium*, 203, pp. 131-137, 2010.

38. E. Cheng, J.W. Grossman, L. Liptak, K. Qiu, and Z.Z. Shen, "Distance Formula and Shortest Paths for the (n, k)-Star Graphs," *Information Sciences*, 180, pp. 1671-1680, 2010.

39. E. Cheng, K. Qiu, and Z.Z. Shen, "On Deriving Explicit Formulas of the Surface Areas for the Arrangement Graphs and Some of the Related Graphs," *International Journal of Computer Mathematics*, Vol. 87, No. 13, pp. 2903-2914, 2010.

Refereed Conference Papers

1. E. Cheng, K. Qiu, and Z.Z. Shen, "A Study of the Decycling Problem for the Generalized Exchanged Hypercube," *Proc. of the 14th International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN)*, IEEE CPS, Exeter, England, UK, June. 2017, pp. 93-99.

2. W. Ding and K. Qiu, "A Quadratic Time Exact Algorithm for Continuous Connected 2-Facility Location Problem in Trees," *Proc. of the 10th Annual International Conference on Combinatorial Optimization and Applications*, Dec, 2016, Hong Kong, LNCS 10043, pp. 408-420.

3. K. Noroozi and K. Qiu, "On the Hamiltonicity, Connectivity, and Broadcasting Algorithm of the KCube," *Proc. 3rd International Symposium on Computing and Networking, Across Practical Development and Theoretical Research (CANDAR'15)*, published by IEEE CPS, Sapporo, Hokkaido, Japan, Dec. 2015. pp. 174-180.

4. W. Ding and K. Qiu, "Approximating the Restricted 1-Center in Graphs," *Proc. of the 9th Annual International Conference on Combinatorial Optimization and Applications*, Dec, 2015, Houston Texas, LNCS 9486, pp. .

5. W. Ding and K. Qiu, "Dynamic Single-Source Shortest Paths in Erds-Rnyi Random Graphs," *Proc. of the 9th Annual International Conference on Combinatorial Optimization and Applications*, Dec, 2015, Houston Texas, LNCS 9486, pp. 537-550.

6. E. Cheng, K. Qiu, and Z.Z. Shen, "Connectivity Results of Hierarchical Cubic Networks as Associated with Linearly Many Faults," *International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN)*, IEEE CPS, Chengdu, China, Dec. 2014. pp. 1213-1220.

7. K. Noroozi, L. Zhao, and K. Qiu, "On the Hamiltonicity of the KCube Interconnection Network," *Proc. 5th International Workshop on Advances in Networking and Computing, the 2nd International Symposium on Computing and Networking (CANDAR'14)*, published by IEEE CPS, Mt. Fuji, Shizuoka, Japan, Dec. 2014, pp. 577-581.

8. F. Zhang, K. Qiu, and J.S. Kim, "Hyper-star Graphs: Some Topological Properties and an Optimal Neighbourhood Broadcasting Algorithm," *Proc. the 14th International Conference on Algorithms and Architectures for Parallel Processing (ICA3PP 2014)*, Da Lian, China, August, 2014, LNCS 8630, pp. 526-534.

9. E. Cheng, L. Liptak, K. Qiu, and Z.Z. Shen, "On the Conditional Diagnosability of Cayley Graphs Generated by 2-Trees and Related Networks," *International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN)*, IEEE Computer Society Press CPS, Texas, Dec. 2012.

10. E. Cheng, K. Qiu, and Z. Shen, "A Faster Algorithm for Finding Disjoint Ordering of Sets," *Proc. of the 3rd International Conference on Networking and Computing*, Okinawa, Japan, Dec. 2012, IEEE Computer Society CPS, pp. 118-124.

11. E. Cheng, K. Qiu, and Z. Shen, "The Edge-Centered Surface Area for the Arrangement Graph," *Proc. of the 6th Annual International Conference on Combinatorial Optimization and Applications*, August, 2012, Banff, Canada, LNCS 7402, pp. 49-60.

12. E. Cheng, K. Qiu, and Z. Shen, "On the Surface Area of the Asymmetric Twisted Cube," *Proc. of the 5th Annual International Conference on Combinatorial Optimization and Applications*, August, 2011, Zhangjiajie, China, LNCS 6831, pp. 411-423.

13. D. Peters, K. Qiu, and P. Liang, "Faster Short Read Alignment with pBWA," *Proc. of International Conference on Applied Mathematics, Modeling and Computational Science (AMMCS)*, Waterloo, Ontario, Canada, July 2011, pp. 131-134.

14. E. Cheng, K. Qiu, and Z. Shen, "The Number of Shortest Paths in the (n, k)-Star Graphs," *Proc. of the 4th Annual International Conference on Combinatorial Optimization and Applications*, The Big Island, Hawaii, 2010, LNCS 6508, pp. 222-236.

Other Contributions

1. Conditional Diagnosability of Some Interconnection Networks (with E. Chang and Z. Shen), *The 28th Midwest Conference on Combinatorics and Combinatorial Computing (MCCCC)*, Las Vegas, Oct. 2014.

2. The Number of Shortest Paths in the (n, k)-Star Graphs (with E. Cheng and Z. Shen), American Mathematical Society 2010 Spring Eastern Sectional Meeting, special session on recent trends in Cayley graphs to model interconnection networks, Newark, NJ, May 2010.

3. Guest Editor's Note: Advances in Quantum Computation, *Parallel Processing Letters*, 20 (3): 211-212, 2010.

Grants Obtained

- 2016-2018 NSERC Discovery Development Grant $10,000 + $6,000/year (Brock)
- 2011-2016 NSERC Discovery Grant $18,000/year.

Editorial and Refereeing Duties

Journal Editorship

- Editorial Board, *Parallel Processing Letter* (since Nov. 2006)
- Editorial Board, *International Journal of parallel, Emergent and Distributed Systems* (since Dec. 2011).

Program Committee Members

- 2012 International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN), San Marcos, Texas, Dec. 2012.
- 2013 International Symposium on Computing and Networking - Across Practical Development and Theoretical Research - (CANDAR'2013), Matsuyama, Japan, Dec. 2013.
- 2014 International Symposium on Computing and Networking - Across Practical Development and Theoretical Research - (CANDAR'2014), Mt. Fuji, Shizuoka, Japan, Dec. 2014.
- 2015 International Symposium on Computing and Networking - Across Practical Development and Theoretical Research - (CANDAR'2015), Hokkaido, Japan, Dec. 2015.
- 2016 International Symposium on Computing and Networking - Across Practical Development and Theoretical Research - (CANDAR'2016), Hiroshima, Japan, Nov. 2016.
- 2017 International Symposium on Pervasive Systems, Algorithms, and Networks (ISPAN), Exeter, England, June, 2017.

Refereeing Duties

- 1986- Reviewed numerous papers for the following journals and conferences:
  - Journals:
    Parallel Computing, Discrete Applied Mathematics, Discrete Mathematics, IEEE Transactions on Computers, IEEE Transactions on Parallel and Distributed Systems, Information Processing Letters, Parallel Processing Letters, VLSI Design, The Journal of Supercomputing, International Journal of Telecommunication Systems, Journal of Parallel and Distributed Computing, Journal of Computer & Software Engineering, Journal of Network and Computer Applications, ARS Combinatoria, International Journal of Computers and Their Applications, Networks, IEICE Transactions (Japan), Theoretical Computer Science, Algorithmica, SIAM Journal on Discrete Mathematics, Journal of Computer and System Sciences, The Computer Journal, International Journal of Networking and Computing (Japan).
  - Conferences:
    International Conference on Computer Communications and Networks, International Symposium on Computing and Networking, Across Practical Development and Theoretical Research (CANDAR), International Conference on Computing and Information, European Parallel Processing Conference CONPAR/VARP, International Conference on Parallel Processing. International Parallel Processing Symposium, The Hawaii International Conference on System Sciences, IASTED International Conference on Parallel and Distributed Computing and Systems (PDCS), IASTED International Conference on Parallel and Distributed Computing and Networks (PDCN).

NSERC CRSNG

Canadian Common CV commun canadien

Protected when completed

This is a draft version only. Do not submit to any funding organization. Only the final version from the History page can be submitted.

Dr. Brian James Ross

Correspondence language: English
Sex: Male

Contact Information

The primary information is denoted by (*)

Address

Primary Affiliation (*)

Department of Computer Science
Brock University
500 Glenridge Ave.
St. Catharines Ontario L2S 3A1
Canada

Telephone

Work (*)	1-905 688-5550 extension: 4284

Email

Work (*)	bross@brocku.ca

Dr. Brian Ross

Language Skills

Language	Read	Write	Speak	Understand	Peer Review
English	Yes	Yes	Yes	Yes	Yes

Degrees

- 1992/11 Doctorate, Artificial Intelligence, University of Edinburgh
- 1988/10 Master's Thesis, Computer Science, University of British Columbia
- 1984/5 Bachelor's Honours, Computer Science, University of British Columbia

User Profile

Research Specialization Keywords: Biological Modeling, Computational Intelligence, Evolutionary Computation, Evolutionary Design, Genetic Programming

Employment

2003/7
Full professor
Computer Science, Brock University
Full-time, Professor
Tenure Status: Tenure

1996/6 - 2003/6
Associate professor
Computer Science, Brock University
Full-time, Associate Professor
Tenure Status: Tenure

1992/6 - 1996/5
Assistant professor
Computer Science, Brock University
Full-time, Assistant Professor
Tenure Status: Tenure Track

1991/9 - 1992/5
Visiting assistant professor
Computer Science, University of Victoria
Part-time
Tenure Status: Non Tenure Track

1992/1 - 1992/3
Software consultant
Government of British Columbia

1984/6 - 1986/5
Engineer scientist
Radian Corporation

Research Funding History

Awarded [n=1]

2016/4 - 2021/3
Principal Applicant

Genetic Programming Techniques for Modelling and Design, Grant

Funding Sources:
Natural Sciences and Engineering Research Council of Canada (NSERC)
Discovery Grants Program
Total Funding - 110,000
Portion of Funding Received - 22,000
Funding Competitive?: Yes

Completed [n=2]

2011/4 - 2016/3
Principal Applicant

Multi-objective Grammar-guided Genetic Programming for Bio-network Modelling and Evolutionary Design, Grant

Funding Sources:
Natural Sciences and Engineering Research Council of Canada (NSERC)
Operating grant
Total Funding - 70,000
Portion of Funding Received - 70,000
Funding Competitive?: Yes

2006/4 - 2011/3
Principal Investigator

The Inference of Concurrent Systems Using Genetic Programming, Grant

Funding Sources:
Natural Sciences and Engineering Research Council of Canada (NSERC)
Operating grant
Total Funding - 63,500
Portion of Funding Received - 63,500
Funding Competitive?: Yes

Student/Postdoctoral Supervision

Bachelor's Honours [n=9]

2017/9 - 2018/1
Principal Supervisor

Tyler Cowan (Completed) , Brock University
Student Degree Expected Date: 2018/6

2017/9 - 2018/1
Principal Supervisor

Jordan Maslen (Completed) , Brock University
Student Degree Expected Date: 2018/6

2015/9 - 2016/4
Principal Supervisor

Earle, James (Completed) , Brock University
Thesis/Project Title: Financial Applications of Genetic Programming

2015/5 - 2016/8
Co-Supervisor

Seelert, Nick (Completed) , Brock University
Thesis/Project Title: Genetic Algorithms for Parameter Fitting of Neuron Models

2010/9 - 2011/4
Principal Supervisor

Mccarney, Dan (Completed) , Brock University
Thesis/Project Title: Evolution of Error-Correcting Codes
Present Position: Lead security engineer, Fastly (San Francisco, CA)

2010/9 - 2011/4
Principal Supervisor

Lamarre, Al (Completed) , Brock University
Thesis/Project Title: Interactive Evolution of Character Animation

2009/1 - 2009/4 Principal Supervisor
Maki, Craig (Completed) , Brock University
Thesis/Project Title: Pixel and Vertex Shader Programming

2009/1 - 2009/4 Principal Supervisor
Garcia, Bruno (Completed) , Brock University
Thesis/Project Title: Social Game Development

2008/9 - 2009/4 Principal Supervisor
Bergen, Steven (Completed) , Brock University
Thesis/Project Title: Evolving Stylized Images using Genetic Algorithms
Present Position: Lead developer, Prodigy (St Catharines, Ontario)

Master's Thesis [n=19]

2017/9 Principal Supervisor
Arpi Sen Gupta (In Progress) , Brock University

2017/1 Co-Supervisor
Mae Leong (In Progress) , Brock University
Student Degree Expected Date: 2021/12
Thesis/Project Title: TBA

2016/9 Principal Supervisor
Fazle Tanjil (In Progress) , Brock University
Student Degree Expected Date: 2018/8
Thesis/Project Title: TBA

2015/9 - 2017/10 Principal Supervisor
Bakurov, Illya (Completed) , Brock University
Student Degree Expected Date: 2018/6
Thesis/Project Title: Non-photorealistic Rendering with Cartesian Genetic Programming using Graphics Processing Units

2015/1 - 2018/2 Principal Supervisor
Gircys, Michael (Completed) , Brock University
Student Degree Expected Date: 2018/6
Thesis/Project Title: Texture Evolution using 2D Power Spectra
Present Position: n/a

2014/9 - 2016/8 Principal Supervisor
Salimi, Elham (Completed) , Brock University
Thesis/Project Title: Statistical Image Analysis for Image Evolution

2014/1 - 2017/10 Principal Supervisor
Grossi, Gina (Completed) , Brock University
Student Degree Expected Date: 2018/6
Thesis/Project Title: Evolution of Cooperating Agents for Pursuit Games
Present Position: Lecturer, Niagara College (Welland, Ontario)

2013/9 - 2015/9 Principal Supervisor
Awuley, Anthony (Completed) , Brock University
Thesis/Project Title: Feature Selection and Classification Using Age-Layered Population Structure Genetic Programming

2012/9 - 2014/8 Principal Supervisor
Maghoumi, Mehran (Completed) , Brock University
Thesis/Project Title: Real-Time Automatic Object Classification and Tracking Using Genetic Programming and NVIDIA CUDA
Present Position: PhD student, U Central Florida (Orlando, FL)

2012/9 - 2015/7 Principal Supervisor
Moylan, Kelly (Completed) , Brock University
Thesis/Project Title: Inverse Illumination Design with Genetic Programming

2011/9 - 2013/5 Principal Supervisor
Baniasadi, Maryam (Completed) , Brock University
Thesis/Project Title: Genetic Programming for Non-Photorealistic Rendering

2011/9 - 2013/10 Principal Supervisor
Oraei, Mahdi (Completed) , Brock University
Thesis/Project Title: Passive Solar Building Design using Genetic Programming,
Present Position: Software engineer, InvistaWare (Calgary, AB)

2010/9 - 2012/10 Principal Supervisor	Harrington, Adrian (Completed) , Brock University Thesis/Project Title: Enabling and Measuring Complexity in Evolving Designs Using Generative Representations for Artificial Architecture Present Position: Co-founder/lead developer Cinema Suite Inc. (Toronto, ON)
2010/9 - 2011/12 Principal Supervisor	Bergen, Steven (Completed) , Brock University Thesis/Project Title: Automatic Structure Generation using Genetic Programming and Fractal Geometry Present Position: Lead developer, Prodigy (St Catharines, Ontario)
2009/9 - 2011/7 Co-Supervisor	Mahmood, Shahid (Completed) , Brock University Thesis/Project Title: Improving the Scalability of Reduct Determination in Rough Sets Present Position: Software consultant, Ontario Ministry of Education (Toronto, ON)
2008/9 - 2011/5 Principal Supervisor	Coia, Corrado (Completed) , Brock University Thesis/Project Title: Automatic Evolution of Conceptual Building Architectures, Present Position: Director of operations, ApprenticeA Productions (Toronto, ON)
2008/9 - 2010/11 Principal Supervisor	Flack, Robert (Completed) , Brock University Thesis/Project Title: Evolution of Architectural Floor Plans Present Position: Software engineer, Google Inc. (Waterloo, ON)
2007/9 - 2009/2 Principal Supervisor	Imada, Janine (Completed) , Brock University Thesis/Project Title: Evolutionary Synthesis of Stochastic Gene NetworkModels Using Feature-based Search Spaces Present Position: Software Developer, PerkinElmer (Cambridge, ON)
2007/9 - 2012/10 Principal Supervisor	Barry, Will (Completed) , Brock University Thesis/Project Title: Generative Aesthetically Pleasing Images in a Virtual Environment Using Particle Swarm Optimization Present Position: Professor, Sheridan College (Oakville, ON)

Presentations

1. (2015). Using Multi-objective Genetic Programming to Evolve Stochastic Logic Gate Circuits. IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology, Niagara Falls, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
2. (2011). Automatic Evolution of Conceptual Building Architectures. CEC 2011, New Orleans, United States
   Main Audience: Researcher
   Invited?: No, Keynote?: No
3. (2011). Evolution of Stochastic Bio-Networks Using Summed Rank Strategies. CEC 2011, New Orleans, United States
   Main Audience: Researcher
   Invited?: No, Keynote?: No
4. (2010). Evolutionary Art using Summed Multi-Objective Ranks. In 2010 Genetic Programming Theory and Practice Workshop, Ann Arbor, United States
   Main Audience: Researcher
   Invited?: Yes, Keynote?: No
5. (2009). Using Multi-objective Genetic Programming to Synthesize Stochastic Processes. In 2009 Genetic Programming Theory and Practice Workshop, Ann Arbor, United States
   Main Audience: Researcher
   Invited?: Yes, Keynote?: No

6. (2009). Evolving Stochastic Processes Using Feature Tests and Genetic Programming. GECCO-2009, Montreal, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No

Publications

Journal Articles

1. BANIASADI M and Ross BJ. (2014). Exploring Non-photorealistic Rendering with Genetic Programming. Genetic Programming and Evolvable Machines. 16(2): 211-239.
   Published
   Refereed?: Yes
2. BERGEN S and Ross BJ. (2013). Aesthetic 3D Model Evolution. Genetic Programming and Evolvable Machines. 4(3): 339-367.
   Published
   Refereed?: Yes
3. BERGEN S & Ross BJ. (2012). Automatic and Interactive Evolution of Vector Graphics Images with Genetic Algorithms. The Visual Computer. 28(1): 35-45.
   Published
   Refereed?: Yes
4. Ross BJ. (2012). The Evolution of Higher-level Biochemical Reaction Models. Genetic Programming and Evolvable Machines. 13(1): 3-31.
   Published
   Refereed?: Yes
5. IMADA J & Ross BJ. (2011). Evolutionary Synthesis of Stochastic Gene Network Models using Feature-based Search Spaces. New Generation Computing. 29(4): 365-390.
   Published
   Refereed?: Yes

Book Chapters

1. Ross BJ. (2012). Evolutionary Learning and Stochastic Process Algebra. Encyclopedia of the Sciences of Learning. : 1193-1194.
   Published, Springer
   Refereed?: No
2. Ross BJ & IMADA J. (2010). Using Multi-objective Genetic Programming to Synthesize Stochastic Processes. Riolo R, O'Reilly U & McConaghy T. Genetic Programming Theory and Practice VII. : 159-175.
   Published, Springer
   Refereed?: No
3. BERGEN S & Ross BJ. (2010). Evolutionary Art Using Summed Multi-Objective Ranks. Genetic Programming Theory and Practice VIII. : 227-244.
   Published, Springer
   Refereed?: No

Reports

1. Brian J. Ross. (2018). A Comparison of Knee Strategies for Hierarchical Spatial Clustering (TR18-01). 14. Brock University

2. MAGHOUMI M, Ross BJ. (2016). Online Image Classification Using Graphics Processing Unit-Based Genetic Programming, Technical report CS-16-02, Dept. of Computer Science. Brock University
3. BARRY W & Ross BJ. (2014). Virtual Photography Using Multi-objective Particle Swarm Optimization, Technical report CS-14-03, Dept. of Computer Science. 9. Brock University
4. MAGHOUMI M & Ross BJ. (2014). Feature Extraction Languages and Visual Pattern Recognition, Technical report CS-14-01, Dept. of Computer Science. 9. Brock University
5. GHOLAMI MMO & Ross BJ. (2014). Passive Solar Building Design Using Genetic Programming, Technical report CS-14-02, Dept. of Computer Science. 9. Brock University
6. HARRINGTON A & Ross BJ. (2013). Generative Representations for Artificial Architecture and Passive Solar Performance, Technical report CS-13-02, Dept. of Computer Science. 10. Brock University
7. MCCARNEY D, Houghten S & Ross BJ. (2012). Evolutionary Approaches to the Generation of Optimal Error Correcting Codes, Technical report CS-12-02, Dept. of Computer Science. 9. Brock University
8. Ross BJ. (2011). Evolution of Stochastic Bio-Networks Using Summed Rank Strategies, Technical report CS-11-05, Dept. of Computer Science. 9. Brock University
9. COIA C & Ross BJ. (2011). Automatic Evolution of Conceptual Building Architectures, Technical report CS-11-02, Dept. of Computer Science. 9. Brock University
10. BERGEN S & Ross BJ. (2011). Automatic and Interactive Evolution of Vector Graphics Images with Genetic Algorithms, Technical report CS-11-01, Dept. of Computer Science. 16. Brock University
11. Ross BJ. (2010). The Evolution of Higher-level Biochemical Reaction Models, Technical report CS-10-02, Dept. of Computer Science. 25. Brock University
12. COIA C & Ross BJ. (2009). User-guided Evolution of Granular Synthesis, Technical report CS-09-09, Dept. of Computer Science. 7. Brock University

Conference Publications

1. Brian J. Ross. (2018). A Comparison of Knee Strategies for Hierarchical Spatial Clustering. IEA-AIE 2018, Montreal, Canada
   Paper
   Accepted
   Refereed?: Yes, Invited?: No
2. Illya Bakurov, Brian J. Ross. (2018). Non-photorealistic Rendering with Cartesian Genetic Programming using Graphics Processing Units. EvoMusArt 2018, Parma, Italy
   Paper
   Published
   Refereed?: Yes, Invited?: No
3. Gina Grossi Brian J Ross. (2017). Evolved Communication Strategies and Emergent Behaviour of Multi-Agents in Pursuit Domains. IEEE Conference on Computational Intelligence in Games 2017, New York, United States
   Conference Date: 2017/8
   Paper
   Published
   Refereed?: Yes, Invited?: No
4. AWULEY A, Ross BJ. (2016). Feature Selection and Classification Using Age Layered Population Structure Genetic Programming. CEC 2016, Vancouver, Canada
   Conference Date: 2016/7
   Paper
   Published
   Refereed?: Yes, Invited?: No

5. Ross BJ. (2015). Using Multi-objective Genetic Programming to Evolve Stochastic Logic Gate Circuits. 2015 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology, Niagara Falls, Canada
   Conference Date: 2015/8
   Paper
   Published
   Refereed?: Yes, Invited?: No

6. MOYLAN K & Ross BJ. (2015). Interior Illumination Design Using Genetic Programming. EvoMusArt 2015, Copenhagen, Denmark
   Conference Date: 2015/4
   Paper
   Published
   Refereed?: Yes, Invited?: No

7. MAGHOUMI M & Ross BJ. (2014). A Comparison of Genetic Programming Feature Extraction Languages for Image Classification. IEEE Symposium Series on Computational Intelligence 2014, Orlando, United States
   Conference Date: 2014/12
   Paper
   Published
   Refereed?: Yes, Invited?: No

8. BANIASADI M and Ross BJ. (2014). Non-photorealistic Rendering Using Genetic Programming. (First place competition winner. Paper submission unpublished).GECCO 2014 Evolutionary Art, Design and Creativity Competition, Vancouver, Canada
   Conference Date: 2014/7
   Paper
   Accepted
   Refereed?: Yes, Invited?: No

9. BARRY W & Ross BJ. (2014). Virtual Photography Using Multi-objective Particle Swarm Optimization. GECCO 2014, Vancouver, Canada (285–292)
   Conference Date: 2014/7
   Paper
   Published
   Refereed?: Yes, Invited?: No

10. GHOLAMI MMO & Ross BJ. (2014). Passive Solar Building Design Using Genetic Programming. GECCO 2014, Vancouver, Canada (1111-1118)
    Conference Date: 2014/7
    Paper
    Published
    Refereed?: Yes, Invited?: No

11. HARRINGTON A & Ross BJ. (2013). Generative Representations for Artificial Architecture and Passive Solar Performance. CEC 2013, Cancun, Mexico
    Conference Date: 2013/6
    Paper
    Published
    Refereed?: Yes, Invited?: No

12. BERGEN S & Ross BJ. (2012). Aesthetic 3D Model Evolution. EvoMusArt 2012, Malaga, Spain
    Conference Date: 2012/4
    Paper
    Published
    Refereed?: Yes, Invited?: No

13. FLACK R and Ross BJ. (2011). Evolution of Architectural Floor Plans. EvoMusArt 2011, Torino, Italy
    Conference Date: 2011/6
    Paper
    Published
    Refereed?: Yes, Invited?: No

14. Ross BJ. (2011). Evolution of Stochastic Bio-Networks Using Summed Rank Strategies. CEC 2011, New Orleans, United States
    Conference Date: 2011/6
    Paper
    Published
    Refereed?: Yes, Invited?: No

15. COIA C and Ross BJ. (2011). Automatic Evolution of Conceptual Building Architectures. CEC 2011, New Orleans, United States
    Conference Date: 2011/6
    Paper
    Published
    Refereed?: Yes, Invited?: No

16. COIA C & Ross BJ. (2010). User-Guided Evolution of Granular Synthesis. International Computer Music Conference, New York, United States
    Conference Date: 2010/7
    Paper
    Published
    Refereed?: Yes, Invited?: No

17. Ross BJ & IMADA J. (2009). Evolving Stochastic Processes Using Feature Tests and Genetic Programming. GECCO 2009, Montreal,
    Conference Date: 2009/7
    Paper
    Published
    Refereed?: Yes, Invited?: No

Curriculum Vitae

PERSONAL DETAILS

Name	Horst Michael Winter
Date of birth	November 30, 1966
Nationality	German
Address	16-7 Gibson Place St. Catharines, Ontario, Canada L2R 0A3
Email	mwinter@brocku.ca

DEGREES

Habilitation	University of the Federal Armed Forces Munich, 2002
Dr. rer. nat.	University of the Federal Armed Forces Munich, 1998
Dipl. Inform.	University of the Federal Armed Forces Munich, 1993

EMPLOYMENT HISTORY

2009 – present	Professor, Brock University
2003 - 2009	Associate Professor, Brock University
1998 - 2003	wissenschaftl. Assistent (Assistant Professor), University of the Federal Armed Forces Munich
1995 - 1998	wissenschaftl. Mitarbeiter (Lecturer), University of the Federal Armed Forces Munich

AWARDS

2017 – Faculty of Graduate Studies Michael Plyley Graduate Mentorship Award, Brock University

2010 - Faculty Award for Excellence in Teaching, Faculty of Mathematics and Science, Brock University

GRANTS

NSERC CRDOJ (Co-Applicant) Development of a heat strain estimator algorithm control for personal cooling in ultra-deep mining, $96,740, 2018-2020

NSERC Discovery Grant, Computing and Information Science A, $23,000/year, 2017-2022

OCE Voucher for Innovation and Productivity (VIP) and NSERC Engage, $49,999, 2015

Match of Minds (Natassia Bork), Summer Ventures, Brock University, $4,500, 2015

NSERC Discovery Grant, Computing and Information Science A, $14,000/year, 2012-2017

NSERC Discovery Grant, Computing and Information Science A, $23,000/year, 2007-2012

COURSES TAUGHT

Brock University (F = Fall, W = Winter, F\W = Fall\Winter, S = Spring):

COSC 5V90 - Functional Programming and Interactive Theorem Proving
(F16 – 5 Students, W18 – 5 Students)
COSC 5P75 – Directed Reading (formerly COSC 5V90)
(W10 – 3 Students, W11 – 2 Students, W12 – 1 Student, W13 – 1 Student, W14 – 2 Students, W16 – 1 Student, W17 – 3 Students, W18 – 3 Students)
COSC 5P05 – Introduction to Lambda Calculus
(W12 – 6 Students, F13 – 5 Students, W15 – 3 Students)
COSC 5P02 – Logic in Computer Science
(F10 – 8 Students, F12 – 8 Students, F14 – 6 Students, F15 – 7 Students, F16 – 6 Students, W18 – 9 Students)
COSC 4P61 – Theory of Computation
(F15 – 44 Students)
COSC 4P42 – Formal Methods in Software Engineering
(F10 – 19 Students, W13 – 33 Students, W15 – 33 Students, F17 – 21 Students)
COSC 4P41 – Functional Programming (formerly COSC 4V81)
(F11 – 35 Students, W14 – 35 Students, W16 – 24 Students)
IASC 4F00 – Team-based Practicum in Interactive Media Design and Production
(F\W11 – 12 Students, F\W12 – 11 Students, F\W13 – 11 Students, F\W14 – 12 Students)
COSC 3P40/91 – Advanced Object Oriented Programming
(W11 – 12 Students, S13(SC) – 25 Students, S14(SC) – 17 Students, S15(SC) – 27 Students, S16(SC) – 23 Students, S17(SC) S1 – 24 Students, S17(SC) S2 – 27 Students)
IASC 3F02 – Interactive Media Practices, Prototyping and Production
(F\W17 – 21 Students)
IASC 3F00 – Imagining Immersive Worlds

(F\W15 – 24 Students, F16 – 14 Students)
IASC 1P30 – Programming for Interactive Media
(F17 – 21 Students)

GRADUATE SUPERVISIONS

Tonet, Adam: Relational Models of Concurrency (tentative title), 2016-2018.

Ghosh, Pranab: Modal Logics for Qualitative Spatial Reasoning (tentative title), 2016-2018.

Alkhulaif, Shams: A Functional Programming Language with Patterns and Copatterns (tentative title), 2016-2018.

Santos Teixeira, Milene: An Implementation of an L-Fuzzy Controller, UFSM Brazil, 2016-2017.

Chowdhury, Durjay: Approximation Algorithms using Allegories and Coq, 2015-2017.

Killingbeck,Dylan: A Generic Matrix Manipulator, Brock University, 2015-2016.

Adjei, Evans: *L-Fuzzy Structural Query Language*. Brock University, 2013-2015.

Chowdhury, Abdul Wazed: *An Abstract Algebraic Theory of L-Fuzzy Relations for Relational Databases*. Brock University, 2013-2015.

Jackson, Ethan: *Fuzzy Controller in Arrow Categories*. Brock University, 2012-2014.

Ghosh, Manas: *Extensional Models of RCC Composition Tables*. Brock University, 2011-2013.

Atampore, Francis Kwesi: A *Library for Relations based on Heterogeneous OMDDs*. Brock University, 2010-2012.

Das, Tuhin Kanti: *A System for First-Order Dynamic Logic*. Brock University, 2010 – 2012.

Lenarćić, Adam: *Formalizing Affordances in Situation Theory*. Brock University, 2010-2011.

Mahmood, Shahid: *Efficient Computation of Reducts in Rough Set based Data Mining*. Brock University 2010-2011.

Hossain, Md Nour: *Equational Reasoning about Object-Oriented Programs*. Brock University, 2009-2011.

Abdalbari, Anwar: *A System for Models of First-order Theories*. Brock University, 2009-2011.

Siddavataam, Prathap: *Generating Relation Algebras for Qualitative Spatial Reasoning*. Brock Univeristy, 2009-2011.

Aameri, Bahar: *Extending RelAPS to full First-Order Logic*. Brock University, 2008-2010.

Zhang, Si: *Generating Finite Ingetral Relation Algebras*. Brock University, 2008-2010.

UNDERGRADUATE SUPERVISIONS

Al Jumaily, Maysara: *Analyzing Soccer Data using Graphs*, 2017.

Simonits, Alexander: *Automatic Quest Generation*, 2017.

Caven, Nichole and Miskimin, Mathew: *3D Virtual Tour of MIWSFPA*, 2016.

Kurylovich, Anton: *Development of an animated geometry learning platform*, 2015-2017.

Kazemi, Yosra and DeForest, Amber: *Interactive Induction for High School Students*, 2015-2017.

Owen, Scott: *Visualizing Proofs in Natural Deduction,* Brock University, 2015.

Jones, Alec: *Dante's Inferno*. Brock University, 2014.

Santos Teixeira, Milene: *A Generic Matrix Manipulator*. Brock University, 2014.

Graham, Fred: *Developing a Hybrid Control System*. Brock University, 2014.

Menonkariyil, Mathew: *Higher-order Matching for Interactive Theorem Proving*. Brock University, 2013.

Jaques, Chris: *Art in Augmented Reality*. Brock University, 2013.

Pascuzzi, Vince: *Simulating Quantum Computing in Haskell*. Brock University, 2012.

Stinson, Christopher*: Operation Olympic - A history simulation*. Brock University, 2012.

Bond, Ron: *Translation of First-Order Properties into relational Equations*. Brock University, 2011-2012.

Jackson, Ethan: *An UNITY Interpreter suitable for Genetic Programming.* Brock University, 2011-2012.

GRAD. SUPERVISORY COMMITTEE MEMBERSHIP/EXTERNAL REFEREE

Grossi, Gina: *Communication strategies for evolved cooperating multi-agent teams in pursuit games.* Brock University, 2014-2017.

Opoku-Amankwaah, Audrey: *Using genetic algorithms for the multi-depot vehicle routing problem*. Brock University, 2014-2016.

Maltese, Justin: *Tackling High-Dimensional Many-Objective Optimization Problems using Computational Intelligence Algorithms.* Brock University, 2014-2016.

Arabpour, Mehrdad: *Interconnection Networks and Parallel Algorithms*. Brock University, 2014-2016.

Rybkin, Oleg: *A Genetic Algorithm Approach for Finding Rough Set Decision Rules.* Brock University, 2013-2015.

Noroozi, Keivan: Properties *and Algorithms of Interconnection Networks*. Brock University, 2013-2015.

Bond, Ron: *Tracking multiple Peaks in Dynamic Environments using PSO*. Brock University, MSc. 2012-2014.

Maghoumi, Mehran: *Real-time Unsupervised Object Classification Tracking using Genetic Programming and NVIDIA CUDA*. Brock University, MSc. 2012-2014.

Zhao, Li: *Properties and Algorithms of the KCube Graphs.* Brock University, MSc. 2010-2013.

Zhang, Tian: *A Unifying Theory of Multi-Exit Programs*. McMaster, PhD., 2013.

Hahmann, Torsten: *Topological and Mereological Relations as Basis for Commonsense Representations of Space*. University of Toronto, PhD., 2008-2012.

Edalamanesh, Mahmood: *Heuristics for critical detection problem*. Brock University, MSc., 2011-2013.

Zhao, Li: *Properties and Algorithms of the KCube-A Novel Architecture For Interconnection Networks*. Brock University, MSc., 2011-2012.

Li, Zhiyuan: *Construction of 1-Deletion-Correcting Ternary Codes*. Brock University, MSc., 2010-2011.

Zhu, He: *Parallel Approximate String Matching Algorithms for Requests of Bioinformatics*. Brock University, MSc., 2010-2012.

Peters, Darren: *Improving Short DNA Sequence Alignment with Parallel Computing*. Brock University, MSc., 2010-2011.

Corrado Coia: *Automatic Evolution of Conceptual Building Architectures*. Brock University, MSc., 2010-2011.

UNIVERSITY/DEPARTMENT SERVICE

- GAME Program Director, 2017-2018.
- Chair of Recruiting and Retention Committee (Department of Computer Science), 2017-2018.
- GAME Program Director, 20016-2017.
- Chair of Recruiting and Retention Committee (Department of Computer Science), 2016-2017.
- Coordinator Seminar Series (Department of Computer Science), 2015-2016.
- GAME Program Director, 20015-2016.
- Chair of Recruiting and Retention Committee (Department of Computer Science), 2015-2016.
- GAME Program Director, 20014-2015.
- Graduate Program Committee (Department of Computer Science), 2014-2015.
- Graduate Program Director (Department of Computer Science), 2013-2014.
- Organizer Computer Science Fair, 2013.
- Organizer Programming Contest, 2014.
- Graduate Program Director (Department of Computer Science), 2012-2013.
- Organizer Computer Science Fair, 2012.
- Organizer Programming Contest, 2012.
- Graduate Program Director (Department of Computer Science), 2011-2012.
- Recruitment and Retention Committee (Department of Computer Science), 2011-2012.
- Organizer Computer Science Fair, 2011.
- Organizer Programming Contest, 2011.
- Organization Committee of the 'Interacting with Immersive Worlds' Conference at Brock University, 2011.
- Chair of the Recruitment and Retention Committee (Department of Computer Science), 2010-2011.
- Recruitment and Retention Committee (Faculty of Mathematics and Science), 2010-2011.
- Graduate Program Committee (Department of Computer Science), 2010-2011.
- Organizer Computer Science Fair, 2010.

- Organizer Programming Contest, 2010.

SCHOLARLY AND PROFESSIONAL ACTIVITIES

Managing editor: *Journal on Relational Methods in Computer Science* (JoRMICS)

Invited talks: *Dependently typed fuzzy sets*,
Computational Topology and its Application,
Kent State University, OH, November 07, 2014

Categories of L-Fuzzy Relations,
Kent State University, OH, October 18, 2013

Categories of L-Fuzzy Relations,
Special Session "A Survey of Lattice-Valued Mathematics and its Applications".
AMS Sectional Meeting, Akron, OH, October 21, 2012

Relation Algebraic Approaches to Fuzzy Relations,
RAMiCS 12, Rotterdam. June 05, 2011

Others: - Referee for numerous journals, book series and organizations, including

- Artificial Intelligence
- Association for Symbolic Logic
- Acta Informatica
- Axioms
- European Journal of Operation Research
- Expert Systems with Applications
- Formal Aspects of Computing
- Fundamenta Informaticae
- Fuzzy Sets and Systems
- INS Information Sciences
- International Journal of Computer Mathematics
- International Journal of Geographical Information Science
- Journal on Logic and Algebraic Programming
- Journal on Multiple Valued Logic and Soft Computing
- Journal on Relational Methods in Computer Science
- Journal of Symbolic Computation
- Knowledge-Based Systems
- Lecture Notes in Artificial Intelligence
- Lecture Notes in Computer Science

  - Lecture Notes in Logic
  - Logic Journal of the IGPL
  - Spatial Cognition and Computation
- Reviewer, Computing Reviews
- Member of the Steering Committee of the international interest group and the conference series on *Relational and Algebraic Methods in Computer Science* (RAMiCS).
- Participant of EU - COST274 / TARSKI Action "Theory and Applications of Relational Structures as Knowledge Instruments"

PUBLICATIONS

1) Life-time summary:

	Published	In-print/Accepted	Submitted
Books authored	3	-	-
Books edited	3	-	-
Chapters in books (invited papers)	4	-	-
Papers in refereed journals	31	-	3
Papers in refereed conference proceedings	27	2	2
Technical reports etc	50	-	-

2) Details:

Papers in refereed journals

Killingbeck D., Santos Teixeira M., Winter M.: *Relations in Linear Algebra.* JLAMP 91(1), 1-16 (2017).

Berghammer R., Stucke I., Winter M: Using *Relation-Algebraic Means and Tool Support for Investigating and Computing Bipartitions.* JLAMP 90(1), 102-124 (2017).

Berghammer R, Winter M.: *Solving Computational Tasks on Finite Topologies by Means of Relation Algebra and the RelView Tool*. JLAMP 88(1), 1-25 (2017).

Winter M.: *Dependencies in Relational Models of Databases*. JLAMP 85(5), 1095-1107 (2016).

Winter M., Jackson E.: *Categories of Relations for Variable-Basis Fuzziness*. Fuzzy Sets and Systems 298, 222-237 (2016).

Winter M.: *Membership Values in Arrow Categories*. Fuzzy Sets and Systems 267. 41-61 (2015).

Winter M, Kempf, P.: *Relational Properties of Sequential Composition of Co-Algebras*. JLAMP 83(2), Special Issue: Festschrift in Honour of Gunther Schmidt on the Occasion of his 75th Birthday, 284-299 (2014).

Berghammer, R., Winter, M.: *Decomposition of Relations and Concept Lattices*. Fundamenta Informaticae 126(1), pp. 37-82 (2013).

Lenarćić, A.,Winter, M.: *Affordances in Situation Theory*. Ecological Psychology 25(2), pp. 155-181 (2013).

Winter M., Hahmann T., Grüninger M.: *On the algebra of regular sets: Properties of representable Stonian p-Ortholattices*. Annals of Mathematics and Artificial Intelligence 65(1), pp. 25-60 (2012).

Koppelberg S., Düntsch I., Winter M.: *Remarks on contact relations on Boolean algebras*. Algebra Universalis 68(3), pp. 353-366 (2012).

Furusawa H., Kawahara Y., Winter M.: *Dedekind Categories with Cutoff Operators*. Fuzzy Sets and Systems 173, pp. 1-24 (2011).

Kawahara Y., Winter M.: *Cardinality Functions in Allegories*. Journal on Logic and Algebraic Programming 79(8), pp. 830-844 (2010).

Berghammer, R., Winter, M.: *Embedding mappings and splittings with applications.* Acta Informatica 47(2), pp. 77-110 (2010).

Books (authored)

Schmidt G., Winter M.: *Relational Topology*. LNM 2208, Springer 2018, ISBN 978-3-319-74450-6.

Books (edited)

Kahl W., Winter M., Oliveira J. (Eds.): Relational and Algebraic Methods in Computer Science, 15th International Conference RAMiCS 2015, LNCS 9348 (2015).

Berghammer, R., Möller, B., Winter, M. (eds.): *Festschrift in Honour of Gunther Schmidt on the Occation of his 75th Birthday*. Journal of Logical and Algebraic Methods in Programming JLAMP 83(2), Elsevier 2014.

Papers in refereed conference proceedings

Ghosh, P.K., Winter, M.: *A Modal and Relevance Logic for Qualitative Spatial Reasoning*. (accepted by RAMiCS 17, June 29, 2018)

Winter, M.: *T-Norm Based Operations in Arrow Categories*. (accepted by RAMiCS 17, June 29, 2018)

Jackson, E., Hughes, J., Daley, M., Winter, M.: *An Algebraic Generalization for Graph and Tensor-Based Neural Networks.* IEEE International Conference on Computational Intelligence in Bioinformatics and Computational Biology (IEEE CIBCB 2017), (2017).

Winter M: *Type-n Arrow Categories*. 16th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 16), LNCS 10266, pp.307-322 (2017).

Killingbeck D., Santos Teixeira M., Winter M.: *Relations among Matrices over a Semiring.* 15th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 15), LNCS 9348, pp. 96-113 (2015).

Adjei E., Chowdhury W., Winter M.: *L-Fuzzy Databases in Arrow Categories.* 15th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 15), LNCS 9348, pp. 288-304 (2015).

Berghammer R., Stucke I., Winter M.: *Investigating and Computing Bipartitions with Algebraic Means*. 15th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 15), LNCS 9348, pp. 252-269 (2015).

Winter M., Jackson E., Fujiwara Y.: *Type-2 Fuzzy Controllers in Arrow Categories*. 14th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 14), LNCS 8428, pp. 293-308 (2014).

Winter M.: *Higher-Order Arrow Categories*. 14th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 14), LNCS 8428, pp. 277-292 (2014).

Ghosh M.., Winter M.: *Refinements of the RCC25 Composition Table*. 14th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 14), LNCS 8428, pp. 379-394 (2014).

Atampore, F., Winter, M.: *Relation Algebras, Matrices, and Multi-Valued Decision Diagrams.* 13th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 13), LNCS 7560, pp. 248-263 (2012).

Winter M.: *Relation Algebraic Approaches to Fuzzy Relations.* 12th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 12), LNCS 6663, pp. 70-73 (2011).

Siddavaatam P., Winter M.: *Splitting Atoms in Relational Algebras*. 12th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 12), LNCS 6663, pp. 331-346 (2011).

Aameri B., Winter M.: *A First-Order Calculus for Allegories*. 12th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 12), LNCS 6663, pp. 74-91 (2011).

Work submitted

Berghammer R., Schmidt, G., Winter M.: *Cryptomorphic Topological Structures: A Computational, Relation-Algebraic Approach*. (submitted to JLAMP, July 10, 2017)

Berghammer, R., Winter, M.: *Order- and Graph-Theoretic Investigation of Dimensions of Finite Topological Spaces and Alexandroff Spaces*. (submitted to Order, July 17, 2018)

Bonnett J., Ralph, W., Brulé, A., Dempsey, E., Bolton, J., Anderson, M., Winter, M., Jaques, C.: *The DataScapes Project: Using Letters, Proteins and Augmented Reality as Constituents for Landscape Art*. (submitted to CYPSY23, March 31, 2018)

Milene Santos Teixeira, M., de Oliveira J.P.M., Winter, M., Machado, A.: *Situation Aware Model for Multiobjective Decision Making in Ambient Intelligence.* (submitted to Expert Systems With Applications, June 26, 2018)

Johansson, M., Eklund, P., Kortelainen, J., Winter, M.: *The Algebra, Logic and Topology of System-of-Systems*. (submitted to DSM 2018, June 01, 2018).

September 23, 2018

STEPHEN C. ANCO

Department of Mathematics & Statistics
Brock University
St. Catharines, Ontario, L2S 3A1 Canada
(905) 688-5550 x3728 sanco@brocku.ca

Education

B.Sc. (Applied Mathematics and Physics)
California Institute of Technology, June 1984.

Graduate Program in Applied Mathematics
Princeton University, September 1984 to May 1985.

Graduate Program (Mathematical Physics)
University of Chicago, September 1985 to December 1990.
M.S., June 1987.
Ph.D., June 1992 (supervisor: R.M. Wald).

Awards and Honors

Undergraduate Research Fellowship (Caltech), 1983.

Caldwell Memorial Scholarship (Princeton University), 1984-1985.

NSERC Post-Graduate Scholarship, 1984-1988.

NSERC Post-Doctoral Fellowship, 1990-1992.

Distinguished Research Award (Faculty of Mathematics and Science, Brock University), 2016.

Academic Positions

Post-doctoral Fellow: Department of Physics, University of British Columbia
January 1991 to May 1993.

Post-doctoral Fellow: Department of Physics, University of British Columbia
and **Lecturer**: Department of Mathematics, University of British Columbia
May 1993 to May 1994.

Visiting Scientist and **Lecturer**: Department of Mathematics, University of British Columbia
May 1994 to August 1996.

Visiting Researcher: Department of Physics, University of Maryland
and **Adjunct Lecturer**: Department of Mathematics, Trinity College
September 1996 to December 1996.

Visiting Assistant Professor: Department of Mathematics and Statistics, American University
and **Visiting Researcher**: Department of Physics, University of Maryland
January 1997 to August 1997.

Visiting Researcher: Courant Institute of Mathematical Sciences, New York University
September 1997 to December 1997. May 1998 to August 1998.

Limited-Term Assistant Professor: Department of Mathematics and Statistics, Concordia University
January 1998 to May 1999.

Assistant Professor: Department of Mathematics, Brock University
June 1999 to June 2001.

Associate Professor: Department of Mathematics, Brock University
July 2001 to June 2007.

Professor: Department of Mathematics, Brock University
July 2007 to present.

Department Chair: Department of Mathematics, Brock University
July 2009 to July 2012. July 2016 to present.

Graduate Program Director: Department of Mathematics, Brock University
September 2005 to September 2007. July 2015 to July 2016.

Visiting Research Professor Department of Mathematics, University of Cadiz (Spain)
June 2017 to July 2017.

Publication List

Books:

1. G. Bluman and S.C. Anco, Symmetry and Integration Methods for Differential Equations. Applied Mathematical Sciences series, Volume 154, Springer (2002).

2. G. Bluman, A.F. Cheviakov, and S.C. Anco, Applications of Symmetry Methods to Partial Differential Equations.
Applied Mathematical Sciences series, Volume 168, Springer (2009).

3. Generalization of Noether's theorem in modern form to non-variational partial differential equations.
   In: Recent progress and Modern Challenges in Applied Mathematics, Modeling and Computational Science, 119–182, Fields Institute Communications, Volume 79 (2017).
   arXiv: mathph/1605.08734

Journal Articles:

1. The dynamics of conservative peakons in the NLS hierarchy (with X. Chang and J. Szmigielski)
   Accepted in Studies in Applied Math. (2018)
   arXiv: 1711.01429

2. Long wavelength solitary waves in Hertzian chains (with PhD student M. Przedborski)
   Accepted in Phys. Rev. E (2018).
   arXiv:math-ph/1705.06718

3. Hamiltonian structure of peakons as weak solutions for the modified Camassa-Holm equation (with postdoc D. Kraus)
   Discrete and Continuous Dynamical Systems (Series A) 38(9), (2018) 4449–4465.
   arXiv: nlin.SI/1708.02520

4. Unitarily-invariant integrable systems and geometric curve flows in SU(n+1)/U(n) and SO(2n)/U(n) (with MSc student A. Ahmed, and E. Asadi)
   J. Phys. A: Math. Theor. 51 (2018) 065205 (35 pages).
   arXiv: 1408.5290 nlin.SI

5. Conserved norms and related conservation laws for multi-peakon equations. (with PhD student E. Recio)
   J. Phys. A: Math. Theor. 51 (2018) 065203 (19 pages).
   arXiv: 1707.05389 math-ph

6. Symmetry invariance of conservation laws. (with A. Kara)
   Euro. J. Appl. Math. 29(1) (2018), 78–117.
   arXiv: 1510.09154 math-ph

7. Solitary waves and conservation laws for highly nonlinear wave equations modeling granular chains. (with PhD student M. Przedborski)
   J. Math. Phys. 58 (2017) 091502 (34 pages).
   arXiv: 1507.04759 math-ph

8. Integrable U(1)-invariant peakon equations from the NLS hierarchy (with MSc student F. Mobasheramini)
   Physica D 355 (2017), 1–23.
   arXiv: 1701.00522 nlin.SI

9. On magnetohydrodynamic gauge field theory (with G.M. Webb)
   J. Phys. A: Math. Theor. 50 (2017) 255501 (34 pages).
   arXiv: 1701.00521

10. Conservation laws and symmetries of radial generalized nonlinear p-Laplacian evolution equations. (with MSc student E. Recio)
    J. Math. Anal. Appl. 452 (2017) 1229–1261.
    arXiv: 1609.07652 math-ph

11. On the incompleteness of Ibragimov's conservation law theorem and its equivalence to a standard formula using symmetries and adjoint-symmetries.
    Symmetry 9(3) (2017), 33 (28 pages).
    arXiv: 1611.02330 math-ph

12. Vorticity and symplecticity in multi-symplectic Lagrangian gas dynamics (with G.M. Webb)
    J. Phys. A: Math. and Theor. 49 (2016) 075501 (48 pages).
    arXiv:1601.05031 math-ph

13. Generalized negative flows in hierarchies of integrable evolution equations (with MSc student S. Mohammad, and T. Wolf, C. Zhu)
    J. Nonlin. Math. Phys. 23 (2016), 573–606.
    arXiv: 1604.07779 nlin.SI

14. Some new aspects of first integrals and symmetries for central force dynamics (with BSc students T. Meadows and V. Pascuzzi)
    J. Math. Phys. 57 (2016), 062901 (35 pages).
    arXiv: math-ph/1508.07258

15. Symmetry properties of conservation laws.
    Int. J. Mod. Phys. B 30(28n29) (2016) 1640004 (12 pages).
    arXiv: math-ph/1512.01835

16. Conservation laws of coupled semilinear wave equations (with M. Khalique).
    Int. J. Mod. Phys. B 30(28n29) (2016) 1640003 (12 pages).
    arXiv: math-ph/1510.09160

17. Integrable systems from inelastic curve flows in 2- and 3- dimensional Minkowski space. (with MSc student K. Alkan)
    J. Nonlin. Math. Phys. 23(2) (2016), 256-299.
    arXiv: nlin.SI/1410.2335

18. Symmetries and conservation laws of the generalized Krichever-Novikov equation. (with E. Avdonina, A. Gainetdinova, L. Galiakberova, N.H. Ibragimov, T. Wolf)
    J. Phys. A: Math. and Theor. 49 (2016) 105201 (29 pages).
    arXiv: nlin.SI/1407.1258

19. Oscillatory solitons of U(1)-invariant mKdV equations II: Asymptotic behavior and constants of motion. (with MSc student A.S. Mia, and M. Willoughby)
J. Math. Phys. 56 (2015) 121504 (21 pages).
arXiv: nlin.SI/1406.6636

20. Oscillatory solitons of U(1)-invariant mKdV equations I: Envelope speed and temporal frequency. (with MSc student A.S. Mia and M. Willoughby)
J. Math. Phys. 56 (2015) 101506 (35 pages).
arXiv: nlin.SI/1406.6630

21. Conserved integrals for inviscid compressible fluid flow in Riemannian manifolds. (with A. Dar and N. Tufail)
Proc. Roy. Soc. A (471) 2015, 20150223 (24 pages).
arXiv: math-ph/1503.08859

22. A family of wave-breaking equations generalizing the Camassa-Holm and Novikov equations. (with P. da Silva and I. Freire)
J. Math. Phys. 56 (2015) 091506 (21 pages).
arXiv: nlin.SI/1412.4415

23. Solutions of gas dynamic equations associated with classical and new conservation laws. (with N.H. Ibragimov, K.V. Imamutdinova, E.N. Karimova)
Applied Math. and Comput. 268 (2015) 52–58.

24. Exact solutions of semilinear radial Schrodinger equations by group foliation reduction. (with W. Feng and T. Wolf)
J. Math. Anal. Appl. 427 (2015), 759–786.
arXiv: math-ph/1408.3751

25. Group-invariant solutions of semilinear Schrodinger equations in multi-dimensions. (with W. Feng)
J. Math. Phys. 54 (2013), 121504 (41 pages).
arXiv: math-ph/1301.5529

26. New conserved vorticity integrals for moving surfaces in multi-dimensional fluid flow.
J. Math. Fluid Mech. 15 (2013), 439–451.
arXiv: math-ph/1209.4251

27. Symplectically-invariant soliton equations from non-stretching geometric curve flows (with E. Asadi).
J. Phys. A: Math. Theor. 45 (2012), 475207 (38 pages).
arXiv: nlin/1206.4040

28. Travelling waves and conservation laws for complex mKdV-type equations. (with M. Mohuddin and T. Wolf)
Appl. Math. Comput. 219 (2012) 679-698.
arXiv: math-ph/1110.2403

29. Conservation laws and symmetries of quasilinear radial wave equations in multi-dimensions. (with MSc student S. MacNaughton and T. Wolf)
J. Math. Phys. 53 (2012), 053703 (33 pages).
arXiv: math-ph/1109.1719

30. Interaction properties of complex mKdV solitons. (with MSc student N. Tchegoum Ngatat, BSc student M. Willoughby)
Physica D 240 (2011) 1378–1394.
arXiv: nlin/1102.3620

31. Symmetry analysis and exact solutions of semilinear heat flow in multi-dimensions. (with S. Ali and T. Wolf)
J. Math. Anal. Appl. 379 (2011), 748–763.
arXiv: math/1011.4633

32. Integrable generalizations of Schrodinger maps and Heisenberg spin models from Hamiltonian flows of curves and surfaces. (with R. Myrzakulov)
J. Geom. Phys. 60 (2010), 1576–1603.
arXiv: nlin/0806.1360

33. Conservation laws of inviscid non-isentropic compressible fluid flow in $n > 1$ spatial dimensions. (with PhD student A. Dar)
Proc. Roy. Soc. A 466 (2010), 2605–2632.
arXiv: physics.flu-dyn/0911.0882

34. Quaternion soliton equations from Hamiltonian curve flows in HP^n. (with E. Asadi)
J. Phys. A: Math. Theor. 42 (2009), 485201 (25 pages).
arXiv: math-ph/0905.4215

35. Classification of conservation laws of compressible isentropic fluid flow in $n > 1$ spatial dimensions. (with PhD student A. Dar)
Proc. Roy. Soc. A 465 (2009), 2461–2488.
arXiv: physics.flu-dyn/0902.3405

36. Curve flows in Lagrange-Finsler geometry, bi-Hamiltonian structures and solitons. (with S. Vacaru)
J. Geom. Phys. 59 (2009), 79–103.
arXiv: math-ph/0609070

37. Spinor derivation of quasilocal mean curvature mass in General Relativity.
Inter. J. Theor. Phys. 47 (2008), 684–695.
arXiv: math-ph/1310.8199

38. Analytical properties and exact solutions of static plasma equilibrium systems in three dimensions. (with A. Cheviakov).
Phys. Lett. A 372 (2008), 1363–1373.
arXiv: math-ph/0708.4247

39. Group-invariant soliton equations and bi-Hamiltonian geometric curve flows in Riemannian symmetric spaces.
J. Geom. Phys. 58 (2008), 1–37.
arXiv: nlin.SI/0703041

40. Mean curvature flow and quasilocal mass for 2-surfaces in Hamiltonian General Relativity.
J. Math. Phys. 48 (2007), 052502 (32 pages).
arXiv: gr-qc/0402057

41. Conservation laws and symmetries of semilinear radial wave equations. (with N. Ivanova)
J. Math. Anal. Appl. 332 (2006), 863–876.
arXiv: math-ph/0608037

42. New conservation laws obtained directly from symmetry action on a known conservation laws. (with G. Bluman and Temuerchaolu)
J. Math. Anal. Appl. 322 (2006), 233–250.

43. Hamiltonian flows of curves in symmetric spaces G/SO(N) and vector soliton equations of mKdV and sine-Gordon type.
SIGMA 2 (2006), 044 (18 pages).
arXiv: nlin.SI/0512046

44. Bi-Hamiltonian operators, integrable flows of curves using moving frames, and geometric map equations.
J. Phys. A: Math. Gen. 39 (2006), 2043–2072.
arXiv: nlin.SI/0512051

45. Symmetries, conservation laws, and cohomology of Maxwell's equations using potentials. (with MSc student D. The)
Acta Appl. Math. 89 (2005), 1–52.
arXiv: math-ph/0501052

46. Some symmetry classifications of hyperbolic vector evolution equations. (with T. Wolf)
J. Nonlinear Math. Phys. 12, Supplement 1 (2005), 13–31;
erratum, J. Nonlinear Math. Phys. 12 (2005), 607–608.
arXiv: nlin.SI/0412015

47. Gauge theory deformations and novel Yang-Mills Chern-Simon field theories with torsion.
Int. J. Geometric Methods in Modern Physics 1 (2004), 493–544.
arXiv: math-ph/0407026

48. Exact solutions of semilinear radial wave equations in n dimensions. (with S. Liu)
J. Math. Anal. Appl. 297 (2004), 317–342.
arXiv: math-ph/0309049

49. Conservation laws of scaling-invariant field equations.
J. Phys. A: Math. and Gen. 36 (2003), 8623–8638.
arXiv: math-ph/0306066

50. Parity violating spin-two gauge theories.
Phys. Rev. D 67 (2003), 124007 (8 pages).
arXiv: gr-qc/0305026

51. Conserved currents of massless spin s fields. (with J. Pohjanpelto)
Proc. Roy. Soc. 459 (2003), 1215–1239.
arXiv: math-ph/0202019

52. Gauge theories of Yang-Mills vector fields coupled to antisymmetric tensor fields.
J. Math. Phys. 44 (2003), 1006–1043.
arXiv: math-ph/0209051

53. Exotic Yang-Mills dilaton gauge theories.
Lett. Math. Phys. 62 (2002), 245–258.
arXiv: math-ph/0209052

54. On multi-graviton and multi-gravitino gauge theories.
Class. Quant. Grav. 19 (2002), 6445–6467.
arXiv: gr-qc/0303033

55. Covariant Hamiltonian boundary conditions in General Relativity for spatially bounded spacetime regions. (with R. Tung)
J. Math. Physics 43 (2002), 5531–5566.
arXiv: gr-qc/0109013

56. Properties of the symplectic structure of General Relativity for spatially bounded spacetime regions. (with R. Tung)
J. Math. Physics 43 (2002), 3984–4019.
arXiv: gr-qc/0109014

57. Direct construction method for conservation laws of partial differential equations II: General treatment. (with G. Bluman)
Euro. Jour. Appl. Math. 13 (2002), 567–585.
arXiv: math-ph/0108024

58. Direct construction method for conservation laws of partial differential equations I: Examples of conservation law classifications. (with G. Bluman)
Euro. Jour. Appl. Math. 13 (2002), 545–566.
arXiv: math-ph/0108023

59. Classification of local conservation laws of Maxwell's equations. (with J. Pohjanpelto)
Acta. Appl. Math. 69 (2001), 285–327.
arXiv: math-ph/0108017

60. Global existence for wave maps with torsion. (with J. Isenberg)
Comm. Partial Diff. Eqns. 25 (2000), 1669–1702.
arXiv: math-ph/0007032

61. Nonlinear gauge theories of a spin-two field and a spin-three-halves field.
Ann. Phys. 270 (1998), 52–125.

62. Integrating factors and first integrals of ordinary differential equations. (with G. Bluman)
Euro. Jour. Appl. Math. 9 (1998), 245–259.

63. Novel generalization of three dimensional Yang-Mills theory.
J. Math. Phys. 38 (1997), 3399–3413.
arXiv: math-ph/0209050

64. Nonlocal symmetries and conservation laws of Maxwell's equations. (with G. Bluman)
J. Math. Phys. 38 (1997), 3508–3532.

65. Direct construction of conservation laws from field equations. (with G. Bluman)
Phys. Rev. Lett. 78 (1997), 2869–2873.

66. Derivation of conservation laws from nonlocal symmetries of differential equations. (with G. Bluman)
J. Math. Phys. 37 (1996), 2361–2375.

67. New spin-one gauge theory in three dimensions.
J. Math. Phys. 36 (1995), 6553–6565.

68. Non-Grassmann generalization of classical supergravity theory.
Phys. Rev. D 50 (1994), 2648–2661.

69. Construction of locally-symmetric Lagrangian field theories from variational identities.
Contemp. Math. (Amer. Math. Soc.) 132 (1992), 27–50.

70. Does there exist a sensible quantum theory of an algebra-valued scalar field? (with R.M. Wald)
Phys. Rev. D 39 (1989), 2297–2307.

Refereed Conference Proceedings:

71. Conservation laws, symmetries, and line soliton solutions of generalized KP and Boussinesq equations with p-power nonlinearities in two dimensions (with M.L. Gandarias and E. Recio)
Theor. and Math. Phys. 196(3) (2018), 1241–1259. Proceedings of the Conference *Physics and Mathematics of Nonlinear Phenomena PMNP2017: 50 years of IST* (Gallipoli, Italy, 2017)
arXiv: math-ph/1710.02739

72. Conservation laws and symmetries of time-dependent generalized KdV equations. (with M. Rosa, M.L. Gandarias)
Discrete and Continuous Dynamical Systems (Series S) 11(4) (2018), 607–615.
Proceedings of the 11th AIMS Conference *Dynamical Systems, Differential Equations and Applications* (Orlando, 2016).
arXiv: 1705.04999 math-ph

73. Conservation laws and potential systems for a generalized thin film equation. (with PhD student E. Recio, M.S. Bruzon) AIP Conference Proceedings 1863 (2017), 280002 (4 pages).
International Conference of Numerical Analysis and Applied Mathematics (Rhodes, 2016)

74. Conservation laws and symmetries of a generalized Kawahara equation. (with M.L. Gandarias, M. Rosa, PhD student E. Recio) AIP Conference Proceedings 1836 (2017), 020072 (6 pages).
Proceedings of the 1st International Conference on Applied Mathematics and Computer Science (Rome, 2017)
arXiv:math-ph/1701.04854

75. A nonlinear generalization of the Camassa-Holm equation with peakon solutions. (with MSc student E. Recio, M. Gandarias, M. Bruzon)
Dynamical Systems, Differential Equations and Applications (2015), 29–37.
Proceedings of the 10th AIMS Conference *Dynamical Systems, Differential Equations and Applications* (Madrid, 2015).
arXiv:math-ph/1609.02473

76. Integrable systems with unitary invariance from non-stretching geometric curve flows in the Hermitian symmetric space Sp(n)/U(n). (with E. Asadi and A. Dogonchi)
Int. J. Mod. Phys. 38 (2015), 1560071 (15 pages).
Proceedings of Conference *Symmetries, Differential Equations, Applications II* (Islamabad, Pakistan, 2014).
arXiv: nlin.SI/1410.1230

77. Exact solutions of nonlinear partial differential equations by the method of group foliation reduction. (with S. Ali and T. Wolf)
SIGMA 7 (2011), 066 (10 pages).
Proceedings of Conference *Symmetry, Separation, Super-integrability and Special Functions (S4)* (University of Minnesota, USA, 2010).
arXiv: math-ph/1105.5303

78. Construction of conservation laws: How the Direct Method generalizes Noether's theorem. (with G. Bluman and A. Cheviakov)
In: Group Analysis of Differential Equations and Integrable Systems (2008), 13–35.
Proceedings of 4th International Workshop *Group Analysis of Differential Equations and Integrable Systems* (Cyprus, 2007).

79. Invertible mappings of nonlinear PDEs to linear PDEs through admitted conservation laws. (with G. Bluman and T. Wolf)
Acta Appl. Math. 101 (2008), 21–38.
Proceedings of International Conference *Geometry and Algebra of PDEs* (University of Tromso, Norway, 2007).
arXiv: math-ph/0712.1835

80. Generalized symmetries of massless free fields on Minkowski space. (with J. Pohjanpelto)
SIGMA 4 (2008), 004 (17 pages).
Proceedings of the 7th International Conference *Symmetry in Nonlinear Mathematical Physics* (Ukraine, 2007).
arXiv: math-ph/0801.1892

81. Hamiltonian curve flows in Lie groups G⊂U(N) and vector NLS, mKdV, sine-Gordon soliton equations.
In: IMA Volumes in Mathematics and its Applications, Vol. 144 (2007), 223–250.
Proceedings of IMA Summer Program *Symmetries and Overdetermined Systems of Partial Differential Equations* (University of Minnesota, USA, 2006).
arXiv: nlin.SI/0610075

82. Some Penrose transforms in complex differential geometry. (with J. Bland and M. Eastwood)
Science in China Series A: Mathematics (2006) Vol. 49 No. 11, 1599–1610.
Proceedings of 6th International Conference *Several Complex Variables* (Beijing, China, 2006).

83. Symmetries and currents of massless neutrino fields, electromagnetic and graviton fields. (with J. Pohjanpelto)
In: CRM Proceedings and Lecture Notes, Vol. 34 (2004), 1–12.
Proceedings of *Workshop on Symmetry in Physics* (CRM, Montreal, 2002).
arXiv: math-ph/0306072

Articles submitted:

i. Hierarchies of new invariants and conserved integrals in inviscid fluid flow. (with G. Webb)
Submitted to J. Fluid Mech. 2018
arXiv: 1809.01544

ii. Global versus local (super)integrability of a nonlinear oscillator. (with M. Gandarias and A. Ballesteros)
Submitted to Phys. Lett. A 2018.
arXiv: 1809.02248

iii. Accelerating dynamical peakons and their behaviour. (with E. Recio)

iv. On the different types of global and local conservation laws for partial differential equations in three spatial dimensions (with A. Cheviakov)
Submitted to Reviews in Mathematical Physics. 2018.
arXiv: math-ph/1803.08859

v. Elastic null curve flows, nonlinear C-integrable systems, and geometric realization of Cole-Hopf transformations, (with Z. Yuzbasi)
Submitted to J. Geom. Phys. 2017. arXiv: math-ph/1709.08234

vi. A general family of multi-peakon equations and their properties (with PhD student E. Recio)
Submitted to J. Phys. A: Math. Theor. 2018.
arXiv:math-ph/1609.04354 math-ph

Articles in preparation:

vii. Conservation laws for a class of equations with compacton solutions. (with M. Gandarias)

viii. Integrable non-local NLS equations. (with E. Asadi)

ix. Group-invariant soliton equations from geometric curve flows in Lie groups.

x. Conservation laws and symmetries of magnetohydrodynamics equations. (with PhD student D. Pshenitsin, and T. Wolf)

xi. Conservation laws of compressible fluid flow on moving volumes with viscosity and heat transfer in n¿1 dimensions. (with A. Dar)

xii. Conservation laws and symmetries of the Teukolsky equation for spin s fields in Kerr blackholes. (with postdoc G. Papadopolous)

Grants

Brock University Advancement Fund (teaching relief award for research), winter term 2004 $3700

Brock University Advancement Fund (funding to host a research workshop), summer 2005 $2500

NSERC individual research grant, 2000-2004 $8000 per year

NSERC individual research grant, 2004-2009 $14000 per year

NSERC individual research grant, 2009-2014 $18000 per year

NSERC individual research grant, 2014-2019 $18000 per year

Invited Talks and Colloquia

12th AIMS International Conference on Dynamical Systems and Differential Equations (Taiwan), 2018
Session on Advances in Analysis and Geometry of Nonlinear Waves and Integrable Systems, *Wave-breaking equations, generalized peakons, and their properties.*
Session on Integrable Peakon Equations and Related Topics, *New integrable peakons equations from a modified AKNS scheme.*
Session on Lie Symmetries, Conservation Laws, and Other Approaches in Solving Nonlinear Differential Equations, *Common errors in finding exact solutions and conservation laws of differential equations.*

Symmetry 2017 – The First International Conference on Symmetry
Session on Symmetry in Mathematics and Computer Science.
Generalization of Noether's theorem to non-variational differential equations.

Cadiz University (Spain), Mathematics Department, 2017
Departmental Colloquium.
Travelling waves of a highly nonlinear fourth-order wave equation.

Burgos University (Spain), Physics Department, 2017
Departmental Colloquium.
New symmetry aspects of first integrals for central force motion.

IV AMMCS International Conference, 2017
Session on Recent Advances in Mathematical and Computational Aspects of Wave Propagation.
Travelling waves of a highly nonlinear fourth-order wave equation.

10th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 2017
Session on Evolution Equations and Integrable Systems.
Peakons: weak solutions or distributional solutions?

American Mathematical Society regional meeting (Charleston, South Carolina), 2017
Session on Geometry and Symmetry in Integrable Systems.
A vortex filament equation with peakon solutions.

University of Texas (Rio Grande Valley), School of Mathematical and Statistical Sciences, 2017
Departmental Colloquium.
Wave-breaking equations,peakons, and their properties.

Workshop on Recent Developments in Integrable Systems and Solitons, (University of Texas, Rio Grande Valley), 2017
Integrable multi-peakon equations from a modified AKNS scheme.
Generalized negative flows in hierarchies of integrable evolution equations.

Canadian Mathematical Society winter meeting (Niagara Falls), 2016
Session on Nonlinear PDEs and Variational Problems.
A vortex filament equation with peakon solutions.
Session on Integrable Systems and Applications.
Integrable multi-component peakon equations from a modified AKNS scheme.

11th AIMS International Conference on Dynamical Systems and Differential Equations (Orlando), 2016
Session on Nonlinear Dispersive Equations and Integrable Systems .
Classification of integrable 2-component peakon equations from Lax pairs.
Session on Lie Symmetries, Conservation Laws and Other Approaches in Solving Nonlinear Differential Equations.
Conservation laws of hydrodynamic systems.

CAIMS Conference (Edmonton), 2016
Session on Exact and Approximate Solutions of Fluid/Gas Dynamics.
Conservation laws of magnetohydrodynamics.

Canadian Mathematical Society summer meeting (Edmonton), 2016
Session on Analysis and Applications of Differential Equations Using Symmetries, Conservation Laws, and Integrability.
New integrable 2-component peak equations.

American Mathematical Society regional meeting (Fargo, North Dakota), 2016
Session on Integrable Dynamical Systems and Special Functions.
Oscillatory solitons of Hirota and Sasa-Satsuma equations.

6th International Workshop on Nonlinear Mathematical Physics
and 13th Chinese National Conference on Integrable Systems (Weifang), 2015
Plenary talk.
Modern developments connecting symmetries and conservation laws of partial differential equations.

8th International Congress on Industrial and Applied Mathematics (Beijing), 2015
Session on Applied Integrable Systems.
New 2-component peakon equations arising from Hirota and Sasa-Satsuma hierarchies.
Session on Lie Symmetries, Solutions and Conservation laws of Nonlinear Differential Equations.
Some classifications of conservation laws of partial differential equations.

MOGRAN 18 Conference/School on Lie Groups and Computation Methods in Nonlinear Problems of Mathematical Modelling (Shenyang), 2015
Conservation laws of partial differential equations and their connections to symmetries.

AMMCS-CAIMS Conference (Waterloo), 2015
Semi-Plenary talk.
Conservation Laws of fluid flow on Riemannian manifolds.
Session on Wave Propagation and Applications.
Generalizations of Camassa-Holm equation and their peakon solutions.

University of Notre Dame, Department of Mathematics, 2015
PDE, Complex Analysis, and Differential Geometry Seminar.
Conservation laws of partial differential equations and their connections to symmetries.

3rd International Workshop on Nonlinear and Modern Mathematical Physics (Cape Town), 2015
Plenary talk.
Conservation laws of partial differential equations and their connections to symmetries.

9th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 2015
Session on Solitons and Nonlinear Dispersive Waves.
Integrable multi-component nonlinear wave equations from symplectic structures.

University at Buffalo, Department of Mathematics, 2015
Applied Math Seminar.
Conservation laws of partial differential equations and their connections to symmetries.

University of South Florida, Department of Mathematics and Statistics, 2014
Departmental Colloquium.
Geometric curve flows and integrable systems.

SIAM Conference on Nonlinear Waves and Coherent Structures (Cambridge, UK), 2014
Session on Nonlinear Wave Equations and Geometry.
Multi-component integrable wave equations and geometric moving frames.
Session on Integrable Systems: Analysis, Geometry, and Applications.
Integrable multi-component wave equations from symplectic structures.

10th AIMS International Conference on Dynamical Systems and Differential Equations (Madrid), 2014
Session on Evolution Equations and Integrable Systems.
Integrable multi-component wave equations from symplectic structures.
Session on Lie Symmetries, Conservation Laws and other Approaches in Solving Nonlinear Differential Equations.
Conservation laws from multipliers and their connections to symmetries.

International Conference on Symmetry Methods, Applications, and Related Fields (Vancouver), 2014
Conservation laws and their connections (old and new) to symmetries.

University at Buffalo, Department of Mathematics, 2014
Applied Math Seminar.
Solitons of U(1)-invariant mKdV equations.

Canadian Mathematical Society summer meeting (Halifax), 2013
Session on Psuedogroups and their Applications.
A group foliation method for finding exact solutions to nonlinear PDEs.
Session on Nonlinear Partial Differential Equations and their Applications.
Symmetry analysis and exact solutions of nonlinear wave equations.

8th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 2013
Session on Analysis and Applications of Nonlinear Wave Equations.
Symmetry analysis and exact solutions of semilinear Schrodinger equations.

International Workshop on Nonlinear and Modern Mathematical Physics (Tampa), 2013
Geometric curve flows and integrable systems.

Canadian Mathematical Society winter meeting (Montreal), 2012
Session on Symmetries of Differential and Difference Equations.
Symmetry analysis and exact solutions of semilinear Schrodinger equations.

McMaster University, Department of Mathematics and Statistics, 2012
Departmental Colloquium.
Geometric curve flows and integrable systems.

9th AIMS International Conference on Dynamical Systems and Differential Equations (Orlando), 2012
Session on Multi-component Integrable Systems, Solitons, and Nonlinear Waves.
Multi-component soliton equations from geometric curve flows.

Joint Mathematics Meetings (Boston, Massachusetts), 2012
AMS Session on Mathematical Principles and Theories of Integrable Systems.
Integrability of geometric map equations using Hasimoto variables.

Canadian Mathematical Society winter meeting (Toronto), 2011
Session on Nonlinear Partial Differential Equations and Applications.
New conserved quantities for wave equations.

CRM (Montreal), 2011
Workshop on Moving Frames in Geometry.
Integrability of geometric evolution equations using classical moving frames.

University of Toronto, Department of Mathematics, 2011
Analysis Applied Math Seminar.
Conserved integrals of inviscid fluid flow in multi-dimensions.

7th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 2011
Session on Recent Developments in Integrable Systems and Solitons.
Integrable systems and bi-Hamiltonian geometric curve flows.

Canadian Mathematical Society winter meeting (Vancouver), 2010
Session on Symmetry Methods for Differential Equations.
New conserved integrals for Euler's equations in $n > 1$ spatial dimensions.

Canadian Applied and Industrial Mathematics Society (St. Johns), 2010
Session on Mathematical and Theoretical Physics.
New conserved integrals of compressible fluid flow in $n > 1$ spatial dimensions.

4th International Workshop on Group Analysis of Differential Equations and Integrable Systems (Cyprus), 2010
Group invariant soliton equations and bi-Hamiltonian geometric curve flows in Klein geometry.

American Mathematical Society regional meeting (St. Paul, Minnesota), 2010
Session on Geometric Flows, Moving Frames and Integrable Systems.
Bi-Hamiltonian geometric curve flows in semi-simple Klein geometries.

Canadian Mathematical Society winter meeting (Windsor), 2009
Session on Exact and Approximation Methods for Differential Equations.
Conserved integrals of compressible fluid flow in $n > 1$ spatial dimensions.

American Mathematical Society regional meeting (Raleigh, North Carolina), 2009
Session on Geometry of Differential Equations.
Klein geometry, group invariant soliton equations, and bi-Hamiltonian geometric curve flows.

Canadian Mathematical Society winter meeting (Ottawa), 2008
Session on Mathematics and Classical Mechanics.
Klein geometry and bi-Hamiltonian structure of soliton equations.

PIMS International Conference on Similarity: Generalizations, Applications and Open Problems (UBC), 2008
Conservation law methods using multipliers and symmetries.

5th World Congress of Nonlinear Analysts (Orlando), 2008
Session on Applied and Integrable Nonlinear Differential Equations.
Group-invariant generalizations of KdV, NLS, and sine-Gordon soliton equations arising from geometric curve flows.

7th AIMS International Conference on Dynamical Systems and Differential Equations (Arlington), 2008.
Session on Recent Developments of Analytic and Algebraic Methods in Integrable Systems and Applications.
Group-invariant soliton equations and bi-Hamiltonian flows in symmetric Lie algebras.

BIRS Workshop on Geometric Flows in Mathematics and Physics, 2008
Hamiltonian integrability of geometric curve flows.

Canadian Mathematical Society winter meeting (London), 2007
Session on Nonlinear Wave Equations and Applications.
Symmetry analysis of nonlinear wave equations in $n > 1$ dimensions.

Institute for Mathematics and its Applications (Minneapolis), 2006
Workshop on Symmetries and Overdetermined Systems of Partial Differential Equations.
Group-invariant soliton equations and bi-Hamiltonian geometric curve flows in Riemannian symmetric spaces and Lie groups.

Florida Institute of Technology (Melbourne), Department of Mathematical Sciences, 2005
Conference on Differential and Difference Equations and Applications
Exact solutions of nonlinear wave equations using symmetry methods.

Ukraine National Academy of Science (Kiev), 2005
Conference on Symmetry in Nonlinear Mathematical Physics
Symmetry-integrability classifications of hyperbolic vector equations.

Canadian Mathematical Society summer meeting (Waterloo), 2005
Session on Invariant Theory and Differential Geometry.
Bi-Hamiltonian operators in Lie group geometry and wave maps.

American Mathematical Society regional meeting (Newark, Delaware), 2005
Session on Symmetry Methods for Partial Differential Equations.
Exact solutions of nonlinear wave equations in $n > 1$ dimensions.

University of Regensburg (Germany), Department of Mathematics, 2004
Conserved Integrals of the Teukolsky equation.

Workshop on Geometry and General Relativity (Regensburg), 2004
Mean curvature flow and geometrical definitions of quasilocal mass-energy in Hamiltonian General Relativity.

4th World Congress of Nonlinear Analysts (Orlando), 2004
Session on Integrable Systems and Nonlinear Waves.
Integrable vector sine-Gordon equations from Riemannian and conformal geometry.

Canadian Mathematical Society summer meeting (Halifax), 2004
Session on Applications of Invariant Theory to Differential Geometry.
Moving frames and integrable PDE maps.

CRM (Montreal), 2003
Workshop on Interaction of classical fields with gravity.
Conservation laws of the Teukolsky equation for massless spin s fields in Kerr spacetime.

BIRS Workshop on Differential Invariants and Invariant Differential Equations, 2003
Applications of frames to nonlinear wave equations and integrable evolution equations.

Canadian Mathematical Society summer meeting (Edmonton), 2003
Session on Geometry and Physics.
Covariant Hamiltonian structure of General Relativity for spatially bounded spacetime regions.

McGill University, Department of Mathematics, 2003
Local and global well-posedness of generalized Yang-Mills equations in 2+1 dimensions.

CRM (Montreal), 2002
Workshop on Symmetry in Physics (in Memory of Robert Sharp).
Local symmetries and conservation laws of spin s>0 fields.

University of Minnesota (Minneapolis), 2002
Conference on Foundations of Computational Mathematics (FoCM) '02,
Session on Symbolic Analysis.
Developments in computational methods for finding conservation laws of PDEs.

Canadian Mathematical Society winter meeting (Vancouver), 2000
Session on Partial Differential Equations.
Well-posedness of the Cauchy problem for a novel generalization of Yang-Mills equations.

Canadian Mathematical Society summer meeting (Hamilton), 2000
Session on Partial Differential Equations.
Global existence for wave maps with torsion.

Utah State University (Logan), Department of Mathematics, 2000
Second Workshop on Formal geometry and mathematical physics.
Symmetries of evolution equations and invariant Lagrangians.
Generalizations of Yang-Mills gauge symmetry.

