BOARD OF GOVERNORS

Wednesday, September 23, 2020
2:00 p.m. to 3:00 p.m.
Videoconference

Videoconference Information:
Toll free 1.888.240.2560 Meeting ID: 279 612 484

AGENDA

No.	Topic	Lead	Allocated Time	Suggested Start Time
	PUBLIC SESSION			
1	**Call to Order**	Chair		2:00 p.m.
2	**Agenda (M)**	Chair		
3	**Chair's Remarks**	Chair		
4	**President's Remarks**	Steven Murphy	10	2:05 p.m.
5	**Budget Update (U)**	Andy Gallagher & Lori Livingston	15	2:15 p.m.
6	**New Program Proposal – Bachelor of Science (Honours) in Integrated Mathematics and Computer Science* (M)**	Ferdinand Jones	10	2:30 p.m.
7	**Other Business**			
8	**Adjournment**	Chair		2:40 p.m.
	BREAK			
	NON-PUBLIC SESSION			
9	**Call to Order**	Chair		2:45 p.m.
10	**Conflict of Interest Declaration**	Chair		
11	**Professor Emeritus Appointment* (M)**	Steven Murphy	5	2:45 p.m.
12	**Board Committee Appointments* (M)**	Cheryl Foy	5	2:50 p.m.
13	**Termination**	Chair		2:55 p.m.

BOARD REPORT

ACTION REQUESTED:

Recommendation	☐
Decision	☒
Discussion/Direction	☐
Information	☐

TO: **Board of Governors**

DATE: **September 23, 2020**

FROM: **Academic Council**

SUBJECT: **New Program Proposal – Bachelor of Science (Honours) in Integrated Mathematics and Computer Science**

BOARD MANDATE:
In accordance with Article 1.4 (a) of By-law No. 2, Academic Council will make recommendations to the Board on matters including the establishment or termination of degree programs. Academic Council is recommending the establishment of a Bachelor of Science (Honours) in Integrated Mathematics and Computer Science program for approval by the Board of Governors.

MOTION FOR CONSIDERATION:
That pursuant to the recommendation of Academic Council, the Board of Governors hereby approves the establishment of a Bachelor of Science (Honours) in Integrated Mathematics and Computer Science program, as presented.

BACKGROUND/CONTEXT & RATIONALE:
The proposed program will build upon the strengths of the existing Applied and Industrial Mathematics and Computer Science programs to provide an integrated curriculum aimed at developing enriched skills in mathematical analysis and modeling, and software design and programming. While the proposed program leverages the foundational courses of existing programs, as well as the discipline-specific expertise of associated faculty members, as an independent program Integrated Mathematics and Computer Science places less emphasis on computer hardware and exposure to the complete software stack of enterprise applications, as well as abstract mathematics. The proposed program focuses instead on where these two disciplines converge, as well as the practical application of computer knowledge and mathematical principles.

The program includes a series of program-specific upper-year “integration and application” courses in which the students will engage in experiential learning through self-directed group projects inspired by industry problems. This essential aspect of the program will ensure that students can integrate their mathematical and computer knowledge in a practical setting. The program will include a Co-operative Education option, through which students may reinforce the career-oriented training they receive in their courses.

Aligned with Ontario Tech’s mission, the proposed program is a response to growth and diversification of the technology industry. The experiential-learning components in the upper years of the program answers Ontario Tech’s mission of promoting engagement, critical thinking and integrating experiences inside and outside the classroom. The program contributes to Ontario Tech’s Strategic Mandate Agreement by linking with the designated Program Area of Expansion of Informatics/Data Science. It also aligns well in that it addresses a sectoral need for employees with a specific skill set. In addition to already existing experiential learning components in Mathematics and Computer Science, the proposed program introduces upper year “application and integration” project-based courses to further the experience of self-driven project-based learning.

Graduates of this program will be qualified for a variety of career paths within the technology industry. They will have the necessary knowledge and skills within each discipline to be competitive in obtaining jobs usually filled by single-discipline Computer Science or Math graduates, but will be particularly desirable candidates for the new class of employment that integrates the two fields. Graduates will also be able to pursue post-graduate education in a variety of Computer Science or Applied Mathematics areas. This program has been designed to allow its graduates to excel in this modern workplace.

