

FINAL ASSESSMENT REPORT

**PERIODIC PROGRAM REVIEW (PPR)
Bachelor of Science (B.Sc.)
In Mathematics and its Applications
Faculty of Science**

In accordance with the Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response and assessments of the undergraduate **Mathematics and its Applications** program. The report identifies the significant strengths of the program, together with opportunities for program improvement and enhancement, and it sets out and prioritizes the recommendations that have been selected for implementation.

The Implementation Plan identifies who will be responsible for leading the implementation of the recommendations; who will be responsible for approving and providing any resources entailed by those recommendations; and timelines for acting on and monitoring the implementation of the recommendations.

A) SUMMARY OF THE PERIODIC PROGRAM REVIEW OF THE MATHEMATICS AND ITS APPLICATIONS PROGRAM

The Mathematics and its Applications program submitted a self-study report to the Vice-Provost Academic on March 12, 2019. The self-study presented the program descriptions and learning outcomes, an analytical assessment of the program, and program data including the data collected from a student survey along with the standard University Planning data tables. Appended were the course outlines for all core required and elective courses in the program and the CVs for all RFA faculty members in the department.

Two external arm's-length external reviewers (Dr. Javad Mashreghi, Professor, Mathematics and Statistics, Faculty of Science and Engineering, Laval University, and Dr. Lisa Jeffrey, Professor, Mathematics, Faculty of Arts and Science, University of Toronto-Scarborough) and one internal reviewer (Dr. Stephen Waldman, Professor, Chemical Engineering, Faculty of Engineering and Architectural Science) were appointed by the Dean of the Faculty of Science from a set of proposed reviewers. They reviewed the self-study documentation and then conducted a site visit at Ryerson University on November 13-14, 2018.

The visit included meetings with the Provost and Vice-President Academic; Vice-Provost Academic; Dean, Faculty of Science; Chair, Mathematics and its Applications; and library staff. The PRT also met with several members of the department including staff and faculty members, as well as students and alumni. A general tour of the campus was provided, including the undergraduate teaching facilities and laboratories.

In their report, dated December 20, 2018, the Peer Review Team (PRT) provided feedback that describes how the Mathematics and its Applications program meets the IQAP evaluation criteria and is consistent with the University's mission and academic priorities. The Peer Review Team (PRT) indicated the current program is relevant to society at large and produces graduates capable of moving into a variety of fields, both in academia and in industry. The curriculum is generally comprehensive and includes well-organized lab components and an option for co-op placement.

The main areas of strength identified by the PRT include:

- Successful in training qualified personnel for various corners of the commercial centers within the GTA;

- Professors and students collaborate very well;
- Positive feedback from students about the department, its atmosphere and the quality of instruction;

The PRT also identified areas for improvement, specifically, the program is neither a traditional pure mathematics program nor a traditional applied mathematics program. This appears to result in students falling into two distinct groups: those aligned with either ‘applied’ or with ‘pure’ mathematics, which may require more clearly defined ‘frontiers’, with the option to move back and forth if students so choose.

The Chair of the Mathematics and its Applications program submitted a response to the PRT Report on January 24, 2019. The response to both the PRT Report and the Program’s Response was submitted by the Dean of Science on March 8, 2019.

The Academic Standards Committee completed its assessment of the Mathematics and its Applications Program Review on May 2, 2019. The Committee indicated that a thorough, analytical and self-critical program review was conducted. The School integrated into the developmental plan feedback from students, alumni, and peer reviewers, and outlined a comprehensive plan for program enhancements moving forward.

The Academic Standards Committee recommends that the program continues, as well as provide a one-year and a two-year follow-up report, as follows:

The one-year follow-up report, due June 30, 2020 is to include:

1. A status report on the initiatives outlined in the Implementation Plan, including changing options to an appropriate alternative (minors, concentrations, majors – see Senate Policy 2);
2. Updated course outlines; and
3. A status report on the new communications course.

The two-year follow-up report, due June 30, 2021 is to include:

1. Employment data for graduates of the Mathematics and its Applications program.

Presented to Senate for Approval: **June 4, 2019**

Start date of next Periodic Program Review: **2024-25**

B) SUMMARY OF THE REVIEWERS’ RECOMMENDATIONS WITH THE PROGRAM’S AND DEAN’S RESPONSES

RECOMMENDATION 1.

It is recommended, with high priority, that the University considers consolidating space for the Mathematics department. In addition, for the sake of integrity, social and academic life, it is recommended that the University considers creating new (dedicated) space for the students.

Department Response: The department agrees with this recommendation wholeheartedly. We realize that a long term solution to our space issues will take time, creativity and good will to resolve. In short, there is no quick fix to this challenge, and the department commits to work in good faith on this with the Dean. With regard to the program, we point out that our students may be the only ones in the Faculty that do not have their own dedicated space. The department resolves to engage with both the students and the Dean to meet this recommendation.