Canadian Mathematical Society winter meeting (Montreal), 1999
Session on Group Theoretical Methods in Mathematical Physics.
Conservation laws of field equations.

Oxford University (Oxford, England), 1999
Conference on Foundations of Computational Mathematics (FoCM),
Session on Symbolic Analysis.
Adjoint symmetries and computation of conservation laws of differential equations.

Utah State University (Logan), Department of Mathematics, 1999
First Workshop on Formal geometry and mathematical physics.
Classification of symmetries and conservation laws of Maxwell's equations.
Geometrical gauge field theories.

CRM (Montreal), 1999
Complete symmetries and conservation laws of Maxwell's equations.

CRM (Montreal), 1998
Construction algorithm for conservation laws of partial differential equations.

Utah State University (Logan), Departments of Mathematics and Physics, 1998
Construction algorithm for conservation laws of partial differential equations.
Nonlocal conservation laws of partial differential equations.
Classification and construction of nonlinear gauge field theories.

University of Pennsylvania (Philadelphia), Department of Mathematics, 1997
Deformation of Yang-Mills gauge theory.

American University (DC), Department of Mathematics and Statistics, 1997
Derivation of differential equation conservation laws.

University of Maryland (College Park), Department of Physics, 1997
Generalizations of Yang-Mills gauge theory in 3 and 4 dimensions.

University of Oregon (Eugene), Institute of Theoretical Science, 1995
The Einstein equations with spatial boundary conditions.

University of Oregon (Eugene), Department of Mathematics, 1995
Extension of Noether's theorem generating nonlocal conservation laws.

University of British Columbia (Vancouver), Department of Mathematics, 1994
Nonlocal symmetries and conservation laws of the linear wave equation.

University of Chicago, Department of Physics, 1992
Symmetries, Noether's theorems, and some variational identities.

University of Washington (Seattle), 1991
AMS Conference on Mathematical Aspects of Classical Field Theory.
New classical supergravity theories.

Major Research Meetings and Conferences

Invited speaker in the Sessions on Advances in Analysis and Geometry of Nonlinear Waves and Integrable Systems, and Lie Symmetries, Conservation Laws and Other Approaches in Solving Nonlinear Differential Equations at the 12th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 7/2018.

Co-organizer of the Session on Integrable Peakon Equations and Related Topics at the 12th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 7/2018.

Invited lecturer at the Summer School on Symmetry, Similarity and Conservation laws in Solid and Fluid Mechanics (Cargese, France), 4/2018.

Invited speaker at Symmetry 2017 – The First International Conference on Symmetry (Barcelona, Spain), 10/2017.

Invited lecturer at the Fourth International Summer School on Modern approach to symmetries: Mathematical models in Biomathematics (University of Cadiz, Spain), 6/2017.

Co-organizer of the Session on Integrable Systems and Applications at the Canadian Mathematical Society winter meeting (Niagara Falls), 12/2016.

Invited speaker in the Sessions on Nonlinear Dispersive Equations and Integrable Systems and Lie Symmetries, Conservation Laws and Other Approaches in Solving Nonlinear Differential Equations at the 11th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 7/2016.

Co-organizer of the Session on Analysis of Nonlinear Dispersive Wave Equations and Integrable Systems and the Session on Applied and Integrable Nonlinear PDEs at the 11th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 7/2016.

Co-organizer of the Session on Analysis and Applications of Differential Equations Using Symmetries, Conservation Laws, and Integrability at the Canadian Mathematical Society summer meeting (Edmonton), 6/2016.

Plenary Speaker at the 6th International Workshop on Nonlinear Mathematical Physics and the 13th Chinese National Conference on Integrable Systems, 8/2015.

Invited speaker in the Sessions on Applied Integrable Systems and Lie Symmetries, Solutions and Conservation laws of nonlinear differential equations at the 8th International Congress on Industrial and Applied Mathematics, 8/2015.

Invited lecturer at the MOGRAN 18 Conference/School on Lie Groups and Computation Methods in Nonlinear Problems of Mathematical Modelling, 8/2015.

Semi-Plenary speaker and Invited speaker in the Session on Wave Propagation and Applications at the AMMCS-CAIMS Conference, 6/2015.

Plenary speaker at the 3rd International Workshop on Nonlinear and Modern Mathematical Physics, 4/2015.

Co-organizer of the Session on Modeling, Geometry, Integrability, and Analysis of Nonlinear Waves at the 9th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 4/2015.

Co-organizer of the Session on Integrable systems: Recent Developments at the Canadian Mathematical Society winter meeting (Hamilton), 12/2014.

Co-organizer and speaker in the Session on Integrable Systems: Analysis, Geometry, and Applications, and Invited speaker in the Session on Nonlinear Wave Equations and Geometry, at the SIAM Conference on Nonlinear Waves and Coherent Structures, 8/2014.

Co-organizer and speaker in the Session on Evolution Equations and Integrable Systems, and Invited speaker in the Session on Lie Symmetries, Conservation Laws and other Approaches in Solving Nonlinear Differential Equations, at the 10th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 7/2014.

Co-organizer and speaker at the International Conference on Symmetry Methods, Applications, and Related Fields, 5/2014.

Invited participant at the BIRS research workshop on Integrable Systems and Moduli Spaces, 8/2013.

Co-organizer and speaker in the Session on Analysis and Applications of Nonlinear Wave Equations at the 8th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 4/2013.

Co-organizer and speaker in the Session on Multi-component Integrable Systems, Solitons, and Nonlinear Waves at the 9th AIMS International Conference on Dynamical Systems, Differential

Equations and Applications, 6/2012.

Invited participant at the BIRS research workshop on New Geometric and Numeric Tools for the Analysis of Differential Equations, 8/2010.

Invited speaker at the 4th International Workshop on Group Analysis of Differential Equations and Integrable Systems, 6/2010.

Co-Organizer and speaker at the PIMS International Conference on Similarity: generalizations, applications and open problems, 8/2008.

Co-Organizer and speaker for the Session on Applied and Integrable Nonlinear Differential Equations at the 5th World Congress of Nonlinear Analysts, 7/2008.

Invited speaker in the Session on Recent Developments of Analytic and Algebraic Methods in Integrable Systems and Applications at the 7th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, 5/2008.

Invited speaker at the BIRS research workshop on Geometric Flows in Mathematics and Physics, 4/2008.

Invited speaker in the Special Session on Symbolic Symmetry Analysis and Its Applications at the International Conference on Applications of Computer Algebra (ACA), 7/2007. (declined due to health reasons)

Invited speaker at the 7th International Conference on Symmetry in Nonlinear Mathematical Physics, 6/2007. (declined due to health reasons)

Invited speaker at the IMA research workshop on Symmetries and Overdetermined Systems of PDEs, 7/2006.

Invited speaker at the 6th International Conference on Symmetry in Nonlinear Mathematical Physics, 7/2005.

Invited speaker at the 4th World Congress of Nonlinear Analysts, 7/2004.

Invited speaker at the BIRS research workshop on Differential Invariants and Invariant Differential Equations, 7/2003.

Invited participant at the Oberwolfach research meeting on Mathematical Relativity, 2/2003.

Invited participant at the Oberwolfach research meeting on Nonlinear Evolution Equations, 5/2001.

Invited participant at the Oberwolfach research meeting on Mathematical Relativity, 7/2000.

Invited speaker at the Conference on Foundations of Computational Mathematics, 1999.

Local Workshops and Conferences

Organizer and speaker at Brock Workshop on Applied and Integrable PDEs, 11/2013.

Scientific Organizing Committees

10th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 4/2017.

Canadian Mathematical Society winter meeting (Niagara Falls), 12/2016

9th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, 4/2015.

International Conference on Symmetry Methods, Applications, and Related Fields, 5/2014.

Professional Activities

Member of the Canadian Mathematical Society and American Mathematical Society.

Editor for the peer-reviewed research journals: *Advances in Mathematical Physics* (Hindawi Publishing, New York, USA), *Symmetry* (MDPI, Switzerland), *International J. Nonlinear Science* (World Academic Press, UK).

Referee for the journals: *Acta Applicandae Math.*, *Analysis and Applications*, *Analysis and Mathematical Physics*, *Applied Mathematics and Computation*, *Euro. J. Applied Mathematics*, *Inter. J. Geometric Methods in Modern Physics*, *J. Applied Analysis and Computation*, *J. Mathematical Analysis (SIAM)*, *J. Mathematical Analysis and Applications*, *J. Mathematical Physics*, *J. Physics A: Math. Gen.*, *J. Nonlinear Math. Physics*, *Mathematical Analysis and Applications*, *Mathematics and Computers in Simulation*, *Mathematical Methods in the Applied Sciences*, *Nonlinear Dynamics*, *SIAM (Mathematical Analysis)*, *Symmetry Integrability Geometry: Methods and Applications (SIGMA)*, *Symmetry*, *J. Geometry and Physics*, *Physics Letters A*, *Physica D*, *Physics of Fluids*, *Classical and Quantum Gravity*.

NSERC grant reviewer in Applied Mathematics.

Reviewer for *Mathematical Reviews*, *American Math. Society monograph series*.

Speaker and panelist at the University of Chicago conference "Lessons from new faculty: Teaching across the physical sciences", 6/2002

Supervision of Students

Ph.D. Thesis

1. Dmitry Pshenitsin (Theoretical Physics), June 2016
   Thesis title: Conservation laws of magnetohydrodynamics and their symmetry transformation properties.
   co-supervisor with Prof. T. Wolf

2. Michelle Przedborski (Theoretical Physics), July 2017
   Thesis title: Nonlinear dynamics of granular assemblies.
   research co-supervisor

M.Sc. Thesis/Project

1. Scott Greenhalgh, August 2008
   Project title: Maple animations of nonlinear waves and computer algebra computation of fluid flow conservation laws.
2. Steve MacNaughton, August 2011
   co-supervisor with Prof. T. Wolf
   Project title: Computation of conservation laws and symmetries of quasilinear radial wave equations by computer algebra.
3. Nestor Tchegoum Ngatat, August 2011
   Project title: Two-soliton solutions of complex mKdV equations and their asymptotic analysis.
4. Sattar Mia, August 2012
   co-supervisor with Prof. T. Wolf
   Project title: Complex mKdV solitons with time varying phase.
5. Kivilcim Alkan, December 2012
   Project title: Inelastic curve flows in 2- and 3- dimensional Minkowskian space.
6. Ahmed Ahmed, June 2014
   Project title: New integrable non-linear Schrodinger systems derived from Hermitian symmetric spaces using Lie algebras.
7. Shahid Mohammad, April 2015
   co-supervisor with Prof. T. Wolf
   Project title: -1 flow in hierarchies of integrable equations
8. Elena Recio, August 2016
   Project title: A general family of multi-peakon equations
9. Fataneh Mobasheramini, August 2016
   Project title: 2x2 Lax pair classification for 2-component peakon equations

10. Sarah Bax, August 2017
    Project title: Lax pairs of integrable non-abelian ODEs
    co-supervisor with Prof. T. Wolf

11. Elise Kinnear, August 2017
    Project title: Peakon solutions of a modified Camassa-Holm equation

12. Evans Boadi (started September 2016)
    Project title: A modified AKNS scheme for integrable peakon equations

13. James Frank (Theoretical Physics, started January 2017)
    Project title: Non-Lagrangian deformations of gauge fields

14. Jordan Fazio (Theoretical Physics, started September 2017)
    Project title: Analogs of the Laplace-Runge-Lenz vector in black-hole spacetimes.

15. Richard (SIcheng) Zhao (started September 2017)

B.Sc. Physics Thesis

1. Tyler Kerr, April 2002
   Thesis title: Exact solutions of linear and nonlinear Maxwell field equations in two spatial dimensions.

2. Andrew Stewart, April 2005
   Thesis title: Spherically symmetric solutions of gravity coupled to a vector field theory.

3. Andrae Blanchard, June 2007
   Thesis title: Exact solutions of chiral fields coupled to gravity.

4. Nathan Eddy, June 2012
   Thesis title: Conserved quantities in the Kepler problem.

5. Michel Grenier, August 2012
   Thesis title: Hamiltonian mass/energy in General Relativity.

6. Tyler Meadows, June 2013
   Thesis title: Conserved quantities and symmetries in a central force potential

7. Vincent Pascuzzi, June 2014
   Thesis title: Conserved integrals of central force motion

8. Alec Ross, June 2014
   Thesis title: On Conserved Quantities in the Schwarzschild Spacetime

Mathematics Honours Projects

1. Andrew Copfer, April 2002
   Title: Generalized similarity solutions of the heat equation.

2. Tyler Kerr, April 2002
   Title: Solutions of nonlinear Maxwell theory.

3. Wai-Hung Tang, April 2003
   Title: Conservation laws of fluid flow.

4. Steve Roach, April 2005
   Title: Exact solutions of nonlinear heat equations in n dimensions.

5. Mike McCausland, April 2005
   Title: Solitons.

6. Adam Profetto, April 2008
   Title: Vector soliton equations.

7. Steve MacNaughton, April 2008
   Title: Symmetries and conservation laws of a radial KdV equation.

8. Marc Skarzinskas, April 2008
   Title: Exact solutions of a radial KdV equation.

9. Mark Willoughby, April 2009
   Title: Hirota's Bilinear Method and Maple Animations of Vector Solitons.

10. Ahmed Ahmed, August 2010
    Title: Complex mKdV and NLS soliton equations.

11. Sarah Bax, June 2014
    Title: Interactions of oscillatory solitons

12. Jordan Fazio, June 2016
    Title: Conserved quantities for orbits in Schwarschild space-time

13. Jordan Fazio, September 2016
    Title: Conserved vectors for orbits in Schwarschild space-time

NSERC Summer Undergraduate Research (USRA)

1. Andrew Copfer, May-August 2002
   Title: Blow-up solutions of radial nonlinear wave equations.

2. Andrae Blanchard, May-August 2007
   Title: Exact solutions of chiral fields coupled to gravity.

3. Michel Grenier, May-August 2011
   Title: Quasi-local mass/energy in General Relativity.

4. Sarah Bax, May-August 2014
   Title: Interactions of oscillatory solitons.

Brock Undergraduate Research Awards (BUSRA)

1. Mike McCausland, January-August 2005
   Title: Soliton solutions of a nonlinear wave system in mathematical physics.

2. Steve Roach, May-July 2005
   Title: Study of solutions of nonlinear Schrodinger equations in n dimensions.

3. Andrew Stewart, June-August 2005
   Title: Black hole solutions of gravity coupled to nonlinear fields.

4. Adam Profetto, September-November 2007
   Title: Analysis of Fourier approximations of multidimensional functions.

Brock Match of Minds awards

1. Jordan Fazio, May-August 2016
   Title: Conserved vectors for orbits in Schwarschild space-time

Brock Experience Works/Plus

1. Stefan Larass, September 2002-April 2003

2. Gary Fekete, May 2003-August 2003

   These two students developed interactive Maplets for animations of initial-value solutions of the heat equation with various boundary conditions.

3. Elias Mkoba, January 2004-April 2004

   This student started the preliminary development of a Maplet for animating single and multi solitons for a water wave equation.

4. Jennifer Vigliotta, September 2006-March 2007

   This student assisted in editing my MICA 3F40 lecture notes in preparation for a new textbook to be based on Math 3F40&3P09.

5. Steve MacNaughton, September 2007-April 2008

   This student worked as a research assistant on symmetry analysis of a radial nonlinear wave equation.

6. Mark Willoughby, September 2008-April 2009

   This student helped with improving the Maplets used in the computer lab for Math 3F40 and also worked on adding new soliton animations to a webpage for Math 4P09/5P09.

External Supervisions

M.Sc. Thesis

1. Dennis The, August 2003
   Department of Mathematics, University of British Columbia
   (co-supervised with Prof. G. Bluman)
   Thesis title: Nonlocal symmetries and nonlocal conservation laws of Maxwell's equations in four-dimensional Minkowski space.
2. Kseniya Imamutdinova, May 2014
   Ufa State Technical University, Laboratory "Group analysis of mathematical models in natural and engineering sciences" (Russian)
   (co-supervised with Prof. R. Gazizov and Prof. N. Imbragimov)
   Thesis title: Conservation laws of Monge-Ampere equation.
3. Elena Karimova, August 2015
   Ufa State Technical University, Laboratory "Group analysis of mathematical models in natural and engineering sciences" (Russian)
   (co-supervised with Prof. R. Gazizov and Prof. N. Imbragimov)
   Thesis title: Exact solutions of gasdynamics equations obtained by the method of conservation laws.

Ph.D. Thesis

1. Amanullah Dar, December 2010
   Department of Mathematics, Quaid-e-Azam University (Pakistan)
   Thesis title: Conservation laws and Hamiltonian symmetries of compressible Euler equations in $n > 1$ spatial dimensions.
2. Zuhal Kucukarslan Yuzbasi, September 2014
   Department of Mathematics, Firat University (Turkey)
   (co-supervised with Prof. M. Bektas)
   Thesis title: Geometric null curve flows and integrable systems in Lorentz space.
3. Liaisan Galiakberova, October 2015
   Ufa State Technical University, Laboratory "Group analysis of mathematical models in natural and engineering sciences" (Russia)
   (co-supervised with Prof. R. Gazizov and Prof. N. Imbragimov)
   Thesis title: Algorithms of theory of approximate transformation groups of differential equations and their use in the study of wave equations.

4. Aliya Gainetdinova, October 2015
   Ufa State Technical University, Laboratory "Group analysis of mathematical models in natural and engineering sciences" (Russia)
   (co-supervised with Prof. R. Gazizov and Prof. N. Imbragimov)
   Thesis title: Symmetry properties and integrability of systems of second-order ODEs.
5. Elena Recio, October 2017
   University of Cadiz, Department of Mathematics (Spain)
   (co-supervised with Prof. M.L. Gandarias and Prof. M. Bruzon)
   Thesis title: Peakon equations.

Ph.D. Research

1. Wei Feng
   Visiting PhD student, September 2011 to August 2012
   Department of Mathematics, Northwest University (China)
   Research area: Symmetry analysis and exact solutions of semilinear Schrodinger equations.
2. Songlin Zhao
   Visiting PhD student, March 2011 to August 2012
   Department of Mathematics, Shanghai University (China)
   Research area: Curve flows and integrable systems in Grassmannians.
3. Nazim Tufail
   Visiting PhD student, September 2011 to August 2012
   Department of Mathematics, Quaid-e-Azam University (Pakistan)
   Research area: Conservation laws of fluid flow in Riemannian manifolds.
4. Zuhal Kucukarslan
   Visiting PhD student, September 2012 to August 2013
   Department of Mathematics, Faculty of Science, Firat University (Turkey)
   Research area: Geometric curve flows.

Postdoctoral Supervisions

Postdocs

1. Natalyia Ivanova (PhD, NAS Mathematics Institute, Kyiv, Ukraine)
   Joint supervision with Prof. G. Bluman, Department of Mathematics, UBC
   September 2005 to September 2006
2. Esmaeel Asadi (PhD, Vrije Universiteit, Amsterdam, The Netherlands)
   June 2008 to May 2009 & August 2010 to September 2010
3. Sajid Ali (PhD, National University of Sciences and Technology, Pakistan)
   February 2009 to August 2011

4. Ali Mahdipour (PhD, School of Mathematics, Iran University of Science and Technology, Tehran, Iran)
   February 2011 to April 2011 & June 2011 to August 2011

5. Georgios Papadopoulos (PhD, Natural Sciences, National and Kapodistrian University of Athens, Greece)
   October 2014 to August 2015

6. Daniel Kraus (PhD, University at Buffalo, USA)
   August 2016 to June 2017

7. Huijun He (PhD, Sun Yat-sen University, China)
   November 2017 to present

Research Associates

1. Jing Ping Wang (PhD, Vrije Universiteit, Amsterdam, The Netherlands)
   Joint supervision with Prof. T. Wolf
   January 2002 to May 2003

CURRICULUM VITAE

Name: Ben-El-Mechaiekh, Hichem

Current Position: Professor of Mathematics

Current Address: Department of Mathematics and Statistics
Brock University
1812 Sir Isaac Brock Way
Saint Catharines, Ontario
L2S 3A1 CANADA

Office: +1 905 688 5550
Telephone: Ext 3758
E-mail: hmechaie@brocku.ca

A. FORMAL EDUCATION

Institution	Degree	Year	Major
Univ. de Montréal	B.Sc.	1980	Mathematics
Univ. de Montréal	M. Sc.	1982	Mathematics
Univ. de Montréal	Ph. D.	1988	Mathematics

B. PROFESSIONAL DEVELOPMENT

Certificate in University Management, Center for Higher Education Research and Development, organized by The University of Manitoba, Banff Center, Alberta, May 13-20, 2011.

C. PAST POSITIONS HELD

Full Professor
July 1997-Present
Department of Mathematics and Statistics, Brock University
St Catharines, Ontario, Canada

Associate Dean (Undergraduate Programs)

July 2014-June 2017
July 2010-June 2013
Faculty of Mathematics and Science, Brock University
St Catharines, Ontario, Canada
Department Chair
July 2003-June 2009
July 1999-June 2000
Department of Mathematics, Brock University
St Catharines, Ontario, Canada

Associate Professor
July 1992-June 1997
Department of Mathematics, Brock University
St Catharines, Ontario, Canada

Assistant Professor (tenure-track)
July 1988-June 1992
Department of Mathematics, Brock University
St Catharines, Ontario, Canada

Invited Professor
August 2002-June 2003
Basic Sciences Department
College of Arts and Science, University of Sharjah, UAE

Professor of Mathematics
September 1997-July 1999, August 2000-July 2002
Department of Computer Science, Mathematics, and Statistics
College of Arts and Science, American University of Sharjah, UAE

Founding Professor of Mathematics
Department Chair (2000-2001)
September 1997-July 1999, August 2002-June 2003
Department of Mathematics
College of Arts and Science, University of Sharjah, UAE

Professor of Mathematics
June 1995
UFR 27 Mathématiques et Informatique
Université Paris I, Panthéon-Sorbonne

Paris, France

Visiting Assistant Professor

July 1987-July 1988
Department of Applied Mathematics, Technical
University of Nova Scotia, Halifax, Canada

Senior lecturer
September 1983-December 1983 and September 1984-May
1987, Département de Mathématiques et de Statistique,
Université de Montréal, Canada

Teaching Assistant
September 1980-May 1987
Département de Mathématiques et de Statistique, Université de
Montréal, Canada

9)

Research Assistant
April 1987-June 1987
January 1983-June 1983
June 1982 to September 1982
Département de Mathématiques et de Statistique, Université de Montréal, Canada
Fields: Fixed point Theory and Convex Analysis
Supervisor: Prof. A. Granas

D. COMMITTEE MEMBERSHIPS AND UNIVERSITY SERVICE

- 2018/08-Present: University Space Committee, Co-Chair
- 2018-Present: Faculty of Mathematics and Science Space Coordinator
- 2014/10 - 2016/11: Committee Member, Scientific Committee: 3rd International Conference on Mathematical Sciences and their Applications: ICEOMFE 2015, November 2015, King Saud University Organize scientific program. Edit proceedings of the conference. (https:// npst.ksu.edu.sa/en/iceomfe/committees)
- 2014/12 - 2015/12: Committee Member, Strategic Enrollment Management Plan, Brock University
- 2014/1 - 2015/4: Committee Member, Brock University Senate Committee on Review and Prioritization of Academic Programs.

- 2016-Present – Chair, BSc Data Science and Analytics New Program Committee.
-
-

- **Service at Brock University**
-
- *As Associate Dean, Undergraduate Programs:*
-
  - Chair of the Faculty of Mathematics and Science Recruitment and Retention Committee and Undergraduate programs Committee, Coordinator for Recruitment at Fall and Winter Previews, Open Houses, and Ontario University Fairs.
  - Representative of the faculty at various university committees (e.g., University Academic Council, Member Elect of the Senate Academic Reviews Committee, National Survey of Student Engagement Committee, University Academic Integrity Committee, etc.).
  - October 2015-Present: University Retention and Progression Committee (Mandate: Establish long term university-wide retention and progression strategies and initiatives.)
  - *As Departmental Chair, 2003-2009 and 1999-2000:*
  - Member of the Dean's Council, member on various departmental, university and faculty committees.
  - Chair of the Departmental Search Committee (1999-2000).
  - Member of the Departmental Program Task Force.
  - Member of the Department's Mathematical Analysis Review Committee
  - (1992-97).
  - Member of the Faculty Graduate Studies and Scholarships Committee (1991-97).
  - Member of President's Research Fund Committee (1995-97).
  - Department of Mathematics Colloquium Talks coordinator (1989-96).
  - Department of Mathematics Equipment Committee (1991-95).
  - Mathematical Analysis Seminar coordinator (1993-97).
  - Dean's representative at various theses' defenses.

- Department of Mathematics library officer (1989-1991).
-

- **Service at the University of Sharjah** (August 2002-June 2003)
  -
  - Founder of the Annual UAE Mathematics Day (May 2003)
  - Chair of the Departmental Search Committee
  - Chair of the College of Arts and Sciences Research and Conferences Committee
  - Chair of the Departmental Promotion Committee
  - Chair of the Departmental Seminar Committee
  - Member of the College Committee for the Evaluation of Chairs and Directors
  - Member of the Chancellor's Committee and Sub-Committee for Drafting the Mission and Vision Statement for the University of Sharjah
  -

- **Service at the American University of Sharjah**
  -
  - Founding member of the Department of Mathematics, Statistics and Computer Science, Department Chair and Member of the Chairs' Council from August 2000 to July 2001.
  - Chair of an ad-hoc committee for promotion in the School of Engineering (2000)
  - Member of the College Theme Course Committee
  - Member and Marshall at the Honors Convocation (1998 and 2000)
  - Chair of the New Faculty Orientation Committee (1998)
  - Chair of the Search Committee for Computer Science, Mathematics, and Statistics (2000-01 and 1998-99)
  -

E. EDITORIAL ACTIVITIES

-

- 2016-Present, Associate Editor, Journal of Nonlinear and Variational Analysis
- 2013/4 - Present Associate Editor, Palestinian Journal of Mathematics, Journal
- 2012/2 – Present, Associate Editor, Journal of Fixed Point Theory (Working Group on Nonlinear Analysis and Computation)
- 2011/12 - Present Associate Editor, Advances in Fixed Point Theory
- 2011/7 - Present Associate Editor, Arabian Journal of Mathematics, SpringerOpen
- 2007/6 - Present Associate Editor, Journal of Fixed Point Theory and Applications, Springer

- 2013/6 - 2014/4 Associate Editor, Abstract and Applied Analysis, Special Issue on Recent Contributions to Fixed Point Theory and Its Applications
- 2008/3 - 2014/1 Associate Editor, Fixed Point Theory and Applications, Springer
- 2007/1 - 2009/1 Guest Associate Managing Editor, Journal of Fixed Point Theory and Applications, Albrecht Dold and Edward Fadell Festschrift Volume

F. ORGANIZATIONAL REVIEW ACTIVITIES

(Sample)

On-going Reviewer

- Various Journals and Publications Reviewer of research articles, chapters, and monographs (periodicals and series of the AMS, J. Math Anal. Appli., Nonlinear Anal. Thy. Meth. Appl., Fixd Point Thy. Appli., J. Fixed Point Thy. Appl., etc.)2014-05-01 - Present

- Reviewer, *Mathematical Reviews - American Mathematical Society*
- 2012-07-29 - 2013-09-06
- External Reviewer, *Portuguese Foundation for Science and Technology Evaluation of 3 applications for research funding*.
- 2009-01-01 - 2017-12-31
- External ReviewerPakistan Evaluation and recommendation for 6 PhD theses (Qaid U Azam University, Islamabad; Institute of Information and technology, Islamabad; Lahore University of Management Science, etc.)
- 2014-01-01 - 2014-05-30
- External Reviewer, Pakistan Assessment and recommendation for applications for promotion to the rank of full professor (University of Management and Technology, Lahore, Pakistan)
- 2011-07-29 - 2013-09-06
- External Reviewer, Portugal Review, assessment and recommendation on three applications for research grants projects for teams.
- 2013-10-01 - 2013-01-25
- External Reviewer, Saudi Arabia Assessment and recommendation for an application for promotion to the rank of full professor (King Abdulaziz University, Jeddah, KSA)
- 2010-11 – 2011-12

- Reviewer of BBA and MBA Courses Files, Canadian University of Dubai
- 2009
- Reviewer for 2 Calculus and Analysis textbooks' for McGraw-Hill Inc. (2009).
- 2005
- Referee for research grants applications to the Natural Sciences and Engineering Research Council of Canada

G. STUDENT SUPERVISION

Bachelor's Honours

8 BSc Honours theses (Brock University), including in the past 5 years:

2011/9 - 2012/5

Amber Shelton (Completed), Brock University Thesis/Project Title: *Computing economic equilibria*

Master of Science Co-Supervision

2009/9 - 2014/12

Allan Walsh (Completed), Co-supervision with Thomas Wolf, Brock University Thesis/Project Title: *Caribou Math Contest: An Analysis of Success Rates by Subject Mathematics Strands and Difficulty*

2008/9 - 2010/11

Sama Malekan (Completed), Co-supervision with Babak Farzad, Brock University Thesis/Project Title*: On Game Theory: From Fundamentals to Application to On-Line Auctions*

Doctorate-Co-Supervision

1995-1997

Souheil Chebbi (Completed), Co-supervision with Monique Florenzano, Université Paris 1 Panthéon-La Sorbonne, France, Thesis Title: *Théorie du point fixe dans les cas non-convexe et non-compact. Applications en théorie des jeux et en économie mathématique*.

1993-95

Jean Forogbe Tounkara (Completed), Co-supervision with Mohamed Oudadess, Ecole Normale Supérieure de Rabat, Thesis

Title: Points fixes pour les Muti-applications dans les espaces uniformes

- **Postdoctorate**
- 2013/4 - 2014/3
- Asma Rashid Butt (Completed), Brock University Thesis/Project Title: *Solvability of Nonlinear Functional Equations*

H. RESEARCH ACTIVITIES

1. Publications Appeared in Print

- **a) Books and Chapter Contributed to Refereed Books**

1. H. Ben-El-Mechaiekh, *Approximations and selections methods for set-valued maps and fixed point theory*, in Fixed Point Theory, Variational Analysis, and Optimization, S. A. R. Al-Mezel, R. A. M. Al-Solamy and Q. H. Ansari Eds., Taylor and Francis (2014) 77-138.
2. Mohammed A. Khamsi, Hichem Ben-El-Mechaiekh, and Bernd Schroeder, Guest Editors, *Recent Contributions to Fixed Point Theory and Its Applications,* Abstract and Applied Analysis, Volume 2014, Hindawi Publishing Corp., 2014.
3. H. Ben-El-Mechaiekh, *Some fundamental topological fixed point theorems for set-valued maps,* in Topics in Fixed Point Theory, S. A. R. Al-Mezel, Q. H. Ansari and M. A. Khamsi Eds., Springer (2014) 245-282.
4. H. Ben-El-Mechaiekh, *Intersection and Fixed Point Theorems in Set-Valued Analysis,* in Topics in Nonlinear Analysis, Q. H. Ansari ed., World Education (2011) 159-183.
5. Ben-El-Mechaiekh Hichem and Robert Dimand, "Mathematical economics," in William A. Darity, Jr., ed., *International Encyclopedia of the Social Sciences*, 2nd. edition, Detroit: Macmillan Reference, 2008.
6. H. Ben-El-Mechaiekh and G. Isac, *Generalized multivalued variational inequalities,* in Topology and Analysis, C. Andreian-Cazacu, O. Letho and T.M. Rassias, Eds., World Scientific Publishing Co. (1998), 115-142.

- **b) Articles in Refereed Journals**

7. Hichem Ben-El-Mechaiekh and Robert R. Dimand, *Louis Bachelier's 1938 monograph on the calculus of speculation: Mathematical finance and randomness of asset prices in*

Bachelier's later work, Revue d'Histoire des Mathématiques, Société Mathématique de France, (24), fascicule 1 (2018), 1-39.

8. M. Abdul Latif and Hichem Ben-El-Mechaiekh, *Topological Fixed Point Theory and Applications to Variational Inequalities,* Fixed Point Theory and Applications (85), 1-26, 2015.
9. Hichem Ben-El-Mechaiekh, *Intersection Theorems for Closed Convex Sets and Applications,* Missouri J. Math. Sc., Volume 17, Issue 1 (2015), 47-63.
10. H. Ben-El-Mechaiekh, *The Ran-Reurings Fixed Point Theorem Without Partial Order: A Simple Proof,* J. Fixed Point Theory and Applications, Springer Basel, 16 (1-2), 373-383 (2015), DOI 10.1007/s11784-015-0218-3.
11. H. Ben-El-Mechaiekh, *On the Convex Hull of Closed Convex Sets in Locally Convex Spaces,* British J. Math & Comp. Sc. 4 (2014) 1351-1355.
12. H. Ben-El-Mechaiekh and F. B. Saidi, *On the Continuous Approximation of Upper Semicontinuous Set-Valued Maps,* Questions & Answers in General Topology 31 (2013) 71-78.
13. H. Ben-El-Mechaiekh, *On Nonlinear Inclusions in non-Smooth Domains,* Arabian J. Math. **1** No. 4 (2012) 395-416.
14. Hichem Ben-El-Mechaiekh and Robert Dimand*, How General Equilibrium Came to North America: Irving Fisher's Mathematical Investigations in the Theory of Value and Prices (1891),* Journal of Economic and Social Measurement, **37** (2012) 97-118.

16. H. Ben-El-Mechaiekh and R. Dimand*, A Simpler Proof of the von Neumann Minimax theorem,* American Mathematical Monthly **118** (2011), 636-641.
17. H. Ben-El-Mechaiekh and R. Dimand*, Von Neumann, Ville, and the Minimax Theorem*, International Game Theory Review **12** No. 2 (2010), 1-23.
18. H. Ben-El-Mechaiekh, P. Bich, and M. Florenzano, *General equilibrium and fixed point theory: a partial survey*, Journal of Fixed Point Theory and Application **6** (2009) 207-226.
19. H. Ben-El-Mechaiekh, *Equilibria for Set-valued Maps on Nonsmooth Domains,* J. Fixed Point Theory and Applications **4** (2008) 177-182.
20. H. Ben-El-Mechaiekh, *Strong Approximation for Nonconvex Set-valued Maps,* J. of Nonlinear and Convex Analysis **9** (2008) 65-70.

21. H. Ben-El-Mechaiekh and R. Dimand, *The von Neumann Minimax Principle Revisited,* Fixed Point Theory and Its Applications, Banach Center Publications, Vol. **77**, Inst. of Mathematics, Polish Academy of Sciences (2007) 23-34.

22. R. Dimand and H. Ben-El-Mechaiekh, *Louis Bachelier,* in Geoffrey Poitras Ed., Pioneers of Financial Economics, Volume 1: Contributions Prior to Irving Fisher, Cheltenham, U.K.,and Northampton, maine: Edward Elgar Publishing, 225-237 (2006).

23. H. Ben-El-Mechaiekh, *The Ky Fan Fixed Point Theorem on Star-Shaped Domains*, Math. Reports. Acad. Sc. Canada, **27** (4) (2005) 97-100.

24. H. Ben-El-Mechaiekh, S. Chebbi, M. Florenzano, *A generalized KKMF Principle and Applications,* J. Math. Anal. Appl **309** (2005) 583-590.

25. H. Ben-El-Mechaiekh, *Spaces and Maps Approximations and Fixed Points,* Special issue on Fixed Point Theory and Applications, Journal of Computational and Applied Mathematics **113** (2000) 283-308.

26. H. Ben-El-Mechaiekh, S. Chebbi and M. Florenzano, A *nonlinear alternative for approximable maps: a simple proof,* Proceedings of the American Math. Soc. **126** (1998) 2345-2349.

27. H. Ben-El-Mechaiekh, S. Chebbi, M. Florenzano and J-V. Llinares, *Abstract convexity and fixed points,* Journal of Math. Analysis and Applications **222** (1998) 138-150.

28. H. Ben-El-Mechaiekh and G. Isac, *Some geometric solvability theorems in topological vector spaces,* Bulletin of the Korean Math. Soc. **34** (1997), 273-285.

29. H. Ben-El-Mechaiekh and W. Kryszewski, *Equilibria for set-valued maps on nonconvex domains,* Transactions of the American Math. Soc. **349** (1997) 4159-4179.

30. H. Ben-El-Mechaiekh and W. Kryszewski, *Equilibria for perturbations of upper semicontinuous set-valued maps by convex processes,* Georgian Journal of Math. **3** (1996) 201-215.

31. H. Ben-El-Mechaiekh and A. Idzik, *Ky Fan type coincidence theorems I,* Bulletin of the Polish Academy of Science **122** (1994) 105-109.

32. H. Ben-El-Mechaiekh and W. Kryszewski, *Equilibres dans les ensembles non-convexes,* Comptes Rendus de l'Académie des Sciences de Paris **320**, Série 1 (1995) 573-576.

33. H. Ben-El-Mechaiekh and M. Oudadess, *Some selection theorems without convexity,* Journal of Math. Analysis and Applications **195** (1995) 614-618.

34. H. Ben-El-Mechaiekh and P. Deguire, *Equilibrium for abstract nonconvex games,* Mathematical Reports of the Academy of Science of Canada **XVII** (1995) 1-6.

35. H. Ben-El-Mechaiekh and G. Isac, *A general variational inequality with application,* Mathematical Reports of the Academy of Science of Canada **XVII** (1994) 235-240.

36. H. Ben-El-Mechaiekh and A. ldzik, A *Leray-Schauder theorem for approximable set-valued maps,* Proceedings of the American Mathematical Society **122** (1994) 105-109.

37. H. Ben-El-Mechaiekh, *Fixed points for compact set-valued maps,* Questions and Answers in General Topology **10** (1992) 153-156.

38. H. Ben-El-Mechaiekh and P. Deguire, *Approachability and fixed points for nonconvex set-valued maps,* Journal of Mathematical Analysis and Applications **17 0** (1992) 477-500.

39. H. Ben-El-Mechaiekh, *General fixed point and coincidence theorems for set-valued maps,* Mathematical Reports of the Academy of Science of Canada **XIII** (1991) 237-242.

40. H. Ben-El-Mechaickh and P. Deguire, *Approximation of non-convex set-valued maps* Comptes Rendus de l'Académie des Sciences de Paris **312** Série 1 (1991) 379-384.

41. H. Ben-El-Mechaiekh and P. Deguire ,*General fixed point theorems for non-convex set-valued maps,* Comptes Rendus de l'Académie des Sciences de Paris **312** Série 1 (1991) 433-438.

42. H. Ben-El-Mechaiekh, *The coincidence problem for compositions of set-valued maps* Bulletin of the Australian Math. Society **41** (1990) 421-434.

43. H. Ben-El-Mechaiekh, *Zeros for set-valued maps with non-compact domains,* Mathematical Reports of the Academy of Science of Canada **XII** (1990) 125-130.

44. H. Ben-El-Mechaiekh, *A remark concerning a matching theorem of Ky Fan,* Chinese Journal of Mathematics **17** (1989), 309-314.

45. H. Ben-El-Mechaiekh, *Fixed points for compositions of set-valued maps,* Extracta Mathematicae **4** (1989), 93-95.

46. H. Ben-El-Mechaiekh, P. Deguire, and A. Granas, *Points fixes et coincidences pour les applications multivoques III. Applications M et M* , C*omptes Rendus de l'Académie des Sciences de Paris **305** Série 1 (1987) 381-384.

47. H. Ben-El-Mechaiekh, P. Deguire, and A. Granas, *Points fixes et coincidences pour les applications multivoques II. Applications de type Φ et Φ* ,* Comptes Rendus de l'Académie des Sciences de Paris **295** Série 1 (1982) 381-384.

48. H. Ben-El-Mechaiekh, P. Deguire, and A. Granas, *Points fixes et coincidences pour les applications multivoques I.- Applications de Ky Fan,* Comptes Rendus de l'Académie des Sciences de Paris **295** Série 1 (1982) 337-340.

49. H. Ben-EI-Mechaiekh, P. Deguire, and A. Granas, *Une alternative non-linéaire en analyse convexe et applications,* Comptes Rendus de l'Académie des Sciences de Paris **295**, Série 1 (1982) 257-259.

c) Refereed Conference Proceedings

50. H. Ben-El-Mechaiekh, *On the solvability of nonlinear inclusions in infinite dimensions,* in Yeol Je Cho (Ed.), Proceedings of the International Conference on Mathematical Analysis and Applications, 1-A (2000), 69-89.

51. H. Ben-El-Mechaiekh, *Fixed points for set-valued maps: a topological approach,* in Wataru Takahashi and Tamaki Tanaka (Eds.), Nonlinear Analysis and Convex Analysis, Proceedings of the International Conference, Niigata University and The Tokyo Institute of Technology, (1999), 118-125.

52. H. Ben-El-Mechaiekh and W. Kryszewski, *Equilibria for set-valued maps without compactness or convexity,* Proceedings of the "Troisième Colloque de la Société Tunisienne de Mathématiques", Hammamet, Tunisia, April 1995.

53. H. Ben-El-Mechaiekh, *Continuous approximation o set-valued maps, fixed points and coincidences,* Proceedings of the Second International Conference on Approximation and Optimization, Havana University, September 1993, M. Florenzano *et al.* Eds., Peter Lang Verlag, Frankfurt, 1995, 69-97.

54. H. Ben-El-Mechaiekh, M. Oudadess and J. Tounkara, *Approximation of multifunctions on uniform spaces and fixed points,* in Topological Vector Spaces, Algebras and Related Areas, A.T-L. Lau and I. Tweddle, Eds., Pitman Research Notes in Mathematics Series, 316, Longman, New York, 1994, 239-250.

55. H. Ben-El-Mechaiekh, *Note On a class of set-valued maps having continuous selections,* Fixed Point Theory and Applications, M.A. Théra. and J.B. Baillon Eds, Proceedings of the "Colloque International sur la Théorie du Point Fixe et Applications", France, 1989, Pitman Research Notes in Math. Series, 252, 1991, 33-43.

d) Selected Research Reports

• H. Ben-El-Mechaiekh, *Continuous approximations of set-valued maps and fixed points,* Rapport de Recherche du Centre de Recherches Mathématiques 1820, Université de Montréal, 1992, 46 pages.
•
• H. Ben-El-Mechaiekh, *A remark concerning a matching theorem of Ky Fan,*
• Publications Mathématiques, Ecole Normale Supérieure de Rabat, 1989, (reviewed by Zentralblatt fur Mat.), 5 pages.
•
• H. Ben-El-Mechaiekh, *The coincidence problem for compositions of set-valued maps* Publications Mathématiques, Ecole Normale Supérieure de Rabat, 1989, (reviewed by Zentralblatt fur Mat.), 10 pages.
•
• H. Ben-El-Mechaiekh, *Principes Topologiques en Analyse Convexe, Partie I. Résultats Géométriques,* Université de Montréal, 1988, 50 pages.
•
• H. Ben-El-Mechaiekh, *Principes Topologiques en Analyse Convexe, Partie II. Formulations Analytiques, Théorèmes de Minimax et Inégalités*
• *Variationnelles,* Université de Montréal, 1988, 40 pages.
•
• H. Ben-El-Mechaiekh and P. Deguire, *Approximation and fixed points for non-convex set-valued maps,* Rapport de recherche Math- 17, Université de Moncton, 1990, 40 pages.

- H. Ben-El-Mechaiekh, P. Deguire, and A. Granas, *Analyse Fonctionnelle Non-Linéaire: Points Fixes et Coincidences pour les Applications Multivoques, Parties I &II,* Université de Montréal, 1982, 20 pages.
- H. Ben-El-Mechaiekh, P. Deguire, and A. Granas*, Une Alternative Non-Linéaire en Analyse Convexe,* Université de Montréal, 1982,7 pages.

e) Theses

- H. Ben-El-Mechaiekh, Quelques Principes Topologiques en Analyse Convexe, PhD Thesis, Université de Montréal, 1987.
- H. Ben-El-Mechaiekh, Points Fixes et Coincidences pour les Applications Multivoques, M.Sc. Thesis, Université de Montréal, 1982.

f) Other

(i) Redaction of Lecture Notes:

- Méthodes Topologiques en Analyse Convexe by A. Granas, NATO Advanced Studies Institute, Séminaire de Mathématiques Supérieures, Presses de l'Université de Montréal, 1990.

(ii) Translation

- Translation from English into French of "Non-linear Boundary Value Problems for Certain Classes of Ordinary Differential Equations", by R.B. Guenther, NATO Advanced Studies Institute, Séminaires de Mathématiques Supérieures, Presses de I'Université de Montréal, 1985.

2. Selected Presentations

a) Selected Invited Talks

- *Generalized Variational Inequalities Without Convexity,* Modern Methods, problems and Applications of Operator Theory and Harmonic Analysis, OTHA 2018, Rostov-on-Don, Russia, April 22-27, 2018.
- *Fixed Points for Set-Valued maps and General Systems of Inequalities Without Convexity,* Workshop on Analysis and Its Applications, American University of Sharjah, October 14, 2017
- *Approximation Methods in Topological Fixed Point and Equilibrium Theory,*

- Equilibrium and Optimization Methodology in Finance and Economics, King Saud University, Riyadh, KSA, November 9-11, 2015.
- *Systems of nonlinear inequalities without convexity: a topological fixed point approach.* 2015 Canadian Mathematical Society Summer Meeting, Charlottetown, Canada.
- *Topological fixed point theorems and constrained nonlinear inequalities,* The 4th International Workshop on Fixed Point Theory and Applications, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, 2015.
- *Panel Discussion: What is the mathematics we 'should' teach and the pedagogy we 'should' use in this 21st Century?* 2014 Canadian Mathematical Society Winter Meeting. Undergraduate Mathematics Education in 21st Century: Rethinking Curriculum, Hamilton, Canada.
- *Approximations of set-valued maps and topological fixed point theorems.*
- Analysis, Topology and Applications 2014, Vrnjacka Banja, Serbia.
- *General solvability theorems for nonlinear inclusions without convexity.*
- Nonlinear Analysis and PDEs Seminar, Tunis, Tunisia. 2014.
- *Continuous Approximations and selections for Set-Valued Maps and Applications,* Main Speaker, Third Mathematics Day, King Abdulaziz University, Jeddah, March 20, 2013.
- *Selections and Approximate Selections for Multimaps and Fixed Points*, Main Speaker, International Workshop on Nonlinear Analysis and Optimization, University of Tabuk, Tabuk, March 18-19, 2013.
- *Approximation Methods in Set-Valued Fixed Point Theory,* Main Speaker, KFUPM 50th
- Anniversary Workshop On Nonlinear Analysis and Fixed Point Theory, King Fahd University of Petroleum and Minerals, Dhahran, December 31, 2012.
- *Zeroes and Fixed Points for a Class of Approximable Set-Valued Maps,* Main Speaker, International Conference on the Theory, Methods and Applications of Nonlinear Equations, Texas A&M University Kingsville, December 17-21, 2012.
- *The Poincaré IVT on Nonsmooth Domains,* Plenary Lecture, 10th UAE Mathematics Day, American University of Sharjah, UAE, April 14, 2012.
- *Zeros for Set-Valued Maps on Nonconvex Domains,* Invited address, International Conference on Analysis and its Applications, Aligarh Muslim University, India, November 19-21, 2011.

- *Equilibria for set-valued maps without convexity,* One hour invited lecture, WCNA 2008 (World Congress of Nonlinear Analysts 2008), Orlando, Florida, July 2-9 2008.
-
- Organizer of a Special Session on *Fixed Point Theory and Applications*, WCNA 2008, Orlando, Florida, July 2-9 2008
-
- *Strong Approximation for set-valued maps and equilibria without convexity,*
- ICNODEA 2007 (International Conference on Nonlinear Operators, Differential Equations and Applications), Babes-Bolyai University, Romania, July 4-8 2007.

-
- *Louis Bachelier's 1938 Volume on the Calculus of Speclation: Efficient Markets and Mathematical Finance in Bachelier's Later Work*, joint session of the American Finance Association and the History of Economics Society at the Allied Social Science Associations annual conference, New Orleans, January 2008 (joint work with Robert Dimand; presented by R. Dimand).
-
- *General Equilibrium Reaches North America: Irving Fisher's Mathematical Investigations in the Theory of Value and Prices (1891),* Conference on "General Equilibrium as Knowledge," Université de Paris I (Panthéon-Sorbonne), September 2007, (joint work with Robert Dimand; presented by R. Dimand).
-
- *The von-Neumann-Sion Minimax Theorem: A Circular Tour,* Gilles Fournier Memorial Conference on Classical and Computational Topological Methods, Bishop's University, September 22-24, 2006.
-
- *On The Solvability of Nonlinear Equations,* Ryerson University Seminar Series in Mathematics, March 15, 2007
-
- *Zeros for set-valued maps on non smooth domains,* McMaster School of Computational Engineering and Science, May 1, 2006.
-
- *Some Remarks on the von Neumann MinimaxTheorem,* International Conference on Fixed Point Theory and Applications, Bedlewo, Poland, August 2005.
-
- *Spaces and Maps Approximations*, Third Congress of Nonlinear Analysis, Catania, Italy, July 2000.
-
- *Solvability of nonlinear problems with nonconvex constraints,* Edmonton Workshop on Methods of Nonlinear Analysis, University of Alberta, Edmonton, August 16-20, 1999.
-
- *Recent developments in fixed point theory for set-valued maps,* International Conference on Mathematical Analysis and Applications, Gyeongsang National University, Korea, August 3-4, 1998.
-
- *Fixed points theory on non-smooth retracts,* Conference on Nonlinear Analysis and Convex Analysis 98, Niigata University and The Tokyo Institute of Technology, July 28-31, 1998.
-
- *Non convex methods in optimization,* International conference in nonlinear analysis, Detroit, June 1997.

- *Equilibria in nonconvex sets,* Meeting of the American Math. Society, Wayne State University, Detroit, May 1997.
- *Existence result for set-valued maps and optimization problems: the nonconvex case,* International Conference on Functional Analysis with Applications, Aligarh Muslim University, Aligarh, India, December 1996.
- *Fixed points and equilibria for set-valued maps without convexity,* Second International Congress in Nonlinear Analysis, University of Athens, Athens, Greece, July 1996.
- *Existence theorems in Lipschitzian retracts,* Workshop on Convex Analysis, Université de Montréal, Montréal, Canada, September 28 - October 1, 1995.
- *Equilibres pour les applications multivoques sans convexité,* Troisième Colloque de la Société Tunisienne de Mathématiques, Hammamet, Tunisia, April 1995.
- *Some remarks on KKM theorems related to differential inclusions,* NATO Advanced Studies Institute, Université de Montréal, Montréal, Canada, July 1994.
- *Fixed points and equilibria for correspondences,* Workshop on Geometry Topology and Markets, The Fields Institute for Research in Mathematical Sciences, Waterloo, Canada, July 1994.
- *Fixed points for non-convex set-valued maps,* Conference on Topological Methods in Nonlinear Analysis, University Nicholas Copernicus, Bachotek, Poland, September 1990.
- *On the fixed point property for set-valued maps,* Conference on Applicable Analysis, Dalhousie University, Halifax, Canada, August 1990.
- *Note on a class of set-valued maps having continuous selections,* Colloque International sur la Théorie du Point Fixe et Applications, Marseille, June 1989.
- **b) Other Selected Contributions**
- Regular invited lectures at various Analysis seminars and colloquia and numerous contributions at international, national, and regional conferences such as:
- Séminaire d'analyse fonctionelle et d'EDP, Faculté des Sciences de Tunis, May 13, 2014.

- Séminaire d'Optimisation de l'Université Paris 1, Panthéon-La Sorbonne, Paris, France, June 1995.
- Séminaire de Mathématiques, Ecole Normale Supérieure et Faculté des Sciences de Rabat, Rabat, Morocco, April 1995, July 1993.
- Séminaire d'Economie Mathématique, Institut des Hautes Etudes Commerciales de Tunis, March 1995.
- Séminaire de Mathématiques de La Faculté des Sciences de Tunis, Tunis, Tunisia, February 1995, July 1993.
- Colloque des sciences mathématiques du Québec, Collège Militaire Royal de St-Jean, Québec, October 31, 1992.
- An Afternoon in Analysis, Brock University, St. Catharines, December 11, 1992.
- 1st Joint meeting of the American Mathematical Society and the London Mathematical Society, Cambridge, England, June 29-July 1, 1992.
- The Second International Conference on Fixed Point Theory and Applications, Dalhousie University - Mount St. Vincent University, Halifax, June 9-14 1991.
- 90th Ontario Mathematics Meeting, McMaster University, Hamilton,
- February 1991.
- **c) Courses and Seminars Given as Invited Scholar**
- Mini-course: *Intersection and Fixed Point Theorems in Set-Valued Analysis: An Introduction*, Training Programme on Nonlinear Analysis with Applications to Optimization and Game Theory, Aligarh Muslim University and Benaras Hindu University, India, November 16-19, 2011.
- Mini-course: *Théorèmes d'existence sans convexité pour les applications multivoques,* Formation Doctorale, Méthodes Mathématiques en Economie, Université Paris I Panthéon-La Sorbonne, June 1995.
- **3. <u>Fellowships and Grants</u>**
- <u>NSERC Research Operating Grant</u>

- April 1996-March 2000 ($ 26,000; Title: Solvability of Nonlinear Problems Lacking Convexity)

- Research Award of The American University of Sharjah
- January 1999-July 1999 (DHS 10,000, Title: Fixed Point Theory for Set-Valued Maps and Applications)
- NSERC Research Operating Grant
- April 1993-March 1996 ($30,000; Title: Coincidence Theory and Applications to Nonlinear Problems)
- NSERC General Operating Grant
- April 1990-March 1993 ($ 36,000; Title: The Coincidence Problem for Set-Valued Maps and Applications
- Brock Universily NSERC GRG/SUS Grant
- July 1988-July 1989
- Fonds F.C.A.R. pour l'aide et le soutien a la recherche
- Gouvernement du Québec, September 1984-September 1985
- NSERC Doctorate Fellowship
- September 1983-September 1984

5. Other Scholarly Activities

a) Organization of Conferences

- Fixed Point Theory and Applications Session organizer, World Congress of Nonlinear Analysts 2008, Orlando, Florida, July 2-9 2008.
- Founder and Chair of the Organizing Committee, *The 2003 UAE Mathematics Day*, May 8 2003, University of Sharjah (This annual event is in its 9^{th} consecutive year).
- Co-chair of the mathematics education conference for school teachers: *Mathermatics, Life and Enjoyment*, American University of Sharjah, April 4-5, 2001 (1100 participants).

- Initiator and Member of the Organizing Committee of the *Conference in Mathematical Analysis and Applications- CMAA 2001*, American University of Sharjah, May 2-4, 2001.

- Organizer of the workshop *An Afternoon in Analysis*, Brock University, April 2000.
- Organizer of the *88th Ontario Mathematics Meeting*, Brock University, April 1990.
- Organizer of *The International Workshop on Topological Methods in Minimax Theory, Optimization and Differential Equations*, Brock University, April 1990.
- Organizer of the workshop *An Afternoon in Analysis*, Brock University, December 1992.
- Organizer of the workshop *Analysis Day*, Brock University, May 1994.

b) Current International Research Collaborations

- 2013-06-01 - 2017-08-31
  - Co-invesitigator, Saudi Arabia Joint project on "Generalized Variational Inequalities and Applications"
- 2016-07-03 - 2018-10-31
  - Co-investigator, United Arab Emirates Research project on "Nonlinear Inclusions Without Convexity and Applications to Differential Equations" with Dr. Ali Saifi and Dr. Suheil Khoury, American University of Sharjah, UAE

b) Other Evidence of Impact

- Contributions to fixed point theory for set-valued maps and applications to nonlinear analysis are regularly and widely cited by other mathematicians. (e.g., in recent monograph *"Antipodal points and fixed points"* by Jan Jaworowski, William A. Kirk and Sehie Park, some of my contributions are cited among important developments of the theory.)
- Regular invitations from international journals to contribute papers on recent advances in fixed point theory and the solvability of nonlinear problems (I have just accepted an invitation to contribute a paper for a special issue of FPTA in honour of Prof. Art Kirk).
- I was invited to be a permanent member of the Scientific Committee of the International Conference on Mathematical Analysis and Applications, South Korea.

• I. COMMUNITY SERVICE

•

• **Sample Activities**

•

• Director and contributor to annual Mathematics camps (Aboriginal math Camp and Canadian Mathematical Society – Esso - Brock University Camp).

•

• Judge at Regional, National and International Science and Engineering Fairs.

•

• Speaker at the annual secondary school mathematics seminars of the Niagara South Board of Education

•

• Co-chair of the Session on International Implications of Bioenergy, International Conference on Sustainability, Bioenergy, and Conservation, Brock University, August 2005.

•

• Traditional cooking demonstration A Taste of North Africa, Brock University 2007 Wellness Conference, June 20, 2007.

•

• Chair of Orientation for New faculty Committee at the American University of Sharjah, August 1998.

•

• Participant at annual Brock University orientation activities for incoming students

Curriculum Vitae

BUTEAU, Chantal
Full Professor
Department of Mathematics and Statistics, Brock University
1812 Sir Isaac Brock Way
St. Catharines, Ontario
CANADA L2S 3A1

Telephone: +1 905-688-5550 extension 3167
Email: cbuteau@brocku.ca

Place of birth: Lévis, Québec (Canada)
Citizenship: Canadian

Languages: French, English, and German (fluent)

FORMAL EDUCATION

1998 – 2003	Doctorate in Mathematics (**Dr. nat. sc.**), University of Zurich (Switzerland) Thesis title: *A Topological Model of Motivic Structure and Analysis of Music: Theory and Operationalization.* Supervisors: Markus Brodmann and Guerino Mazzola
1995 – 1998	Master in Mathematics (**M.Sc**.), Université Laval (Québec, Canada) Thesis title: *Motivic Topologies and Their Meaning in the Motivic Analysis of Music.* Supervisors: Günter Frei and Guerino Mazzola (University of Zurich)
(1996-1997)	Exchange year at ETH Zurich
1992 – 1995	Bachelor in Mathematics (**B.Sc**), Université Laval (Québec, Canada)
(Winter 1994)	Exchange semester at Scripps College (California, USA)

ACADEMIC POSITIONS HELD

2018	**Full Professor** Brock University, Department of Mathematics and Statistics (St. Catharines, Canada)
2009 – 2018	**Associate Professor** Brock University, Department of Mathematics and Statistics (St. Catharines, Canada)
2015	**Visiting Scholar** (3 months) Universidad de Buenos Aires (Buenos Aires, Argentina)
2004 – 2009	**Assistant Professor** Brock University, Department of Mathematics and Statistics (St. Catharines, Canada)
2008	**Visiting Scholar** (5 months) Institut de Recherche et Coordination Acoustique/Musique (Paris, France)

1998 – 2004 **Teaching Assistant**
ETH Zurich, Department of Mathematics (Zurich, Switzerland)

ACADEMIC DISTINCTIONS AND AWARDS

2000 – 2001 Bourse de Doctorat en recherche (B2) by Fonds pour la formation de chercheurs et l'aide à la recherche (FCAR) – $7,566

1999 – 2001 Postgraduate Scholarship ÉS B by Natural Sciences and Engineering Research Council of Canada (NSERC) – $38,200

1995 – 1997 Bourse de maîtrise en recherche (B1) by Fonds pour la formation de chercheurs et l'aide à la recherche (FCAR) – $22,000

1996 – 1997 Bourse d'échange ETH Zürich/Université Laval by ETH Zurich – $17,250

1992 – 1995 Bourse d'excellence du Canada – $7,000

RESEARCH THEMES

Computational thinking in and for math learning; information and communication technology (ICT) in math learning; post-secondary mathematics education; mathematics training for future mathematics teachers; epistemic mathematics video games; mathematical theory in music (more particularly, topological analysis of the melodic structure of the music).

RESEARCH GRANTS

External

2017-22 **Social Science and Humanities Research Council (SSHRC)**, Insight grant. Project titled *Educating for the 21st Century: post-secondary students learning 'progmatics' (computer programming for mathematical investigation, simulation, and real-world modeling)*. Principal investigator: Buteau. Co-applicant: Joyce Mgombelo (Brock University); and collaborator: Ana Isabel Sacristán (Cinvestav, Mexico). ($**183,981)**

2016-20 **Ontario Ministry of Education**, Knowledge Network for Applied Education Research grant. Project titled *Mathematics Knowledge Network*. Co-directors: George Gadanidis (Ontario Western University) and Donna Kotsopoulos (Wilfrid Laurier University). Partners: Buteau and Brock University et al. **($1,294,172)**

2016-18 **Social Sciences and Humanities Research Council (SSHRC)**, partnership development grant. Project titled *Computational Thinking in Mathematics Education*. Project co-directors: George Gadanidis (Ontario Western University) and Nathalie Sinclair (Fraser University). Co-applicants: Buteau et al. **($199,380)**

2008-10 **Social Sciences and Humanities Research Council (SSHRC)**, International Opportunities Fund Project Grant. Project titled *Computer Algebra Systems (CAS) in University Instruction: An International Research Study on CAS Usage and Sustainability*.

Principal investigator: Daniel Jarvis (Nipissing University). Co-applicants: Buteau and Zsolt Lavicza (Cambridge University, England). **($53,500)**

2007-08 **Social Sciences and Humanities Research Council (SSHRC)**, International Opportunities Fund Development grant. Project titled *Implementing Computer Algebra Systems (CAS) in University Mathematics*. Principal investigator: Daniel Jarvis (Nipissing University). Co-applicant: Zsolt Lavicza (Cambridge University, England) and collaborator: Buteau. **($15,000)**

2001-02 **Swiss National Science Foundation (SNF)**. Project titled *Computational Steering Algorithms for Sheaves of Weight Functions on Musical Motive Spaces*. Supervisor: Guerino Mazzola; Research assistant: Buteau. **($42,000)**

Internal

2016 Brock University SSHRC ORS Supplementary funds. Project titled *Educating for the 21st Century: post-secondary students learning computer programming for mathematical investigation, simulation, and real-world modeling*. Principal investigator: Buteau **($3,500)**

2016 Brock BSIG Internal Grant – Special Purposes. Project titled *International Congress on Mathematics Education.* Principal investigator: Buteau ($**1,000**)

2014 Brock BSIG Internal Grant. Project titled *Mathematics Exploratory Objects and Microworlds*. Principal investigator: Buteau **($3,250)**

2014 Brock BSIG Internal Grant – Special Purposes. Project titled *Constructionism and Creativity International Conference.* Principal investigator: Buteau ($**1,000**)

2013 Brock University 4A Supplementary Funding. Project titled *Appraising Implemented Mathematics Exploratory Objects in a Microworlds Framework.* Principal investigator: Buteau; collaborators: Eric Muller (Brock University), Ana Isabel Sacristán (Cinvestav, Mexico) and Joyce Mgombelo (Brock University). **($2,000)**

2008 Brock University Advancement Fund. Project titled *Computer Algebra Systems Usage and Sustainability in University Mathematics Instruction: A Literature Review Pilot Study*. Principal Investigator: Buteau. Co-supervisors: Daniel Jarvis (Nipissing University) and Zsolt Lavicza (University of Cambridge, England). **($2,000)**

2006-07 Brock University Advancement Fund. Project titled *Mathematics Learning Objects: Establishing a Learning Community on Brock MICA Philosophy*. Principal Investigator: Joyce Mgombelo (Brock University). Co-applicant: Buteau. **($5,500)**

2006 - … Cumulative Brock University Experience Works and Match of Mind Program Funding for undergraduate research assistants. Diverse projects in mathematics education and mathematical music theory. ($**67,200 cumulative**)

2004 New Faculty Start-up funding. ($**35,000**)

ORGANIZATION OF ACADEMIC EVENTS

Buteau, C. & Gadanidis, G. (forthcoming – Nov. 2018). Computational thinking in Mathematics Education Session. *Fields Institute for Research in Mathematical Sciences, Toronto (Canada).*

Namukasa, I., **Buteau**, C., Gadanidis, G., & Kotsopoulos, D. (2017). *Symposium on Computational Thinking in Mathematics Education*. University of Ontario Institute of Technology (UOIT), Toronto (Canada), October 13-15, 2017. *Funding ($10,000) received from the Fields Institute for Research in Mathematical Sciences, Toronto (Canada).*

Buteau, C. & M. Lovric (2014). *Undergraduate Mathematics Education in 21st Century: Rethinking Curriculum*. Two-day scientific session at the Canadian Mathematical Society (CMS) Winter Reunion. Hamilton (Canada), December 2014.

Buteau, C. & J. Mgombelo (2013). Local hosts of the *Canadian Mathematics Education Study Group (CMESG) 2013 Annual Meeting*, Brock University, St. Catharines, May 24-28, 2013.

Mgombelo, J., **Buteau**, C. & J. Irvine (2013). *Mathematics Education Research and Mathematics Teaching: Illusions, Reality, and Opportunities*. CMESG 2013 Pre-Conference, Brock University, St. Catharines (Canada), May 24, 2013. *Funding received from the Fields Institute for Research in Mathematical Sciences, Toronto (Canada).*

Mgombelo, J., & **Buteau**, C. (2011). Local host of the monthly Fields MathEd Forum, Brock University, St. Catharines, October 2011. *Funding received from the Fields Institute for Research in Mathematical Sciences, Toronto (Canada).*

Buteau, C., Jarvis, D., & Z. Lavicza (2010). *Atelier sur l'intégration de la technologie dans l'enseignement post-secondaire aux étudiants en mathématiques*. Centre de recherches mathématique (CRM), Montreal, October 1, 2010.

Buteau, C., Jarvis, D., & Z. Lavicza (2010). *Workshop on Technology Integration in Teaching Undergraduate Mathematics Students*. Fields Institute for Research in Mathematical Sciences, Toronto (Canada), October 29, 2010.

Buteau, C. & C. Anagnostoupoulo (2008). *International Computational Music Analysis Workshop*. *MaMuX: Mathematics, music and relations with other disciplines seminar session,* Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris (France), April 29-30, 2008.

Buteau, C., Jarvis, D., & Z. Lavicza (2008). *Technology Use in Post-Secondary Mathematics Instruction.* Scientific session at the Canadian Mathematical Society (CMS) Winter Reunion, Carleton University, Ottawa (Canada), December 2008.

Earn, D. & **Buteau**, C. (2005). *Music Research Day*. Department of Mathematics of McMaster University, Hamilton (Canada), July 2005.

WORKING GROUP LEADERSHIPS (BY INVITATION)

Modeste, S., **Buteau**, C. & Nguyen, C.T. (forthcoming). *Projet spécial 5: Mathématiques et informatique*. Espace Mathématiques Francophone (**EMF**) 18 Congress, Cergy-Pontoise (France), October 22-26, 2018.

Buteau, C., Gadanidis, G., Lovric, M., & Muller, E. (2017). *Computational Thinking and Mathematics Curricula/La pensée computationnelle et le programme de mathématiques*. Proceedings of the Canadian Mathematics Education Study Group (**CMESG**) 2016 Annual Conference, Kingston (Canada), June 2016, 119-135.

Buteau, C. & N. Sinclair (2013). *Technology and Mathematics Teachers (k-16)/La technologie et l'enseignant*

mathématique (K-16). Proceedings of the Canadian Mathematics Education Study Group (**CMESG**) annual 2012 meeting, Ste-Foy (Canada), May 2012, 95-100.

Buteau, C., Etchecopar, P. & Gadanidis, G. (2009). *New mathematical and information technology use in post-secondary education/Utilisation de technologies dans l'enseignement mathématique postsecondaire*. Proceedings of the Canadian Mathematics Education Study Group (**CMESG**) annual 2008 meeting, Sherbrooke (Canada), May 2008, 65-74.

CHAPTERS CONTRIBUTED TO EDITED BOOKS

Buteau, C., & Muller, E. (2014). Teaching Roles in a Technology Intensive Core Undergraduate Mathematics Course. In Clark-Wilson, Robutti, & Sinclair (eds): *The Mathematics Teacher in the Digital Era*. Springer Netherlands, 163-185.

Assude, T., **Buteau**, C., & Forgasz, H. (2009). Factors Influencing Implementation of Technology-Rich Mathematics Curriculum. In L. H. Son, N. Sinclair, J.-B. Lagrange, & C. Hoyles (Eds.), *Mathematics Education and Technology —Rethinking the terrain: The 17th ICMI Study.* New York: Springer, 405-419.

Vale, C. & Julie, C. with **Buteau**, C., and Ridgeway, J. (2009). Implementation of technology-rich mathematics curricula: issues of access and equity. In L. H. Son, N. Sinclair, J.-B. Lagrange, & C. Hoyles (Eds.), *Mathematics Education and Technology —Rethinking the terrain: The 17th ICMI Study.* New York: Springer, 349-360.

Mazzola, G., with Göller, S. & Müller, S. (2002). The Topos of Music: Geometric logic of concepts, theory, and performance. Contribution to chapter 22: *Motif Gestalts* (pp. 465-498). Basel, Switzerland: Birkhäuser.

PAPERS IN PEER REFEREED JOURNALS

Buteau, C. & E. Muller (in press). *Case Study of An Epistemic Mathematics Computer Game*. International Journal of Game-Based Learning (IJGBL).

Jarvis, D. & **Buteau**, C., Novoseltsev, Z., & Doran, C. (in press). *Innovative CAS Technology Use in University Mathematics Teaching and Assessment: Findings from a Case Study in Edmonton, Canada.* Journal of Computers in Mathematics and Science Teaching, 37(4).

Broley, L. **Buteau**, C. and Muller, E. (2017). Struggles and Growth in Mathematics Education: Reflections by Three Generations of Mathematicians on the Creation of the Computer Game E-Brock Bugs. *Journal of Humanistic Mathematics*, 7(1), 62-86. (DOI) 10.5642/ jhummath.201701.06.

Buteau, C., & Muller, E. (2016). Assessment in Undergraduate Programming-Based Mathematics Courses. *Digital Experiences in Mathematics Education*, 3(2): 97-114. DOI 10.1007/s40751-016-0026-4.

Buteau, C., Muller, E, Marshall, N, Sacristán, A.I., & Mgombelo, J. (2016). Undergraduate mathematics students appropriating programming as a tool for modelling, simulation, and visualization: A case study. *Digital Experience in Mathematics Education*, 2(2), 142-156. (DOI) 10.1007/s40751-016-0017-5.

Broley, L., **Buteau**, C., & Muller, E. (2015). E-Brock Bugs©, an Epistemic Math Computer Game. *Journal of Humanistic Mathematics, 5*(2), 3-25.

Buteau, C., Muller, E & Marshall, N. (2015). When a university mathematics department adopted

course mathematics courses of unintentionally constructionist nature – really? *Digital Experience in Mathematics Education*,1(2-3), 133-155. (DOI) 10.1007/s40751-015-0009-x

Marshall, N. & C**. Buteau** (2014). Learning by designing and experimenting with interactive, dynamic mathematics exploratory objects. *International Journal for Technology in Mathematics Education*, 21 (2), 49-64.

Gueudet, G., C. **Buteau**, Mesa, V., & Misfeld, M. (2014). Instrumental and documentational approaches: from technology use to documentation systems in university mathematics education. *Research of Mathematics Education*, Special Issue: Institutional, sociocultural and discursive approaches to research in university mathematics education, 16 (2), 139-155.

Jarvis, D. H., Lavicza, Z., & **Buteau**, C. (2014). Systemic shifts in instructional technology: Findings of a comparative case study of two university mathematics departments. *International Journal for Technology in Mathematics Education*, 21(4), 117-142.

Buteau, C., Jarvis, D. & Lavicza Z. (2014). On the Integration of Computer Algebra Systems (CAS) by Canadian Mathematicians: Results of a National Survey. In *Canadian Journal of Science, Mathematics and Technology Education*, 14(1), 35-57.

Jarvis, D. H., **Buteau**, C., & Lavicza, Z. (2014). Computer Algebra System (CAS) usage and sustainability in university mathematics instruction: Findings from an international study. *The Electronic Journal of Mathematics & Technology* (Special Issue, Part 2: ICME-12 Topic Study Group 18, "Analysis of Uses of Technology in the Teaching of Mathematics"), 8(4).

Marshall, N., **Buteau**, C. & Muller, E. (2014). Exploratory Objects and Microworlds in University Mathematics Education. *Teaching Mathematics and its Applications*, 33, 27-38.

Martinovic, D., E. Muller & C. **Buteau** (2013). Intelligent partnership with technology: Moving from a math school curriculum to an undergraduate program. In *Computers in the Schools*, 30 (1-2), 76-101.

Buteau, C., & C. Anagnostopoulou (2012): Mathematical and Computational Modeling Within a Music Analysis Framework: Motivic Topologies as a Case Study. In *Journal of Mathematics and Music*, 6 (1), 1-16.

Mgombelo, J. & C. **Buteau** (2012): Learning Mathematics for Teaching Through Designing, Implementing, and Testing Learning Objects. *Issues in the Undergraduate Mathematics Preparation of School Teachers: The Journal*, Vol 3. 16pp.

Marshall, N., C. **Buteau**, D. Jarvis & Z. Lavicza (2012). Do mathematicians integrate Computer Algebra Systems in university teaching? Comparing a literature review to an international survey study. *Computers & Education*, 48(1), 423-424.

Buteau, C., Marshall, N., Jarvis, D. & Lavicza, Z (2010). Integrating Computer Algebra Systems in Post-Secondary Education - Preliminary Results of A Literature Review. In *International Journal for Technology in Mathematics Education*, 17 (2), 57-68.

Mgombelo, J. & **Buteau**, C. (2009). Prospective Secondary Mathematics Teachers Repositioning by Designing, Implementing and Testing Learning Objects: A Conceptual Framework. In *International Journal of Mathematical Education in Science and Technology*, 40 (8), 1051-1068.

Muller, E., **Buteau**, C., Ralph, B., Mgombelo, J. (2009). Learning mathematics through the design and implementation of Exploratory and Learning Objects. In *International Journal for Technology in Mathematics Education*, 16 (2), 63-74.

Muller, E., **Buteau**, C., Klincsik M., Perjési-Hámori I. & Sárvári C. (2009). Systemic integration of evolving technologies in undergraduate mathematics education and its impact on student retention. In *International Journal of Mathematical Education in Science and Technology*, 40 (1), 139-155.

Buteau, C. & G. Mazzola (2008). *Motivic Analysis Regarding Rudolph Réti: Formalization Within A Mathematical Model*. In *Journal of Mathematics and Music*, 2 (3), 117-134.

Buteau, C., J. Vipperman (2008). *Representations of Motivic Spaces of a Score in OpenMusic*. *Journal of Mathematics and Music* for the special issue on *Computations*, 2 (2), 61-79.

Buteau, C. (2005). *Topological Motive Spaces, and Mappings of Scores' motivic Evolution Trees,* Grazer Mathematische Berichte, ISSN 1016—7692, H. Fripertinger & L. Reich (Eds.), 27-54.

Buteau, C. (2004). *Motivic Spaces of Scores through RUBATO's MeloTopRUBETTE* in Perspectives in Mathematical and Computational Music Theory, Mazzola, G., Th. Noll, and E. Lluis-Puebla (eds.), Verlag epOs-Music, Osnabrück, 330-342.

Buteau, C. (2001): *Reciprocity between Presence and Content Functions on a Motivic Composition Space* in Tatra Mt.Math.Publ. 23, 17-45.

Buteau, C. and G. Mazzola (2000): *From Contour Similarity to Motivic Topologies* in Musicae Scientiae, European Society for Cognitive Sciences of Music (ESCOM), Vol IV (2), 125-149.

PUBLISHED REFEREED CONFERENCE PROCEEDINGS

Buteau, C., Sacristán, A. I., & Muller, E. (2018). *Teaching in a Sustained Post-Secondary Constructionist Implementation of Computational Thinking for Mathematics*. Proceedings of Constructionism 2018, Vilnius (Lithuania), August 2018.

Buteau, C., Muller, E., Sacristán, A. I., & Mgombelo, J. (forthcoming). *Pensée Informatique en enseignement des mathématiques post-secondaires : un cadre théorique*. Proceedings of Espace mathématique francophone 2018, Paris-Genevilliers (France), October 2018.

Buteau, C, Muller, E., Mgombelo, J., & Sacristán, A. (2018). *Computational Thinking in University Mathematics Education: A Theoretical Framework.* Proceedings of Research in Undergraduate Mathematics Education conference, San Diego (USA), February 2018.

Broley, L., **Buteau,** C., & Muller, E. (2017). *(Legitimate peripheral) computational thinking in mathematics*. Proceedings of the Congress of European Society for Research in Mathematics Education (CERME), Dublin (Ireland), February 2017.

Buteau, C., Marshall, N., & Muller, E. (2014). *Learning university mathematics by creating and using fourteen 'microworlds'*. In G. Futschek & C. Kynigos (Eds.), Constructionism and Creativity. Proceedings of the 3rd International Constructionism Conference 2014 (pp. 401-406). Vienna, Austria: Österreichische Computer Gesellschaft (OCG).

Buteau, C., Marshall, N., & Muller, E. (2014). *Perception on the Nature of Core University Mathematics Microworld-Based Courses*. In G. Futschek & C. Kynigos (Eds.), Constructionism and Creativity. Proceedings of the 3rd International Constructionism Conference 2014 (pp. 379-389). Vienna, Austria: Österreichische Computer Gesellschaft (OCG).

Buteau, C., Muller, E., & Marshall, N. (2014). *Competencies Developed by University Students in Microworld-type Core Mathematics Courses*. In Proceedings of *Joint Meeting Int. Group Psychology Mathematics Education (PME 38)*, Vancouver, Canada, 2014, 209-18.

Marshall, N., **Buteau**, C. & E. Muller (2013). Exploratory Objects and Microworlds in University Mathematics Education. In *Proceedings of the 11th International Conference on Technology in Mathematics Teaching*, Bari (Italy), July 2013, 187-193.

Jarvis, D. H., Z. Lavicza & C. **Buteau** (2012). Computer Algebra System (CAS) Usage and Sustainability in University Mathematics Instruction: Findings from an International Study. In *Proceedings of the 12th International Congress on Mathematical Education (ICME-12)*. Seoul, Korea.

Muller, E., & **Buteau**, C. (2012). An innovative integration of evolving technologies in undergraduate mathematics education. In *Essays on Mathematics and Statistics*, Vol.2, Akis, V. (Ed.), Athens Institute for Education and Research (publisher), 117-122.

Buteau, C., & C. Anagnostopoulou (2011). *Motivic Topologies: Mathematical and Computational Modelling in Music Analysis*. In *Mathematics and Computation in Music III*, C. Agon, M. Andreatta, G. Assayag, E. Amiot, J. Bresson, & J. Mandereau (eds), Communications in Computer and Information Science Series, 6726, 330-333.

Buteau, C. & E. Muller (2010). *Student Development Process of Designing and Implementing Exploratory and Learning Objects.* In *Proceedings of the Sixth Conference of European Research in Mathematics Education Lyon, France - Jan. 28th - Feb. 1, 2009*, 1111-1120.

Buteau, C., Jarvis, D., Lavicza, Z. & Marshall, N. (2010). *Issues in Integrating CAS in Post-Secondary Education - A Literature Review.* In *Proceedings of the Sixth Conference of European Research in Mathematics Education Lyon, France - Jan.28th - Feb. 1, 2009*, 1181-1190.

Mgombelo, J. & **Buteau**, C. (2010). *Mathematics Teacher Education Research and Practice: Researching Inside the MICA Program.* In *Proceedings of the Sixth Conference of European Research in Mathematics Education (CERME 6)*,Lyon (France), 2009, 1901-1910.

Buteau, C., J. Vipperman (2009). *Melodic Clustering Within Motivic Spaces: Visualization in OpenMusic and Application to Schumann's Träumerei*. In Communications in Computer and Information Science Series (37), Klouche, T., Noll, T. (eds), Springer, 59-66.

Buteau, C., with K. Adiloglu, O. Lartillot, C. Anagnostopoulou (2009). *Computational Analysis Workshop: Comparing Four Approaches to Melodic Analysis*. In Communications in Computer and Information Science Series (37), Klouche, T., Noll, T. (eds), Springer, 247-249.

Jarvis, D., Lavicza, Z., & **Buteau**, C. (2008). *Computer Algebra Systems (CAS) in University Mathematics Instruction: A Preliminary Research Report Investigating CAS Technology Usage and Sustainability*. In on-line proceedings of the *11th Annual Conference on Research in Undergraduate Mathematics Education (RUME)*. San Diego (USA), 11 pp.

Buteau, C. (2006). *Melodic Clustering Within Topological Spaces of Schumann's Träumerei* in Proceedings of the International Computer Music Conference 2006, New Orleans (USA), 104-110.

Buteau, C. & Muller, E (2006). *Evolving technologies integrated into undergraduate mathematics education,* In L. H. Son, N. Sinclair, J. B. Lagrange, & C. Hoyles (Eds.), *Proceedings for the Seventeenth ICMI Study Conference: Digital Technologies and Mathematics Teaching and Learning: Revisiting the Terrain, Hanoi University of Technology, 3rd-8th December, 2006*, Hanoi (Vietnam) (c42)[CD-ROM], 8 pp.

Muller, E. & C. **Buteau** (2006). *Un nouveau rôle de l'informatique dans la formation initiale des enseignants*. In Bednarz, N., Mary, C. (Eds.), "*L'enseignement des mathématiques face aux défis de l'école et des communautés*", Actes du colloque EMF 2006, Sherbrooke: Éditions du CRP [CD-ROM], 17 pp.

Buteau, C. (2005). *Automatic Motivic Analysis including Melodic Similarity for Different Contour Cardinalities: Application to Schumann's Of Foreign Lands and People* in Proceedings of the International Computer Music Conference, Barcelona (Spain), 239-242.