RESOURCES REQUIRED:

As the proposed program draws on the existing expertise in Computer Science and Mathematics, in the Faculty of Science, no new faculty members are required for this program.

The current courses offered in the program have the capacity to absorb the projected student enrollments. Marginal increases in various areas would be required to accommodate the increased enrolments, primarily in the Computer Science courses that include a lab component. The main impact to resource areas include teaching assistantships in the laboratories and tutorials, and increased administrative and faculty supervisory workload resulting from thesis supervisions.

To accommodate the increase in enrolment, additional lab tutorial/sections will be made available. The primary impact will be in the Computer Science courses, where an additional lab section will be required to accommodate an increase in the number of students. The Faculty currently has the teaching laboratory space to accommodate this increase in student enrolment, and no additional physical lab space is anticipated. There is sufficient capacity in the Mathematics courses, particularly in the upper years, to accommodate the additional 20 students per year. No significant increased resource requirements are anticipated in terms of library holdings, information technology support and student services.

Only limited additional financial resources will be required to support this program. The direct costs will be course assignments for IMCS 3010U and CSCMA 3020U, as well as additional TA time. The main financial needs will be the creation of the two new Integrated Applications courses, and additional lab and tutorial sections needed to accommodate the new students.

CONSULTATION AND APPROVAL:

- Supplementary External Review: July 2020
- Academic Council: November 19, 2019
- Undergraduate Studies Committee Review and Recommendation: October 15th, 2019
- Final Faculty Council Approval: October 1st, 2019
- Undergraduate Curriculum Committee: September 27th, 2019
- Program Development and Faculty Consultation: 2018-2019

NEXT STEPS:

- The expected date of implementation is the fall semester of 2021.

SUPPORTING REFERENCE MATERIALS:

- New Program Proposal (Appendices available upon request)

Bachelor of Science Honours in Integrated Mathematics and Computer Science

Faculty of Science

Prepared Date:
May 2020

Proposed Program Start Date:
September 2021

Table of Contents

1. INTRODUCTION

a. Background

The technology industry has long benefited from trained talents in Mathematics and Computer Science. In recent years, there has been a steady increase in demand for individuals with skill sets that combine the two disciplines. Machine Learning & Artificial Intelligence and Data Science are among the fastest growing career paths. The proposed *Integrated Mathematics and Computer Science* program will provide an integrated curriculum aimed at developing enriched skills in mathematical analysis and modeling, and software design and programming. Building upon the strengths of the existing Computer Science and Applied and Industrial Mathematics programs within the Faculty of Science, the proposed Integrated Mathematics and Computer Science program leverages the foundational courses of these programs, as well as the discipline-specific expertise of associated faculty members. However, as an independent program culminating in a Bachelor of Science honours degree, the Integrated Mathematics and Computer Science program places less emphasis on computer hardware and exposure to the complete software stack of enterprise applications, as well as abstract mathematics. The proposed program focuses instead on where these two disciplines converge, as well as the practical application of computer knowledge and mathematical principles.

In the first two years of study, the proposed Integrated Mathematics and Computer Science program will emphasize foundational topics in Computer Science and Mathematics. A structured complement of first and second year courses will ensure that students are well grounded in the fundamental concepts of Computer Science and Applied Mathematics. The upper years of the program will be more specialized, with a focus on application and integration of key concepts through experiential learning. Specifically, students will have flexibility in choosing how they further their study of Computer Science and Applied Mathematics through senior-level courses in each discipline. In addition, the program includes a series of program-specific upper-year "integration and application" courses in which the students will engage in experiential learning through self-directed group projects inspired by industry problems. This essential aspect of the program will ensure that students can integrate their mathematical and computer knowledge in a practical setting. Students will be able to build up a rich portfolio of achievements through this practical learning component to further their competitiveness upon graduation. Similarly, the Integrated Mathematics and Computer Science program will include a Co-operative Education option, through which students may reinforce the career-oriented training they receive in their courses.

