Final Assessment Report

Physics

Graduate and Undergraduate Programs

(reviewed 2021/22)

A. Summary

1. The Department's Self-Study was considered and approved by the Senate Academic Review Committee on Jan 4, 2022.
2. The Review Committee consisted of two external reviewers: Mark Gallagher (Lakehead University) and David Feder (University of Calgary), and one internal reviewer, Karen Campbell (Brock University).
3. The virtual review occurred on April 11, 13, 14, 2022.
4. The Reviewers' Report was received on May 30, 2022.
5. The Senate Undergraduate Program Committee response was received on June 13, 2022. They had no comments related to the recommendations provided.
6. The Department response was received on July 6, 2022.
7. The Senate Graduate Studies Committee response was received on September 12, 2022. It addressed all recommendations but #s2-5, #9 and #12.
8. The Vice-Provost and Dean, Faculty of Graduate Studies response was received on September 28, 2022. It addressed all recommendations but #s2-5, #9 and #12.
9. The Dean, Faculty of Mathematics and Science, response was received on October 5, 2022.
10. Annual Implementation Reports will be submitted from 2023-2026.
11. The next Cyclical Academic Review is scheduled to take place in 2029/2030.

This review was conducted under the terms and conditions of the IQAP approved by Senate on May 25, 2016 and the Codicil to the Brock IQAP, approved by Senate December 15, 2021, which serves until the revised IQAP is fully approved by the Quality Council and Senate.

Program Outcome Categories:

Based on their knowledge of the discipline, the content of the Self-Study and the interviews conducted during the site visit, the Review Committee gave the programs the following Outcome Categories:

Program(s)	Excellent Quality	Good Quality	Good Quality with Concerns	Non-Viable
PhD		✓		
MSc		✓		
MSc Materials Physics (ISP)		✓		
BSc (Honours and Pass)		✓		
BSc (with Major)		✓		
BSc (Honours) Co-op			✓	
Combined Major (Honours) with Computer Science, Mathematics and Statistics			✓	
Combined Major (Honours and Pass) with Biological Sciences			✓	

Concerns raised by the Review Committee, leading to the Program Outcome Categories above, are highlighted below in red.

Executive Summary:

The Reviewers wrote:

The Department of Physics offers a full suite of programs at both the undergraduate and graduate levels. All stakeholders (faculty, staff and students) commented on the relaxed and highly collegial atmosphere present in the department. The department has clearly strived to make the physical and virtual spaces collaborative and useful, and their success demonstrates the high value faculty place on working with students and mentoring their scientific development, and the high value students place on these interactions. Technical and administrative staff also communicate strong satisfaction.

The number of students in the undergraduate programs is relatively small (approximately 50 over all years). This results in small class sizes which is not common in research-intensive departments. As such, the department is able to offer exceptional student-focused instruction and training compared to the experience at other universities. The high number of teaching awards for the relatively small department is strong evidence of this quality. The review team has determined that all the programs offered at the undergraduate and graduate level are of good quality. That said, consistently low enrolment in upper-year undergraduate and graduate courses presents its own challenges. Offering courses annually with as few as a single student may not be the best use of departmental resources. Furthermore, three programs have had little or zero uptake, and are assessed as “good quality with concerns”. The review team would ask that these three programs be critically

assessed; however, as long as the marginal costs associated with these programs is small they should be allowed to continue.

Research is central to the department, and their excellence and reputation in condensed matter physics is well-established in Ontario and indeed across Canada. Most faculty members are research active, many consistently hold tri-council grant funding, and several have been successful securing additional external funding (for example CFI) and internal grants. The number of graduate students in the department is a large fraction of the total student population and in fact is comparable to or exceeds the fraction at top-flight research-active Physics departments in Canada. Students' research work is being regularly published in peer-reviewed journals that are standard in their fields. The vitality of the graduate research programs is a testament to the priority and value the department places on research training.

The MSc in Materials Physics Program (MSMP) is a unique and exciting course-based graduate program that provides students with extraordinary access to research-grade experimental equipment and an excellent palette of graduate courses. The program is focused on international students, and partly because of covid has seen a decline in enrolment in recent years. As a flagship program for the department, the MSMP should be nurtured going forward. The department is encouraged to explore ways to increase enrolment and strengthen student training, including opening the program to domestic students and supporting operations with a dedicated technical staff member.

B. Program Strengths

The reviewers noted the following strengths:

This review process has allowed us to identify a number of strengths.

i. It was quite apparent during our virtual visit that the working environment in the Physics was highly collegial. Almost everyone we talked to (faculty, staff, and students) remarked on the collaborative environment.
ii. Relatively small class sizes lead to small cohort teaching.
iii. The lab experience in both the undergraduate programs and the MSMP is outstanding. The implementation of iOLab based experiments in first and second was particularly well done. Students also liked the use of oral examinations in several of the senior laboratory courses.
iv. The MSMP is quite innovative. The quantity and quality of laboratory-based instruction is impressive for a course-based program.
v. Student common room (room B203) which is a shared lab / computer / tutorial / social room for all members. Traditionally, it has been a space where junior and senior undergrads work and socialize together at all hours, or meet informally with graduate students, postdoctoral fellows, and academic staff. The pandemic has effectively eliminated the dynamic of this very important cultural space. The Department is working on ways to revitalize the space and the review team provides some additional ideas in Section 5.8.