Abstracts only:

Buteau, C., Broley, L. & Muller, E. (2014). *E-Brock Bugs©: An Epistemic Math Computer Game* in Proceedings of Joint Meeting Int. Group Psychology Mathematics Education (PME 38), July 2014, Vancouver, Canada.

Mgombelo, J., & **Buteau**, C. (2006): *Establishing a Mathematics Learning Community in the Study of Mathematics for Teaching* in Proceedings of the Annual Meeting of the International Group for the Psychology of Mathematics Education (PME), Prague (Czech Republic), 2006, 301.

INVITED GUEST LECTURES AT SCHOLARLY MEETINGS

Buteau, C. (forthcoming). *Pensée informatique et mathématiques*. Invited keynote at the research colloquim of *16è Congrès de l'APTICA (Association pour l'avancement pédagogique des technologies de l'information et de la communication en Atlantique)*, Université de Moncton, October 30 – Novembre 4, 2017.

Buteau, C. (2015). *Undergraduates Learning of Programming for Simulation and Investigation of Mathematics Concepts and Real-World Modelling*. Invited paper presentation at *Didactics of Mathematics in Higher Education as a Scientific Discipline,* Hannover (Germany), December 2015.

Buteau, C., Rat, R., & E. Muller (2015). *Thinking in "code" and coding for thinking: a university implementation*. Invited presentation at *Fields Mathematics Education Forum (Theme: Thinking in "code": Exploring relationships between mathematics and computer programming)*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), November 2015.

Broley, L., **Buteau**, C., & E. Muller (2013). *E-Brock Bugs: A New Free Online Math Computer Game for the Development of Mathematical Thinking-Integrating Probability concepts in MDM4U.* Invited presentation at *Fields Mathematics Education Forum (Theme: Games for Learning)*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), November 2013.

Buteau, C., Jarvis, D., & Lavicza, Z. (2010). *Computer Algebra Systems (CAS)-based Technology Use in Post-Secondary Mathematics Instruction: Preliminary Results of a Canadian Survey.* Invited presentation at *Fields Mathematics Education Forum*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), April 2010.

Buteau, C. (2008). *Encourager la créativité mathématique et l'indépendance intellectuelle des étudiants universitaires par l'utilisation de la technologie: une implémentation à Brock University*. Invited presentation for the Mathematics Education Session at the *Deuxième Congrès Canada-France 2008*, Université du Québec à Montréal, Montreal (Canada), June 2008.

Buteau, C. (2007). *Going from CAS to MICA: Integration of Technology in Brock Curriculum*. Keynote presentation at *First Canadian Computer Algebra System and Dynamic Geometry Systems in Mathematics Education Conference*, Nipissing University, North Bay (Canada), September 2007.

Buteau, C. (2007). *Brock Students Learning Mathematics by Designing Learning Objects*. Invited presentation at *Fields Mathematics Education Forum*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), November 2007.

Buteau, C., Camilleri, S., Fodil, K., Mgombelo, J., Lacroix, M.-E. (2007). *When a Grade 5 Class Design a Learning Object*. Invited presentation at *Fields Mathematics Education Forum*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), November 2007.

Buteau, C. (2006). *Mathematics Summer Camps at Brock University*, Invited presentation at *Fields Mathematics Education Forum*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), November 2006.

Buteau, C. (2005). *Mathematics and Music*. Invited topic presentation at the *Canadian Mathematics Education Study Group (CMESG)* Annual 2005 Meeting, University of Ottawa, Ottawa (Canada), May 2005.

Buteau, C. (2005). *Théorie mathématique de la musique.* Invited public lecture at the end of the three-day session of Laval University students' Honours projects presentations, Laval University, Québec (Canada), April 2005.

Buteau, C. (2004). *Topological Motive Spaces, and Mappings of Scores' Motivic Evolution Trees*. Invited lecture at *Mini Colloquim on Mathematical Music Theory*, KF-Universität Graz/Institut für Mathematik, Graz (Austria), May 2004.

OTHER SCIENTIFIC PAPERS DELIVERED AT SCHOLARLY EVENTS

Buteau, C. & Muller, E. (2016). Systemic integration of programming in undergraduate mathematics: from implementation to theory. *International Congress on Mathematical Education (ICME) 2016,* Hamburg (Germany), July 2016.

Buteau, C. (2015). Coding in undergraduate and B.Ed programs at Brock. *Math+Coding Symposium*, London (Ontario), June 2015. This led to:

> **Buteau**, C., Muller, E., & Ralph, B. (2015). Integration of programming in the undergraduate mathematics program at Brock University. Online Proceedings of Math+Coding Symposium, London, ON. Retrieved from: http://researchideas.ca/coding/docs/ ButeauMullerRalph-Coding+MathProceedings-FINAL.pdf

Buteau, C. (2014). Undergraduates Learning Programming for Simulation and Investigation of Mathematics Concepts and Real-World Modelling. In the *Undergraduate Mathematics Education in 21st Century: Rethinking Curriculum* session at *Canadian Mathematical Society Winter 2014* meeting, Hamilton (Canada), December 2014.

Buteau, C. & Lovric, M. (2014). Undergraduate Mathematics Education in 21St Century: Rethinking Curriculum - Introduction. In the *Undergraduate Mathematics Education in 21st Century: Rethinking Curriculum* session at *Canadian Mathematical Society (CMS) Winter 2014* meeting, Hamilton (Canada), December 2014.

Marshall, N. with C. **Buteau** (2012). Contextualizing the Learning Activity of Designing and Experimenting with Interactive, Dynamic Mathematics Exploratory Objects. *Fields Mathematics*

Education Forum (Theme: Research Day), Fields Institute for Research in Mathematical Sciences, Toronto (Canada), January 2012.

Buteau, C., D. Jarvis, E. Muller & Z. Lavicza (2011). Systemic integration of technology in undergraduate mathematics programs: Results of a Canadian study and issues of implementation. *Symposium on Teaching Mathematics in Higher Education*, Centre for Teaching and Learning, University of Toronto, Toronto (Canada), June 2011.

Buteau, C., Jarvis, D. H., & Lavicza, Z. (2010). Rapport du sondage Canadien (printemps 2009) sur l'intégration de logiciel de calcul formel dans l'enseignement post-secondaire des mathématiques. Presented at *Atelier sur l'intégration de la technologie dans l'enseignement post-secondaire aux étudiants en mathématiques,* Centre de recherche mathématique (CRM), Montréal (Canada), October 2010.

Jarvis, D. H., **Buteau**, C., & Lavicza, Z. (2010). Report on Canadian survey (Spring 2009) regarding Computer Algebra Systems integration in post-secondary mathematics teaching. Presented at *Workshop on Technology Integration in Teaching Undergraduate Mathematics Students*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), October 2010.

Lavicza, Z., Jarvis, D. H., **Buteau**, C., & Monaghan, J. (2010). Computer Algebra Systems (CAS) in post-secondary mathematics instruction: Preliminary results from a research study investigating CAS usage and sustainability. *Computer Algebra and Dynamic Geometry Systems in Mathematics Education (CADGME 2010)*, Hluboká nad Vltavou, Czech Republic. *Presented by Lavicza*

Lavicza, Z., Jarvis, D. H., & **Buteau**, C. (2010). A comparative analysis of academic mathematicians' conceptions and professional use of technologies in university mathematics. *15th Asian Technology Conference in Mathematics (ATCM 2010),* Kuala Lumpur (Malaysia), December 2010. *Presented by Lavicza*

Buteau, C. (2009). Mais quelles sont les pratiques canadiennes de l'utilisation de la technologie dans l'enseignement mathématique post-secondaire? *53e Congrès Annuel de l'Association Mathématique (AMQ) du Québec — Mathématiques et informatique: Une puissante alliance!*, Montreal (Canada), October 2009.

Jarvis, D., Lavicza, Z., & C. **Buteau** (2009). Computer Algebra Systems (CAS) in Post-Secondary Mathematics Instruction: Preliminary Results from a Research Study Investigating CAS Usage and Sustainability. *The Ninth International Conference on Technology in Mathematics Teaching (ICTMT) 2009*, Metz (France), July 2009.

Buteau, C., Marshall, N., Jarvis, D., & Lavicza, Z. (2009). Integrating Computer Algebra Systems in Post-Secondary Mathematics Education - Preliminary Results of A Literature Review. *Applications of Computer Algebra 2009*, Montreal (Canada), June 2009.

Buteau, C. (2009). A Systemic Integration of A Computer Algebra System in University Mathematics Education at Brock University. *Applications of Computer Algebra 2009*, Montreal (Canada), June 2009.

Buteau, C. (2008). Triggering University Students' Mathematical Creativity and Intellectual Independence by Use of Technology. *Canadian Mathematical Society (CMS) Winter 2008 Meeting* in the session titled *Technology Use in Post-Secondary Mathematics Instruction*, Carleton University, Ottawa (Canada), December 2008.

Jarvis, D., **Buteau**, C., Lavicza, Z. & Marshall, N. (2008). Issues surrounding technology integration in university education: results of a literature review. *Canadian Mathematical Society (CMS) Winter 2008 Meeting* in the session titled *Technology Use in Post-Secondary Mathematics Instruction*. Carleton University, Ottawa (Canada), December 2008.

Buteau, C. & Anagnostopoulou, C. (2008). Computational Analysis Workshop Introduction: First movement of Brahms' Op 51 No 1 and an Overview of the Proposed Computational Approaches. *Séminaire MaMuX: Mathématiques, musique et relations avec d'autres disciplines* in the session titled *Computational Music Analysis*, Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris (France), April 2008.

Buteau, C. (2008). Topological Spaces of Motives of Brahms Op. 51 No1. *Séminaire MaMuX: Mathématiques, musique et relations avec d'autres disciplines* for the session titled *Computational Music Analysis*, Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris (France), April 2008.

Lavicza, Z., Jarvis, D., & **Buteau**, C. (2008). CAS-based technology in university mathematics teaching: Exploring issues of teacher beliefs, implementation obstacles, and cultural differences, in *on-line program of The 11th International Congress on Mathematical Education (ICME)*. Monterrey (Mexico), 2008, 6 pp.

Buteau, C. & Muller, E. (2006). Examples of Undergraduate Student Achievement in a Technological Learning Environment. Project presentation at the *Seventeenth International Commission on Mathematical Instruction (ICMI) Study Conference: Digital Technologies and Mathematics Teaching and Learning: Revisiting the Terrain*, University of Hanoi (Vietnam), December 2006.

Buteau, C. (2004). Topological Spaces of Music Motives: An Application of T_0-Spaces. *Canadian Mathematical Society (CMS) Winter 2005 Meeting*, McGill University, Montreal (Canada), December 2004.

Buteau, C. (2004). Topological Model of Motivic Analysis. Workshop on *Music Information Processing Systems* in the *Neural Information Processing Systems Conference (NIPS)*, Whistler (Canada), December 2004.

Buteau, C. (2004). Motivic Topologies of Messiaen's Regard III: A Computational Motivic Analysis. *Séminaire MaMuX: Mathématiques, musique et relations avec d'autres disciplines* pour la séance *Outils informatiques en analyse musicale*, Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris (France), May 2004.

Buteau, C. (2004). A Topological Model of Motivic Analysis of Music: Theory and Implementation. *American Mathematical Society Joint Mathematics Meetings* in AMS-MAA special session on *Mathematical Techniques in Musical Analysis*, Phoenix (USA), January 2004.

Buteau, C. (2003). A Topological Model of Motivic Analysis of Music. *Herbsttagung der SMG (Swiss Mathematical Society)*, Solothurn (Switzerland), September 2003.

Buteau, C. (2003). Modèle topologique de l'analyse motivique: Théorie, application et implémentation dans RUBATO. *Séminaire MaMuX: Mathématiques, musique et relations avec d'autres disciplines*, Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris (France), April 2003.

Buteau, C. (2002). RUBATO's MeloTopRubette for Topological Analysis of Melodic Paradigms.

Second Conference of Understanding and Creating Music, Caserta (Italy), November 2002.

Buteau, C. (2001). Reciprocity Between Motivic Presence and Content Functions. *Second International Seminar on Mathematical Music Theory*, Sauen (Germany), July 2001.

OTHER CONTRIBUTIONS AT SCHOLARLY EVENTS

Buteau, C., Muller, E., Mgombelo, J., Rafiepour, A., & Sacristán, A. I.(forthcoming). Features of 'Authentic' Programming-based Mathematical Tasks. Proceedings of Mathematics Education in the Digital Age, Copenhagen (Denmark), September 2018.

Broley, L., **Buteau**, C., & Muller, E. (2017). *Legitimate peripheral computational thinking in mathematics*. Poster presentation at the Math Gallery, Canadian Mathematics Education Study Group 2017, McGill University (Canada), June 2017.

Monaghan, M., with **Buteau**, C. (2017). *My Engagement with and Views on Computational Thinking as a Mathematics (MICA) Co-op Honours Student*. Poster presentation at the Math Gallery, Canadian Mathematics Education Study Group 2017, McGill University (Canada), June 2017.

Buteau, C. & Muller, C. (2017). *MDM4U students' mathematics in-game identity when playing E-Brock Bugs© computer game*. Poster presentation at *Fields MathEd Forum Annual Research Day Symposium*, Fields Institute for Research in Mathematical Sciences, Toronto (Canada), January 28, 2017.

Buteau, C., Muller, E., & Marshall, N. (2014). *Could 'It' be an Implementable Form/Alternative To Microworlds*? Poster presentation and proceedings of the Canadian Mathematics Education Study Group (CMESG) 2013 annual meeting, St. Catharines (Canada), May 2013, 241-242.

Martinovic, D. & C**. Buteau** (2011). *Simulations and Role-Playing in the Context of Problem-based Learning: This is too good to be true!".* Poster presentation at the University of Windsor-Oakland University Fifth Annual Conference on Teaching and Learning, University of Windsor, Windsor (Canada), May 19-20, 2011.

Marshall, N., with **Buteau**, C., Jarvis, D. H., & Lavicza, Z. (2011). Do mathematicians integrate computer algebra systems (CAS) in university teaching? Comparing a literature review to an international survey study. Poster presentation at *Fields Math Education Forum Annual Research Day Symposium,* Fields Institute for Research in Mathematical Sciences, Toronto, Ontario. *Poster presented by Marshall*

Buteau, C. (2007). Invited panelist at the *Mathematics and Computation in Music* conference for the discussion titled: *Dialogue on Topoï of Music: A Birthday Panel*. Staatliches Institut für Musikforschung, Berlin (Germany), 2007.

Buteau, C. (2006). Invited panelist at the *Music and Mathematics* at *Creative and Scientific Legacies of Iannis Xenakis International Symposium* for the discussion: *Music and Mathematics*. University of Guelph/Fields Institute for Research in Mathematics Sciences/University of Waterloo (Canada), 2006.

CREATION OF FREE ONLINE MATHEMATICS VIDEO GAMES

Broley, L., with **Buteau, C**. & Muller, E. (2013). E-Brock Bugs©, a video game for learning basic probability concepts. Access to game : https://brocku.ca/mathematics-science/departments-and-centres/mathematics/resources/ brock-bugs/e-brock-bugs-video-game

Broley, L., **Buteau, C**. & Muller, E. (2013). Teacher document for E-Brock Bugs©: https://brocku.ca/webfm_send/32032

Buteau, C., Muller, E., and Broley, L. (2013). E-Brock Bugs© Webpage for teachers : https://brocku.ca/mathematics-science/departments-and-centres/mathematics/resources/brock-bugs

WORK SUBMITTED FOR PUBLICATION

Buteau, C, Muller, E., Mgombelo, J., & Sacristán, A. (2018). *Computational Thinking in University Mathematics Education: A Theoretical Framework.* Submitted in August 2017 for presentation at the Research in Undergraduate Mathematics Education conference, San Diego (USA), February 2018.

Buteau, C, Mamolo, A., Muller, E., & Monaghan, M. (2018). *Computational Thinking in Mathematics: Undergraduate Student Perspectives.* Poster presented at the Research in Undergraduate Mathematics Education conference, San Diego (USA), February 2018.

Buteau, C., & Muller, E., & Broley, L. (2017). Computational Thinking : In our Undergraduate Mathematics programs? Accepted for publication in December 2017 in *Canadian Mathematical Society Notes.*

EDITORIAL AND REFEREEING DUTIES

Journal editorship:

Anagnostoupoulo, C. & **Buteau**, C., Eds (2010). Computational Music Analysis [Special Issue]. *Journal of Mathematics and Music*, 4 (2).

including:

Anagnostoupoulo & C. **Buteau** (2010). Introduction. Can computational music analysis be both musical and computational? *Journal of Mathematics and Music* for the special issue *Computational Music Theory*, C. Anagnostoupoulo & C. Buteau (eds), 4 (2), pp. 75-83.

Journal editorial board membership

2011 – 2015 Fields Mathematics Education Journal (FMEJ)

Journal paper referee:

Computer Music Journal
Digital Experiences in Mathematics Education
International Journal of Technology in Mathematics Education

Journal of New Music Research
Grazer Mathematische Berichte
Teaching Mathematics and Computer Science Journal

was also invited to referee for:

International Journal of Mathematical Education in Science and Technology
International Journal of Research in Undergraduate Mathematics Education
Mathematical Thinking and Learning
SIAM Journal on Applied Algebra and Geometry

Conference paper proposal referee:

Congress of European Research in Mathematics Education (CERME) 2009, 2015, 2017
Mathematics and Computations in Music (MCM) 2009, 2011, 2013, 2015, 2017
International Conference for Mathematics Education (ICME) 2016
International Society for Music Information Retrieval (ISMIR) conference 2011, 2012
International Computer Music Conference (ICMC) 2005

EVALUATION OF GRANT APPLICATIONS

2017 Invited to serve on the Education & Social Work adjudication committee for the Social Science and Humanities Research Council (SSHRC) 2017 Insight Grant and 2017 Insight Development Grant competitions

2015 External expert for grant evaluation (Insight Program) at Social Science and Humanities Research Council (SSHRC)

2014 External expert for grant evaluation (Insight Program) at Social Science and Humanities Research Council (SSHRC)

COURSES TAUGHT AT BROCK UNIVERSITY

Undergraduate courses

MATH 1P11/12 Linear Algebra I
MATH 1P40 Mathematics Integrated with Computers & Applications I
MATH 1P97 Calculus with Applications
MATH 1P98 Practical Statistics
MATH 2P12 Linear Algebra II
MATH 2P95 Mathematics and Music
MATH 3P41 Visual and Interactive Mathematics
MATH 4P96 Technology and Mathematics Education
MATH 4F90 Honours Thesis

Graduate course

MATH 5P96 Technology and Mathematics Education

STUDENT SUPERVISION

Thesis Committee (doctorate)

2014-Present Amy Lin, Faculty of education (Brock University)

including a *doctoral directed study co-supervision*

Winter 2015 EDUC 7P51 Directed Study co-supervision with J. Mgombelo (Fac. of Education)

Masters Thesis Direction (M.Sc. mathematics, with specialization in education)

2010-12 Neil Marshall

Thesis title: *Contextualizing the Learning Activity of Designing and Experimenting with Interactive, Dynamic Mathematics Exploratory Objects.*

Masters Thesis Committee (M.Ed.)

2011 Amanjot Toor (Brock University, Faculty of education).

Thesis title: *Undergraduate students' experiences of their mathematical identity*

Masters Thesis External Evaluator (M.Sc.)

2017 Karl-Philippe Tremblay (Université du Québec à Montréal (UQAM), Department of mathematics).

Thesis title: *Étude des effets transformateurs de la technologie pour l'activité mathématique: analyse de trois logiciels utilisés dans le milieu scolaire*

Honours Thesis (B.Sc.)

2018 Elsa Chambers, …

2017 *Charles Austria.* Math Raisers: A Mathematics Video Game.

2014 *Alicia Mancuso.* The effect the computer game, *E-Brock Bugs*, has on student achievement and motivation in Mathematics students and different genders

2013 *Laura Broley.* E-Brock Bugs: The Creation and Analysis of an Epistemic Mathematics Computer Game

2012 *Marc Jovanov.* Capture the Flag: Educational Board Game Research and Creation

2010 *Neil Marshall.* Do Mathematicians Integrate Computer Algebra Systems in University Teaching? Comparing a Literature Review to an International Survey Study

2008 *Amanjot Toor.* Gender Equity in Undergraduate Mathematics Curricula (co-supervision with Joyce Mgombelo, Faculty of Education)

2007 *Sarah Camilleri.* Fantasy Fractions Learning Object: A Collaborative Grade 5 Class Project (co-supervision with Joyce Mgombelo, Faculty of Education)

2007 *Jennifer Corbett.* Recreational Mathematics Clubs in Elementary and Secondary School (co-supervision with Joyce Mgombelo, Faculty of Education)

2005 *Denis Poulin (Université Laval). Topologie musicale (co-supervision with Charles Cassidy)*

CONTRIBUTIONS TO THE BROCK MATHEMATICS CURRICULUM — INTRODUCTION OF NEW COURSES, AND THEIR TEACHING

*MATH 2P95 Mathematics and Music**
Scales and temperaments, history of the connections between mathematics and music, set theory in atonal music, group theory applied to composition and analysis, enumeration of rhythmic canons, measurement of melodic similarity using metrics, topics in mathematical music theory, applications of statistics to composition and analysis.

** taught for the first time in Fall 2013*

*MATH 3P41 Visual and Interactive Mathematics***
Techniques in the visual representation of mathematical data and the interactive presentation of mathematical ideas. Topics may include modelling and simulation, visualization of real world data, interactive learning environments, and interactive websites.

*** designed by building on former MATH 2F40 and adapted for future mathematics teachers for the integration of computational thinking in school mathematics education. Taught for the first time in Winter 2017*

*MATH 4/5P96 Technology and Mathematics Education****
Topics may include contemporary research concerning digital technologies, such as computer algebra systems and Web 2.0, in learning and teaching mathematics, design of educational tools using VB.NET, HTML, Geometer's Sketchpad, Maple, Flash, etc., critical appraisal of interactive learning objects in mathematics education.

**** designed and taught for the first time in Fall 2012*

INVITED CONTRIBUTIONS TO SEMINARS AND COLLOQUIA RELEVANT TO TEACHING AND LEARNING

Buteau, C. (2017). L'expérience de l'étudiant dans la classe universitaire à *faire des mathématiques différemment* par la programmation informatique. Invited seminar talk at Université du Québec À Montréal (UQÀM), Montreal (Canada), April 2017.

Buteau, C. (2016). *Mathematics and Music*. Workshop at '*Mathematics is a Verb* ', Brock University (Hamilton campus), Hamilton, February 2016.

Buteau, C. (2015). Math & Music: From Pythagoras until Today. *Colloquium of the Department of Mathematics,* Trent University, Peterborough (Canada), January 2015.

Buteau, C. (2015). A topological modeling of melodic structure and analysis of music. *Colloquium of the Department of Mathematics*, University of Buenos Aires, Buenos Aires (Argentina), April 2015.

Buteau, C. (2015). About the use of technology in teaching and learning mathematics. *Centro de Formación e Investigación en Ensenanza de las Ciencias*, University of Buenos Aires, Buenos Aires (Argentina), April 2015.

Buteau, C. (2008). Triggering University Students' Mathematical Creativity by Use of Technology. *Mathematics Education Lunch Time Seminar*, University of Cambridge (England), February 2008.

Buteau, C. (2005). Modèle topologique de l'analyse mélodique de la musique: Espaces T_0 de motifs. Research colloquium at the *Centre de Recherche Mathématique (CRM) – Université de Sherbrooke – Bishop's College*, Université de Sherbrooke, Sherbrooke (Canada), February 2005.

Buteau, C. (2005). Modèle mathématique de l'analyse motivique selon Rudolph Réti. Invited presenter at the *Music Department*, University of Sherbrooke, Sherbrooke (Canada), February 2005.

Buteau, C. (2005). *A Deterministic Model of Germinal Motives.* Presentation at Mathematics of Music Seminar Day, Department of Mathematics & Statistics at McMaster University, Hamilton (Canada), July 2005.

Buteau, C. (2004). *A Model of Motivic Analysis of Music.* Presentation at the Graduate Colloquium, ETH Zurich, Zurich (Switzerland), June 2004.

Also, organisation of seminars:

Buteau, C. & J. Mgombelo (since Fall 2013). Math Ed Seminar Series @ Brock. Instigators and organizers of the seminar series (2-4 invited seminars/year).

D. Earn & **Buteau**, C. (2005). *Music Research Day*. Department of Mathematics of McMaster University, Hamilton (Canada), July 2005.

SCIENTIFIC POPULARISATION ARTICLES

Buteau, C. (2008). *Quelques liens entre musique et mathématiques*. Actes du 49e congrès Association mathématique du Québec, University of Sherbrooke, May-June 2006, 43-49.

Buteau, C. (2006). *Another Summer's Dalliance: The Musical Group*. Ontario Mathematics Gazette, 44(4), 20-21.

Buteau, C. (2000). *Et si les maths nous aidaient à mieux comprendre la musique?* Mathématiques d'hier et d'aujourd'hui, Collection L'Astéroïde, Modulo-Éditeur, Mont- Royal, Canada, 91-96.

DISSEMINATION TO PROFESSIONAL ASSOCIATIONS

University mathematics professors

Buteau, C. & Muller, E. (2017). *When a university mathematics department adopted course mathematics courses of unintentionally constructionist nature – really?* Online video posted on : https://www.youtube.com/watch?v=SNvTdaG04gc&feature=youtu.be

Buteau, C. & Muller, E. (2017). *Programming and Mathematics at Brock University (Canada).* Online video excerpt posted on : https://www.youtube.com/watch?time_continue=12&v=AeTmwVrK4uM

Muller, E., **Buteau**, C., & Sacristán, A. (2015). Through the Looking-Glass: Programming interactive environments for advanced mathematics. Hoyles & Noss (guest eds.): Special issue *Windows on Advanced Mathematics* in *Mathematics Today*, 212-217.

Buteau, C., & Lovric, M. (2015). Undergraduate Math Curriculum in 21st Century: Dictated by the Job Market? *Canadian Mathematical Society Notes, 47*(2), 10-12.

Buteau, C., Jarvis, D. & Lavicza Z. (2014). About your Use of Computer Algebra Systems in University Teaching: A Canadian Survey. *Canadian Mathematical Society, 46*(4), 8.

Buteau, C., Hardy, N., & Mgombelo, J. (2014). Should (or does) mathematics education research inform our mathematics teaching practices? / Est-ce que la recherche en didactique des mathématiques informe (ou devrait informer) notre enseignement des maths? *Canadian Mathematical Society Notes, 46*(6), 10-11.

Buteau, C., D. Jarvis & Z. Lavicza (2011). Technology Use in Undergraduate Mathematics Teaching and Learning. *Fields Notes*, 11(2), 10, 20.

Jarvis, D., **Buteau**, C. & Z. Lavicza (2009). Technology Use in Post-Secondary Mathematics Instruction: Report of a CMS Winter 2008 Meeting Session. *Canadian Mathematical Society Notes*, 41(4), 6-7.

Ben-El-Mechaiekh, H., **Buteau**, C., Ralph, B. (2007). MICA: A Novel Direction in Undergraduate Mathematics Teaching. *Canadian Mathematical Society Notes*, 39(6), 9-11.

School mathematics teachers – Articles in professional journals

Buteau, C. & Muller, E. (2017). Coding + Math at University: Just like Mathematicians do it! In *Math+Code'Zine,* 2 (3), May 2017.

Mulder, A., with **Buteau**, C. (2017). Needles, pi(e) and coding, In *Math+Code'Zine,* 2 (3), May 2017.

Broley, L, **Buteau**, C., & Muller, E. (2015). *The E-Brock Bugs computer game: What if becoming a (better) mathematician was a fun-filled adventure?* Ontario Mathematics Gazette, 53(3), 27-32.

Buteau, C., Camilleri, S., Fodil, K., Lacroix, M.-E., Mgombelo, J. (2008). *Fantasy Fractions: When a Grade 5 Class Creates Computer Mathematics Games*. Ontario Mathematics Gazette, 46(3), 26-30.

Buteau, C., Camilleri, S., Fodil, K., Lacroix, M.-E., Mgombelo, J. (2008). *Fractions Fantastiques*: *Lorsqu'une classe de 5e année crée un jeu informatique de mathématiques*. *Revue Envol*, 143, 19-23.

Buteau, C. (2007). *Technology in University Mathematics Instruction? At Brock, Yes!* Ontario Mathematics Gazette, 46(2), 26-27.

School mathematics teachers – Presentations and workshops at their conferences

Buteau, C. & N. Marshall (2017). *Coding icebreaker: In/for math learning*. Workshop at Ontario Association for Mathematics Education (OAME) Annual Meeting, Kingston (Canada), May 11-13, 2017.

Buteau, C. & N. Marshall (2017). *E-Brock Bugs: Computer "game" your MDM4U class!* Workshop at Ontario Association for Mathematics Education (OAME) Annual Meeting, Kingston (Canada), May 11-13, 2017.

Buteau, C. & Khan, S. (2017). *Coding icebreaker: In/for math learning*. Workshop for K-8 teachers at the Ontario Association for Mathematics Education (OAME) Annual Regional Chapter Meeting, Brock University, St. Catharines (Canada), April 2017.

Buteau, C. (2014). *Math Computer Game.* Workshop at Ontario Association for Mathematics Education (OAME) Annual Meeting, Toronto (Canada), May 2014.

Buteau, C. (2014). *Digital technology: What Research Has to Say!* Presentation at Ontario Association for Mathematics Education (OAME) Annual Meeting, Toronto (Canada), May 2014.

Buteau, C. & Broley, L. (2013). *Assessment in the Digital Era.* Workshop at Ontario Association for Mathematics Education (OAME) Annual Meeting, Toronto (Canada), May 2013.

Buteau, C. & Broley, L. (2013). *Grade 12 Math Computer Games (MDM4U – MCV4U)*. Workshop at Ontario Association for Mathematics Education (OAME) Annual Meeting, Toronto (Canada), May

2013.

Buteau, C. (2013, 2009, 2006-2007). *Math and Music: From Pythagoras until Today.* Presentation at Ontario Association for Mathematics Education (OAME) Annual Meeting.

Buteau, C., Corbett, J., with Mgombelo, J. (2007). *Recreational Maths Activities: Let's Play!* Workshop at Ontario Association for Mathematics Education (OAME) Annual Regional Chapter Meeting, Brock University, St. Catharines (Canada), April 2007.

Buteau, C., Poulin, D. (2006). *Mathématiques et Musique*. Presentation at congrès annuel de l'Association des Mathématiques du Québec (AMQ), Université de Sherbrooke, Sherbrooke (Canada), June 2006.

Buteau, C. (2006). *From Brain to Computer and Back*. Presentation at Ontario Association for Mathematics Education (OAME) Annual Regional Chapter Meeting, Brock University, St. Catharines (Canada), May 2006.

Buteau, C. (2005). *Maths & Music*. Short presentation at Ontario Association for Mathematics Education (OAME) Annual Regional Chapter Meeting , Brock University, St. Catharines (Canada), April 2005.

Buteau, C. (2004). *Application mathématique à la musique: Espaces de mélodies.* Presentation at congrès annuel de l'Association mathématique du Québec (AMQ), Cégep Lévis-Lauzon, Lévis (Canada), October 2004.

UNIVERSITY COMMUNITY SERVICE

Internal

2016 – …	Library liaison officer
2016 – …	Departmental committee for sessional & ILTA teaching
2008, 2015 – …	Departmental committee for service courses
2011 – …	Departmental committee for Future Mathematics Teachers (chair)
2004 – 09, 11 – …	Departmental undergraduate curriculum committee (chair & member)
2004 – 09, 15 – …	Departmental Outreach Committee (chair & member)
2008 – 09 , 17	Inter-faculty Concurrent Program Committee
2005 – 06	Departmental MSc Committee
2005	Master Committee as Dean's Delegate

External

2012 – …	Webmaster of online registration for *Canadian Mathematics Education Study Group* (CMESG)
2012 – 15	Webmaster for *Canadian Mathematics Education Study Group* (*CMESG)* website
2010 – 11	Executive member of *Canadian Mathematics Education Study Group* (*CMESG)*
2007 – …	Elected member of the committee for the *Society of Mathematics and Computation in Music*

TEACHER COMMUNITY SERVICE: EVENTS ORGANISATION

Provincial

2010 Local organizer for the *Ontario Association for Mathematics Education 2010 Annual Conference*, May 10-12, 2010.

Regional

2014 – … Local co-organizer (with Joyce Mgombelo and Steven Khan, Faculty of Education) of the regional chapter of the international Math Kangaroo Contest, including a related regional award ceremony.

2010 Coordinator of *Show Math* event hosted by Brock University Faculty of Mathematics and Science and Faculty of Education on May 12 for Niagara region Grade 9-12 school students., May 2010

2005 – … Local organizer (since 2013, co-organizer with Joyce Mgombelo, Faculty of Education) of the annual meeting for the *Ontario Association for Mathematics Education Golden Section*.

COMMUNITY SERVICE

Buteau, C. (2012). Invited scientific table host ("mathematics and music") in the *Royal Canadian Institute*'s "Science 2012 Gala", MaRS auditorium, Toronto, April 26, 2012.

PROFESSIONAL DEVELOPMENT

Workshops hosted by funding agency:

2004 (Aug) NSERC General Information Session (hosted by NSERC), Brock University

Workshops hosted by Brock University:

2014 (June) Grant Writing Workshop. Facilitators: Office of Research Services

2014 (May) Research Leadership Day. Facilitators: Office of Research Services

2005 (May) *Best Practices in Teaching and Learning Symposium: Assessment and Evaluation* workshop, Brock CTLET

2004 - 05 CTLET workshop *Faculty Development Series*. Facilitators: Dr. Maureen Connolly and Jill Grose

Henryk Fukś **Curriculum Vitae**

CONTACT INFORMATION

Department of Mathematics
Brock University
St. Catharines, Ontario
Canada L2S 3A1

Phone: +1 905 688 5550 ext. 3296
Fax: +1 905 682 9020
E-mail: hfuks@brocku.ca
WWW: http://lie.math.brocku.ca/~hfuks

A. EDUCATION

- University of Illinois at Chicago. Doctor of Philosophy in Physics, December 1997. Advisor: Prof. Nino Boccara. Thesis topic: "Cellular Automata Models of Diffusion of Information and Highway Traffic Flow".
- University of Illinois at Chicago. Master of Science in Physics, May 1996. Bachelor of Science in Physics with College Honors and with Highest Distinction in Physics, May 1993.
- Jagiellonian University, Kraków, Poland. Studies at the Faculty of Mathematics and Physics, 1987–1990.

B. ACADEMIC DISTINCTIONS AND AWARDS

- Faculty of Mathematics and Science Distinguished Research Award, Brock University (2018)
- Faculty Award for Excellence in Teaching, Brock University (2005)
- Postdoctoral Fellowship, Natural Sciences and Engineering Research Council of Canada (1998–2000)
- University of Illinois Graduate Fellowship, awarded twice (for academic year 1995/96 and 1996/97)
- Larry L. Abels Memorial Scholarship, University of Illinois at Chicago (May 1993)
- Rector's Award two times, Jagiellonian University (1988, 1989)
- Science Scholarship for three years, Jagiellonian University (1988–1990)

C. ACADEMIC POSITIONS HELD

- Professor, Department of Mathematics, Brock University, July 2012–present
- Adjunct Professor, Department of Physics, Brock University, August 2004–present
- Associate Professor, Department of Mathematics, Brock University, July 2003–July 2012
- Assistant Professor, Department of Mathematics, Brock University, 2000-2003
- Special Graduate Faculty, Department of Mathematics and Statistics, University of Guelph (2000-2002)
- NSERC Postdoctoral Fellow, Department of Mathematics and Statistics, University of Guelph (Guelph, ON), 1998–2000.
- The Fields Institute for Research in Mathematical Sciences (Toronto, ON), 1998–2000:
  - *Probability and Its Applications*, Program Visitor, August 1998 – August 1999
  - Non-Program Visitor, September 1999 – June 2000
- NCE-MITACS (Network of Centres of Excellence - Mathematics of Information Technology and Complex Systems) part-time postdoctoral fellow:
  - *Mathematical and Computer Modelling of Epidemics with Public Health Applications*, January 1999 – June 2000
  - *Building and Modelling Semiconductor Nanostructures Using Cellular Automata*, September 1999 – June 2000
- Graduate Fellow, Department of Physics, University of Illinois at Chicago (Chicago, IL), 1995-1997

D. CREATIVE AND SCHOLARLY ACTIVITIES

JOURNAL ISSUES EDITED

- H. Fukś and A. Lawniczak, Eds., Summer Solstice 2015 International Conference on Discrete Models of Complex Systems, special issue of *Acta Physica Polonica B*, vol. 9 no. 1, (2016)
- H. Fukś and A. Lawniczak, Eds., AUTOMATA 2007, 13th International Workshop on Cellular Automata, special issue of *Journal of Cellular Automata*, part I, vol. 4 no. 2, (2009)
- H. Fukś and A. Lawniczak, Eds., AUTOMATA 2007, 13th International Workshop on Cellular Automata, special issue of *Journal of Cellular Automata*, part II, vol. 4 no. 3, (2009)
- H. Fukś and A. Lawniczak, Eds., AUTOMATA 2007, 13th International Workshop on Cellular Automata, special issue of *Journal of Cellular Automata*, part III, vol. 5 no. 6, (2010)

CHAPTERS CONTRIBUTED TO BOOKS

- John Clements, Babak Farzad, and Henryk Fukś. Dynamics of large-scale networks following a merger. In Tansel Özyer and Reda Alhajj, editors, *Machine Learning Techniques for Online Social Networks*, Lecture Notes in Social Networks, pages 173–193. Springer, Cham, 2018
- Henryk Fukś. Orbits of Bernoulli measures in cellular automata. In Robert A. Meyers, editor, *Encyclopedia of Complexity and Systems Science*, pages 1–19. Springer, Berlin, Heidelberg, 2017
- H. Fukś. Computing the density of ones in probabilistic cellular automata by direct recursion. In P. Y. Louis and F. R. Nardi, editors, *Probabilistic Cellular Automata - Theory, Applications and Future Perspectives*, 2017. To appear in Lecture Notes in Computer Science
- H. Fukś. Mysterious sequence in A. A. Kochański's Observationes Cyclometricae. In W. Więsław, editor, *Dzieje matematyki polskiej (History of Polish mathematics)*, pages 97–109. Instytut Matematyki Uniwersytetu Wrocławskiego, Wrocław, 2012
- H. Fukś. *Modeling, Simulation, and Optimization*, chapter Cellular automata simulations - tools and techniques, pages 223–243. IN-TECH, Vienna, 2009. ISBN 978-953-307-056-8
- A. Gerisch, A.T. Lawniczak, R. A. Budiman, H. Fukś, and H. E. Ruda. Surface roughening in homoepitaxial growth: a lattice gas cellular automaton model. In M. A. Sloot, B. Chopard, and A. G. Hoekstra, editors, *Cellular Automata*, pages 286–295, Heidelberg, 2004. Springer
- H. Fukś. A class of cellular automata equivalent to deterministic particle systems. In A. T. Lawniczak S. Feng and R. S. Varadhan, editors, *Hydrodynamic Limits and Related Topics*, Fields Institute Communications Series, Providence, RI, 2000. AMS
- N. Boccara and H. Fukś. Modeling diffusion of innovations with probabilistic cellular automata. In M. Delorme and J. Mazoyer, editors, *Cellular Automata: A Parallel Model*, Dordrecht, 1998. Kluwer Academic Publishers

ARTICLES IN REFEREED JOURNALS

- K. Brudzynski, D. Miotto, L. Kim, C. Sjaarda, L. Maldonado-Alvarez, and H. Fukś. Active macromolecules of honey form colloidal particles essential for honey antibacterial activity and hydrogen peroxide production. *Scientific Reports*, 7:1–15, 2017
- H. Fukś. Explicit solution of the Cauchy problem for cellular automaton rule 172. *J. of Cellular Automata*, 12(6):423–444, 2017
- H. Fukś and J. Midgley-Volpato. An example of a deterministic cellular automaton exhibiting linear-exponential convergence to the steady state. *Acta Phys. Pol. B*, 9(1):49–62, 2016

– H. Fukś. Three mathematical papers of Adam Adamandy Kochański – annotated English translation. *Antiquitates Mathematicae*, 9:31–65, 2015

– H. Fukś and N. Fatès. Local structure approximation as a predictor of second-order phase transitions in asynchronous cellular automata. *Natural Computing*, 14:507–522, 2015

– H. Fukś. Solving two-dimensional density classification problem with two probabilistic cellular automata. *Journal of Cellular Automata*, 10(1–2):149–160, 2015

– H. Fukś and J-M. Gómez Soto. Exponential convergence to equilibrium in cellular automata asymptotically emulating identity. *Complex Systems*, 23:1–26, 2014

– H. Fukś. Minimal entropy approximation for cellular automata. *J. of Statistical Mechanics: Theory and Experiment*, 4:P02009, April 2014

– H. Fukś, B. Farzad, and Y. Cao. A model of language inflection graphs. *Int. J. Mod. Phys. C*, 25(6):1450013, 2014

– H. Fukś. Construction of local structure maps for cellular automata. *J. of Cellular Automata*, 7:455–488, 2013

– H. Fukś. Adam Adamandy Kochański's approximations of π: reconstruction of the algorithm. *Mathematical Intelligencer*, 34:40–45, December 2012

– H Fukś and A. Skelton. Orbits of Bernoulli measure in asynchronous cellular automata. *Dis. Math. Theor. Comp. Science*, AP:95–112, 2011

– J-M. Gómez Soto and H. Fukś. Performance of the majority voting rule in solving the density classification problem in high dimension. *J. Phys. A: Math. Theor.*, 44:art. no. 445101, 2011

– H. Fukś. Probabilistic initial value problem for cellular automaton rule 172. *DMTCS proc.*, AL:31–44, 2010

– H. Fukś and A. Skelton. Response curves for cellular automata in one and two dimensions – an example of rigorous calculations. *International Journal of Natural Computing Research*, 1:85–99, 2010

– H. Fukś and J. Haroutunian. Catalan numbers and power laws in cellular automaton rule 14. *Journal of cellular automata*, 4:99–110, 2009

– H. Fukś and M. Krzemiński. Topological structure of dictionary graphs. *J. Phys. A: Math. Theor.*, 42:art. no. 375101, 2009

– H. Fukś. Remarks on the critical behavior of second order additive invariants in elementary cellular automata. *Fundamenta Informaticae*, 78:329–341, 2007

– H. Fukś and K. Sullivan. Enumeration of number-conserving cellular automata rules with two inputs. *Journal of Cellular Automata*, 2:141–148, 2007

– N. Boccara and H. Fukś. Motion representation of one-dimensional cellular automaton rules. *Int. J. Mod. Phys. C*, 17:1605–1611, 2006

– H. Fukś. Dynamics of the cellular automaton rule 142. *Complex Systems*, 16:123–138, 2006

– H. Fukś, A. T. Lawniczak, and R. Duchesne. Effects of population mixing on the spread of SIR epidemics. *Eur. Phys. J. B*, 50:209–214, 2006

– A. T. Lawniczak, H. Fukś, and B. Di Stefano. Individually based SIR models, their motivation, and their spatio-temporal dynamics. *Dyn. Contin. Discrete Impuls. Syst. Ser. A Math. Anal.*, 13B(suppl.):437–455, 2006

– H. Fukś. Critical behaviour of number-conserving cellular automata with nonlinear fundamental diagrams. *J. Stat. Mech.: Theor. Exp.*, 2004. art. no. P07005

– H. Fukś. Probabilistic cellular automata with conserved quantities. *Nonlinearity*, 17:159–173, 2004

– H. Fukś. Sequences of preimages in elementary cellular automata. *Complex systems*, 14:29–43, 2003

– N. Boccara and H. Fukś. Number-conserving cellular automaton rules. *Fundamenta Informaticae*, 52:1–13, 2002

– H. Fukś. Non-deterministic density classification with diffusive probabilistic cellular automata. *Phys. Rev. E*, 66:066106, 2002

– H. Fukś and N. Boccara. Convergence to equilibrium in a class of interacting particle systems. *Phys. Rev. E*, 64:016117, 2001

– H. Fukś and A. T. Lawniczak. Individual-based lattice model for the spatial spread of epidemics. *Discrete Dynamics Dynamics in Nature and Society*, 6:191–200, 2001

– H. Fukś, A. T. Lawniczak, and S. Volkov. Packet delay in models of data networks. *ACM Transactions on Modelling and Simulations*, 11:233–250, 2001

– N. Boccara and H. Fukś. Critical behavior of a cellular automaton highway traffic model. *J. Phys. A: Math. Gen.*, 33:3407–3415, 2000

– H. Fukś. Exact results for deterministic cellular automata traffic models. *Phys. Rev. E*, 60:197–202, 1999

– H. Fukś and A. T. Lawniczak. Performance of data networks with random links. *Mathematics and Computers in Simulation*, 51:103–119, 1999

– N. Boccara and H. Fukś. Cellular automaton rules conserving the number of active sites. *J. Phys. A: Math. Gen.*, 31:6007–6018, 1998

– H. Fukś and N. Boccara. Generalized deterministic traffic rules. *Int. J. Mod. Phys. C*, 9:1–12, 1998

– N. Boccara, H. Fukś, and S. Geurten. A new class of automata networks. *Physica D*, 103:145–154, 1997

– N. Boccara, H. Fukś, and Q. Zeng. Car accidents and number of stopped cars due to road blockage on a one-lane highway. *J. Phys. A: Math. Gen.*, 30:3329–3332, 1997

– H. Fukś. Solution of the density classification problem with two cellular automata rules. *Phys. Rev. E*, 55:2081R–2084R, 1997

ARTICLES PUBLISHED IN REFEREED CONFERENCE PROCEEDINGS

– Henryk Fukś and Francis Kwaku Combert. Evaluating the quality of local structure approximation using elementary rule 14. In Jan M. Baetens and Martin Kutrib, editors, *Cellular Automata and Discrete Complex Systems - 24th IFIP WG 1.5 International Workshop, AUTOMATA 2018, Ghent, Belgium, June 20-22, 2018, Proceedings*, volume 10875 of *Lecture Notes in Computer Science*, pages 43–56. Springer, 2018

– H. Fukś. Magic squares of subtraction of Adam Adamandy Kochański. In Maria Zack and Elaine Landry, editors, *Research in History and Philosophy of Mathematics – The CSHPM 2016 Annual Meeting in Calgary, AB*, pages 81–95. Springer, 2017

– J. Clements, B. Farzad, and H. Fukś. Dynamics of large scale networks following a merger. In Ravi Kumar, James Caverlee, and Hanghang Tong, editors, *Proceedings of the 2016 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, ASONAM 2016*, pages 471–476, 2016

– H. Fukś and J. Midgley-Volpato. An example of degenerate hyperbolicity in cellular automaton with 3 states. In J. Kari, I. Törmä, and M. Szabados, editors, *21st International Workshop on Cellular Automata and Discrete Complex Systems*, volume 24 of *TUCS Lecture Notes*, pages 47–55, Turku, Finland, 2015

– H. Fukś and N. Fatès. Bifurcations of local structure maps as predictors of phase transitions in asynchronous cellular automata. In *Lecture Notes in Computer Science*, volume 8751, pages 556–560. Springer, 2014

– H. Fukś and A. Skelton. Classification of two-dimensional binary cellular automata with respect to surjectivity. In *Proceedings of the 2012 International Conference on Scientific Computing: CSC-2012*, pages 51–57. CSERA Press, 2012

– H. Fukś and A. Skelton. Response curves and preimage sequences of two-dimensional cellular automata. In *Proceedings of the 2011 International Conference on Scientific Computing: CSC-2011*, pages 165–171. CSERA Press, 2011

– H. Fukś. Inflection system of a language as a complex network. In *Proceedings of 2009 IEEE Toronto International Conference – Science and Technology for Humanity TIC-STH 2009*, pages 491–496, 2009

– H. Fukś and M. Krzeminski. Core decomposition spectra of large graphs and their applications in modelling. In E. Wamkeue, editor, *Proceedings of the 19th IASTED International Conference on Modelling and Simulation*, pages art. no. 620–143. Acta Press, 2008

– H. Fukś and C. Phipps. Toward a model of language acquisition threshold. In E. Wamkeue, editor, *Proceedings of the 17th IASTED International Conference on Modellin g and Simulation*, page 263. Acta Press, 2006

– H. Fukś, R. Duchesne, and A. Lawniczak. Spatial correlations in SIR epidemic models. In *Proceeding of 7th WSEAS International Conference on Applied Mathematics, Canun, Mexico, May 11-14 2005*, pages 108–113, 2005

– A. Gerisch, A. T. Lawniczak, R. A. Budiman, H. E. Ruda, and H. Fukś. Lattice gas cellular automaton modeling of surface roughening in homoepitaxial growth in nanowires. In *Proceedings of Canadian Conference on Electrical and Computer Engineering, Montreal, May 2003*, pages 1413–1416, 2003

– B. Di Stefano, H. Fukś, and A. T. Lawniczak. Application of fuzzy logic in CA/LGA models as a way of dealing with imprecise and vague data. In *Proceedings of Canadian Conference on Electrical and Computer Engineering, Halifax, May 2000*, pages 212–217, 2000

– B. Di Stefano, H. Fukś, and A. T. Lawniczak. Object-oriented implementation of CA/LGCA modelling applied to the spread of epidemics. In *Proceedings of Canadian Conference on Electrical and Computer Engineering, Halifax, May 2000*, pages 26–31, 2000

NON-REFEREED PUBLICATIONS

– H. Fukś. Mathematical formulae on coins. part 1: Einstein. *The Canadian Numismatic Journal*, 61(4):167–169, 2016

– H. Fukś. Mathematical formulae on coins. part 2: from Pythagoras to the 20th century. *The Canadian Numismatic Journal*, 61(5):208–213, 2016

– H. Fukś "Mathematics on coins, part I: The Tale of Two Queens and Two Towering Figures", *The Canadian Numismatic Journal*, vol. 57 No. 5 (2012), pp. 304-315

– H. Fukś, "Solutio Theorematum by Adam Adamandy Kochański - Latin text with annotated English translation", arXiv:1111.1688 p. 1-13, 2011

– H. Fukś, "Observationes Cyclometricae by Adam Adamandy Kochański - Latin text with annotated English translation", arXiv:1106.1808 p. 1-7, 2011

– H. Fukś and A. T. Lawniczak, "Workshop on Cellular Automata", Fields Notes vol. 8:2 (January 2008)

– H. Fukś (2006), "Percolation models", Wiadomości Naftowe i Gazowe 7(99), 14-16 (in Polish).

– H. Fukś (2000). "Regularities in sequences of numbers of preimages in elementary cellular automata." Report FI-NP-2000-001, The Fields Institute for Research in Mathematical Sciences, Toronto.

– H. Fukś, A. T. Lawniczak, and B. Di Stefano (2000). "Epilab: software implementation of epidemic models based on lattice gas cellular automaton." Report FI-NP-2000-003, The Fields Institute for Research in Mathematical Sciences, Toronto.

CONFERENCE PRESENTATIONS

The following abbreviations are used:
R - Presentation with fully refereed paper
A - Presentation with refereed abstract
I - Invited presentations

– H. Fukś, *Explorations of ternary cellular automata*, Summer Solstice 2018 Conference on Discrete Models of Complex Systems, Gdańsk, Poland, June 25-27, 2018.

– H. Fukś, *Approximating cellular automata by finite-dimensional maps*, 24th Annual International Workshop on Cellular Automata (CAs) and Discrete Complex Systems AUTOMATA 2018, Ghent, Belgium June 20. (**I**)

– H. Fukś, *Evaluating the quality of local structure approximation using elementary rule 14*, 24th Annual International Workshop on Cellular Automata (CAs) and Discrete Complex Systems (DCSs) AUTOMATA 2018, Ghent, Belgium, June 21. (**R**)

– H. Fukś, *Open problems from the 17th century: Adam Adamandy Kochanski and his mathematical works*, 2016 Annual Meeting of the Canadian Society for History and Philosophy of Mathematics, Calgary, May 30, 2016 (**A**)

– J. Clements, H. Fukś, and B. Farzad, *Dynamics of Large Scale Networks Following a Merger* , IEEE/ACM ASONAM 2016, Calgary, 18–21 August, 2016 (**R**, presented by J. Clements)

– H. Fukś, *Hyperbolic and degenerate hyperbolic behaviour in cellular automata*, 2015 Summer Solstice International Conference on Discrete Models of Complex Systems, June 19, 2015, Toronto, Canada

– H. Fukś and J. Midgley-Volpato, *Degenerate hyperbolicity in cellular automata*, Automata 2015, Turku, Finland, August 6, 2015. (**R**)

– H. Fukś and N Fatés, *Bifurcations of local structure maps as predictors of phase transitions in asynchronous cellular automata*. Workshop on Asynchronous Cellular Automata, part of ACRI 2014 - Cellular Automata for Research and Industry, Kraków, Poland, September 2014 (**R**)

– *Can stochasticity increase performance of cellular automata in solving density classification problem in two dimensions?* Unconventional Computation and Natural Computation 2014, London, Canada, June 2014 (**A**)

– *Local structure maps in cellular automata*, 2013 Summer Solstice International Conference on Discrete Models of Complex Systems, 27–29 June 2013, Warsaw, Poland

– *Inflection graphs and their models*, 37th Conference of the Middle European Cooperation in Statistical Physics, MECO37, Tatranské Matliare, Slovakia, March 19–21, 2012

– *Scaling in inflection graphs*, The International Nonlinear Science Conference, Barcelona, Spain, 15-17 March 2012

– *Orbits of the Bernoulli measure in single-transition asynchronous cellular automata*, Automata 2011: University of Chile, Santiago, Chile, November 21, 2011 **R**

– *Probabilistic initial value problem for cellular automaton rule 172*, Automata 2010, Nancy, France, June 14–16, 2010 (**R**)

– *Vocabulary of human languages as a complex system*, Summer Solstice 2009 International Conference on Discrete Models of Complex Systems, Gdańsk, Poland, 22-24 June 2009 (**I**)

– *Inflection system of a language as a complex network*, IEEE Toronto International Conference - Science and Technology for Humanity, Toronto, September 2009 (**R**)

– *Core Decomposition Spectra of Large Graphs and their Applications in Modelling*, presented at 19th IASTED International Conference on Modelling and Simulation, May 2008 (**R**)

– *Enumeration of number-conserving cellular automata*, presented at CANADAM conference, Banff, May 2007 (**I**)

– *Preimage trees in cellular automata*, 13th International Workshop on Cellular Automata AUTOMATA 2007, August 30, 2007 (**A**)

– *Combinatorial Structure of Pre-Image Trees in Cellular Automata*, NKS 2008, July 13, 2007 (**A**)

– *Toward a Model of Language Acquisition Threshold*, 17th IASTED International Conference on Modelling and Simulation, Montreal, May 2006 (**R**).

– *Dynamics of the language acquisition process*, Southern Ontario Dynamics Day Workshop, The Fields Institute, Toronto, April 7, 2006 (**I**).

– *Phase transitions in cellular automata with additive invariant*, AUTOMATA 2005, 11th Workshop on Cellular Automata, Gdansk, Poland, 3-5 September 2005 (**I**).

– *Spatial correlations in SIR epidemic models*, 7th WSEAS International Conference on Applied Mathematics , Canun, Mexico, May 11-14 2005 (**R**).

– *Number-conserving probabilistic cellular automata*, AIMS Fifth International Conference on DSDE June 16, 2004, Pomona, California (**I**).

– *Localized structures in number conserving cellular automata*, American Physical Society meeting in Montreal, March 24, 2004 (*Bulletin of the APS*, 49:1002 (2004) (**A**).

– *Discrete Models of Intersecting Granular Flows with Storage Rings*, First Joint Meeting of CAIMS and SIAM, June 16-20, 2003, Montreal, QC, Canada. (**A**).

– *Computation in simple models of parallelism* CASCON 2000 (IBM Centre for Advanced Studies Conference), Toronto, October 1, 2002.

– *Dynamics of two-dimensional cellular automata with additive invariants*, SIAM 50th Anniversary Meeting, Philadelphia, PA, June 2002 (**A**).

– *Dynamics of density-conserving cellular automata*, SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 2001 (**A**).

– *Dynamics of data network models with random links*, Dynamical Networks in Complex Systems Conference, University of Kiel, Germany, July 2001 (**A**).

– *Individual-based lattice model for spatial spread of epidemics*, poster and software demonstration, MITACS (Mathematics of Information Technology and Complex Systems) Annual Meeting, June 6-7, 2000.

– *EPILAB: modeling and simulation of epidemics*, poster and Technology Showcase software demonstration at CASCON 2000 (IBM Centre for Advanced Studies Conference), Toronto, November 13-16, 2000.

– *Spatial Epidemic Models*, meeting of MITACS project on Mathematical and Computer Modeling of Epidemics with Public Health Applications, The Fields Institute for Research in Mathematical Sciences, Toronto, September 1999.

– *Dynamics of Cellular Automata Rules Conserving the Number of Active Sites*, Dynamics Day, McMaster University, Hamilton, February 1999 (**I**).

– *Agent-based Simulations of Epidemics*, meeting of MITACS project on Mathematical and Computer Modeling of Epidemics with Public Health Applications, The Fields Institute for Research in Mathematical Sciences, Toronto, January 1999 (**I**).

– *Simulations of Complex Systems Dynamics with Lattice Models Using Parallel Update Algorithms*, IBM Centre for Advanced Studies Conference (CASCON'99), Mississauga, Ontario, November 10, 1999.

– *Cellular Automata Conserving the Number of Active Sites*, Workshop on Hydrodynamic Limits, The Fields Institute for Research in Mathematical Sciences, Toronto, October 1998. (**I**).

OTHER PRESENTATIONS

– *Can you solve cellular automata?*, Trent University, Peterborough, invited colloquium talk, March 18, 2010
– *Euler vs. Lagrange: additive invariants in discrete dynamics*, University of Guelph, Department of Mathematics and Statistics, invited colloquium talk, November 2, 2004
– *Pleasures of discrete dynamics*, Brock Institute for Scientific Computing, October 2002.
– *Collective phenomena induced by transport*, University of Guelph, Department of Mathematics and Statistics, March 9, 2000.
– *Cellular and lattice gas automata models of complex systems with a large number of interacting components*, Brock University, Department of Mathematics, March 3, 2000.
– *Collective Dynamics of Data Network Models with Random Links* and *Propagation of Epidemic Waves in Lattice Gas Automata SIR Model*, posters, Guelph-Waterloo Physics Institute Info Night, Waterloo, January 27, 2000.
– Seminar series on cellular automata and their applications, Department of Mathematics and Statistics, University of Guelph
  – *Lattice Gas Automata Models of Epidemics*, October 14, 1999
  – *Cellular Automata Theory and Applications I: Introduction*, October 21, 1999
  – *Cellular Automata Theory and Applications II: Models of Traffic and Granular Flow*, October 28, 1999.
– Demonstration of software simulations of spatial models of complex systems, *Cases in Applied Mathematics* seminar, University of Toronto, November 29, 1999.
– *Spatial Epidemic Models*, demonstration presented at The Fields Institute Open House, Toronto, February 5, 1999.
– *Cellular Automata and Granular Flow*, Department of Applied Mathematics, University of Western Ontario, London, December 1998.
– *Modeling Real World Phenomena with Cellular Automata*, UIC Department of Economics, November 1997.
– *Cellular Automata Models for Diffusion and Transport Phenomena in Complex Systems*, Santa Fe Institute, Santa Fe, New Mexico, April 1997.
– *Diffusion of Information*, Condensed Matter Physics Seminar, UIC Department of Physics, November 1996.

GRANTS OBTAINED

– NSERC Discovery grant, *Computational problems in spatially Â■extended discrete dynamical systems*, $11,000, 2015–2020.
– NSERC Discovery Grant, *Large complex graphs in discrete dynamical systems*, $12000/year, 2010-2015.
– The Fields Institute conference grant, $10,000, to organize AUTOMATA 2007 (13-th International Workshop on Cellular Automata), co-applicant with A. Lawniczak
– NSERC Discovery Grant, *Dynamical processes on complex networks*, $9000/year, 2005-2010.
– NSERC strategic grant, *Microbial Food Safety -Integrated Modelling Techniques*, $200,000 per year (group grant administered by University of Guelph), 2002-2005, co-applicant with M. Griffiths (University of Guelph) *et. al.*

– NSERC individual research grant, *Development of new mathematical methods for intermediate level analysis of dynamics of complex systems*, $12,000/year, 2001-2004.

– Brock University start-up grant, $9,100, 2000–2001.

– financial support form Santa Fe Institute to attend Complex Systems Summer School, Summer 1995.

EDITORIAL BOARDS OF JOURNALS

– Member of the Editorial Board of *Journal of Cellular Automata*, 2008–present

– Member of International Editorial Review Board of *International Journal of Natural Computing Research* (2009–present)

– Associate Editor (2006–2008) and member of the Editorial Board (2008-present) of *International Journal of Applied Mathematics and Statistics*

– Guest editor for special issues of *Journal of Cellular Automata*: vol. 4 no. 2 and 3, (2009), vol. 5 no. 6, (2010).

MEMBERSHIP IN PROGRAM COMMITTEES

– Scientific Program Committee of SUMMER SOLSTICE 2018, International Conference on Discrete Models of Complex Systems, Gdańsk, Poland, June 25–27, 2018

– Programme committee of Automata 2018, Ghent, Belgium, June 20–22, 2018

– Program Committee of the Asynchronous Cellular Automata workshop, part of ACRI conference, Fez, Morocco, September 5-8, 2016.

– Scientific Program Committee of SUMMER SOLSTICE 2015, International Conference on Discrete Models of Complex Systems

– Program Committee of TCA 2014 - Workshop on TRAFFIC AND CELLULAR AUTOMATA

– Program Committee of SUMMER SOLSTICE 2014, International Conference on Discrete Models of Complex Systems

– International Program Committee of the 4th Workshop on Cellular Automata Algorithms and Architectures, July 1–5, 2013, Helsinki, Finland

– Program Committee of TCA – Second International Workshop on Traffic and Cellular Automata, Santorini, Greece, September 24-27, 2012

– Program Committe of AUTOMATA 2011, Santiago, Chile

– Scientific Programme Committee of Summer Solstice 2011, International Conference on Discrete Models of Complex Systems, 6-10 June 2011, Turku, Finland

– Program Committee of TCA 2010 - First International Workshop on Traffic And Cellular Automata, Ascoli Piceno, Italy, September 21, 2010

– Program Committee of ACA- First international workshop on Asynchronous Cellular Automata, Ascoli Piceno, Italy, September 21, 2010

– Program Committee of Special Session on Cellular Automata, Algorithms and Architectures (CAAA 2010) at HPCS 2010, Caen, France, June 28 – July 2, 2010

– Steering Committee and the Program Committee of AUTOMATA 2010, Nancy, France, 14th – 16th June 2010.

– Program Committee of AUTOMATA 2009

– Program Committee of Summer Solstice 2009 International Conference on Discrete Models of Complex Systems

– Scientific Committee of The 9th WSEAS International Conference on Applied Mathematics (MATH 06)

REFEREED ARTICLES FOR JOURNALS

- *Automata 2015* proceedings
- *Fundamenta Informaticae*
- *Theory of Computing Systems*
- *Journal of Physics A: Mathematical and General*
- *International Journal of Modern Physics: Physics and Computers*
- *Statistical Physics and Transport Phenomena*
- *Journal of The Franklin Institute*
- *Chaos*
- *Physical Review Letters*
- *Physical Review E*
- *New Journal of Physics*
- *International Journal of Mathematics and Computer Modelling*
- *Journal of Biological Systems*
- *Journal of Cellular Automata*
- *Theoretical Computer Science*
- *LATIN 2006* conference

ORGANIZATION OF CONFERENCES

- Co-organizer (with A. Lawniczak, D. Makowiec, B. DiStefano and M. Cojocaru) of Summer Solstice 2015, International Conference on Discrete Models of Complex Systems, Toronto, June 17–19, 2015
- Co-organizer (with B. Farzad) of 18th Ontario Combinatorics Workshop, St. Catharines, May 7–8, 2010
- Co-organizer (with B. Farzad) of 18th Ontario Combinatorics Workshop, St. Catharines, May 7–8, 2010
- Co-organizer (with A. Lawniczak) of AUTOMATA 2007, 13-th International Workshop on Cellular Automata
- Vice-Chair of the IEEE Symposium on "Complex Systems Modeling and Simulation: Paradigms and Applications" (part of IEEE Science and Technology for Humanity - TIC-STH 2009 conference)

OTHER SCHOLARLY ACTIVITIES

- Member of Working Group 1.5 "Cellular Automata and Discrete Complex Systems" (part of the technical committee TC-1 "Foundations of Computer Science" in the International Federation for Information Processing)
- Refereed grant applications for Natural Sciences and Engineering Research Council of Canada (NSERC), Chilean Research Fund Council (FONDECYT), and The Netherlands Organisation for Scientific Research (NWO).
- Member of Canadian Research Institute for Food Safety (2000-2005)

SOFTWARE DEVELOPED

- "HCELL", software library for symbolic manipulation and direct manipulation of deterministic and probabilistic cellular automata (2005)
- Algorithm and graphical front-end for simulation and visualisation of congestion in a model of data networks (1998-1999)
- Algorithm and graphical front-end (EPILAB) for visualisation of an epidemic process on a lattice (1999)

- C++ class library for cellular automata simulations and symbolic manipulations (1995-1997)
- "Percolator", an educational software which demonstrates critical behavior of disordered systems using optimized Hoshen-Copelman algorithm. (1996)
- Created various tools for cellular automata visualisation and analysis (1995-1997)

E. TEACHING ACTIVITIES

COURSES TAUGHT

- Graduate:
  - Math 594, Mathematics Seminar, Winter 2013, enrollment: 1
  - Math 5P31, Advanced Topics in Mathematical Models of Complex Systems; Fall 2010, enrollment: 8 Winter 2010, enrollment: 4, Winter 2007, enrollment: 2.
  - Math 5P31, Complexity, entropy and chaos. Fall 2017: enrollment: 2
  - Math 5P30, Dynamical Systems, Winter 2017, enrollment: 5, Winter 2015, enrollment: 9, Winter 2009, enrollment: 1, Fall 2006, enrollment: 3, Fall 2012, enrollment: 4
- Undergraduate:
  - Math 4P93, Special Topics in Dynamical Systems and Topology, Winter 2007, enrollment: 10, Winter 2006, enrollment: 7
  - Math 3P96, Computational Ergodic Theory and Dynamical Systems, Fall 2016, enrollment: 16. Fall 2017: enrollment: 11
  - Math 3P72, Continuous optimization, Winter 2008, enrollment: 5, Winter 2004, enrollment: 12.
  - Math 3P40, Mathematics integrated with computers and applications III; Winter 2018, enrollment: 8, Winter 2017, enrollment: 11.
  - Math 3P06, Vector calculus and differential geometry; Winter 2018, enrollment: 19
  - Math 3P03, Real Analysis; Winter 2011, enrollment: 4, Fall 2009, enrollment: 4, Fall 2008, enrollment: 3, Fall 2007, enrollment: 5,
  - Math 2P40, Mathematics integrated with computers and applications II; Fall 2015, enrollment: 29.
  - Math 2F40, Mathematics integrated with computers and applications II;
    Fall 2010/Winter 2011, enrollment: 52, Fall 2009/Winter 2010, enrollment: 50, Fall 2008/Winter 2008, enrollment: 14, Fall 2007/Winter 2008, enrollment: 32, Fall 2006/Winter 2007, enrollment: 30, Fall 2005/Winter 2006, enrollment: 19, Fall 2004, enrollment: 20, Fall 2003/Winter 2004, enrollment: 23, Fall 2002/Winter 2003, enrollment: 12, Fall 2012/Winter 2013, enrollment: 24. Fall 2013/Winter 2014, enrollment: 10. Fall 2014/Winter 2015, enrollment: 11.
  - Math 2P03, Calculus III, Fall 2003, enrollment: 53 Fall 2016, enrollment: 62 Fall 2015, enrollment: 80 Fall 2004, enrollment: 41 Fall 2004, enrollment: 66, Fall 2003, enrollment: 25, Fall 2002, enrollment: 20, Fall 2001, enrollment: 20.
  - Math 2F00, Advanced Calculus, Fall 2000/Winter 2001, enrollment: 9
  - Math 1P02, Calculus II, Winter 2002 enrollment: 94
  - Math 2P04, Basic Concepts of Analysis, Winter 2002, enrollment:13
  - Math 1P12, Linear Algebra I, Fall 2001, enrollment: 128
  - Math 1P97, Differential and Integral Methods, Winter 2001, enrollment: 250
  - Physics 099 (Preparation for Physics Courses), Spring 1995, enrollment: 50 (University of Illinois at Chicago, Department of Physics)

STUDENTS SUPERVISED

- Graduate students

- Francis Combert (co-supervision with T. Wolf), M.Sc. student (September 2016–present)
- Maryam Molakarimi Dastjerdi (co-supervision with J. Li), M.Sc. student (May 2016–present)
- Joel Midgley-Volpato (co-supervision with O. Kihel), M.Sc. student (Sept. 2013 – Sept. 2015), co-supervision with O. Kihel
- John Clement, M.Sc. student (Sept. 2013 – February 2015), co-supervision with B. Farzad
- Arnoosh Golestanian, M.Sc. student (January 2014 – August 2015), co-supervision with B. Farzad
- Asefeh Salarinezhad, M.Sc. student (January 2014 – August 2015), co-supervision with B. Farzad
- Ayodeji Olumide Oluwole, M. Sc. student (January 2013– summer 2013), transferred to Dept. of Education
- Yvonne Adjei-Mensah, (co-supervision with J. Yuen), M. Sc. student (September 2012–April 2014) *Determining the critical value of the control parameter of a probabilistic cellular automaton*
- Yi Cao, M.Sc. student (co-supervision with B. Farzad) (September 2009 – August 2011) *Modelling of Language Inflection Graphs*
- Andrew Skelton, M.Sc. student (September 2009 – August 2011), *Response Curves of Deterministic and Probabilistic Cellular Automata in One and Two Dimensions*
- Christopher Hockey, M.Sc. student (September 2008 – April 2011). *Conservation of lattice animals and phase transitions in 2D cellular automata*
- Mark Krzeminski, M.Sc. student (September 2006-August 2008). Project title: *Linguistic Applications of Random Graph Models*
- Member of the advisory committee of Peng Zhao, M. Sc. student at the Department of Mathematics and Statistics, University of Guelph (2000-2002)

- Undergraduate students
  - Roman Procyk, Density classification problem in ternary cellular automata, physics undergraduate thesis, September 2017-May 2018
  - Josh Friesen (January 2016 – May 2016), analysis of local structure approximation of cellular automaton rule 60200
  - Andrew Cheesman (May–August 2011), development of software tools for statistical analysis of Latin texts (Experience Works program)
  - Daniel Rammuno, summer 2008, preimage trees for all nearest-neighbour one-dimensional cellular automata, BUSRA award
  - Mark Krzeminski, M.Sc. student (September 2006-August 2008)
  - Bryan Penfound, summer 2007, core decomposition and visualization of large graphs, BUSRA award
  - Jeff Haroutunian, summer 2007, dynamical processes on geometric graphs, NSERC USRA award
  - Jeff Haroutunian, Fall 2006/Winter 2007, regularities in preimage sequences of cellular automata (Math 4F90 Honours Project)
  - Kate Sullivan, Fall 2005/Winter 206, enumeration of conservative cellular automata (Math 4F90 Honours Project)
  - Colin Phipps, summer 2005 and summer 2006, dynamics of the language acquisition process, NSERC USRA award
  - Darius Dadgari, summer 2004, dynamics of interacting particles in 2D space (Math 4F90 Honours Project)

- Ryan Duchesne, Fall 2003/Winter 2004, epidemic models on random graphs (financed by Experience Plus program grant)
- Konrad Wagner, summer 2003, cellular automata models of traffic flow (Math 4F90 Honours Project)
- Salil Sharma, summer 2002, development of a library for visualization of growth and diffusion phenomena on a two-dimensional lattice (financed from NSERC grant)
- Joseph W. Troop, summer 2002, visualization of three-dimensional cellular automata (financed from NSERC grant)
- Sumit Rohatgi, Fall 2002/Winter 2003, simulations of discrete dynamical systems (financed by Experience Plus program grant)

OTHER PEDAGOGICAL CONTRIBUTIONS

- *Cellular automata modelling*, presentation to Brock Brain Benders high school students, Feb. 17, 2009
- *Introduction to mathematical modelling*, presentation and lab for high school student participants of CMS/Esso Mathematics Camp, yearly in August 2002 - 2007.
- Participated in CBC Radio One broadcast *A new kind of science*, September 28, 2002
- Presented seminar series on lattice gas automata and cellular automata. University of Guelph, Department of Mathematics and Statistics, Fall 1999.
- Served as an instructor in a workshop for new teaching assistants, University of Illinois at Chicago, Summer 1997.
- Teaching Assistant for laboratory, tutorial and computer workshop sections of various undergraduate physics courses. University of Illinois at Chicago, 1993–1997.