Graduates of this program will be qualified for a variety of career paths within the technology industry. They will have the necessary knowledge and skills within each discipline to be competitive in obtaining jobs usually filled by single-discipline Computer Science or Math graduates, but will be particularly desirable candidates for the new class of employment that integrates the two fields. Graduates will also be able to pursue post-graduate education in a variety of Computer Science or Applied Mathematics areas.

b. Relationship to the Institutional Vision, Mission, and Strategic Plan

Institutional Vision

With its foundation in technology, the sciences and professional practice, Ontario Tech University advances the discovery and application of knowledge that accelerates economic growth, regional development and social innovation and inspires graduates who will continue to make an impact on the world, as it is and as it will be.

Institutional Mission

- Provide superior undergraduate and graduate programs that are technology-enriched and responsive to the needs of students and the evolving workplace.
- Conduct research that creates knowledge, solves problems, results in economic and social innovation and engages students.
- Facilitate life-long learning that is flexible, inclusive and emphasizes college university transfers.
- Develop academic and research collaborations with industry and community that stimulate and enhance the region and university at home and abroad.
- Cultivate a dynamic learning environment for students by promoting social engagement, fostering critical thinking and integrating experiences inside and outside the classroom.

Ontario Tech's 2017-2022 Strategic Plan focuses on the three goals for Challenge, Innovate, and Connect.

CHALLENGE:
We will produce and inspire future leaders who have real-world skill sets.

INNOVATE:
We will create new approaches, partnerships, and solutions to improve society.

CONNECT:
We will build lasting relationships to make UOIT a remarkable place for work and study.

Aligned with Ontario Tech's mission of providing undergraduate programs that are technology-enriched and responsive to the needs of the evolving workspace, the proposed Integrated Mathematics and Computer Science program is a response to growth and diversification of the technology industry. The new program represents our continuing efforts to provide superior educational value to students so that they are prepared for success in the changing job market. Similarly, the dynamic learning experiences which will be offered through the experiential-learning components in the upper years of the Integrated Mathematics and Computer Science program, answers Ontario Tech's mission of promoting engagement, critical thinking and integrating experiences inside and outside the classroom. Students will have repeated opportunities to exercise critical thinking and to apply their in-class academic knowledge to scenarios outside of the classrooms. Students have the opportunity to further their hands-on experience and develop career skills through the Co-operative Education option.

The proposed Integrated Mathematics and Computer Science program contributes to Ontario Tech's Strategic Mandate Agreement by linking with the designated Program Area of Expansion of

Informatics/Data Science (section 6.0 Enrolment Strategy and Program Direction). It also aligns well in that it addresses a sectoral need for employees with a specific skill set. Furthermore, an important component of the training involves experiential learning in a project-based, team-learning environment (outlined in Section 2.0 Innovation in Teaching and Learning Excellence), which is an integral component of the Integrated Mathematics and Computer Science program. In addition to already existing experiential learning components in Mathematics and Computer Science, the proposed program introduces upper year "application and integration" project-based courses to further the experience of self-driven project-based learning.

The introduction of this program is specifically motivated to provide an opportunity for Ontario Tech students to participate in a growing area within the job market. An increasing number of jobs are moving away from being exclusively computer science based. Instead, there is an emphasis on in-depth knowledge of mathematical algorithms and general analytical skills. This program has been designed to allow its graduates to excel in this modern workplace.

c. Student Demand

In recent years, the demand for undergraduate programs in Computer Science has grown tremendously. This is due to large extent on the availability of employment for graduates with Computer Science degrees. The proposed program will leverage this demand. In particular, the Integrated Mathematics and Computer Science program will appeal to strong students who recognize that having a solid background in Mathematics in addition to basic computing and programming skills will significantly enhance their career prospects. We expect that the demand for this program will continue to grow over the next few years, as knowledge of the evolving employment landscape increases within the general public. We believe that the Integrated Mathematics and Computer Science program will become a small, yet elite flagship program, drawing upon students with strong mathematical and programing aptitude.

d. Societal Need

There has been a rapidly growing demand in the technology industry for individuals who have a combined knowledge of both Computer Science and Mathematics. This is particularly true in the area of applied machine learning. Between 2017 and 2019, for example, a number of companies (e.g. Element AI, Vector Institute, Samsung, LG, Royal Bank of Canada) have established centers in the Greater Toronto Area to focus on the development, application and commercialization of AI and machine learning. This job creation is based on advances in both Computer Science and Mathematics. Companies will be seeking a competitive edge by hiring talent who can use, understand and enhance methods and systems for collecting and analyzing large, complex data sets. These are explicitly the skill set that graduates of the proposed program will have.