The Dean of Mathematics & Science made an additional broad statement regarding graduate programs:

The graduate programs of the Physics Department were evaluated positively by the reviewers. The reviewers noted that the graduate programs in Physics were comparable to other programs in Canada, and they noted that the graduate programs were research focused, and that the MSMP was innovative and outstanding. They noted that the small size of the department with a focus on condensed matter physics provided students opportunities for research and publication that were not available at larger institutions with comparable sized programs.

C. Opportunities for Improvement and Enhancement

Recommendation #1

The department should consider opening the MSMP program to domestic students.

The Department responded:

> We're pleased that throughout the Review, the Reviewers appreciate the importance of this program to the Department's overall success. The program is however space-limited in that we only have one of each of the research-grade experimental equipment. We must manage scheduling the equipment carefully.

The Senate Graduate Studies Committee responded:

> This recommendation pertains to the MSMP graduate program. However, it is for the consideration of the faculty and department, and outside of the purview of SGSC, though we support efforts for growth and diversity in graduate training.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

> I fully support this recommendation and would like to see the program explore expansion of this to domestic students. The enrolment of this MSc in Materials Physics has not been strong. It would be helpful to the overall graduate programs in Physics to see increased enrolments for students in their courses and programs. This would also further support the strategic priorities of the institution centered on transformative and accessible academic and university experience as well as fostering a community of inclusion, accessibility, reconciliation and decolonization.

The Dean of Mathematics & Science responded:

> We agree with the recommendation to have the MSMP program open to domestic students. Nevertheless, space, equipment, and personnel requirements must be considered; the technical support for the MSMP program is a minimum requirement to allow an increase in enrollment in this program.

ARC Disposition of the Recommendation

ARC considers the recommendation to expand the MSMP program to allow for domestic students be accepted and in the process of implementation. The Committee expects that the Department will proceed through normal channels of advocacy for any associated space requirements.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #2

The department should evaluate the viability of the combined majors programs.

The Department responded:

> The no-cost combined Major programs are often just an afterthought carried forward from previous iterations of the Undergraduate Calendar. They are difficult to find as an option within Brock's external recruiting effort, with only a passing mention as being possible in the public viewbook, and are not mentioned in *brocku.ca/programs*. We hope that the Brock's Administration and Senate can provide more strategic guidance on the importance of such programs to the University going forward, and help us reach out and educate prospective students of the benefits of these programs.

The Dean of Mathematics & Science responded:

> We will evaluate with all four departments whether there actually is a cost to offering these programs and whether there are barriers that prevent students from pursuing them.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee expects that the Department will consider the viability of the combined major programs as part of a larger curriculum review.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #3

We recommend that a thesis be required in the Honours program.

The Department responded:

About 1/4 to 1/3 of our Y4 students participate in PHYS 4F90 or 4F91 thesis research, however, many students who do not still are well prepared to continue onto graduate school.

An ideal long-term goal is to introduce a major research paper 0.5-credit course in Y4, mandatory for all students not already involved in a PHYS 4F90/91 thesis project. In 2022, we have begun a process of creating a four-year framework for writing for research, touching every aspect of professional scientific communication from lab reports in Y1-Y4, to literature reviews, poster presentations, and seminars in undergraduate and graduate courses. We have not yet implemented such a Y4 course, as we need to work through the implications of making this course mandatory, should this credit replace other advanced undergraduate courses.

The Dean of Mathematics & Science responded:

Honours theses are no longer required in multiple FMS Honours programs, although students with interests in research are highly encouraged to participate.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted for consideration. The Committee believes that the Department is best placed to determine the feasibility of a thesis being required.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #4

The department should consider offering both an algebra-based and a calculus-based stream to students in first year.

The Department responded:

In June 2022 we have been in discussion[s] with the new Department of Engineering on their request for two separate sections each of Introductory Physics I and II with Labs. We have already identified this cohort of students as the best and most likely opportunity at creating calculus based introductory Physics that would also benefit our majors.

The Dean of Mathematics & Science responded:

Development of Engineering will provide opportunities to adjust the content of the Physics undergrad program.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee encourages the Department to continue working with the Yousef Haj-Ahmad Department of Engineering as they undertake these curriculum changes.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #5

That the Major and Honours programs require COSC 1P02 [Introduction to Computer Science] and the [Introduction to] Scientific Computing course ([PHYS] 4P10).

The Department responded:

In addition to the scientific writing framework discussed above, it is our mid-term goal to create a four-year framework in computation, developing skills that are useful to physics majors in their post-graduation careers. (cf. AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum.) Our goal for the next two years is to strike a team to determine the technology suitable for use in theory and lab courses, how they will be used across the degree program, and in which courses such training should take place.

The Dean of Mathematics & Science responded:

Adding opportunities to incorporate and hone computing skills is desirable in all FMS programs. Development of Engineering will provide opportunities to adjust the content of the Physics undergrad program.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted for consideration. The Committee expects that the Department will consider requiring COSC 1P02-Introduction to Computer Science and PHYS 4P10-Introduction to Scientific Computing as part of a larger curriculum review.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #6

We recommend the use of key software: Matlab, LaTeX, MS, Python, and Mathematica / Maple.