F. UNIVERSITY SERVICE

Department of Mathematics

- Lead writer of the mathematics part of the joint PhD proposal with Computer Science (July 2018–present)
- Member of Applied Mathematics Committee (2016-18)
- Member of Rules of Procedure Committee (2016-18)
- Member of Mathematics Integrating Computers and Applications (MICA) Committee (2016-18)
- Lead writer of the self-study document for the review of Mathematics and Statistics M.Sc. program (June 2013–December 2013)
- **Graduate Program Director** for Mathematics graduate program (July 2007– July 2010, July 2012–July 2015, and July 2018–present)
- Member of committees revising MICA program and designing new mathematics major program (Spring 2013)
- Member of MICA curriculum committee (2005–2007, 2010/2011)
- Member of departmental graduate committee (2003-2011, committee chair 2007-2010)
- Member of the departmental committee developing mathematics co-op program (2009/10)
- Member of the departmental computer committee (Fall 2005–2007)
- Member of the advisory committee for the statistics position (Winter 2006)
- Member of the search committee (Fall 2003 – Winter 2004)
- Member of the statistics position search committee, (Fall 2001-Winter 2002)
- Member of the departmental committee on double cohort (2000/2001)
- Member of the departmental MICA program committee (2000/2001)

Faculty of Mathematics and Science

- Member of the Advisory Committee for selection of associate deans (Fall 2017)
- Member of the Advisory Committee for selection of associate deans (Spring 2013)
- Member of adjudication committee for NSERC Undergraduate Student Research Awards (2010/2011)
- Member of the advisory committee for selection of the Dean and Associate Deans for Faculty of Mathematics and Science (2009/2010)
- Member of the Undergraduate Curriculum Review Committee, Faculty of Mathematics and Science (several times 2003–2007)
- Member of the Brock Institute for Scientific Computing

Brock University

- Member of IT Strategic Planning Committee (Fall 2005–2007)
- Member of Graduate Council (2007-2010)

Examination committees

- Member of examination committee in M.Sc. thesis defence of Mahsa Daneshmandmehrabani, July 2017
- Member of examination committee in M.Sc. thesis defence of Oksana Picugina, September 17, 2015
- External examiner in M.Sc. thesis defence of Mohammad Goodarzi, January 31, 2014, Dept. of Computer Science, Brock University
- External examiner in M.Sc. thesis defence of M. Edalatmanesh, August 26, 2013, Dept. of Computer Science, Brock University
- External examiner in Ph.D. thesis defence of Heather Betel, University of Ottawa, May 10, 2012
- External examiner in M.Sc. thesis defence of Corrado Coia, May 2011, Dept. of Computer Science, Brock University
- Member of examination committee in M.Sc. thesis defence of Samaneh Malekan, January 2011, Department of Mathematics, Brock University
- External examiner in M.Sc. thesis defence of Ryan Faulkner, November 2010, Department of Mathematics, Trent University
- External examiner in M.Sc. thesis defence of Joseph Brown, August 2009, Dept. of Computer Science, Brock University
- Member of examination committee in M.Sc. thesis defence of Chris Plyley, July 2009, Department of Mathematics, Brock University
- External examiner in M.Sc. thesis defence of Mohammad Naeem, December 2009, Dept. of Computer Science, Brock University

CURRICULUM VITAE

Mei Ling Huang

August, 2018

Department of Mathematics, Brock University
St. Catharines, Ontario, Canada L2S 3A1
Tel: (905)688-5550 Ext.4255; Fax: (905)378-5713
E-mail:mhuang@brocku.ca
Web: http://www.brocku.ca/mathematics/people/huang

A. FORMAL EDUCATION

INSTITUTION	DEGREE	YEAR	MAJOR
University of Windsor	Ph.D.	1990	Statistics
University of Windsor	M.Sc.	1986	Mathematics
China Academy of Railway Science	M.Sc.	1981	Mathematics
China Hobei Normal University	B.A.	1964	Mathematics

B. ACADEMIC POSITIONS

Professor	July, 2001 – Present	Department of Mathematics	Brock University
Visiting Professor	Sept. 1995 – Dec. 1995	Department of Statistics	Stanford University
Associate Professor	July, 1995 – June, 2001	Department of Mathematics	Brock University
Assistant Professor	July, 1991 – June, 1995	Department of Mathematics	Brock University
Research Associate	May, 1990 – June, 1991	Dept. of Management Science	Univ. of Windsor
Teaching Assistant	Sept.,1985 – April,1990	Department of Mathematics	Univ. of Windsor
Research Assistant	Sept.,1985 – April,1990	Department of Mathematics	Univ. of Windsor
Assistant Professor	Jan., 1982 – July, 1985	The Graduate School, Dept. of Mathematics	China Academy of Railway Sciences
Lecturer	Sept.,1964 – July, 1978	Dept. of Mathematics	China Hobei Teaching College

C. SCHOLARLY ACTIVITIES

1. PUBLICATIONS *(HQP with "*")*

(A) ARTICLES IN REFEREED JOURNALS

1. **Huang, M. L. and *Nguyen, C. (2018).** "A Nonparametric Approach on Quantile Regression", ***Journal of Statistical Distributions and Applications.*** *Volume 5, Issue* 3**,** *pp.1-14.*. https://doi.org/10.1186/s40488-018-0084-9.
2. **Huang, M. L., Kerman, R. and *Spector, S. (2018).** "An Estimate of the Root Mean Square Error Incurred when Approximating an $f \in L^2(\mathbb{R})$ by a Partial Sum of its Hermite Series*", **Mathematics, 2018**, *Volume* ***6***, *Issue* ***64***; pp. 1-18, https://doi.org/ 10.3390/ math 6040064.
3. **Huang, M. L. and *Rat, R. (2017).** "A New Weighted Quantile Regression", ***Cogent Mathematics (2017), 4: 1357237,*** *pp.1-19.* https://doi.org/10.1080/23311835.2017.1357237.
4. **Huang, M. L. and *Nguyen, C. (2017).** "High Quantile Regression for Extreme Events", ***Journal of Statistical Distributions and Applications,*** *Volume* ***4****, Issue* ***1,*** *Article 4, pp.1-20.* https://doi.org/10.1186/s40488-017-0058-3.
5. **Huang, M. L., Xu, X., and *Tashnev, D. (2015).** "A Weighted Quantile Linear Regression", ***Journal of Statistical Computation and Simulation,*** *Volume* ***85****, No.****13,*** *pp. 2596-2618.* https://doi.org/10.1080/00949655.2014.938240.
6. **Ha, H., Huang, M. L., and Li, D. (2014). "**A Remark on Strong Law of Large Number for Weighted U-Statistics", ***Acta Mathematica Sinica,*** *Volume* ***30, No. 9, pp.*** *1595-1605*.
7. ***Coia, V. and Huang, M. L. (2014). "**A Sieve Model for Extreme Values", ***Journal of Statistical Computation and Simulation,*** *Volume* ***84****, No.* ***8,*** *pp. 1692-1710.*
8. ***Fajardo, V. A. and Huang, M. L. (2014).** "A Least Square Method on Confidence Regions for High Quantile of Heavy Tailed Distributions", ***Advances and Applications in Statistics,*** *Volume* ***38****, Number* ***2****, pp. 81-111.*
9. **Huang, M. L. and *Zhao, K. (2013). "**Weighted Efficient Estimation for Risk Models", ***ISRN Probability and Statistics,*** *Volume 2013, pp. 1-12*.
10. **Huang, M. L., *Coia, V., and Brill, P. H. (2013). "**A Cluster Truncated Pareto Distribution and its applications", ***ISRN Probability and Statistics,*** *Volume 2013, pp. 1-10.*

11. **Huang, M. L., Yuen, W. K., and *Zhang, M. (2013).** "Efficient Methods on Confidence Intervals of Prediction Intervals", ***Advances and Applications in Statistics***, *Volume **33**, No. 1, pp.1-21.*
12. ***Yu, K., Huang, M. L., and Brill, P. H. (2012).*** "An Algorithm for Fitting Heavy-Tailed Distributions with Generalized Hyperexponentials", ***INFORMS Journal on Computing,*** *Volume 24, No. **1**, pp. 42-52.*
13. **Huang, M. L. (2011). "**Optimal Estimation for the Pareto Distribution", ***Journal of Statistical Computation and Simulation,*** *Volume **81**, No. **12**, pp. 2059-2076.*
14. **Huang, M. L. and *Zhao, K. (2010). "**On Estimation of the Truncated Pareto Distribution", ***Advances and Applications in Statistics**, Volume **16**, No. **1**, pp. 83-102.*
15. **Huang, M. L. (2010). "**An Efficient Estimation Method for the Pareto Distribution", ***Journal of Statistics, Advances in Theory and Applications,*** *Volume **3**, No. **1**, pp. 61-78.*
16. **Huang, M. L. and Yuen, W. K. (2010).** "A Bivariate Density Estimation Method based on Level Crossings", ***Statistics, a Journal of Theoretical and Applied Statistics,*** *Volume **44**, No. **1**, pp.31-55.*
17. **Kerman, R., Huang, M. L., and *Brannan, M. (2009).** "Error Estimates for Dominici's Hermite Function Asymptotic Formula and Some Applications", ***The ANZIAM Journal,*** *Volume **50**, pp.550-561.*
18. **Yuen, W. K. and Huang, M. L. (2009).** "A Weighted Bivariate Density Estimation Method", ***Advances and Applications in Statistics**, Volume **13**, No. **2**, pp. 181-191.*
19. **Brill, P. H., Huang, M. L., and Hlynka, M. (2009).** "A Note on an <s, S> Inventory System with Decay", ***IAENG International Journal of Applied Mathematics***, *Volume **39**, Issue **3**, pp. 171-174.*
20. **Huang, M. L. (2008).** "A Weighted Estimation Method for the Survival Function", ***Applied Mathematical Sciences,*** *Volume **2**, No. **16**, pp. 753-762.*
21. **Huang, M. L. Pollanen, M., and Yuen, W. K. (2007).** "An Efficient Randomized Quasi Monte-Carlo Method for the Pareto Distribution", ***Monte Carlo Methods and Applications, 13(1)**, pp. 1-20.*
22. **Huang, M. L. (2007).** "A Quantile-Score Test for Experimental Design", ***Applied Mathematical Sciences,*** *Volume **1**, No. **11**, pp. 507-516.*
23. **Huang, M. L. (2006).** "The D-Stirling Numbers", ***International Mathematical Forum, Journal for Theory and Applications,*** *Volume **1**, No. **17 – 20**, pp. 867-884.*
24. **Huang, M. L. and Brill, P. H. (2004). "**A Level Crossing Distribution Estimation Method", ***Journal of Statistical Planning and Inference,*** *Volume **124**, Number **1**, pp. 45-62.*
25. **Huang, M. L. (2003).** "The Efficiencies of the Estimators for the D Distribution", ***The International Mathematical Journal,*** *Volume **4**, Number **3**, pp. 265-280.*
26. **Huang, M. L.(2003).** "The Risks of the Estimators for the R Distribution", ***The International Mathematical Journal,*** *Volume **3**, Number **8**, pp. 851-862.*
27. **Huang, M. L. (2002),** "The R Numbers and a Restricted Occupancy Model", ***The International Mathematics Journal**, Volume **1**, Number **3**, pp. 211-222.*
28. **Huang, M. L. (2001).** "On a Distribution-Free Quantile Estimator", ***Computational Statistics & Data Analysis,*** *Volume **37**, Number **4**, pp. 477-486.*
29. **Huang, M. L. and Brill, P. H. (2001).** "On Estimation of M/G/c/c Queues", ***International Transactions in Operational Research,*** *Volume **8**, Number **6**, pp. 647-657.*
30. **Huang, M. L. and Brill, P. H. (2001).** "A Nonparametric Regression Method", ***Nonlinear Analysis, Theory, Methods and Applications,*** *Volume **47**, Number **3**, pp. 1467-1475.*
31. **Li, D., Huang, M. L., and Rosalsky, A. (2000).** "Strong Invariance Principle for Arrays", ***Bulletin of the Institute of Mathematics Academia Sinica,*** *Volume **28**, Number **3**, pp. 167-181.*
32. **Huang, M. L. and Brill, P. H. (1999). "**A Level Crossing Quantile Estimation Method", ***Statistics and Probability Letters,*** *Volume **45**, Number **4**, pp. 111-119.*
33. **Li, D. and Huang, M. L. (1998). "**A Note on Moments of the Maximum of Cesàro Summation", ***Statistics and Probability Letters,*** *Volume **38**, Number **1**, pp. 73-81.*
34. **Huang, M. L., Kerman, R. A., and Weit, Y. (1997). "**Abel Summability of the Autoregressive Series for the Best Linear Least Squares Predictor", ***Illinois Journal of Mathematics,*** *Volume **41**, Number **3**, pp. 557-587.*
35. **Huang, M. L.** and **Fung, K. Y. (1997).** "On Moments and Cumulants of the D Compound Poisson Distribution", ***Statistical Papers,*** *Volume **38**, Number **3**, pp. 357-361.*
36. **Huang, M. L. and Brill, P. H. (1997). "**A Level Crossing Density Estimation Method", ***Nonlinear Analysis, Theory, Methods and Applications,*** *Volume **30**, Number **7**, pp. 4403-4414.*
37. **Huang, M. L. and Fung, K. Y. (1993).** "The D Compound Poisson Distribution", ***Statistische Hefte,*** *Volume **34**, pp. 319-338.*
38. **Huang, M. L. and Fung, K. Y. (1993).** "The D Distribution and its Applications", ***Statistische Hefte,*** *Volume **34**, pp. 143-159.*

39. **Huang, M. L. and Brill, P. H. (1991). "**Recurrence Relation for the Minimum Variance Unbiased Estimator for the Probability Function of the R Distribution", ***Communications in Statistics, Theory and Methods,*** *Volume* ***20****, Number* ***12,*** *pp. 4005-4019.*
40. **Huang, M. L. (1990). "**Recurrence Relation for the R Distribution", ***Communications in Statistics, Theory and Methods,*** *Volume* ***19****, Number* ***1,*** *pp. 145-154, 1990.*
41. **Huang, M. L. and Fung, K. Y. (1989). "**The R Distribution and its Applications", ***Communications in Statistics, Simulations and Computations,*** *Volume* ***18****, Number* ***1,*** *pp. 99-119.*
42. **Huang, M. L. and Fung, K. Y. (1989). "**Intervened Truncated Poisson Distribution", ***Sankhya, Series B,*** *Volume* ***51****, pp. 302-310.*
43. **Huang, M. L. and Fung, K. Y. (1988). "**A More Generalized Stirling Distribution of the Second Kind", ***Communications in Statistics, Theory and Methods,*** *Volume* ***17****, Number* ***12,*** *pp. 4337-4356.*
44. **Huang, M. L. (1984). "**Mathematical Methods for Minimal Cost Movement of Repairmen", ***Railway Science Journal,*** *Volume* ***3****, pp. 24-27.*
45. **Huang, M. L. (1983). "**Frequency Analysis in Truncated Samples", ***Journal of China Railway Society,*** *Volume* ***5****, Number* ***4,*** *pp. 62-75.*

(B) PUBLICATIONS IN REFEREED PROCEEDINGS

46. **Brill, P. H. and Huang, M. L. (2018).** "The Posterior Service Time in an M/G/1 Queue with a Workload Barrier and Extreme Prior Service Time", to appear ***2018 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association.***.
47. ***Tieu, J. and Huang, M. L. (2018).** "On Nonparematric Quantile Regression Method", to appear ***2018 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association***. .
48. ***Morris, R. Huang, M. L. (2018).** "A Direct Quantile Regression Method", to appear ***2018 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association****,*
49. **Brill, P. H. and Huang, M. L. (2017).** "Approximating Probability Distributions in an Extreme Renewal Process", ***2017 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association,*** *pp. 1393-1401.*
50. **Huang, M. L., *Rat, R. and Yuen, W. K. (2017).** "An Efficient Method for Quantile Regression", ***2017 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association****, pp. 1426-1435.*
51. **Huang, M. L. and *Nguyen, C. (2016).** "On Optimal Quantile Regression", ***2016 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association****, 2532-2541.*
52. **Huang, M. L., *Mottola, J. and Brill, P. H. (2015).** "On a Mixture Pareto Distribution", ***2015 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association****, pp. 1416-1427.*
53. **Huang, M. L., *Xu, Y., and Yuen, W. K. (2015).** "On Quantile Regression for Extremes", ***2014 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association,*** *pp. 591-601.*
54. **Brill, P. H. and Huang, M. L. (2014).** "Example of a Renewal Process with No-mean Interarrival Times", ***2014 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association,*** *pp. 633-642.*
55. **Huang, M. L., *Thorpe, L., and Brill, P. H. (2013).** "A Nonparametric Method for Extreme Values", ***2013 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association,*** *pp.2905-2914.*
56. **Huang, M. L., *Coia, V., and Brill, P. H. (2012).** "A Mixture Truncated Pareto Distribution", ***2012 JSM Proceedings, Statistical Computing Section. Alexandria, VA: American Statistical Association,*** *pp.2488-2498.*
57. **Huang, M. L., Brill, P., H., and Gross, D. (2005).** "A Weighted Estimation Method for the Pareto Variance", ***Proceedings of the American Statistical Association, Nonparametric Statistics Section,*** *pp.1649-1654, 2005.*
58. **Huang, M. L. and *Tang J. (2004).** "On Estimation of the Pareto Distribution", ***2004 Proceedings of the American Statistical Association, Nonparametric Statistics Section,*** *pp. 1975-1979.*
59. **Huang, M. L. (2004).** "On Weighted Distribution Function Estimation", ***2004 Proceedings of the International Conference on Distribution Theory, Order Statistics and Inferences in Honor of Barry C. Arnold, SA-775-2004, I.S.B.N. 84-688-1752-7,*** *pp. 1-15.*
60. **Huang, M. L. (2003).** "The Efficiency of a Weighted Distribution Function Estimator", ***2003 Proceedings of the American Statistical Association, Nonparametric Statistics Section,*** *pp.1891-1896.*
61. **Huang, M. L. and Brill, P. H. (2002).** "On Rank Tests for Experimental Designs", ***2002 Proceedings of the American Statistical Association, Statistical Computing Section,*** *pp. 1502-1506.*
62. **Huang, M. L. (2000).** "A Nonparametric Predictor", ***2000 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 38-41.*
63. **Huang, M. L. and Brill, P. H. (1999).** "A Weighted Regression Method", ***1999 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 143-146.*

64. **Huang, M. L. (1999).** "The Model of Training Creative High Quality Scientists in the 21st Century", ***the Proceedings of the Conference of Training Creative High Quality Scientists,*** *pp. 293-295****, Springer,*** *1999, ISBN 7-04-008390-6.*
65. **Huang, M. L. (1998).** "On Weighted Quantile Estimators", ***1998 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 97-101.*
66. **Huang, M. L. (1997).** "On Efficiencies of Quantile Estimators", ***1997 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 76-81.*
67. **Huang, M. L. (1997).** "The D compound Distribution", ***Proceedings of the 1997 International Symposium on Contemporary Multivariate Analysis and its Applications,*** *pp. 25-26.*
68. **Huang, M. L. and Brill, P. H. (1996).** "A Nonparametric Quantile Estimation Method", ***1996 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 206-211.*
69. **Huang, M. L. and Brill, P. H. (1995).** "A New Weighted Density Estimation Method", ***1995 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 125-130.*
70. **Brill, P. H. and Huang, M. L. (1995).** "A New Weighted Estimation Method", ***The 50th Session of International Statistical Institute Conference Volume of Proceedings,*** *pp. 120-121.*
71. **Huang, M. L. and Brill, P. H. (1994).** "Some Estimation Problems in M/M/c/c Queues", ***1994 Proceedings of the American Statistical Association, the Statistical Physical & Engineering Sciences Section,*** *pp. 151-156.*
72. **Brill, P. H. and Huang, M. L. (1993).** "System Point Estimation of the Probability Distribution of the Waiting Time in Variations of $M/G^B/1$ Queues", ***1993 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 236-241.*
73. **Huang, M. L. and Brill, P. H. (1992).** "On Estimators of the R Distribution", ***1992 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 140-145.*
74. **Huang, M. L. and Brill, P. H. (1991).** "Recurrence Relation for the Minimum Variance Unbiased Estimator for the Probability Function of the More Generalized Stirling Distribution of the Second Kind", ***1991 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 89-94.*
75. **Huang, M. L. (1990).** "A Computational Method for the Generalized Stirling Distribution", ***1990 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 234-238.*
76. **Huang, M. L. and Fung, K. Y. (1989).** "Certain Properties of the R Distribution", ***1989 Proceedings of the American Statistical Association, the Statistical Computing Section,*** *pp. 243-246.*

(C) PUBLICATIONS IN WORKING PAPER SERIES

1. **Huang, M. L. and Brill, P. H. (1999).** "A Level Crossing Method", ***Windsor Mathematics & Statistics Report, University of Windsor, No. WMSR#99-01, pp. 1-28, 1999.***
2. **Huang, M. L. and Brill, P. H. (1996).** "Empirical Distribution Based on Level Crossing", ***Working Paper Series, University of Windsor, No. W96-01, ISSN No. 1714-6191, 1996.***
3. **Huang, M. L. and Brill, P. H. (1996).** "A Density Estimator Based on Level Crossing", ***Working Paper Series, University of Windsor, No. W96-02, ISSN No. 1714-6191, 1996.***

(D) THESES

1. "The D Numbers and the D Distribution", ***Ph.D. Dissertation, University of Windsor, 1990.***
2. "Intervened Truncated Poisson Distribution and Its Applications", ***M.Sc. Major Paper, University of Windsor, 1986.***
3. "Frequency Analysis in Truncated Samples", ***M.Sc. Thesis, China Academy of Railway Sciences, 1981.***

2. PAPERS SUBMITTED TO REFEREED JOURNALS

1. **Brill, P. H., Huang, M. L. and Hlynka, M.,** "On the Service Time in a Worklord-Barrier M/G/1 Queue with Joiners and Rejects", submitted to ***Operations Research Letters***, 2018.
2. **Huang, M. L., *Mottola, J., and Brill, P. H.** "A Mixture Pareto Distribution", submitted to ***STAT,*** 2018.
3. **Huang, M. L. and *Xu, Y.** "A Weighted Quantile Regression for Extremes", submitted to ***Journal of Optimization,*** 2018.
4. **Brill, P. H. and Huang, M. L.** "Approximating the Fixed Finite-time t Distributions in an Extreme Renewal Process by related Limited Distribution", submitted to ***Probability and Statistics Letters***, 2018.

3. WORK IN PROCESS

- **Invitation to Write Book:** "On Heavy Tailed Distributions", invited by David Grubbs, the Editor of Chapman Hall/CRC, New York, August, 2017.
- **Research Papers**

1. **Hunag, M, L.** "A New Method for Confidence Intervals for High Quantiles", 2018.
2. **Hunag, M, L. and *Yan, X.** "A Method for Confidence Intervals for High Quantiles", 2018.
3. **Huang, M. L.,** "An Improvement on Weighted Quantile Regression", 2018.
4. **Huang, M. L. and *Thorpe, L.** "On Nonparametric Estimation for Extremes", 2018.
5. **Huang, M. L.** "On Estimation for the Pareto Variance", 2018.
6. **Huang, M. L.** "On Orthogonal Series Density Estimator", 2018.
7. **Huang, M. L.** "A Weighted Distribution Estimator", 2018.
8. **Huang, M. L. "**Non-kernel Quantile Estimators", 2018**.**
9. **Huang, M. L. and *Falsetti, H., "**On Estimation for the Generalized Pareto Distribution", 2018**.**
10. **Huang, M. L.** "Exact Efficiency Function of a Weighted Distribution Function Estimator", 2018**.**
11. **Huang, M. L.** "On the Sample Quantile Estimator", 2018**.**
12. **Huang, M. L.** "On Nonparametric Regression and Prediction Models", 2018.
13. **Brill, P. H. and Huang, M. L.** "On the Waiting Time in State Dependent Bulk Service Queues", 2018.
14. **Brill, P. H. and Huang, M. L.** "M/G/1 Queues with Reneging", 2018.

4. PRESENTATIONS

- **INVITED LECTURES (selected)**

1. **Brill, P. H. and Huang, M. L. (2018).** "An M/G/1 Queue with a Workload Barrier and Extreme Service times", ***Invited by Prof. M. Ali Ulku, Dalhousie University, at the 60th Annual Canadian Operational Research Society (CORS) Conference, Halifax, Nova Scotia, June 4-6, 2018.***
2. **Huang, M. L. and *Nguyen, C. (2016).** "High Quantile Regression", ***Invited by Prof. S. Ejaz Ahmed, Brock University, at the 2nd International Conference on Statistical Distributions and Applications (ICOSDA 2016), Niagara Falls, Ontario, Canada, October 14-16, 2016.***
3. **Brill, P. H. and Huang, M. L. (2016).** "A Renewal Process for Extremes", ***Invited by Prof. S. Ejaz Ahmed, Brock University, at the 2nd International Conference on Statistical Distributions and Applications (ICOSDA 2016), Niagara Falls, Ontario, Canada, October 14-16, 2016.***
4. ***Nguyen, C., Huang, M. L. and Yuen, W. K. (2016).** "On Weighted Quantile Regression***", Invited by Prof. Edward Susko, Program Chair, at the 44th Annual Meeting of the Statistical Society of Canada, Brock University, St. Catharines, ON, Canada, May 29-June 1, 2016.***
5. **Brill, P. H. and Huang, M. L. (2013).** "On a Renewal Process with No-mean Inter-arrival Times", ***Invited by Prof. E. Jewkes, University of Waterloo, at the 15th Annual Conference for Canadian Queueing Theorists and Practitioners, University of waterloo, Waterloo, ON, Canada, August 23-24, 2013.***
6. **Brill, P. H., Huang, M. L., and Hlynka, M. (2012).** "On M/G/1 Queues with Reneging", ***at the 54th Annual Conference of Canadian Operational Research Society (CORS), Niagara Falls, ON, Canada, June 11-13, 2012.***
7. **Brill, P. H. and Huang, M. L. (2011).** "Analysis of Single server Queues with Bulk Service via Level Crossing", ***Invited by Prof. W. Grassmann, University of Saskatchewan, at the 13th Annual Conference for Canadian Queueing Theorists and Practitioners, Banff International Research Station (BIRS), Banff, AB, Canada, August 26-28, 2011.***
8. **Brill, P. H. and Huang, M. L. (2010).** "M/M/c/c Queues with State-dependent Arrival Rate", ***Invited by Prof. A. Alfa, University of Manitoba, at the 12th Annual Conference for Canadian Queueing Theorists and Practitioners, Radisson Resort Hecla Provincial Park, MB, Canada, August 27-29, 2010.***
9. **Huang, M. L. (2008).** "Extreme Value Distribution and Risk Analysis", ***Invited by Prof. K. Y. Fung, Department of Mathematics & Statistics, University of Windsor, Windsor, Ontario, Canada, December 4, 2008.***
10. **Huang, M. L. (2006).** "Orthogonal Series Density Estimators", ***Invited by Prof. D. Li, Department of Mathematics & Statistics, Lakehead University, Thunder Bay, Ontario, Canada, October 13, 2006.***
11. **Brill, P. H. and Huang, M. L. (2006).** "Analysis of Reneging in Queues" ***Invited by Prof. M. Carter, Department of Mechanical and Industrial Engineer, University of Toronto, Toronto, Ontario, Canada, October 5, 2006.***
12. **Brill, P. H. and Huang, M. L. (2006).** "Discussion of Reneging in Queues" ***Invited by Prof. A. Ingolfsson, University of Alberta, at the 8th Annual Conference for Canadian Queueing Theorists and Practitioners, Banff International Research Station, Canada, September 14-16, 2006.***
13. **Huang, M. L. (2006).** "Hermite Wavelet Estimator of Probability Density", ***Invited by Prof. R. Lockhart, Simon Fraser University, Statistics Society of Canada (SSC) Program Chair, at the 34th Annual Meeting of SSC, London, Ontario, Canada, May 28-31, 2006.***
14. **Huang, M. L. (2005).** "A Weighted Distribution Function Estimation" ***Invited by Prof. R. Singh, Department of Mathematics and Statistics, Guelph University, Guelph, Ontario, Canada, November 11, 2005.***

15. **Huang, M. L. (2005).** "On Nonparametric Distribution Function Estimation" ***Invited by Prof. R. Viveros, Department of Mathematics and Statistics, McMaster University, Hamilton, Ontario, Canada, October 4, 2005.***
16. **Huang, M. L. (2004).** "On Weighted Distribution Function Estimation", ***Invited by Prof. N. Balakrishnan, McMaster University, at the International Conference on Distribution Theory, Order Statistics and Inferences in Honor of Barry C. Arnold, University of Cantabria, Santander, Spain, June 16-18, 2004.***
17. **Huang, M. L. (2003).** "On Nonparametric Quantile Estimation Methods", ***Invited by Prof. Donald Gross, the Department of System Engineer and Operation Research, George Mason University, Fairfax, Virginia, U.S.A., April 28, 2003.***
18. **Brill, P. H. and Huang, M. L. (2001).** "Some Variations of M/G/1 Queues and Their Applications", ***Invited by Prof. Les Servi, MIT, Lincoln Lab, the INFORMS International Conference in Maui, Hawaii, U.S.A., June 18, 2001.***
19. **Huang, M. L. (2000).** "A Nonparametric Regression Method", ***Invited by Prof. P. Lakshmikantham, the President of International Federation of Nonlinear Analysts, at the Third World Congress of Nonlinear Analysis, Catania, Italy, July 24, 2000.***
20. **Huang, M. L. (1999).** "On the R numbers" ***Invited by Prof. P. Chen, at the Institute of Applied Mathematics, China Academy of Sciences, Beijing, China, September 12, 1999.***
21. **Huang, M. L. (1999).** "On Nonparametric Forecasting of Time Series" ***Invited by Prof. Z. Hou, the President of the Changsha Railway University, at the Department of Mathematics, Changsha Railway University, Changsha, Hunan, China, September 3, 1999.***
22. **Huang, M. L. (1999).** "A Level Crossing Analysis of Bulk Service Queues" ***Invited by Prof. Z. Hou, the President of the Changsha Railway University at the Department of Mathematics, Changsha Railway University, Changsha, Hunan, China, September 2, 1999.***
23. **Brill, P. H. and Huang, M. L. (1999).** "On the Waiting Time in State Dependent Bulk Service Queues" ***Invited by Prof. Z. Hou, the President of the Changsha Railway University, at the International Workshop on Markov Processes & Controlled Markov Chains, Changsha, Hunan, China, August 24, 1999.***
24. **Huang, M. L. and Brill, P.H. (1999).** "On Estimation in M/G/c/c Queues" ***Invited by Prof. C. M. Harris, at the International Federation of Operational Research Societies, 15th Triennial Conference (IFORS99), Beijing, China, August 20, 1999.***
25. **Huang, M. L. (1999).** "The Model of Training Creative High Quality Scientists in the 21st Century", ***at the Conference of Training Creative High Quality Scientists, Beijing, China, September 21 - October 2, 1999.***
26. **Huang, M. L. (1998).** "On Quantile Estimators", ***Invited by Prof. N. Balakrishnan, at the International Conference IISA 1998, McMaster University, Hamilton, Ontario, Canada, October 10, 1998.***
27. **Huang, M. L. (1997).** "The D Number and D Distribution" ***Invited by Prof. R. Viveros, Department of Mathematics and Statistics, McMaster University, Hamilton, Ontario, Canada, October 8, 1997.***
28. **Huang, M. L. and Brill, P.H. (1997).** "A Level Crossing Density Estimation Method", ***Invited by Prof. C. P. Tsokos, the Vice President of International Federation of Nonlinear Analysts, at the 2nd World Congress of Nonlinear Analysis, Athens, Greece, July 12, 1996.***
29. **Brill, P. H. and Huang, M. L. (1995).** "Level Crossing Estimation in Variants of $M/G^{a,b}/1$ Queues", ***Invited by Prof. H. G. Hui, the Director of the Institute of Applied Mathematics, China Academy of Sciences, Beijing, China, August 31, 1995.***
30. **Huang, M. L. (1995).** "The R Distribution and Its Applications", ***Invited by Prof. S. Xing, the Chairman of the Dept. of Mathematics, Graduate School of China Academy of Railway Sciences., Beijing, China, Sept. 6, 1995.***
31. **Huang, M. L. and Brill, P. H. (1995).** "A Level Crossing Empirical Distribution Function", ***Invited by Prof. B. Efron, Max H. Stein Professor of Humanities and Sciences, Professor of Statistics and Biostatistics, Department of Statistics, Stanford University, Stanford, California, U.S.A., November 15, 1995.***

- **PRESENTATION AT OTHER CONFERENCES (selected)**

1. **Brill, P. H. and Huang, M. L. (2018).** "The Posterior Service Time in an M/G/1 Queue with a Workload Barrier and Extreme Prior Service Time", ***at the 2018 Joint Statistical Meeting of the American Statistical Association, Vancouver, BC, Canada., July 28- August 2, 2018.***
2. ***Tieu, J. and Huang, M. L. (2018).** "On Nonparematric Quantile Regression Method", ***at the 2018 Joint Statistical Meeting of the American Statistical Association, Vancouver, BC, Canada., July 28- August 2, 2018.***
3. ***Morris, R. and Huang, M. L. (2018).** "A Direct Quantile Regression", ***at the 2018 Joint Statistical Meeting of the American Statistical Association, Vancouver, BC, Canada., July 28- August 2, 2018.***
4. **Brill, P. H. and Huang, M. L. (2017).** "Approximating Probability Distributions in an Extreme Renewal Process", ***at the 2017 Joint Statistical Meeting of the American Statistical Association, Baltimore, Maryland, U.S.A., July 29- August 3, 2017.***

5. **Huang, M. L., *Rat, R. and Yuen, W. K. (2017).** "An Efficient method for Quantile Regression", ***at the 2017 Joint Statistical Meeting of the American Statistical Association, Baltimore, Maryland, U.S.A., July 29- August 3, 2017.***
6. ***Tieu, J., *Rat, R. and Huang, M. L. (2017).** "A New Weighted Quantile Regression***", at the 45th Annual Meeting of the Statistical Society of Canada, University of Manitoba, Winnipeg, MB, Canada, June 11-14, 2017.***
7. **Huang, M. L. and *Nguyen, C. (2016).** "On Optimal Quantile Regression", ***at the 2016 Joint Statistical Meeting of the American Statistical Association, Chicago, Illinois, U.S.A., July 30- August 4, 2016.***
8. **Huang, M. L. *Mottola, J. and Brill, P. H. (2015).** "On a Mixture Pareto Distribution", ***at the 2015 Joint Statistical Meeting of the American Statistical Association, Seattle, Washington, U.S.A., August 8-13, 2015.***
9. **Huang, M. L. (2015),** "On Estimation of High Quantile Regression", at the ***at the 2015 IMS-China International Conference on Statistics and Probability, Yunnan University, Kunming, China, July 1-4, 2015.***
10. **Huang, M. L. (2015),** "On High Conditional Quantiles for Extremes", at the ***at the 9th Conference on Extreme Value Analysis, Probability Models and their Applications, University of Michigan, Ann Arbor, Michigan, U.S.A., June 15-19, 2015.***
11. ***Nguyen, C., *Mottola, J. and Huang, M. L. (2015).** "On Inference of a Mixture Pareto Distribution", ***at the 43th Annual Meeting of the Statistical Society of Canada, Dalhousie University, Halifax, NS, Canada, June 14-17, 2015.***
12. **Brill, P. H. and Huang, M. L. (2014).** "Example of a Renewal Process with No-mean Interarraval Times", ***at the 2014 Joint Statistical Meeting of the American Statistical Association, Boston, MA, USA, August 2-7, 2014.***
13. **Huang, M. L., *Xu, Y., and Yuen, K. W. (2014).** "On Quantile Regression for Extremes", ***2014 Joint Statistical Meeting of the American Statistical Association, Boston, MA, USA, August 2-7, 2014.***
14. ***Thorpe, L., and Huang, M. L. (2014).** "On Nonparametric Methods for Extreme Value Distributions", ***at the 42th Annual Meeting of the Statistical Society of Canada, University of Toronto, Toronto, ON, Canada, May 25 – 28, 2014.***
15. ***Xu, Y., Huang, M. L., and Yuen, K. W. (2014).** "On High Quantile Regression", ***at the 42th Annual Meeting of the Statistical Society of Canada, University of Toronto, Toronto, ON, Canada, May 25 – 28, 2014.***
16. **Huang, M. L., *Thorpe, L., and Brill, P. H. (2013).** "A Nonparametric Method for Extremes Values", ***at the 2013 Joint Statistical Meeting of the American Statistical Association, Montreal, Quebec, Canada, August 3-8, 2013.***
17. ***Yan, X. and Huang, M. L. (2013).** "On Confidence Intervals of High Quantile", ***at the 41th Annual Meeting of the Statistical Society of Canada, University of Edmonton, Edmonton, AB, Canada, May 26 – 29, 2013.***
18. **Huang, M. L., *Coia, V., and Brill, P. H. (2012).** "A Mixture Truncated Pareto Distribution", ***at the 2012 Joint Statistical Meeting of the American Statistical Association, San Diego, CA, U.S.A., July 28 – August 2, 2012.***
19. ***Coia, V. and Huang, M. L. (2012).** "On Estimation of Heavy Tailed Distributions", ***at the 40th Annual Meeting of the Statistical Society of Canada, Guelph University, Guelph, Ontario, June 3 – 6, 2012.***
20. **Huang, M. L. and Brill, P. H. (2011).** "An Efficient Estimation Method for Risk Models", ***at the 7th Conference on Extreme Value Analysis, Probability Models and their Applications, University of Lyon, Lyon, France, June 27 - July 1, 2011.***
21. ***Farjado, V. A. and Huang, M. L. (2011).** "On Confidence Regions for High Quantiles of a Heavy Tailed Distribution", ***at the 39th Annual Meeting of the Statistical Society of Canada, Acadia University, Wolfville, Nova Scotia, June 12 – 15, 2011.***
22. **Brill, P. H. and Huang, M. L. (2010).** "M/G/c/c Queues with Workload-dependent Arrival Rate", ***at the 3rd Madrid Conference on Queueing Theory, Toledo, Spain, June 28-July 1, 2010.***
23. ***Falsetti, H. and Huang, M. L. (2010).** "Tail Index Estimation for Heavy Tailed Distributions", ***at the 38th Annual Meeting of SSC, Quebec City, Quebec, Canada, May 23-26, 2010.***
24. ***Conroy, T. and Huang, M. L. (2010).** "On Estimation of Extreme values in Survival Analysis", ***at the 38th Annual Meeting of SSC, Quebec City, Quebec, Canada, May 23-26, 2010.***
25. **Brill, P. H. and Huang, M. L. (2009). "**An Inventory System with Order-size Dependent Cost Rate**", *at the 2009 Annual Conference for Canadian Queueing Theorists and Practitioners, Windsor, Ontario, Canada, August 27-28, 2009.***
26. **Brill, P. H. and Huang, M. L. (2009).** "A Note on an <s, S> Inventory System with Decay", ***at the 2009 International Conference of Computational Statistics and Data Engineering, July 1-3, London, UK, 2009.*** This paper was nominated the Best Paper Award in the conference.
27. ***Zhang, Z. and Huang, M. L. (2009).** "On High Quantile Estimation for Heavy Tailed Distributions", ***at the 37th Annual Meeting of SSC, Vancouver, BC, Canada, May 31-June 3, 2009.***
28. ***Zhao, K. and Huang, M. L. (2008).** "On Inverse Power Laws and Risk Analysis", ***at the 36th Annual Meeting of SSC, Ottawa, Ontario, Canada, May 25-29, 2008.***

29. **Huang, M. L. and Brill, P. H. (2007). "**On Orthogonal Series Estimation Methods**",** ***at the 5th International Conference on Multiple Comparison Procedures, Vienna, Austria, July 8-11, 2007.***
30. **Huang, M. L. (2007).** "An Efficient Randomized Quasi Monte-Carlo Method for the Pareto Distribution", ***at the 35th Annual Meeting of SSC, St. John's, Newfoundland, Canada, June 10-13, 2007.***
31. **Huang, M. L. (2006).** "Hermite Series Density Estimator", ***at the Statistics Workshop, Brock University, October 19, 2006.***
32. **Huang, M. L. (2005).** "A Weighted Estimation Method for the Pareto Variance", ***at the 2005 Joint Statistical Meeting of the American Statistical Association, Minneapolis, Minnesota, U.S.A., August 7-11, 2005.***
33. **Huang, M. L. (2005).** "A Bivariate Distribution Estimation Method based on Level Crossings", ***at the CSPS/IMS Joint Meeting, Peking University, Beijing, China, July 9-12, 2005.***
34. **Huang, M. L. (2005).** "A Weighted Multivariate Density Estimation Method", ***at the International Statistical Conference, Baplist University, Hong Kong, China, June 20-24, 2005.***
35. ***Tang, J. and Huang, M. L. (2004).** "On Estimation of the Pareto Distribution", ***at the 2004 Joint Statistical Meeting of the American Statistical Association, Toronto, Canada, August 8-11, 2004.***
36. **Huang, M. L. (2003).** "The Efficiency of a Weighted Distribution Function Estimator", ***at the 2003 Joint meetings of the American Statistical Association, San Francisco, California, August 3-7, 2003.***
37. **Huang, M. L. (2002).** "On Rank Tests for Experimental Designs", ***at the 2002 Joint Meetings of the American Statistical Association, New York City, New York, U.S.A., August 11-15, 2002.***
38. **Brill, P. H. and Huang, M. L. (2001).** "Steady State Analysis of $G^{(1)} + ... + G^{(N)}/M_i/1$ Queues", ***at the Canadian Queueing 2001 Conference, Waterloo, Canada, August 24-25, 2001.***
39. **Huang, M. L. (2000).** "A Nonparametric Predictor", ***at the 2000 Joint Meetings of the American Statistical Association, Indianapolis, Indiana, U.S.A., August 13-17, 2000.***
40. **Huang, M. L. (1999).** "A Weighted Regression Method", ***at the 1999 Joint Meetings of the American Statistical Association, Baltimore, MD, U.S.A., August 8-12, 1999.***
41. **Huang, M. L. (1998).** "On Weighted Quantile Estimators", ***at the 1998 Joint Meetings of the American Statistical Association, Dallas, Texas, U.S.A., August 9-13, 1998.***
42. **Huang, M. L. (1997).** "On Efficiencies of Quantile Estimators", ***at the 1997 Joint Meetings of the American Statistical Association, Anaheim, California, U.S.A., August 10-14, 1997.***
43. **Huang, M. L. (1997).** "On the D Numbers and D Compound Distribution", ***at the International Conference on Combinatorial Methods and Applications to Probability and Statistics, Hamilton, Ontario, Canada, June 25-28, 1997.***
44. **Huang, M. L. (1997).** "The D Compound distribution", ***at the 1997 International Symposium on Contemporary Multivariate Analysis and its Applications, Hong Kong, May 19-22, 1997.***
45. **Huang, M. L. (1996).** "A Nonparametric Estimation Method", ***at the 1996 Joint Meetings of the American Statistical Association, Chicago, Illinois, U.S.A., August 4-8, 1996.***
46. **Huang, M. L. (1995).** "A New Weighted Estimation Method", ***at the 50th Session of International Statistical Institute Conference, Beijing, China, August 21-29, 1995.***
47. **Huang, M. L. (1995).** "A New Weighted Density Estimation Method", ***at the 1995 Joint Meetings of the American Statistical Association, Orlando, Florida, U.S.A., August 13-17, 1995.***
48. **Huang, M. L. (1994).** "Some Estimation Problems in M/G/c/c Queues", ***at the 1994 Joint Meetings of the American Statistical Association, Toronto, Ontario, Canada, August 14-18, 1994.***
49. **Brill, P. H. and Huang, M. L. (1993).** "System Point Estimation of the Probability Distribution of the Waiting Time in Variations of $M/G^B/1$ Queues", ***at the 1993 Joint Meetings of the American Statistical Association, San Francisco, California, U.S.A., August 8-12, 1993.***
50. **Huang, M. L. (1992).** "On Estimation of the R Distribution", ***at the 1992 Joint Meetings of the American Statistical Association, Boston, Massachusetts, U.S.A., August 10-13, 1992.***
51. **Huang, M. L. (1991).** "Recurrence Relation for the Minimum Variance Unbiased Estimator for the Probability of the More Generalized Stirling Distribution of the Second Kind", ***at the 1991 Joint Meetings of the American Statistical Association, Atlanta, Georgia, U.S.A., August 18-22, 1991.***
52. **Huang, M. L. (1990).** "A Computational Method for the Generalized Stirling Distribution", ***at the 1990 Joint Meetings of the American Statistical Association, Anaheim, California, U.S.A., August 5-9, 1990.***
53. **Huang, M. L. (1989).** "Certain Properties of the R Distribution", ***at the 1989 Joint Meetings of the American Statistical Association, Washington, D. C., U.S.A., August 6-10, 1989.***
54. **Huang, M. L. (1989).** "Some Properties of the R Distribution", ***at the 1989 Annual Meeting of the Statistical Society of Canada, Ottawa, Ontario, Canada, May 30 – June 2, 1989.***

55. Huang, M. L. (1989). "Applications of the R Distribution", ***at the 1989 CORS/TIME/ORSA Joint International Annual Conference, Vancouver, Canada, May 8-10, 1989.***

5. CONFERENCES ATTENDED OR PLAN TO ATTEND

YEAR	CONFERENCE	LOCATION	DATE
2018	Joint Statistical Meetings (ASA-IMS)	Vancouver, BC, Canada	July 28-August 2, 2018
2018	60th Annual CORS Conference	Halifax, NS, Canada	June 4-6, 2018
2017	Joint Statistical Meetings (ASA-IMS)	Baltimore, MD, U.S.A.	July 29-August 3, 2017
2017	45th SSC Annual Meeting	Winnipeg, MB, Canada	June 11- 14, 2017
2016	2nd ICOSDA 2016 Conference	Niagara Falls, ON, Canada	October 14-16, 2016
2016	Joint Statistical Meetings (ASA-IMS)	Chicago, Illinois, U.S.A.	July30-August 4, 2016
2016	World Congress of Prob. and Stat./IMS	Toronto, ON, Canada	July 11-15, 2016
2016	44th SSC Annual Meeting	St. Catharines, ON, Canada	May 29-June 1, 2016
2015	Joint Statistical Meetings (ASA-IMS)	Seattle, Washington, U.S.A.	August 8-13, 2015
2015	IMS International Conf. on Stat. & Prob.	Kunming, China	July 1-4, 2015
2015	9th Conference on Extreme Value Analysis	Ann Arbor, MI, U.S.A.	June 15-19, 2015
2015	43th SSC Annual Meeting	Halifax, NS, Canada	June 14-17, 2015
2014	Joint Statistical Meetings (ASA-IMS)	Boston, MA, U.S.A.	August 2-7, 2014
2014	42th SSC Annual Meeting	Toronto, ON, Canada	May 25-28, 2014
2013	Canadian Queueing 2013 Conference	Waterloo, ON, Canada	August 23-24, 2013
2013	Joint Statistical Meetings (ASA-IMS)	Montreal, QB, Canada	August 3-8, 2013
2013	41th SSC Annual Meeting	Edmonton, AB, Canada	May 26-29, 2013
2012	Joint Statistical Meetings (ASA-IMS)	San Diego, CA, U.S.A.	July 28-August 2, 2012
2012	CORS Annual Meeting 2012	Niagara Falls, ON, Canada	June 11-14, 2012
2012	40th SSC Annual Meeting	Guelph, ON, Canada	June 3-6, 2012
2011	Canadian Queueing 2011 Conference	Banff, AB, Canada	August 26-28, 2011
2011	7th Conference on Extreme Value Analysis	Lyon, France	June 27-July 1, 2011
2011	39th SSC Annual Meeting	Wolfville, NS, Canada	June 12-15, 2011
2010	3rd MCQT'10 Conference	Toledo, Spain	June 28-July 1, 2010
2010	38th SSC Annual Meeting	Quebec City, QB, Canada	May 23-26, 2010
2009	ICCSDE'09 Meeting	London, UK	July 1-3, 2009
2009	37th SSC Annual Meeting	Vancouver, BC, Canada	May 31-June 3, 2009
2008	36th SSC Annual Meeting	Ottawa, ON, Canada	May 25-29, 2008
2008	SORA Annual Meeting	Toronto, ON, Canada	May 15, 2008
2007	5th International Conference on MCP	Vienna, Austria	July 8-11, 2007
2007	35th SSC Annual Meeting	St. John's, NF, Canada	June 10-13, 2007
2006	Canadian Queueing 2006 Conference	Banff, AB, Canada	September 14-16, 2006
2006	34th SSC Annual Meeting	London, Canada	May 28 - 31, 2006
2005	Joint Statistical Meetings (ASA-IMS)	Minneapolis, U.S.A.	August 7-11, 2005
2005	CSPS/IMS Joint Meeting	Beijing, China	July 9-12, 2005
2005	International Conference on Statistics	Hong Kong, China	June 20-24, 2005
2004	Joint Statistical Meetings (ASA-IMS)	Toronto, ON, Canada	August 8-11, 2004
2004	Conference on Distribution Theory	Santander, Spain	June 16-18, 2004
2004	32th SSC Annual Meeting	Montreal, QB, Canada	May 30 - June 2, 2004
2003	Canadian Queueing 2003 Conference	Toronto, Canada	September 19-20, 2003
2003	Joint Statistical Meetings (ASA-IMS)	San Francisco, U.S.A.	August 3-7, 2003
2002	Joint Statistical Meetings (ASA-IMS)	New York City, U.S.A.	August 11-15, 2002
2002	30th SSC Annual Meeting	Hamilton, ON, Canada	May 26-29, 2002
2001	MAA Seaway Section Fall Meeting	St. Catharines, ON, Canada	November 2-3, 2001
2001	Canadian Queueing 2001 Conference	Waterloo, Canada	August 24-25, 2001
2001	INFORMS International Conference	Maui, Hawaii, U.S.A.	June 17-21, 2001
2001	ICSA Applied Statistics Symposium	Chicago, IL, U.S.A.	June 7-9, 2001

(Conference Continues)

YEAR	CONFERENCE	LOCATION	DATE
2000	Canadian Queueing 2000 Conference	London, ON, Canada	Sept. 15 -16, 2000
2000	Joint Statistical Meetings (ASA-IMS)	Indianapolis, U.S.A.	August 13-17, 2000
2000	3rd World Congress of Nonlinear Analysis	Catania, Italy	July 19-26, 2000
1999	IFORS99	Beijing, China	August 16-20, 1999
1999	Joint Statistical Meetings (ASA-IMS)	Baltimore, U.S.A.	August 8-12, 1999
1998	IISA98 Conference	Hamilton, ON, Canada	October 11-12, 1998
1998	Joint Statistical Meetings (ASA-IMS)	Dallas, U.S.A.	August 9-13, 1998
1997	Joint Statistical Meetings (ASA-IMS)	Anaheim, U.S.A.	August 10-14, 1997
1997	Combinatorial to Prob. & Statistics	Hamilton, ON, Canada	June 25-28, 1997
1997	Multivariate Analysis Symposium	Hong Kong	May 19-22, 1997
1996	Joint Statistical Meetings (ASA-IMS)	Chicago, U.S.A.	August 4-8, 1996
1996	Joint Statistical Meetings (ASA-IMS)	Chicago, U.S.A.	August 4-8, 1996
1996	2nd World Congress of Nonlinear Analysis	Athens, Greece	July 10-17, 1996
1996	SSC Annual Meeting	Waterloo, ON, Canada	June 3-5, 1996
1995	ISI 50th Session Conference	Beijing, China	August 21-29, 1995
1995	Joint Statistical Meetings (ASA-IMS)	Orlando, U.S.A.	August 13-17, 1995
1994	Joint Statistical Meetings (ASA-IMS)	Toronto, ON, Canada	August 14-18, 1994
1993	Joint Statistical Meetings (ASA-IMS)	San Francisco, U.S.A.	August 8-12, 1993
1993	Directions on Probability Meeting	Stanford Univ., U.S.A.	August 6-7, 1993
1992	Joint Statistical Meetings (ASA-IMS)	Boston, MA, U.S.A.	August 10-14, 1992
1992	21st Stochastic Proc. & Appl. Conference	York Univ., ON, Canada	June 14-19, 1992
1991	Joint Statistical Meetings (ASA-IMS)	Atlanta, U.S.A.	August 18-22, 1991
1991	SSC Annual Meeting	Univ. of Toronto, Canada	June 3-6, 1991
1990	Joint Statistical Meetings (ASA-IMS)	Anaheim, U.S.A.	August 5-9, 1990
1989	Joint Statistical Meetings (ASA-IMS)	Washington, D. C., U.S.A.	August 6-10, 1989
1989	SSC Annual Meeting	Ottawa, ON, Canada	May 30 – June 2, 1989
1989	CORS/TIMS/ORSA Joint Conference	Vancouver, Canada	May 8-10, 1989

6. AWARDS OF GRANTS AND FELLOWSHIPS

2018 **DEAN's DISTINGUISHED SCHOLAR AWARD,** Brock University
2016-2017 **MATCH AND MINDS RESEARCH GRANT**, Brock University
2014-2019 **NSERC DISCOVERY RESEARCH GRANT, Canada**
2009-2014 **NSERC DISCOVERY RESEARCH GRANT, Canada**
2004-2009 **NSERC DISCOVERY RESEARCH GRANT, Canada**
2004 **FACULTY AWARD FOR EXCELLENCE FOR TEACHING,** Brock University
2001 **YWCA WOMEN OF DISTINCTION AWARD, SCIENCE & TECHNOLOGY**
2000-2004 **NSERC RESEARCH GRANT, Canada**
1996-2000 **NSERC RESEARCH GRANT, Canada**
1994-1995 **NSERC GENERAL GRANT**, Brock University
1993-1996 **NSERC RESEARCH GRANT, Canada**
1991-1993 **NSERC GENERAL GRANT**, Brock University
1990-1991 **RESEARCH POSTDOCTORAL FELLOWSHIP**, University of Windsor
1987-1990 **DELTA KAPPA GAMMA WORLD FELLOWSHIP**, Delta Kappa Gamma Society
1987-1990 **UNIVERSITY OF WINDSOR SCHOLARSHIP**, University of Windsor
1985-1987 **C. P. CROWLEY SCHOLARSHIP**, University of Windsor
1985-1990 **TEACHING/RESEARCH ASSISTANTSHIPS**, University of Windsor

7. MEMBERSHIPS AND PROFESSIONAL SERVICES

- **Membership in Associations**

American Statistical Association (ASA), 1988-Life time;
Institute of Mathematical Statistics (IMS), 1988-Life time;
International Chinese Statistical Association (ICSA), 1988-2004, 2014-life time.
Statistical Society of Canada (SSC), 1986-present

- Serve as the Representative of the SSC at Brock University, 2009 – 2017.
- Brock Univ. became an Institutional Member of the SSC, 2009-present.
- Brock Univ. became an Institutional Member of the Canadian Statistical Sciences Institute (CSSI), 2015- present.
- Member of the Local Organizing Committee of the 44th Annual Meeting of the SSC in 2016 at Brock University.

Canada Statistical Sciences Institute (CANSSI), 2015-present
- Serve as the Representative of the CANSSI at Brock University, 2017
- Brock Univ. became an Institutional Member of the CANSSI, 2015-present.

- **Professional Service**
  - **Serve as an Associate Editor of *Journal of Statistical Distribution and Applications, SpringerOpen, December 2015-present.***
  - **Referee papers for Journals:**
    AStA Advances in Statistical Analysis
    Annals of the Institute of Statistical Mathematics,
    American Statisticians;
    Communications in Statistics: Theory and Methods
    Communications in Statistics: Simulation and Computation
    Computational Statistics and Data Analysis
    International Transactions in Operational Research
    Journal of American Statistical Association
    Journal of Applied Statistics
    Journal of Nonparametric Statistics
    Journal of Statistical Distributions and Applications
    Journal of Zhajiang University Science A
    Mathematics of Operations Research,
    Statistical Heft.
    Statistics: a Journal of Theoretical and Applied Statistics
  - **Referee papers for conferences:**
    The 20th WMSCI Conference, 2016. December, 2015.
  - **Referee for applications of NSERC Discovery Research Grants, 2006(1), 2008(2). 2017(1), 2018(1).**
  - **Referee for Faculty Promotions, Canadian universities, 2006(1), 2007(1), 2009(1), 2010(2), 2011(2), 2017(2),**
  - **Reviewer for *Mathematical Reviews*, 2009(2), 2010(2), 2011(2), 2012(1).**
  - **Attended *the Heads Meeting at the Annual Meetings of the SS C, 2004, 2006-2010, 2014, 2016-2017.***
  - **Attended *the Annual meeting of CANSSI, as the Representative of Brock University, 2017. ,***
  - **Served as a member of the Scientific Program Committee for *the 2nd International Conference on Statistical Distributions and Applications (ICOSDA 2016)*. Organized a Topic-invited session "Extreme Value Distributions and Models", Niagara Falls, Ontario, Canada, October 14-16, 2016.**
  - **Organized and chaired an invited session "Quantile Regression and Extreme Value Analysis", for *the 44th Annual Meeting of the SSC in 2016 at Brock University, may 29-june 2, 2016.***
  - **Assisted organizing *the Fields Institute Distinguished Lecture Series, Dr. Fabrizio Ruggeir "Bayesian Methods in Complex Problems", October 24, 2017; and a Mini Course "Bayesian Inference for Poisson Processes and Applications in Reliability, October 24-26. 2017.***
  - **Organized, chaired and attended the six colloquium talks in Statistics at Brock University, 2015-1016.**
  - **Organized and chaired "Workshop on Level Crossing Methods in Stochastic Models", Brock University, August 27-28, 2013.**
  - **Organized and chaired "Actuarial Science Workshop", Brock University, October 29, 2010.**
  - **X. Xu and M. L. Huang presented *the Statistical Society of Canada*:** "The Statistical Society of Canada and Statistical Programs", ***at the Co-op Programs Association Night, Brock University, October 29, 2007.***
  - **Organized and chaired "Statistics Workshop", Brock University, October 14, 2006.**
  - **Member of the International Advisory Committee *of the Third International Conference on Sustainable Agriculture for Food, Energy and Industry,* *hosted by International Council for Sustainable Agriculture,* St. Catharines, Ontario, Canada, August 22-27, 2005.**
  - **Organized and chaired session for Meetings:** Statistical Session in ***IFORS99, Beijing, 1999.***

D. UNIVERSITY/COMMUNITY SERVICE

- **UNIVERSITY SERVICE**
  - Serve as the Representative of *the Statistical Society of Canada* at Brock University, 2009-2018.
  - Serve as the Representative of *the Society of Actuaries* (US and Canada) at Brock Univ., 2007-2018.
  - Served as member on Wan-Yi Huang's M.Sc. Thesis Committees,2014- 2015.
  - Serve as a consultant for the Administration of Brock Univ. and BUFA Workload Task Force, 2012.
  - Serve as a jury panel member in Science & Technology for YWCA Women of Distinction Awards, Canada, 2005 - 2012.
  - Served as the Dean's Delegate on Y. Lin's M.Sc. Committee, 2004.
  - BUFA representative of "Senate Budget Advisory Committee", Brock University, 2003-2004.
  - Member of "Advisory Committee of the Appointment of the Dean of the Faculty of Mathematics and Science", Brock University, 2001-2002.
  - Member of "Salary and Benefits Committee", Brock University Faculty Association, 1999-2000.
  - Member of "Pension Committee", Brock University, 1999-2000.
  - Served as Dean's representative on G. Tachon's M.Sc. Committees, 1997.
  - Served as Dean's representative on D. Moor's M.Sc. Committees, 1993.
  - Member of "Senate Research Committee", Brock University, 1996-1997.
  - Member of "Undergraduate Curriculum Committee", Brock University, 1992-1995.
  - Member of "Curriculum Review Committee", Brock University, 1992-1993.
  - Member of "Status of Women in Sciences Committee", Brock University, 1991-92, 93-94.
    - Organized "Scientifically Yours" Workshop, 1992, 1994.
- **DEPARTMENT SERVICE**
  - Chair (or member) of "Statistics Committee", 1992-2018.
  - Serve as "Advisor of the Concentration in Statistics Undergraduate Honor Program", 2010-2018.
  - Chair (or Member) of "Committee of Promotion and Tenure", 2009-2013, 2017-2018.
  - **M**ember of "Hiring committee for Statistics Position", 2018.
  - Member of "Undergraduate Curriculum Committee", 2007-2010, 2016-2017.
  - Member of "Service Course Committee", 2016-2017.
  - Member of "Sessional & ILTA Teaching Committee", 2016-2018.
  - Member of "Professional Applied Statistics Masters Program Committee", 2012-2018.
  - **M**ember of "Hiring committee for the Mathematical Help Center", 2015.
  - **M**ember of "Hiring committee for the Online Course Developer", 2015.
  - Serve as a coordinator of the Statistics Co-op Program, 2010.
  - Serve as a Mentor for a tenured faculty member, Dr. Xiaojian Xu, 2006-2010.
  - Serve as a coordinator of the Statistics Co-op Program, 2010.
  - Served as an Acting Chair, July 6 – 31, 2009.
  - Member of "Applied Statistics Master Program Committee", 2007-2008.
  - Member of "Statistics Accreditation Committee", 2005-2009.
  - Member of "Master in Science Program Committee", 2003-2007
  - Member of "Recruitment Committee", 1993-1995, 1996-2003, 2005-2006.
  - Member of "Statistics Service Course Committee", 2000-2003.
  - Member of "Task Force Committee", 1999-2002.
  - Member of "Planning Committee", 1997-1998.
  - Member of "Graduate Scholarships Committee", 1997-1998.
  - Member of "Equipment Purchase Committee", 1993-1995.
- **CONSULTING SERVICE (*Non-Remunerated*)**

In 1993, Brock University did not have many statisticians. Since 1993, a number of consulting projects within or outside Brock University were overwhelming. I have made non-remunerated consulting contributions to Brock University and communities in Canada, United States and China. These are examples:

- Consulted for a DNA research project of Geron Corporation, California, U.S.A.
- Consulted for research projects (6) of Guelph University, University of Toronto, State University of New York at Buffalo, U.S.A., Shanton University, China. .

- Consulting for several (over 22) research projects of Agriculture Canada, Niagara Weather Network, Niagara Pest Monitoring, Niagara Municipality and other Agencies in Toronto and Niagara region.
- Consulted on a quality control problem for John Deere Company.
- Consulted for research projects (over 58) for the Dept. of Biology, Chemistry, Computer Sciences, Applied Linguistics, Economics, Psychology and Political Science, Earth Science, Faculty of Business, Cool Climate Oenology and Viticulture Institute, the Applied Health Science, Education, Brock University.
- Consulted for Ph.D. theses (1), Sabdra VanderKaay, Rehabilittation Science, McMaster University, Canada.
- Consulted for Ph.D. theses (5), Masters theses (18) of the Cool Climate Oenology and Viticulture Institute, Dept. of Biology, Earth Sciences and Faculty of Applied Healthy Science, Brock University.

E. TRAINING HIGHLY QUALIFIED PERSONNEL

A number of my students have become MSc, Ph.D.s. and professional statisticians in government, hospitals, companies, schools and universities. These are some examples:

1. Supervisor of the ***Master students***: ***26***

- Prentice, Brayden, "Approximations on Heavy Tailed distributions", September 2018-June 2020.
- Clemens, Rachel, "Methods of Nonparametric Quantile Regression", September 2018-June 2020.
  2018-2019 NSERC Canada Graduate Scholarship Award.
  2018 NSERC Under Graduate Student Research Award (USRA).
- Morris, Rachel, "Direct Nonparametric Quantile Regression", Jan. 2018-June 2019.
  2018-2019 Ontario Graduate Scholarship Award (OGS)
  Co-op Risk Analyst, Sun Life Financial, 2016-2017.
- Kenig, Andrew, "Extreme Quantile Regression", Sept. 2017-October 2019.
  2018-2019 Ontario Graduate Scholarship Award (OGS)
  2017-2018 Art Bicknell Graduate Scholarship in Mathematics,
  2017-2018 NSERC Canada Graduate Scholarship Award.
  2017 Dean's Gold Medal for the Faculty of Mathematics and Science, Brock University.
- Tieu, Jenny, "Nonparametric Quantile Regression", Sept. 2017-October 2019.
  2018-2019 Ontario Graduate Scholarship Award (OGS)
  2017-2018 NSERC Canada Graduate Scholarship Award.
  Research Associate, Brock University, May-June, 2017
  2016 NSERC Under Graduate Student Research Award (USRA)
- Rat, Ramona, "On Inference of Quantile Regression", Jan. 2016-June 2017.
  Digital Analyst, Burberry Headquarter, London, United Kingdom
  2017 Distinguished Graduate Student Award, Brock University.
  2015-2017 NSERC Canada Graduate Scholarship Award, Brock University
  Research Associate, Brock University, May-June, -2017
  Co-op Credit Risk Analyst, Canadian Tire Financial, 2013-2014.
- Nguyen, Christine (co-supervised with Dr. J.Yuen), "On Weighted Quantile Regression", Sept. 2014-June 2016.
  Process Validation Coordinator, Apotex Company, Toronto, 2017-Present
  Research Associate, Brock University, Jan. 2016-2017
  Lecturer, Niagara College, 2016
  2014-2016 Queen Elizabeth II Graduate Scholarship in Science and Technology (QEII-GSST).
- DeAngelis, Christian (co-supervised with Dr. J. Yuen), "Predicting the Development of Coronary Heart Disease through a Joint Modeling Framework and Non-HDL Cholesterol", Sept. 2014-October 2016.
  Ph.D. student, University of Guelph, 2017-present;
  Lecture, Brock University, 2016-2017
  Lecturer, Niagara College, 2015-2017.
- Moosajee, Hassan (co-supervised with Dr. X. Xu), "Optimal Designs for Weighted Quantile Regression", Sept. 2014-October 2016.
  Business Analyst, Compass Group Canada, Mississauga, Ontario, Canada, August 2017-present.
- Mottola, Justyne, "Mixture Pareto Distribution", Sept. 2013-June 2015.
  Senior Institutional Analyst of the Institutional Analysis and Planning, Brock University, Sept. 2018-present.
  Credit Risk Analyst, Canadian Tire Financial, Jan. 2015-Sept. 2018.
  2013-2014 Ontario Graduate Scholarship Award (OGS).
- Xu, Yin, (co-supervised with Dr. J. Yuen), "Quantile Regression for Extremes", Sept. 2012-June 2014.

Actuarial Analyst, Al State Insurance Company, Toront, 2017-present
Risk Model Analyst, TD Bank Group, Toronto, 2015-2017
2014 Governor General's Gold Medal Award.
2014 Distinguished Graduate Student Award, Brock University.

- Thorpe, Lucas, "Estimation Methods for Extreme Value Distributions", Sept. 2012- June, 2014.
  Credit Risk Analyst, Canadian Tire Financial, 2014-present.
- Yan, Xiang, "On Methods of Confidence Intervals of High Quantiles", Sept. 2011- June 2013.
  Research Associate, May-June, 2017, Brock University
  Lecture, Brock University, 2013-present
  Professor, Niagara College, 2013-present.
- Coia, Vincenzo, "*On Estimation of Extreme Value Distributions*", Sept. 2011- August, 2012.
  Teaching Fellow, University of British Columbia, 2017-2018;
  Ph.D., Dept. of Statistics, University of British Columbia, 2012-2017.
  2013 Governor General's Gold Medal Award.
  2013 Distinguished Graduate Student Award, Brock University.
  2012-2015 NSERC Postgraduate Scholarship Award, Ph.D. (PGS).
  2011-2012 NSERC Alexander Graham Bell Canada Graduate Scholarship Award, MSc. (CGSM).
  2011 Presedent's Surgite Award, Brock University.
  2011 Dean's Gold medal, for the Faculty of Mathematics and Science, Brock University.
  2011 Distinguished Undergraduate Student Award, Brock University.
  2010 NSERC Under Graduate Student Research Award (USRA)
- Chen, Youwei, "*On High Quantile Estimation Methods*", Sept. 2010- June, 2012.
  Financial Manager, Kunlun Bank, Beijing, China.
- Sindelar, Erika, (co-supervised with Dr. J. Yuen)**, "***Applications of Bayesian Longitudinal Models"*, Sept. 2010–August 2012.
  Professor, Niagara College, 2012-present.
  Lecture, Brock University, 2012.
- Cheung, Chi Ho, (co-supervised with Dr. J. Vrbik) *"Approximate Confidence Interval for Generalized Pareto Distribution",* Sept. 2009-June, 2011.
  Senior Statistical analyst, Canadian Tire, January, 2018-present
  Senior Data Scientist, Precima, Loyaltyone, Toronto, Ontario, July-December, 2017.
  Ph.D., Dept. of Mathematics and Statistics, University of Windsor, 2011-2017.
- Fajardo, Val Andrei**, "***On Confidence Regions for High Quantile of a Heavy Tailed Distribution"*, Sept. 2009–Dec., 2010.
  Machine Learning Scientist, Integrat.ai, Toronto, October 2017-present.
  Senior Data Scientist, Precima, Loyaltyone, Toronto, Ontario, Jan. 2016-Septenber 2017.
  Ph.D., Dept. of Statistics and Actual Science, University of Waterloo, 2011-2015.
  2012-2015 NSERC Postgraduate Scholarship Award, Ph.D. (PGS).
  2011 Governor General's Gold Medal Award.
  2011 Distinguished Graduate Student Award, Brock University.
  2009-2010 NSERC Alexander Graham Bell Canada Graduate Scholarship Award, MSc. (CGSM).
- Conroy, Theresa*, "On Estimation of Extreme Value in Survival Analysis"*, Sept. 2008–Dec., 2009.
  Professor, St. Lawrence College, Kingston, 2016-present.
  Lecture, Brock University, 2010-2015.
  Lecturer, Niagara College, 2010-2015.
- Falsetti, Holly, *"On Tail Index Estimation of Heavy Tailed Distributions"*, Sept. 2008–Dec., 2009.
  Risk Modelling Analyst, TD Bank group, Ontario, 2010-present.
  Lecture, Brock University, 2010.
- Tashnev, Dmitry*,* (co-supervised with Dr. X. Xu) *"On Quantile Regression"*, Sept. 2008–Dec., 2009.
  Research Analyst, Blackberry Company, Canada 2009- present
- Zhang, Zheng, *"On High Quantile Estimation of a Heavy Tailed Distribution"*, Sept. 2007–June, 2009.
  Senior Actuarial Associate, Manulife Company, Toronto, 2010-present.
  2009 Distinguished Graduate Student Award, Brock University;
- Zhang, Miao (co-supervised with Dr. J.Yuen)*, "On Confidence Interval of a Quantile"*, Sept. 2007 – Dec. 2008.
  Research Analyst, GFK Company, Beijing, China, 2007-present
- Zhao*,*Ke, *"On Inverse Power Laws and Risk Analysis"*, Jan., 2007 – August, 2008.

Portfolio Analyst, Accountability and Operations, Advance Education, Government of Albert, 2017-present.
Project Assistant, Alberta Health, 2013-2017.
Ph.D., Dept. of Mathematics and Statistics, University of Calgary, 2009-2012.
2008 Distinguished Graduate Student Award, Brock University.

- Fisher, Jacqueline, *"On Estimation of Survival Function"*, Sept. 2006 – Dec. 2007.
  Analyst, Goldfarb Marketing, Toronto.
- Homryer, Cheryl (co-supervised with Dr. Lorne Stobbs), "*Sensitivities of Isolates of Venturia Inaequalis to Metiram"*, 2000-2003.

2. Supervisor of ***NSERC Postdoctoral Fellows: 5***

- Liu, Chao (co-supervised with Dr. Y. Li), Ph.D., Nankai University, China, "Combinatorial Number Theory and Applications in Statistical Models", August 2018 – July 2019.
- Spektor, Susanna (co-supervised with Dr. R. Kerman), Ph.D., University of Alberta, Canada, "An Estimate of the Root Mean Square Error Incurred when Approximating an $f \in L^2(\mathbb{R})$ by a partial Sum of its Hermite Series", Sept. 2014 – April 2016.
- Yu, Kaiqi (co-supervised with Dr. P. H. Brill), Ph. D., Western University, Canada, "*Approximation Methods for Heavy Tailed Distributions*", Sept. 2008 – August, 2010.
- Liu, Zaiming (co-supervised with Dr. P. H. Brill)*, Ph.D., Southern University, China, "Steady State Analysis of G(1)+…+G(N)/M/1 Queues"*, May-August 2001;
- Chen, Peter (co-supervised with Dr. P. H. Brill)*, Ph.D., Colorado State University, U.S.A. "Level Crossing Method",* Feb.1998 – August 1999.

3. Supervisor of students of the ***NSERC Undergraduate Student Research Award (USRA): 6***

- Clemens, Rachel, "On High Quantile Regression Methods", May-June 2018.
- Tieu, Jenny, *"On Quantile Regression and Heavy Tailed Distributions",* May-August, 2016.
- Coia, Vincenzo, *"On Heavy Tailed Distributions and their Applications"*, May-August, 2010.
- Couture, Kristen, "*On Estimation of Heavy Tailed Distributions*", May-August, 2005;
  Methodologist, Statistics Canada, 2008 - present.
  2006-2007 NSERC Graduate Scholarship Award.
  MSc student of University of Waterloo, 2006-2008.
- Tomaino, Nicholas, "*On Nonparametric Quantile Estimation*", May-August, 1999.
- Painter, Deborah, Western Ontario Univ., *"Kernel Spectral Bootstrap Estimation"*, May-August, 1996.

4. Supervisor of students of the ***BURSA Award*** : ***1***

- Couture, Kristen, *"On Estimation of the Lognormal Distribution*", August 2005 – April 2006.

5. Supervisor of students of ***the NSERC Research Projects: 13***

- Yan, Xiang, *"Conference Interval for Extreme Quantiles",* May-June, 2017.
- Tieu, Jenny, *"A Direct Method for Quantile Regression",* May-June, 2017.
- Rat, Ramona, *"A Direct Method for Quantile Regression",* January-April, 2017.
- Morris, Rachel, "*On Applications of Quantile Regression and Heavy Tailed Distributions",* May-August, 2016.
- Rat, Ramona, *"On Quantile Regression",* May-October, 2015.
- Nguyen, Christine, *"On High Quantile Regression",* May-August, 2014.
- Mottola, Justyne, *"On Models of Extreme Value Distribution",* May-August, 2013.
- Coia, Vincenzo, *"On Estimation of Heavy Tailed Distributions"*, May-August, 2011.
- Zhang, Zheng*, "On High Quantile Estimation of a Heavy Tailed Distribution"*, May –August, 2009.
- Zhao*,* Ke, *"On Generalized Pareto Distributions"*, May –August, 2009.
- Tang, Jing, *"On Estimation of the Pareto Distribution, Part II",* July -August 2004;
  Research Analyst, Fraser Health Authority, Surrey, BC, Canada.
  MSc student of University of Windsor, 2004-2006;
- Tang, Jing, *"On Estimation of the Pareto Distribution, Part I",* May -August 2003;
- Reinhart, Michael, *"Estimation of Quantiles",* June – September 1994.

6. Supervisor of ***Undergraduate Theses (or Honors Projects): 9***

- Thorpe, Lucas,*"On Extreme Value Distributions",* Sept. 2011-April 2012.
- Marshall, William, *"On Orthogonal Series Density Estimation",* Sept. 2006-April 2007;
  Assitant Professor, Brock University, January, 2019-present.
  Postdoctoral Fellow, University of Wisconsin-Madison, 2014-Dec. 2018.

MSc and Ph.D., Dept. of Statistics and Actual Science, University of Waterloo, 2007-2014.
2007-2011 NSERC Graduate Scholarship Award;

- Maddalena, Kristen, *"Estimation of the Pareto Distribution*", Sept. 2004-April 2005;
  Market Segment Analyst, Meridian Credit Union, Canada.
  MSc student of University of Waterloo, 2005-2007;
- Eckert, Mike, *"Estimation of the Moments of the Pareto Distribution",* Sept. 2004-April 2005;
- Tang, Wai Hung, *"Nonparametric Rank Tests",* Sept. 2003-April 2004;
- Tang, Jing, *"On Estimation of the Pareto Distribution, Part II",* May -August 2003;
- Wills, Chris, *"Statistical Analysis of Traffic Collision in Niagara Region",* Sept. 2001-April 2002;
  Teacher, Sutton District High School, Toronto, Ontario.
  MSc student of University of Windsor, 2002-2004;
- Bell, Michael, *"Factor Affecting the Levels of Downy and Powdery Mildews"*, Sept. 2001-April 2002;
  Teacher, Lindsay High School, Peterborough, Ontario, Canada.
- Absolonne, Fred, *"On Quantile Estimation",* Sept. 1997-April 1998.

7. Trained a number of students who have obtained Ph.D.'s or MSc's and have become professors, or other professionals in the U.S.A., Australia, Canada and China, 1982 - 2007. E.g.

- Dr. Marshall, B. was a Mathematics student under my supervision Honors Undergraduate Thesis *"On Orthogonal Series Density Estimation",* Sept. 2006-April 2007. He had a Ph. D. at University of Waterloo in 2014. Currently is an Assistant professor at Brock University
- Dr. Brannan, M. was a research associate during, 2007, under supervision of I and Dr. Kerman. He was a Ph.D. at Queens University, currently is an Assistant professor at University Illinois at Urbana-Champaign.
- Dr. Pratola, M. entered the Undergraduate Honors Statistics Program. I supervised his case study project "Analyzing Greenhouse Gas Emission in Canada" in 2003. He had a Ph. D. of Simon Fraser University in 2010. Currently is an Assistant professor at Ohio State University.

8. Served as members of several Ph.D. and MSc. committees, 1984 - 2015.

9. Supervised Case Study Projects in Statistics courses, in average 15 projects per year, 1992 – 2015.

F. TEACHING ACTIVITIES

COURSES TAUGHT AT CHINA ACADEMY OF RAILWAY SCIENCES, 1982-1985

Graduate Level Courses

Course	Times	Enrollment *(Average)*
Probability Theory	***4***	***35***
Mathematical Statistics	***4***	***35***
Stochastic Processes	***2***	***40***

COURSES TAUGHT AT CHINA HOBEI TEACHING COLLEGE, 1964-1978
(There were interruptions during the Cultural Revolution (1966 – 1976) in China.)

Undergraduate Level Courses

Course	Times*	Enrollment *(Average)*
Advanced Calculus	***4***	***60***
Analytic Geometry	***4***	***60***
Linear Algebra	***4***	***55***
Mathematical Analysis	***3***	***50***

COURSES TAUGHT AT BROCK UNIVERSITY

Graduate Level Courses, 2007-2018

Course	Name	Times	Enrollment *(Total)*
Math5P81	Sampling Theory	***9***	***17***
Math5P82	Nonparametric Statistics	***7***	***11***
Math5P99	Master Project	***10***	***24***
Math5V75	Selected Topic in Statistics	***1***	***1***

Undergraduate Level Courses, 1991 – 1993

Course	Name	Times	Enrollment *(Average)*
MATH 1P98	Basic Statistical Methods	***2***	***182***
MATH 1P97	Differential and Integral Methods, labs	***2***	***180***
MATH 2F96	Mathematical Probability and Statistics	***2***	***20***
MATH 4F21	Topics in Advanced Statistics	***1***	***3***

1993-2001: Developed a Concentration in Honors Program Statistics and a SAS Lab

In 1993, we started four new upper-year statistics courses* for the Department of Mathematics, and also started a new SAS (Statistical Analysis System, the top statistics package in the world) Computer Lab which was the first SAS lab at Brock University. These courses and SAS lab attracted a number of students, faculty members and staffs of Brock University and Agriculture Canada. These efforts built the foundation for a new statistics program. In 1999, we started a new Mathematics Honors program (Concentration in Statistics) and several new Combined Major Honors Programs. They all have been very successful.

Course	Name	Times	Enrollment *(Average)*
MATH 1P98	Basic Statistical Methods	***1***	***292***
MATH 2F96	Mathematical Probability and Statistics	***1***	***36***
***MATH 3P95**	Experimental Design	***5***	***10***
***MATH 3P96**	Sampling Theory	***6***	***8***
MATH 4F21	Topics in Advanced Statistics	***2***	***13 or Thesis (1)***
***MATH 4P22**	Regression Analysis	***4***	***8***
***MATH 4P23**	Nonparametric Statistics	***5***	***6***

2001-2018
Developed a Honors Concentration in Statistics Program, 1999-2018
Developed a Concentration in Statistics MSc Program, 2006-2018
Developed a Statistics Co-op Program, 2010 -2018
Developed a Professional Masters of Applied Statistics Program, 2012 -2018
Developed a Data Science Program, 2016 -2018

- Designing an application for Accrediting Statistics Program by the SSC (*Statistical Society of Canada*) - a graduate of this program will earn a certification of "Associate Statistician", 2005-2018.
- Member of "MSc Program Committee", designed and stared a new MSc graduate Program (Concentration in Statistics) at Brock University. 2005-2006.
- Member of "MICA Program Committee". Designed a new Concentration in Statistics in MICA Program at Brock University, 1999-2002.
- Member of "Task Force Committee" which designed new "MICA" Honors Programs in Mathematics and several new Combined Major Honors Programs. 1999-2002.
- Designed and started a new Honors Program in Mathematics (Concentration in Statistics) and several new Combined Major Honors Programs (Concentration in Statistics). 1999.

Course	Name	Times	Enrollment (*Average*)
MATH 1P98	Basic Statistical Methods	***2***	***315***
MATH 2P82	Mathematical Statistics	***1***	***11***
MATH 3P81	Experimental Design	***16***	***18***
MATH 3P82	Regression Analysis	***12***	***17***
MATH 4P81	Sampling Theory	***65***	***18***
MATH 4P82	Nonparametric Statistics	***14***	***18***
MATH 4F83	Topics in Advanced Statistics	***1***	***2, Theses***
MATH 4F90	Honors Thesis or project	***6***	***6, Projects***

TEACHING PROFESSIONAL DEVELOPMENT

A. Developed and Enhance a Concentration in Statistics Honor Program, 1994-2018

We developed new statistics courses for the Mathematics department and the first SAS Statistics computer Lab at Brock University in 1994. These courses attracted a number of students, faculty members and staffs of Brock University and Agriculture Canada. A new Statistics program started in 1999 – Honors Program in Mathematics (Concentration in Statistics) and several new Combined Major Honors Programs (Concentration in Statistics). They all have been very successful. We have been sending students to the best graduate schools in Statistics successfully. A number of graduates have become Ph.D.s or professional statisticians in government, hospitals and universities. A number of senior students earned NSERC Scholarships and Research Awards and presented their research projects in Statistics conferences. A number of their projects have been written as research papers and published in refereed journals. Above effects provided good conditions to the new MSc program in Statistics and Accrediting Statistics Program.

B. Developed and Enhance a Concentration in Statistics MSc Program, 2006-2018

The concentration in statistics MSc program with eight new courses started in Sept., 2006. It has successfully attracted a number of students from other universities, international students. A number of graduates have become Ph.D.s or professional statisticians. Students presented their projects in several SSC meetings. Their projects have been written as research papers and published in refereed journals.

C. Developed and Enhance a Statistics Co-op Program, 2010-2018

I have served as a coordinator of a new Statistics Co-op Program in 2010. The program started in 2010, and some students have been successfully worked in Statistics Canada, Canadian Tire, Hydra One, Sun Life and Royal Bank, etc.

D. Developed a Professional Applied Statistics MSc Program, 2012-2018

I with other statisticians designed a new Professional Applied Statistics MSc Program during in 2012-2018.

E. Developed a Data Science Program, 2016-2018

I with other statistician*ns participate to design a new Undergraduate Data Science Program in 2016. The program is planned to start in 2018. We hope the program will attract a number of students.

THE MAIN CONTRIBUTIONS

1. **Established the Concentration in Statistics Undergraduate Honor Programs at Brock University.**
2. **Established the MSc Concentration in Statistics Graduate Program at Brock University**
3. **Established a number of new Statistics courses in the Department of Mathematics**
4. **Designing an application procedure for Accrediting Statistics Program by the SSC (*Statistical Society of Canada*) - a graduate of this program will earn a certification of "Associate Statistician".**
5. **Designed a Statistics Co-op program.**
6. **Designed a Profession Applied Statistics MSc Program.**
7. **Designed a Data Sciences Program.**
8. **Established the first SAS (Statistical Analysis System) Labs at Brock University.**
9. **I Serve as the Representative of *the Society of Actuaries* (US and Canada) at Brock Univ., 2007-2018. Two Statistics Courses MATH 3P82, MATH 5P84 have been successfully approved by the *Society of Actuaries* as VEE credit courses, 2007-2018.**
10. **Helped Students taking Actuarial Science Exams. A number of Students were successful.**
11. **Helped Students taking Statistics Canada Exams. A number of Students were successful.**
12. **Innovative Teaching Methods:**
    - **Use "Case Study" method to develop students' thinking and application ability**
    - **Introduce history, significant impact and recent developments of subjects, combined with "Statistical Videos", "Work Sheet" and "Group Discussion" to motivate students to learn.**
    - **Use a series of high level textbooks and new computer technology to challenge students.**

CURRICULUM VITAE

Omar Kihel
Professor
Department of Mathematics
Brock University
500 Glenridge Avenue
St. Catharines, Ontario
Canada L2S 3A1
Tel. (Office): (905) 688-5550 ext. 3295
E-mail: okihel@brocku.ca

A. Formal Education

Ph.D. in Mathematics (Université Laval, Canada)

MSc. in Mathematics (Université Lyon I, France)

B. Academic Distinctions and Awards

- *Distinguished teaching award, Faculty of Mathematics and Science, Brock University, June 2017.*
- *Fellow of the Papua New Guinea Mathematical Society, since November 2013.*
- *Teaching award, First Year Calculus, The University of Lethbridge, Winter* 2002.
- Teaching award, CERTIFICAT-MERITANT, Université Laval, February 2000.
- First Prize at the department of Mathematics in Algeria for the undergraduate studies.
- Laureate of a national examination in mathematics organized by Algerian universities.
- Scholarship from Université Laval for doctoral studies.
- McGill University and Concordia University Scholarship Fellow, 1996-1997.

C. Academic Positions Held

2013- Present • Professor at Brock University

2006 - 2013 • Associate Professor at Brock University

2002 - 2006 • Assistant Professor at Brock University

2000 - 2002 • Assistant Professor at The University of Lethbridge

1998 - 2000 • Post-Doctoral Fellow at Université Laval, CICMA

1997-1998 • Assistant Professor, Riyad, Saudi Arabia

1996 - 1997 • Post-Doctoral Fellow at McGill University, CICMA

1995 - 1996 • Instructor at Université Laval

1992 - 1995 • TA at Université Laval

1991- 1992 • Instructor at Université Paris XIII.

1990 - 1991 • TA at Université Paris XIII.

D. Creative/Scholarly Activities

1. Publications

a) Refereed Journals

1. (With M. Ayad and R. Bouchenna), Indices in a Number Field II, accepted for publication in International Journal of Number Theory.

2. (With T. Garici and J. Larone), The number of solutions to y^2=px(Ax^2+2), Publications de l'institut mathematiques, nouvelle serie, tome 118, 1-8, (2018).

3. (With M. Ayad and J. Larone), When does a given polynomial with integer coefficients divide another? The American Mathematical Monthly, 123(04): 376-381, (2016).

4. (With F. Bencherif, N. Benyahia-Tani, S. Bouroubi), Integer partitions into Diophantine pairs, Quaest. Math. 40, 435-442, (2017).

5. (With M. Ayad and R. Bouchenna), Indices in a Number Field, Journal Theorie des Nombres de Bordeaux, 29, 201-216, (2017).

6. (With N. Benyahia Tani and Sadek Bouroubi), An effective approach for integer partitions using exactly two distinct sizes of parts, Elemente der Mathematik, 72, no. 2. 630-637, (2017).

7. (With S. Kebli) On a variant of Lucas' square pyramid problem. Ann. Math. Inf, Volume 46, 245-250, 2016.

8. (With M. Ayad and A. Bayad), On the denominator of an algebraic number in a number field, J. Number Theory 149, 1-14 (2015).

9. (With Jesse Larone), Prime rational functions, Acta Arith. 169, No. 1, 29-46 (2015).

10. (With M. Ayad and K. Belghaba), On Permutation Binomials over Finite Fields, The Bulletin of The Australian Mathematical Society, Volume 89, Issue 01, 112-124, 2014.

11. Permutation Polynomials over Finite Fields, South Pacific Journal of Pure and Applied Mathematics, 2014.

12. (With M. Ayad and K. Belghaba), On Permutation Binomials over Finite Fields, The Rocky Mountain Journal of Mathematics, 45, No. 2, 389-399 (2015).

13. M. Ayad, V. Coia, **O. Kihel**, On relatively prime sets, J. Integer Sequences, 17, No. 3, Article 14.3.7, 8 p, 2014.

14. M. Ayad, **O. Kihel**, A new class of permutation polynomials of F_q, Elemente der Mathematik, volume 68, n 2, 53-55, 2013.

15. (With M. Talbi and J. Van Druten A parametric family of dihedral extensions of degree 12 over Q and an independent system of units Ann. Sci. Math. Québec **36** (2012), 2, 535-543

16. **O. Kihel,** J. Lizotte, Small generators and reduced elements in a quadratic number field, J. Number Theory, Volume 132, Issue 9, September 2012, 1888–1895.

17. M. Ayad, **O. Kihel**, Recognizing the primes using permutations, Inter. J. Number Theory, Vol. 8, No. 8 (2012) 2045–2057.

18. (With B. He and A. Togbe) Solutions of a class of quartic Thue inequalities, Computers & Mathematics with Applications Volume 61, (2011), 2914-2923.

19. M. Ayad, **O. Kihel**, Common Divisors of Values of Polynomials and Common Factors of Indices in a Number Field, accepted for for publication, Inter. J. Number Theory, Volume: 7, Issue: 5 (2011), 1173-1194.