Data Science and Artificial Intelligence are predicted to be among the fastest growing opportunities in the coming years, according to *The Globe and Mail* and *Techrepublic*.
https://www.theglobeandmail.com/business/commentary/article-the-global-race-for-artificial-intelligence-supremacy-is-on-and/

https://www.techrepublic.com/article/why-data-scientist-is-the-most-promising-job-of-2019/

Examples of the types of industry positions for which graduates of the Integrated Mathematics and Computer Science program would be qualified, including sample job postings from January 2019, include:

1. Data Scientists
    - Nestle: Data Scientist (Food)
    - Schulich School of Business, York University (Education)
    - Agility Consulting (Consulting)
    - Aviva (Insurance)
2. Computational Analyst
    - Tangerine: requires programming with open source software, statistical and mathematical analytical skills, software development.
    - RBC Bank: perform fraud detection with machine learning
    - CIBC: visual and text analytics with machine learning, software development with Python and statistical tools.
    - TD: statistics and programming skills required
3. Software Developer
   Graduates of the Integrated Mathematics and Computer Science program would also be qualified to enter the technology industry as general software developers.

Further career paths may include software engineering and design, statistics and data analysis, actuarial science, and financial and investment analysis.

Students in the discipline of Computer Science and Applied Mathematics are expected to have sound understanding in the areas of: Foundations of Computer Science and Applied Mathematics; Programming, Software Design and Implementation; Numerical and Scientific Computing; Development of Complex Software Systems; Modelling and Analysis of Complex Systems; Scientific and Technical Communication and Collaboration. The program curriculum is designed to meet these expectations in the discipline with the following course offerings.

Foundations of Computer Science:

1. *CSCI 1030U - Introduction to Computer Science*
2. *CSCI 2010U - Data Structures*
3. *CSCI 3070U - Analysis and Design of Algorithms*

Foundations of Applied Mathematics

1. *MATH 1010U, 1020U, 2010U - Calculus I, II, III*
2. *MATH 2050U, 2055U - Linear Algebra, Advanced Linear Algebra*
3. *MATH 2080U - Discrete Mathematics*
4. *MATH 2060U - Differential Equations*
5. *MATH 3060U - Complex Analysis*
6. *STAT 2010U - Statistics and Probability*

Programming, Software Design and Implementation

1. *Programming Workshop I and II*
2. *CSCI 2020U - Software Systems Development and Integration*
3. *CSCI 2040U - Software Design and Analysis*

Numerical and Scientific Computing

1. *MATH 2072U - Computational Science I*
2. *MATH 4020U - Computational Science II (elective)*

Development of Complex Software Systems (breadth)

1. *Senior electives (e.g. Database; Compilers; Web; Mobile; Massive Parallelism; Big Data Analytics; Computer Vision; Machine Learning)*

Modelling and Analysis of Complex Systems (breadth)

1. *Senior electives (e.g. Math Modelling, Industrial Mathematics, Optimization, Dynamical Systems, Mathematical Physics, Partial Differential Equations, Topics in Applied Mathematics)*

Scientific and Technical Communication and Collaboration

1. *IMCS 3010U, 3020U - Integrated Application Project I, II*
2. *Breadth requirements in communications (e.g. Business Communications, Technical Communications, Collaborative Leadership, etc.)*