The Department responded:

As stated in our response to #5, it is our mid-term goal to create a four-year framework in computation, developing skills that are useful to physics majors in their post-graduation careers. (cf. AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum.) Our goal for the next two years is to strike a team to determine the technology suitable for use in theory and lab courses, how they will be used across the degree program, and in which courses such training should take place.

The Senate Graduate Studies Committee responded:

This recommendation likely pertains to both undergraduate and graduate programs. However, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

Decisions such as these fall outside of FGS' purview.

The Dean of Mathematics & Science responded:

The Physics department has indicated they will investigate the suitability of additional programs keeping in mind career prospects after graduation. We agree with their approach.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted for consideration. The Committee expects that the Department will consider the use of key software as part of a larger curriculum review.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #7

That the department evaluate course offerings with an eye on streamlining courses.

The Department responded:

In May and June 2022, we have been consulting with the Department of Mathematics and Statistics, who have been providing us with course outlines and exams of courses taken by Physics majors. This will inform a thorough review of our required and elective math courses, which will help us begin to streamline the program by identifying which required courses would be better as electives, and which defunct courses might become viable again.

The Senate Graduate Studies Committee responded:

This recommendation pertains to both undergraduate and graduate programs. However, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

I fully support this recommendation as it pertains to graduate course offerings. The reviewers suggest that only required courses be offered annually and other courses biennially. It is important that students have a clear picture of their academic journey and the availability of courses. Moreover, streamlining and clarifying when required courses are offered helps students to manage their progression and complete their program in a timely manner.

The Dean of Mathematics & Science responded:

The Department is currently evaluating course offerings and how often they should be offered.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee encourages the Department to continue working with the Department of Mathematics and Statistics and others as they evaluate their course offerings.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #8

Remove courses not offered in the past six years from the calendar.

The Department responded:

As stated in our response for #7, In May and June 2022, we have been consulting with the Department of Mathematics and Statistics, who have been providing us with course outlines and exams of courses taken by Physics majors. This will inform a thorough review of our required and elective math courses, which will help us begin to streamline the program by identifying which required courses would be better as electives, and which defunct courses might become viable again.

The Senate Graduate Studies Committee responded:

This recommendation pertains to both graduate and undergraduate course offerings. It is consistent with the Faculty Handbook 3B. Graduate Academic Regulations 4.4. Course Deletions, in that courses not taught for five years, and not being taught in the 6th year are removed from the calendar by SGSC unless exceptions are sought by department and approved by the committee.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

I fully support this recommendation. As mentioned in my previous response, it is important for students to know what courses are available to them. This is integral to progression, recruitment, and retention.

The Dean of Mathematics & Science responded:

We agree with streamlining the calendar. Adjustments are already being made to the 2023 Undergraduate Calendar in response to this recommendation.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee again encourages the Department to continue working with the Department of Mathematics and Statistics and others as they evaluate their course offerings.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #9

The review team strongly recommends that the department should avail themselves of the resources of the Brock Library to integrate library or information literacy skills into the curriculum.

The Department responded:

> The four-year scientific communication framework, discussed above, will certainly incorporate library research skills and writing for the lay public (ie. #scicomm), a recent development in writing-for-research pedagogy. The Library, CPI, and Co-op resources will be an important part of our framework.

The Dean of Mathematics & Science responded:

> The Department is currently considering how incorporate more writing experience into their pedagogical framework.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee expects that the Department will work with the Library to utilize the resources of this unit to integrate information literacy skills into the curriculum.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #10

The department should work with the Centre for Pedagogical Innovation and Co-op / Experiential Education group to bolster communication and professional skills.

The Department responded:

As stated in our response for #9, the four-year scientific communication framework, discussed above, will certainly incorporate library research skills and writing for the lay public (ie. #scicomm), a recent development in writing-for-research pedagogy. The Library, CPI, and Co-op resources will be an important part of our framework.

The Senate Graduate Studies Committee responded:

This recommendation likely pertains to both undergraduate and graduate programs. However, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

FGS supports this recommendation and the Department's response.

The Dean of Mathematics & Science responded:

We agree with the Physics department's response to this recommendation, whereby they indicate how they will implement this recommendation.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee again expects that the Department will work with CPI, CCEE, and the Library, to utilize the resources of these units to bolster communication and professional skills within the curriculum.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #11

The department should work to develop a Strategic Plan which includes an analysis of faculty workload.

The Department responded:

We acknowledge the increased reliance of sessional instructors for Y1 courses for a variety of reasons, including a number of recent retirements, massive growth in Astronomy 1P01/1P02, and plans to incorporate computational and Y4 thesis courses. We are also planning for additional growth from Engineering sections of Y1 Physics with a request for an additional ILTA position.

The current resource-based budget model should provide good justification to continuing to offer our Astronomy courses, and as MSMP becomes more stable, we may have room to consider hiring outside condensed and soft matter physics.

A strategic plan to manage these changes is appropriate.

The Senate Graduate Studies Committee responded:

This recommendation is operational and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

This falls outside of FGS' purview; however, I appreciate the Department's response.