20. **O. Kihel**, F. Luca and A. Togbe, *VARIANTS OF THE DIOPHANTINE EQUATION n! + 1 = y2*, Portugal. Math. (N.S.) Portugaliae Mathematica, Vol. 67, Fasc. 1, 2010, 1–11.

21. **O. Kihel,** *A note on the Nagell-Ljungren Diophantine equation*, **Journal of Algebra, Number Theory and Applications**, 131-135, Volume 13 No. 2 (2009).

22. M. Ayad, **O. Kihel**, *On relatively prime sets*, **J. INTEGERS**, Vol. 9, A28, 343–352, de Gruyter Publisher, 2009.

23. M. Ayad, **O. Kihel**, *The number of relatively prime subsets of {1, ..., n}*, **J. INTEGERS**, 9, 2009 de Gruyter Publisher.

24. M. Ayad, **O. Kihel**, *On the number of subsets relatively prime to an integer*, **J. Integer Seq**. 11 (2008), 4 pp.

25. **O. Kihel**, F. Luca, *Variants of the Brocard-Ramanujan equation*. J. Théor. Nombres Bordeaux 20 (2008), no. 2, 353--363.

26. **O. Kihel**, F. Luca, *Perfect powers with all equal digits but one,* **Journal of Integer sequences**, 1-7, no. 8, (2005).

27. **O. Kihel** and C. Levesque, *On the diophantine equation* $X^4-DY^4 = \pm Z^2$ *and its associated elliptic curve* $V^2=U^3-DU$, **International Journal of Pure and Applied Mathematics,** 21 (2005), no. 3, 369--388.

28. K. Nwabueze, **O. Kihel** and A. Choudry, *Defining a group operation on the set of solutions of a parametrised quadratic Diophantine equation*, **International Journal of Pure and Applied Mathematics,** no. 18 (2005), no. 4, 441-444

29. B. Dufour and **O. Kihel**, *The Brocard-Ramanujuan diophantine equation*, **International Math. J.**, 5, (2004) 577-580.

30. **O. Kihel**, *Large k-Smith numbers*, **Transactions of WSEA, New York**, 469-81, (2004).

31. **O. Kihel** and K. Nwabueze, *On few diophantine equations related to the Brocard Ramanujan Diophantine equation* **International Journal of Pure and Applied Mathematics**, no. 16, (2004), 477-483.

32. **O. Kihel**, *Extensions diédrales et courbes elliptiques*, **Acta Arith.,** 102 (2002), no. 4, 309-314.

33. **O. Kihel** and C. Levesque, *On a few diophantine equations related to Fermat's last theorem*, **Can. Math. Bull.,** 45 (2002), no. 2, 247-256.

34. A. Kihel and **O. Kihel**, *Sets in witch the product of any k elements increased by t is a* k^{th}*-power of an integer*, **Fib. Quart.**, Vol. 39(2), (2001), 376-381.

35. A. Kihel and **O. Kihel**, *On the intersection and the extendibility of* P_t*-sets*, **Far East J. Math. Sci. (FJMS)** 3(4) (2001), 637-643.

36. M. El Kadhi and **O. Kihel**, *Some remarks on the diophantine equation* $(x^2-1)(y^2-1)=(z^2-1)^2$, **Proc. Japan. Acad.**, Ser. A Vol. 77, 2001, 155-159.

37. **O. Kihel**, *Groupe des unités pour une famille infinie d'extensions diédrales de degré 10 sur* Q, **J. Théor. Nombres Bordeaux,** Vol. 13, 2001, 469-481.

38. **O. Kihel**, *On the extendibility of the set {1,2,5}*, **Fib. Quart.**, Vol. 38(3), 2000, 466-470.

39. B. Dufour and **O. Kihel**, *The Brocard-Ramanujuan diophantine equation*, **International Math. J.**, 5, (2004) 577-580.

40. **O. Kihel**, *Sur une conjecture de M. Ruppert*, **C. R. Math. rep. Acad. Sci. Canada** Vol. 22 (2), 2000, 66-69.

2. Work submitted for journal publication/ Work in progress

41. (With M. Ayad and A. Bayad), Common divisors of the values of polynomials and algebraic number fields, work to be submitted.

42. (With N. BERBARA, S. MAVECHA, and J. MIDGLEY), ON THE DIOPHANTINE EQUATION $h(a)x^2 + f(a) = g(a)a^n$

.

3. Presentations at national and international conferences

.

- Invited speaker at International Conference, University Dakar, February 2018
- Invited speaker at The American University of Sharjah, UAE, December 2016
- Invited speaker at The University of Sharjah, UAE, December 2016
- Invited speaker (two talks) at KICM International Conference on Mathematics, Bangkok, Thailand, December 2016
- Invited talk at Math Seminar at York University, Toronto, Canada, November 2016.
- Invited talk at Math Seminar at McMaster University, Toronto, Canada, November 2016.
- Invited speaker, Algeria, February 2016.
- Invited speaker (three talks) at Colloque sur la cryptographie et les codes connecteurs, Dakar, Senegal, December 2015.
- Invited scholar, South Korea, December 2015.
- Invited speaker (two presentations) at International Conference of Pure and Applied Number Theory, Daejeon, South Korea, August 2015.
- Talk at CMS meeting, Charlottetown, PEI, June 2015.
- Talk at Univérsité Cadi-Ayad, Marrakech, Morocco, May 2015.
- Talk at Kasetsart University, Bangkok, December 2014.
- Talk at Univérsité Laval, July 2014.
- Invited speaker at Univérsité Ain Temouchent, May 2015
- Invited speaker at Paupa New Guinea, two invited talks, December 2014.

- Invited speaker a USTHB, Algiers, Algeria, November 2014.
- Invited speaker at Quebec-Maine Number Theory, September 2014, Univérsité Laval, Quebec.
- Invited talk at Tokyo University of Sciences, Japan, February, 2014.
- Invited talk at University of Nakhon Pathom, Thailand, February, 2014.
- Invited talk at Mahidol University, Thailand, March, 2014.
- Invited talk at University of Nakhon Pathom, March 2014.
- Invited talk (2 talks) at International Conference of Mathematics, Ain Temouchent, Algeria, April, 2014.
- Invited speaker at an International Conference in Number Theory, University of Algiers, Algeria, October 2013.
- Keynote speaker at International Conference On Pure and Applied Mathematics, ICPAM-LAE, PNG University of Technology, LAE, PAPUA NEW GUINEA, 26-28 Nov, 2013.
- Invited speaker at University of Port Moresby, Nov, 2013.
- Invited speaker Quebec-Maine Number Theory Conference, University of Maine at Orono, October 2013.
- Talk at Additive and Combinatorial Number Theory Conference, CANT, New York, May 21-24, 2013.
- Invited speaker at Quebec-Maine Number Theory Conference, September 2012.
- Invited speaker at Conference Internationale : Les journées mathématiques computationnelles, Algeria, Oran, June 2012.
- Invited talk at Université Limoges, France, December 2011.
- Talk The Combinatorial and Additive Number Theory (CANT 2011), the CUNY Graduate Center, New York, May 2011.
- Invited speaker at Journees arithmetiques de Meknes, Morocco, October 25-29, 2010.
- Invited speaker at Université Laval, Quebec, December 2010.
- Invited speaker at Université Calais, France, May 2010.
- Invited speaker at Université Limoges, France, May 2010.
- Invited speaker at Université Oran, Algeria, December 2009.
- Invited talk at The Quebec/Maine Number Theory Conference, Quebec, October 2008.
- Talk at The 4th INTERNATIONAL KYIV CONFERENCE on ANALYTIC NUMBER THEORY and SPATIAL TESSELLATIONS, September 2008**.**
- Conference on cryptography for high school students' La Marche, Welland, February 2008.
- Talk at Combinatorial and additive number theory (CANT), New York, May 2007.
- Talk at International Conference of Algebra and Number Theory, Morocco, May 2006
- Invited speaker at Symposium in discrete mathematics, Oran, Algeria, November 2006.
- Talk at Journées Arithmétiques, Marseille France July 2005.
- Invited speaker at Integers Conference 2005, State University of West Georgia, GA, October 2005, couldn't attend because of teaching.

- Talk given at Université Oran, Algeria, June 2005.
- Talk at Université Laval, April 2005.
- Participated at 12th International Workshop, FSE, Paris, France, February 2005.
- Invited speaker at Integers Conference 2003, State University of West Georgia, GA, November 2003.
- Invited speaker at Maine-Québec congress, October 2002.
- Invited speaker at Université Laval, August 2001.
- Talk given at the Canadian Mathematical Society, Montréal, December 1999.
- Talk given at the congress of the S.M.Q., Sherbrooke, October 1999.
- Invited speaker at Maine-Québec congress, University of Maine at Orono, October 1999.
- Invited speaker at Journées arithmétiques, Univérsité Laval, July 1998.
- Invited speaker at Université de Sherbrooke, June 1997.
- Invited speaker at Riyadh, Saudi Arabia, April 1998.
- Talk given at the congress of the S.M.Q., McGill University, April 1997.
- Invited speaker at the Quebec-Vermont Number Theory Seminar, Concordia University, December 1996.
- Talk given at the fifth conference of the Canadian Number Theory Association, Carleton University, Ottawa, August 1996.
- Talk given at Colloque des sciences mathématiques et congrès de l'A.M.Q., Québec-Lévis, November 1995.
- Talk given at Colloque des sciences mathématiques et congrès de l'A.M.Q., Université de Montréal, April 1994.

4. Grants Obtained

a. Internal Grants

- BUAF, Brock University 2014.
- Brock International Grant, 2008-2009.
- Start-Up Grant Brock University, 2002.
- The University of Lethbridge Research Fund, ULRF, 2001 – 2002.

b. External Grants

- NSERC: 2017-2022
- NSERC: 2012-2017
- Fields Institute Grant: 2011
- NSERC: 2011
- NSERC: 2006-2011
- NSERC: 2002 – 2006

5. Other Creative and Scholarly Activities

- Editor of three international journals of Mathematics.
- Invited Professor for one month, Université d'Evry, Paris, December 2012-January 2013.
- Invited Scholar for 2 weeks, Algeria, Université Oran, End November-December 2012.
- International Peer-Reviewer for Shota Rustaveli National Science Foundation of Georgia.
- Invited Professor for one month, Université du Littoral a Calais, June 2010.
- Invited Professor for one month, Université du Littoral a Calais, June 2008.
- Referee for International Journal of Number Theory
- Referee for Journal of Integer Sequences.
- Referee for Journal INTEGERS, de Gruyter Publisher.
- Referee for for Journal Discrete Mathematics.
- Referee for the journal Computers and Mathematics with Applications.
- Referee for the journal AJMS.
- Referee for the journal Publicationes Mathematicae Debrecen.
- Referee for Journal of Number Theory.
- Referee for Annales de mathématiques du Québec
- Referee for Fixed Point Theory and Applications.
- Referee for Czechoslovak Mathematical Journal.
- Referee for Acta Mathematica Academiae Paedagogicae Nyíregyháziensis.
- External member for six Ph.D. thesis.
- External member and reporter for a Ph.D. thesis, Université du Littoral, Calais, France, 2007.

- Member of the scientific committee and chair of Number Theory Session in Symposium in discrete mathematics, Oran, Algeria, November 2006.

- Chair of a Number Theory Session in International Conference of Algebra and Number Theory, Morocco, May 2006.

- Adjunct Professor, Department of Mathematics and Computer Science, The University of Lethbridge, 2001-2004.

- Adjunct Professor, Department of Mathematics, Université Laval, 2000-2003.

- Reviewer for Mathematical reviews.

- Reviewer for NSERC, 2001/2002, 2004/2005, 2009/2010 and 2010/2011.

- External member for the committee of a master thesis, Université Laval, 2005.

1. Student Supervision

- 1 post-doc (co-supervision).
- 33 graduate students and honor projects at Brock University and overseas.

2. Other Contributions Devoted to Pedagogical Interest

- Conference on cryptography for high school students' La Marche, Welland, February 2008.

- PUTNAM advisor for Brock University

F. University/Community Service

- I organized an international conference at Brock University August 2014.
- Co-organizer of **International Conference in Number Theory** at Brock University, September 9th, 10th, 11th 2011.
- I organized a conference "Number Theory and Algebra", July 2009 at Brock University.

- Organizer of the Number Theory Session at CMS, June 2002, Québec.

- Senate Budget Committee: Faculty representative: Fall 2003 and Winter 2004.

- University NSERC Committee: Departmental representative, 2002/2003.

- Graduate committee, department of mathematics, 2006–present.

- External member in the committee for the Master program, department of computer science, 2002 – 2011.
- Master committee as Dean's representative, November 2003.
- Organizer of the Math Colloquium for the years 2002/2012 (except when I was on leave).
- Member of several departmental Committees
- Member of a few universities committees
- Many graduate committees.
- Participated in the Math Camp and gave talks, August 2002, August 2003, July 2005 and July 2008.
- Co-organizer of An Afternoon in Financial Mathematics and Mathematical economics, April 2004.
- Math Majors Advising and Welfare Committee, 2005–2006.

CURRICULUM VITAE

Dr. Yuanlin Li
Department of Mathematics
Brock University
500 Glenridge Avenue
St. Catharines Ont.
Canada L2S 3A1

A. Formal Education

1993.12 - 1996.12: Ph.D. Pure Mathematics, Memorial University of Newfoundland, Canada.
Supervisor: M.M.Parmenter; Ph.D. May, 1997.
Thesis Title: Units In Integral Group Rings.

1985.9 - 1988.5 : M.Sc. Pure Mathematics, Nanjing University, China.
(Supervisors: Boxun Zhou and Wenting Tong; M.Sc. June 1988.
Thesis Title: Finitely Presented Dimension And Coherent Rings).

1978.2 - 1982.1 : B.Sc. Mathematics, Jiangsu University, China. B.Sc. January 1982.

B. Academic Distinctions, Awards and Major Appointments

2014-present: External Ph.D. Supervisor in Combinatorial Math. Nankai University, China (Co-supervised Ph. D. Students, Pingping Zhao, Hanbing Zhang, Chao Liu and Siao Hong).

2014-present: Guest Professor, Jiangsu University, China.

2012-present: External Ph.D. Supervisor in Pure Math. Southeast University, China (Co-supervised Ph. D. Students, Honglin Zhou, and Yanyan Gao).

2014-2016 : Awards: State Key Talent Recruitment Project. Nankai University, China.

2010-present: Editorial boards: (1) "Far East Journal of Mathematical Sciences". (2) "JP Journal of Algebra, Number Theory and Applications". (3) "International Journal of Mathematics and Scientific Computing" (2011-2018).

2009, 2013 : Awards: Priority Research Project for visiting international experts, Shanghai Jiaotong University.

1997 : The Fellow of the School of Graduate Studies, Memorial University of Newfoundland.

1993-1997 : Ph. D. Graduate scholarship, Memorial University of Newfoundland.

1992 : Provincial Award: The young outstanding teacher and researcher of Jiangsu Province, China.

C. Academic Positions Held

2007.7 - Present : Full Professor at Brock Univ.
Courses Taught: Modern Algebra (5P10), Group Rings (5P11) Ring Theory (5V76) and Algebraic Coding Theory (5V77) (for graduate students),Coordinator for Graduate Seminar (5P94), Advanced Group Theory (4P11), Advance Ring Theory (4P13), Advanced Mathematical Structures: Group Algebra (4P14), Abstract and Applied Algebra (3P13 and 3P12), (Abstract) Linear Algebra (2P12 and 2P13).

2009.7 -2010.6 : Interim Chair of Mathematics Department at Brock Univ.
Courses Taught: Modern Algebra (5P10) and Group Rings (5P11) (for graduate students), Coordinator for Graduate Seminar (5P94), Applied Algebra (3P12).

2003.7 - 2007.6 : Associate Professor at Brock Univ.
Courses Taught: Advanced Group Theory, Abstract Algebra, Applied Algebra, Abstract Linear Algebra, Linear Algebra, I, II.

2001.7 - 2003.6 : Assistant Professor at Brock Univ.
Courses Taught: Group Theory, Abstract Algebra, Applied Algebra, Linear Algebra, I, II, III Calculus I.

2000.9 - 2001.7 : Assistant Professor at the Univ. of Ottawa. Adjunct Professor at Memorial Univ. of Newfoundland.
Courses Taught: Linear Algebra, Calculus I, II, III.

1998.9 - 2000.8 : Assistant Professor at Memorial Univ. of Newfoundland.
Courses Taught: Linear Algebra, Calculus I, II, Precalculus.

1997.9 - 1998.8 : Postdoctoral fellow and Instructor at the Univ. of Alberta. Sessional Instructor at the Univ. of Lethbridge.
Courses Taught: Calculus I, II, Linear Algebra, Statistics.

1997.5 - 1997.8 : Postdoctoral fellow at Memorial Univ. of Newfoundland, Canada.

1997.1 - 1997.4 : Instructor at Memorial Univ. of Newfoundland, Canada.
Courses Taught: Calculus I.

1993.12 - 1996.12: Dept. of Mathematics & Statistics., Memorial Univ. of Newfoundland, Canada.
Substitute instructor for algebra courses: Ring Theory, Group Theory, Abstract Algebra, Discrete Math. Linear Algebra. Lab instructor and marker for Calculus II & III. Discrete Math, Number Theory, Abstract Algebra, Ring Theory and Group Theory.

1993.1 - 1993.11 : Associate Professor.
Dept. of Mathematical Sciences, Jiangsu Univ. of Science and Tech., China.

1988.6 - 1992.12 : Assistant Professor at the same university.

1982.1 - 1985.8 : Instructor at the same university.
Courses Taught:
(The class size for undergraduate students is around 120 and the class size for graduate students varies from 2 to 20.)

- Calculus I, II & III;
- Linear Algebra I & II;
- Vector Calculus I & II;
- Complex Analysis and Ordinary Differential Equations;
- Discrete Mathematics, Group Theory and Ring Theory;
- Abstract Algebra (for both Undergraduate and Graduate Students);
- Matrix Theory and Applications (for Graduate Students);
- Statistics and Probability.

D. Creative/Scholarly Activities

1. Publications

a) Articles In Refereed Journals

For all joint papers authors share work equally.

1. W. Gao*, Y. Li, C. Liu and Y. Qiu, *product one subsequences over subgroups of a finite group*, Acta Arith. Accepted August, 2018.
2. X. Zeng and Yuanlin Li*, *The structure of minimal zero-sum sequences of length five*, Ars Combinatoria, Accepted September 2017.
3. W. Gao, Y. Li, J. Peng and G. Wang*,*A unifying look at zero-sum invariants*, Int. J. Number Theory, 14(3) (2018) 705-711.
4. L. Xia, Y. Li* and J. Peng, *Minimal zero-sum sequences of length five over finite cyclic groups of prime power order*, Ars Combinatoria, 135 (2017) 369-390.
5. X. Zeng*, P. Yuan and Y. Li, *On the structure of long unsplittable minimal zero-sum sequences*, Acta Arith. 176 (2) 2016, 131-159.
6. Zhengxing Li*, Yuanlin Li and Hongwei Zhao, *The influence of maximal quotient groups on the normalizer conjecture of integral group rings*, J. Group Theory, 19 (6)(2016) 983-992.
7. H. Huang, Y. Li*, and P. Yuan, *Star-clean group rings II*, Comm. Algebra,44 (7) (2016) 3171-3181.
8. Zhengxing Li and Yuanlin Li*, *Class-preserving Coleman automorphisms of permutational wreath products with 2-closed base groups*, J. Algebra Appl. 15 (10) (2016) 1650189 (11 pages).
9. W. Gao*, Yuanlin Li, P. Zhao and J. Zhuang, *On sequences over a finite abelian group with zero-sum subsequences of forbidden lengths*, Colloq. Math. 144 (1) (2016) 31- 44 (DOI:10.4064/ cm6488-8-2015).
10. P. Yuan and Y. Li* *Long unsplittable zero-sum sequences over a finite cyclic group*, Int. J. Number Theory, 12, (4)(2016)979-993(DOI: 10.1142/S1793042116500615).

11. H. Huang and Y. Li* *On B(5,18) groups*, Comm. Algebra, 44 (2) (2016) 568-690 (DOI: 10.1080/00927872.2014.981751).
12. Zhengxing Li* and Yuanlin Li, *Coleman automorphisms of generalized dihedral groups*, Acta Mathematica Sinica (English Series) 32 (2) (2016) 251-257.
13. H. Huang, Y. Li* and G. Tang *On *-clean non-commutative group rings*, J. Algebra Appl. 15 (8) (2016) 1650150 (17 pages).
14. F. Aliniaeifard*, M. Behboodib and Y. Li, *The Annihilating-Ideal Graph of a Ring*, J. Korean Math. Soc. 52 (6) (2015) 1323-1336.
15. W. Gao, Y. Li*, P. Yuan and J. Zhuang, *On the structure of long zero-sum free sequences and n-zero-sum free sequences over finite cyclic groups*, Arch. Math.(Basel), 105 (4) (2015) 361-370 (DOI: 10.1007/s00013-015-0813-y).
16. X, Zeng, Yuanlin Li* and P. Yuan, *On a conjecture of Lemke and Kleitman*, Acta Arith. 168 (3) (2015) 289-299.
17. Hongdi Huang and Yuanlin Li*, *On B(4,14) non-2-groups*, J. Algebra Appl. 14, (7) (2015) 1550118 (14 pages).
18. Yanyan Gao*, Jianlong Cheng and Yuanlin Li, *Some $*$-clean group rings*, Algebra Colloq. 22 (1) (2015) 169-180.
19. Yuanlin Li*, M. M. Parmenter and Pingzhi Yuan *On Star-clean group rings*, J. Algebra Appl. 14 (1) (2015) 1550004 (11pages).
20. Tongsuo Wu*, Dancheng Lu and Yuanlin Li, *On zero divisors and prime elements of bounded semirings*, Front. Math. China, 9 (6) (2014) 1381-1399.
21. L. Xia*, C. Shen and Yuanlin Li, *On the index of length four minimal zero-sum sequences*, Colloq. Math. 135 (2) (2014), 201-209.
22. W. Gao*, Yuanlin Li and J. Peng, *An Upper Bound for the Davenport Constant of Finite Groups*, Journal of Pure and Applied Algebra, 218 (10) (2014), 1838-1844.
23. F. Aliniaeifard and Yuanlin Li*, *Zero-divisor Graphs for Group Rings*, Comm. Algebra, 42 (11) (2014), 4790-4800.
24. Gaohua Tang, Yangjiang Wei and Yuanlin Li*, *Unit groups of group algebras of some small groups*, Czechoslovak Math. Journal. 64 (139) (2014), 149-157.
25. Yuanlin Li* and M.M. Parmenter, *Central units in integral group rings II.* International journal of Algebra, 8 (2014) 47-55.
26. Yuanlin Li* and Yilan Tan, *On B-5 Groups*, Ars Combin, 114, (2014) 3-14.
27. Jiangtao Peng and Yuanlin Li*, *Minimal zero-sum sequences of length five over finite cyclic groups*, Ars. Combin. 112 (2013) 373-384.
28. F. Aliniaeifard, Yuanlin Li* and K. Nicholson, *Morphic p-groups* , Journal of Pure and Applied Algebra, 217 (2013) 1864-1869.
29. Yuanlin Li* and Jiangtao Peng, *Minimal zero-sum sequences of length four over finite cyclic groups II*, Int. J Number Theory, 9 (2013) 845-866.

30. Yuanlin Li*, and Xiaoying Pan, *On B(5,k) groups*, Bull. Aust. Math. Soc. 84 (2011) 393-407.
31. Weidong Gao*, Yuanlin Li and Jiangtao Peng, *A quantitative aspect of non-unique factorizations: the Narkiewicz constants II*, Colloq. Math. 124 (2011) 205-218.
32. Yuanlin Li* and Yilan Tan, *On B(4,13) 2-Groups*, Comm. Algebra, 39 (10) (2011) 3769-3780.
33. Weidong Gao and Yuanlin Li*, *Remarks on group rings and Davenport's constant*, Ars Combinatoria, CI (2011), 417-423.
34. Weidong Gao*, Yuanlin Li, Jiangtao Peng, Chris Plyley and Guoqing Wang, *On the index of sequences over cyclic groups*, Acta Arith. 148, No. 2, 119-134 (2011).
35. W. Gao and Yuanlin Li* *On Duo group rings*, Algebra Colloq. 18 (1) (2011) 163-170.
36. H. Bell and Yuanlin Li*, *On a combinatorial commutativity condition for rings*, Comm. Algebra, 39 (1) (2011) 601-607.
37. Yuanlin Li*, C. Plyley, P. Yuan and X. Zeng, *Minimal Zero Sum Sequences of Length Four over Finite Cyclic Groups*, Journal of Number Theory, 130 (2010) 2033-2048.
38. Yuanlin Li and K. Nicholson*, *Ehrlich's Theorem for Groups*, Bull. Austral. Math. Soc. 81 (2010) 304-309.
39. Yuanlin Li and K. Nicholson* and L. Zan, *Morphic groups*, Journal of Pure and Applied Algebra, 214 (2010) 1827-1834.
40. Yuanlin Li* and Yilan Tan, *On B(4,k) groups* , Journal of Algebra and Its Applications, 9 (2010) 27-42.
41. W. Gao* and Yuanlin Li *The Erdös-Ginzburg-Ziv theorem for finite solvable groups* J. Pure Appl. Algebra, 214 (2010) 898-909.
42. N. Ding*, Yuanlinm Li and L. Mao *J-coherent rings*, Journal of Algebra and Its Applications, 8(2009) 139-155.
43. N. Ding*, Yuanlin Li and L. Mao, *Strongly Gorenstein Flat Modules*, J. Austral. Math. Soc., 86(2009) 323-338.
44. Y. Li and M.M. Parmenter* *Graded reversibility in integral group rings* , Acta Applicandae Mathematicae, 108 (2009) 129-133.
45. W. Gao*, Y. Li, J. Peng and F. Sun *On subsequence sums of a zero-sum free sequence II*, E. J. Combinatorics, 15 (1) 2008 R117.
46. W. Gao*, Y. Li, J. Peng and F. Sun *Subsums of a zero-sum free subset of an abelian group*, E. J. Combinatorics, 15 (1) 2008 R116.
47. Zsolt Balogh and Yuanlin Li*, *On the derived length of the group of units of a group algebra*, Journal of Algebra and Its Applications, 6 (6) (2007) 991-999.
48. Yuanlin Li* and M.M. Parmenter, *Reversible group rings over commutative rings*, Comm. Algebra, 35 (12) (2007) 4096-4104.

49. Yuanlin Li*, *Strongly clean matrix rings over local rings*, Journal of Algebra, 312 (2007), 397-404.
50. H.E. Bell and Yuanlin Li*, *Duo group rings*, Journal of Pure and Applied Algebra, 209(3)(2007), 833-838.
51. A. Herman and Yuanlin Li*, *Trivial torsion units in G-adapted group rings*, Journal of Algebra and Its Applications, 5(6) (2006), 781-791.
52. Yuanlin Li*, H.E. Bell and C. Phipps, *On reversible group rings* , Bulletin of The Australian Mathematical Society, 74 (2006), 139-142.
53. A. Herman and Yuanlin Li*, *Class preserving automorphisms of Blackburn groups*, Journal of The Australian Mathematical Society, 80 (2006), 351-358.
54. Jianlong Chen, Yuanlin Li* and Yiqiang Zhou *Morphic group rings*, Journal of Pure and Applied Algebra, **205** (2006) 621-639.
55. A. Herman and Yuanlin Li* *Trivial units for group rings over rings of algebraic integers*, Proceedings of American Mathematical Society, **134**, (2006), 631-635.
56. E.G. Goodaire, Yuanlin Li and M.M. Parmenter *Hypercentral units in alternative loop rings*, Journal of Algebra, **283** (2005), 317-326.
57. Yuanlin Li and M.M. Parmenter *Upper central series of the unit group of an integral group ring*, Communications in Algebra, **33** (2005), 1409-1415.
58. A. Herman, Yuanlin Li and M.M. Parmenter *Trivial units for Group rings with G-adapted coefficient rings*, Canadian Mathematical Bulletin, **48** (2005), 80-89.
59. Yuanlin Li and M.M. Parmenter *Some results on hypercentral units in integral group rings*, Communications in Algebra, **31** (2003),no 7,3207-3217.
60. Yuanlin Li *On the normalizer problem for G-adapted group rings of torsion groups*, Bulletin of the Australian Mathematical Society, **67** (2003), no 1, 171-176.
61. Yuanlin Li *On the normalizer problem of integral group rings of torsion groups*, Israel Journal of Mathematics, **132** (2002), 169-176.
62. Yuanlin Li *The normalizer of a metabelian group in its integral group ring*, Journal of Algebra, **256** (2002), no 2, 343-351.
63. Jianlong Chen, Nanqing Ding, Yuanlin Li and Yiqiang Zhou *On (m. n)-injectivity of modules*, Communications in Algebra, **29** (2001), no 12, 5589-5603.
64. Edgar Goodaire and Yuanlin Li *The normalizer conjecture in the alternative case*, Algebra Colloquium, **8** (2001) 455-462.
65. Yuanlin Li *Some results on bicyclic units in an integral group ring*, Communications in Algebra, **29** (2001) no 3, 1339-1345.
66. M.M. Parmenter and Yuanlin Li, *Hypercentral Units in Integral Group Rings*, Proc. Amer. Math. Soc., **129** (2001) no 8, 2235-2238.
67. Yuanlin Li, S.K. Sehgal and M.M. Parmenter, *On the normalizer property of an integral group ring*, Communications in Algebra, **27** (1999), no 9, 4217-4223.

68. Yuanlin Li, *Units of* $\mathbb{Z}(G \times C_2)$, Quaestiones Mathematicae, **21** (1998), 201-218.
69. Yuanlin Li, *The hypercentre and the n-centre of the unit group of an integral group ring*, Canadian Journal of Mathematics, **50** (1998), no. 2, 401-411.
70. Yuanlin Li, *On the normalizers of the unitary subgroup in an integral group ring*, Communications in Algebra, **25** (1997), no. 10, 3267-3282.
71. Yuanlin Li and M.M. Parmenter, *Central units of the integral group ring* $\mathbb{Z}A_5$, Proc. Amer. Math. Soc., **125** (1997), no. 1, 61–65. (MR. 97c: 16041)
72. Yuanlin Li, *Finitely presented dimension and coherent rings*, J. Math., **13** (1993), no. 2, 182–188. (MR. 94m: 13026)
73. Yuanlin Li, *The syzygy theorem for finitely presented dimension*, J. Math. Res. Exposition, **13**(1993), no. 2, 283–288. (MR. 94g: 16007)
74. Yuanlin Li and Dianchen Lu, *Finitely presented dimensions of Cartesian squares*, Nanjing Daxue Xuebao Shuxue Bannian Kan, **9** (1992), no. 1, 102–112. (MR. 93i: 16013)
75. Yuanlin Li, *Generalized finitely presented modules*, J. Jiangsu Inst. Tech., **13** (1992), no. 2, 101–107. (MR. 97c: 16002)
76. Yuanlin Li, *A remark on the reduced group* $\tilde{K}_0(R)$, Nanjing Daxue Xuebao Shuxue Bannian Kan, **8** (1991), no. 1, 79–82 (MR. 92m: 19002)
77. Yuanlin Li, *Some theorems on change of rings of the finitely presented dimension*, Nanjing Daxue Xuebao Shuxue Bannian Kan, **7** (1990), no. 1, 75–84. (MR. 91k: 16013)
78. Yuanlin Li, χ_n*–coherent rings*, J. Jiangsu Inst. Tech., **11** (1990), no. 4, 97–102. (MR. 97c: 16029)
79. Yuanlin Li, *Some properties of socles*, Nanjing Daxue Xuebao Shuxue Bannian Kan, **5** (1988), no. 2, 266–273. (MR. 90a: 16016)

c) Published In Refereed Conference Proceedings

1. H. Bell and Yuanlin Li, *Reversible and Duo group rings*, Advance in Ring Theory, Trend in Mathematics, Birkhäuser/ Springer Basel AG (2010) 37-46. (Proceedings of the international conference on "Algebra and its Applications" in honor of Prof. S.K. Jain's 70th Birthday, Athens Ohio, USA, June 2008).
2. Yuanlin Li and M.M. Parmenter, *Decomposition of central units of integral group rings*, Groups, Rings, and Group Rings, 275-278, Lecture Notes in Pure and Applied Mathematics **248**), Chapman & Hall/CRC, Boca Raton, FL, 2006, (Proceedings of the international conference on "Groups, Rings, and Group Rings", Ubatuba, Brazil, 2004).
3. J. Chen, Yuanlin Li and Y. Zhou, *Constructing Morphic Rings*, Advances in Ring Theory, 26-32, World Scientific Publishing Co. Hackensack, NJ, 2005, (Proceedings of the 4th China-Japan-Korea international ring theory conference, Nanjing, China, 2004).

4. Yuanlin Li, *The normalizer conjecture of integral group rings*, Proceedings of the international conference on "Groups and Group Rings", Wisla, Poland, 2000.
5. Yuanlin Li, *Finitely presented dimensions of Cartesian squares(II)*, Proceedings of the First China-Japan International Symposium on Ring Theory (Guilin, 1991), 95–97, Okayama University, Okayama, 1992. (MR. 93k: 16001)
6. Yuanlin Li, *Some equivalent conditions on coherent rings*, Proceedings of the Fourth Chinese National Conference on Algebra, XiAn, China, 1989.

2. Work Submitted For Publication

1. J. Peng, W. Hui, Y. LI and F. Sun, *On subset sums of zero-sum free sets of abelian groups*, Submitted 2018.
2. F. Aliniaeifard, M. Behboodib and Yuanlin Li, *Noetherian Rings Whose Annihilating-Ideal Graphs Have Positive Genus*, Submitted 2015.

4. Papers Presented at Conferences and Invited talks

- " On Reversible group rings", Colloquium, Tongji University, Shanghai, China, June 15, 2018
- Attended China - US joint Mathematics Meeting, Shanghai, China, June 10-15, 2018
- " non-commutative *-clean group rings ", Colloquium, Nanjing University, Nanjing, China, June 4, 2018
- " *-clean group rings II", Colloquium, Tianjin Polytechnic University, Tianjin, China, June 1, 2018
- " *-clean group rings ", Colloquium, Nankai University, Tianjin, China, May 30, 2018
- " A combinatorial problem in group theory – B(n, k) groups", Invited talk, International conference on groups, representations and related topics, Yongchun, Chongqing, China, May 16-20, 2018
- " Non-commutative *-clean group rings ", Colloquium, South East University, Nanjing, China, May 14, 2018
- " Some research problems in combinatorial group theory", Colloquium, Jiangsu University, Zhengjiang, China, May 10, 2018
- " *-clean group rings over non-abelian groups", International conference on Rings and Factorizations, Graz Austria, Feb. 20, 2018
- " Reversible group rings", Invited talk, University of Buffalo, USA, Nov. 13, 2017
- " A combinatorial problem in group theory", Colloquium, Sichuan Normal University, Chengdu, China, June 15, 2016
- " $*$-clean group rings", Colloquium, Sichuan University, Chengdu, China, June 14, 2016
- " Coleman automorphisms of generalized dihedral groups" The 14th National Conference on Algebras, Yangzhou, China, May 26-31, 2016

- "Recent development on the four-zero conjecture" Colloquium, Nanjign University, Nanjing, China, May 23, 2016
- "Reversible group rings" Colloquium, Qingdao University, Qingdao, China, May 19, 2016
- "A combinatoric problem in group theory" Colloquium, University of China Civil Aviation, Tianjin, China, May 16, 2016
- "Algebraic codes from matrices and group rings" Colloquium, Nankai University, Tianjin, China, May 14, 2016
- "Zero-divisor graphs of group rings" Colloquium, Tianjin Polytechnic University, Tianjin, China, May 12, 2016
- "Long zero-sum free and n-zero-sum free sequences over nite cyclic groups" Combinatorial and Additive Number Theory 2016, Graz, Austria, Jan. 4-8, 2016
- "$*$-clean group rings II" The 7th CHINA-JAPAN-KOREA International Symposium On Ring Theory, Hangzhou, China, July, 2-6, 2015
- "On Star-clean group rings II" Colloquium, Southeast University, Nanjing, China, May, 2015
- "On B(5, 18) Groups" Colloquium, Jiangsu University, Zhenjiang, China, May, 2015
- "On The Davenport Constant" Colloquium, Nanjing University, Nanjing, China, May, 2015
- "On Reversible Group Rings" Colloquium, Nanjing Normal University, Nanjing, China, May, 2015
- "A Combinatorial Problem in Group Theory" Colloquium, Dalian Maritime University, Dalian, China, May, 2015
- "Star-clean group rings II" Colloquium, Nankai University, Tianjin, China, May, 2015
- "Additive Number Theory and The Davenport Constant" Colloquium, Memorial University, St. John's NL April, 2015
- "Davenport Constant" Colloquium, Shanghai Jiaotong University, Shanghai, China, May, 2014
- Invited talk "Star-Clean Group Rings" Algebra Workshop, Nanjing Normail University, Nanjing, China, May, 16-17, 2014
- "Star-Clean Group Rings" Colloquium, Nanjing University, Nanjing, China, May, 2014
- "Reversible Group Rings" Colloquium, Tianjin University of Science and Technology, Tianjin, China, April, 2014
- "Star-clean group rings" Colloquium, Nankai University, Tianjin, China, April, 2014
- "Davenport Constant" Colloquium, Luo Yang Teachers University, Luo Yang, China, April, 2014
- "Davenport Constant of a finite abelian group" The Fourth Algebra International Workshop at Brock University, Saint Catharines Brock University, Ontario, March 19, 2014
- Invited talk "On The Davenport Constant" Number Theory Seminar at The Fields Institute, Toronto Canada, Feb. 2014

- Short course on "group rings" Shanghai Jiaotong University, Shanghai, China, June, 2013
- "Star-clean group rings" Colloquium, Shanghai Jiaotong University, Shanghai, China, June, 2013
- "Morphic groups II" Colloquium, Nankai Univ. Tanjin, China, May, 2013
- "Morphic groups I" Colloquium, Nankai Univ. Tanjin, China, May, 2013
- "Mathematics Education in Canada" Colloquium, Jiangsu Univ. Zhengjiang, China, April, 2013
- "Zero-divisor graphs for group rings (most recent report)" Atlantic Algebra Center, Memorial University, St. John's Nfld, Nov. 2012
- "Zero-divisor graphs for group rings" Colloquium, Shanghai Jiaotong University, Shanghai, China, Nov. 2012
- "Zero-divisor graphs for group rings II" Colloquium, Nanjing University, Nanjing, China, Nov, 2012
- "Reversible group rings-Recent development" Colloquium, Guangxi Teacher's Education University, Nanning, China, Oct. 2012
- "Mathematics education in Canada" Invited talk in Guangxi Teacher's Education University, Nanning, China, Oct. 2012
- "Zero-divisor graphs for group rings I" , Ohio Algebra conference on ring theory, Columbus, Ohio, USA, May, 2012.
- "Morphic p-groups", Colloquium, Southeast University, Nanjing, China, May, 2012
- "Reversible group rings over commutative rings", Colloquium, Nankai Univ. Tanjin, China, April, 2012.
- "The 4-sum conjecture", Colloquium, Jiangsu Univ. Zhenjiang, China, April 20, 2012.
- "Morphic groups", Colloquium and Graduate Seminar Series, Brock University, Jan.25 2012.
- "Reversible group rings: Most Recent Development.", Colloquium and Graduate Seminar Series, Brock University, Jan.18 2012.
- "Reversible group rings", Colloquium, Wilfrid Laurier University, Oct. 2011.
- "Minimal Zero Sum Sequences of Length Four over Finite Cyclic Groups ", Brock international conference in number theory, St. Catharines, Ontario, Sept. 9-11, 2011.
- "On morphic groups", International conference on groups, rings and group rings , Edmonton, Alberta, July, 10-16, 2011.
- "Groups with small squaring properties", Colloquium, Jiangsu Univ. Zhenjiang, China, May, 2011.
- "B(5,k) groups", Colloquium, South China Normal University, Guangzhou, China, May, 2011.
- "The four sum conjecture", Colloquium, Najing Univ. May, 2011.
- "On morphic properties", Colloquium, Najing Univ. May, 2011.
- "Morphic groups", Colloquium, Shanghai Jaotong Univ. May, 2011.

- "On a combinatorial commutativity condition for rings", Chinese 12th National Congress on Algebra, Lanzhou, China, June, 20-24, 2010.
- " Recent development in group rings", Colloquium, Jiangsu Univ. June, 2010.
- " B-5 groups", Colloquium, Civil Aviation University of China, Tianjin, China, June, 2010.
- " B-k rings", Colloquium, NanKai Univ. June, 2010.
- " B-4 and B-5 rings", South East University. June, 2010.
- " A combinatorial commutativity condition in ring theory", Shanghai Jiaotong Univ. June 2010.
- " A combinatorial Problem in group theory", Colloquium, Nanjing Univ. June, 2010.
- "Duo group rings (over integral domains)", Aachen, Germany, March, 2010.
- "Reversible and Duo group rings", Porto Cesareo, Lecee, Italy, June, 2009.
- " A combinatorial Problem in group theory", Colloquium, Shanghai Jiaotong Univ. July, 2009.
- " Group rings and related topics", Colloquium, NanKai Univ. July, 2009.
- "A combinatorial problem in an Abelian group", Brock Algebra Workshop, Brock University, Feb 2009.
- "Subsums of a zero-sum free subset of an Abelian group", International Conference on Groups, Rings, and Group Rings, Ubatuba, Sao Paulo, Brazil, 28th to Aug 2nd, 2008.
- "On duo group rings" (Recent Development), International Conference on Algebra and its Applications, Ohio, USA, June, 2008.
- "Reversible group rings ", Colloquium, Shanghai Jiaotong University, June, 2008.
- "Recent Development in Duo group rings", Colloquium, Nanjing University, May, 2008.
- "On duo group rings", Algebraic and combinatorial methods in concrete classes of algebras and groups, Alden Biesen, Belgium, Sept., 2007.
- "Strongly clean matrix rings over local rings", Groups, Rings, Lie and Hopf Algebra II, Gros Morne, Newfoundland, Aug., 2007.
- "The derived length of the unit group in a group algebra", Brock Algebra Workshop, Brock University, March, 2007.
- "Strongly clean matrix rings", Brock Algebra Conference, Brock University, Aug., 2006.
- "Hypercentral units in G-adapted group rings", Colloquium, Shanghai Jiaotong University, June, 2006.
- "Duo group rings", Colloquium, Southeast University, June, 2006.
- "On reversible group rings on commutative rings", Colloquium, Nanjing University, May, 2006.
- "Hypercentral units in group rings" Colloquium, Nankai University, May, 2006.
- "Reversible group rings on commutative rings" Colloquium, Memorial University of Newfoundland, March, 2006.

- "Hypercentral units in arbitrary group rings", International Conference on Groups, Rings, and Group Rings, Ubatuba, Sao Paulo, Brazil, July, 2004.
- "The morphic problem in group rings", The fourth China-Japan-Korea International Conference on Ring Theory, Nanjing, China, June, 2004.
- "Trivial units in G-adapted group rings", Canadian Mathematical Society, Summer Meeting, Halifax, Nova Scotia, June, 2004
- "Ascending central series of the unit group in an integral group ring" Alberta Algebra conference, Kananaskis, Alberta, Feb. 2004.
- "Hypercentral units in integral group rings", Colloquium, the University of Regina, May, 2002.
- "The normalizer problem and its recent developments", Colloquium, Brock Univ., Feb. 2001.
- "Cryptography and group ring transformations" video-conference, University of Alberta, Dec. 2000.
- "C-automorphisms and the normalizer problem of integral group rings" Algebra seminar, University of Ottawa, Nov. 2000.
- "The normalizer conjecture of integral group rings" International conference "Groups and Group Rings", Wisla, Poland, June, 2000.
- "On the normalizer problem of integral group rings" Colloquium, York Univ., May, 2000.
- "On the normalizer problem of integral group rings of metabelian groups" CMS summer meeting, St.John's, NF, June, 1999.
- "Normalizer property for integral group rings", Colloquium, Memorial Univ., Feb. 1999
- "Some results on unitary and generalized unitary units", Algebra Seminar, Univ. of Alberta, Nov. 1998.
- "Normalizers of unitary units in integral group rings", Hopf Algebra and Group Rings workshop, Memorial Univ. May, 1997.
- "Units in integral group rings", Algebra Seminar, Concordia University, March, 1997.
- "Generalized unitary units in integral group rings", Algebra Seminar, Memorial Univ., March, 1996.
- "Unitary units in integral group rings", Algebra Seminar, Memorial Univ., Feb., 1996.

5. Grants Obtained

1. **a) Internal Grants**

• Funding for Brock International Conference on Groups Rings and Group Rings July 28-Aug. 2 2014; BUAF. Special Purpose Conference Support Fund $4700, Funds from Dean of Math and Science, Dean of Graduate Studies, Office of Research and Department of Mathematics and Statistics, $ 7000, 2014.
• Zero-sum problem in combinatorial number theory, BUAF, Special Purpose Grant,

$1000, 2012.
• Inverse problems to Zero-Sum theory supported by NSERC (Natural Sciences and Engineering Research Council of Canada) through Brock (BUICFI), $1800, 2009.
• Zero-Sum and Related Problems in Combinatorial Group Theory and Number Theory supported by NSERC (Natural Sciences and Engineering Research Council of Canada) through Brock (BUICFI), $3000, 2007.
• Computation of Class-preserving automorphisms of metabelian groups with GAP supported by Brock University Experience Works fund, 2006-2007.
• Computation of small reversible non-commutative rings with GAP supported by Brock Undergraduate Student Research Award , 2005-2006.
• Computation of automorphisms of metabelian groups with GAP supported by Brock University Experience Works fund, 2003-2004.
• Computation of units in group rings with GAP supported by Brock University Experience Works fund, 2002-2003.
• Description of the unit groups of group rings supported by Brock University Star-up fund, 2001-2002.

2. **b) External Grants**

- Arithmetic in group rings and study of zero-sum problems in combinatorial number theory supported by NSERC (Natural Sciences and Engineering Research Council of Canada), $70000, 2017-2022 (Principal grant holder).
- The Fields Institute Conference Fund $ 15,000 (Sponsoring Brock International Conference on Groups, Rings and Group Rings) 2014.
- Arithmetic in group rings and study of zero-sum problems in combinatorial number theory supported by NSERC (Natural Sciences and Engineering Research Council of Canada), $60000, 2012-2017 (Principal grant holder).
- Algebraic structure of group rings and related topics supported by NSERC (Natural Sciences and Engineering Research Council of Canada), $50000, 2007-2012 (Principal grant holder).
- Algebraic structure of group rings supported by NSERC (Natural Sciences and Engineering Research Council of Canada), $36000, 2003-2007 (Principal grant holder).
- Group rings and related topics supported by NSERC (Natural Sciences and Engineering Research Council of Canada), $33600, 1999-2003 (Principal grant holder).
- Homological characterization of certain special rings supported by the Young Scientist Grants of Jiangsu University of Science and Technology, 1991-1993 (Principal grant holder).
- Homological Algebra and its applications supported by the Young Scientist Grants of Jiangsu University of Science and Technology, 1989-1991 (Principal grant holder).
- Homological characterization of rings and K-theory supported by the Chinese National Science Grants, 1985-1988.

6. Work in Progress

- Subsums of a zero-sum free subset of an abelian group.
- The Normalizer problem and Coleman automorphisms.
- Index problem of zero-sum sequences.
- Group rings and their applications in combinatorial number theory.
- Groups with small squaring property.
- Constructing central units in group rings.
- On Davenport constant.
- Improvement of the EGZ theorem.
- Algebraic codes in group rings.

7. Other Creative and Scholarly Activities

a) Referee Work

- Handled 2 papers as editor. Refereed 3 journal papers and wrote 4 Math reviews in the academic year 2017-2018.
- Handled 2 papers as editor. Refereed 2 journal papers and wrote 1 Math reviews in the academic year 2016-2017.
- External reviewer for a research proposal for The United Arab Emirates University (UAEU)(2017).
- External reviewer for a Postdoctoral Fellow Renewal for Andreas Bachle (FWO-Belgium National Science Foundation)(2016).
- External reviewer for a National Science Fund for Eric Jespers (FWO-Belgium National Science Foundation)(2016).
- Handled 4 papers as editor. Refereed 6 journal papers and wrote 2 Math reviews in the academic year 2015-2016.
- Handled 3 papers as editor. Refereed 5 journal papers and wrote 2 Math reviews in the academic year 2014-2015.
- External Examiner (Starting from June 3, 2015) for a Ph.D Thesis of Gurmail Singh at the University of Regina and also for his final oral defense on Aug. 26, 2015. (Thesis Title: "Torsion Units of Integral Group Rings and Scheme Rings).
- External Examiner for a Ph.D Thesis of Huadong Su at Memorial University of Newfoundland and also for his final oral defence on April 23, 2015. (Thesis Title: A Study of Unit Graphs and Cayley Graphs Associated With Rings).
- Handled 3 papers as editor. Refereed 4 journal papers and wrote 2 Math reviews in the academic year 2013-2014.
- External referee for a Ph.D thesis defence of Meng Ye, Shanghai Jiaotong University. Shanghai, China, May, 2013 (Thesis Title: Graph Blow-up and Its Applications in Comaximal Graphs and Co-maximal Ideal Graphs).
- Refereed 3 journal papers and wrote 2 Math reviews in the academic year 2012-2013.
- Refereed 3 journal papers and wrote 3 Math reviews in the academic year 2011-2012.
- Chair of a Ph.D thesis defence committee for Guixin Deng, Sun Yet-Son University. Guangzhou, China, May, 2011.
- Refereed 7 journal papers and wrote 3 Math reviews in the academic year 2010-2011.

- External examiner for the master's thesis written by Zafor Ahmed in computer science at Brock, 2009.
- Reviewer for NSERC Individual Discovery Research Grants (Since 2007).
- Reviewer for the Georgian National Science Foundation (Since 2008).
- Reviewed the latest draft of the text book: Linear Algebra with Applications, 6th edition, by Keith Nicholson, (10 chapters and 600+ pages) 2008.
- Dean's delegate for M. Molly's master's thesis defence, September, 2007.
- The external referee for a master's thesis entitled "Classifying groups with small squaring properties" by T. Eddy, July, 2006.
- Reviewed the first draft of a text book: Linear Algebra with Applications, 6th edition, by Keith Nicholson, (9 chapters and 500+ pages) 2006.
- Referee for the "Journal of Combinatorial Theory, Series A " (since 2014).
- Referee for the "JP Journal of Algebra, Number Theory and Applications" (since 2010).
- Referee for the "Science China" Mathematics (since 2010).
- Referee for the "International Electronic Journal of Algebra" (since 2010).
- Referee for the "Bulletin Malaysian Mathematical Sciences Society" (since 2009).
- Referee for the "Canadian Mathematical Bulletin" (since 2007).
- Referee for the "Canadian Journal of Mathematics" (since 2006).
- Referee for the Journal "International Journal of Mathematics and Mathematical Sciences" (since 2006).
- Referee for the "Journal of Algebra and Its applications" (since 2006).
- Referee for the Journal "Communications in Algebra" (since 2005).
- Referee for the Journal "Algebra Colloquium" (since 2004).
- Referee for the Journal "ÓSarajevo Journal of Mathematics" (since 2004).
- Referee for the Journal "International Journal of Mathematics" (since 2003).
- Referee for the "Far East Journal of Mathematical Sciences" (since 2002).
- Reviewer for the Mathematical Reviews (since 2002). Reviewed 2-4 articles annually.
- Referee for the Journal "the Proceedings of the American Mathematical Society" (since 2001).
- Coordinator for the Mathematical Association of America at Brock (2001-2006).

b) Professional Memberships

- The Canadian Mathematical Society.
- The American Mathematical Society.
- The Mathematical Association of America.

c) Conferences Organized

- Brock International Conference on "Groups, Rings and Group Rings" sponsored by The Fields Institute For Research In Mathematical Science and Brock University, Brock University, St.Catharines, Ontario, July 28 to Aug. 1, 2014.

- The Fourth Brock Algebra Workshop on "Algebras and Combinatorics", Brock University, St.Catharines, Ontario, March 19, 2014.
- Brock Algebra Workshop on "Algebras and Related Topics ", Brock University, St.Catharines, Ontario, Feb. 20, 2009.
- Brock Algebra Workshop on "noncommutative rings, group rings and combinatorial number theory", Brock University, St. Catharines, Ontario, March 14, 2007.
- Brock Algebra Conference on "noncommutative rings and related topics", Brock University, St. Catharines, Ontario, Aug. 8-9, 2006.
- (Co-organized with H. Bell) A special session on "noncommutative ring theory" at the American Mathematical Society Meeting, Binghamton, New York, Oct. 11-12, 2003.

d) Training Highly Qualified Personnel

- Sponsored over 20 research visits at Brock through visiting (international) scholar program since 2004:

1. Dr, C Liu, Nankai University, China, Aug. 1 2018 -July,31, 2019 (Postdoc at Brock).
2. Prof. W. Gao, Nankai University, China, July 23 -Aug,31, 2018.
3. Prof. J. Peng, Civil Aviation University of China, May 22-2018- May 20, 2019.
4. Prof. W. Gao, Nankai University, China, Aug.1 -Aug,31, 2017.
5. Prof. Lijuan Qian, Jiansu University. China, Sep. 2016 - Aug. 2017.
6. Prof. Wujie Shi, Chongqing University of Arts and Sciences, China, September, 2016.
7. Prof. Xiangneng Zeng, Zhongshan University, China, July 14-Aug. 15, 2016.
8. Prof. W. Gao, Nankai University, China, June 30-July 30, 2016.
9. Prof. W. Gao, Nankai University, China, Feb. 15-29, 2016.
10. Prof. Greg Lee, Lakehead University, Canada, April, 2015.
11. Prof. Zhengxing Li, Qingdao University, China, Mar. to Sep. 2015.
12. Prof. W. Gao, Nankai University, China, Feb., 2015.
13. Prof. Pingzhi Yuan, South China Normal University, July 23 to Aug, 22, 2014.
14. Prof. Yushuang, Fan, China University of Geosciences, July 1 to July 29, 2014.
15. Prof. Jujuan Zhang, Dalian Maritime University, China, Feb 2014 to Feb 2015.
16. Prof. W. Gao, Nankai University, China, Aug, 2013.
17. Prof. W. Gao, Nankai University, China, Oct. 10 to Nov. 10, 2011.
18. Prof. Tongsuo Wu, Shanghai Jiaotong University, China, July 10 to July 21, 2010.
19. Prof. W. Gao, Nankai University, China, Feb 1 to Feb. 28, 2010.
20. Prof. W. Gao, Nankai University, China, Feb 1 to March 31, 2009.
21. Prof. H. Qin, Nanjin University, China, July, 2008.
22. Prof. W. Gao, Nankai University, China, Feb. 1 to March 31, 2008.
23. Prof. X. Zheng, BTU Cottbus, Germany, July 15 to July 24, 2007.
24. Prof. L. Mao, Nanjing Institute of Technology, China, July 30 to Aug. 27, 2007.
25. Prof. W. Gao, Nankai University, China, March 1 to March 31, 2007.
26. Prof. Z. Balogh, College of Nyíregyháza, Hungary, Dec. 2006 to May 31, 2007.
27. Prof. N. Ding, Nanjing University, China, Aug. 1 to Aug. 31, 2006.
28. Prof. W. Gao, from Nankai, University, China, July 1 to Aug. 31, 2006.
29. Prof. J. Chen, Southeast University, China, May, 1- May, 31, 2004.
30. Prof. Y. Liu, University of Texas, USA, May, 20-22, 2004.

- Supervision of Postdoctoral Fellows and Research Associates.

1. Dr, C Liu, Nankai University, China, Aug. 1 2018 -July,31, 2019 (Postdoc at Brock).
2. Dr. Xiangneng Zeng, Zhongshan University, China,July 14 to Aug. 15, 2016.
3. Dr. Zhengxing Li, Qingdao University, China, Mar. to Sep. 2015.
4. Dr. Yushuang, Fan, China University of Geosciences, July 1 to July 29, 2014.
5. Dr. Jujuan Zhuang, Dalian, Maritime University, Dalian Liaoning China, Feb. 2014 to Jan. 2015.
6. Dr. Jiangtao Peng, Civil Aviation University of China, Tianjin, China, Jan 23 to July 23, 2011.
7. Dr. Z. Balogh, College of Nyíregyháza, Hungary, Dec. 2006 to May 31, 2007.

- Supervision of Ph. D. Students.

1. Siao Hong (co-supervised with Dr. Weidong Gao at Nankai University, China, since 2017).
2. Chao Liu (co-supervised with Dr. Weidong Gao at Nankai University, China, since 2017). Completed July. 2018.
3. Honglin Zhou (co-supervised with Dr. J. Chen at Southeast University, China, since 2014).
4. Hanbing Zhang (co-supervised with Dr. Weidong Gao at Nankai University, China, since 2014). Completed Aug. 2017, Current position: Postdoctoral fellow at the Institute of Science Academy of China.
5. Pingping Zhao (co-supervised with Dr. Weidong Gao at Nankai University, China, since 2014), Completed Aug. 2016, Current Position: Assistant Professor, Tianjin Institute of City Construction.
6. Yanyan Gao (co-supervised with Dr. J. Chen at Southeast University, China), Completed Sep. 2013, Current Position: Assistant Professor, Nanjing Institute of Technology.

- Supervision of Masters Students:

  1. Jiachao Wu and Yuchen Jin, (co-supervised with Prof. Fuks) (September 2018-July-2020).
  2. Maryam Molakarimi, (April, 2016 to April-2018).
  3. Vannesa Hamilton, (Sept,2014 to Aug.2016), Recipient of NSERC Graduate Scholarship, OGS and Dean of Graduate Scholarship.
  4. Hongdi Huang, (Sept. 2013 and Aug. 2015), Current position: a Ph. D student at the University of Waterloo starting in Sep. 2015. We have written 4 research papers and all of then have been accepted for publication.
  5. Farid Aliniaeifard, (Sept. 2011- Aug. 2013), Current posiiton: Ph. D student York University (Sep. 2013 to Present).
  6. Vivian Apety, (Sept. 2011- Aug. 2013), Current position: Ph.D student Univ. of Sashcatchwen (Sep. 2014 to)
  7. Xiaoying Pan, (Sept. 2009- Aug. 2011), Current position: Intermediate Actuarial Analyst in Sun Life Financial, Waterloo Canada.
  8. Christoper Plyley (Sept. 2007 - Aug. 2009), Current position: Assistant Professor (Tenured Track), University of US Virgin Islands. (The first graduate student in the Thesis Stream in the department of Mathematics at Brock University, Ph.D, Western University, and a postdoc work with Prof, David Riley, Two joint papers with me, in top journals in number theory).
  9. Yilan Tan (Sept. 2007 - Aug. 2009), Current position: Visiting Assistant Professor, University of California at Riverside, (Ph.D, University of Alberta and 3 joint papers with me).

- Supervision of Undergraduate Honor and Research Students.

1. 4F90, (Honor Project), Tyler Nelson, (Sept. 2014 - April 2015), Research project: Representation of groups and character theory.
2. 4F90, Vanessa Hamilton, (Sept. 2013 - April 2014), Research project: Algebra codes generated by matrices and group rings.
3. 4F90, Jesse Ireland (Sept. 2011 - April 2012) Research project: Group character theory and its application in zero sum theory.
4. 4F90, Jesse Larone,(Sept. 2011 - April 2012), Research project: Constructing a large subgroup of the group of central units in group rings.
5. 4F90, Tyson Moss, (Jan. - April 2011), Research project: Small squaring properties of groups.
6. 4F90, Bryan Penfound, (July - Dec., 2007), Research project: Character theory and its applications.
7. Work Experience Plus Program, Jason Lizotte, (January - April 2007), Research project:Computing class-preserving automorphisms of met-abelian groups with GAP.
8. BUSRA (Brock Undergraduate Student Research Award), Colin Phipps, (Sep. 2005 - April, 2006, Research project: Using GAP to analyze small reversible rings,(published a joint paper with me).
9. 4F90, Kaisheng Tang, (Sep. 2004 - April, 2005), Research project: Metabelian groups and their automorphism groups.
10. Work Experience Plus Program, Amy Mcneely,(Sep. 2003 - April, 2004), Research project: Computing group automorphisms with GAP.
11. Work Experience Plus Program, Congfeng Lin, (January, 2003 - April, 2003), Research project: Computing units in group rings with GAP.

E. Teaching Activities

1. Courses Taught

2018,1 - 2018,8 : 2P13 and 4P10.
2017,9 - 2017.12: 3P12. (medical reduction for a half course).
2017.1 - 2017.8 : No teaching assignments (due to Medical leave).
2016.9 - 2015.12: 3P12 and 4P13.
2016.1 - 2016.8 : No teaching assignments (due to Sabbatical leave).
2015.9 - 2015.12: 4P11 Topics in group theory, Fall, 2015, Class size: 5.
: 5P10 Modern Algebra, Fall, 2015, Class size: 6.
: 4P13 (Reading Course) Advanced Topics in Rings, Fall 2015, Class size: 2.
2014.9 - 2015.8 : 2P12 Linear Algebra II, Fall, 2014, Class size: 71.
: 4P13/5V76 Advanced Topics in Rings, Fall, 2014, Class size: 8.

: 5V77 (Reading Course) Algebraic Codes, Fall, 2014, Class size: 1.
: 2P13 Abstract Linear Algebra, Winter, 2015, Class size: 11.
: 3P13 Abstract Algebra, Winter 2014, Class size: 10.
2013.9 - 2014.8 : 3P12 Applied Algebra, Fall, 2013, Class size: 37.
: 5P10 Modern Algebra, Fall, 2013, Class size: 3.
: 4P11 Topics in group theory, Winter, 2014, Class size: 8.
: 3P13 Abstract Algebra, Winter 2014, Class size: 17.
2012.9 - 2013.8 : No teaching assignments (due to Sabbatical leave).
2011.9 - 2012.8 : 2P12 Linear Algebra II, Fall, 2011, Class size: 76.
: 5P10 Modern Algebra, Fall, 2011, Class size: 5.
: 4P11 Topics in group theory, Fall, 2011, (Reading Course), Class size: 3.
: 2P13 Abstract Linear Algebra, Winter 2012, Class size: 24.
: 5P11 & 4P14 Group rings, Winter, 2014, Class size: 6.
: Supervised two graduate students and two 4F90 students.
: Coordinator and speaker for 5P94 Graduate Seminar Course, Winter, 2012, Class size: 4.
2010.9 - 2011.8 : 3P12 Applied Algebra, Fall, 2010, Class size: 41.
: 4P11 Topics in group theory, Fall, 2010, Class size: 2.
: 3P13 Abstract Algebra, Winter 2011, Class size: 16.
: 2P13 Abstract Linear Algebra, Winter, 2011, Class size: 10.
: Supervised one graduate student and one 4F90 student.
2009.9 - 2010.8 : 3P12 Applied Algebra, Fall, 2009, Class size: 23.
: 5P10 Modern Algebra, Fall, 2009, Class size: 3.
: 5P11 Group Rings, Winter 2010, Class size: 1.
: Coordinator and speaker for 5P94 Graduate Seminar Course, Winter, 2010, Class size: 3.
: Supervised one graduate student.
2008.9 - 2009.8 : 2P12 Linear Algebra II, Fall, 2008, Class size: 35.
: 3P12 Applied Algebra, Fall, 2008, Class size: 18.
: 3P13 Abstract Algebra, Winter, 2009, Class size: 6.
: 4P11 Advanced Topics in Group Theory, Winter, 2009, Class size: 4.
: Coordinator for 5P94 Graduate Seminar Course, Spring, 2008, Class size: 3.
: Supervised two graduate students.
2007.9 - 2008.8 : 2P13 Abstract Linear Algebra, Winter, 2008, Class size: 6.
: 3P13 Abstract Algebra, Winter, 2008, Class size: 8.
: 5P11/4P14 Group Rings, Winter 2008, Class size: 3.
: 4P11 Advanced Topics in Group Theory, Fall, 2007, Class size: 3.
: 5P10 Modern Algebra, Fall, 2007, Class size: 2.
: Supervised a 4P90 honor project research student.
2006.9 - 2007.6 : 2P13 Abstract Linear Algebra, Winter, 2007, Class size: 18.
: 3P13 Abstract Algebra, Winter, 2007, Class size: 8.
: 4P11 Advanced Topics in Group Theory, Fall, 2006, Class size: 10.
: 3P12 Applied Algebra, Fall, 2006, Class size: 32.

2006.1 - 2006.6 : Sabbatical Leave.
: Supervised a (BUSRA) research student.
2005.9 - 2005.12: 4P11 Advanced Topics in Group Theory, Fall, 2005, Class size: 8.
: 2P12 Linear Algebra II, Fall, 2005, Class size: 63.
2004.9 - 2005.7 : 2P13 Abstract Linear Algebra, Winter, 2004, Class size: 11.
: 3P13 Abstract Algebra, Winter, 2005, Class size: 11.
: 1P12 Linear Algebra I, Fall, 2004, Class size: 198.
: 2P12 Linear Algebra II, Fall, 2004, Class size: 67.
: 3P12 Applied Algebra, Fall, 2004,(Overload Teaching), Class size: 35.
: 4P11 Advanced Topics in Group Theory, Winter, 2005,(reading course), Class size: 1.
: 4F90, Honor Project, Fall and Winter, 2004-2005, Class size: 1
2003.9 - 2004.7 : 2P13 Abstract Linear Algebra, Winter, 2004, Class size: 13.
: 3P13 Abstract Algebra, Winter, 2004, Class size: 15.
: 1P12 Linear Algebra I, Fall, 2003, Class size: 150.
: 2P12 Linear Algebra II, Fall, 2003, Class size: 29.
2002.9 - 2003.7 : 2P13 Abstract Linear Algebra, Winter, 2003, Class size: 6.
: 3P13 Abstract Algebra, Winter, 2003, Class size: 9.
: 1P12 Linear Algebra I, Fall, 2002, Class size: 147.
: 2P12 Linear Algebra II, Fall, 2002, Class size: 18.
: 4F10 Advance topics in Algebra, Fall (Overload Teaching), 2002-2003, Class size: 1 .
2001.7 - 2002.8 : 3P13 Abstract Algebra, Winter, 2002, Class size: 3.
: 1P97 Introductory Calculus, Winter, 2002, Class size: 192.
: 3P12 Applied Algebra, Fall, 2001, Class size: 3.
: 2P12 Linear Algebra II (Overload Teaching), Class size: 20.
2000.9 - 2001.7 : Mat 1301 Introductory Calculus, Winter, 2001, Class size: 120 (at the Univ. of Ottawa).
: Mat 1320 Calculus I, Winter, 2001, Class size: 93.
: Mat 1322 Calculus II, Winter, 2001, Class size: 244.
: Mat 1302 Linear Algebra, Fall, 2000, Class size: 140.
: Mat 1301 Introductory Calculus, Fall, 2000, Class size:180.
: Mat 2322 Calculus III, Fall, 2000, Class size: 147.
1999.9 - 2000.8 : Math 1000 Calculus I, Winter, 2000, Class size: 70 (at Memorial Univ.).
: Math 1000 Calculus I, Winter, 2000, Class size: 35.
: Math 2050 Linear Algebra I, fall, 1999, Class size: over 82.
: Math 1090 Precalculus, fall, 1999, Class size:70.
1998.9 - 1999.8 : Math 1081 Calculus II, Winter, 1999 (two sections), Class size: 70 for each section.
: Math 1080 Calculus I, Fall, 1998 (two sections), Class size: above 50 for each section.
1997.9 - 1998.8 : Math 120 Linear Algebra I, Summer, 1998, Class size: 27 (at the Univ. of Alberta).
: Stat 1770, Introduction to Probability and Statistics, Summer, 1998, Class size: 18 (at the Univ. of Lethbridge, Edmonton Campus).
: Math 101, Calculus II, Winter, 1998, Class size: 52 (at the Univ. of Alberta).

: Math 100, Calculus II, Fall 1997, Class size: 40.
1997.1 - 1997.7 : Math 1081, Calculus II, Winter, 1997, Class size: 48 (at Memorial Univ.).

F. University and Community Service

1. Member of Ad Hoc Committee for joint Ph. D proposal (2018).
2. University OGS Scholarship Adjudication committee (2018).
3. Member of departmental service courses committee (2016-2018).
4. Member of departmental curriculum committee (2016-2018).
5. Member of departmental pure math committee (2016-2018).
6. I am the contact person for the exchange program with Jiangsu University in China. I will visit Jiangsu University again this April and to explore the possibility of a joint 3+1 undergraduate program. This work was started from 2004, and through a lot of work (email and phone contacts) an exchange agreement between 2 universities has been established. I have arranged a visit for Dean Brindle to Jiangsu University in November 2005 and during his visit, Dean Brindle signed a draft copy of the above mentioned agreement with Jiangsu. The formal agreement was signed by presidents Yang and Lightstone in September 2006, when a delegation of Jiangsu university visited Brock. In September 2007, another delegation from Jiangsu University visited Brock to reenforce and broaden the cooperations. Meanwhile, two delegations from Brock led by our president and a vice-president respectively visited Jiangsu University. I also arranged the financial support to sponsor a faculty member from Jiangsu to visit Brock to do joint research with our faculty members and to participate in the exchange program (since 2004).
7. Member of departmental sessional and ILTA teaching committee (2015-2016).
8. Member of departmental curriculum committee (2015-2016).
9. University OGS Scholarship Adjudication committee (2015).
10. Member of departmental sessional and ILTA teaching committee (2014-2015).
11. Member of departmental graduate curriculum and policy committee (2014-2015).
12. Member of departmental graduate admission and recruitment committee (2014-2015).
13. University NSERC Quenn II, CIHR Scholarship Adjudication committee (2014).
14. Departmental Committee for Linear Algebra Stream, Chair (2013-2014).
15. University NSERC USRA Adjudication committee (2012).
16. Departmental Working Committee preparing document for 4th year course offering (2012).
17. Departmental Working Committee for R. Kerman Replacement (2012).
18. Departmental Tenure and Promotion Committee Chair (2010-2012).
19. Distinguished Mathematics & Science Alumni Award Committee (2010).

20. Member of departmental graduate committee (2008-2009 and 2010-2012).
21. Member of Dean Advisor committee (2006).
22. Member of university pension committee (2004-2010).
23. Departmental library representative (2006-2007).
24. Departmental conference organizer (2006-2006).
25. Member of Faculty of Mathematics and Science Graduate Committee. Reviewed several applications for graduate study in Computer Science, Chemistry, Biology, and Earth Science.
26. Member of departmental Curriculum Committee (2005-2009).
27. Member of departmental M.Sc. Program Committee (2003-2005). Designed the new Mathematics Master program and developed new graduate courses: 5P10 and 5P11.
28. Departmental contact person for Mathematical Association of America (2001-2006).
29. Member of University Academic Programm Committee (2002 - 2003).
30. Involved in promotion of high school mathematics and the Esso Mathematics Training Camp at Brock (since 2001).

COMPUTER SKILLS

- Languages : Modula 2, C, C^{++}.
- Operating Systems: Unix, MS-DOS, Windows 3.1, Windows 95.
- Software : Wordperfect, Latex, Maple, Magma, GAP.
- Experience : • Used Maple to calculate units in certain integral group rings and instructed students to solve problems with Maple in their Linear Algebra Course.
  • Excelled in various computer science courses including Vocational Languages, Computer Organization, Computer Architecture and Operating System, Abstract Machines, Languages and Computations, Algorithms and Complexity, Database Systems and Computer Networks.
  • Designed algorithms and coded several projects related to designing a (Computer Network) data link layer protocol, designing and implementing a database management system, simulating a finite state machine, and simulating a CPU processor.

REFERENCES

Prof. H. Bell,
Dept. of Mathematics
Brock University
St. Catharines Ont. L2S 3A1
Tel: (905) 688-5550 ext.3758
Email: hbell@brocku.ca

Prof. H. Ben-El-Mechaiekh
Dept. of Mathematics
Brock University
St. Catharines Ont. L2S 3A1
Tel: (905) 688-5550 ext. 3297
Email: hmechaie@brocku.ca

Prof. M.M. Parmenter,
Dept. of Mathematics
Memorial Univ. of Newfoundland
St. John's NF Canada A1C 5S7
Tel: (709) 737-8095
Email: michael1@math.mun.ca

Prof. Sudarshan K. Sehgal
Dept. of Mathematical Science
University of Alberta
Edmonton, AB. Canada T6G 2G1
Tel: (403) 492-2705
Email: S.Sehgal@ualberta.ca

Prof. David, M. Riley,
Dept. of Mathematics
University of Western Ontario
London, ON, Canada N6A 5B7
Tel: (519) 661-3639
Email: DMRiley@uwo.ca

Prof. Mazi Shirvani
Dept. of Mathematical Science
University of Alberta
Edmonton, AB. Canada T6G 2G1
Tel: (403) 492-0109
Email: mazi.shirvani@ualberta.ca

Prof. Edgar Goodaire
Dept. of Mathematics
Memorial Univ. of Newfoundland
St. John's NF Canada A1C 5S7
Tel: (709) 737-8097
Email: edgar@math.mun.ca

Prof. Eric Jespers
Dept. of Mathematics
Vrije Universiteit Brussel
Pleinlaan 2, 1050 Brussel-Belgium
Tel: +32- (0)2 - 6293493
Email: efjesper@vub.ac.be

Prof. Cesar Polcino Miles
Instituto de Matematica e Estatistica
Universidade de Sao Paulo,
Sao Paul, Brasil

Email: polcino@ime.usp.br

Prof. Inder Bir Passi
Mathematics
Harish-Chandra Research Institute
Chhatnag Road, Jhunsi, Allahabad 211019
Jhunsi, India
Email: passi@mri.ernet.in

PERSONAL INFORMATION

Last Name: ODESSKI

First Name: Alexandre

Middle: Vladimirovich

Date of Birth: 16 March 1964

Place of Birth: Odessa (ex-USSR)

Nationality: RUSSIA, CANADA

Family situation: married, have two sons

Personal address: 119 ½ Keefer Road, Thorold, Ontario, Canada, L2V 4N1

Telephone home: 1 (905) 680-8234; work: 1-905-6885550 extension: 3297

Email: aodesski@brocku.ca

PROFESSIONAL INFORMATION

EDUCATION /QUALIFICATION

1.Abilitation (Doctor of Science in Mathematics), Landau Institute for Theoretical
Physics, Russia, June, 2004

2.Qualification of Professor in Mathematics, Ministry of Education and Researches,
France, March 24, 2004

3.PhD in Mathematics, Department of Mathematics and Mechanic, Moscow State University, Russia, advisor Professor A.A.KIRILLOV, January 10, 1992.

4.Master degree in Applied Mathematics, Technical University in Moscow, Russia, February 3, 1987

POSITIONS HELD

06.1990 -09.1995: Researcher at the Institute of New Technologies in Education, Moscow.

09.1995 - 12.1999: Researcher at the Institute of Non-Linear Researches, Moscow.

01.2000 - 07.2008: Senior researcher at the Landau Institute for Theoretical Physics,
Moscow.

09.2005- 08.2008: Lecturer in Mathematics at the University of Manchester, Manchester, UK

07.2008- present: Associate member of Landau Institute for Theoretical Physics, Moscow, Russia

PERMANENT POSITION

07.2008- present: Associate Professor (Full Professor since July 2012) and SHARCNET Research Chair at Brock University, Department of Mathematics, St Catharines, Canada

TEACHING ACTIVITIES IN RUSSIA

1993-1995: Associated invited professor at the Institute for Theoretical and Experimental Physics (ITEP), Moscow.

1995-1999: Associated professor at the Department of Mathematics, Independent University of Moscow.

RESEARCH AND TEACHING ACTIVITIES

July - August 1992: Invited researcher at RIMS, Kyoto, Japan.

May - August 1995: Invited researcher at RIMS, Kyoto, Japan.

March - August 1996: Invited professor at RIMS, Kyoto, Japan.

July 1997: Invited researcher at RIMS, Kyoto, Japan.

July - August 1998: Invited researcher at RIMS, Kyoto, Japan.

November - December 1998: Invited researcher at MPIM, Bonn, Germany.

November - December 1999: Invited researcher at MPIM, Bonn, Germany.

April 2000: Invited professor at the University of Chicago, USA.

May 2000: Invited researcher at ENS (rue d'Ulm), Paris, France.

June 2000: Invited professor at the Department of Mathematics, University of Angers, France.

June-July 2001: Invited professor at the Department of Mathematics, University of Angers, France.

September - December 2001: Invited researcher at MPIM, Bonn, Germany.

August 2002 - August 2003: Invited researcher at IHES, Bures-sur-Yvette, France.

September 2003 - May 2004: Invited researcher at the Laboratory for Theoretical Physics, University Paris-Sud XI, Orsay, France.

June 2004: Invited professor at the Department of Mathematics, University of Saint-Etienne, France.

July 2004: Invited professor at the Department of Mathematics, University of Angers, France.

October 2004: Invited professor at the Department of Mathematics, University of Saint-Etienne, France.

January - June 2005: Invited researcher at MPIM, Bonn, Germany.

May 2007: Visitor at the Department of Mathematics, Brock University, Canada.

September - October 2007: Invited researcher at MPIM, Bonn, Germany.

November 2007: Invited researcher at IHES, Bures-sur-Yvette, France.

July - August 2011: Invited researcher at IHES, Bures-sur-Yvette, France.

March 11-16 2012: Participant of the Workshop: Advances in hyperkähler and holomorphic symplectic geometry, Banff International Research Station, Canada.

May - June 2012: Invited researcher at IHES, Bures-sur-Yvette, France.

February 19, 20, 26, 27 2015: Master Class on Elliptic Algebras and Poisson Structures at Fields Institute, Toronto, Canada

April 15 - June 15 2015: Invited researcher at IHES, Bures-sur-Yvette, France.

May 3 - July 4 2017: Invited researcher at IHES, Bures-sur-Yvette, France.

April 1 - May 31 2018: Invited researcher at IHES, Bures-sur-Yvette, France.

INVITED TALKS AT THE CONFERENCES

International NATO Conference
Integrable structures of exactly solvable two-dimensional models of quantum field
theory, Kiev, 2000

Workshop
« Développements récents en théorie de Lie et Poisson »,
University of Reims, 27-28 June 2001

Workshop
Classification Problems in the theory of Integrable Systems,
SISSA, Trieste, Italy, October 1-5, 2002

« Journées d'algèbre »,
University of Saint-Etienne, 31 January -1 February 2003

International Workshop
Recent Advances in the Theory of Quantum Integrable System,

LAPTH, Annecy -le -Vieux, France, 25-28 March 2003

XV Coloquio Latinoamericano de Álgebra,
Ex-Hacienda Cocoyoc, Mor. México, 20-26 July 2003

Colloque
« Quantification par déformation et algèbres elliptiques »,
University of Bourgogne,
University Blaise Pascal (Clermont-Ferrand II)
Dijon, France, 8-12 March 2004

Workshop
Hopf Algebras, Quantification (in the largest sense), bialgebras, associators, topological invariants
CIRM Marseille, Luminy, March 29- April 3, 2004

Conference
"Singularities of Differential Equations, Integrable Systems and Quantum Groups"
University Louis Pasteur, Strasbourg, France, November 24-27, 2004

Workshop
Compact course for PhD-students
Department of Mathematics, University of Aarhus, Denmark, September 5-9, 2005

Workshop
Integrable day in Loughborough
Department of Mathematics, Loughborough University, November 25, 2005

Conference
Sklyanin Algebras and Beyond, Department of Mathematics, University of Leeds, December 16-17, 2005

XXth Meeting on Representation Theory of Algebras, University of Sherbrooke, 24.10.2008-25.10.2008

Workshop on Algebraic Structures in Geometry and Physics Leicester, UK, July 21-25, 2008

XXVIII Workshop in Geometric Methods in Physics, Bialowieza, Poland, June 28-July 4, 2009

XXIth Meeting on Representation Theory of Algebras, University of Sherbrooke, Canada, 2.10.2009-3.10.2009

XXIX Workshop in Geometric Methods in Physics, Bialowieza, Poland, June 27- July 3, 2010

Workshop Surfaces and Representations, University of Sherbrooke, Canada, 6.10.2010-9.10.2010

XXX Workshop in Geometric Methods in Physics, Bialowieza, Poland, June 26- July 2, 2011

Brock International Conference in Number Theory, St. Catharines, Ontario, Canada, September 9-11, 2011

XXXI Workshop in Geometric Methods in Physics, Bialowieza, Poland, June 24- 30, 2012

2013 CMS Summer Meeting, Canada, Nova Scotia, Halifax, June 4-7, 2013

XXXII Workshop in Geometric Methods in Physics, Bialowieza, Poland, June 30-July 6, 2013

2014 CMS Witer Meeting, Canada, Ontario, Hamilton, December 5-8, 2014

5-day Workshop Modern Applications of Complex Variables: Modeling, Theory and Computation (15w5052) at BIRS, Banff, Canada, January 11-16, 2015

2016 CMS Winter Meeting, Canada, Ontario, Niagara Falls, December 2 - 5, 2016

2016 CMS Summer Meeting, Host: Univeristy of Alberta, Canada, Alberta, Edmonton, June 24 - 27, 2016

RESEARCH INTERESTS

Integrable Systems, Mathematical Physics, Computer Algebra, High Performance Computing, Representation Theory, Non-commutative Geometry, Algebraic Geometry, Number Theory

LANGUAGES AND INFORMATICS EXPERIENCE

RUSSIAN - native language;

ENGLISH, FRENCH - fluent;

MAPLE, REDUCE, Mathematica, FORTRAN, TEX;

High performance computing with computer algebra on SHARCNET clusters.