Dean’s Response: This is the top priority of the university. There is great momentum towards breaking ground on a new Science building, which has in its plan to consolidate the Mathematics Department. Dedicated Mathematics student space, however is not part of that plan. It could be that some of the vacated space currently occupied by the department could be retrofitted for student occupation. In the shorter term, to accommodate Mathematics

operations, there will be a further dispersing of the department. This involves the move of the department office to Kerr Hall.

RECOMMENDATION 2.

It is recommended that the program considers creating two streams. One in applied mathematics (the existing program) and another in pure mathematics. The existing applied mathematics program should be supplied with more programming and applied courses. The new pure mathematics stream should contain more rigorous courses to enhance the knowledge of students and prepare them for postgraduate studies.

It is also recommended to have a mechanism to allow outstanding students to follow both streams if they wish. It happens quite often that a pure mathematician needs computer language skills, or an applied mathematician feels the necessity of grasping more rigorous results. In such situations, the student should have an option to pursue more courses on the other stream, most possibly at the expense of staying longer in the program.

Department Response: This is the most interesting recommendation by the PRT. Their visit brought to light a certain dichotomy in the attitude of the students about the program. The entire Periodic Program Review (PPR) process shed much light on the program, but it was not until the actual site visit that the department learned how the students who want an 'applied' education feel that the program is not applied enough, while the students wanting more theory felt that the 'pure' aspects of the program did not go far enough.

The department feels that it would be unwieldy to offer two distinct streams as suggested by the report. This program takes in 50 students per year and is therefore a small program. Dividing this group into two smaller subgroups, each with its own individual needs, does not appear to be economically feasible. Rather, through curriculum changes discussed below it is felt that the two groups of students, pure and applied, can be satisfied moving forward. These changes will address the needs of both groups.

Dean's Response: There is a tendency for program review to make suggestions of splitting streams within programs to accommodate different student perceptions, abilities and needs. Sometimes this is practical, sometimes not. At this point in time there does not appear to be sufficient demand or resources to undertake the commissioning of a split stream for mathematics. The department and the Dean are in agreement on this.

RECOMMENDATION 3.

It is recommended that the program should increase the minimum entrance requirements and should revisit the high school courses required for admission.

If the decision is to not change the entrance (high school) course requirements, it is recommended that a mandatory diagnostic test be utilized. For students who do poorly on the diagnostic test, they would either be offered extra help in the summer before enrollment, or placed in a new one-term course that teaches the material of *Calculus & Vectors* which would be a prerequisite for *Calculus I*.

Department Response: The department will explore, with the Registrar's office and the Dean, the idea of changing the enrollment criteria. The addition of *Calculus and Vectors* as a requirement for admission has its appeal and is consistent with the departmental goal of attracting the best students possible. This is not a decision to be made only by the department alone as there may be implications regarding the department's intake goals. It is to be determined how the addition of this extra requirement will affect the number of applications received and how this might influence our enrollment numbers.

Regardless of the outcome the department has recently implemented a diagnostic test given to all first year students. Incoming students are offered help through a summer program, and students who do not do well on the diagnostic test are offered resources through the Math Help Centre to improve their pre-calculus abilities.

Dean's Response: All programs would like to believe that bumping up the entry level GPA will result in a "better quality of student". This may or may not be true and it is unclear how high the GPA would have to rise before a noticeable difference would take place. Moreover, the enrollment corridor makes it challenging for this to be enforced. Indeed it is often that a higher quality (perceived or otherwise) of program attracts a higher quality student. There is also the continuing issue of math fear in K-12 that compels students to avoid mathematics. This

recommendation may be unattainable at present.

RECOMMENDATION 4.

It is recommended to enhance more programming languages (e.g. R, SAS, Python and C++) in the existing courses, or even create new ones to address this issue.

Department Response: In the curricular changes discussed below it will be evident that the department embraces this recommendation. We are actively seeking that R, SAS and Python be added to the program.

Dean's Response: The Dean supports the department response.

RECOMMENDATION 5.

In terms of core course delivery, the PRT suggests offering the existing courses according to the following plan:

Year	Fall Semester	Winter Semester
1	Calculus I Discrete I Science I Liberal	Calculus II Discrete II Science II Liberal
2	Linear Algebra I Statistics I Calculus III	Linear Algebra II Statistics II ODE
3	Analysis	Algebra
4	Complex Analysis	

Department Response: Looking at the included table, one will see that the revised curriculum follows the recommended changes.

Dean's Response: The Dean supports the department response. Additionally, the trading out of a Communications course to an internal "communications" course should also be seriously thought through. The ethos of the CMN course is to help science students communicate to the public. The suggested Math course seems more about communications within the math culture. Both are important. The Dean suggests talking with FCS about making a section of the CMN course more appropriate for math students, if possible. And if not, then communicating math to the public should be integrated into the courses within the math program itself.

RECOMMENDATION 6.