The Dean of Mathematics & Science responded:

We agree with this recommendation.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted. The Committee believes that the Department is best positioned to determine appropriate strategies to move forward with developing a Strategic Plan.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #12

The department should conduct a thorough inventory of Mathematics courses required for degree completion and the topics therein.

The Department responded:

As stated in our responses for #6 and #7, In May and June 2022, we have been consulting with the Department of Mathematics and Statistics, who have been providing us with course outlines and exams of courses taken by Physics majors. This will inform a thorough review of our required and elective math courses, which will help us begin to streamline the program by identifying which required courses would be better as electives, and which defunct courses might become viable again.

The Dean of Mathematics & Science responded:

The Department is currently evaluating course offerings and adjustments to the undergrad program, especially with respect to the development of the Engineering program.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted an in the process of implementation. The Committee expects that the Department will conduct a thorough inventory of Mathematics courses required for degree completion as part of a larger discussion about curriculum.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #13

The review team recommends that graduate students be trained explicitly in ethical norms.

The Department responded:

As part of our work on laboratory and communications skills frameworks, we will incorporate training in scientific and academic integrity.

The Senate Graduate Studies Committee responded:

This recommendation pertains to graduate programs in Physics and is consistent with Brock's Degree Level Expectations, however, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

I support the recommendation and the Department's response as it is an important aspect of graduate education and, as stated in the SGSC response, consistent with our DLEs.

The Dean of Mathematics & Science responded:

We agree with the Physics department's response to this recommendation, whereby they indicate how they will implement this recommendation.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted. The Committee believes that the Department is best positioned to determine appropriate strategies, consistent with Brock's DLEs, to train graduate students explicitly in ethical norms.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #14

Add [PHYS] 5N01 [Scientific Writing] as a required course in the thesis-based MSc program.

The Department responded:

We will consider adding this requirement to the program.

The Senate Graduate Studies Committee responded:

This recommendation pertains to graduate programs, and is consistent with Brock Graduate Degree Level Expectations, however, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

I appreciate the Department's consideration of the recommendation. I suggest that exploring this in context of the broader PhD and Masters' programs requirements.

The Dean of Mathematics & Science responded:

We agree with the Physics department's response to this recommendation, whereby they indicate they will consider this recommendation.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted for consideration. The Committee encourages the Department to work with the Faculty of Graduate Studies to explore adding PHYS 5N01-Scientific Writing as a required course within the context of the broader PhD and Masters' program requirements.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #15

The department should seek avenues to boost program enrolments.

The Department responded:

We concur with the Reviewers that our community engagement should highlight the offerings of Physics. We will strive to improve our recruitment and retention, including rebuilding the inclusive social community of students in MCB203 we enjoyed pre-pandemic, and connecting more with Physic educators in the GTA.

The Senate Graduate Studies Committee responded:

This recommendation pertains to both undergraduate and graduate programs and is consistent with Brock's Strategic Plan. However, it is for the consideration of the faculty and department, and outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

Given the low enrolments in the graduate programs in Physics, FGS would be happy to work with the Department around marketing and recruitment strategies to support their efforts.

The Dean of Mathematics & Science responded:

> We agree with the departmental response – they are planning to use outreach opportunities to facilitate student intake.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee expects that the Department will work with the Faculty of Graduate Studies and the Office of Student Recruitment to determine appropriate strategies to boost program enrolments.

Implementation Plan (1st Priority)	
Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics & Science to report by the end of academic year 2022/23.

Recommendation #16

The Faculty of Mathematics and Science should provide financial resources to the department to hire technical support for the MSMP program.

The Department responded:

> We have already been approved at the Dean level for a contract Instructor/Technician position paid from MSMP revenue for the 2022/23 academic year, however budget mitigation measures at higher administrative levels have made this uncertain.

The Senate Graduate Studies Committee responded:

> The recommendation is financial and pertaining to the workload of a particular BUFA member and is therefore outside of the purview of SGSC.

The Vice-Provost and Dean, Faculty of Graduate Studies responded:

> While this falls outside of FGS' purview and is up to the FMS to determine and approve resourcing, I recommend that rethinking expanding enrolment to domestic students to support growth in enrolment might be helpful for increasing resources for this program.

The Dean of Mathematics & Science responded:

> The technical support for the MSMP program is a minimum requirement to allow an increase in enrollment in this program.

ARC Disposition of the Recommendation

ARC considers the recommendation to be not accepted as it lies outside of the Committee's jurisdiction. The Committee expects that the Department will proceed through normal channels of advocacy for increased resources.

Implementation Plan
Recommendation not accepted as it lies outside of the Committee's jurisdiction.