TEACHING EXPERIENCE (outside Brock University)

1. Compact course for PhD-students: five two-hour lectures and two exercises sessions on the topic “Elliptic algebras”. Department of Mathematics, University of Aarhus, Denmark, September 5-9, 2005.

2. Two supervision classes in the first semester, September-December, 2005 (Sets, Numbers and Functions), University of Manchester, UK.

3. Two lecture courses in the second semester, January-May, 2006 (Discrete Optimization and Coding Theory), University of Manchester, UK.

4. Two supervision classes in the first semester, September-December, 2006 (Sets,
Numbers and Functions), University of Manchester, UK.

5. Supervision classes in the second semester, January-May, 2007 (Calculus and
Applications), University of Manchester, UK.

6. Two lecture courses in the second semester, January-May, 2007 (Classical Integrable Systems and Calculus of Several Variables), University of Manchester, UK.

Grants obtained:

I had NSERC grant from 2009-2010 fiscal year for 5 years, $14,000 per year

I have renewed this grant for the next 5 years, $14,000 per year

PUBLICATIONS

Preprint

[1] A. Odesskii, B. Feigin, "Functional equations in algebra", arXiv:1709.00750 [math.QA],

Academic Journal Papers, refereed

[2] A. Odesskii, "K-projectors", to appear in the Journal of Algebra,

[3] A. V. Odesskii, "Integrable structures of dispersionless systems and differential geometry",
Theoretical and Mathematical Physics, May 2017, Volume 191, Issue 2, pp 692–709,

[4] M. Babela, A. Odesskii, "A family of integrable evolution equations of third order",
J. Nonlinear Math. Phys. 24 (2017), no. 1, 73–78

[5] A. Odesskii, "A simple construction of integrable Whitham type hierarchies",
Geometric methods in physics, 195–208, Trends Math., Birkhäuser/Springer, Cham, 2014

[6] V. E. Zakharov, A. V. Odesskii, A. V., M. Cisternino, M. Onorato, "Five-wave classical scattering matrix and integrable equations",
Theoret. and Math. Phys. 180 (2014), no. 1, 759–764

[7] A. V. Odesskii, V. N. Rubtsov, V. V. Sokolov, "Parameter-dependent associative Yang-Baxter equations and Poisson brackets",
Int. J. Geom. Methods Mod. Phys. 11 (2014), no. 9

[8] A. V. Odesskii, V. N. Rubtsov, V. V. Sokolov, "Double Poisson brackets on free associative algebras",
Noncommutative birational geometry, representations and combinatorics, 225–239,
Contemp. Math., 592, Amer. Math. Soc., Providence, RI, 2013

[9] A. Odesskii, V. Sokolov, "Non-homogeneous systems of hydrodynamic type possessing Lax representations",
Comm. Math. Phys. 324 (2013), no. 1, 47-62

[10] A. Odesskii, T. Wolf, “Compatible quadratic Poisson brackets related to a family of elliptic curves”, J. Geom. And Physics (63),
2013, 107–117

[11] A. V. Odesskii, V. N. Rubtsov, V. V. Sokolov, “Bi-Hamiltonian ordinary differential equations with matrix variables”,
Teoret. Mat. Fiz., 171:1 (2012), 26–32

[12] E.V. Ferapontov, Alexander Odesskii, and N.M. Stoilov,
Classification of integrable two-component Hamiltonian systems of hydrodynamic
type in 2+1 dimensions, Journal of Mathematical Physics 52, 2011

[13] A. Odesskii, V. Sokolov, Integrable (2+1)-dimensional systems of hydrodynamic type, Theoretical and Mathematical Physics,
163:2 (2010), 179–221

[14] A. Odesskii, V. Sokolov, Integrable pseudopotentials related to generalized
hypergeometric functions, Selecta Mathematica (2010) 16:145.

[15] E. V. Ferapontov, A. V. Odesskii, Integrable Lagrangians and modular forms, Journal of Geometry and Physics 60 (2010) 896-906.

[16] A. Odesskii, V. Sokolov, Classification of integrable hydrodynamic chains, Journal of Physics A: Math. Theor. 43(2010) 434027 (15pp.).

[17] A. Odesskii, V. Sokolov, Integrable elliptic pseudopotentials, Theoretical and
Mathematical Physics, 161(1): 1338-1350 (2009).

[18] Odesskii, Alexander; Rubtsov, Vladimir, Integrable systems associated with elliptic algebras. Quantum groups, 81--105, IRMA Lect. Math. Theor. Phys., 12, Eur. Math. Soc., Zürich, 2008.

[19] Odesskii, A. V.; Sokolov, V. V., On (2+1)-dimensional systems of hydrodynamic type possessing a pseudopotential with movable singularities. (Russian) Funktsional. Anal. i Prilozhen. 42 (2008), no. 3, 53--62, 96; translation in Funct. Anal. Appl. 42 (2008), no. 3, 205--212

[20] Odesskii, A. V.; Pavlov, M. V.; Sokolov, V. V., Classification of integrable
Vlasov-type equations. (Russian) Teoret. Mat. Fiz. 154 (2008), no. 2, 249--260.
(Reviewer: Yuri B. Suris)

[21] Odesskii, Alexander, A family of (2+1)-dimensional hydrodynamic type systems possessing a pseudopotential. Selecta Math. (N.S.) 13 (2008), no. 4, 727--742. (Reviewer: Ian A. B. Strachan)

[22] Odesskii, Alexander; Sokolov, Vladimir, Pairs of compatible associative algebras, classical Yang-Baxter equation and quiver representations. Comm. Math. Phys. 278 (2008), no. 1, 83--99. (Reviewer: Zhong Qi Ma) 17B62 (81R12)

[23] Odesskii, Alexander; Sokolov, Vladimir, Algebraic structures connected with pairs of compatible associative algebras. Int. Math. Res. Not. 2006, Art. ID 43734, 35 pp. (Reviewer: Thierry Dana-Picard)

[24] Odesskii, A. V.; Sokolov, V. V., Integrable matrix equations related to pairs of
compatible associative algebras. J. Phys. A 39 (2006), no. 40, 12447--12456. (Reviewer: Stanislav Z. Pakuliak)

[25] Odesskii, A. V.; Sokolov, V. V., Compatible Lie brackets related to elliptic curve, J. Math. Phys. 47 (2006), no. 1, 013506, 14 pp.
(Reviewer: Olivier G. Schiffmann)

[26] Odesskii, Alexander, Bihamiltonian elliptic structures. Mosc. Math. J. 4 (2004),
no. 4, 941--946, 982.

[27] Odesskii, Alexander, Set-theoretical solutions to the Yang-Baxter relation from

factorization of matrix polynomials and θ-functions. Mosc. Math. J. 3 (2003), no. 1, 97--103, 259. (Reviewer: Gigel Militaru)

[28] Odesskii, A. V.; Rubtsov, V. N., Polynomial Poisson algebras with a regular
structure of symplectic leaves. (Russian) Teoret. Mat. Fiz. 133 (2002), no. 1, 3--23;
translation in Theoret. and Math. Phys. 133 (2002), no. 1, 1321--1337 (Reviewer: Zakaria Giunashvili)

[29] Enriquez, B.; Odesskii, A., Quantization of canonical cones of algebraic curves.
Ann. Inst. Fourier (Grenoble) 52 (2002), no. 6, 1629--1663. (Reviewer: Olivier G.
Schiffmann)

[30] Belavin, A. A.; Odesskii, A. V.; Usmanov, R. A., New relations in the algebra of the Baxter Q-operators. (Russian) Teoret. Mat. Fiz. 130 (2002), no. 3, 383--413;
translation in Theoret. and Math. Phys. 130 (2002), no. 3, 323--350 (Reviewer: Andrey V. Tsiganov)

[31] Braden, H. W.; Gorsky, A.; Odesskii, A.; Rubtsov, V., Double-elliptic dynamical systems from generalized Mukai-Sklyanin algebras. Nuclear Phys. B 633 (2002), no. 3, 414--442. (Reviewer: Alexander V. Shapovalov)

[32] Odesskii, A. V., Belavin elliptic R-matrices and exchange algebras. (Russian)
Funktsional. Anal. i Prilozhen. 36 (2002), no. 1, 59--74, 96; translation in Funct. Anal. Appl. 36 (2002), no. 1, 49--61 32G34

[33] Feigin, B. L.; Odesskii, A. V., Quantized moduli spaces of the bundles on the
elliptic curve and their applications. Integrable structures of exactly solvable
two-dimensional models of quantum field theory (Kiev, 2000), 123--137, NATO Sci. Ser. II Math. Phys. Chem., 35, Kluwer Acad. Publ., Dordrecht, 2001. (Reviewer: Zhenbo Qin)

[34] Feigin, B. L.; Odesskii, A. V., Functional realization of some elliptic
Hamiltonian structures and bosonization of the corresponding quantum algebras. Integrable structures of exactly solvable two-dimensional models of quantum field theory (Kiev, 2000), 109--122, NATO Sci. Ser. II Math. Phys. Chem., 35, Kluwer Acad. Publ., Dordrecht, 2001. (Reviewer: Shao-Ming Fei)

[35] Feigin, B. L.; Odesskii, A. V., Vector bundles on an elliptic curve and Sklyanin
algebras. Topics in quantum groups and finite-type invariants, 65--84, Amer. Math. Soc. Transl. Ser. 2, 185, Amer. Math. Soc., Providence, RI, 1998. (Reviewer: Michel Van den Bergh)

[36] Feigin, B. L.; Odesskii, A. V., Coordinate ring of the quantum Grassmannian and intertwiners for the representations of Sklyanin algebras. Topics in quantum groups and finite-type invariants, 55--64, Amer. Math. Soc. Transl. Ser. 2, 185, Amer. Math. Soc., Providence, RI, 1998. (Reviewer: Michel Van den Bergh)

[37] Feigin, Boris; Jimbo, Michio; Miwa, Tetsuji; Odesskii, Alexandr; Pugai, Yaroslav, Algebra of screening operators for the deformed $W\sb n$ algebra. Comm. Math. Phys. 191 (1998), no. 3, 501--541. (Reviewer: Jun'ichi Shiraishi)

[38] Odesskii, A. V.; Feigin, B. L., Elliptic deformations of current algebras and
their representations by difference operators. (Russian) Funktsional. Anal. i Prilozhen. 31 (1997), no. 3, 57--70, 96; translation in Funct. Anal. Appl. 31 (1997), no. 3,
193--203 (1998) (Reviewer: V. Leksin)

[39] Feigin, Boris; Odesskii, Alexander, A family of elliptic algebras. Internat. Math.
Res. Notices 1997, no. 11, 531--539. (Reviewer: Michel Van den Bergh)

[40] Odesskii, A. V.; Feigin, B. L., Sklyanin's elliptic algebras. The case of a point
of finite order. (Russian) Funktsional. Anal. i Prilozhen. 29 (1995), no. 2, 9--21, 95;
translation in Funct. Anal. Appl. 29 (1995), no. 2, 81--90

[41] Odesskii, A. V.; Feigin, B. L., Constructions of elliptic Sklyanin algebras and of
quantum R-matrices. (Russian) Funktsional. Anal. i Prilozhen. 27 (1993), no. 1, 37--45; translation in Funct. Anal. Appl. 27 (1993), no. 1, 31--38 (Reviewer: Tomasz Brzeziiski)

[42] Odesski, Aleksandr V., Rational degeneration of elliptic quadratic algebras.
Infinite analysis, Part A, B (Kyoto, 1991), 773--779, Adv. Ser. Math. Phys., 16, World Sci. Publ., River Edge, NJ, 1992. (Reviewer: Michel Van den Bergh)

[43] Odesskii, A. V.; Feigin, B. L., Sklyanin's elliptic algebras. (Russian)
Funktsional. Anal. i Prilozhen. 23 (1989), no. 3, 45--54, 96; translation in Funct. Anal. Appl. 23 (1989), no. 3, 207--214 (1990) (Reviewer: S. Paul Smith)

[44] Odesskii, A. V., An analogue of the Sklyanin algebra. (Russian) Funktsional. Anal. i Prilozhen. 20 (1986), no. 2, 78--79

Review Articles, refereed

[45] Odesskii, A. V., Elliptic algebras. (Russian) Uspekhi Mat. Nauk 57 (2002), no.
6(348), 87--122; translation in Russian Math. Surveys 57 (2002), no. 6, 1127--1162
(Reviewer: Dmitriy A. Rumynin)

Conference contributions, refereed

[46] A.V.Odesskii and B.L.Feigin, Quantized moduli spaces of the bundles on the
elliptic curve and their applications. Integrable structures of exactly solvable

two-dimensional models of quantum field theory (Kiev, 2000), 123--137, NATO Sci. Ser. II Math. Phys. Chem., 35, Kluwer Acad. Publ., Dordrecht , 2001. (Reviewer: Zhenbo Qin), math.QA/9812059

[47] A.V.Odesskii and B.L.Feigin, Functional realization of some elliptic Hamiltonian structures and bosonization of the corresponding quantum algebras. Integrable structures of exactly solvable two-dimensional models of quantum field theory (Kiev , 2000), 109--122, NATO Sci. Ser. II Math. Phys. Chem., 35, Kluwer Acad. Publ., Dordrecht , 2001. (Reviewer: Shao-Ming Fei), math.QA/9912037

CURRICULUM VITAE

Jan Vrbik

Birth date : September 23 rd 1945

Birth place : Brno, Czechoslovakia

Nationality : Canadian citizen

Marital status: Married, with three children

UNIVERSITY EDUCATION

1. 1963-1968 Charles' University, Prague, Czechoslovakia.

   Field of specialization: *Nuclear Physics.*
   Degree received: *MSc.* equivalent.
   Thesis: *Study of Rotational States of Nonspherical Nuclei by (d,d') Scattering* (in Czech).

   This was a five year study (standard in Czechoslovakia) with the course work dedicated almost entirely to Physics and Mathematics. During the last year I was employed by the university as a part-time Assistant Professor.

2. 1969-1971 University of Calgary, Canada.

   Field of specialization: *Theoretical Physics.*
   Degree received: *MSc.*
   Thesis: *Nonlinear Realizations of Groups.*

   I pursued my interests in the fields of Classical Electrodynamics and Elementary Particles.

3. 1971-1977 University of Calgary, Canada.

   Field of specialization: *Statistics.*
   Degree received: *PhD.*
   Thesis: *Matching of Simple Markov Chains.*

   My research was carried out in the area of Applied Statistics and Monte Carlo simulation. Due to my full-time employment (from 1974 on) I had to complete the program on a part-time basis.

EMPLOYMENT

1. 1974-1975 Department of Mathematics, Statistics and Computing Science, University of Calgary.

I was a Sessional Instructor, teaching several Statistics courses.

2. 1975-1981 Department of Academic Computing, University of Calgary.

I worked as a statistical and mathematical consultant to the university community, and was also heavily involved with design and development of computer software.

3. 1981-1982 Petroleum Recovery Institute, Calgary.

My official title was Senior Simulation Scientist. The job consisted of modeling petroleum reservoirs by computer, and recommending the appropriate course of action to the field operator.

4. 1982-present: Department of Mathematics, Brock University.

I was hired as Associate Professor, promoted to Full Professor effective July 1988. I teach courses in Mathematical Statistics, Stochastic Processes, and Numerical Analysis.

PUBLICATIONS

1) Dhaliwal R S, Singh B M, and Vrbik J: "Semi-infinite medium with a cylindrical inclusion twisted by an annular die" *J. of Elasticity* **10** #2 (1980) 121-134.

2) Dhaliwal R S, Singh B M, and Vrbik J: "External crack in torsion in an infinite medium with a cylindrical inclusion" *Int. J. of Solids and Structures* **16** #7 (1980) 577-583.

3) Singh B M, Haddow J B, Vrbik J, and Moodie T B: "Dynamic stress intensity factors for penny-shaped crack in twisted plate" *ASME J. of Applied Mechanics* **47** (Dec. 1980) 963-965.

4) Nosal M, and Vrbik J: "Stratigraphic analysis and the asymptotic distribution of the coefficient of cross-association" *Math. Geol.* **14** #1 (1982) 11-36.

5) Singh B M, Dhaliwal R S, and Vrbik J: "Diffraction of SH waves by a moving crack" *Acta Mechanica* **48** (1983)71-79.

6) Singh B M, Haddow J B, Moodie T B, Vrbik J, and Dhaliwal R S: "Sudden appearance of external crack by anti-plane shear or by normal tractions" *ZAMM* **63** #9 (1983) 433-443.

7) Vrbik J: "Test of independence by repeated matching of stratigraphic sections" *Math. Geol. J.* **15** #3 (1983) 427-444.

8) Singh B M, Dhaliwal R S, and Vrbik J: "Torsional-impact response of an external circular crack in a thick-walled hollow cylinder" *ZAMM* **63** #6 (1983) 269-272.

9) Dhaliwal R S, Singh B M, and Vrbik J: "Sudden twisting of an external circular crack in an infinite medium with a cylindrical inclusion" *Eng. Fracture Mech.* **18** #2 (1983) 417-426.

10) Dhaliwal R S, Singh B M, and Vrbik J: "Torsional impact of a layer or a cylinder bonded to an elastic half-space" *Int. J. of Eng. Sci.* **21** #11 (1983) 1397-1408.

11) Singh B M, Dhaliwal R S, and Vrbik J: "Closed-form solution for external cracks in an infinitely long elastic layer under shear" *J. Math. & Phys. Sci.* **17** #5 (l983) 455-465.

12) Singh B M, Dhaliwal R S, and Vrbik J: "Diffraction of torsional waves by a flat annular crack at the interface of two bonded dissimilar elastic solids" *Eng. Fract. Mech.* **19** #4 (1984) 771-776.

13) Vrbik J: "Statistical properties of the number of runs of matches between two random stratigraphic sections" *Math. Geol.* **17** #1 (1985) 29-40.

14) Vrbik J: "Asymptotic distribution of the coefficient of cross-association based on a simple Markov-chain model" *J. of Appl. Prob.* **22** (1985) 946-950.

15) Vrbik J, and Rothstein S M: "Quadratic-accuracy diffusion Monte Carlo" *J. of Compt. Phys.* **63** (1986) 130-139.

16) Vrbik J: "Monte Carlo technique for finding the lowest eigenvalue of a modified Schroedinger equation" *J. of Physics A* **18** (1985) 1327-1335.

17) Singh B M, Danyluk H T, and Vrbik J: "A note on plastic deformation at the tip of an edge crack" *Acta Mechanica* **55** #1-2 (1985) 81-86.

18) Dhaliwal R S, Singh B M, and Vrbik J: "Formation of external circular crack by normal impact or by sudden twisting" *Eng. Fract. Mech*. **20** #1 (1984) 93-101.

19) Selvadurai A P S, Singh B M, and Vrbik J: "The Reissner Sagoci problem for a nonhomogeneous solid" *J. of Elasticity* **16** #4 (1986) 383-391.

20) Dhaliwal R S, Singh B M, and Vrbik J: "Torsional oscillations by an annular disc on an Infinite cylinder embedded in an elastic half- space" *Eng. Fract. Mech*. **20** #5-6 (1984) 719-727.

21) Dhaliwal R S, Singh B M, Vrbik J, and Khan S M: "Interaction of torsional waves with an annular crack in an infinitely long cylinder" *Eng. Fract. Mech*. **20** #5-6 (1984) 729-733.

22) Dhaliwal R S, Singh B M, Vrbik J, and Selvadurai A P S: "Diffraction of torsional wave or plane harmonic compressional wave by an annular rigid disc" *Soil Dynamics and Earthquake Engineering* **3** #3 (1984) 150-156.

23) Singh B M, Danyluk H T, Vrbik J, and Selvadurai A P S: "Impact response of a penny-shaped crack in an elastic-plastic material" *Eng. Fract. Mech.* **24** #1 (1986) 39-44.

24) Vrbik J: "Calculating the pseudo-skin factor due to the partial well completion" *J. of Canadian Petroleum Technology* **25** #5 (1986) 57-61.

25) Vrbik J, and Rothstein S M: "Optimal spacing and weights in Diffusion Monte Carlo" *Int. J. of Quantum Chemistry* **XXIX** (1986) 461-468.

26) Rothstein S M, Patil N, and Vrbik J: "Time step error in diffusion Monte Carlo simulations: An empirical study" *J. of Compt. Chem.* **8** #4 (1987) 412-419.

27) Vrbik J: "Monte Carlo simulation of general elliptic operator" *J. of Phys. A* **20** (1987) 2693-2698.

28) Dhaliwal R S, Singh B M, Rokne J G, and Vrbik J: "Torsion by an annular disc of a hemisphere embedded in an elastic half-spaced" *Internat. J. Engrg. Sci.* **24** #1 (1986) 79-85.

29) Rothstein S M, and Vrbik J: "Statistical error of diffusion Monte Carlo" *J. of Compt. Phys.* **74** #1 (1988) 127-142.

30) Rothstein S M, and Vrbik J: "A Green's function used in diffusion Monte Carlo" *J. Chem. Phys.* **87** (1987) 1902-1903.

31) Vrbik J, DePasquale M F, and Rothstein S M: "Estimating the relativistic energy by diffusion Monte Carlo" *J. Chem. Phys*. **88** (1988) 3784-3787.

32) Singh B M, Cardou A, Danyluk H T, and Vrbik J: "Plastic zone correction in a stretched cylinder with an external circumferential crack" *Theor. Appl. Fract. Mech.* **8** #3 (Dec.1987) 193-197.

33) DePasquale M F, Rothstein S M, and Vrbik J: "Reliable diffusion quantum Monte Carlo." *J. Chem. Phys*. **89** (Sept. 1988) 3629-3637.

34) East A L L, Rothstein S M, and Vrbik J: "Sampling the exact electron distribution by diffusion quantum Monte Carlo." *J. Chem. Phys*. **89** (Oct. 1988) 4880-4884.

35) Singh B M, Selvadurai A P S, Cardou A, Au M C, and Vrbik J: "Closed form solution for two finite-length cracks moving in an orthotropic layer under anti-plane loading" *Theor. Appl. Fract. Mech*. **10** #3 (Dec. 1988) 197-212.

36) Vrbik J, Lagare D A, and Rothstein S M: "Infinitesimal differential diffusion quantum Monte Carlo: Diatomic molecular properties" *J. Chem. Phys.* **92** (Jan. 1990) 1221-1227.

37) East A L L, Rothstein S M, and Vrbik J: "Reply to Comment on: 'Sampling the exact electron distribution by diffusion quantum Monte Carlo" *J. Chem. Phys.* **92** #3 (1990) 2120.

38) Bueckert H, Rothstein S M, and Vrbik J: "Optimization of quantum Monte Carlo wavefunctions using analytical derivatives" *Can. J. Chem.* **70** (1992) 366-371.

39) Vrbik J, and Rothstein S M: "Infinitesimal differential diffusion quantum Monte Carlo study of diatomic vibrational frequencies" *J. Chem. Phys*. **96** #3 (1992) 2071-2076.

40) Vrbik J: "A simple approximation to the pseudoskin factor resulting from restricted entry" *SPE Formation Evaluation* (Dec. 91) 444-446.

41) Danyluk H T, Singh B M, and Vrbik J: "Ductile penny-shaped crack in a transversely isotropic cylinder" *Int. J. Fract.* **51** #4 (1991) 331-342.

42) Bueckert H, Rothstein S M, and Vrbik J: "A method for relativistic Monte Carlo calculations" *Chem. Phys. Letters* **190** #5 (March 1991) 413-416.

43) Vrbik J: "A chain sliding off a table" *Am. J. Phys*. **61** #3 (March 1993) 258-261.

44) Belohorec P, Rothstein S M, and Vrbik J: "Infinitesimal diffusion quantum Monte Carlo study of CuH spectroscopic constants" *J. Chem. Phys*. **98** #8 (1993) 6401-6405.

45) Vrbik J: "Celestial mechanics via quaternions" *Can. J. Phys.* **72** (1994) 141-146.

46) Vrbik J: "Dirac equation and Clifford algebra" *J. Math. Phys.* **35** #5 (May 1994) 2309-2314.

47) Vrbik J: "Two-body perturbed problem revisited" *Can. J. Phys.* **73** (1995) 193-198.

48) Vrbik J: "Perturbed Kepler problem in quaternionic form" *J. Phys. A* **28** (1995) 6245-6252.

49) Singh B M, Danyluk H T, Selvadurai A P S, and Vrbik J: "A note on the torsion of a non-homogeneous solid by an annular disc" *Int. J. Solids and Structures* **32** (1995) 2961-2965

50) Vrbik J, Singh B M, and Danyluk H T: "Contact problem of a pair of flat rectangular stamps resting on an elastic half-space" *Acta Mechanica* **112** (1995) 77-82

51) Danyluk H T, Singh B M, and Vrbik J: "The Reissner-Sagoci problem for a non-homogeneous half-space with a penny-shaped crack" *J. of Engineering Math.* **29** (1995) 437-449

52) Danyluk H T, Singh B M, and Vrbik J: "Plastic zones in an orthotropic plate of finite width containing a Griffith crack" *International Journal of Fracture* **75** #4 (1995) 307-22

53) Danyluk H T, Singh B M, and Vrbik J: "A Dugdale-type estimation of the plastic zone for a penny-shaped crack in a thick transversely isotropic layer due to radial shear" *Engineering Fracture Mechanics* **51** (1995) 735-740

54) Vrbik J: "Resonance formation of Kirkwood gaps and asteroid clusters" *J. Phys. A* **29** #12 (1996) 3311-16

55) Vrbik J: "Oblateness perturbations to fourth order" *Mon. Not. R. Astron. Soc.* **291** (1997) 65-70

56) Langfelder P, Rothstein S M, and Vrbik J: ADiffusion quantum Monte Carlo calculation of nondifferential properties for atomic ground states@ *J. Chem. Phys.* **107** (1997) 8525-35

57) Vrbik J: "Novel analysis of tadpole and horseshoe orbits" *Celestial Mechanics & Dynamical Astronomy* **69** (1998) 283-291

58) Vrbik J: AIterative solution to perturbed Kepler problem via Kustaanheimo-Stiefel equation@ *Celestial Mechanics and Dynamical Astronomy* **71** (1999) 273-287

59) Vrbik J: "Simple simulation of solar system@ *Astrophysics and Space Science* **266** #4 (1999) 557-567

60) Vrbik J: Perturbative solution of an asteroid=s motion in resonance with Jupiter *Monthly Notices of the Royal Astronomical Society* **316** (2000) 459-463

61) Vrbik J: Quaternionic processor@ *Celestial Mechanics and Dynamical Astronomy* **80** #2 (2001) 111-118

62) Vrbik J, Singh B M, Rokne J, Dhaliwal R S: External crack in torsion in an infinite non-homogeneous medium with a non-homogeneous cylindrical inclusion *ZAMM* **81** #7(2001) 489-497

63) Singh B M, Danyluk H T, Selvadurai A P S, Dhaliwal R S, Rokne J and Vrbik J: Effects of inclusion in ductile cracks *ZAMP* **52** (2001) 680-695

64) Vrbik J, Singh B M, Rokne J and Dhaliwal R S: Plastic deformation at the tip of an edge crack@ *ZAMM* **81** #9 (2001) 642-647

65) Vrbik J: Erratum: oblateness perturbations to forth order *Monthly Notices of the Royal Astronomical Society* **331** #4 (2002) 1072

66) Vrbik J, Singh B M, Rokne J, et al.: The problem of a penny-shaped crack in a non-homogeneous medium under shear *Eur. J. Mech. A-Solid* **21** #5 (Sep -Oct 2002) 773-777

67) Vrbik J, Singh B M, Rokne J, at al.: The breaking of a non-homogeneous fiber embedded in an infinite non-homogeneous medium *Z. Angew Math. Phys.* **54** #2 (March 2003) 212-223

68) Singh B M, Rokne, J, Dhaliwal R S and Vrbik J: Contact problem for bonded nonhomogeneous materials under shear loading *Int. J. of Math. and Math. Sci.* **2003** # 29 (May 2003) 1821-1832

69) Singh B M, Danyluk HT, Vrbik J, et al.: The Reisner-Sagoci problem for a non-homogeneous half-space with a surface constraint *Meccanica* **38** #4 (2003) 453-465

70) Vrbik J: A novel solution to Kepler=s problem *European J. of Phys.* **24** #6 (2003) 575-583

71) Rokne J, Singh B M, Dhaliwal R S and Vrbik J: Mixed boundary value problem in a non-homogeneous medium under steady distribution of temperature *Meccanica* **39** #2 (2004) 113-123

72) Rokne J, Singh B M, Dhaliwal RS and Vrbik J: The Reissner-Sagoci type problem for a non-homogeneous elastic cylinder embedded in and elastic non-homogeneous half-space *IMA J. Appl. Math.* **69** #2 (2004) 159-173

73) Vrbik J, Singh B M, Rokne J, et al.: On the expansion of a penny-shaped crack by a rigid circular disc inclusion in a thick plate *ZAMM,* **84** #8 (2004) 538-550

74) Rokne J, Singh B M, Dhaliwal R S and Vrbik J: The axisymmetric Boussinesq-type problem for half-space under optimal heating of arbitrary profile *Int. J. of Math. and Math. Sciences* **40** (2004) 2123-2131

75) Vrbik J: Zonal-harmonics perturbations *Celestial Mechanics & Dynamical Astronomy* **91** (2005) 217-237

76) Vrbik J: Moments of AR(1)-model estimators *Communications in Statistics (Simulation and Computation)* **34** #3 (2005) 595-600

77) Vrbik J: Finite-*n* corrections to Normal approximation *Communications in Statistics (Simulation and Computation)* **34** #4 (2005) 827-837

78) Vrbik J: Population moments of sampling distributions *Computational Statistics* **20** #4 (2005) 611-621

79) Vrbik J: Solving Lunar problem via perturbed K-S equation *New Astronomy* **11** #5 (March 2006) 366-373

80) Singh B M, Rokne J, Vrbik J and Dhaliwal R S: Finite Griffith crack propagating in a non-homogeneous medium *European J. of Mechanics A - Solids* **25** #5 (Sept.-Oct. 2006) 867-875

81) Singh B M, Rokne J, Dhaliwal RS and Vrbik J: Diffraction of torsional waves by a penny-shaped crack in a non-homogeneous thick fibre bonded to a non-homogeneous matrix *European J. of Mechanics A - Solids* **25** #6 (Nov-Dec 2006) 938-949

82) Vrbik J: Kepler problem with time-dependent and resonant perturbations *Journal of Mathematical Physics* **48** (2007) 1-13

83) Li Y, Vrbik J, and Rothstein SM: Towards a field-free quantum Monte Carlo approach to polarizabilities of excited states: Application to the $n = 2$ hydrogen atom *Chem. Phys. Lettr.* **445** (2007) 345-349

84) Vrbik J: Monte-Carlo computation of ground-state energy derivatives *International Journal of Quantum Chemistry* **108** (2008) 493-502

85) Singh B M, Rokne J, Dhaliwal R S, Vrbik J: Antiplane crack at the interface of two bonded dissimilar graded piezoelectric materials *European Journal of Mechanics A - Solids* **27** #3 (May-June 2008) 346-364

86) Vrbik J: Confidence regions based on Edgeworth expansion *Communications in Statistics - Simulation and Computation* **28** (2009) 1004-1018

87) Singh BM, Rokne J, Dhaliwal RS and Vrbik J: Scattering of anti-plane shear waves by an interface crack between two bonded dissimilar functionally graded piezoelectric materials *Proceedings of the Royal Society A - Mathematical, Physical and Engineering Sciences* **465** #2104 (2009) 1249-1269

88) Vrbik J: Second Erratum: Oblateness perturbations to the fourth order *Monthly Notices of the Royal Astronomical Society* **399** (2009) 1088

89) Vrbik J: *New Methods of Celestial Mechanics*, Bentham Science Publishers (2010), **eIBSN** 978-1-60805-187-8

90) Vrbik J: Moments of AR(2)-model parameter estimators *Advances and Applications in Statistics* **18** #1 (September 2010) 57-72

91) Vrbik J: Confidence Regions for Two-parameter Estimation; Improving Normal Approximation *Pioneer Journal of Theoretical and Applied Statistics* **1** #1 (2011) 43-50

92) Vrbik J: Simulating a Chain Sliding off a Desktop *The Mathematica Journal* (2011) **13** #3

93) Vrbik J: Monte Carlo Simulation of Simple Molecules *The Mathematica Journal* (2011) **13** #5

94) Vrbik J: "Solving Kepler's Problem" *The Mathematica Journal* (2011) **13** #12

95) Vrbik J: "Betting Two Patterns against Each Other" *The Mathematica Journal* (2011) **13** #15

96) Vrbik J: "Sampling Distribution of ML Estimators" *The Mathematica Journal* (2011) **13** #19

97) Vrbik J: "Mathematical Exploration of Kirkwood Gaps" *The Mathematica Journal* (2012) **14** #1

97) Vrbik J: "Motion of a Spinning Top" *The Mathematica Journal* (2012) **14** #4

98) Vrbik J: "Gambler's Ruin and the First Passage Time" *The Mathematica Journal* (2012) **14** #7

99) Vrbik J: "Relativistic Motion of a Charged Particle and Pauli Algebra" *The Mathematica Journal* (2012) **14** #10

100) Vrbik J: "Accurate Confidence Regions based on MLEs" *Advances and Applications in Statistics* **32** #1 (2013) 33-56

101) Vrbik J: "Chaos in Planar, Circular, Restricted Three-body Problem" *Applied Mathematics* **4** #1 (2013) 40-45

102) Vrbik J and Vrbik P: "*Informal Introduction to Stochastic Processes with Maple*" Springer (2013) **ISBN-13:** 978-1461440567

103) Vrbik J: "Errata and Addendum to 'Accurate Confidence Regions based on MLEs' *" Adv. Appl. Stat.* **35** #2 (2013) 161-163

104) Vrbik J: "Asymptotic Expansion of Sampling Distribution of an MLE to 1/n Accuracy" *Adv. Appl. Stat.* **38** #1 (2014) 37-50

105) Vrbik J: "Erratum to 'Confidence Regions based on Edgeworth Expansion' " *Communications in Statistics - Simulation and Computation* **45** #1 (2015): 59-74

106) Vrbik J: "Improving Accuracy of Chi-squared Test of Independence" *Adv. Appl. Stat.**39*** #2 (2014) 81-94

107) Vrbik J: "Moments of AR(k) Parameter Estimators" *Communications in Statistics - Simulation and Computation* **44** #5 (2015) 1239-1252

108) Vrbik J: "Finding an ARMA(p,q) model given its spectral density or its correlogram" *arXiv* 1406.4062 (June 2014)

109) Duszak K and Vrbik J: "Improving Accuracy of Goodness-of-fit Test" *arXiv* 1410.6869 (Oct. 2014)

110) Zhang H Y and Vrbik J: “Accurate distribution of $X^T X$ with singular, idempotent variance-covariance matrix” *arXiv* 1411.5305 (Nov. 2014)

111) Abraham R and Vrbik J: “Three competing patterns” *arXiv* 1412.6658 (Dec. 2014)

112) Liu Y and Vrbik J: “Formula to evaluate a limit related to AR(k) model of Statistics” *arXiv* 1506.03131 (June 15)

113) Kalitsi C and Vrbik J: “Cumulants of products of normally distributed random variables” *arXiv* 1506.05319 (June 2015)

114) Vrbik J and Vrbik P: “Playing several patterns against each other” *arXiv* 1507.01322 (July 2015)

115) Vrbik J, Ospadov E and Rothstein S M: “Note: A pure-sampling quantum Monte Carlo algorithm with independent Metropolis” *J. Chem. Phys.* **145** #2 (2016)

116) Vrbik J and Vrbik P: “Yet another proof of Sylvester’s determinant identity” a*rXiv* 1512.08747 (Dec. 2015)

117) Vrbik J: “Molecular geometry and vibrational frequencies by parallel sampling” *arXiv* 1704.03113 (Apr. 2017)

118) Vrbik J: “Approximate distribution of sample quantiles” *Adv. Appl. Stat.* **50** #5 (2017) 397-410

119) Nkingi E and Vrbik J: "Confidence Regions for Parameters of Negative Binomial Distribution" arXiv 1612.08113v1 (Dec. 2016)

120) Vrbik J: “General formulas for serial correlation, variance and likelihood function related to AR(k) models”, *Adv. Appl. Stat.* **50** #5 (2017) 411-421

121) Li N and Vrbik J: “Linear Regression with Non-Normal Errors”, *Adv. Appl. Stat.* **53** #2 (2018) 153-164

122) Vrbik J: “Small-sample corrections to Kolmogorov-Smirnov test statistic”, *Pioneer Journal of Theoretical and Applied Statistics*

123) Li N, Vrbik J and Xu X: “Linear regression with non-normal or mis-specified error distribution”

RESEARCH GRANTS

NSERC three year (1984-87) operating grant of $8,300 (total value).

NSERC three year (1987-90) operating grant of $17,840 (total value).

NSERC three year (1990-93) operating grant of $18,000 (total value).

NSERC four year (1993-97) operating grant of $32,000 (total value).

NSERC four year (1997-2001) operating grant of $26,400 (total value)

MSc STUDENT SUPERVISION

Jennifer VIGLIOTTA	2008
Kylie MAHAU	2009
Luo WANG	2010
Chi Ho CHUENG	2011
Emmanuel NKINGI	2012
Clarence KALITSI	2013
Hao Yuan ZHANG	2014
Yuhao LIU	2015
Siqi WANG	2018 (in progress)
Matthew ROMANO	2017
Veson LEE	2018
Na LI	2018
Julian DIFRANCESCO	2018 (in progress)

UNDERGRADUATE STUDENT SUPERVISION

Michelle VRBIK	2012
Corey WEHR	2012
Kris DUSZAK	2013
Rita ABRAHAM	2014
Sean FARQUHARSON	2018

This is a draft version only. Do not submit to any funding organization. Only the final version from the History page can be submitted.

Protected when completed

Dr. Thomas Wolf

Correspondence language: English
Sex: Male

Contact Information

The primary information is denoted by (*)

Address

Primary Affiliation (*)

Department of Mathematics
Brock University
500 Glenridge Avenue
St.Catharines Ontario L2S 3A1
Canada

Telephone

Work (*) 905-6885550 extension: 3803

Email

Work (*) twolf@brocku.ca

Dr. Thomas Wolf

Language Skills

Language	Read	Write	Speak	Understand	Peer Review
English	Yes	Yes	Yes	Yes	Yes
German	Yes	Yes	Yes	Yes	Yes

Degrees

- 1990/11	Habilitation, Mathematics, Friedrich Schiller Universitaet Jena
- 1985/11	Doctorate, Physics, Friedrich Schiller Universitaet Jena
	Supervisors: Hans Stephani, 1981/11 -
- 1981/11	Diploma, Physics, Friedrich Schiller Universitaet Jena
	Supervisors: Hans Stephani, 1980/9 -

User Profile

Research Specialization Keywords: Integrability, Computer Algebra, Classical General Relativity, Mathematics and Computerization of Go, Combinatorial Game Theory

Employment

2002/11	Faculty Mathematics, Brock University Full-time, Professor Tenure Status: Tenure
2001/7	Faculty Mathematics, Brock University Full-time, Associate Professor Tenure Status: Tenure Track
1990/8	Senior Lecturer School of Mathematical Sciences, Queen Mary, University of London Full-time, Lecturer Tenure Status: Tenure

Research Funding History

Awarded [n=2]

2017/5 - 2022/4
Principal Applicant

Applications of advances in computer algebra to studying classical integrable systems and related algebraic structures, Grant

Funding Sources:
Natural Sciences and Engineering Research Council of Canada (NSERC)
Discovery Grant
Total Funding - 120,000
Portion of Funding Received - 120,000
Funding Competitive?: Yes

2012/5 - 2017/4
Principal Applicant

Applications of advances in computer algebra to studying classical integrable systems and various algebraic structures, Grant

Funding Sources:
Natural Sciences and Engineering Research Council of Canada (NSERC)
Discovery
Total Funding - 60,000
Portion of Funding Received - 60,000
Funding Competitive?: Yes

Student/Postdoctoral Supervision

Bachelor's [n=12]

2018/1 - 2018/8
Principal Supervisor

Parmdeep Bansal, Brock University
Thesis/Project Title: Unlikely Correlations in Contests indicating Misconduct (co-op placement)
Present Position: BSc student

2018/1 - 2018/8
Principal Supervisor

Ryan Seguin, Brock University
Thesis/Project Title: An intelligent automated help robot (co-op placement)
Present Position: BSc student

2017/5 - 2017/8
Principal Supervisor

Tyler Crane, Brock University
Thesis/Project Title: Combinatorial game theory applied to Chomp (co-op placement)
Present Position: BSc student

2017/5 - 2017/8
Principal Supervisor

Ashley Kapoor, Brock University
Thesis/Project Title: A Workbench for Mathematical Knot Theory (co-op placement)
Present Position: BSc student

2017/1 - 2017/4
Principal Supervisor

Parmdeep Bansal (In Progress) , Brock University
Thesis/Project Title: Detecting Unfair Collaboration in Contests (co-op placement)
Present Position: BSc student

2016/5 - 2016/8
Principal Supervisor

Tyler Crane (In Progress) , Brock University
Thesis/Project Title: Analysis and programming of the Sliding Boxes game (co-op placement)
Present Position: BSc student

2016/5 - 2016/8
Principal Supervisor

Karina Latcu (Completed) , Brock University
Thesis/Project Title: Design of Challenging Math Problems in Contests (co-op placement)
Present Position: MSc student in Germany

2015/5 - 2015/8 Principal Supervisor	Sarah Lahey (Completed) , Brock University Thesis/Project Title: Combinatorial Game Theory Applied to the Hackenbush game (co-op placement) Present Position: BSc student
2015/5 - 2015/8 Principal Supervisor	Sarah Bax (Completed) , Brock University Thesis/Project Title: Calcrostic Puzzles (summer research placement) Present Position: teacher at math school for gifted kids
2015/5 - 2016/8 Principal Supervisor	Anton Kurylovich (Completed) , Brock University Thesis/Project Title: Development of an animated geometry testing and adaptive learning platform for online math competitions (hired under a NSERC-Engage grant) Present Position: programmer at an IT company
2015/5 - 2015/8 Principal Supervisor	Madeleine Hill (Completed) , Brock University Thesis/Project Title: The Map Colouring Problem (co-op placement) Present Position: just completed another degree, applying for jobs
2013/5 - 2013/8 Principal Supervisor	Ramona Rat (Completed) , Brock University Thesis/Project Title: Symmetries and Conservation Laws of Families of Integrable Non-Abelian Ordinary Differential Equations (co-op placement) Present Position: MSc student, Brock University

Bachelor’s Equivalent [n=1]

2017/5 - 2017/8 Principal Supervisor	Madelleine Hill (Completed) , Mohawk College Thesis/Project Title: Lax Pairs of non-commutative Laurent ODE systems Present Position: completed Mohawk College, applying for jobs

Bachelor’s Honours [n=3]

2014/5 - 2015/1 Principal Supervisor	Madeleine Hill (Completed) , Brock University Thesis/Project Title: Integrability of Non-Abelian Ordinary Differential Equations Present Position: just completed another degree, applying for jobs
2013/9 - 2014/4 Principal Supervisor	Ramona Rat (Completed) , Brock University Thesis/Project Title: Lax Pairs of Integrable Non-Abelian Ordinary Differential Equations Present Position: high school math teacher in the UK
2010/9 - 2011/5 Principal Supervisor	Kenneth Webster (Completed) , Brock University Thesis/Project Title: The Inclusion of Precomputed Algebraic Solutions of Sparse Linear Systems into Multigrid Methods Present Position: not known

Master’s non-Thesis [n=1]

2017/9 - 2019/8 Co-Supervisor	Sicheng (Richard) Zhao, Brock University Thesis/Project Title: TBA. Present Position: MSc student

Master’s Thesis [n=12]

2016/10 - 2018/11 Co-Supervisor	Francis Kwaku Combert (In Progress) , Brock University Student Degree Expected Date: 2018/12 Thesis/Project Title: TBA. Present Position: MSc student

2016/9 - 2018/8 Co-Supervisor	Evans Clifford Boadi (In Progress) , Brock University Student Degree Expected Date: 2018/8 Thesis/Project Title: TBA. Present Position: MSc student
2014/11 - 2015/7 Co-Supervisor	Elena Karimova (Completed) , Ufa State Aviation Technical University Thesis/Project Title: Exact solutions of gasdynamics equations obtained by the method of conservation laws Present Position: not known
2014/9 - 2016/7 Co-Supervisor	Chimaobi Amadi (Completed) , Brock University Thesis/Project Title: Generation of 7x7 Calcrostic Puzzles and Rational Solution of Underdetermined Polynomial Systems Present Position: PhD student
2014/9 - 2016/8 Co-Supervisor	Fatane Mobasheramini (Completed) , Brock University Thesis/Project Title: Classification of integrable 2-component peakon equations from Lax pairs Present Position: PhD student
2013/9 - 2014/6 Co-Supervisor	Kseniya Imamutdinova (Completed) , Ufa State Aviation Technical University Thesis/Project Title: Conservation laws of Monge–Ampere equation Present Position: not known
2013/1 - 2015/2 Co-Supervisor	Shahid Mohammad (Completed) , Brock University Thesis/Project Title: -1 Flow in the Hierarchies of Integrable Equations Present Position: not known
2011/9 - 2015/2 Co-Supervisor	Allan Walsh (Completed) , Brock University Thesis/Project Title: Caribou Math Contests: Success Rates by Strands and Difficulty Levels Present Position: mathematics teacher
2010/9 - 2012/4 Co-Supervisor	Mohammad Abdus Samad Bhuiyan (Completed) , Brock University Thesis/Project Title: Application of the Schouten brackets in computation of Poisson Cohomology Present Position: PhD student
2010/9 - 2012/8 Co-Supervisor	Abdus Sattar Mia (Completed) , Brock University Thesis/Project Title: Complex mKdV solitons with time varying phase Present Position: not known
2009/9 - 2011/8 Principal Supervisor	Mohammad Mohiuddin (Completed) , Brock University Thesis/Project Title: Symmetry Investigations of Supersymmetric Evolutionary PDEs Present Position: not known
2008/9 - 2011/10 Co-Supervisor	Steven MacNaughton (Completed) , Brock University Thesis/Project Title: Computation of symmetries and conservation laws of nonlinear wave equations by computer algebra Present Position: high school mathematics teacher

Doctorate [n=4]

2014/11 - 2015/10 Co-Supervisor	Liaisan Galiakberova (Completed) , Ufa State Aviation Technical University Thesis/Project Title: Algorithms of theory of approximate transformation groups of differential equations and their use in the study of wave equations Present Position: unknown

2014/11 - 2015/10 Co-Supervisor	Aliya Gainetdinova (Completed) , Ufa State Aviation Technical University Thesis/Project Title: Symmetry properties and integrability of systems of second-order ODEs Present Position: unknown
2011/9 - 2012/8 Co-Supervisor	Wei Feng (Completed) , Brock University and Northwest University, China Thesis/Project Title: Exact solutions of equations in mathematical physics by separation of group foliation variables Present Position: Assistant Prof, Zhejiang University of Technology, Hangzhou, China
2011/5 - 2016/7 Co-Supervisor	Dmitry Pshenitsin (Completed) , Brock University Thesis/Project Title: Conservation laws of magnetohydrodynamics and their symmetry transformation properties Present Position: not known, changed a few times

Post-doctorate [n=1]

2009/2 - 2011/8 Co-Supervisor	Sajid Ali (Completed) , Brock U. and National U. of Sciences and Technology, Islamabad, Pakistan Thesis/Project Title: Symmetries, group-foliation reduction and exact solutions of equations in mathematical physics Present Position: Professor, National U. of Sciences and Technology, Islamabad, Pakistan

Research Associate [n=3]

2015/9 - 2016/7 Co-Supervisor	Amber DeForest (In Progress) , Brock University Thesis/Project Title: Development of an animated geometry testing and adaptive learning platform for online math competitions (hired under an OCE-VIP & NSERC engage project) Present Position: not known
2015/9 - 2016/7 Principal Supervisor	Anthony Awuley (Completed) , Brock University Thesis/Project Title: Development of an animated geometry testing and adaptive learning platform for online math competitions (hired under a OCE-VIP & NSERC-Engage grant) Present Position: software developer, employed in a software company
2015/8 - 2016/2 Principal Supervisor	Oleg Rybkin (Completed) , Brock University Thesis/Project Title: Development of an animated geometry testing and adaptive learning platform for online math competitions (hired under a OCE-VIP & NSERC-Engage grant) Present Position: Programmer, Manufacturing Company in St Catharines

Editorial Activities

2011/9 - 2020/12	editorial board member, book series titled "Atlantis Studies in Mathematical Physics: Theory and Applications" published by Springer Verlag (Heidelberg) and Atlantis Press (Paris), Book
2010/10 - 2020/12	Editor, Journal of Baduk Studies, ISSN 1738-3730, Journal
2010/1 - 2020/12	Editor, Pacific Journal of Applied Mathematics, Journal

Organizational Review Activities

2011/10 - 2011/11	external examiner for PhD thesis, Friedrich-Schiller-Universitat Jena Theoretisch Physikalisches Institut, external Examiner of the PhD thesis of Christian Teichmueller

Presentations

1. *Amadi C. (2016). Poster: Generation of 7x7 Calcrostic Puzzles and Rational Solution of Underdetermined Polynomial Systems. International Symposium on Symbolic and Algebraic Computation (ISSAC) 2016, Wilfrid Laurier University, Waterloo, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
2. *Bax S. (2016). Poster and short presentations: Caribou Contests - A Different Kind of Mathematics Contest. Superior Tech For Teachers Conference (ST4T) 2016, Clearwater, United States
   Main Audience: Knowledge User
   Invited?: No, Keynote?: No
3. (2016). Caribou Contests - A Different Kind of Mathematics Contest. CONNECT 2016 - Canada's Learning & Technology Conference, Niagara Falls, Canada
   Main Audience: Knowledge User
   Invited?: No, Keynote?: No
4. Anco S. (2016). Conservation laws of incompressible magnetohydrodynamics. CMS (Canadian Math Soc) summer, Edmonton, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
5. *Amadi C. (2016). Generation of 7x7 Calcrostic Puzzles and Rational Solution of Highly Underdetermined Polynomial Systems. CMS (Canadian Math Soc) summer meeting, Edmonton, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
6. (2016). Computing Symmetries and Recursion Operators of Evolutionary Super-Sytstems. CMS (Canadian Math Soc) summer meeting, Edmonton, Canada
   Main Audience: Researcher
   Invited?: Yes, Keynote?: No
7. (2016). Panel Discussion and Press conference: Future of Go in Canada. University of Toronto, Toronto, Canada
   Main Audience: General Public
   Invited?: Yes, Keynote?: No
8. Anco S. (2015). Exact solutions of semilinear radial Schrödinger equations by group foliation reduction. AMMCS 2015 Conference in Session "Recent Advances in Lie Symmetry Methods and Conservation Laws for Differential Equations and Applications", Waterloo, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
9. Odesskii A. (2015). Compatible quadratic Poisson brackets related to a family of elliptic curves. AMMCS 2015 Conference in Session "Geometric and Analytic Methods in Classical and Celestial Mechanics", Waterloo, Canada
   Main Audience: Researcher
   Invited?: No, Keynote?: No
10. *Hill M. (2014). Poster: Lax Pairs of Integrable Non-Abelian Ordinary Differential Equations. Compute Ontario Research Day 2014 held at the Perimeter Institute, Waterloo, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

11. Anco S. (2014). A group foliation method for finding exact solutions to nonlinear PDEs. International Conference "Symmetry Methods, Applications and Related Fields" celebrating the work of George W. Bluman, Vancouver, Canada
    Main Audience: Researcher
    Invited?: Yes, Keynote?: No

12. Anco S. (2014). Integrability Study of Breaking-Wave Equations. CMS Winter meeting at McMaster U., Hamilton, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

13. (2013). A group foliation method for finding exact solutions to nonlinear PDEs. in session "Lie symmetry and other approaches in theory and applicatios of nonlinear equations" at the International Conference on Applied Mathematics, Modeling and Computational Science (AMMCS2013), St Catharines, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

14. Anco S. (2013). Symmetry analysis and exact solutions of nonlinear wave equations. CMS summer meeting 2013, Session on Nonlinear Partial Differential Equations and their Applications, Halifax, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

15. (2013). The many faces of integrability from an algebraic computation point of view. 15th International Workshop on Computer Algebra in Scientific Computing (CASC 2013), Berlin, Germany
    Main Audience: Researcher
    Invited?: Yes, Keynote?: Yes

16. Anco S. (2013). Symmetry analysis and exact solutions of semilinear Schrödinger equations. 8th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, University of Georgia, United States
    Main Audience: Researcher
    Invited?: No, Keynote?: No

17. (2013). About integrable non-abelian Laurent ODEs. Workshop "Applications of symmetries to differential equations", Brock University, St Catherines, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

18. (2013). Traveling Waves and Conservation Laws for Complex mKdV-type Equations. in session "Symmetry in Nonlinear Dynamics: Theory and Applications" at the International Conference on Applied Mathematics, Modeling and Computational Science (AMMCS2013), Waterloo, Canada
    Main Audience: Researcher
    Invited?: No, Keynote?: No

19. (2013). The Mathematics of Seki. ACGA Spring Go Expo at Harvard University, Cambridge, United States
    Main Audience: Knowledge User
    Invited?: Yes, Keynote?: No

20. (2013). About integrable non-commutative Laurent polynomial ODE systems. Integrable Systems and Quantum Symmetries, Prague, Czech Republic
    Main Audience: Researcher
    Invited?: No, Keynote?: No

21. (2013). Poster: A Linear Sparse Systems Solver (LSSS) applied to the Classification of Integrable non-abelian Laurent ODEs. 38th International Symposium on Symbolic and Algebraic Computation ISSAC 2013, Boston, United States
    Invited?: No, Keynote?: No

22. (2013). About integrable non-abelian Laurent ODEs. Seminar talk at Dept of Math at University of Western Ontario, London, Canada
Main Audience: Researcher
Invited?: Yes, Keynote?: No

23. (2013). Solving very Large Linear Algebraic Systems for Integrability Investigations. Second Brock-Kobe Bilateral Workshop On Scientific Computation, 20-21 Aug, St Catharines, Canada
Main Audience: Researcher
Invited?: No, Keynote?: No

24. (2012). Integrable non-abelian Laurent ODEs. Symmetries of Differential Equations: Frames, Invariants and Applications A conference in honor of the 60th birthday of Peter Olver, Minneapolis, United States
Main Audience: Researcher
Invited?: No, Keynote?: No

25. (2012). Integrable non-abelian Laurent ODEs. New Jersey Institute of Technology, Bridgewater, United States
Main Audience: Researcher
Invited?: No, Keynote?: No

26. (2012). Recent extensions of the package CRACK for the solution of non-polynomial differential systems of equations. Canadian Applied and Industrial Mathematics Annual Meeting, CAIMS 2012 in MS 4279 Minisymposium Applications of computer algebra in applied and industrial mathematics 2 at the Fields Institute, Toronto, Canada
Main Audience: Researcher
Invited?: No, Keynote?: No

27. (2012). Hyperdeterminants as integrable 3D difference equations. Graduiertenkolleg Theoretisch Physikalisches Institut Universität Jena, Jena, Germany
Main Audience: Researcher
Invited?: No, Keynote?: No

28. (2012). Travelling waves and conservation laws for complex mKdV-type equations. SIAM Conference on Nonlinear Waves and Coherent Structures in the session Novel Symbolic Methods to Investigate (Integrable) Nonlinear Differential Equations that was co-organized with Willy Hereman, University of Washington, Seattle, United States
Main Audience: Researcher
Invited?: No, Keynote?: No

29. (2012). Travelling waves and conservation laws for complex mKdV-type equations. CMS Winter Meeting in Montreal in the session ``Symmetries of Differential and Difference Equations'', Montreal, Canada
Invited?: No, Keynote?: No

30. (2012). Basic Seki in Go. International Go Symposium, Black Mountain, United States
Main Audience: Knowledge User
Invited?: No, Keynote?: No

31. (2012). Graph Theory applied to seki positions in the game of Go. Graduiertenkolleg Theoretisch Physikalisches Institut Universität Jena, Jena, Germany
Main Audience: Researcher
Invited?: No, Keynote?: No

32. (2012). A solver for linear algebraic systems resulting from filtering discrete structures. SIAM Conference on Discrete Mathematics DM12 at session MS41 Interactions between Computer Algebra and Discrete Mathematics - Part I of III Dalhousie University, Halifax, Canada
Main Audience: Researcher
Invited?: Yes, Keynote?: No

Publications

Journal Articles

1. Wolf T, *Amadi C. (2016). Rational Solutions of Underdetermined Polynomial Equations. Zapiski POMI (in English) and arXiv: 1608.00697.
   Accepted
   Refereed?: Yes
2. Anco S C, *Mohammad S, Wolf T, Zhu C. (2016). Generalized negative flows in hierarchies of integrable evolution equations. JNMP and arXiv: 1604.07779 nlin.SI.
   Accepted
   Refereed?: Yes
3. Anco S C, *Avdonina E D, *Gainetdinova A, *Galiakberova L R, Ibragimov N H, Wolf T. (2016). Symmetries and conservation laws of the generalized Krichever-Novikov equation. J. Phys. A: Math. and Theor. and arXiv:1407.1258 [nlin.SI]. 49(10): 105201 (29 pages).
   Published
   Refereed?: Yes, Open Access?: Yes
4. Wolf T. (2016). Seki with 2 Liberties per Chain. ICGA Journal. 39(2)
   Submitted
   Refereed?: Yes
5. Wolf T. (2015). Caribou Math Contests: Not just a contest but a way of learning and enjoying math. Fields Notes. 15(2): 6-7.
   Published
   Refereed?: No, Open Access?: Yes
6. Wolf T. (2015). A Classification of Semeai with Approach Moves. ICGA Journal. 38(4): 224-241.
   Published
   Refereed?: Yes
7. Anco S C, *Feng W, Wolf T. (2015). Exact solutions of semilinear radial Schrodinger equations by separation of group foliation variables. Journal of Mathematical Analysis and Applications and arXiv:1408.3751. 427(2): 759–786.
   Published
   Refereed?: Yes
8. Euler M, Euler N, Wolf T. (2013). The Two-Component Camassa-Holm Equations CH(2,1) and CH(2,2). Journal of Nonlinear Mathematical Physics, supplement 1, DOI:10.1142/S1402925112400025. 19: 13-22.
   Published
   Refereed?: Yes
9. Wolf T, *Efimovskaya O. (2012). On integrability of the Kontsevich non-abelian ODE system. Lett. in Math. Phys. and arXiv:1108.4208v1 [nlin.SI]. 100(2): 161-170.
   Published
   Refereed?: Yes, Open Access?: Yes
10. Odesskii A, Wolf T. (2012). Compatible quadratic Poisson brackets related to a family of elliptic curves. J. Geom. Phys. and arXiv:1204.1299. 63: 107-117.
    Published
    Refereed?: Yes
11. Anco S C, *MacNaughton S, Wolf T. (2012). Conservation Laws and Symmetries of Quasilinear Wave Equations in multi-dimensions. J. Math. Phys. and arXiv:1109.1719. 53(053703): 1-33.
    Published
    Refereed?: Yes, Open Access?: Yes

12. Wolf T, Schruefer E, *Webster K. (2012). Solving large linear algebraic systems in the context of integrable non-abelian Laurent ODEs. Programming and Computer Software and arXiv: 1109.2785 (nlin.SI).
Published
Refereed?: Yes, Open Access?: Yes

13. Anco S C, *Mohiuddin M, Wolf T. (2012). Traveling waves and conservation laws for complex MKdV-type equations. Appl. Math. Comput. and arXiv:1110.2403. 219: 679-698.
Published
Refereed?: Yes

Manuals

1. Wolf T, Schruefer E. (2016). SSTools - a computer algebra package for computing symmetries and recursion operators of evolutionary super-systems. Computer Algebra System REDUCE, first submission in 2016.
Published, Sourceforge

2. Wolf T. (2016). CRACK - Solving overdetermined algebraic- and differential systems. Computer Algebra System REDUCE, first submission in 1992, typically quarterly updated and extended.
Published

3. Wolf T. (2015). LiePDE - computation of infinitessimal symmetries of differential equations and systems. Computer Algebra System REDUCE, first submission in 1995, typically bi-annually updated.
Published

4. Wolf T. (2015). ConLaw - computation of conservation laws of polynomial and differential systems. Computer Algebra System REDUCE, first submission in 1999, bi-annually updated.
Published

5. Wolf T, Schruefer E. (2012). LSSS - Linear Sparse Systems Solver for general linear algebraic systems especially for extremely large but sparse systems. Computer Algebra system REDUCE.
Published

CURRICULUM VITAE

NAME: Xiaojian Xu RANK: Associate professor, tenured.

FORMAL EDUCATION

- Ph.D., University of Alberta, Canada, 2006
- M.A., State University of New York at Brockport, USA, 2000
- B.Sc., Shandong Teachers' University, China, 1987

ACADEMIC DISTINCTIONS AND AWARDS

- NSERC discovery grant (individual) for 2015-2020
- Excellent Oral Presentation Award, 2018 International Conference on Mathematics and Artificial Intelligence, Chendu, China, April 2018
- NSERC discovery grant (individual) for 2010-2015
- NSERC discovery grant (individual) for 2007-2010
- Winner of the 2006 Paper Award in Survey Methods, June 2007, the Statistical Society of Canada
- Student Travel Awards, May 2006, Survey Research Methods Section of the American Statistical Association
- Province of Alberta Graduate Fellowship, 05/2005-04/2006, Government of the Province of Alberta
- Research Internship Fund, 09/2005-01/2006, Mathematics of Information Technology and Complex Systems (MITACS), Canada
- Professional Development Award, 07/2005, University of Alberta
- Mary Louise Imrie Graduate Student Award, 06/2005, University of Alberta
- Province of Alberta Graduate Fellowship, 05/2004-04/2005, Government of the Province of Alberta
- Province of Alberta Graduate Fellowship, 01/2004-04/2004, Government of the Province of Alberta
- Eoin L Whitney Scholarship, 05/2003, University of Alberta
- Graduate Intern Tuition Supplement Award, 01/2003, University of Alberta
- Graduate TA Scholarship, 09/2001-04/2004, University of Alberta
- Graduate Teaching Assistantship, 09/2001-04/2004, University of Alberta
- Graduate Teaching Assistantship, 08/1999-12/2000, SUNY Brockport
- Excellence in Teaching Award, 09/1989, Training School of Weifang Diesel Company

ACADEMIC POSITIONS HELD

- Professor, Brock University, St. Catharines, Ontario, 07/2018 to present
- Associate Professor, Brock University, St. Catharines, Ontario, 07/2010 to present
- Assistant Professor, Brock University, St. Catharines, Ontario, 07/2006 to 06/2010
- Research Internship fellow at Statistics Canada, Ottawa, Ontario, 09/2005 to 12/2005

- Teaching and research assistant at the Department of Mathematical and Statistical Sciences, University of Alberta, Edmonton, Alberta, 09/2001 to 08/2005
- Instructor at Department of Science, Grant MacEwan College, Edmonton, Alberta, 09/2003 to 12/2003
- Consultant at Training Consulting Centre (TCC) of Department of Mathematical and Statistical Sciences in University of Alberta, 09/2002 to 05/2005
- Graduate assistant at the Department of Mathematics, SUNY Brockport, New York, 09/1999 to 12/2000
- Programmer at Information Technology Experts (ITX) Corp., Rochester, New York, 02/1999 to 08/1999
- Instructor at the Language Intelligent Company Ltd., Rochester, New York, 11/1998 to 02/1999
- Lecturer of mathematics and computer science at Shandong Physical Education Institute, Jinan, China, 07/1994 to 06/1998
- Assistant professor of mathematics and computer science at Shandong Physical Education Institute, Jinan, China, 10/1991 to 06/1994
- Instructor of mathematics at the Training School of Weifang Diesel Company, Weifang, China, 08/1987 to 09/1991.

CREATIVE/SCHOLARLY ACTIVITIES (list each of the following under separate headings)

1. Publications (note that the names with * are my students)

a. Books and chapters contributed to books

- **X. Xu**, and W. Huang* (2016). Optimal Robust Designs for Step-stress Accelerated Life Testing Experiments for Proportional Hazards Models. *Mathematical and Computational Approaches in Advancing Modern Science and Engineering*, Eds: Bélair, J., Frigaard, I.A., Kunze, H., Makarov, R., Melnik, R., Spiteri, R.J., New York: Springer, 585-594.
- **X. Xu** (2008). Probability, Limits in. *International Encyclopedia of the Social Sciences, 2nd Edition*. Ed: Darity, W. A. Jr., Detroit: Macmillan Reference USA, Vol. 6, 486-489.
- Y. Sun, and **X. Xu** (1995). *Applied computer science*. Beijing: China Business Press.
- **X. Xu** (1994). *Advanced mathematics in sport science*, Ed: Cheng, Z., Xi An: Shanxi People's Press (1994), Chapter two.

b. Papers published in refereed journals

- **X. Xu**, and X. Chen* (2018). A Practical Method of Robust Estimation in Case of Asymmetry. *Journal of Statistical Theory and Practice*, 12(2), 370-396. DOI:10.1080/15598608.2017.1393779.
- **X. Xu**, and M. Krzeminski* (2018). Optimal Designs for Accelerated Life Tests with Multiple Stress Factors and Heteroscedasticity. *Communications in Statistics - Theory and Methods*, *Communications in Statistics - Theory and Methods*, 47(6), 1273-1306. DOI:10.1080/03610926.2017.1317809.

- **X. Xu**, and X. Shang* (2017). D-optimal Designs for Full and Reduced Trigonometric Regression Models. *Statistical Papers*, 58(3), 811–829. DOI: 10.1007/s00362-015-0727-6.
- C. Lu, M. McGinn, **X. Xu**, and J. Sylvestre (2017). Living in Two Cultures: Chinese Canadians' Perspectives on Health. *The Journal of Immigrant and Minority Health*, 19(2), 423-429.
- S.K. Sinha, and **X. Xu** (2016). Sequential Designs for Repeated Measures Experiments. *Journal of Statistical Theory and Practice*, 10(3), 496-514.
- M. Huang, **X. Xu**, and D. Tashnev* (2015). A Weighted Linear Quantile Regression. *Journal of Statistical Computation and Simulation*, 85(13), 2596-2618.
- **X. Xu**, and X. Shang* (2014). Optimal and Robust Designs for Trigonometric Regression Models. *Metrika*, 77(6), 753-769.
- **X. Xu**, and A. Chen* (2014). Robust Prediction and Extrapolation Designs for Nonlinear Regression. *Metron*, 72(1), 25-44.
- S.E. Saffari, **X. Xu**, and R. Adnan (2013). On the Hurdle Negative Binomial Regression Model with Excess Zeros for a Right Truncated Count Data. *Journal of Mathematical Research and Applications*, 1, 1-9.
- **X. Xu**, and S. Hunt* (2013). Robust Designs of Step-Stress Accelerated Life Testing Experiments for Reliability Prediction. *Matematika*, 29, 203-212.
- S. Hunt*, and **X. Xu** (2012). Optimal Design for Accelerated Life Testing with Simple Step-stress Plans. *International Journal of Performability Engineering.* 8(5), 575-579.
- S.K. Sinha, and **X. Xu** (2011). Sequential Optimal Designs for Generalized Linear Mixed Models. *Journal of Statistical Planning and Inference*, 141, 1394-1402.
- **X. Xu**, and W.K. Yuen (2011). Applications and Implementations of Continuous Robust Designs. *Communications in Statistics – Theory and Methods*, 40(6), 969-988.
- **X. Xu**, and L. Zhao* (2011). Robust Designs for Haar Wavelet Approximation Models. *Applied Stochastic Models in Business and Industry*, 2795), 531-550.
- A.J. Adewale, and **X. Xu** (2010). Robust Designs for Generalized Linear Models with Possible Overdispersion and Misspecified Link Functions. *Computational Statistics and Data Analysis*, *Computational Statistics and Data Analysis*, 54 (4), 875-890.
- **X. Xu,** and P. Lavallée (2009). Treatments for Link Nonresponse in Indirect Sampling. *Survey Methodology*, 35(2), 153-164.
- C. Lu, and **X. Xu** (2009). The Effect of Student Teaching Experience on Selected Personality Traits in Physical Education. *African Journal for Physical, Health Education, Recreation and Dance.* 15(3), 442-458.
- **X. Xu** (2009). Robust Designs for Misspecified Exponential Regression Models. *Applied Stochastic Models in Business and Industry.* 25(2), 179-193.
- **X. Xu** (2009). Robust Prediction and Extrapolation Designs for Censored Data. *Journal of Statistical Planning and Inference.* 139, 486-502

- D.P. Wiens, and **X. Xu** (2008). Robust Designs for One-point Extrapolation. *Journal of Statistical Planning and Inference,* 138 (5), 1339-1357.
- D.P. Wiens, and **X. Xu** (2008). Robust Designs for Biased Generalized Linear Regression Models. *Journal of Statistical Planning and Inference,* 138 (1), 30-46.
- M. Zuo, Z. Fang, J. Huang, and **X. Xu** (2003). Performance Evaluation of Decreasing Multi-Stat Consecutive-k-out-of-n: G Systems. *International Journal of Reliability, Quality and Safety Engineering*, *10* (3), 345-358.
- **X. Xu** (1995). Several problems of applied mathematics in sport science. *Journal of Shandong Physical Education Institute, 11* (3), 17-21.
- C. Lu, and **X. Xu** (1992). The constitution of research methods in sport science. *Research on Sport Science, 11* (1), 1-4.
- **X. Xu,** and C. Lu (1992). Improving the mathematical quality in sport science. *Journal of Shandong Physical Education Institute, 8* (1), 1-3.
- C. Lu, and **X. Xu** (1991). A study of research methods in sport science. *Symposium of Junior Scientists and Technicians on Sport Science*, 105-106.

c. Paper submitted to refereed journals

d. Published refereed conference proceedings

- **X. Xu** (with W. Huang, 2018). Constrained Optimal Designs for Step-stress Accelerated Life Testing Experiments. *Proceedings of the 3rd IEEE International Conference on Cloud Computing and Big Data Analysis. 633-638.*
- **X. Xu** (with S. Hunt*, 2012). Robust Designs of Step-stress Accelerated Life Testing Experiments for Reliability Prediction. *Proceedings of the 1st ISM International Statistical Conference. 504-511.*
- **X. Xu** (with X. Shang*, 2011). Optimal and Robust Designs for Full and Reduced Fourier Regression Models. *Proceedings of International Conference on Applied Mathematics, Modeling & Computational Science* (*July 25-29, Waterloo, Canada*). 289-292.
- **X. Xu** (with A. Chen*, 2011). Robust Designs for Three Commonly Used Nonlinear Models. *Proceedings of International Conference on Applied Mathematics, Modeling & Computational Science*. 313-316.
- **X**. **Xu** (with X. Shang*, 2011). Optimal Designs for Fourier Regression Models. *Proceedings of the Seventh International Conference on "Mathematical Methods in Reliability".* 889-895.
- **X. Xu** (2007). Robust Estimation and Extrapolation Designs of Misspecified Exponential Regression Models. *Proceedings of Joint ENBIS-DEINDE 2007 Conference (European Network for Business and Industrial Statistics & DEsign of INDustrial Experiments): Computer Experiments versus Physical Experiments.* 224-235.
- **X. Xu**, and W.K. Yuen (2007). Implementation Schemes for Continuous Designs under Kolmogorov-Smirnov Criterion. *Proceedings of the 9th Islamic Countries Conference on Statistical Sciences 2007*, 775-785.

- P. Lavallée, and **X. Xu** (2006). Indirect Sampling and the Problem of Identification of Links. *Proceedings of the 2006 Joint Statistical Meetings,* Alexandria, VA. American Statistical Association, 3292-3296.

e. Theses or other publications not falling into any of the above categories

- **X. Xu** (2006) Robust Prediction and Extrapolation Designs, with Applications to Accelerated Life Testing, Ph D. Thesis, University of Alberta.

2. Papers presented at conferences and learned societies (indicate refereed papers)

- **Xu, X.** (2018). Invited talk. "Robust Sequential Designs for Approximate Inference in Generalized Linear Mixed Models''. *The 9th International Workshop on Simulations*, Barcelona, Spain. June 25-29.
- **Xu, X.** (2017). Invited talk. "Robust design for a generalized linear mixed model when different types of departures may occur from its assumed form''. *BIRS Workshop on "Latest Advances in the Theory and Applications of Design and Analysis of Experiments"*, Banff, Canada, Aug. 6-11.
- **Xu, X.** (2017). Invited talk. "Model-Robust Designs for Generalized Linear Mixed Models with Possible Misspecifications." *The 45th Annual Meeting of Statistical Society of Canada*, Winnipeg, Manitoba, Canada. June 11-14.
- **Xu, X.** (2016). Invited talk. "Optimal designs for regression when measurement error is present." *The Second International Conference on Statistical Distributions and Applications*, Niagara Falls, Canada, Oct. 14-16.
- **Xu, X.** (2016). Invited talk. "Robustification in a statistical process." Workshop on "Robustness Theory and Methodology: Recent Advances and Future Directions". *Banff International Research Station*, Banff, Canada, Sept. 2-4.
- **Xu, X.** and Puglia*, S. (2016). Invited talk. "Optimal designs for measurement error models when the second-order least square estimator is adopted." *Ordered Data and their Applications in Reliability and Survival Analysis: An International Conference in Honour of N. Balakrishnan for his 60th Birthday*, Hamilton, Canada, Aug. 7-10.
- Puglia*, S. (presenter) and **Xu, X.** (2016). Contributed talk. "D-optimal designs of linear measurement error models." *The 44th Annual Meeting of Statistical Society of Canada*, St. Catharines, Ontario, Canada. May 19-June 1.
- Huang*, W. (presenter) and **Xu, X.** (2015). Contributed talk. "Optimal and robust designs of step-stress accelerated life testing experiments for proportional hazards models." *International Conference on Applied Mathematics, Modeling & Computational Science*, Waterloo, Canada. June 7-12.
- Sinha, S. (presenter) and **Xu, X.** (2014). Invited talk. "Optimal Designs for Generalized Linear Mixed Models", *International Conference on Advances in Interdisciplinary Statistics and Combinatorics*, Greensboro, North Carolina, Oct. 10-12.
- **Xu, X.** (2014). Invited talk. "Planning Accelerated Life Testing with Two Experimental Factors when Heteroscedasticity is Present", *The Australian Statistical Conference in conjunction with the Institute of Mathematical Statistics Annual Meeting*, Australia, Sydney, August 7-10.

- **Xu, X.** (2014). Invited lecture. “Optimal and Robust Designs for Accelerated Life Testing”, Faculty of Statistics and Mathematics, Shandong University of Finance & Economics, Jinan.
- Mizutani*, S. (presenter) and **Xu, X.** (2014). “Optimal designs for shrinkage estimation in linear regression”. *The 2nd Annual Statistical Society of Canada Student Conference*, Toronto, May 24.
- Huang*, W. (presenter) and **Xu, X.** (2014). “Optimal designs for accelerated life testing experiment with step-stress plans for proportional hazards model”. *The 2nd Annual Statistical Society of Canada Student Conference*, Toronto, May 24, 2014.
- Krzeminski*, M. (presenter) and **Xu, X.** (2014). Contributed talk. “Optimal Designs for Accelerated Life Tests with Multiple Stress Factors.” *The 41st Annual Meeting of Statistical Society of Canada*, Edmonton, May 26-29.
- **Xu, X.** and M. Krzeminski*. (2013). Contributed talk. “Optimal Designs for Bivariate Accelerated Life Testing Experiments”. *2013 ENAR Spring Meeting*, Orlando, Mar 10 - 13.
- **Xu. X.** (2012). Invited talk. “Optimal Designs for Accelerated Life Testing Experiments with Step-stress Plans”. *Design and Analysis of Experiments Conference 2012, Athens, Georgia, USA*. Oct. 17-20.
- **Xu, X.** (2012). Contributed talk. “Optimal Step-Stress Designs for Heteroscedastic Accelerated Life Testing Models”. *2012 Joint Statistical Meetings*, San Diego, USA. July 28 - Aug. 2.
- Hunt*, S. (presenter) and **Xu, X.** (2014). Contributed talk. Robust Designs for Accelerated Life Testing Models with a Step-Stress Plan. *The 40th Annual Meeting of the Statistical Society of Canada*, *Guelph*, Canada. June 3-6, 2012.
- **Xu, X.** (with X. Shang*). Invited talk. “Optimal and robust designs for full and reduced Fourier regression models”. *International Conference on Applied Mathematics, Modeling & Computational Science*, Waterloo, Canada. July 25-29, 2011.
- **Xu, X**. (with X. Chen*). Contributed talk. “Robust designs for nonlinear regression”. *International Conference on Design of Experiments*, Memphis, USA. May 10-13, 2011.
- **Xu, X**. (with A. Chen*). Invited talk. “Robust estimation in case of asymmetry”. Robust Estimation in Case of Asymmetry. *The 39th Annual Meeting of Statistical Society of Canada*, Wolfville, NS, Canada, June 12-15, 2011.
- **Xu, X.** (with W.K. Yuen). Contributed talk. “Optimal Implementations for Robust Designs with Densities”. *The 38th Annual Meeting of the Statistical Society of Canada*, Québec City. May 2010.
- **Xu, X.** (with X. Shang*). Contributed talk. “Optimal Designs for Fourier Regression Models”. *The 38th Annual Meeting of the Statistical Society of Canada*, Québec City. May 2010.
- **Xu, X.**. Seminar. “Robust Designs for Misspecified Regression”. Robustness research group, Brock University. May 2010.
- **Xu, X.**. Invited lecture. “Robust Designs for Regression”, Faculty of Statistics and Mathematics, Shandong University of Finance & Economics, Jinan. June 2009.
- **Xu, X.** (with L. Zhao*). Contributed talk. “Robust Designs for Wavelet Approximation Models”. *The 37th Annual Meeting of Statistical Society of Canada*,

Vancouver. June 2009.

- **Xu, X**. (with W.K. Yuen). Contributed talk. "Applications and Implementations of Continuous Robust Designs". *2009 Spring Research Conference on Statistics in Industry and Technology*, Vancouver. May 2009.
- **Xu, X.** (refereed, Contributed talk, June 2005). Robust Designs and Weights for Biased Regression Models with Possible Heteroscedasticity in Accelerated Life Testing. *International Conference on Statistics*, Hong Kong.
- **Xu, X.**. Seminar. "Optimal Implementation of a Continuous Design Measure". *Robustness Workshop,* Department of Mathematical and Statistical Sciences, University of Alberta. October 2003.
- **Xu, X.** (with Wiens, D.P.). Refereed contributed talk. "Robust Design in Accelerated Life Testing". *MITACS 4th Annual Conference & Ottawa Interchange*, Ottawa, Ontario. October 2003.
- **Xu, X.** (with Mendez, E.). Contributed talk. "A Profile of Incoming Freshman and Transfer Students in SUNY Brockport". *Scholars Day Conference*, Brockport, New York. April, 2000.

3. Grants obtained

a) Internal grants

- $30,000 start-up fund in Brock University in 2006.

b) Refereed external grants

- $55,000 NSERC discovery grant for 2015-2020.
- $60,000 NSERC discovery grant for 2010-2015.
- $36,000 NSERC discovery grant for 2007-2010.

4. Work in progress (list any scholarly activity which has not reached the writing/drafting stage)

- **Xu, X.** "Combined estimation functions for linear/nonlinear regression".
- **Xu, X.** (with Wiens, D., and Kong, L.) "Optimal Designs for Weighted Composite Quantile Regression".
- **Xu, X.** (with Ghahramani, M., and Hossain, S.) "A Composite estimating functions approach to generalized linear models".
- **Xu, X.** "Compromised designs and C-optimal designs for estimating nonlinear effects".
- **Xu, X.** (with Sinha, S.) "Robust designs for generalized linear mixed models with misspecification in the assumed random effect distribution".
- **Xu, X.** and Puglia*, S. (2016). "D-optimal designs for measurement error models when the second-order least square estimator is adopted."

5. Other creative and scholarly activities

a) **Service as an assessor/referee for book manuscripts, journals, and/or grant applications**

- Referee of *the Canadian Journal of Statistics* (2005, 2007, 2008, 2015, 2016, 2017).