As the Society for Industrial and Applied Mathematics (SIAM) phrases it, "Part of the preparation for your future is obtaining a solid foundation in mathematical and computational knowledge (...) Preparation for a career in applied mathematics and computational science also involves being able to apply these skills to real-life problems, and achieving practical results." In addition, the ability to formulate and communicate ideas is essential. As such, we have incorporated computing and communication skills and real-world problem solving throughout the program curriculum. In particular, we train our students in these skills from their first semester by requiring core courses in introductory computer science, scientific computing, and mathematical modelling, and by including significant presentations, reports, and oral examinations in the assessments of many courses. The ultimate goal is to ensure that our graduates can identify and clearly formulate problems, select the appropriate analytical and computational techniques to solve them and clearly communicate the outcomes. These are essential attributes of a present-day math graduate in an increasingly data-driven market place.

e. Duplication

The proposed program has not been duplicated from an existing program at another university. It has been designed to leverage the unique synergies between the existing Computer Science and Applied and Industrial Mathematics undergraduate programs within the Faculty of Science, including strong ties between associated faculty members. Built upon comprehensive foundation courses in basic mathematics, statistics, and computing, which are core to the existing undergraduate programs, the Integrated Mathematics and Computer Science program expands on the interdisciplinary nature of Computer Science and Mathematics through program-specific courses which integrate concepts and methods from both fields of study. These courses will require students to work in groups on projects related to problems and initiatives they may encounter in industry. This model is practical and sustainable due to the non-departmental structure of the Faculty of Science, which provides a unique environment in which to offer an interdisciplinary program. Students in the Integrated Mathematics and Computer Science program will have access to courses taught by area experts, as well as the ability to select between upper year courses specific to their career trajectory and interests.

Canadian Universities with undergraduate BSc programs with focuses in Mathematics and Computer Science include the following:

Table 1 – Programs at other Canadian Universities for comparison

Institution	McMaster University
Program Name & Credential	Honours Mathematics and Computer Science (B.Sc.)
Program Description	The program combines the possibility of including both mathematics and computer science courses in the curriculum.
Similarity & Differences	Similarity: This program allows students to take both mathematics and computer science courses to build up the curriculum. Difference: There is no guarantee that students receive a well-balanced mixture of Math and Computer Science. The courses are not grouped into areas (but rather levels), so it does not guarantee a breadth of coverage on the foundations of Mathematics and Computer Science. There is no emphasis on the experiential learning component or integration of Computer Science and Math as provided by the Integrated Application Project courses and Undergraduate Thesis of the proposed program.
Links	https://academiccalendars.romcmaster.ca/preview_program.php?catoid=32&poid=18578&returnto=6690

Institution	Brock University
Program Name & Credential	Computer Science and Mathematics (BSc)
Program Description	The 4.5-year program combines the Computer Science program with the Mathematics program, showing you how to apply what you learn in Mathematics by using technology.
Similarity & Differences	Similarity: This program allows students to take both mathematics and computer science courses to build up the curriculum. Difference: Program is 4.5 years rather than 4 years There is no emphasis on the experiential learning component or

	integration of Computer Science and Math as provided by the Integrated Application Project courses and Undergraduate Thesis of the proposed program.
Links	https://brocku.ca/programs/undergraduate/computer-science-and-mathematics/

Institution	York University
Program Name & Credential	Computational Mathematics (BSc)
Program Description	York's program in Computational Math combines the study of math, computer science and specialized computer applications. It's a more specialized program in computation than Applied Math.
Similarity & Differences	Similarity: Covers various aspects of Mathematics and Computer Science. Difference: More emphasis on math; focuses on the computational side of mathematics rather than the combination of computer science and mathematics. There is no emphasis on the experiential learning component or integration of Computer Science and Math as provided by the Integrated Application Project courses and Undergraduate Thesis of the proposed program.
Links	https://futurestudents.yorku.ca/program/computational-math

Institution	University of Waterloo
Program Name & Credential	Bachelors of Mathematics (Computer Science)
Program Description	The program combines the bulk of a Computer Science degree with the basic required courses of the Mathematics program.
Similarity & Differences	Similarity: Both programs cover the foundational material in both Computer Science and Mathematics. Difference: This program emphasizes Computer Science at the higher

	level, with no required courses in Mathematics at the highest level. There is no emphasis on the experiential learning component or integration of Computer Science and Math as provided by the Integrated Application Project courses and Undergraduate Thesis of the proposed program, except as related to the Co-op activity.
Links	http://ugradcalendar.uwaterloo.ca/page/MATH-Bachelor-of-Mathematics-Computer-Science-1

This program is not being offered as a joint program with another institution, in part, because of the challenges created by geographic separation, as well as the associated administrative overhead. The vast majority of the courses are already offered as part of either the Applied and Industrial Mathematics program or the Computer Science program and are currently offered in a face-to-face pedagogical mode. The "application and integration" project-based courses will represent a unique collaboration among faculty in those two "core" programs.