D. Summary of Recommendations:

First Priority:
Recommendation(s) 1-15

Not Accepted:
Recommendation(s) 16

Appendix A

Physics
Cyclical Academic Review
Brock University

April 11, 13, 14, 2022
Via Videoconference (Microsoft Teams)

Meeting Connection Information:	
Platform:	Microsoft Teams
Meeting Name:	Review-PHYS
Join by Video:	Click here to join the meeting
Video Conference ID:	117 056 244 5
Join by Audio:	1-888-862-4985 CANADA
Phone Conference ID:	947 446 281#
Find a Local Number:	Find a local number |

FINAL SCHEDULE

Monday, April 11	
10:30–11:15am	**Review Team Orientation** Brian Power, Vice-Provost and Associate Vice-President, Academic Ejaz Ahmed, Dean, Faculty of Mathematics and Science Christina Phillips, Manager, Quality Assurance
11:15–11:30am	Transition
11:30-12:00pm	**Department Chair** Thad Harroun, Professor
12:00–1:00pm	**Lunch Break**
1:00–1:30pm	**Faculty** Shyamal Bose, Professor and Associate Dean, Undergraduate Programs Kirill Samokhin, Professor
1:30-1:45pm	Transition
1:45–2:15pm	**Faculty/Advising Discussion** David Crandles, Professor Ed Sternin, Associate Professor
2:15–2:30pm	Transition
2:30–3:00pm	**Faculty** Ganesh Ramachandran, Assistant Professor Barak Shoshany, Assistant Professor

3:00-3:45pm	Discussion/Writing time
3:45-4:15pm	**Library** Andrew Colgoni, Associate University Librarian, Student Success Ian Gordon, Liaison Librarian, Physics
Wednesday, April 13	
11:15–11:45am	**Technical** Ivana Metcalf, Senior Laboratory Coordinator/Demonstrator Phil Boseglav, Laboratory Demonstrator
11:45–12:45pm	**Lunch Break**
12:45-1:15pm	**Co-op, Career and Experiential Education** Cara Krezek, Director, Co-op, Career and Experiential Education
1:15-1:30pm	Transition
1:30-2:15pm	**Faculty/Graduate Programs Discussion** Maureen Reedyk, Professor and Graduate Program Director Feridoon Razavi, Professor
2:15-2:30pm	Transition
2:30-3:30pm	**Meeting with Students**
3:30-3:45pm	Transition
3:45–4:30pm	**Meeting with Vice-Provost, Graduate Studies & Dean, Faculty of Graduate Studies** Suzanne Curtin
4:30-5:00pm	**Administrative Support** Elizabeth Horvath, Administrative Assistant (Retired) Courtney Lee, Administrative Assistant
Thursday, April 14	
10:30–11:00am	**Meeting with Dean, Faculty of Mathematics and Science** Ejaz Ahmed
11:00-11:15am	Transition
11:15–12:00pm	**Meeting with Provost & Vice-Provost, Academic** Lynn Wells, Provost and Vice-President, Academic Brian Power, Vice-Provost and Associate Vice-President, Academic
12:00–1:30pm	Lunch/Writing time
1:30-2:30pm	**Department Chair** Thad Harroun, Professor

Reviewers:	
Mark Gallagher	Professor and Chair Department of Physics Lakehead University
David Feder	Associate Professor Department of Physics University of Calgary
Karen Campbell	Associate Professor Department of Psychology Brock University

APPENDIX B

Four Year Report (2020)

Physics
Graduate and Undergraduate Programs
(reviewed 2013-16)

A. Summary of Review

This review was conducted under the terms and conditions of the IQAP approved by Senate on June 6, 2011.

1. The academic programs offered by the Department of Physics which were examined as part of the review were:

   BSc in Physics
   BSc in Physics with concentration in Applied Optics and Laser Technology
   BSc in Biophysics
   BSc in Computing and Solid-State Device Technology
   BSc/BEd (I/S)
   MSc in Physics
   PhD in Physics
2. The Review Committee consisted of: Jeff Hutter (University of Western Ontario), Frank Marsiglio (University of Alberta) and an internal reviewer, Stefan Brudzynski (Brock University).
3. The site visit occurred on March 30-Apr 1, 2016.
4. The Final Assessment Report was approved by Senate on April 12, 2017.
5. The reviewers assigned the programs as follows:

   Good Quality:
   BSc in Physics
   BSc in Biophysics
   BSc in Computing and Solid-State Device Technology
   BSc/BEd (I/S)
   MSc and PhD in Physics

   Non-Viable:
   BSc in Physics with concentration in Applied Optics and Laser Technology

6. The next review of the graduate and undergraduate programs in the Department of Physics will be in 2021/22.

B. Recommendations

Recommendation #1

We recommend that an additional faculty member, specifically in the area of biophysics, be hired into Physics in advance of the next retirement, if possible.

ARC Disposition of the Recommendation
ARC considers the recommendation to be worthy of consideration but outside of the jurisdiction of the Committee. It is expected that the program will proceed through normal channels of advocacy for these faculty resources.

Implementation Plan
Recommendation not accepted.