- Referee of *Journal of Computational Statistics and Data Analysis* (2016).
- Referee of *Journal of the Institute of Industrial Engineers, Transactions* (*IIE Trans)* (2011, 2016).
- Referee of *Journal of Statistical Planning and Inference* (2014).
- Referee of *Journal of Statistical Computation and Simulation* (2014, 2015, 2016).
- Referee of *Communications of Statistics – Simulation and Computation* (2013).
- Referee of *IEEE Transactions in Reliability* (2013).
- Referee of *Metron, International Journal of Statistics* (2012, 2013).
- Referee of *Pakistan Journal of Statistics* (2012).
- Referee of *Matematika* (2012).
- Referee of *Journal of Statistical Modeling and Analytics* (2012).
- Reviewed for abstracts submitted to *the first ISM international Statistical Conference* 2012.
- Referee of Journal: *Statistical Papers* (2010).
- Refereed Research Proposal for NSERC (2009).
- Reviewed abstracts and papers for *European Network for Business and Industrial Statistics 2009 conference* at the Ecole Nationale Supérieure des Mines de St-Etienne.
- Reviewed applications for *IMS New Researcher Conference* 2007, and 2008.
- Reviewed proposals for *IMS New Researcher Conference* 2007, 2008, and 2009.
- Contributor to *International Encyclopaedia of the Social Sciences (IESS)*, 2nd Edition (2007-08).

b) Memberships (including executive positions held) in scholarly and/or professional societies/organizations or other federal or provincial agencies having an academic connection

- Session Chair of the 3rd IEEE International Conference on Cloud Computing and Big Data Analysis (April 20-22), Chengdu, China.
- Organizer of the topic-invited session “Recent Developments in Designs and Analysis of Statistical Experiments” in *the second International Conference on Statistical Distributions and Applications* (Oct. 14-16, 2016), Niagara Falls, Canada.
- Organizer of the invited session “recent development in design of statistical experiments” in honour of Professor Doug Wiens’ 65th birthday. *2016 Annual Meeting of the Statistical Society of Canada* (May 29 – June 1), St. Catharines, Ontario.
- International Organizing Committee Member of *the First ISM International Statistical Conference 2012 with Special Application in Sciences and Engineering (ISM-1)*, Hohor Bahru, Malaysia, Dec. 2011 – Sept. 2012.
- Organizer of the invited session “robust designs of statistical experiments” for *2010 Annual Meeting of the Statistical Society of Canada* (Nov. 2010 -June 2011).

- Committee Member of Institute of Mathematical Statistics (IMS) on New Researchers (3 year appointment, Sept. 2006 - Aug. 2009).
- Reviewing Committee Member of *European Network for Business and Industrial Statistics 2009 conference* at the Ecole Nationale Supérieure des Mines de St-Etienne (ENBIS EMSE) (Mar. – July, 2009).
- Member of International Chinese Statistical Association since 2014.
- Member of the Statistical Society of Canada (SSC) since 2006.
- Member of the American Statistical Association (ASA) since 2006.
- Life Member of the Institute of Mathematical Statistics (IMS).
- Life Member of Bernoulli Society (BS).

c) Consulting activities

- Consulted by Dr. Ian Brindle, Professor Emeritus, Department of Chemistry, at Brock, on sample size determination of 3-way ANOVA experiments, June, 2018.
- Consulted by Dr. Ernest Biktimirov, Associate Professor in Department of Finance, Operations & Information Systems at Brock, on Multivariate Regression for his research work, Sept. 2016.
- Consulted by Dr. Anton Knigavko, Postdoctor in Department of Physics at Brock, on Multivariate analysis of mineral data for improvement the QEMSCAN technology for mining industry, April 7, 2015.
- Consulted by Dr. Sheila Bennett, Professor in Department of Teacher Education at Brock, on Statistical Analysis and Interpretation for her research work, Mar. 17, 2015.
- Consulted by Dr. Veena Dwivedi, Associate Professor in Department of Applied Linguistics at Brock, on Logistic Regression Analysis for her research work, Nov. 2013.
- Consulted by Dr. Ernest Biktimirov, Associate Professor in Department of Finance, Operations & Information Systems at Brock, on Multivariate Statistical Modeling for his research work, Feb. 2012 and July 2013.
- Consulted by Dr. Veena Dwivedi, Assistant Professor in Department of Applied Linguistics at Brock, on Mixed Effect Models for her research work, April 2011.
- Consulted by Raphael Dotan, Lab Coordinator in Faculty of Applied Health Sciences at Brock on nonlinear regression for his research work, Dec. 2009.
- Consulted by an MSc student, KwanYin Lee, Department of Finance, Operations and Information Systems, Brock University, on F-test, for his thesis research, Feb 3, 2009.
- Consulted by an MSc student, Yilan Tan, Department of Mathematics, Brock University, for his prospective PhD study, October 2008.
- Consulted by a PhD student, Javad Hakimi, Department of Biological Sciences, Brock University, on principle component analysis, for his dissertation research, April 2008.
- Consulted by Mark Krzeminski, our MSc graduate, and John Lauro, a fourth year student, for their Statistics Canada Mathematical Statistics (MA) Written

Tests, Oct. 2009 and 2006 respectively. John is now working for Statistics Canada since 2007.

TEACHING ACTIVITIES and SUPERVISIONS:

1. **Courses Taught (list all courses taught during the past five years and the number of times each was taught, including the course number and title of each course and enrolment)**

2006-2007

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	F	Lecture	3	3
MATH 2P82	W	Lecture	3	33
		Lab	1	
MATH 3P86	W	Lecture	3	7
		Lab	1	

2007-2008

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	W	Lecture	3	3
MATH 5P83	F	Lecture	3	6
MATH 2P82	W	Lecture	3	28
		Lab	1	
MATH 3P86	F	Lecture	3	4
		Lab	1	

2008-2009

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	W	Lecture	3	6
MATH 5P83	F	Lecture	3	7
MATH 2P82	W	Lecture	3	32
		Lab	1	
MATH 3P86	F	Lecture	3	8
		Lab	1	

2009-2010

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	W	Lecture	3	5
MATH 5P83	W	Lecture	3	5
MATH 2P82	W	Lecture	3	35
		Lab	1	
MATH 3P86	F	Lecture	3	9
		Lab	1	

2010-2011

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	W	Lecture	3	5
MATH 5P83	F	Lecture	3	5
MATH 2P82	W	Lecture	3	48

		Lab	2	
MATH 3P86	F	Lecture	3	7
		Lab	1	

2011-2012

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	W	Lecture	3	5
MATH 5P83	F	Lecture	3	5
MATH 2P82	W	Lecture	3	32
		Lab	2	
MATH 3P86	F	Lecture	3	18
		Lab	1	

2012-2013
Sabbatical Leave.

2013-2014

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	F	Lecture	3	6
MATH 5P83	F	Lecture	3	11
MATH 2P82	W	Lecture	3	57
		Labs	2	
MATH 3P86	W	Lecture	3	15
		Lab	1	

2014-2015

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	F	Lecture	3	8
MATH 5P83	W	Lecture	3	4
MATH 2P82	W	Lecture	3	33
		Lab	2	
MATH 3P86	F	Lecture	3	17
		Lab	1	

2015-2016

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	F	Lecture	3	6
MATH 5P83	F	Lecture	3	4
MATH 2P82	W	Lecture	3	57
		Labs	2	
MATH 3P86	W	Lecture	3	13
		Lab	1	

2016-2017
Sabbatical Leave in Fall 2016.

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P83	W	Lecture	3	3
MATH 2P82	W	Lecture	3	38
		Labs	2	

2017-2018

Course Number and Title	Term	type	Hrs/Wk	Enrol
MATH 5P86	F	Lecture	3	8
MATH 5P83	W	Lecture	3	7
MATH 2P82	W	Lecture	3	38
		Labs	2	
MATH 3P86	F	Lecture	3	27
		Lab	1	

*Lecture, seminar, laboratory, tutorial, etc. (specify combinations)

2. STUDENTS SUPERVISED (GRADUATE AND UNDERGRADUATE):

Name of Student	Course No.	Started	Completed	Status
Soave, David (under co-supervision with Professor W. K. Yuen)	Math 4F90	Sept. 2006	Aug. 2007	Full-time
Zhao, Lin	MSc in Statistics	Sept. 2007	Feb. 2009	Full-time
Shang, Xiaoli	MSc in Statistics	Aug. 2008	Jan. 2010	Full-time
Tashnev, Dmitry (under co-supervision with Professor M. Huang)	MSc in Statistics	Aug. 2008	Jan. 2010	Full-time
Chen, Xiaoyu	MSc in Statistics	Aug. 2009	June 2011	Full-time
Chen, Arnold	MSc in Statistics	Aug. 2009	July 2011	Full-time
Hunt, Scott	MSc in Statistics	Sept. 2010	June 2012	Full-time
Krzeminski, Mark	MSc in Statistics	Aug. 2011	Aug. 2013	Full-time
Wanyi Huang	MSc in Statistics	Aug. 2013	April 2015	Full-time
Soshi Mizutani	Math 4F90	Oct. 2013	June 2014	Full-time
Hassan Moosajee (under co-supervision with Professor M. Huang)	MSc in Statistics	Sept. 2014	April 2016	Full-time
Stefano Puglia	MSc in Statistics	Sept. 2014	Dec. 2017	Part-time
Shijun Li	MSc in Statistics	Sept. 2015	Dec. 2017	Full-time
Na Li (under co-supervision with Professor J. Vrbik)	MSc in Statistics	Sept. 2016	Aug. 2018	Full-time
Anthony Greco	MSc in Statistics	Sept. 2017	Aug. 2019	Full-time
Julian DiFrancesco (under co-supervision with Professor J. Vrbik)	MSc in Statistics	Sept. 2017	Aug. 2019	Full-time
Allison To (under co-supervision with Professor J. Vrbik)	MSc in Statistics	Sept. 2018	Aug. 2020	Full-time
Charlie Shay	MSc in Statistics	Sept. 2018	Aug. 2020	Full-time

*Actual or estimated date (Month, Year); **full-time, part-time or inactive

UNIVERSITY/COMMUNITY SERVICE (e.g., memberships and executive positions on the Board of Trustees, Senate, BUFA; presidential/departmental Committees; community organizations)

- Chair of Statistics Hiring Committee, Department of Mathematics and Statistics, Brock University (Mar. - June, 2018).
- Member of Data Science Program Development Committee, Department of Mathematics and Statistics, Brock University (Jan, 2017 – present).
- Member of NSERC USRA Selection Committee, Brock University (Feb. – Mar. 2015).
- Adjudication member of OGS at Brock University (Nov. 2014).
- Member of Tenure & Promotion Committee of the Faculty of Mathematics and Science at Brock University (July 1, 2013 – June 30, 2014).
- Chair of Statistics Committee, Department of Mathematics and Statistics, Brock University (July 1 – December 31, 2013).
- Statistics Program Advisor, Department of Mathematics and Statistics, Brock University (July 1 – December 31, 2013).
- Member of Committee on Early Retirements at Brock University (May 2007 – present).
- Member of Ad hoc Committee for permanent instructor replacement position (Feb. 2014 – Aug. 2016)
- Member of Committee for Rules of Procedure, Department of Mathematics and Statistics, Brock University (Sept 2014 – Aug. 2016, Jan 2017-Present)
- Member of Graduate Program Committee, Department of Mathematics and Statistics, Brock University (Sept. 2008 – June 2012, Jan. 2014 – Aug. 2016, Jan 2017-Present).
- Member of Undergraduate Curriculum Committee, Department of Mathematics and Statistics, Brock University (Sept. 2010 – June 2012, Jan. -- June 2017).
- Member of 11 Supervisory Committees (for MSc. Students: Ryan Zhang, Jan. 2008 – Sept. 2009; Bryan Christopher, Theresa Conroy, and Holly Falsett, Sept. 2008 – Jan. 2010; Andrei Fajardo, Jan. 2010 – Jan. 2011; Tanbing Yan, Jan. 2010 – June 2012; Amy Ching, Jan. 2011 – June 2012; Youwei Chen, Jan. 2011 – June 2012; Xiang Yan, Jan. 2011 – July 2013; Maria Biamonte, Sept. 2013 – March 2014; Justine Mottola, Sept. 2013 – Jan. 2015), Department of Mathematics and Statistics, Brock University.
- Member of Statistics Committee, Department of Mathematics and Statistics, Brock University (Sept. 2006 - present).
- Member of Scholarship Ranking Committee, Department of Mathematics and Statistics, Brock University (Sept. 2011 – Nov. 2011).
- Mathematical Association of America (MAA) Liaison (Sept. 2006 – Sept. 2008).

Appendix F

Miscellaneous:
- Support letters

A-Z Learning Services, Student Success Centre

Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
T Your Telephone
F Your Fax

brocku.ca

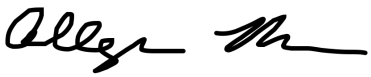
December 19, 2017

To Dr. Beatrice Ombuki-Berman and Dr. Omar Kihel

It is my pleasure to write a letter of support for the department of Computer Science's application for a PhD program. Particularly, we're excited for the opportunity to support these future PhD students through facilitation of COSC 5N01, a non-credit scientific writing course designed to develop graduate-level writing skills.

Learning Services is dedicated to supporting students at every stage of the academic journey, and COSC 5N01 will add to our graduate student support while building on an existing course provided for the departments of Chemistry and Physics: CHEM 5N01.

Sincerely,



Allyson Miller, B.A., M.A.
A-Z Learning Services, Manager
Brock University | Student Success Centre
Niagara Region | 1812 Sir Isaac Brock Way | St. Catharines, Ontario L2S 3A1
brocku.ca | T 905 688 5550 x 5882 | F 905 984 4854

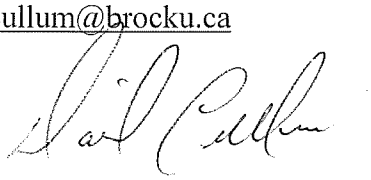
Information Technology Services

Brock Information Technology Services strongly supports the development of a PhD program in Modeling and Applied Computing proposed by the Department of Computer Science, Department of Mathematics and Statistics.

With such transdisciplinary strengths, this program entails will no doubt draw students already here at Brock and external to Brock. We live in a world of ever changing technology with increasing data demands and by introducing such a program, Brock is heading in the right direction. Graduates of this PhD program will no doubt be well prepared to enter the job market.

David Cullum

Associate Vice President
Information Technology Services
Brock University
Niagara Region | 1812 Sir Isaac Brock Way | St. Catharines, Ontario L2S 3A1
brocku.ca | T 905 688-5550 x4200
dcullum@brocku.ca



Faculty of Mathematics and Science
Office of the Dean

Brock University
Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
T 905 688 5550 x3421

March 2, 2021

To: Brian Power
Vice-Provost & Associate Vice-President, Academic

From: Ejaz Ahmed
Dean, Faculty of Mathematics and Science

RE: **PhD in Intelligent Systems and Data Science reviewers report.**

As recommended in the external reviewers' report for the new PhD in Intelligent Systems and Data Science I have approved $30,000 to address the request that a GPU cluster be bought to support the program.

Appendix G

Library report

Brock University Library Report

Support for the PhD in Modeling with Mathematics and Applied Computing program

Tim Ribaric, Liaison Librarian, Computer Science

Ian Gordon, Liaison Librarian, Mathematics & Statistics

March 1, 2019

1.0 Summary and Future Directions

The Brock University Library endeavors to contribute to a positive learning experience for graduate / doctoral students in Computer Science and Mathematics & Statistics by:

- Acquiring and maintaining collections to meet their curriculum needs
- Providing teaching, learning and research services
- Continuously assessing needs that inform the development of our collections and services
- Providing hands-on consultation, programming and assistance with Makerspace and the soon to be completed Rankin Family Pavilion's Digital Scholarship Lab.

We have identified the following areas for future development in support of this joint program, such as:

- increased collaboration in curriculum development e.g. programming languages and platforms
- orientation to research support systems and services e.g. Zotero
- access to collections in support of open source initiatives, research, data management and writing for scholarly audiences, especially for students where English is not their first language
- supporting Brock's proposal for a BSc in Data Science & Analytics and innovative humanistic engineering programs.

Based on evidence provided in this review, the Brock University Library provides excellent support to Computer Science and Mathematics & Statistics at the doctoral level.

1.1 Communication with the Department

The Library collaborates with Library Representatives for academic units to facilitate mutual communication. Library Representatives ensure their academic areas are aware of relevant Library resources and services, while also informing Liaison Librarians of important issues related to curriculum, research and scholarship. The Library invites Library Representatives to meetings in the spring and fall terms; regular communication between Liaison Librarians and Library Representatives occurs via email. The current Library Representative for Computer Science is Robson De Grande, Stephen Anco is the representative for Mathematics & Statistics.

2.0 Teaching and Learning

Managing information effectively is a key competency in Brock's Undergraduate Degree Level Expectations. The information literate student is one who is able to access information efficiently, critically assess it, assimilate and synthesize it effectively.

Liaison Librarians Tim Ribaric, MLIS, MSC and Ian Gordon, Hon BSc, MLIS, MEd, are available to work collaboratively with faculty to address graduate degree-level expectations, students' unique information requirements, competencies and research needs.

2.1 Online Learning Support

The liaison librarian provides online support in the form of the Library Research Guides, one-on-one research consultations by phone, live chat and email, and customized research guides. General library help and support is also available on the library website.

The Library Research Guide for the Computer Science and Mathematics & Statistics program is an online guide for students that includes recommended databases, videos and tutorials for finding articles, search tips, writing and citing help and more.

2.2 Consultations with Liaison Librarian

Computer Science students are referred to the Liaison Librarian for individual consultations by faculty, Library staff at the Ask Us Desk and fellow students in the program who have benefited from consultations.

3.0 Collections

The university has made a significant investment in the Library's Acquisitions Budget since 2016. The full impact of this investment is only starting to be felt in the acquisition of books/ebooks, digital collections, databases and electronic journals.

3.1 The Collection

The library supports graduate research with subscriptions to licensed and open access databases including a selective list:

- Association of Computing Machine Digital Library (ACM)
- MathSciNet (AMS)
- CiteSeerX
- Web of Science Core Collection
- IEEE Xplore Digital Library
- ArXiv.org e-Print Archive
- DOAG (Directino of Open Access Journals)
- ProQuest Dissertations and Theses Global
- Google Scholar
- Brock Digital Repository

The Library offers an Interlibrary Loan (ILL) service at no cost to Brock students, faculty and staff for materials that we do not currently own.

3.2 Library Acquisitions

The Liaison Librarians manages a budget for books (print & electronic) and other materials that do not involve an annual fee, and makes recommendations for new subscription materials including ebook packages, journal subscriptions, databases, and other relevant material. These decisions are best informed by consultation with graduate students, lecturers, and faculty.

4.0 Services and Spaces

4.1 Physical Services

The Brock University Library includes the James A. Gibson Library main collection, the Archives and Special Collections, the Map, Data and GIS Library, and a Makerspace. The main entrance to the University Library is located at the Matheson Learning Commons along with A-Z Learning Services and Career Education Services. The Learning Commons offers opportunities for students to collaborate with their peers, exchange ideas, and find support for their academic and career pursuits. The Library's Makerspace offers access to new and emerging technologies (including 3D printers/scanners, robotics kits, audio/video editing tools, etc.). It is designed to support the teaching, learning, and research objectives of the University by providing an open collaborative space for students.

The main library space is distributed among the Learning Commons, floors 5-10 of the Schmon Tower with additional staff offices located on the 11th floor. There are over 1,500 spaces for both individual and group study.

The Library provides extended study hours in the Library Learning Commons. This area, with 483 student study spaces, is now open until 2:30 a.m. during the fall and winter semesters from after Reading Week until the end of exams.

The Library continues to improve student study facilities throughout the building. Recent renovations to the sixth floor were designed to provide flexible, collaborative learning spaces.

4.2 Remote Services

Increasingly, library resources are digital whether that be journals and ebook or repositories for primary historical documents. Library staff and librarians manage and maintain access to this vast array of subscription digital resources for both on- and off-campus use. The library website offers direct access to an extensive number of online journals and e-books, image, video and sound databases, primary archival repositories as well as numeric and statistical resources. Resources not owned by the University Library can be requested from other Canadian libraries through the Library's Interlibrary Loan Service. There is also online help via our Ask a Librarian service that provides students with research help though a chat portal on the Library's website.

Library Reserves, traditionally a print-based, physical collection of course readings, has recently undergone fundamental changes. Newly purchased software, along with changes in copyright legislation related to education, allow the vast majority of course readings to be made available electronically via Sakai. The Library now plays a central role providing faculty with support to locate, scan and provide

(and where necessary pay for) copyright clearance for course readings to the extent that course-pack texts increasingly unnecessary.

Student Access to Expertise

Personnel (FTE)	**2013-2014**	**2014-2015**	**2015-2016**
Librarians	21	20	19
Support Staff	37.1	30.3	29
Reference Questions Answered			
In person, online, and in librarian consultations	22,833	19,902	11,331
Sessions Taught by Librarians			
# sessions	326	342	219
# students	13,920	14,411	7775

Peer Comparators

Computer Science has identified comparator programs at Guelph University, Memorial University, UOIT, University of Windsor, and University of Lethbridge. The table below shows expenditure data (delayed by 2 years) for Brock and the comparator institutions. Data from Canadian Association of Research Libraries (CARL).

Brock Library and Comparator Libraries

	Brock	Median CARL Institution	Guelph	Ryerson	UOIT
Student FTE (2016-17)	17,216	28,020	21,813	33,694	8,929
Librarians	19	40	31	31	8
Students per Librarian	906.1	700.5	703.6	1086.9	1,116.1
Monograph Expenditure	$756,287	$1,363,117	$1,363,117	$730,059	$45,569
Journals/Database Expenditure	$3,185,476	$8,811,389	$5,763,233	$4,471,387	$1,929,015
Total Acquisitions Expenditure	$4,069,260	$10,772,038	$7,952,684	$5,220,689	$2,011,087
Acquisitions Expenditure per Student	$236.36	$384.44	$364.85	$154.94	$225.23

Note: No data available for Lethbridge

SOURCE: CARL (data not yet public) and OCUL

Appendix H

Ph.D. Programs in Ontario

Ph.D. degree titles in Ontario – mathematics, computer science and related areas

Source: www.universitystudy.ca

There are about 70 PhD degrees in computer science, mathematics, statistics and related areas in Ontario. They fall into following categories.

Degrees with Computer Science or Computing in the title:

- *PhD in Computer Science – 10* places: Carleton, McMaster, Ryerson, Ottawa, Toronto, Waterloo, Windsor, Western, Royal Military College, Ontario Tech (Waterloo also has *PhD in Computer Science - Quantum Information)*
- *PhD Computational Sciences* - Guelph
- *PhD in Computing* - Queen's

Other degrees related to computer science and information processing:

- *PhD in Information Technology* Carleton
- *PhD in Information,* Toronto,
- *PhD Bioinformatics* University of Guelph,
- *PhD Modelling and Computational Science, UOIT*

The degrees with mathematics or statistics in the title:

- *PhD in Mathematics and Statistics* – 6 places: Carleton, Queen's, Ottawa, Windsor, York, Guelph
- *PhD in Mathematics* – 5 places: Toronto, Windsor, Western, McMaster, Royal Military College
- *PhD in Pure Mathematics* - Waterloo
- *PhD in Statistics* – 4 places: McMaster, Toronto, Waterloo, Western (Wareloo also has *PhD in Statistics-Biostatistics)*
- *PhD in Applied Mathematics* – 2 places: Waterloo and Western (note: Waterloo has two specializations in addition to general degree, *PhD in Applied Mathematics-Quantum Information*, *PhD in Applied Mathematics – Water*)
- *PhD in Mathematical and Statistical Modelling* - Wilfrid Laurier
- *PhD in Mathematical Modelling and Methods* - Ryerson

Other degrees related to mathematics and statistics

- *PhD in Combinatorics and Optimization* – Waterloo (they also have *PhD in Combinatorics and Optimization - Quantum Information*)
- *PhD in Epidemiology and Biostatistics* - Western
- *PhD in Mathematics and Engineering* - Queen's
- *PhD in Actuarial Science* - Waterloo

Computer and software engineering degrees:

- *PhD in Electrical and Computer Engineering* – 12 places: Carleton, Lakehead, McMaster, Waterloo, Queen's, Ryerson, Ottawa, Toronto, Waterloo, Western, York, Ontario Tech
- *PhD in Computer Engineering* - Royal Military College
- *PhD in Software Engineering* - McMaster, Royal Military College

As this list shows, the vast majority of PhD degrees are in a single discipline. There are not too many degrees with an interdisciplinary name which would say “Discipline A and Discipline B”. The only examples (excluding “mathematics and statistics” and “electrical and computer engineering”) would be *PhD in Mathematics and Engineering or PhD in Epidemiology and Biostatistics.*

There is no single example of a general degree combining computational and mathematical sciences explicitly in the name, and none combining computing, mathematics, and statistics. There is a degree in *Mathematical and Statistical Modelling* at Wilfrid Laurier, but id does not include computing. Somewhat similar to it is *PhD in Mathematical Modelling and Methods* (Ryerson) but again, it does not mention computing.

There are only two degrees with the word *computing/computational, PhD* in *Computing* (Queen’s) and *PhD in Computational Sciences* (Guelph). These do not include mathematics or statistics.

Four Year Report (2021)

Applied Disability Studies
Graduate Programs
(reviewed 2016/17)

A. Summary of Review

This review was conducted under the terms and conditions of the IQAP approved by Senate on May 25, 2016.

1. The academic programs offered by the Department of Applied Disability Studies which were examined as part of the review were:

   Master of Arts in Applied Disability Studies
   Master of Applied Disability Studies
   Graduate Diploma in Applied Disability Studies

2. The Review Committee consisted of two external reviewers: Lisa Serbin (Concordia University) and Raymond Miltenberger (South Florida University) and an internal reviewer, Colleen Hood (Brock University).

3. The site visit occurred on March 12-14, 2017.

4. The Final Assessment Report was approved by Senate on November 8, 2017.

5. The reviewers assigned the programs the following outcome categories:

Programs	Excellent Quality	Good Quality	Good Quality with Concerns	Non-Viable
Master of Arts in Applied Disability Studies Stream 1: MA/ABA Stream 2: MA without ABA	X		X (With concerns related to program breadth)	
Master of Applied Disability Studies (MADS) Stream 1: MADS/ABA Stream 2: MADS without ABA	X		X (With concerns related to cohort issues, mentor/advising; quality of PT instructors; program breadth)	
Graduate Diploma in Applied Disability Studies	X			

6. The next review of the graduate programs in the Department of Applied Disability Studies will be in 2024/25.

B. Recommendations

Recommendation #1

Review degree and department title to more closely address the focus of the program (ABA) (particularly diploma).

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and under consideration by the Department (please note that the Centre became the Department of Applied Disability Studies as of July 1, 2017).

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	Year Action Started	Year Action Completed
Action #1 Name Change for Department	17/18	HOLD
Action #2 Degree and Diploma Name Changes for ABA Program	17/18	HOLD

Explanation of Actions Taken, Status and Results:

We voted on the name change at our June retreat in 2017. We decided to defer the name change to allow new faculty to participate. The FOSS dean agreed with our delay. We re-opened discussion at the June 2019 retreat. It was decided to wait until we see if our new programs (ABA.D., ABA PhD, MA and PhD in Clinical Psychology, revised General program) are approved before deciding on a name that will capture the breath of programs in our dept. We decided at June 2020 retreat to continue to wait until status of Doctoral Programs is determined, and with consideration of the major modification to the "general" program described below.

Similar to the department name change, we have a proposed set of degree names to help with differentiation and alignment with the doctoral programs if they are approved. We believe that bringing all of the changes to ARC/Senate together and launching all approved changes at once will be more cohesive from a marketing/brand strategy perspective.

Following through with this recommendation is part of the Department's workplan and the discussions relating to the change have been fruitful in completing other recommendations.

Recommendation #2

Review the no-ABA programs to determine breadth of program.

ARC Disposition of the Recommendation
ARC considers the recommendation to review the no-ABA programs to be accepted and under consideration by the Department.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	**Year Action Started**	**Year Action Completed**
Action #1 Differentiate Degree in Course Calendar.	17/18	18/19
Action #2 Promote ADS program directly	17/18	18/19
Action #3 Develop ADS Program Committee	18/19	18/19

Explanation of Actions Taken, Status and Results:

The non-ABA MA and MADS program were undersubscribed at the time of the review and there was a need to revisit the breadth of the program. We took some concrete steps to improve the calendar descriptions and engage in targeted marketing. We also created an ABA program committee which made the difficult decision to not accept students into the non-ABA stream of the program in 2019 and 2020. During that time considerable work was done to review the ADS (general) programs internally, including seeking input from community advisory committee members. A major modification was approved by ARC and Senate in Fall of 2020, and we are delighted to be launching a new specialization for both MADS and MA (full-time only) in 2021 called Leadership, Diversity, Community and Culture (LDCC) to replace our previous ADS (general) MA and MADS. This program modification also supports the expanded offerings in recommendation #3. Recommendation # 2 is considered complete, though ongoing work with CPI on mapping and program outcomes may lead to further refinements.

Recommendation #3

Increase offerings in the no-ABA programs.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and under consideration by the Department.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	Year Action Started	Year Action Completed
Action #1 Explore offerings outside of ADS	17/18	18/19
Action #2 Approach other departments	17/18	19/21
Action #3 Create ADS Special Interest Group on Campus	18/19	Ongoing

Explanation of Actions Taken, Status and Results:

As described in response to recommendation #2, ADS had reviewed the General degrees (MA and MADS) to consider their breadth and foci. This review led us to excute several actions to expand the offerings for the ADS (Gen) program within our department. These actions included developing new courses, revising degree requirements, and changing the programs from default general degrees to a new MA and MADS specialization in Leadership, Diversity, Community and Culture. The requisite major program modification was approved by ARC and Senate. These new programs are on track for admissions for 2021/22 academic year, and are viable based on accepted offers.

In addition to work done within the department, considerable work was done to explore relevant course offerings outside of ADS, including discussing possible synergies with other departments within and outside of FOSS. We initiated discussions with the Graduate Associate Dean in the Goodman School of Business regarding the new Multidisciplinary Master's in Management SOI and proposed creating a specialization in "Applied Disability Studies." We and our community advisory committee agree that there are many disability service managers who would be interested in such a program as well as Management students who could focus on a career in

disability services. The Associate Dean was supportive of these conversations and the MIMM SOI was approved by Senate in December 2020, with further work to be done on the program brief. ADS lent support to that proposal and some additional courses were added to our calendar in service of developing this interdisciplinary program.

We continue to provide continuing education events for community professionals including many of our alumni now working in the field. Our students and faculty are also involved in these events. Brock students and faculty are welcome to attend our free colloquia intended for non-professional community members such as persons with disabilities and their caregivers. Dr. Nirbhay Singh, from Augusta U., USA, gave two colloquia on Mindfulness in 2019, one directed to academics and students and one for caregivers of persons with disabilities. At the same caregiver event, Mr. Mike Lake, MP Edmonton-Wetaskiwin, spoke of his experiences raising a child with autism. In April 2020, Dr. Maria Valdovinos, Drake U., USA, gave a virtual workshop and a keynote on the use of psychotropic medications with persons who have intellectual and developmental disabilities. In a few months, Dr. Clauda Drossel will be providing a community workshop on brain health and physical health and its relationship to ability level and health in later life. We have a colloquium on April 1, 2021, featuring a group of self-advocates with intellectual disabilities and faculty involved in community engaged scholarship and participatory action research. We also offer ongoing continuing education events to community professionals who supervise our students in their practicum placements. We have encouraged our faculty to join the Lifespan Developmental Research Centre and participate in its educational events, along with their students. We are pleased with the progress made on this recommendation and consider many of the activities to be complete, though we will continue to embrace new opportunities to collaborate with other departments, and to provide internal and community events related to applied disability studies. We feel we now have laid the groundwork to establish an inclusive ADS Special Interest Group on campus

Recommendation #4

Examine strategies related to increasing sense of community in off-campus cohorts.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and under consideration by the Department.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	Year Action Started	Year Action Completed
Action #1 Survey students	17/18	18/19
Action #2 Examine feasibility of expanded offerings	17/18	18/19
Action #3 Trial expanded offerings	18/19	19/20

Explanation of Actions Taken, Status and Results:

We created and implemented a student survey to assess the interest in meetings/gatherings to create a sense of community in both on and off campus students. We have continued to survey our students. We examined the feasibility of expanding activities to offer workshops and webinars at other times of the year to all students and created a plan to make different opportunities available at different times to meet student availability. We have offered students access to many presentations carried out by invited speakers as well as faculty and graduate students. We offered a live podcast by a panel of community practitioners about starting up your own clinical practice. We find that students ask for these events, but attendance can be limited. Over the past year we have been engaging our new MA students to consider developing an ADS Student Association in conjunction with the GSA and they are eager to do that. We have offered departmental support to assist them in launching some events that "don't feel like school" to improve engagement. We feel that we have met this recommendation, though the practices that we undertook will remain in place on an ongoing basis.

Recommendation #5

Examine strategies related to supporting sessional instructors.

ARC Disposition of the Recommendation

ARC considers the recommendation to examine strategies to support sessional instructors to be accepted while acknowledging that the provision of resources for additional faculty or staff lies outside the purview of the Committee.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	Year Action Started	Year Action Completed
Action #1 General Orientation and Training for PT Faculty	17/18	18/19
Action #2 Course specific Orientation ABA	17/18	17/18
Action #3 Assess impact	17/18	18/19

Explanation of Actions Taken, Status and Results:

To minimize load on faculty supporting PT instructors, the Chair/GPD provided an initial orientation webinar for all PT instructors related to University and departmental processes, resources for students, academic integrity, Sakai, and student inquiries should be directed. The Chair/GPD has offered a range of supports such as monthly group webinars and/or individual meetings, depending on the number of new PT faculty each term. For each ABA course, instructional teams (all those teaching the course) are introduced after each PT faculty hiring. Full-time faculty provide support/share materials as necessary to support the PT faculty. It is important to note that at the time of our review we had considerable over-reliance on PT instructors. Today we have considerably reduced reliance on part-time faculty, making it much easier to share this load. We are grateful for the on-going support of our Dean and Provost in this regard. We discussed this arrangement in the ABA program committee as well as at Department meetings and faculty are managing well with the current system. These activities are considered completed, and discussions regarding support for part-time faculty are ongoing.

Recommendation #6

Advocate for continuing increases in resources to support the program.

ARC Disposition of the Recommendation
ARC considers the recommendation to advocate for resources to be accepted while acknowledging that the provision of resources lies outside the purview of the Committee.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	Year Action Started	Year Action Completed
Action #1 **Clinic Development**	17/18	19/20
Action #2 **Advocate for Space**	17/18	Ongoing

Explanation of Actions Taken, Status and Results:

We continue to advocate for the relocation of ADS offices, labs, and for space required for the proposed MA and doctoral programs , as well as an expanded clinic. We were involved in discussions about a proposed new building on campus that would house health-related programs. At present we are situated in Thistle (behind the market) and finding and accessing our space is challenging. With our most recent hires, we are short one office, as well as one research lab space, which will need to be addressed before we return to working on Campus post COVID-19.

The ADS clinic is operating in the BRIC building down the road from the main campus. Student training and faculty/student research is underway. The department received funding from the FOSS Dean's Discretionary Fund to hire co-op students from GSB to help us develop a clinic business plan. We have secured more space in our wing of BRIC so that when renos are completed we will no longer be sharing space with a community professional and our wing will be separated from non-ADS activities in the BRIC building. We will continue to advocate for more clinic space as we proceed with developing three new graduate programs.

We consider the activities related to this recommendation to have been completed though we will have to continue to advocate for our space needs related to expansion and growth.

Recommendation #7

Examine carefully the future plans for the Centre in terms of a balance of senior and junior faculty.

ARC Disposition of the Recommendation
ARC considers the recommendation to plan for future faculty renewal to be accepted while acknowledging that the provision of faculty resources lies outside the purview of the Committee.

Implementation Plan (2nd Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2018/2019

Actions Taken	Year Action Started	Year Action Completed
Action #1 Request New Faculty	17/18	19/20
Action #2 Request Additional Space	17/18	ongoing
Action #3 Advocate for additional faculty	17/18	ongoing

Explanation of Actions Taken, Status and Results:

At the time of our review, we had 6 full-time faculty, of which two were tenured (one full-professor and one associate), two were tenure stream, and 2 were limited-term appointments, and we had considerable over-reliance on part-time instructors. At the present time we have 12 full-time faculty, with 5 tenured (one full-professor, and 4 Associate), and 3 tenure stream (one P&T application under review). A third of our positions are limited term, with 3 LTAs, and 1 ILTA, despite ongoing strong enrollment to justify additional tenure stream faculty. We are grateful to our Dean and Associate Dean for their advocacy and to the Provost's office for supporting our substantiated on-going need for additional faculty. We will continue to submit requests for faculty to reduce our reliance on part-time instructors and BUFA overload and will continue to request conversion to tenure stream for our limited term appointments.

The program currently has a better balance of senior, mid-level and junior faculty. Mounting a MA/PhD. Program in Clinical Psychology and the ABA.D and ABA PhD programs would also require new faculty positions from senior to junior. These positions will be built into the Program Proposal Briefs to be submitted to ARC.

Recommendation #8

Support junior faculty as they move towards tenure.

ARC Disposition of the Recommendation
ARC considers the recommendation to reflect current practice within the Department. The Committee acknowledges that workload issues which might impact tenure and promotion are regulated under the Collective Agreement.

Implementation Plan
No further action required.

Recommendation #9

Solicit community/practitioner input on the program.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted and in the process of implementation.

Implementation Plan (2nd Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2018/2019

Actions Taken	**Year Action Started**	**Year Action Completed**
Action #1 Survey Practicum Supervisors Chair	17/18	18/19
Action #2 Plan for Community Partner feedback	17/18	19/20
Action #3 Stakeholder Meeting	17/18	19/20

Explanation of Actions Taken, Status and Results:

Beginning in 2018, we sent out annual surveys to practicum supervisors and students. The results were used to guide changes to practicum course requirements (e.g., number of practicum tasks, flexibility in tasks), as well as to guide additional professional development for community-based practicum supervisors. Our practice has evolved from a full day workshop in September and a full-day workshop in June to a two-part webinar series on supervision (Fall and Winter) and an in-person full-day supervisor training usually in June (due to the pandemic the 2020 event was, and the 2021 event will be, online). We also increased practicum preparation for students by offering a complementary 2-part webinar series with the same speaker.

We designated a list of stakeholders (agencies and individuals) who were invited to serve as our advisors to help us in strategic planning, career opportunities for our students, and our involvement in the community. We held an advisory committee meeting in April 2019. Advisors attended in person or by video conferencing. This led to very fruitful discussion and input into the development of our new LDCC specialization. The LDCC program was featured recently in Brock News. We were unable to host our second Advisory meeting in May 2020 due to COVID-19 as our stakeholders were occupied with COVID related needs of their service recipients and staff teams. We hope to host an online meeting in Spring of 2021.

Though we consider the activities completed for the purpose of reporting, it is important to note that these activities have become part of our regular operations.

Recommendation #10

Review external communication for prospective students.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted and in the process of implementation.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2017/2018

Actions Taken	**Year Action Started**	**Year Action Completed**
Action #1 Set up a more formal system for tracking prospective student inquiries	17/18	18/19
Action #2 Porting of the website to the new platform	17/18	17/18
Action #3 Review website and provide suggested revisions	17/18	19/20
Action #4 Increase communications with MA students about TA applications.	17/18	19/20
Action #5 Discuss the TA situation with Sr. Admin	17/18	19/20

Explanation of Actions Taken, Status and Results:

In Sep. 2017, we set up a more formal system for tracking prospective student inquiries and these inquiries are being actively inputted on an ongoing basis. Chair/GPD, faculty, admin, and Grad studies have been asked to copy Dept. email ads@brocku.ca on initial responses to inquiries by prospective students to ADS so that these can be tracked. Also, a bank of responses to FAQs has been generated and is reviewed annually. Our website was ported to Wordpress and has been reviewed by faculty .It is updated frequently by our admin assistant. A new website committee was struck in 2020 F al which included faculty and students with the mandate to revisit the current website and expand the information being offered, as well as enhance

useability and ease of navigation. Our department admin has been working with staff from FOSS, Marketing and Communications, and FGS to streamline our communications.

Though we considered these activities complete in 2019/2020, issues relating to our students graduate assistant funding persisted in the 20/21 academic year. We have tried several different approaches including instructing incoming and continuing MA students to apply for TAships within and outside of ADS, providing MA profiles to all relevant departments for incoming MA students to alert those ranking students of these students' qualifications and consideration for TA ships. ADS can only control the TA allocation in our department and when relevant (e.g., student transfers from MADS to MA), we prioritize our incoming MA students to ensure that our funding responsibilities are met. Until recently, some funds to support graduate assistantships for a few students who do not get TAships were included in the ADS budget, though TAships are preferred for well-rounded graduate training. We have discussed the TA situation with Sr. Admin., the Dean of FOSS, FOSS Associate Deans (Graduate and Undergraduate), and Dean of FGS to alert them to the situation.

The Faculty of Social Science Dean and Associate Dean of (FOSS Graduate) continue to encourage other Faculty of Social Sciences departments to prioritize our qualified MA-1 applicants for TA positions in their undergraduate courses. Each year we create profiles for and with each incoming ADS MA student to indicate the student's major and minors and which courses they appear eligible to TA in each relevant dept. MA-1's are assumed to apply for all TA positions, but we send profiles and alert other depts. of good matches between their TA positions and our students. We will also send the profiles to the FOSS Associate Dean who has helped find TA positions for our students. We will notify the Associate Dean which of our students failed to get a TAship so that the Associate Dean can follow up with the depts. in question or find alternative research assistant positions for these students. Issues with TA funding resulted in a decrease in our 21/22 targets for MA students below what was requested by faculty. We are required to justify any increase in targets by providing information on how TA funding allocation will be achieved, although we have no control on hiring in other depts. Given budgetary reductions for the 21/22 fiscal year and some likely decreases in TAships across the University, we will continue to work with Sr. Admin to creatively solve these issues.

Recommendation #11

In response to changing demographic of incoming students (i.e., more full-time students and more students coming directly from undergrad studies), expand full-time program offerings and structure.

ARC Disposition of the Recommendation

ARC considers the recommendation to consider how the full-time program might expand in the future to be accepted, while acknowledging that the provision of the necessary resources for this to be implemented lies outside the purview of the Committee.

Implementation Plan (2nd Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Social Sciences to report by the end of academic year 2018/2019

Actions Taken	Year Action Started	Year Action Completed
Action #1 Continue to advocate for resources to expand our admission targets for full-time students.	17/18	19/20

Explanation of Actions Taken, Status and Results:

We have successfully advocated for new faculty. In 2018, we hired three new 3-year LTAs and took 18 more FT MADS students. In 2019, we hired one Tenure Stream (Assistant Professor) and one ILTA (2 year contract) and we agreed to take 18 more PT MADS students plus continue to take another cohort of 18 FT MADS. In 2020, we were approved to hire a new 3-year LTA and renew the ILTA for 2 years. However, given the demographics of our dept., we will have a spate of sabbaticals over the next few years (3 faculty will be on sabbatical in 21/22) as well as parental leaves (one faculty in 20-21). The ILTA will cover some of the courses normally taught by faculty on sabbatical, but we still rely heavily on part-time instructors (who are not easy to find to teach our graduate ABA courses because of external credentialling requirements). Nonetheless, we increased our FT admissions targets to 60 in 20/21. We are carefully watching our applications for 21/22 and will approach the Dean for additional faculty resources if there are sufficient qualified applicants to expand our offerings. Recently, two 3 -year LTA's were approved for a 3-year renewal.

C. Unit Summative Analysis and Evaluation

1. To what extent has the Unit achieved the improvements suggested by the reviewers?

   We feel that we have achieved and benefitted from the improvements suggested by the reviewers as they were closely aligned with our own desires for continued quality improvement.

2. What overall impact has it had on the Unit's programs?

   We feel that the review has helped to substantiate recognized needs in the department and has helped us and our Dean to continue to advocate for necessary resources to support our very productive department. As this was our first review as a centre (now department), it was a huge undertaking and the benefit of that was that we learned many things about Brock processes and systems as we went through the self-study and review process.

3. Is the Unit adopting a process of continuous quality improvement for its programs?

The unit was already committed to quality improvement, as we began as a cost-recovery program, we were well attuned to quality metrics and had been strongly advocating for program enhancements to improve quality. Since the review, we have incorporated many new processes into our daily operating procedures. We have also met with CPI as a new team to refine our Program Learning Outcomes and to revisit our curriculum mapping given changes to our ABA curriculum relating to accreditation requirements, our new LDCC program, and proposed new graduate program developments in ABA and clinical psychology.

4. How well do the programs now align with Brock University strategic priorities?

Our programs fulfill key elements of the University's mission statement.
Feedback from students and the our graduates' "pass rate" for first time writers of the BCBA professional examination is exemplary and well above the examination mean. This outcome demonstrates our provision of "professional education of the highest quality"(p.11). Several Brock News and FOSS Newsletter features on our students' and faculty members' research, awards, and community engagement have demonstrated the degree to which ADS "enhance[s] Brock's growing reputation for excellence in teaching, research, creativity and innovation" (p. 11) and provides learning experiences focused on training students to become "educated and engaged citizens in local and global communities" (p. 11). Many students in our programs and graduates from our programs are clinicians supporting people with and without disabilities and other underserved populations. Some are business owners, some hold leadership positions in public agencies and private businesses focused on "enhance[ing] the economic, social, cultural and intellectual lives" (p. 11) of surrounding local, national, and international communities, as well as "contribute to the well-being and betterment of society in the 21st century" (p. 11). Our deparment's vision "to be an internationally recognized, preeminent academic program that contributes to the betterment of the lives of people in our community and beyond with a focus on persons with disabilities and underserved populations." speaks directly to the University's mission as well.

The ADS programs were well-aligned with Brock's strategic priorities before the review, but we believe the enhancements made strengthen that alignment.

We offer "a transformational and accessible academic and university experience" in our ADS courses that include full-time, part-time; weekday and weekend in-person course offerings; synchronous and asynchronous on-line offerings; and experiential learning opportunities with community practitioners. Our MA program with its emphasis on research training; our MADS program with emphasis on scientist practitioners and community engaged scholarship; paired with diverse faculty research interests, internal, national and international collaborations, and exemplary research productivity contribute to "build research capacity across the University.

"Enhance the life and vitality of our local region and beyond:" Our ABA specialization has markedly increased the availability of highly trained clinicians to meet increasing clinical needs of vulnerable people in Niagara and across the province. Our cohort-based program is offered on main campus, Hamilton Campus, Toronto, and Ottawa, with many students coming from other provinces and internationally.

"Foster a culture of inclusivity, accessibility, reconciliation and decolonization:" Our department includes diverse faculty and students with representation from several traditionally marginalized groups. We strive to fulfil our mission to educate students who will be agents of change to help better the lives of people in our community and beyond with a focus on persons with disabilities and underserved populations, we strive to contribute knowledge and improve services by conducting cutting edge basic and applied research, and by providing transdisciplinary, quality postgraduate education to the next generation of professionals, researchers and educators, and experienced professionals in the field.

5. How does this review and its results position the programs as the Unit moves into the next review cycle?

   We feel that this review was an excellent learning experience and helped us to articulate and substantiate departmental needs, leading to securing much needed resources. We expect to have ongoing data to inform our next self-study and reveal future opportunities for ongoing improvement as the department grows. We are proud of our accomplishments to date and keenly aware of the work that remains to be done.

   We believe that the new LDCC specialization will enhance the weakest part of the review (our previous ADS-GEN program) through expanded breadth and interdisciplinary collaboration, and through the hard work and effort of the new LDCC program committee. We hope to be able to advocate for faculty specifically for that specialization as almost all coursework is scheduled to be taught on BUFA overload or by part-time faculty.

   We hope that this review and the subsequent improvements will also substantiate the need for program growth to allow us to expand our offerings with new masters and doctoral programs in areas with high demand and high market value such as clinical psychology and Applied Behaviour Analysis to address service gaps in Niagara region and beyond.

D. ARC Final Summary

In final summary of the 2016/17 cyclical academic review of the programs offered by the Department of Applied Disability Studies, ARC has determined the following:

1. The Reviewers' Recommendations have been addressed satisfactorily.

2. The Unit has established a direction for next steps as it prepares for the next review cycle.

3. The Unit has achieved a broad-based, reflective and forward-looking self-assessment.

Request for a Major Modification to an Existing Program

Summary:	
Name of Program being Modified:	MA Psychology
Academic Unit housing the Program:	Department of Psychology
Date modification to become effective:	Immediately
Name of person submitting:	Stephen Emrich, PhD, Graduate Program Director
Email of person submitting:	semrich@brocku.ca
Date of Submission:	15 February, 2020
Short Description of Modification:	Modify admissions requirements to omit the thesis (or equivalent) requirement

Impetus for the Major Modification

Please provide a brief explanation of what led to the program change being made (for example, recommendation from last review, evolution of the discipline, result of monitoring a new program, change in faculty expertise, student demand, efficiencies, etc.) Document the results of Program Committee or Department discussions.

Admission requirements for the Psychology MA currently state: "An empirical Honours thesis, or evidence of similar research is required." We aim to modify this language to remove the thesis requirement. The impetus for this modification stemmed from experiencing issues surrounding the language in previous years. Specifically, there had been confusion among the admissions committee and as well as applicants as to what was considered "evidence of similar research." Moreover, discussion surrounding the requirement for a thesis emerged in light of international discussions surrounding equity, diversity and inclusion initiatives in graduate programs. We believe that the thesis requirement might specifically disadvantage students from underrepresented groups who may not have known the "hidden curriculum" due to limited exposure to academic institutions, or due to the limited availability of thesis positions in some institutions.

Discussions surrounding the proposed modifications to the admissions criteria were held at the Psychology Graduate Committee meeting on September 30th, 2020. Proposed language was circulated to the committee on November 9th, 2020, and sent to the Department for review. The Department discussed the proposed changes and unanimously voted to adopt them at a Department meeting November 13th, 2020.

A Detailed Description of the Proposed Changes

The proposal is the remove the empirical Honours thesis "or evidence of similar research" as a requirement to admission to the MA program. The aim is to replace that requirement with a list of specific courses students are expected to have, as well as evidence of intellectual contributions to research.

Our current admissions requirements are as follows:

Successful completion of an Honours Bachelor's degree, or equivalent, in Psychology or Neuroscience with a minimum average of 78%. Successful applicants typically have achieved an average of at least 80% in each of their last two years of undergraduate study. **An empirical Honours thesis, or evidence of similar research is required.** Scores on the General Graduate Record Examination (GRE) are recommended but not required.

The proposed modified requirements are as follows:

Successful completion of an Honours Bachelor's degree, or equivalent, in Psychology or Neuroscience, **including courses in research methods and statistics,** with a minimum average of 78%**.** Successful applicants typically have achieved an average of at least 80% in each of their last two years of undergraduate study. **Normally, applicants will have completed an Honours thesis (where possible)**. **In the absence of an Honours thesis, applicants must provide evidence of research experience that includes conceptual contributions to a research project (e.g., proposal, paper, poster)**. Scores on the General Graduate Record Examination (GRE) are recommended but not required.

The Pedagogical Rationale for the Proposed Changes

The changes allow for a broader (and potentially more diverse) pool of applicants, while also making explicit what constitutes a suitable substitute for a thesis, and maintaining the standards of admission to the program. Specifically, these modified requirements are as follows:

- **Courses in research methods and statistics**: undergraduate courses in research methods and statistics are typically part of an Honours Degree with a Thesis, as these courses would be required to carry out the necessary research for empirical research. By outlining these specific course requirements, the aim is to ensure that students without a thesis would still have had the necessary training for graduate level statistics, as well as the theoretical understanding of research design and other issues that would be required to successfully carry out an empirical thesis at the MA level.
- **Normally, applicants will have completed an Honours thesis (where possible)**: this language was included to emphasize that a thesis is still an asset for admission to the program. This was included with an eye towards our own undergraduate program – specifically, we wanted to emphasize the pedagogical value of an undergraduate thesis to preparing students for a Masters degree, while leaving open the potential for alternative career trajectories.
- **In the absence of an Honours thesis, applicants must provide evidence of research experience that includes conceptual contributions to a research project (e.g., proposal, paper, poster):** The aim of this addition was to provide clear expectations to potential applicants as to what the admissions committee would be looking for when considering applicants without an undergraduate thesis. Moreover, the aim was to ensure that the potential applicants without a thesis still had sufficient research experience to succeed in the Masters program. Specifically, this clause is aimed at replicating some of the expectations of a thesis which demonstrate a student's intellectual contribution to research (i.e., the written thesis), but recognizing that such contributions may come in many forms.

Impact of Changes on Students

1. Overall, we anticipate an increase in the number of applicants to our MA program, as many programs in Ontario do not have a thesis requirement. Thus, those students who had not thesis as part of their degree may not have considered Brock for the MA program.

2. In particular, we anticipate an increase in the number of applicants from diverse backgrounds, including first-generation students, as these students may be less likely to have taken a "traditional" education path.

3. We anticipate an increase in the overall size of our graduate program, as in the past faculty have indicated a desire to supervise students who did not meet the admissions requirement due to the absence of thesis, or have not been able to find suitable students (perhaps due to the thesis requirement discouraging students from applying).

4. As graduate students will also be Teaching Assistants, undergraduate students will benefit from their TAs having had a more diverse background, both in terms of their academic background, and in terms of potentially increasing the proportion of students (and therefore TAs) from underrepresented groups.

Details of Resource Implications
Describe any new or re-distributed resource implications (human, physical and budgetary) as a result of the proposed change.

The short-term resource implications of the proposed changes are negligible. These modifications may require modifications to the admissions portal, and to department and Faculty websites, outlining the revised requirements. The Administrative Coordinator will also be required to aggregate and process additional applications/offers.

In the medium term: If successful in attracting additional strong applications over the next several years, we anticipate a growth in the number of graduate students in our MA and PhD programs. This will have resource implications for Psychology faculty (research costs, supervision time), our graduate program (grad course offerings, supervisory committee memberships), and administration (student funding from Graduate Studies).

Explain how the revised program would fit with the Brock University Institutional Strategic Plan 2018-2025.

The proposed revisions will help us achieve the goal to offer **a transformational and accessible academic and university experience by** e**xpanding lifelong learning opportunities for students**. Specifically, these changes will facilitate applications from students who may want to apply to a Masters degree despite an alternative academic

trajectory where a thesis may not have been feasible (e.g., students returning to school while working part time).

The proposed revisions will help **to build research capacity within the University** by further growing our graduate program and recruiting the best possible students.

Importantly, the proposed changes will fit within the strategic priority to **foster a culture of inclusivity, accessibility, reconciliation and decolonization**. Namely, by removing barriers to admission to the MA program, we hope that these changes will encourage applications from diverse backgrounds, including from students who have historically been underrepresented in graduate programs at Brock and elsewhere.

Evidence of Consultation with affected academic units

Include the results of any consultation with other units (academic or administrative) that will be impacted by the program discontinuation.

The proposed changes will have no academic or administrative effects on other academic units.

Decanal Comments

Include a letter from the relevant Dean(s) that the proposed major modification is appropriate and in line with the strategic direction of the Faculty. For undergraduate programs, the relevant Dean(s) shall be the Dean(s) of the Faculty within which the program resides. For graduate programs, the appropriate Deans shall be both the Dean of Graduate Studies and the Dean(s) of the relevant Faculty or Faculties.

See attached letters from the Deans.

Appendix 1 – Thesis-Related Admissions Requirements for Brock MA/MSc Programs

Brock Program	MA/MSc program
Applied Health Sciences	No
Applied Linguistics	No
Biological Sciences	No
Biotechnology	No
Chemistry	No
Child and Youth Studies	No
Educational Studies	No
Geography	No
Physics	No
Psychology	Yes

Notes. [1]Based on 2020-2021 Graduate Program Calendar entries.

Appendix 2 – Thesis-Related Admissions Requirements for Research-Oriented Psychology Ma/MSc Programs in Ontario

University	
Brock	Yes
Carleton	Yes
Guelph	Yes
McMaster	No
Ottawa	No
Queen's	No[1]
Ryerson	No
Toronto	No
Waterloo	No
Western	Yes[2]
Wilfrid Laurier	No
York	No

Notes. [1]Thesis or major research project "preferred". [2]Requires "a thesis or independent study that involved data collection and a written submission similar to a thesis project".

Memo

Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
brocku.ca

To: Stephen Emrich, PhD, Graduate Program Director

Copies: Brian Power, Vice-Provost and Associate Vice-President, Academic, and members of Academic Review Committee (ARC)

From: Suzanne Curtin, Vice Provost & Dean Graduate Studies

Date: March 1, 2021

Subject: **Major Modification**

I am writing in support of the Major Modification to Admission Requirements to the Masters' Program submitted by the Department of Psychology. Changing the language for admissions that required an Honours' thesis and broadening it to allow for a range of experiences that demonstrate an understanding of research will help to remove barriers for students who otherwise have the necessary skills and background to succeed in the program.

I am fully supportive and impressed by the Program's desire for a more inclusive admission criterion. This will attract diverse, strong applications, and aligns with the University's Strategic Priority to "Offer a transformational and accessible academic and university experience" and a number of the goals contained within this priority.

Faculty of Social Sciences
Office of the Dean

Niagara Region
1812 Sir Isaac Brock Way
St. Catharines, ON
L2S 3A1 Canada
T 905 688 5550 x3425
F 905 641 5076

brocku.ca

MEMORANDUM

FROM: Ingrid Makus, Dean, Faculty of Social Sciences

TO: Brian Power, Vice-Provost and Associate Vice-President, and members of the Academic Review Committee (ARC)

cc: Stephen Emrich, Graduate Program Director, Psychology
Dawn Zinga, Associate Dean, Graduate Studies & Research

DATE: March 8, 2021

RE: **Major Modification to Admission Requirements to the Pscyhology MA Program**

I am in full support of the major modification to the admission requirements for the MA in Psychology program. It contributes to Faculty and University-wide goals of making graduate education more accessible.

IM/fn

Request for a Major Modification to an Existing Program

Summary:	
Name of Program being Modified:	**BSc (Honours) Biological Sciences**
Academic Unit housing the Program:	**Department of Biological Sciences**
Date modification to become effective:	September 2021
Name of person submitting:	**Dr. Jeff Stuart**
Email of person submitting:	**jstuart@brocku.ca**
Date of Submission:	Feb 7, 2021
Short Description of Modification:	**Addition of co-op option to program**

Impetus for the Major Modification

Please provide a brief explanation of what led to the program change being made (for example, recommendation from last review, evolution of the discipline, result of monitoring a new program, change in faculty expertise, student demand, efficiencies, etc.) Document the results of Program Committee or Department discussions.

The impetus for the program change has come from several sources. Over the past number of years, we have received an increasing number of queries from potential students enquiring if we offer a Co-op in biology. In our programs that currently offer a Co-op stream, we have experienced a steady shift toward the Co-op streams. Students realize that having work experience upon graduation provides a distinct competitive advantage.

We have also received enquiries and support from local employers willing to offer positions to our students. Faculty and staff in the department believe that this program's introduction will complement our existing programs and help recruit robust students to our department. In addition, it will give our students the opportunity to gain practical work experience in areas that will support and strengthen their academic learning.

In early 2020 the department formed a committee to consider introducing a new Biology co-op program. This has resulted in several meetings with the Co-op, Career and Experiential Education Office, concluding that the introduction of this program would be beneficial for both the department and the university. It is believed that the demand exists for this program and that enrolments will increase if the program is introduced. We also think this program will increase ties to community partners, and improve job prospects for our graduates.

A Detailed Description of the Proposed Changes

The Biology Co-op program would follow a similar format to other science co-op programs at Brock that combine academic and work terms over a five-year period. Students would spend two years in an academic setting, where they will acquire the necessary background prior to taking the first work placement. During these two years students will be required to complete several Lab Links modules giving them additional laboratory experience. Lab Links is a program we currently run that provides

technical training, testing, and certification for our students in a wide range of disciplines. During the spring term (year 2) students will complete BIOL 0N01 and 2C01. In the fall (year 3) they will return for another academic term followed by a winter term in placement completing BIOL 0N02 and 2C02. Fall term (year 4) will consists of placement with students completing Biol 0N03 and 2C03. Students will return to campus for the winter term and complete 2.5 credits. During year five students will complete their last five credits.

Biol Co-op Schedule

Year 1

- BIOL 1P91, 1P92 and 1P96
- one credit from APCO 1P00, 1P01, 1P93, ERSC 1P01 and 1P02, PHYS 1P21 or 1P91 (recommended), PHYS 1P22 or 1P92(recommended; see program notes 2 and 3)
- CHEM 1P91 and 1P92
- MATH 1P97 (see program note 1)
- one Humanities context credit or one Social Sciences context credit

Year 2

- BIOL 2P02, 2P03, 2P05 and 2Q04
- one credit from BIOL 2P92, 2P94, 2P96, 2P98
- third ancillary science credit (see program note 4)
- the Humanities context credit or Social Sciences context credit (not taken in year 1)

- SCIE O*(zero)*N90

Spring Summer Session:

- BIOL 0N01 and 2C01

Year 3
Fall term:

- 1.5 BIOL or BCHM credits numbered 2*(alpha)*90 or above (see program notes 5 and 6)
- one elective credits

Winter Term:
BIOL 0N02 and 2C02

Year 4
Fall Term:
BIOL 0N03 and 2C03

Winter Term:

- 1.5 BIOL or BCHM credits numbered 2*(alpha)*90 or above (see program notes 5 and 6)
- one elective credits

Year 5

- Three BIOL credits numbered 3*(alpha)*90 or above
- one BIOL credit numbered 2*(alpha)*90 or above
- one elective credit

The Pedagogical Rationale for the Proposed Changes

Introducing a co-op option in biology will offer students a unique experience to support and broaden their academic learning. Cooperative education is a highly immersive form of experiential learning that can contribute substantially to learning and provide an environment to develop disciplined thinking, improved motivation and ultimately better academic grades. At its core, cooperative education immerses students in a situation that requires them to be a more active participant. It will give highly motivated students the opportunity to integrate school and work learning experiences and thus improve critical thinking and problem-solving skills. It will allow for the acquisition of new skills, refine previously acquired skills, and increase opportunities to work in a collaborative environment enhancing interpersonal and communication skills. A co-op program will promote reflective practices that should nurture an increased interest in biology and give students a better understanding of themselves, available opportunities, and their future goals.

Impact of Changes on Students

We envision the co-op program enhancing the student experience by contributing to the following program learning outcomes, which focus heavily on the development of autonomy and professional capacity:

a) Exercise of initiative, personal responsibility, professionalism, and accountability.
b) Work effectively as an independent individual and a collaborative team member.
c) Manage time effectively and develop personal responsibility and accountability
d) Ability to manage learning within and outside of the discipline, with an increase in disciplined thinking
e) Model behaviour consistent with academic integrity and social responsibility.
f) Make decisions and express opinions on scientific, social, moral, ethical, environmental, and economic grounds based upon sound understanding and judgement within the context of biological sciences.
g) Develop curiosity and understanding of the environment and one's place in the living, material and physical world.
h) Establish the foundation for more advanced learning and future careers in biological sciences and related disciplines (e.g., medicine, dentistry, nursing, chiropractic, physiotherapy, occupational therapy, food science, agriculture, environment, etc.).
i) Appreciate the importance of interdisciplinary science.
j) Value the importance and necessity of ongoing studies to maintain and expand acquired skills.
k) Recognize the role of creativity, inventiveness, and resourcefulness in the development of the sciences.
l) Demonstrate organizational skills for learning, life, and work.
m) Demonstrate and value the ethical conduct expected of a professional scientist.

n) Students will receive lab Links certifications that will enhance their resume.

Details of Resource Implications
Describe any new or re-distributed resource implications (human, physical and budgetary) as a result of the proposed change.

We believe that a Biology Co-op program will require an additional staff member to be hired to support this new Co-op education, and the expansion of Lab Links, which will become entwined with the program. This position would be required to organize appropriate co-op positions in relevant biological sciences companies. The ideal candidate would have to come from a Biology or at least Life Science background.

Explain how the revised program would fit with the Brock University Institutional Strategic Plan 2018-2025.

The introduction of a Biology Co-op program would support Brock University's Institutional Strategic plan in many ways, including:

- to deliver high-quality programs that meet the interest and needs of students and support them to achieve their potential in life.
- Develop programs that **meet labour market and societal needs** by tailoring them to provide students with the skills required for current and potential areas of growth.
- **Increase experiential learning** and high-impact practices across all academic programs.
- To **enhance the life and vitality of our local region** and beyond.

Cooperative learning fosters self-directed, transformational learning that is student-centred and grounded in adult learning theories. It supports students' education and career/life plans by providing them with different learning opportunities that recognize different cognitive styles and often provide personalized experiences that enhance their educational experiences. Participating in cooperative education can be a powerful tool to help meet students' needs and offer them different career possibilities and pathways. Cooperative education can also support students in making meaningful career and community connections that will help them become active, engaged citizens, and enhance the life and vitality of the Niagara region. This cooperative program will benefit local employers by creating a pool of enthusiastic employees, help save on the cost of recruitment, help create a dynamic work environment and increased interaction between local industries and the university. Cooperative learning encourages students to adopt a deeper approach to learning. Students who adopted this deeper approach to learning are more likely than surface learners to report positive perceptions of the teaching environment and thus enhance Brock's reputation within the community.

Evidence of Consultation with affected academic units
Include the results of any consultation with other units (academic or administrative) that will be impacted by the program discontinuation.

See attached Report from Co-op, Career and Experiential Education Office.
Decanal Comments Include a letter from the relevant Dean(s) that the proposed major modification is appropriate and in line with the strategic direction of the Faculty. For undergraduate programs, the relevant Dean(s) shall be the Dean(s) of the Faculty within which the program resides. For graduate programs, the appropriate Deans shall be both the Dean of Graduate Studies and the Dean(s) of the relevant Faculty or Faculties.
See attached communications from the Dean.

Faculty of Mathematics and Science

Brock University
Niagara Region
1812 Sir Isaac Brock Way.
St. Catharines, ON
L2S 3A1 Canada

February 5, 2021

I strongly support the introduction of a biology coop program as this supports many of the strategic priorities described in the Faculty of Mathematics and Science strategic plan. It will offer a new transformational and accessible academic and university experience for our students. It will provide another innovative program delivering a high degree of hands-on experience. It will maintain and indeed enhance our commitment to providing experiential education opportunities.

The new Co-op stream illustrates our commitment to offering alternatives to traditional program and course delivery and will contribute to our commitment to enhance the life and vitality of our local region and beyond.

Warm regards,

Ejaz Ahmed
Dean Faculty of Math & Science

RE: Biological Sciences major mod

S. Ejaz Ahmed <sahmed5@brocku.ca>

Fri 4/2/2021 1:34 PM

To: Brian Power <bpower@brocku.ca>; Jeff Stuart <jstuart@brocku.ca>; Trish Greydanus <pgreydanus@brocku.ca>
Cc: Lynn Wells <lwells@brocku.ca>; Hannah Zhang <hzhang@brocku.ca>; Dorothy Witte <dwitte@brocku.ca>

Hi Brian,

Lynn talked to me on this ma er, CO-OP office will provide the usual support. In-house support will be financed by the Dean's office. We are good to go!

Thanks,
Ejaz

Co-op, Career & Experiential Education

New Co-op Program Proposal

This form is to be used by academic units seeking to introduce a co-op program to its new or existing degree program at either the Undergraduate or Graduate level. The New Co-op Program Proposal is to be completed by the academic unit with a full consultation with the Co-op Education Office prior to submitting the Statement of Intent (SOI).

The purpose of this form is to help assess the viability of the new co-op program based on the following areas:

1. The learning outcome of the proposed new co-op program;
2. The employer demand and student interest of such a co-op program;
3. The lead time and additional resources (both financial and staffing) would be required to undertake and maintain the quality and viability of the new co-op program.

Co-op Program Proposal for the

BSc (Honours) Biological Sciences

Proponent	Academic*	Co-op Education
Name:	Jeff Stuart	Julia Zhu
Title & Unit:	Chair of Department of Biological Sciences	Associate Director, Co-op Education – Co-op, Career and Experiential Education
Email:	jstuart@brocku.ca	jzhu@brocku.ca

*Note: The Academic Proponent will be the support person within the academic unit who will act as an academic support to the Co-op Education Office to assist in decision making, communication and upholding the quality and associated requirements of the co-op program. The Academic Proponent may not necessarily be the same lead as the lead member for the PPB process in the academic unit.

1. Program objective and structure

How does the co-op program contribute to the educational goals of the degree program?

Our program level learning outcomes reflect our focus on experience-based learning and cover the acquisition, understanding, application and communication of knowledge across a wide range of Biological Sciences. Methodology is a core component of this process. A co-op option could complement our exisiting modes of delivering the Biological Sciences program through laboratories, lectures, seminars, assignments and projects.

We envision the co-op program enhancing the student experience by contributing to the following program learning outcomes which focus heavily on the developement of autonomy and professional capacity:

a) Exercise of initiative, personal responsibility, professionalism, and accountability;
b) Working effectively as an individual and with others;
c) Decision-making in complex contexts;
d) Ability to manage learning within and outside of the discipline;
e) Model behaviour consistent with academic integrity and social responsibility;
f) Make decisions and express opinions on scientific, social, moral, ethical, environmental, and economic grounds based upon sound understanding and judgement of Biology;
g) Develop curiosity and understanding of the environment and one's place in the living, material and physical world;
h) Establish the foundation for more advanced learning and future careers in Biological Sciences and related disciplines (eg: medicine, dentistry, nursing, chiropractic, physiotherapy, occupational therapy, food science, agriculture, environment, etc.);
i) Appreciate the importance of interdisciplinary science;
j) Value the importance and necessity of ongoing studies in order to maintain and expand acquired skills;
k) Recognize the role of creativity, inventiveness and resourcefulness in the development of the sciences;
l) Demonstrate organizational skills for learning, life and work;
m) Demonstrate and value the ethical conduct expected of a professional scientist.

Is the proposed program structure able to support a three-semester system with year-round supply of co-op students? YES

Year 1

- BIOL 1P91, 1P92 and 1P96
- one credit from APCO 1P00, 1P01, 1P93, ERSC 1P01 and 1P02, PHYS 1P21 or 1P91 (recommended), PHYS 1P22 or 1P92(recommended; see program notes 2 and 3)
- CHEM 1P91 and 1P92
- MATH 1P97 (see program note 1)
- one Humanities context credit or one Social Sciences context credit

Year 2

- BIOL 2P02, 2P03, 2P05 and 2Q04
- one credit from BIOL 2P92, 2P94, 2P96, 2P98
- third ancillary science credit (see program note 4)
- the Humanities context credit or Social Sciences context credit (not taken in year 1)

- SCIE ON90

Spring Summer Session:

- *BIOL 0N01 and 2C01*

Year 3
Fall term:

- 1.5 BIOL or BCHM credits numbered 2*(alpha)*90 or above (see program notes 5 and 6)
- one elective credits

Winter Term:
BIOL 0N02 and 2C02

Year 4
Fall Term:
BIOL 0N03 and 2C03

Winter Term:

- 1.5 BIOL or BCHM credits numbered 2*(alpha)*90 or above (see program notes 5 and 6)
- one elective credits

Year 5

- Three BIOL credits numbered 3*(alpha)*90 or above
- one BIOL credit numbered 2*(alpha)*90 or above
- one elective credit

Employment market demand

Are there co-op programs of a similar nature offered by other post-secondary institutions that may/will provide competition to this proposed co-op program?

- ☐ YES
- ☐ NO

Is there any projected impact of existing Brock programs on co-op employment for proposed co-op program?

- ☐ YES
- ☐ NO

If "YES", please list programs that will be impacted:

Students from this program may compete with the current BTEC and BCHEM coop programs. However, there should be many areas, for example ecology, microbiology, bioinformatics, and plant physiology, that students from this proposed program can gain employment

Does the academic unit feel there is a strong demand for students with the skill being taught by the proposed degree program?

- ☐ YES
- ☐ NO

Please list examples of positions available in the employment market:

***Laboratory assistant**, laboratory technician – perform lab procedures, develop lab processes, support researchers –*

***Bioinformatician or computational biologist**, - data capture, data analysis, software/program development - Public Health*

***Research assistant**-provide administrative & technical support in a research/science or technical environment; review, edit and write scientific material (grant applications, scientific articles or presentation; standard operating procedures; tabulate format and translate scientific information for the general public*

***Sales representative** – there are many companies involved in the sales of lab equipment, reagents etc. that require a background in science*

***Environmental or science educator** – local conservation authorities, zoos, parks*

***Conservation field staff** -*

***Environmental technician or sampler –** ecosystem restoration*

Plant Pathology and Integrated pest control scout or technician

Agronomist

What is the geographic scope of the employer need?

- ☐ Local
- ☐ Regional
- ☐ Provincial
- ☐ National
- ☐ International

Please list examples of employer prospects from selected location above:
Vineland Research and Innovation Centre
Brock University
Ministry of Agriculture, Food and Rural Affairs
Ministry of Environment, Conservation and Parks
Ministry of Natural Resources and Forestry
Pest Management Centre Ottawa
Harrow Research and Development Centre
Guelph Research and Development Centre
Norgen Biotek
Entomogen
Niagara Peninsula Conservation Authority; Conservation Halton
Niagara Parks commission
Niagara Region
Deep Genomics
Stantec, Hamilton
Charles River Labortories, Laval, QC

2. Resources

Will Co-op Education require additional staffing resources to be hired to support this program?

X YES

Yes, we do believe that a Biology Co-op program will require an additional staff member to be hired to support this new Co-op education. This position would be required in order to locate and organize appropriate co-op positions in the Biology field. We will require Talent Partnership Consultant to develop suitable employer partnerships for Biology co-op program. Depending on the enrolment, we will also require student facing staff to support the one to one coaching through the four and half year of their journey in co-op.

Will Co-op Education require an increase in budget allotment resulted from the proposal?

- ☐ YES
- ☐ NO

If "YES", please provide details:

The introduction of this program may require the addition of a new staff member if the program cannot be accommodated by the current coop staff. Therefore, we would foresee an increase in the budget. This will be offset by Coop program fees.

We would also suggest that Coop students in this program complete the Lab Links program and additional funding may be needed to accommodate these additional students, or they will be required to pay separately for Lab Links.

TO: Chabriol Colebatch, Secretary to the University and General Counsel Brock University

FROM: Professor Drew Dane
Chair, Senate Undergraduate Program Committee

DATE: April 13, 2021

REPORT TO SENATE 689, April 21, 2021

Consent Items

MOVED (DANE/)
THAT the Senate approve the addition of information to Certificate in Pre-Law and Certificate in Ethics to outline eligible applicants to the program.

Submission Rationale: To articulate who is eligible to be admitted to the certificate program. See **Appendix 1**.

MOVED (DANE/)
THAT the Senate approve the draft articulation agreement between Brock University Sport Management and Niagara College Sport Administration.

Submission Rationale: UPC Reviewed the draft agreement and is submitting the draft to Senate prior to the Office of the Provost and Vice-President, Academic proceeds to the next steps with the agreement. See **Appendix 2**.

MOVED (DANE/)
THAT the Senate approve the renumbering of CLAS 2P51 as CLAS 3P10.

Submission Rationale: 2nd year course changed to a 3rd year course to increase 3rd year course offerings, meet needs of department and make students' progression through the history sequence more intuitive. **Appendix 3.**

MOVED (DANE/)
THAT the Senate approve the addition of CLAS 3V20 (also offered as VISA 3V20) 2021-2022: Virtual Study Tour of Italy be added to the course bank as a variable topics course.

Submission Rationale: to reflect faculty member area of expertise, meet needs of department and increase 3rd year course offerings. **Appendix 4.**
MOVED (DANE/)

THAT the Senate approve the addition of CLAS 3V70 (also offered as HIST 3V70) 2021-2022: Digital Modelling in Archaeology be added to the course bank as a variable topics course.

Submission Rationale: to reflect faculty member area of expertise, meet needs of department and increase 3rd year course offerings. **Appendix 5.**

MOVED (DANE/)
THAT the Senate approve the program requirements changes in Year 2 and 3 in the Department of Psychology.

Submission Rationale: We are moving 2 courses from 3Pxx to 2Pxx to allow students more flexibility in degree completion. Changes make it clear that students can use these course to fulfill 2nd or 3rd year requirements. **Appendix 6.**

MOVED (DANE/)
THAT the Senate approve the renumbering of PSYC 3P51 to PSYC 2P92 and as exclusion be added.

Submission Rationale: Re-number to 2P90 to allow students to use it to fulfill their 2nd OR third year requirements, will help with enrolment pressures in 2nd year courses. Changes to course description clarify course content, the note about replacement is required because of the re-numbering. **Appendix 7.**

MOVED (DANE/)
THAT the Senate approve the renumbering of PSYC 3P52 to PSYC 2P90 and an exclusion be added.

Submission Rationale: Re-number to 2P90 to allow students to use it to fulfill their 2nd OR third year requirements, will help with enrolment pressures in 2nd year courses. Changes to course description clarify course content, the note about replacement is required because of the re-numbering. **Appendix 8.**

MOVED (DANE/)
THAT the Senate approve the addition of a course note to PSYC 2P12.

Submission Rationale: The department would like to have the flexibility to offer this course in either format in any given year depending on varying circumstances including who is teaching the course. **Appendix 9.**

MOVED (DANE/)
THAT the Senate approve the revision to course format in PSYC 3P68.

Submission Rationale: The course contact will include only 3 hours lecture (no seminar). This change is being made at the instructor's request. **Appendix 10.**

MOVED (DANE/)
THAT the Senate approve the revision to course format in PSYC 3P72.

Submission Rationale: this change is being made at the request of the instructor. **Appendix 11.**

MOVED (DANE/)
THAT the Senate approve the addition of a course note to PSYC 4P28.

Submission Rationale: The department would like to have the flexibility to offer this course in either format in any given year depending on varying circumstances including who is teaching the course. **Appendix 12.**

MOVED (DANE/)
THAT the Senate approve the revision to course format in PSYC 4P30.

Submission Rationale: The course will be taught in a 3 hour seminar format in the future. This change is at the request of the instructor. **Appendix 13.**

MOVED (DANE/)
THAT the Senate approve the deletion of HIST 3P82 (also offered as ADST 3P82) from the 2021-2022 course bank.

Submission Rationale: This course has not been taught since 2017 and will likely not be taught again as History does not have Faculty with expertise in this area of study. **Appendix 14.**

MOVED (DANE/)
THAT the Senate approve the revisions to Program Requirements in Year 3 and 4 in the Mathematics Co-op and Statistics Co-op programs.

Submission Rationale: To allow flexibility in scheduling. **Appendix 15.**

Consent item for Information

1. Non-credit Certificates

The following non-credit certificates were submitted to UPC for review as per the FHB 3 A.7.6.1:

The Goodman Group – Goodman School of Business

1. Canadian Business for Internationally Trained Professionals
2. Emotional Intelligence (EQ)
3. Non-Profit Leadership Certificate
4. NextGen Municipal Leadership Program

2. University Library Consultation

At the April 5th, 2021 UPC meeting, Mark Robertson (University Librarian) and Andrew Colgoni (Associate University Librarian) presented on the Library Restructuring and invited feedback and questions from the committee. The Committee discussed the importance of cyclical reviews and the library's role in supporting faculty and programming.

3. Department of Engineering Consultation

The committee received a report and presentation on the Faculty of Mathematics and Science proposal for the creation of a new Department of Engineering. This item was recommended for approval; however, the motion for Senate's consideration will be captured in the joint report with the Graduate Studies Committee at a future Senate meeting following the joint meeting as per the Faculty Handbook procedures for creating new academic units, specified in FHB Section 3.C.16.

Certificate in Ethics

The Certificate in Ethics would be of particular interest to teachers, lawyers, social workers, therapists, psycho-therapists, counsellors, people who train volunteers, personnel managers, union organizers and market consultants who wish to add to existing qualifications or to acquire courses which might later be applied to a degree. Studies include the development of skills, such as assessing and evaluating ethical and moral arguments, generating principles of conduct, developing humane practices and policies, empathizing, abstracting the core from the periphery, questioning, accommodating, compromising, and self-presentation. University admission standards apply.

This certificate provides an overview for interested people who do not wish to proceed to a degree or those who have already obtained a degree with a major other than Philosophy. Only under exceptional circumstances and with special permission from the department will applicants who are majoring in Philosophy or already have a degree with a major (or combined major) in Philosophy be admitted.

Ethics (4 credits)

- One of PHIL 1F90, 1F91, 1F93, 1F94, 1F95, 1F96, 1F97
- PHIL 2P09 and 2P95
- two of PHIL 2P12, 2P13, 2P17, 2P99 or 2Q90
- one credit in either the Health Sciences, Social Sciences, or Math & Science

Certificate in Pre-Law

The Certificate in Pre-Law would be of particular interest to teachers, lawyers, social workers, therapists, psycho-therapists, counsellors, people who train volunteers, personnel managers, union organizers and market consultants who wish to add to existing qualifications or to acquire courses which might later be applied to a degree, especially a law degree. Studies include the development of skills, such as assessing and evaluating ethical, moral and legal arguments, generating principles of conduct, developing humane practices and policies, empathizing, abstracting the core from the periphery, questioning, accommodating, compromising, and self-presentation. University admission standards apply.

This certificate provides an overview for interested people who do not wish to proceed to a degree or those who have already obtained a degree with a major other than Philosophy. Only under exceptional circumstances and with special permission from the department will applicants who are majoring in Philosophy or already have a degree with a major (or combined major) in Philosophy be admitted.

Pre-Law (4 Credits)

- One of PHIL 1F90, 1F91, 1F93, 1F94, 1F95, 1F96, 1F97
- PHIL 2P09, 2P25, and 2P95
- one of PHIL 2P12, 2P13, 2P17, 2P99, 2Q90
- one credit in either the Health Sciences, Social Sciences, or Math & Science

Articulation Agreement
Brock Sport Management – Niagara College Sport Administration
Pathway for students from Niagara College

_____.

PARTIES Brock University "Brock"
1812 Sir Isaac Brock Way
St. Catharines, ON L2S 3A1

and

Niagara College "Niagara"
100 Niagara College Boulevard
Welland, ON L3C 7L3

DATE January 15, 2021

BACKGROUND

Brock is a public university operating under the authority of provincial legislation and is located in St. Catharines, Ontario, Canada.

Niagara is a public college operating under the authority of provincial legislation and is located in Welland, Ontario, Canada.