It is recommended that additional TA positions be made available for the program and reduce tutorial section sizes accordingly. As a positive side effect, increasing the number of TA's would have the additional benefit of providing employment for Ryerson mathematics graduate students.

Department Response: The department agrees that tutorial sizes can be overlarge and hopes that the requisite funding is made available to meet this recommendation. The department realizes that in order for this resource to be cost effective it is crucial that the faculty members of the department diligently endeavor to make the best use of it. Spending money on smaller tutorials is only as effective as the effort that is put into making them an effective learning experience.

Dean's Response: The Dean supports the department response. Altering tutorial size may require resources, which will have to be considered and designed carefully.

RECOMMENDATION 7.

It is recommended to have a long term plan for the delivery of program elective courses so students can appropriately plan their studies and complete their program in a timely fashion.

Department Response: The department acknowledges that the offering of electives on a yearly basis can be improved. The main constraints in offering electives are class size and faculty complement.

In spite of the large list of potential electives the department can only offer a few of them per semester, given the teaching resources available. The department has a large number of service courses that it must offer and this constrains the number of electives that it may also offer in any given semester. Fortunately, with four new hires this year, this constraint shall be overcome in the future. But even with the possibility of being able to offer more electives, sometimes the enrollment numbers in elective courses are low. The number of upper year students in the program is small, and this greatly constrains the number of electives that are offered.

This requires the department to carefully manage *how* the electives are offered. The main strategy is to offer certain electives every other year. The idea is that in the span of two years a student will be able to take a given elective in one of those two years. We have pursued this strategy, but we have not been as rigorous as we could have. In order to commit to this strategy, and to help students in their long-range planning, the department will commit to publishing which electives will be offered for the next two to three years.

Dean's Response: The Dean supports the department response.

C) IMPLEMENTATION PLAN

Recommendation/Priority # 1
Recommendation: Curriculum modification I: Computer Science
Rationale: Identified in self-study and PRT report that computer science knowledge is crucial to the discipline.
Objective: Improve and strengthen LO 8: essential programming skills.
Actions: <ul style="list-style-type: none"> • Removal of CPS 118 in semester 1 and replace with CPS 109. • The addition of CPS 209 as a potential second science course. • Addition of R language programming to statistics courses. (Done) • More coherent use of programming in later courses.
Timeline: 2018-19 academic year with submission of proposal to VPA by June 30, 2019; commences Fall 2020
Responsibility for leading initiative: Program Director and Chair
Responsibly for approving recommendation, providing any resources made necessary by the recommendation, and overall monitoring of the implementation of the recommendation: Chair and Faculty Dean

Recommendation/Priority # 2
Recommendation: Curriculum Modification 2: <i>Restructure program.</i>
Rationale: Self-study and PRT report identify the need to modify the program to address retention issues.
Objective: To improve student retention and time-to-graduation by improvement of the curriculum structure.
Actions: <ul style="list-style-type: none"> • Add one hour of lecture to the first year calculus courses, MTH 207 and MTH 310 to allow more time to develop the same material. (Done) • Provide added learning resources through SLGs offered through the Learning Centre. (Done) • Move MTH 525 and MTH 617 from 7th and 8th semesters to the 5th and 6th semesters respectively. • Move MTH 719 from 8th semester to 4th semester (Completed 2019)
Timeline: 2018-19 academic year with submission of proposal to VPA by June 30, 2019; commences Fall 2020
Responsibility for leading initiative: Program Director and Chair
Responsibly for approving recommendation, providing any resources made necessary by the recommendation, and overall monitoring of the implementation of the recommendation: Chair and Faculty Dean

Recommendation/Priority # 3
Recommendation: Curriculum modification 3: Proof writing

Rationale: Self-study and PRT report identify students' weakness in developing and communicating mathematical proofs.

Objective: To improve students' achievement of LO 7a—d.

Actions:

- Develop a new course to introduce students to proof writing. (Done)
- Better reinforce mathematical writing in the core mathematics courses.

Timeline: 2018-19 academic year with submission of proposal to VPA by June 30, 2019; commences Fall 2020

Responsibility for leading initiative: Program Director and Chair

Responsibly for approving recommendation, providing any resources made necessary by the recommendation, and overall monitoring of the implementation of the recommendation: Chair and Faculty Dean

Recommendation/Priority # 4

Recommendation: Better planning of electives

Rationale: As provided by the self-study and the PRT report, students find the present system of elective offerings confusing.

Objective: To give students better opportunity to plan their elective choices in the long term.

Actions:

- *Develop a two- to three-year plan of elective course offerings.*
- Publish this plan so students are aware of which electives they can count on in future years.

Timeline: 2018-19 academic year with submission of proposal to VPA by June 30, 2019; commences Fall 2020

Responsibility for leading initiative: Program Director and Chair

Responsibly for approving recommendation, providing any resources made necessary by the recommendation, and overall monitoring of the implementation of the recommendation: Chair and Faculty Dean