Recommendation #2

We recommend a careful evaluation and overhaul of the first-year Physics offerings, particularly in Physics 1P21/1P91.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted and in the process of implementation. The Committee encourages the Department to continue its curriculum review, utilizing the curriculum map developed for the Self Study, to review first year Physics offerings as well as address several of the Reviewers' following recommendations.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Form a curriculum review subcommittee.	2016	2017
Action #2 Review curriculum. Prepare to make changes.	2016	
Action #3 Redesign the final exam format.	2016	2017

Explanation of Actions Taken, Status and Results:

The Curriculum Review Subcommittee was formed in 2016 and continues its work, bringing it to the full Departmental Committee on several occasions.
Y1 Physics offerings have been overhauled: instead of PHYS 1P21/91, PHYS 1P22/92, and PHYS 1P23/93, the Department now offers two algebra-based Introductory Physics courses PHYS 1P21/91 and PHYS 1P22/92, as well as calculus-based, Physics-majors-oriented, course PHYS 1P94.
In addition to a considerable redistribution of material, other Y1 pedagogical changes include reformulation of midterm and final exams to offer more single-step problems, as well as moving pre-lab homework for PHYS 1P91 to WeBWork (see also Recommendation #4). The impact of these changes, and that of PHYS 1P94, which was offered for the first time in Winter 2019, is still being assessed.

Recommendation #3

We recommend the use of *Matlab*, and possibly *Maple*, software for numerical work and computations in Physics courses.

ARC Disposition of the Recommendation
ARC considers the recommendation to use these particular software packages to be not accepted. The Committee believes that the Department is best positioned to determine which software to use and when it should be introduced in order to graduate students who are proficient with computational tools and methods.

Implementation Plan
Recommendation not accepted.

Recommendation #4

The labs in first- and second-year Physics courses require some adjustment/attention.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted and in the process of implementation. The Committee expects that the curriculum review referenced in response to Recommendation #2 will also address first- and second-year labs.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Identify issues and ways to improve labs.	2016	
Action #2 Ensure instructors maintain supervision of labs in their courses.	2016	
Action #3 Move pre-lab homework to WeBWorK.	2016	2019

Explanation of Actions Taken, Status and Results:

Adjustments to the labs and the pre-lab homework are developed on an ongoing basis by the Y1 and Y2 instructors and the Physics Lab Demonstrators. In particular, the pre-lab homework for PHYS 1P91 has been moved to WeBWork and, as a consequence of the Y1 curricular change (see Recommendation #2), the Y1 labs have been rearranged.
Although instructors are encouraged to keep a close eye on the labs in their courses, and try to include materials relevant to the labs in the lectures and homework, the volume of work required makes it difficult to achieve and equipment limitations do not currently allow us to offer all labs in sequence.
A major revision of PHYS 2P20 labs is currently being implemented and two Electronics lab courses, PHYS 2P31 and PHYS 2P32, have been merged into one new course PHYS 2P30, to begin in 2020/21.

Recommendation #5

We recommend that the Dept. of Physics discuss coordination of the coverage of topics in required courses offered by the Dept. of Mathematics.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted and in the process of implementation. The Committee expects that the Departments of Physics and Mathematics and Statistics will continue to explore opportunities for cooperation.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	ear Action Started	Action Completed
Action #1 Communicate with Math to ensure appropriate learning objectives in Math service courses for Physics.	2016	
Action #2 Supplement Math offerings with Mathematical Methods in Physics course in the Physics Department.	2016	2017

Explanation of Actions Taken, Status and Results:

The Physics and Math departments communicate regularly and productively (the latest meeting of the Physics and Math representatives on the curriculum matters took place in January 2020).
We continue to monitor the math skills of Physics students and intend to keep offering PHYS 3P94 Mathematical Methods in Physics as a supplemental/remedial course.

Recommendation #6

We recommend that all senior students majoring in Physics be required to enroll in either the senior thesis course or another project course that requires written work and/or presentations.

ARC Disposition of the Recommendation
ARC considers the recommendation accepted for consideration by the Department. The Committee expects that the curriculum review referenced in response to Recommendation #2 will consider the possibility of a senior thesis or project course for all Physics majors.

Implementation Plan (2nd Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2017/18

Actions Taken	Year Action Started	Year Action Completed
Action #1 Introduce a Y4 major project course, mandatory for students not completing PHYS 4F90/91 theses.		

Explanation of Actions Taken, Status and Results:

Although our long-term goal is to introduce a Major Research Paper half-credit course in Y4, mandatory for all students not already involved in a PHYS 4F90/91 thesis project, we had to postpone its implementation. We need to work through the implications of this course, e.g., whether our graduates will have adequate preparation for graduate school if this credit is used to replace some of the advanced undergraduate courses. Also, the Department does not currently have adequate human resources to offer this course.

The Department is encouraging individual Y3 and Y4 instructors to implement term projects/presentations whenever possible in upper-year courses, to implement the spirit if not the letter of the Recommendation.

Recommendation #7

We suggest that certain rooms (even labs) be set aside for use as classrooms on an as-needed basis to reduce timetable conflicts.

ARC Disposition of the Recommendation
ARC considers the recommendation to be worthy of consideration but outside of the jurisdiction of the Committee. The Committee expects that the Department, with the assistance of the Dean, will proceed through normal channels of advocacy to address this recommendation.

Implementation Plan
Recommendation not accepted.

Recommendation #8

We suggest that the Department provide students with outlines of suggested timetables and degree paths for their programs.

ARC Disposition of the Recommendation
ARC considers the recommendation to be current practice. The Committee encourages the program to promote the location of the degree path information to Physics students.

Implementation Plan
No further action required.