Brock and Niagara (individually, the "Party" and collectively, the "Parties") have agreed to provide a degree pathway for graduates of the Niagara Sport Administration program to Brock in accordance with the terms set out in this agreement ("Agreement") and the course equivalencies set out in Appendix A of this Agreement.

The participating divisions at the respective institutions are the Brock Department of Sport Management, Faculty of Applied Health Science as well as the Niagara Sport Administration, School of Hospitality, Tourism and Sport

1. AGREEMENT

In consideration of the mutual terms and covenants contained in this Agreement, the Parties agree as follows:

1. PROGRAM

1.1. Degree Requirements. Students admitted to Brock Sport Management program are required to complete a minimum of 20.0 credits for a Sport Management degree as described in the Brock University Academic Calendar in

order to obtain their degree. Brock retains sole discretion with respect to all student admission decisions.

1.2. Equivalent Courses.

Brock will award a maximum of 5.0 specified credits towards a Bachelor of Sport Management degree to incoming students from Niagara College 2-year Sport Administration program.

Brock will award a maximum of 7.5 specified credits towards a Bachelor of Sport Management degree to incoming students from Niagara College 3-year Sport Administration program.

The Niagara College courses agreed by both Parties to count towards satisfying these credit requirements are outlined in Appendix A attached hereto.

1.3. Ongoing Review. Brock and Niagara will review and update the list of course equivalents in Appendix A bi-annually in order to recognize program changes at either institution.

1.4. Admission Requirements.

Students may apply for transfer to the Brock portion of the program during Year 2 or Year 3 at Niagara College.

Students with a cumulative average of 75% or over from the Niagara College Sport Administration 2-year program may be admitted and may receive up to 5.0 credits towards a 20.0 credit degree in Sport Management at Brock University.

Students with a cumulative average of 75% or over from Niagara College Sport Administration program (3-year program) may receive up to 7.5 credits toward a 20.0 credit degree in Sport Management at Brock University.

2. TERM & TERMINATION

2.1. Term. This Agreement commences on the Effective Date of July 1, 2021 and shall continue for a three (3) year period until July 1, 2024 ("Term") unless terminated earlier in accordance with this agreement.

2.2. Termination. This Agreement may be terminated as follows:

2.2.1. Termination for cause: The occurrence of any one or more of the following events or conditions will constitute an event of default of a Party, and the other Party may terminate this Agreement immediately:

2.2.1.1. if any representation, warranty, or statement made or given by or on behalf of a Party is determined to have been untrue in any material respect at the time it was made or deemed to be made;

2.2.1.2. if a Party becomes insolvent or files or has filed against it a petition in bankruptcy; or

2.2.1.3. if a Party ceases or threatens to cease to carry on business.

2.2.2. Termination for convenience. Either Party may terminate this Agreement for convenience, and without penalty, upon providing one (1) year written notice to the other party at any time during the Term.

2.2.3. Termination by both Parties. This Agreement may be terminated upon written agreement of both parties.

2.3. Consequences of termination. Termination of this Agreement will not relieve either Party from any obligations accrued but unsatisfied prior to such termination and unless the Parties otherwise agree in writing, the Parties will immediately update their students and any relevant promotional material regarding the subject matter of this Agreement accordingly. In all cases of suspension, amendment or termination, any active students will have the opportunity to complete or withdraw from the Program.

3. CONFIDENTIALITY OBLIGATIONS

3.1. Definition of Confidential Information. "Confidential Information" will include any and all information of a confidential or proprietary nature which is disclosed during the Term by Brock University to Niagara College or by Niagara College to Brock University, and is identified by the Party that discloses the Confidential Information (the “Disclosing Party”) as confidential, either in writing or orally, or should reasonably be known to be confidential given the nature of the information and the circumstances in which it was furnished. For further clarity, "Confidential Information" will include any recorded information about an identifiable individual. Confidential Information does not include information that: (a) is or becomes generally known to the public through no act on the part of the Party that receives the Confidential Information (the “Recipient”); (b) is furnished or made known to the Recipient on a non-confidential basis by a third party who has a lawful right to disclose such information; or (c) is required by law or court order to be disclosed, but only to the extent of such required disclosure and provided that the Disclosing Party is first given notice of such required disclosure and an opportunity to contest such required disclosure.

3.2. Use. During the Term, the Recipient may have access to Confidential Information. The Recipient will use the Confidential Information solely for the purpose of fulfilling the Recipient’s obligations under this Agreement.

3.3. Security. The Recipient will protect the Confidential Information with the same degree of care as the Recipient utilizes for its own similar confidential or non-public information, but in no event with less than a reasonable degree of care.

3.4. Disclosure. During the Term and following expiry or termination of the Agreement, neither the Recipient, nor any person acting on behalf of the Recipient will disclose any Confidential Information to any third party, including any governmental authority, without the express written consent of the Disclosing Party, unless otherwise required by law. The Recipient will restrict access to Confidential Information to those individuals who need to have access in order to fulfil the obligations under this Agreement.

3.5. Return/Destruction. The Recipient agrees that upon the conclusion of this Agreement, or earlier if requested by the Disclosing Party, the Recipient will promptly return to the Disclosing Party all Confidential Information in the Recipient's possession and that the Recipient will delete all such information from all of its electronic, digital or similar document storage systems.

3.6. Breach. The Recipient agrees to promptly notify the Disclosing Party in the event of any actual, potential or threatened breach of any obligations under this section and will take all necessary and appropriate actions to restrain any and all use or further continuing use or disclosure of such Confidential Information.

3.7. Survival. This section will survive the expiration and/or termination of this Agreement for the maximum period provided by law.

4. FREEDOM OF INFORMATION

4.1. Niagara College acknowledges that Brock is subject to the requirements of the Freedom of Information and Protection of Privacy Act, R.S.O. 1990, c. F.31 ("FIPPA").

4.2. Niagara College agrees to (i) treat all Personal Information (as such term is defined in FIPPA) received by it in connection with the Agreement as required by FIPPA; and (ii) be responsible to Brock for any breach of FIPPA by it or its directors, officers and employees relating to such Personal Information. Obligations in this section shall survive any termination of this Agreement.

4.3. Each Party will:

4.3.1. provide all necessary assistance and cooperation as reasonably requested by the other to enable that Party to comply with its obligations under FIPPA;

4.3.2. where they relate to the other Party, to transfer to the other all requests for information relating to this Agreement that it receives as soon as practicable; and

4.3.3. co-operate in the provision of information which is in its possession or control in the form that the affected Party requires as soon as practicable of the affected Party's request for such information.

5. GENERAL

5.1. Entire agreement and amendment. This Agreement represents the entire agreement between the Parties with regard to the subject matter of this Agreement and supersedes any previous understandings, commitments or agreements, whether written or oral. Any amendment to this Agreement must be in writing and signed by authorized representatives of both Parties.

5.2. Trademarks. Both parties agree, the other party's name, trademarks, logos or graphic images may only be used on materials, or in electronic format, such as a web presence, with the express written permission of the other party.

5.3. Binding effect. This Agreement is binding upon and will continue to the benefit of the parties and their respective successors, administrators, executors and permitted assigns.

5.4. Severability. If any provision of this Agreement is wholly or partially unenforceable for any reason, all other provisions will continue in full force and effect.

5.5. Counterparts. This Agreement may be executed in one or more counterparts, each of which will be deemed an original, but all of which will constitute one and the same instrument. Delivery by facsimile or by electronic transmission in portable document format (PDF) of an executed counterpart of this Agreement is as effective as delivery of an originally executed counterpart of this Agreement.

5.6. Governing law. This Agreement will be governed and construed in accordance with the laws of the Province of Ontario and the laws of Canada and the Parties submit to the exclusive jurisdiction of the courts of Ontario.

IN WITNESS WHERE OF the Parties have executed this Agreement:

Niagara College

_____ _____

Dr. Fiona Allan Date
Vice President, Academic

_____ _____

Dr. Justin Williams Date
Dean, Business, Hospitality, Tourism and Sport Studies

Brock University

_____ _____

Dr. Lynn Wells Date
Provost and Vice-President, Academic

_____ _____

Dr. Peter Tiidus Date
Dean, Faculty of Applied Health Sciences

APPENDIX A: Transfer credits

RECOMMENDATIONS of Options for Program Transfer Credits

From 2-year Sport Administration diploma based on 75% overall average - 5 credits

SPMA 1P91 Introduction to Sport Management
SPMA 1P92 Understanding Sport Industry Sectors
SPMA 1P94 Professional Engagement for the Sport Industry
SPMA 2P06 Sport Policy
SPMA 2P08 Facility Management
SPMA 2P65 Sport Marketing
SPMA 2P96 Introduction to Sport and the Law
SPMA 2P98 Sport Event Management
SPMA 3P21 Managing Human Resources in Sport Organization
SPMA 3P25 Sponsorship

From 3-year Sport Management diploma based on 75% overall average – 7.5 Brock credits

SPMA 1P91 Introduction to Sport Management
SPMA 1P92 Understanding Sport Industry Sectors
SPMA 1P94 Professional Engagement for the Sport Industry
SPMA 2P06 Sport Policy (BUSN 1268)
SPMA 2P65 Sport Marketing
SPMA 2P96 Introduction to Sport and the Law
SPMA 2P98 Sport Event Management
SPMA 3P21 Managing Human Resources in Sport Organizations
SPMA 3P25 Sponsorship
SPMA 2P08 Facility Management
SPMA 3P02 Sport Management Field Work
SPMA 3P96 Globalization of Sport
1.5 SPMA unspecified 300 level elective

Background Information:

Niagara College - Program Of Instruction

- A 2-year program (terms 1-4)
- An optional 3rd year of the program (terms 5 & 6)

Level: 01 Term: 14 Weeks
BUSN 1180 Introduction to Sport Management N 3.00 42.00
BUSN 1271 Leadership in Sport N 3.00 42.00
COMM 1510 Communication Foundations N 3.00 42.00
MATH 1206 Mathematics of Finance N 3.00 42.00
MICR 1583 Spreadsheet Applications N 3.00 42.00
Completion of additional General Education elective (1 course required)

Level: 02 Term: 14 Weeks
ACCT 1198 Financial Accounting Concepts N 3.00 42.00
BUSN 1252 Negotiations and Law for Sport N 3.00 42.00
BUSN 1268 Governance of Sport Organizations N 3.00 42.00
COMM 1520 Communication Skills for the Emerging Professional N 3.00 42.00
EVMT 1210 Sport Sponsorship N 3.00 42.00
MKTG 1104 Marketing for Sport and Recreation N 3.00 42.00

Level: 03 Term: 14 Weeks
BUSN 1361 Ethics in Sport N 3.00 42.00
HOTL 9680 The Global Economy in Sports N 3.00 42.00
MKTG 1320 Professional Selling I N 3.00 42.00
PERS 1226 Fundamentals of Human Resources N 3.00 42.00
BUSN 1301 Media and Sport N 3.00 42.00
Completion of additional General Education elective (1 course required) 3.00 42.00

Level: 04 Term: 14 Weeks
BUSN 1225 Customer Service N 3.00 48.00
COMM 1530 Industry Reports
EVMT 1325 Event Management
MATH 1310 Statistical Concepts
RECL 1439 Sport Facilities Management
Completion of additional General Education elective (1 course required)

Level: 05 Term: 14 Weeks
PRAC 1200 Work-Integrated Learning Module-Sport Management

Level: 06 Term: 14 Weeks
BUSN 1207 Global Sport Business
BUSN 1380 Contemporary Issues in Sport
ENTR 1360 Entrepreneurial Recreation and Sports
TOUR 1175 Sport Tourism
SOCL 1350 Sociology of Sport
BUSN 1370 Sport Management Research

Brock University, Department of Sport Management – Program of Instruction

SPMA 1P91 Introduction to Sport Management
SPMA 1P92 Understanding Sport Industry Sectors
SPMA 1P94 Professional Engagement for the Sport Industry
SPMA 1P97 Research Design and Evaluation

SPMA 2P00 Analysis of Professional Sport
SPMA 2P06 Sport Policy
SPMA 2P08 Facility Management
SPMA 2P21 Organizational Behaviour in Sport Organizations
SPMA 2P27 Introduction to Sport Finance
SPMA 2P65 Sport Marketing
#SPMA 2P90 The Labour of Sport
SPMA 2P91 Public Relations and Communications for Sport Management
SPMA 2P92 Data Management and Technology for Sport Management
#SPMA 2P95 Masculinities: A Feminist Perspective
SPMA 2P96 Introduction to Sport and the Law
SPMA 2P98 Sport Event Management

SPMA 3P05 Management Concepts in Non-profit Sport Organizations
SPMA 3P07 Quantitative Analysis for Sport Management
SPMA 3P17 Qualitative Analysis for Sport Management
SPMA 3P21 Managing Human Resources in Sport Organizations
#SPMA 3P22 Media and Sport
SPMA 3P25 Sport Sponsorship
SPMA 3P26 Governance in Sport
SPMA 3P27 Advanced Sport Finance
#SPMA 3P55 The Sociology of Professional Wrestling
SPMA 3P92 Intellectual Property and Licencing in Sport
SPMA 3P93 Sport for Development
SPMA 3P94 Information Systems for Sport Analytics
SPMA 3P95 Sport Sales and Promotion
SPMA 3P96 Globalization of Sport
SPMA 3P98 Sport Event Critical Issues Management
SPMA 3P99 Special Studies in Sport Management
SPMA 3V90-3V99 Special Topics in Sport Management

SPMA 4F03 Honours Research Project
SPMA 4F04 Research Proposal
SPMA 4F05 Honours Research Thesis
SPMA 4P08 Sport Management Ethics
SPMA 4P09 Leadership in Sport Management
SPMA 4P10 Innovation and Entrepreneurship in Sport Organizations
SPMA 4P18 Sport and Social Responsibility
SPMA 4P25 Strategic Alliances in Sport Management
SPMA 4P27 Application of Economics to Sport Management
SPMA 4P85 Sport and the Consumer
SPMA 4P86 Legal Drafting and Contract Analysis for Sport Management
SPMA 4P91 Power, Politics and Policy in Sport
SPMA 4P94 Sport Analytics
SPMA 4P95 Advanced Sport Marketing
SPMA 4P96 Negotiation of Deals and Disputes in Sport Organizations
SPMA 4P97Advanced Analysis of the Sport Industry: Hockey
SPMA 4P99 Advanced Special Studies in Sport Management
#SPMA 4Q90 Foundations of Collaboration and Teamwork

SPMA 4V90-4V99
SPMA 3P02 Sport Management Field Work
SPMA 4P92 Sport Management Practicum
SPMA 4P93 Sport for Development Field Experience
SPMA 4P98 Major Games Field Course
SPMA 4F01 Sport Management Internship Project
SPMA 4F02 Sport Management Internship

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: CLAS 3P10 **Crosslisting code(s):** NA

Course title: CLEOPATRA

1. **Proposal for this course revision:**

CLAS 3P10 to be renumbered from 2P51

2. **Explanation for this course revision:**

2nd year course changed to a 3rd year course to increase 3rd year course offerings, meet needs of department and make students' progression through the history sequence more intuitive.

3. Is this course listed as a context credit *(Dean approval required)*?

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

( ) No (●) Yes Identify the course code below:

CLAS 2P51

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Barb Chatwin		bchatwin@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

R. Angus K. Smith
Chair (Print Name)

R. Angus K. Smith
Chair (Signature)

March 17, 2021
Date

Neta Gordon
Dean or Designate (Print Name)

Neta Gordon
Dean or Designate (Signature)

March 17, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

CLAS ~~2P51~~ 3P10
Cleopatra
History, biography, and representation in literature, art and modern media of the most renowned and controversial queen of the ancient world.
Lectures, seminar, 3 hours per week.
Completion of this course will replace previous assigned grade and credit obtained in CLAS 2P51.

CalendarRevisionSubmission

Form C-1 – Course Additions

Form C-1 is to be completed when there is an addition to the course bank. One complete submission for each course. Cross-listed courses are to be submitted by the home/primary Department/Centre.

Course code: CLAS 3V20

Cross-listed course codes (if applicable): VISA 3V20

Course title: 2021-2022: Virtual Study Tour of Italy

Course description:

Archaeological and art historical investigation of Etruscan and Roman Italy. Sites to be visited virtually through synchronous and asynchronous online sessions include Rome, Pompeii, Hadrian's Villa, Cerveteri, and Tarquinia.

Format/Contact hours:

Restriction:

permission of the Instructor.

Pre-requisites:

Co-requisites:

Note:

may be offered on-site, online, or blended. Students may produce models locally using photogrammetry, and laser/structured light scanning

Exclusion:

Please provide responses to the questions below:

1. **Proposal for this course addition:**

CLAS-VISA 3V20 be added to the course bank.

2. **Explanation for this course addition:**

to reflect faculty member area of expertise, meet needs of department and increase 3rd year course offerings.

3. Is this course listed as a context credit?

(●) No ( ) Yes, a Form A – Program Additions/Terminations will be uploaded with the submission.

4. Is this course cross-listed?

( ) No (●) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. **Are additional expenses to be borne by the student (e.g. field trip, materials fees, practicum fees, etc)?**

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended purpose will be uploaded with the submission.

6. Does this addition affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded with this submission.

7. Does this addition affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this addition have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded with the submission.

9. Will this course be delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

( ) No (●) Yes, an ITS/CPI Support Form will be uploaded with this submission

10. Does this course result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) of the split or joined course(s) below:

11. Does this course result from the renumbering of another (current or previously offered) course?

(●) No ( ) Yes (please identify the course code of the current or previously offered that is being renumbered below):

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Barb Chatwin	3575	bchatwin@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

R. Angus K. Smith
Chair (Print Name)

R. Angus K. Smith
Chair (Signature)

March 4, 2021
Date

Neta Gordon
Dean or Designate (Print Name)

Neta Gordon
Dean or Designate(Signature)

March 4, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- ○ No
- ◉ Yes. Please complete the Verification of Consultation form and upload with submission.

James A. Gibson Library
Library Support for New Courses Form

Niagara Region
1812 Sir Isaac
Brock Way
St. Catharines, ON
L2S 3A1

To be completed by the Academic Program

☑ Undergraduate Program Committee ☐ Graduate Studies Committee

Academic Unit: CLASSICS **Course Number:** CLAS-VISA 3V20

Course Title: 2020-2021: VIRTUAL STUDY TOUR OF ITALY

Proposed Calendar Description:

Archaeological and art historical investigation of Etruscan and Roman Italy.
Sites to be visited virtually through synchronous and asynchronous online sessions include Rome, Pompeii, Hadrian's Villa, Cerveteri, and Tarquinia.
Offered online.
Restriction: permission of the Instructor.

To be completed by the Liaison Librarian

Assessment of existing collection (print & online) in areas relevant to this course:

☐ Strong, no budgetary implications
☒ Adequate, minimal budgetary implications beyond current funding allocations
☐ Inadequate, requires additional one time only and/or ongoing additional funding

Comments: Existing collections are sufficient

Budget implications of this proposed course:

☐ Books, e-books, monographic collections, etc.
☐ Reference resources, handbooks, encyclopedias, dictionaries, etc.
☐ Journals, newspapers, serials, databases, etc.
☐ Geospatial maps, data, statistics, GIS, etc.
☐ Special collections, primary resources, etc.

Comments:

☒ The Library can support this proposed course with current funding
☐ The Library can support this proposed course with additional funding
☐ The Library can't support this proposed course

Evelyn Feldman	Evelyn Feldman	March 4, 2021
Liaison Librarian	Signature	Date
R. Angus K Smith	R. Angus K. Smith	MAR 4 2021
Academic Program Library Representative, Chair or Director	Signature	Date

Verification of Consultation Form
for Changes affecting other Faculties/Departments/Centres

This form verifies that we are aware and have engaged in consultation regarding the proposed changes in this submission that affect our respective programs (e.g. additions, deletions, revisions to courses or course components, revision to program requirements that impact a program in another Department/Centre).

Relevant/appropriate evidence regarding this consultation (e.g., confirmation e-mail, memo, letters) is attached.

Reason for consultation (identify addition/deletion/revision as appropriate):
Cross-listing of new course: CLAS 3V20/VISA 3V20

☒ All parties agree to the proposed changes and have updated our UPC submissions to reflect the changes.

☐ Consultation has occurred but changes have not been agreed to by all parties.

I. For changes that cross Departments/Centres within the *same* Faculty:

R. Angus K. Smith

Chair/Director (submitting Dept/Centre)

Shawn Serfas

Chair/Director (affected Dept/Centre) Chair/Director (affected Dept/Centre)
(if multiple Dept/Centres affected, please include all signatures on this form)

Chair/Director (affected Dept/Centre) Chair/Director (affected Dept/Centre)

II. For changes that cross Faculties:

Dean (submitting Faculty)

Dean (affected Faculty)

CalendarRevisionSubmission

Form C-1 – Course Additions

Form C-1 is to be completed when there is an addition to the course bank. One complete submission for each course. Cross-listed courses are to be submitted by the home/primary Department/Centre.

Course code: CLAS 3V70

Cross-listed course codes (if applicable): HIST 3V70

Course title: 2021-2022: Digital Modelling in Archaeology

Course description:

Introduction to 3D modeling of archaeological artifacts, and ethical considerations of utilization. Training in computer applications for processing/analysis of digital models created as part of the Marzamemi Maritime Heritage Project.

Format/Contact hours:

Lectures, seminar, 3 hours per week

Restriction:

permission of the instructor.

Pre-requisites:

Co-requisites:

Note:

may be offered on-site, online, or blended. Students may produce models locally using photogrammetry, and laser/structured light scanning

Exclusion:

Please provide responses to the questions below:

1. **Proposal for this course addition:**

CLAS-HIST 3V70 be added to the course bank.

2. **Explanation for this course addition:**

to reflect faculty member area of expertise, meet needs of department and increase 3rd year course offerings.

3. Is this course listed as a context credit?

(●) No ( ) Yes, a Form A – Program Additions/Terminations will be uploaded with the submission.

4. Is this course cross-listed?

( ) No (●) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. **Are additional expenses to be borne by the student (e.g. field trip, materials fees, practicum fees, etc)?**

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended purpose will be uploaded with the submission.

6. Does this addition affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded with this submission.

7. Does this addition affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this addition have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded with the submission.

9. Will this course be delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

( ) No (●) Yes, an ITS/CPI Support Form will be uploaded with this submission

10. Does this course result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) of the split or joined course(s) below:

11. Does this course result from the renumbering of another (current or previously offered) course?

(●) No ( ) Yes (please identify the course code of the current or previously offered that is being renumbered below):

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Barb Chatwin	3575	bchatwin@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

R. Angus K. Smith
Chair (Print Name)

R. Angus K. Smith
Chair (Signature)

March 4, 2021
Date

Neta Gordon
Dean or Designate (Print Name)

Neta Gordon
Dean or Designate(Signature)

March 4, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- ○ No
- ◉ Yes. Please complete the Verification of Consultation form and upload with submission.

James A. Gibson Library
Library Support for New Courses Form

Niagara Region
1812 Sir Isaac
Brock Way
St. Catharines, ON
L2S 3A1

To be completed by the Academic Program

☑ Undergraduate Program Committee ☐ Graduate Studies Committee

Academic Unit: CLASSICS **Course Number:** CLAS-HIST 3V70

Course Title: 2020-2021 FIELD TO MUSEUM: 3D MODELLING IN ARCHAEOLOGY

Proposed Calendar Description: Introduction to 3D modeling of archaeological artifacts, and ethical considerations with their utilization. Training in computer applications for processing/analysis of digital models created as part of the Marzamemi Maritime Heritage Project. In-person contact allowing production of models locally using photogrammetry, and laser/structured light scanning. Restriction: permission of the Instructor. ~~Prerequisite(s): one of CLAS 2P32, 2P34, 3P22, 3P23, 3P24, 3P25 or permission of the Department.~~

To be completed by the Liaison Librarian

Assessment of existing collection (print & online) in areas relevant to this course:

☐ Strong, no budgetary implications
☑ Adequate, minimal budgetary implications beyond current funding allocations
☐ Inadequate, requires additional one time only and/or ongoing additional funding

Comments:

Budget implications of this proposed course:

☑ Books, e-books, monographic collections, etc.
☐ Reference resources, handbooks, encyclopedias, dictionaries, etc.
☐ Journals, newspapers, serials, databases, etc.
☐ Geospatial maps, data, statistics, GIS, etc.
☐ Special collections, primary resources, etc.

Comments: If the course has a research component, additional ebooks on 3D modelling in an archaeological context may be needed.

☑ The Library can support this proposed course with current funding
☐ The Library can support this proposed course with additional funding
☐ The Library can't support this proposed course

Evelyn Feldman
Liaison Librarian

Evelyn Feldman
Signature

March 4, 2021
Date

R. Angus K. Smith
Academic Program
Library Representative,
Chair or Director

R. Angus K. Smith
Signature

March 4, 2021
Date

Verification of Consultation Form
for Changes affecting other Faculties/Departments/Centres

This form verifies that we are aware and have engaged in consultation regarding the proposed changes in this submission that affect our respective programs (e.g. additions, deletions, revisions to courses or course components, revision to program requirements that impact a program in another Department/Centre).

Relevant/appropriate evidence regarding this consultation (e.g., confirmation e-mail, memo, letters) is attached.

Reason for consultation (identify addition/deletion/revision as appropriate):
Cross-listing of new course: CLAS 3V70/HIST 3V70

☒ All parties agree to the proposed changes and have updated our UPC submissions to reflect the changes.

☐ Consultation has occurred but changes have not been agreed to by all parties.

I. For changes that cross Departments/Centres within the *same* Faculty:

R. Angus K. Smith

Chair/Director (submitting Dept/Centre)

Maureen Lux, History

Chair/Director (affected Dept/Centre) Chair/Director (affected Dept/Centre)
(if multiple Dept/Centres affected, please include all signatures on this form)

Chair/Director (affected Dept/Centre) Chair/Director (affected Dept/Centre)

II. For changes that cross Faculties:

Dean (submitting Faculty)

Dean (affected Faculty)

Calendar Revision Submission

Form B – Program Changes

Form B to be completed when there is a revision to Officers of Instruction, General Information, Program Notes, and/or Program Requirements.

Upload a Word document that includes:

1. A detailed **Proposal** and **Explanation** of the proposed revision to the Program. Provide details if this program impacts other Departments or Admissions requirements.
2. If this is a Major Modification, upload verification of approval through ARC and Senate.
3. Provide the proposed revisions to the calendar by copying the existing web calendar content and highlight new additions and ~~strikethrough~~ deletions.

Program name: Psychology

Brief description of proposed revision(s):

We are moving 2 courses from 3Pxx to 2Pxx to allow students more flexibility in degree completion. Changes make it clear that students can use these course to fulfill 2nd or 3rd year requirements.

Consultation and Approvals

Kirsti van Dorsser

Departmental Designate for Questions

kvandorsser@brocku.ca

Brock E-Mail

Tanya Martini

Chair (Print Name)

Chair (Signature)

March 24, 2021

Date

INGRID MAKUS

Dean or Designate(Print Name)

Dean or Designate (Signature)

March 24, 2021

Date

Verification of Consultation

Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

◉ No ○ Yes. Please complete the Verification of Consultation form and upload with submission.

Program Changes

Comprehensive Stream (Honours only)

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Year 3

- PSYC 3P30 (see program note 4)
- two and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99 (see program note 5)
- two elective credits (see program note 1)

Year 4

- PSYC 4P07 or 4P92
- PSYC 4P08
- two PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99 (see program note 5)
- two elective credits (see program note 1)

Research Stream (Honours only)

Year 1

- PSYC 1F90
- one Humanities context credit

- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Year 3

- PSYC 3F40 and 3P39 (see program notes 2 and 4)
- one and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99
- two elective credits (see program note 1)

Year 4

- PSYC 4F91, 4P92 and 4P93 (see program note 2)
- one PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99 (see program note 3)
- two elective credits (see program note 1)

Comprehensive Stream Co-op (Honours only)

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 0N90, 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49

- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Spring/Summer Sessions:

- PSYC 0N01 and 2C01

Year 3

- PSYC 3P30 (see program note 4)
- two and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99 (see program note 5)
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N02 and 2C02

Year 4

- PSYC 4P07 or 4P92
- PSYC 4P08
- two PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99 (see program note 5)
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N03 and 2C03

Research Stream Co-op (Honours only)

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 0N90, 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Spring/Summer Sessions:

- PSYC 0N01 and 2C01

Year 3

- PSYC 3F40 and 3P39 (see program notes 2 and 4)
- one and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~ 90 or above
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N02 and 2C02

Year 4

- PSYC 4F91, 4P92, and 4P93 (see program note 2)
- one PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99 (see program note 3)
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N03 and 2C03

BA with Major Program

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Year 3

- PSYC 3P30 (see program note 4)
- two and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99
- two elective credits (see program note 1)

Year 4

- One and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 4*(alpha)*99
- one PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99
- PSYC 4P07
- two elective credits (see program note 1)

BA with Major Co-op

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 0N90, 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30

- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99

- one elective credit (see program note 1)

Spring/Summer Sessions:

- PSYC 0N01 and 2C01

Year 3

- PSYC 3P30 (see program note 4)
- two and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N02 and 2C02

Year 4

- One and one-half PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 4*(alpha)*99
- one PSYC credit numbered 3*(alpha)*90 to 4*(alpha)*99
- PSYC 4P07
- two elective credits (see program note 1)

Spring/Summer Sessions:

- PSYC 0N03 and 2C03

Yukon College Degree Completion Program (BA with Major)

For Yukon College students attending Brock in Year Three

Year 3 is now closed

Year 4
(taken at Brock University)

- PSYC 3P30 and 4P07 (see program note 4)
- four PSYC credits numbered 3*(alpha)*00 to 4*(alpha)*99 or elective credits (see program notes 1 and 5)
- one PSYC credit numbered 3(*alpha*)90 to 4(*alpha*)99
- four elective credits (see program note 1)

Pass Program

Year 1

- PSYC 1F90
- one Humanities context credit
- one Sciences context credit
- two elective credits (see program note 1)

Year 2

- PSYC 2F23 and 2P01
- one of PSYC 2P20, 2P35, 2P36, 2P49
- PSYC 2P25 or 2P30
- one ~~and one-half~~ PSYC credit~~s~~ numbered 2*(alpha)*00 to 2*(alpha)*~~9~~89

  one half PSYC credit numbered 2*(alpha)*00 to 2*(alpha)*99
- one elective credit (see program note 1)

Year 3

- Three PSYC credits numbered ~~3~~2*(alpha)*~~00~~90 to 3*(alpha)*99
- two elective credits (see program note 1)

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 2P92 **Crosslisting code(s):**

Course title: Health Psychology

1.**Proposal for this course revision:**

Renumber the course.

2.**Explanation for this course revision:**

Re-number to 2P90 to allow students to use it to fulfill their 2nd OR third year requirements, will help with enrolment pressures in 2nd year courses. Changes to course description clarify course content, the note about replacement is required because of the re-numbering.

3.Is this course listed as a context credit*(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

( ) No (●) Yes Identify the course code below:

PSYC 3P51

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

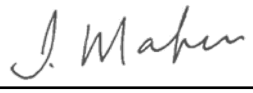
Approvals

Kirsti van Dorsser		kvandorsser@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Tanya Martini
Chair (Print Name)

Chair (Signature)	March 24, 2021
	Date

Ingrid Makus
Dean or Designate (Print Name)



Dean or Designate (Signature)	March 24, 2021
	Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC ~~3P51~~ 2P92

Health Psychology

Introduction to psychological aspects of health and illness. How behaviour, social context and attitudes influence physiological processes and our health. Topics include health promotion, stress, psychoneuroimmunology, health and physical activity, pain and the health care system.

Lectures, seminar, 3 hours per week.

Restriction: open to PSYC (single or combined), NEUR, PHTH majors and PSYC minors until date specified in Registration guide. After that date open to PSYC (single or combined), NEUR, PHTH majors, GHUM, SOSC students and PSYC minors until date specified in Registration guide.

Prerequisite(s): PSYC 1F90.

Completion of this course will replace previous assigned grade and credit obtained in PSYC 3P51.

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 2P90 **Crosslisting code(s):**

Course title: Introduction to Community Psychology

1.**Proposal for this course revision:**

Renumber course, revise course description, restrictions and replacements.

2.**Explanation for this course revision:**

Re-number to 2P90 to allow students to use it to fulfill their 2nd OR third year requirements, will help with enrolment pressures in 2nd year courses. Changes to course description clarify course content, the note about replacement is required because of the re-numbering.

3.Is this course listed as a context credit*(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

( ) No (●) Yes Identify the course code below:

PSYC 3P52

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Kirsti van Dorsser
Departmental Designate for Questions

Ext

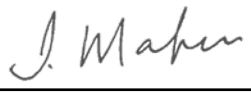
kvandorsser@brocku.ca
Brock E-Mail Address

Tanya Martini
Chair (Print Name)


Chair (Signature)

March 24, 2021
Date

Ingrid Makus
Dean or Designate (Print Name)


Dean or Designate (Signature)

March 24, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC ~~3P52~~ 2P90

Introduction to Community Psychology

Overview of history, approaches and ~~E~~ethical issues ~~and approaches~~ ~~to~~ with psychological research and practice in community settings ~~(e.g.~~ including deinstitutionalization, research with vulnerable communities, Indigenous research~~)~~ , structural interventions, and community empowerment.

Lectures, seminar, 3 hours per week.

Restriction: open to PSYC (single or combined) majors and minors until date specified in Registration guide. ~~Students must have a minimum of 8.0 overall credits or 3.0 PSYC credits above PSYC 1F90~~.

Prerequisite(s): PSYC 1F90; ~~PSYC 2P30~~.

Completion of this course will replace previous assigned grade and credit obtained in PSYC 3P52.

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 2P12 **Crosslisting code(s):**

Course title: Lifespan Development

1. **Proposal for this course revision:**

Add note that course may be offered online or in person.

2. **Explanation for this course revision:**

The department would like to have the flexibility to offer this course in either format in any given year depending on varying circumstances including who is teaching the course. The course has been taught online this year, so I answered yes to # 9 below, but it is not a new modality.

3. Is this course listed as a context credit *(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

( ) No (●) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

(●) No ( ) Yes Identify the course code below:

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

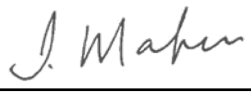
Kirsti van Dorsser	na	kvandorsser@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Tanya Martini
Chair (Print Name)

Chair (Signature)

March 24, 2021
Date

Ingrid Makus
Dean or Designate (Print Name)



Dean or Designate (Signature)

March 24, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC 2P12

Lifespan Development

Introduction to theories and research in human development across the lifespan. Topics include development in physical, perceptual, cognitive, linguistic, social and/or emotional domains.
Lectures, 1.5 hours per week; online activities, 1.5 hours per week.
Restriction: open to PSYC (single or combined), HEAR, NEUR, RECL, SPLS majors and PSYC minors until date specified in Registration guide.
Prerequisite(s): PSYC 1F90.
Note: may be offered on-site or online. Students may not concurrently register in CHYS 2P10. Completion of this course will replace previous assigned grade and credit obtained in CHYS 2F05 and 2P10.

University Educational and Information Technology Services Support for Course Additions/Deletions/Revisions

This two-part form is intended to assess and confirm that adequate technical resources will be available to support the delivery of this course. All UPC submissions are asked to have the first part of this form completed upon submission. Submissions of the course types *Synchronous Conferencing, Blended Learning* or *Fully Online Learning (asynchronous)* are asked to complete both parts and have both parts reviewed by Information Technology Services (ITS) and the Centre for Pedagogical Innovation (CPI).

ACADEMIC UNIT: PSYC	COURSE NUMBER: 2P12
COURSE TITLE: Lifespan Development	PROJECTED ENROLLMENT: 240
PROPOSED CALENDAR DESCRIPTION:	INSTRUCTOR (if applicable): Mondloch

PSYC 2P12 Lifespan Development Introduction to theories and research in human development across the lifespan. Topics include development in physical, perceptual, cognitive, linguistic, social and/or emotional domains. Lectures, 1.5 hours per week; online activities, 1.5 hours per week. Restriction: open to PSYC (single or combined), HEAR, NEUR, RECL, SPLS majors and PSYC minors until date specified in Registration guide. Prerequisite(s): PSYC 1F90. Note: may be offered on-site or online. Students may not concurrently register in CHYS 2P10. Completion of this course will replace previous assigned grade and credit obtained in CHYS 2F05 and 2P10.

Note: Only the format has been changed (highlighted).

Chair/Director March 29, 2021

Dean: _____ Date: March 29, 2021

Part 1: Course Type

Please approximate the distribution between online delivery and other types of delivery:

Measures might be in the form of percentage, ratios, time, etc.

According to the following descriptions, based on the Ministry of Training, Colleges and Universities' categorizations, what type of course is this?

a ***Face-to-Face***
This type of course can be considered a conventional or classical course at Brock University. Typically these courses have physical space associated with the delivery of the course where instructors and students meet two or more hours a week.

b ***Directed reading***
Research course with directed study and regular meetings with a faculty member on or offline. Pre-allocated physical space is typically not associated with the delivery of this type of course, meetings are coordinated between the student(s) and the instructor.

c ***Blended Learning Course***
This is a course where face-to-face teaching time is reduced, but not eliminated, to allow students more time for online study. This model comes in a number of formats; however **the online component is typically 50%-80% of the total course delivery**. In this case, a blended learning course may have components delivered via traditional face-to-face; however, over half the course delivery should be online.

d ***On-Line: Synchronous Conferencing Course***
This describes a course delivered through audio and video conferencing to provide synchronous communications (i.e., at the same time) between an instructor at one site and students at other sites. **A course is considered to be offered via synchronous conferencing if 80% or more of the content is delivered this way.** For example, a synchronous conferencing course may have occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered through audio and video conferencing.

e ***On-Line: Fully Online Learning (asynchronous) Course***
This is a form of distance learning delivered to individuals with access to the Internet, either at home, work or through an access centre. Although courses may have a set start date and set due dates for assignments, students can otherwise access and participate in courses at times and places of their own choosing. **The online component is typically over 80% of the total delivery.** For example, a fully online course may include occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered online.

For all course types

Information Resources and Protection Privacy

1 Will you, or anyone involved in this course, be sharing any information about Brock University students with a third party as part of the delivery of this course?

We would like to know about third parties that/who will receive private student information and ensure that a Confidentiality and Privacy Agreement is arranged with these third parties if one does not already exists. Turnitin.com is an example of a third party, though there is an existing Confidentiality and Privacy Agreement. Other examples might be eTextbook providers or "clicker" services which require the university to provide student information, as opposed to students being asked to optionally provide it.

I use turnitin.com and I use Connect, an e-platform with McGraw Hill. The latter is used for SmartBook (interactive reading), quizzes, and quests (an interactive learning tool). I have used both tools in 2020-21 with no problems.

2 Please describe any student assessment to be submitted or collected electronically.

We would like to know this because depending on the size of the item being submitted, and the number of students, special accommodations may need to be made. Text-based items are rarely an issue, multi-media items have the potential to be an issue.

Students submit most assignments via the Sakai assignment box; one assignment is interactive and takes place via Teams; one assignment involves creating a short oral presentation and students provide links to their presentation via Teams. All of these have occurred without any issues in 2020-21.

Electronic Copyright and Accessibility

3 Have all items used as part of the online delivery of this course been demonstrated to meet Brock University and the Government of Ontario's requirements for accessibility, or is there a plan to address the accessibility of the content?

Accessibility is important for student learning and a requirement in Ontario. There are many measures of the accessibility content. Please identify any issues and how they might be overcome.

Students have access to the e-book which can be delivered in auditory feedback; videos are close captioned; accommodations (e.g., extra time on tests/assignments) are easily administered.

4 Will you ensure that all items distributed electronically are either:

a Owned by Brock University or yourself;

b Covered by a licence from the copyright holder;

c Out of copyright (i.e., the copyright has expired); or

d Covered by an exception in the Canadian Copyright Act?

5

YES. In each case I have worked with the library.

It is important to note that copyright is applied differently online than in a classroom in Canada.

Part 2: On-Line Synchronous Conferencing Course, Blended Learning Course or Fully Online Learning Course

For Synchronous Conferencing Courses

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

For example: A web cam, microphone, tablet computer...

2 What service(s) will be used to facilitate Synchronous Conferencing?

For example: A piece of video conferencing hardware, Skype, Elluminate, Saba Centra, Adobe or Citirx solutions...

3 Who is/are the service provider(s) or host(s)?

For example: Brock University, Contact North, another institution or commercial provider such as Skype

4 Please describe where participants (including instructors) will be located?

For example: Their homes, a lecture hall, other countries....

5 Please indicate the approximate frequency and duration of each meeting.

For example: 2 times a week for an hour.

For Blended Learning and Fully Online Learning Course

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

For example: web cam, microphone, tablet computer...

2 Will there be non-text-based forms of instruction such as video, audio or large computer files and what services will be used to distribute these files?

For example: A weekly video produced by the instructor or from other sources that is posted on a service like YouTube as an unlisted video.

3 Will there be non-text-based forms of assessment such as video, audio or large computer files and what services will be used to collect these files?

For example: Video submitted to the Isaak/Sakai Assignments tool or posted on a public video site such as YouTube.

For Brock University central services:

CPI recommendation:

CPI has no issue with this course proceeding, as Brock University has privacy agreements covering all platforms mentioned, including McGraw Hill.

Matt Clare
Associate Director,
Technology-Enabled Learning
Centre for Pedagogical Innovation

ITS recommendation:

ITS has no concerns with this course proceeding.

Andy Morgan

Director, Client Services

Information Technology Services

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 3P68 **Crosslisting code(s):**

Course title: Sleep and Wakefulness

1.**Proposal for this course revision:**

Remove seminar from course contact.

2.**Explanation for this course revision:**

The course contact will include only 3 hours lecture (no seminar). This change is being made at the instructor's request.

3.Is this course listed as a context credit*(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

(●) No ( ) Yes Identify the course code below:

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Kirsti van Dorsser		kvandorsser@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Tanya Martini
Chair (Print Name)

Chair (Signature)

March 24, 2021
Date

Ingrid Makus
Dean or Designate (Print Name)

Dean or Designate (Signature)

March 24, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC 3P68

Sleep and Wakefulness

Functions, mechanisms, rhythms, physiology and psychology of sleep contrasted with counterparts during wakefulness. Current issues in sleep research and sleep disorders medicine.

Lectures~~, seminar,~~ 3 hours per week.

Restriction: open to PSYC (single or combined), NEUR majors and PSYC minors until date specified in Registration guide. After that date open to PSYC (single or combined), NEUR majors, GHUM, SOSC students and PSYC minors until date specified in Registration guide. Students must have a minimum of 8.0 overall credits or 3.0 PSYC credits above PSYC 1F90.

Prerequisite(s): PSYC 1F90.

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 3P72 **Crosslisting code(s):**

Course title: Drugs and Behaviour

1. **Proposal for this course revision:**

Adjust contact hours. Remove seminar and replace with online activities.

2. **Explanation for this course revision:**

This change is being made at the request of the instructor.

3. Is this course listed as a context credit *(Dean approval required)***?**

(•) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(•) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(•) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(•) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(•) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(•) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(•) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(•) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

(•) No ( ) Yes Identify the course code below:

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

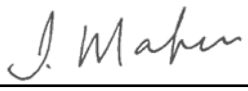
Kirsti van Dorsser		kvandorsser@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Tanya Martini
Chair (Print Name)

Chair (Signature)

March 24, 2021
Date

Ingrid Makus
Dean or Designate (Print Name)



Dean or Designate (Signature)

March 24, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC 3P72

Drugs and Behaviour

Basic principles of the kinetics of drugs and drug action, drug effects and drug interactions. Psychology of addictive behaviour. Effects of psychoactive drugs on behaviour and experience. Focus on recreational drugs and psychiatric medications.

Lectures, ~~seminar~~ online activities, 3 hours per week.

Restriction: open to PSYC (single or combined), NEUR, PHTH majors and PSYC minors until date specified in Registration guide. Students must have a minimum of 8.0 overall credits or 3.0 PSYC credits above PSYC 1F90.

Prerequisite(s): PSYC 1F90.

University Educational and Information Technology Services Support for Course Additions/Deletions/Revisions

This two-part form is intended to assess and confirm that adequate technical resources will be available to support the delivery of this course. All UPC submissions are asked to have the first part of this form completed upon submission. Submissions of the course types *Synchronous Conferencing, Blended Learning* or *Fully Online Learning (asynchronous)* are asked to complete both parts and have both parts reviewed by Information Technology Services (ITS) and the Centre for Pedagogical Innovation (CPI).

ACADEMIC UNIT: Psyc

COURSE NUMBER: 3P72

COURSE TITLE: Drugs and Behaviour

PROJECTED ENROLLMENT: 60

PROPOSED CALENDAR DESCRIPTION:

From 2017 calendar:

PSYC 3P72
Drugs and Behaviour
Basic principles of the kinetics of drugs and drug action, drug effects and drug interactions. Psychology of addictive behaviour. Effects of psychoactive drugs on behaviour and experience. Focus on recreational drugs and psychiatric medications.
Lectures, 1 hour per week; online activities, 2 hours per week.
Restriction: open to PSYC (single or combined), NEUR, PHTH majors and PSYC minors until date specified in Registration guide. Students must have a minimum of 8.0 overall credits or 3.0 PSYC credits above PSYC 1F90.
Prerequisite(s): PSYC 1F90.

INSTRUCTOR (if applicable): Kimberly Cote

Note: this course was run in BLENDED format by Dr Cote on 5 prior occasions between 2016-18. It was only changed temporarily to a standard format to allow for a part-time instructor to cover the course while Dr. Cote was Chair. There are no new IT considerations for the course.

Chair/Director:  March 30, 2021

Dean: _____ Date: March 30, 2021

Part 1: Course Type

Please approximate the distribution between online delivery and other types of delivery:

Lectures, 1 hour per week; online activities, 2 hours per week.

Measures might be in the form of percentage, ratios, time, etc.

According to the following descriptions, based on the Ministry of Training, Colleges and Universities' categorizations, what type of course is this? ***Blended Learning Course***

a ***Face-to-Face***
This type of course can be considered a conventional or classical course at Brock University. Typically these courses have physical space associated with the delivery of the course where instructors and students meet two or more hours a week.

b ***Directed reading***
Research course with directed study and regular meetings with a faculty member on or offline. Pre-allocated physical space is typically not associated with the delivery of this type of course, meetings are coordinated between the student(s) and the instructor.

c ***Blended Learning Course***
This is a course where face-to-face teaching time is reduced, but not eliminated, to allow students more time for online study. This model comes in a number of formats; however **the online component is typically 50%-80% of the total course delivery**. In this case, a blended learning course may have components delivered via traditional face-to-face; however, over half the course delivery should be online.

d ***On-Line: Synchronous Conferencing Course***
This describes a course delivered through audio and video conferencing to provide synchronous communications (i.e., at the same time) between an instructor at one site and students at other sites. **A course is considered to be offered via synchronous conferencing if 80% or more of the content is delivered this way.** For example, a synchronous conferencing course may have occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered through audio and video conferencing.

e ***On-Line: Fully Online Learning (asynchronous) Course***
This is a form of distance learning delivered to individuals with access to the Internet, either at home, work or through an access centre. Although courses may have a set

start date and set due dates for assignments, students can otherwise access and participate in courses at times and places of their own choosing. **The online component is typically over 80% of the total delivery.** For example, a fully online course may include occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered online.

For all course types

Information Resources and Protection Privacy

1 Will you, or anyone involved in this course, be sharing any information about Brock University students with a third party as part of the delivery of this course?

NO

We would like to know about third parties that/who will receive private student information and ensure that a Confidentiality and Privacy Agreement is arranged with these third parties if one does not already exists. Turnitin.com is an example of a third party, though there is an existing Confidentiality and Privacy Agreement. Other examples might be eTextbook providers or "clicker" services which require the university to provide student information, as opposed to students being asked to optionally provide it.

2 Please describe any student assessment to be submitted or collected electronically.

Quizzes on Sakai as before. 5-min digital power point presentation uploaded to Sakii, as before. Essays submitted in Assignments on Sakai, as before.

We would like to know this because depending on the size of the item being submitted, and the number of students, special accommodations may need to be made. Text-based items are rarely an issue, multi-media items have the potential to be an issue.

Electronic Copyright and Accessibility

3 Have all items used as part of the online delivery of this course been demonstrated to meet Brock University and the Government of Ontario's requirements for accessibility, or is there a plan to address the accessibility of the content?

Yes, all items are accessible. In the 6 prior times this course was taught in the same format, there were no issues if accessibility raised. Should there be any issues raised though SDC they will be addressed accordingly.

Accessibility is important for student learning and a requirement in Ontario. There are many measures of the accessibility content. Please identify any issues and how they might be overcome.

4 Will you ensure that all items distributed electronically are either:

- a Owned by Brock University or yourself;
- b Covered by a licence from the copyright holder;
- c Out of copyright (i.e., the copyright has expired); or
- d Covered by an exception in the Canadian Copyright Act?

It is important to note that copyright is applied differently online than in a classroom in Canada.

Yes.

Part 2: On-Line Synchronous Conferencing Course, Blended Learning Course or Fully Online Learning Course

For Synchronous Conferencing Courses

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

For example: A web cam, microphone, tablet computer...

2 What service(s) will be used to facilitate Synchronous Conferencing?

For example: A piece of video conferencing hardware, Skype, Elluminate, Saba Centra, Adobe or Citirx solutions...

3 Who is/are the service provider(s) or host(s)?

For example: Brock University, Contact North, another institution or commercial provider such as Skype

4 Please describe where participants (including instructors) will be located?

For example: Their homes, a lecture hall, other countries....

5 Please indicate the approximate frequency and duration of each meeting.

For example: 2 times a week for an hour.

For Blended Learning and Fully Online Learning Course

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

NO

For example: web cam, microphone, tablet computer...

2 Will there be non-text-based forms of instruction such as video, audio or large computer files and what services will be used to distribute these files?

Yes, short (20 min) videos of lectures on Sakai, same as before. Links to digital resources such as films, news stories, podcasts.

For example: A weekly video produced by the instructor or from other sources that is posted on a service like YouTube as an unlisted video.

3 Will there be non-text-based forms of assessment such as video, audio or large computer files and what services will be used to collect these files?

Already mentioned above – a 5-min video power point assignment.

For example: Video submitted to the Isaak/Sakai Assignments tool or posted on a public video site such as YouTube.

For Brock University central services:

CPI recommendation:

CPI has no concerns with this course proceeding.

Matt Clare
Associate Director,
Technology-Enabled Learning
Centre for Pedagogical Innovation

ITS recommendation:

ITS has no concerns with this course proceeding.

Andy Morgan
Director, Client Services
Information Technology Services

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 4P28 **Crosslisting code(s):**

Course title: Person Perception

1. **Proposal for this course revision:**

Add a note indicating the course may be offered online or in person.

2. **Explanation for this course revision:**

The department would like to have the flexibility to offer this course in either format in any given year depending on varying circumstances including who is teaching the course. The course has been taught online this year, so I answered yes to # 9 below, but it is not a new modality.

3. Is this course listed as a context credit *(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

(●) No ( ) Yes Identify the course code below:

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Kirsti van Dorsser
Departmental Designate for Questions

Ext

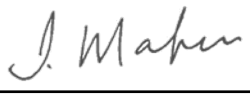
kvandorsser@brocku.ca
Brock E-Mail Address

Tanya Martini
Chair (Print Name)


Chair (Signature)

March 24, 2021
Date

Ingrid Makus
Dean or Designate (Print Name)


Dean or Designate (Signature)

March 24, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC 4P28

Person Perception

Examination of how we perceive and form impressions of other people, including the perception of facial displays of emotion, perception of facial identity and social judgements. Topics include the development of person perception, underlying neural mechanisms and implications for daily life.
Seminar, 3 hours per week.
Restriction: open to PSYC (single or combine) majors and minors until the date specified in the Registration guide. Students must have a minimum of 13.5 credits and 5.0 PSYC credits above PSYC 1F90.
Prerequisite(s): PSYC 1F90; PSYC 3F40 or 3P30.
Note: may be offered on-site or online.

University Educational and Information Technology Services Support for Course Additions/Deletions/Revisions

This two-part form is intended to assess and confirm that adequate technical resources will be available to support the delivery of this course. All UPC submissions are asked to have the first part of this form completed upon submission. Submissions of the course types *Synchronous Conferencing, Blended Learning* or *Fully Online Learning (asynchronous)* are asked to complete both parts and have both parts reviewed by Information Technology Services (ITS) and the Centre for Pedagogical Innovation (CPI).

ACADEMIC UNIT: PSYC COURSE NUMBER: 4P28

COURSE TITLE: Person Perception PROJECTED ENROLLMENT: 40

PROPOSED CALENDAR DESCRIPTION: INSTRUCTOR (if applicable): Mondloch

PSYC 4P28 Person Perception Examination of how we perceive and form impressions of other people, including the perception of facial displays of emotion, perception of facial identity and social judgements. Topics include the development of person perception, underlying neural mechanisms and implications for daily life. Seminar, 3 hours per week. Restriction: open to PSYC (single or combine) majors and minors until the date specified in the Registration guide. Students must have a minimum of 13.5 credits and 5.0 PSYC credits above PSYC 1F90. Prerequisite(s): PSYC 1F90; PSYC 3F40 or 3P30. Note: may be offered on-site or online.

Note: Only the format has been changed (highlighted).

Chair/Director:  March 29, 2021

Dean: _____ Date: March 29, 2021

Part 1: Course Type

Please approximate the distribution between online delivery and other types of delivery:

Measures might be in the form of percentage, ratios, time, etc.

According to the following descriptions, based on the Ministry of Training, Colleges and Universities' categorizations, what type of course is this?

a ***Face-to-Face***
This type of course can be considered a conventional or classical course at Brock University. Typically these courses have physical space associated with the delivery of the course where instructors and students meet two or more hours a week.

b ***Directed reading***
Research course with directed study and regular meetings with a faculty member on or offline. Pre-allocated physical space is typically not associated with the delivery of this type of course, meetings are coordinated between the student(s) and the instructor.

c ***Blended Learning Course***
This is a course where face-to-face teaching time is reduced, but not eliminated, to allow students more time for online study. This model comes in a number of formats; however **the online component is typically 50%-80% of the total course delivery**. In this case, a blended learning course may have components delivered via traditional face-to-face; however, over half the course delivery should be online.

d ***On-Line: Synchronous Conferencing Course***
This describes a course delivered through audio and video conferencing to provide synchronous communications (i.e., at the same time) between an instructor at one site and students at other sites. **A course is considered to be offered via synchronous conferencing if 80% or more of the content is delivered this way.** For example, a synchronous conferencing course may have occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered through audio and video conferencing.

e ***On-Line: Fully Online Learning (asynchronous) Course***
This is a form of distance learning delivered to individuals with access to the Internet, either at home, work or through an access centre. Although courses may have a set start date and set due dates for assignments, students can otherwise access and participate in courses at times and places of their own choosing. **The online component is typically over 80% of the total delivery.** For example, a fully online course may include occasional face-to-face meetings, a proctored exam, etc. with the remainder of the content delivered online.

For all course types

Information Resources and Protection Privacy

1 Will you, or anyone involved in this course, be sharing any information about Brock University students with a third party as part of the delivery of this course?

We would like to know about third parties that/who will receive private student information and ensure that a Confidentiality and Privacy Agreement is arranged with these third parties if one does not already exists. Turnitin.com is an example of a third party, though there is an existing Confidentiality and Privacy Agreement. Other examples might be eTextbook providers or "clicker" services which require the university to provide student information, as opposed to students being asked to optionally provide it.

I use turnitin.com through Sakai.

2 Please describe any student assessment to be submitted or collected electronically.

We would like to know this because depending on the size of the item being submitted, and the number of students, special accommodations may need to be made. Text-based items are rarely an issue, multi-media items have the potential to be an issue.

Students submit weekly assignments via Sakai. End-of-term projects are group-based and submitted via Teams. These comprise multi-media presentations (typically ppt presentations with audio, but students have many options available). Both of these have occurred without any issues in 2020-21.

Electronic Copyright and Accessibility

3 Have all items used as part of the online delivery of this course been demonstrated to meet Brock University and the Government of Ontario's requirements for accessibility, or is there a plan to address the accessibility of the content?

Accessibility is important for student learning and a requirement in Ontario. There are many measures of the accessibility content. Please identify any issues and how they might be overcome.

Videos are close captioned[MC1]. Accommodations are handled on a case-by-case basis. 2 hours/week are synchronous and involve group discussions; 1 hour/week comprises posted videos and mini lectures.

4 Will you ensure that all items distributed electronically are either:
   a Owned by Brock University or yourself;

b Covered by a licence from the copyright holder;

c Out of copyright (i.e., the copyright has expired); or

d Covered by an exception in the Canadian Copyright Act?

5

YES. In each case I have worked with the library.

It is important to note that copyright is applied differently online than in a classroom in Canada.

Part 2: On-Line Synchronous Conferencing Course, Blended Learning Course or Fully Online Learning Course

For Synchronous Conferencing Courses

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

For example: A web cam, microphone, tablet computer...

2 What service(s) will be used to facilitate Synchronous Conferencing?

For example: A piece of video conferencing hardware, Skype, Elluminate, Saba Centra, Adobe or Citirx solutions...

3 Who is/are the service provider(s) or host(s)?

For example: Brock University, Contact North, another institution or commercial provider such as Skype

4 Please describe where participants (including instructors) will be located?

For example: Their homes, a lecture hall, other countries....

5 Please indicate the approximate frequency and duration of each meeting.

For example: 2 times a week for an hour.

For Blended Learning and Fully Online Learning Course

1 Are there any required technologies that differ from what Brock University currently provides in computer labs?

For example: web cam, microphone, tablet computer...

2 Will there be non-text-based forms of instruction such as video, audio or large computer files and what services will be used to distribute these files?

For example: A weekly video produced by the instructor or from other sources that is posted on a service like YouTube as an unlisted video.

3 Will there be non-text-based forms of assessment such as video, audio or large computer files and what services will be used to collect these files?

For example: Video submitted to the Isaak/Sakai Assignments tool or posted on a public video site such as YouTube.

For Brock University central services:

CPI recommendation:

CPI has no concerns with this course proceeding.

Matt Clare

Associate Director,

Technology-Enabled Learning

Centre for Pedagogical Innovation

ITS recommendation:

ITS has no concerns with this course proceeding.

Andy Morgan
Director, Client Services
Information Technology Services

CalendarRevisionSubmission

Form C-3 –CourseRevisions

Form C-3 is to be completed when there is a revision to a course in the course bank. One complete submission for each course. If multiple revisions are being made only one Consultation and Approval section required. Cross-listed course revisions are to be submitted by the home/primary Department/Centre and revisions will be matched in the cross-listed course.

Please upload a Word file with the details of the course revision where new additions are to be highlighted and deletion to have a ~~strike through~~.

Course code: PSYC 4P30 **Crosslisting code(s):**

Course title: Positive Psychology

1. **Proposal for this course revision:**

Adjust contact hours, remove lecture.

2. **Explanation for this course revision:**

The course will be taught in a 3 hour seminar format in the future. This change is at the request of the instructor.

3. Is this course listed as a context credit *(Dean approval required)***?**

(●) No ( ) Yes, approval by the Dean has been received to revise the context credit and will be uploaded with this submission.

4. Is this course cross-listed?

(●) No ( ) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. Does the revisions result in additional expenses to be borne by the student (e.g. field trip,materials fees, practicum fees, etc)?

(●) No ( ) Yes, fees align with current Provincial Ministry guidelines/regulations. A description of the fees and intended proposal will be uploaded.

6. Does this revision affect program requirements in your department?

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded.

7. Does this revision affect program requirements in other departments?

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

8. Does this revision have any impact on future admission requirements to Brock?

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded.

9. Will this revision result in the course being delivered on-line? Is this a new modality (i.e. formerly delivered face to face)?

(●) No ( ) Yes, a ITS/CPI Support Form will be uploaded with this submission.

10. Does this course revision result from the splitting or joining of course(s) in the course bank?

(●) No ( ) Yes (split) ( ) Yes (joined) Identify the course code(s) below:

11. Does this course revision result from the renumbering of another course?

(●) No ( ) Yes Identify the course code below:

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Kirsti van Dorsser		kvandorsser@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Tanya Martini
Chair (Print Name)

Chair (Signature)	March 24, 2021
	Date

Ingrid Makus
Dean or Designate (Print Name)

Dean or Designate (Signature)	March 24, 2021
	Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- (●) No
- ( ) Yes. Please complete the Verification of Consultation form and upload with submission.

PSYC 4P30

Positive Psychology

Focus on positive experiences, characteristics, and institutions. Main themes include positive psychology as a source of information about well-being and optimal human functioning, central role of psychological science in the study of positive psychology, positive psychology as a lens through which to view all psychological inquiry.

~~*Lectures,*~~ S~~s~~*eminar, 3 hours per week.*

Restriction: open to PSYC (single or combined) majors and minors until the date specified in Registration guide. Students must have 13.5 credits or 5.0 PSYC credits above PSYC 1F90.

Prerequisite(s): PSYC 1F90; PSYC 2P25 or 2P30; PSYC 3F40 or 3P30.

Calendar Revision Submission

Form C-2 – Course Deletions

Form C-2 is to be completed when there is a deletion to the course bank. One complete submission for each course. Cross-listed courses are to be submitted by the home/primary Department/Centre.

Course code: HIST 3P82

Cross-listed course codes (if applicable): ADST 3P82

Course title:

A History of Disability Technologies

Please provide responses to the questions below:

1. **Proposal for this course deletion:**

- That the Department of History delete HIST 3P82 from its list of course offerings

2. **Explanation for this course deletion:**

This course has not been taught since 2017 and will likely not be taught again as History does not have Faculty with expertise in this area of study.

3. **Is this course listed as a context credit** *(Dean approval required)***?**

(●) No ( ) Yes, a Form A – Program Additions/Terminations will be uploaded with the submission.

4. **Is this course cross-listed?**

( ) No (●) Yes, as the Primary/Home Department (financially responsible for the course) a Verification of Consultation form will be uploaded with this submission.

5. **Does this deletion affect program requirements in your department?**

(●) No ( ) Yes, a Calendar Submission – Form B- Calendar Revisions will also be uploaded with this submission.

6. **Does this deletion affect program requirements in other departments?**

(●) No ( ) Yes, a Verification of Consultation form will be uploaded with this submission.

7. **Does this deletion have any impact on future admission requirements to Brock?**

(●) No ( ) Yes, record of the approval from Academic Review Committee will be uploaded with the submission.

8. **Is this course deletion the result of a course being split or joined and new course(s) being created?**

(●) No ( ) Yes (split) ( ) Yes (joined) If yes, enter new course codes below:

9. **Is this course deletion the result of a course renumbering?**

(●) No ( ) Yes (identify the course code of the newly renumbered course below):

Consultation and Approvals

Academic Consultation and Results
Please identify consultations with all departments/centers (Faculty as appropriate) affected by these changes and the results of those discussions. Upload a copy of all correspondence, verifying agreement of all parties, to the proposed changes.

IT/ET Consultation
Please upload a copy of the IT/ET support form for each on-line course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Library Consultation
Please upload a copy of the Library Support form for each course added to the course bank (with the exception of cross-listed courses which already exist in another department/centre).

Approvals

Frances Meffe	3500	history@brocku.ca
Departmental Designate for Questions	Ext	Brock E-Mail Address

Dr. Maureen Lux, Chair, History
Chair (Print Name)

Maureen Lux
Chair (Signature)

March 16, 2021
Date

Dr. Neta Gordon, Assoc. Dean, F.O.H.
Dean or Designate (Print Name)

Neta Gordon
Dean or Designate (Signature)

March 16, 2021
Date

Verification of Consultation
Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

- ○ No
- ◉ Yes. Please complete the Verification of Consultation form and upload with submission.

Verification of Consultation Form
for Changes affecting other Faculties/Departments/Centres

This form verifies that we are aware and have engaged in consultation regarding the proposed changes in this submission that affect our respective programs (e.g. additions, deletions, revisions to courses or course components, revision to program requirements that impact a program in another Department/Centre).

Please provide relevant/appropriate evidence regarding this consultation (e.g., confirmation e-mail).

Reason for consultation (identify addition/deletion/revision as appropriate):

Deletion of HIST/ADST 3P82 from the Calendar

(●) All parties agree to the proposed changes and have updated our UPC submissions to reflect the changes.

( ) Consultation has occurred but changes have not been agreed to by all parties.

I. For changes that cross Departments/Centres within the *same* Faculty:

Chair/Director (submitting Dept/Centre) — Signature

If multiple Dept/Centres affected, please include all signatures on this form.

Dr. Maureen Lux, History — Chair/Director (affected Dept/Centre)

Maureen Lux — Signature

Dr. Maurice Feldman, ADS — Chair/Director (affected Dept/Centre)

Maurice Feldman 2021.03.17 10:21:20 -04'00' — Signature

Chair/Director (affected Dept/Centre) — Signature

II. For changes that cross Faculties:

Dr. Neta Gordon, FOH — Dean (submitting Faculty)

Neta Gordon — Signature

Dr. Kate Bezanson, FOSS — Dean (affected Faculty)

KBezanson Digitally signed by SOCI-M601410 DN: cn=SOCI-M601410 Date: 2021.03.23 13:50:42 -04'00' — Signature

Calendar Revision Submission

Form B – Program Changes

Form B to be completed when there is a revision to Officers of Instruction, General Information, Program Notes, and/or Program Requirements.

Upload a Word document that includes:

1. A detailed **Proposal** and **Explanation** of the proposed revision to the Program. Provide details if this program impacts other Departments or Admissions requirements.
2. If this is a Major Modification, upload verification of approval through ARC and Senate.
3. Provide the proposed revisions to the calendar by copying the existing web calendar content and highlight new additions and ~~strikethrough~~ deletions.

Program name: Mathematics Co-op and Statistics Co-op Program

Brief description of proposed revision(s):

See attached

Consultation and Approvals

Stephen Anco

Departmental Designate for Questions

sanco@brocku.ca

Brock E-Mail

Stephen Anco

Chair (Print Name)

Stephen Anco

Chair (Signature)

March 26, 2021

Date

Dean or Designate(Print Name)

Dean or Designate (Signature)

Date

Verification of Consultation

Does this proposed revision to the calendar impact another Faculty/ Department/ Centre?

○ No ◉ Yes. Please complete the Verification of Consultation form and upload with submission.

MATH/STAT 3P81
Math Co-op program:
Year 3, Fall term, replace "3P81" to "3P81 or 3P82"; and Year 4 replace "3P82" to "3P81 or 3P82"

MATH/STAT 4P85 Stat Co-op program:
Year 4, Winter term, replace "4P85" to "4P84 or 4P85"; and Year 5, Fall term, replace "4P84" to "4P84 or 4P85".

Mathematics Co-op (Honours only)

Year 1

- MATH 1P01, 1P02, 1P11 and 1P40
- three elective credits (see program note 1)

Year 2

- MATH 2P03, 2P08, 2P12, 2P40, STAT 2P81 and 2P82
- SCIE 0N90
- the Humanities context credit, Sciences context credit or Social Sciences context credit not taken in year 1
- one elective credit

Spring/Summer Sessions:

- MATH 0N01 and 2C01

Year 3

Fall Term:

- MATH 3P12 ~~and STAT 3P81~~
- STAT 3P81 or 3P82
- one MATH or STAT credit numbered 3*(alpha)*00 or above
- one-half elective credit

Winter Term:

- MATH 0N02 and 2C02

Year 4

- MATH 3P40 ~~and 3P82~~
- STAT 3P81 or 3P82
- one credit from MATH 3P04, 4P06, 4P09, 4P13, ~~-~~4P92, 4P94, STAT 3P85, 3P86, 4P84
- one credit from MATH 4P09, 4P11, 4P92, 4P94, STAT 4P84
- one MATH or STAT credit numbered 3*(alpha)*00 or above
- one elective credit

Spring/Summer Sessions:

- MATH 0N03 and 2C03

Year 5

Fall Term:

- One and one-half MATH or STAT credits numbered 4*(alpha)*00 or above
- one elective credit

Statistics Co-op (Honours only)

Year 1

- MATH 1P01, 1P02, 1P11 and 1P40
- three elective credits (see program note 1)

Year 2

- MATH 2P03, 2P08, 2P12, 2P40, STAT 2P81 and 2P82
- the Humanities context credit, Sciences context credit or Social Sciences context credit not taken in year 1
- one elective credit (see program note 6)

Year 3

- STAT 3P81, 3P82, 3P85 and 3P86
- one MATH or STAT credit numbered 3(*alpha*)00 or above (see program note 6)
- SCIE 0N90
- two elective credits (see program note 6)

Spring/Summer Sessions:

- MATH 0N01 and 2C01

Year 4

Fall Term:

- MATH 0N02 and 2C02

Winter Term:

- STAT 4P82 ~~and 4P85~~
- STAT 4P84 or 4P85
- one-half MATH or STAT credit (see program notes 6 and 7)
- one elective credit (see program notes 6 and 7)

Spring/Summer Sessions:

- MATH 0N03 and 2C03

Year 5

Fall Term:

- STAT 4P81 ~~and 4P84~~
- STAT 4P84 or 4P85
- one-half MATH or STAT credit
- one MATH or STAT credit numbered 3 (alpha) 90 or above

Verification of Consultation Form
for Changes affecting other Faculties/Departments/Centres

This form verifies that we are aware and have engaged in consultation regarding the proposed changes in this submission that affect our respective programs (e.g. additions, deletions, revisions to courses or course components, revision to program requirements that impact a program in another Department/Centre).

Please provide relevant/appropriate evidence regarding this consultation (e.g., confirmation e-mail).

Reason for consultation (identify addition/deletion/revision as appropriate):

MATH/STAT 3P81 addition Fall 2021-22, MATH/STAT 4P85 addition Winter 2021-22

(●) All parties agree to the proposed changes and have updated our UPC submissions to reflect the changes.

( ) Consultation has occurred but changes have not been agreed to by all parties.

I. For changes that cross Departments/Centres within the *same* Faculty:

Stepehn Anco, Chair	Stephen Anco
Chair/Director (submitting Dept/Centre)	Signature

If multiple Dept/Centres affected, please include all signatures on this form.

Sandy Howe, Acting Director, CCEE	Sandy Howe
Chair/Director (affected Dept/Centre)	Signature
Chair/Director (affected Dept/Centre)	Signature
Chair/Director (affected Dept/Centre)	Signature

II. For changes that cross Faculties:

Dean (submitting Faculty)	Signature
Dean (affected Faculty)	Signature

Calendar change request

Julia Zhu
Wed 3/24/2021 10:29 AM

To:

- Jayne Zarecky

Cc:

- Sandy Howe

Verification of Consultation Form - SH sign.pdf
157 KB

Hi Jayne,

Please find attached singed form by Sandy Howe, our Acting Director for CCEE. We hope we captured everything in the form properly.

Regards,
Julia

Julia Zhu, MA
Associate Director, Co-op Education
Brock University | Co-op, Career & Experiential Education
Niagara Region | 1812 Sir Isaac Brock Way | St. Catharines, ON L2S 3A1
brocku.ca | M 289-668-6980 | E jzhu@brocku.ca
NOTE: If you receive this email outside of your normal working hours, it is because I am working flexibly in a manner to allow focus time that works for me. I respect your working patterns, and don't expect you to reply outside of your normal working hours.

From: Jayne Zarecky <jzarecky@brocku.ca>
Sent: March 23, 2021 8:36 AM

To: Julia Zhu <lzhu@brocku.ca>
Subject: Fw: Calendar change request

Hi Julia,

Thanks for following up on this. Yes, the student can complete in either of the terms.

Jayne

From: Julia Zhu <lzhu@brocku.ca>
Sent: Monday, March 22, 2021 5:38 PM
To: Jayne Zarecky <jzarecky@brocku.ca>
Subject: RE: Calendar change request

Hi Jayne,

Sorry for my delay on getting back to you.

I believe this will need to be signed by our Acting Director, Sandy Howe and I will check with her.

Meanwhile, I wanted to make sure that based on the change, it means that a Math of STAT co-op student can complete these courses (i.e. 3P81 and 3P82)in either of the term, correct?

Thanks,
Julia

Julia Zhu, MA
Associate Director, Co-op Education
Brock University | Co-op, Career & Experiential Education
Niagara Region | 1812 Sir Isaac Brock Way | St. Catharines, ON L2S 3A1
brocku.ca | M 289-668-6980 | E jzhu@brocku.ca
NOTE: If you receive this email outside of your normal working hours, it is because I am working flexibly in a manner to allow focus time that works for me. I respect your working patterns, and don't expect you to reply outside of your normal working hours.

From: Jayne Zarecky <jzarecky@brocku.ca>
Sent: March 18, 2021 9:33 AM
To: Julia Zhu <lzhu@brocku.ca>
Subject: Calendar change request

Hi Julia,

I'm not sure that you are the correct person to send this request to but if not, please forward.

While Scheduling was creating the academic blocks for Fall/Winter 2021-2022, they noticed some issues. The calendar indicates that MATH/STAT 3P81 is to be taken in the Fall term, but it is only offered in Winter term. The calendar states that MATH/STAT 4P85 is to be taken in the Winter term, but it is only offered in Fall term. The committee would like to keep the flexibility of our offering these courses in either term and the department voted and approved the calendar change request below.

MATH/STAT 3P81

Math Co-op program:

Year 3, Fall term, replace "3P81" to "3P81 or 3P82"; and Year 4 replace "3P82" to "3P81 or 3P82"

MATH/STAT 4P85

Stat Co-op program:

Year 4, Winter term, replace "4P85" to "4P84 or 4P85"; and Year 5, Fall term, replace "4P84" to "4P84 or 4P85".

Jayne Zarecky
Administrative Assistant
Brock University | Department of Mathematics and Statistics
Niagara Region | 1812 Sir Isaac Brock Way | St. Catharines, ON L2S 3A1
brocku.ca | 905 688 5550 ext. 3300

SENATE

To: Chabriol Colebatch, University Secretary & General Counsel

From: Professor Francine McCarthy
Chair, Senate Graduate Studies Committee

DATE: April 13, 2021

Report to Senate 689, April 21, 2021

ACTION ITEMS

- None

DISCUSSION ITEMS

- None

CONSENT ITEMS – FOR APPROVAL

- None

CONSENT ITEMS – FOR INFORMATION

1. Department of Engineering Consultation

   The SGSC received a report and presentation on the Faculty of Mathematics and Science proposal for the creation of a new Department of Engineering. This item was recommended for approval; however, the motion for Senate's consideration will be captured in the joint report with the UPC at a future Senate meeting following the joint meeting as per the Faculty Handbook procedures for creating new academic units, specified in FHB Section 3.C.16.

2. University Library Consultation

   On the April 6, 2021 SGSC meeting Mark Robertson (University Librarian) presented on the Library Restructuring Plan and invited feedback from the SGSC members. The committee provided feedback on collaboration and teamwork and the importance of creating structures for better communication and support.

3. Fall Planning and Vice-Provost Role

   Lynn Wells Provost & Vice-President, Academic attended the April 6, 2021 SGSC meeting for consultation on Fall Planning and the role of Vice Provost & Associate VP, Students currently under review. The Committee members had the opportunity to ask questions and provide feedback.

4. Senate Graduate Studies Awards Sub-Committee Report Outlined in **Appendix 1**

Appendix 1

Report of the Senate Graduate Studies Awards Sub-committee

To: Senate Graduate Studies Committee

Date: April 6 2021

Awards Sub-committee members: Bareket Falk (Chair), Beatrice Ombuki-Berman, Nicole Nolan, Brian Roy (non-voting)

The Awards Sub-committee met on Apr. 6th (mtg #4), 2021.

Two student representatives joined the meeting: Haley Myatt and Amanda Williams

We adjudicated 1 award: The Michael Plyley Graduate Mentorship Award.

One award was recommended, under the Master's/Doctoral category.

There were no eligible candidates under the Master's only category. (Note that there was one original candidate listed in this category. However, it was evident that this candidate also supervised a PhD student and was therefore moved to the Master's/Doctoral category.)

This concludes the adjudication of awards for this year.

Thank you to a great team.

Reporting: Bareket Falk

TO: Chabriol Colebatch
University Secretary & General Legal Counsel

FROM: Professor Carole Stewart
Chair, Teaching and Learning Policy Committee

DATE: April 14, 2021

REPORT TO SENATE 689 April 21, 2021

CONSENT ITEMS - INFORMATION

April 9 Meeting

1. **Presentation of Library Restructuring Plan**

   Mark Robertson, University Librarian, delivered a presentation titled "Library Restructuring Plan" and a draft of the "Library Organizational Framework – Senate Committee Consultations" dated April 2021, for discussion. Based on an external review, the restructuring plan would align with the strategic plan. The committee discussion raised questions about Transdisciplinarity and Indigenization, and how the library might address these within the disciplinary structuring.

2. **A Report on the Experiences of Indigenous Faculty**

   The committee discussed a document titled **"**Lighting the Fire: Experiences of Indigenous Faculty in Ontario Universities," a report from the Council of Universities (COU) working group, forwarded by Two Row Council (TRC). The calls to actions from the report on "support for faculty to include Indigenous content and pedagogies and mentoring Indigenous faculty." TLP&C has a working group on Indigenous Teaching & Learning that is also drafting a report to present to senate for discussion that addresses some of these issues, and the report from COU will be considered in the final drafting of that report to present to T&LPC in May, and then to TRC and Senate. We also discussed the call to action concerning more flexible classroom spaces for Indigenous pedagogies and the cross over with IT&I and the Registrar (scheduling) to address these issues.

3. **Working group on Indigenous Learning**

Madelyn Law presented a draft of the report from the working group. The report will be reviewed again, revised, and presented in May at T&LPC. The Committee also discussed writing a summary of the report for a generative discussion with Senate.

4. **Working Group on Teaching Innovation**

Madelyn Law discussed the report on online Teaching and the survey that was circulated. Preliminary results were given from 123 Faculty, 3 Librarians, 87 part-time instructors, and 92 TA's, senior lab demonstrators, and ESL instructors. The final report will be presented to T&LPC in May.

5. **Course Components and Course Delivery Modes - Definitions**

Madelyn Law presented a document on definitions for course classifications, which will be presented to UPC. T&LPC supported the definitions and suggested the following: expand on the definition of Seminar to including testing and learning concepts; and delete "short term" from the definitions of Field Course and International Field Experience.

March 12 Meeting

6. **Indigenization**

The Committee received the following updates on Indigenization:

Four indigenous teaching positions have been created. On April 26 the University will be receiving a gift – a Teaching Lodge, to be placed at the front of the Plaza building. The Lodge will be a part of the teaching process and students will get an opportunity to train there. Brock is one of three sites gifted a Teaching Lodge. Robyn Bourgeois and Brian Power are working in consultation with Two Row Council and the Aboriginal Education Council to develop undergraduate degree level expectations. A Sub-committee is reviewing the IEAC report to determine what needs to be done and what has already been done

7. **Discussion with Provost on Fall 2021 guidelines**

Provost Lynn Wells reported that guidelines for Fall 2021 were circulated around campus for feedback. The guidelines are being vetted at Senate committees and bargaining units. The plan is that students will return to campus in person Fall 2021. The Registrar's Office is working on plans to pivot back to online/hybrid course delivery should Public Health measures require a lockdown. Lynn Wells responded to questions related to social distancing, and implications for non-vaccinated international students. Discussions are ongoing nationally at COU on the matter and legal advice is being sought. At this time there is no requirement for proof of vaccination. With respect to Covid-19 the University is guided by Public Health. Members were encouraged by the Provost to e-mail her with further questions.

8. **Digital Learning Resources**

   The committee provided feedback for the document on course definitions that was presented at the April meeting

9. **Updates from Working groups** on Indigenization and on Teaching Innovations (see April minutes above for more info.)

Report to Senate #689, April 21, 2021

TO: Chabriol Colebatch, University Secretary and General Legal Counsel

FROM: Jens Coorssen
Chair, Governance Committee

DATE: April 21, 2021

Consent Items for Information

1. Meeting with Committee Chairs, Vice-Chairs, and Secretaries

The Governance Committee met with the committee chairs, vice-chairs, and secretaries to discuss and/or gather feedback on the following topics:

- Opening committee meetings and welcoming external guests
- Reviewing committees' terms of reference
- Fall planning – Senate and committee meetings
- Scheduling of Senate and committee meetings

The Secretariat will review the feedback and provide any recommendations to the Governance Committee.

2. Faculty Handbook Section 4 Revisions – Project Timelines

The Committee provided feedback on timelines and consultation/engagement approaches for the review of Faculty Handbook Section 4 which addresses senior academic searches.

3. Experiences of Indigenous Faculty in Ontario Universities

The Committee reviewed the action items and findings outlined in a recent report from the Council of Ontario Universities regarding the experiences of Indigenous faculty members. The report can be viewed at https://ontariosuniversities.ca/reports/experiences-of-indigenous-faculty

4. Determinations of the Elections Sub-Committee – April 2021

- The Sub-Committee granted a request from a Senator for an exemption from FHB 2: 3.3.1 because, at the time of the request, they were on a leave that was precisely three months, the leave was already half complete, the Senator had continued attending Senate and Committee meetings during the leave, and flexibility had recently been granted for leaves due to complications surrounding the COVID pandemic.

- The Sub-Committee also confirmed the status of a nomination as incomplete since it was missing signatures from the candidate and four nominators.

5. Appointments to the Advisory Committee on the Dean of the Goodman School of Business

The Committee considered nominations to the Advisory Committee on the Dean of the Goodman School of Business and recommended individuals for appointment to the Provost and Vice-President, Academic.