Recommendation #9

We recommend the elimination of low enrolment courses to reduce teaching needs and/or free up resources for teaching duties either in first-year or in the new course-based MSc program.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted for consideration by the Department. The Committee expects that the curriculum review referenced in response to Recommendation #2 will consider the future of low enrolment courses and the deployment of teaching resources.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	ear Action Completed
Action #1 Advocate for an additional tenure-track position in the Department of Physics.	2016	

Explanation of Actions Taken, Status and Results:

The Department strives to maintain a balance between offering large popular money-making courses and low-enrolment courses needed to maintain the integrity of our undergraduate and graduate programs.
To balance the quality of our programs with the personnel constraints (note that we graduate slightly more majors per year, per faculty member, than most Physics Departments in the country), the Department is continually reviewing our course offerings. Several courses (PHYS 3P90, PHYS 3P94) have been moved to an alternating-years pattern and two Y2 Electronics courses have been merged into one (PHYS 2P30). To ensure success of the recently launched course-based ISP Master's program in Materials Physics (MSMP), an additional experimental tenure-track position is required.

Recommendation #10

Unless a new injection of will occurs in the immediate future, we recommend termination of the combined program with the Niagara College of Applied Arts and Technology.

ARC Disposition of the Recommendation
ARC considers the recommendation to terminate the program with Niagara College to be not accepted as there has been a new injection of will from the Department, Dean's Office and counterparts at Niagara College. The Committee understands that a new agreement is being negotiated which will utilize the resources of both institutions to develop a strong, viable program.

Implementation Plan (1st Priority)

Responsible for approving:	Department, Dean
Responsible for resources:	Department, Dean
Responsible for implementation:	Department, Dean
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Communicate with NC to develop an alternate course sequence for Y3 of the Photonics program.	2016	2017
Action #2 Renew the MOA with NC based on the revised program.		

Explanation of Actions Taken, Status and Results:

The Photonics (Concentration in Applied Optics and Laser Technology) program has been terminated, since the MOA with Niagara College has not been renewed.
Given Brock's newly expressed interest in developing engineering programs, Photonics may be revived in the future.

Recommendation #11

Every effort should be made to continue and enhance both online and in-class delivery of the first-year Astronomy course, which has been a resounding success.

ARC Disposition of the Recommendation
ARC considers the recommendation to be accepted. The Committee encourages the Department to advocate for the resources necessary to continue and enhance the delivery of the first-year Astronomy course.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Renew ILTA position for a three-year term.	2018	2019
Action #2 Revise and renew ASTR online content as necessary.	2016	

Explanation of Actions Taken, Status and Results:

In 2019, the ILTA position teaching Astronomy courses was renewed for another three years. The content of the online ASTR course is constantly being revised and updated. In particular, the video lectures have been re-recorded with better quality.

Recommendation #12

We recommend that the Faculty lobby on behalf of its departments to locate dedicated IT staff in the Faculty of Mathematics and Science to serve the needs of the departments concerning local issues.

ARC Disposition of the Recommendation

ARC considers the recommendation to lobby for dedicated IT staff in the Department to be accepted and in the process of implementation. The Committee recognizes that the lack of IT resources is having a negative effect on the academic quality and viability of the Physics programs. The Committee believes that this issue is of high importance and will bring it to the attention of the Senate Information Technology and Infrastructure Committee and include it in the next ARC Semi-Annual Report to Senate.

Implementation Plan (1st Priority)

Responsible for approving:	Department, Dean of Mathematics and Science
Responsible for resources:	Department, Dean of Mathematics and Science
Responsible for implementation:	Department, Dean of Mathematics and Science
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	ear Action Completed
Action #1 Improve communications with ITS Linux support.	2016	
Action #2 Continue to lobby for dedicated IT support @ FMS.	2016	

Explanation of Actions Taken, Status and Results:

Despite some improvements in the interaction with ITS, the Department continues to be concerned about the fragility of its IT-dependent commitment to online, computing-intensive teaching (there continues to be a sole individual within ITS that responds to all Linux requests, among his many other duties).
The Department continues to strongly advocate for a dedicated IT support staff in the FMS.

Recommendation #13

We recommend that resources continue to be allocated to the Faculty of Mathematics and Science machine and electronic shops and that some provision be provided to allow graduate students more hands-on experience in these shops.
ARC considers this recommendation to be in two parts.

a. The Committee considers the recommendation to allocate resources for machine and electronic shops to be not accepted as it lies outside the jurisdiction of the Committee.

Implementation Plan
Recommendation not accepted.

b. The Committee considers the recommendation to make some provisions to allow graduate students more hands-on experience in these shops to be accepted. ARC expects that the Department is best-positioned to determine strategies to move forward with this part of the recommendation.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Continue to support FMS Tech Services.	2016	
Action #2 Discuss student access with Head of Mech Shop	2016	2017

Explanation of Actions Taken, Status and Results:

The existing arrangement of Physics students having access to tools and expertise of the Electronic Shop continues. However, allowing graduate or undergraduate students access to Mechanical or Glassblowing shops is not possible due to liability concerns, and a lack of sufficient personnel to provide training and ensure safety.

The Department anticipates involvement of the FMS Tech Services in the delivery of the new undergraduate Certificate in Applied Physics, which is currently under development.

Recommendation #14

We recommend that communication increase between the Department and the Library, both to prioritize holdings and to facilitate the training of graduate students and students in undergraduate thesis projects in the effective use of Library facilities.

ARC Disposition of the Recommendation

ARC considers the recommendation to be accepted and in the process of implementation. The Committee encourages the Department Library representative and GPD to work with their Liaison Librarian on a strategy to address this recommendation.

Implementation Plan (1st Priority)

Responsible for approving:	Department
Responsible for resources:	Department
Responsible for implementation:	Department
Timeline:	Dean of Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	Year Action Completed
Action #1 Continue to communicate with the Subject Librarian on acquisitions.	2016	
Action #2 Implement mandatory Library orientation for students.	2016	2019

Explanation of Actions Taken, Status and Results:

All incoming graduate students, including the students in the ISP Master's program in Materials Physics (MSMP), are now required to complete Library Orientation. We appreciate the efforts of the Physics Librarian in supporting this initiative.
An Introduction to the Library is one of the topics under consideration for the new Physics-majors-oriented Y1 course (PHYS 1P94).

Recommendation #15

We recommend that the new Materials Physics course-based MSc program be carefully monitored to assess its usefulness, and whether or not it is detrimental to the other programs in Physics.

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 Mathematics and Sciences to report by the end of academic year 2016/17

Actions Taken	Year Action Started	ear Action Completed
Action #1 Improve communications with International Recruitment.	2016	
Action #2 Monitor enrollments and impact on teaching loads.	2016	

Explanation of Actions Taken, Status and Results:

While the MSMP enrollment has continued to grow for the third straight year, the program is approaching its capacity. So far the MSMP impact on teaching loads has been mitigated by streamlining the Y1 and Y2 offerings and involving the Physics Senior Lab Demonstrator in delivering PHYS 5P92. However, further growth, including diversifying the experimental techniques taught, will only be possible with injection of new resources, in particular with hiring an additional experimental tenure-track faculty, continuing to invest in new lab equipment, and maintaining the commitment to hire a Lab Technician focused on the MSMP labs.

Although the Chair and the Graduate Program Director have had several fruitful discussions with the International Services representatives about boosting the MSMP recruitment efforts, the overall marketing and recruitment strategy needs a significant qualitative improvement. One possibility would be to hire a dedicated FMS ISP Recruitment Officer in charge of promoting the program and coordinating contacts with

educational recruiters overseas.

Recommendation #16

We suggest that Department money be set aside to provide "Departmental USRAs," to attract even more students to summer research positions.

ARC Disposition of the Recommendation

ARC considers the recommendation to be not accepted as it lies outside the jurisdiction of the Committee. The Committee expects that the Department will use its funds as it deems appropriate.

Implementation Plan

Recommendation not accepted.

C. Unit Summative Analysis and Evaluation

1. To what extent has the Unit achieved the improvements suggested by the reviewers?

The Department has completed the majority of the actions suggested by the reviewers. We will continue to work with the Faculty of Math and Science and other units on the ongoing implementation of the remaining recommendations. In particular, the Department is (i) constantly reviewing the Y1 Introductory Physics and Astronomy courses, as well as Y1 and Y2 Physics labs (Recommendations 2, 4, and 11), (ii) regularly communicating with the Math Department on the service curriculum matters (Recommendation 5), and (iii) striving to balance the expansion of the cost-recovery MSMP program with the existing resource limitations (Recommendations 9, 12, and 15).

2. What overall impact has it had on the Unit's programs?

The Department believes that as a result of implementing the recommendations, all Physics programs remain of Good Quality, with the exception of BSc Physics with Concentration in Applied Optics and Laser Technology which was terminated in 2019.

3. Is the Unit adopting a process of continuous quality improvement for its programs?

Yes. The Department as a whole and the Curriculum Review Committee meet regularly to discuss the curriculum changes and the program delivery and development issues. We continually seek feedback from our current and former students in order to improve the quality of our programs.

4. How well do the programs now align with Brock University strategic priorities?

The implementation of the reviewers' recommendations has strengthened the Physics academic programs. For example, the Y1 and Y2 curriculum changes have diversified our offerings and enhanced the students' experiences with state-of-the-art undergraduate laboratories. This fits into the University's strategic goal of offering a transformational and accessible academic and university experience.

The Physics graduate programs (MSc, PhD) have maintained the culture of active, high-impact research helping to meet Brock's target of building research capacity across the university. Our newest ISP MSc program in Materials Physics (MSMP) offers globally-oriented programming and has shown exponential growth of enrollment since 2016.

5. How does this review and its results position the programs as the Unit moves into the next review cycle?

This review offered the Department an opportunity to assess our strengths and needs for improvement, as well as directions for growth. While striving to constantly improve our existing undergraduate and graduate programs through a continuous curriculum review, we have also been working to develop new and innovative programs. The latter include an undergraduate Certificate in Applied Physics, which is expected to attract a significant number of students, both international and domestic, especially new immigrants wishing to upgrade their skills, and also a course-based MSc program in Physics. In order to keep providing high quality individual-oriented education and hands-on training to all our students, the Department needs additional resources, which was recognized and recommended by the reviewers.

D. ARC Final Summary

In final summary of the 2013-16 cyclical academic review of the programs offered by the Department of Physics, 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.