2. DEGREE REQUIREMENTS

a. Program learning outcomes and degree level expectations

The degree requirements and structure of the curriculum have been designed to be consistent with the institution's mission and academic vision. This has been accomplished by focusing on the institution's mission statements when crafting the program learning outcomes that will guide the curriculum at the course level, the learning activities and assessments. The program requirements allow graduates exposure to "technology-enriched" environments and allow them to participate in the "evolving workplace" through in-class experiential learning opportunities and work-integrated learning the co-op option. The program's integration of computer science and math theories with practice in real-world settings, aligns with the institution's vision for academic programs that will "inspire graduates to make an impact on the world, as it is, and as it will be". As the institution does not have its own set of degree level expectations, the program utilized the undergraduate degree level expectations set out by OCAV in order to create appropriate outcomes. Below are these degree level expectations discussed in relation to the developed program learning outcomes.

Upon graduation, students of the Integrated Mathematics and Computer Science program will have specialized abilities that are consistent with the provincial degree level expectations:

1. *Depth and Breadth of Knowledge*
   The courses core to the Integrated Mathematics and Computer Science program will expose students to a broad range of fundamental Computer Science and Mathematics concepts, particularly within the first two years of study. Depth of knowledge in both fields will be developed through requirements of senior elective courses in Computer Science and Mathematics, respectively. Furthermore, the combination of the senior course requirements together with the project-based courses, will ensure that students can:

- **use** critical thinking and analytical skills to **identify** practical problems in terms of concepts from Computer Science and Mathematics including mathematical modeling, data analysis, programming and software design, and
- **articulate** problems and their solutions that combine mathematics and computer science.

2. *Knowledge of Methodologies*
   Knowledge of the methodologies and analysis techniques core to the fields of Mathematics and Computer Science, including but not limited to quantitative analyses in mathematics and statistics, computer software applications, data analysis, and modeling, will be primarily developed through the program's core courses. These will ensure that students can:

   - **demonstrate** solid understanding of the fundamental principles and techniques of Mathematics and Computer Science.

   In addition, the required Statistics and Probability course (STAT 2010U) and Scientific Data Analysis course (CSCI 2000U) will, in particular, ensure that students can:

   - rely on the fundamental principles and techniques of Mathematics and Computer Science to **evaluate** and critically **examine** available experimental and observed data to draw valid conclusions.

3. *Application of Knowledge*
   The Integrated Mathematics and Computer Science program emphasizes the integration and application of computer and mathematical knowledge. Specifically, the Integrated Application Project courses, and Undergraduate Thesis requirements, will require students to work on projects that combine aspects of both Mathematics and Computer Science. This will ensure that students can:

   - **integrate** the principles and methodologies from both Computer Science and Mathematics in the problem solving process, and
   - expertly **apply** Mathematics and Computer Science in a variety of multidisciplinary problems, and serve as a productive member of an interdisciplinary team.

4. *Communication Skills*
   An important deliverable of the Integrated Mathematics and Computer Science program will be effective communications skills. Students will be required to develop their written and oral communication skill set throughout the degree program, primarily through project proposals and presentations. This is particularly true of the Integrated Application Project courses and Undergraduate Thesis, where students will be required to present the results of their projects in both oral and written form. The interdisciplinary nature of the projects will ensure that students can:

   - **combine** the vocabularies of Mathematics and Computer Science to formulate effective **communication** methodology and findings to professionals from different disciplines and

the general public.

5. *Awareness of Limits of Knowledge*
   Through course and project-based work, students will develop the ability to:

   - **recognize** the limits of mathematics and computer science, especially in terms of limitations of computation and mathematical analysis, and their appropriateness and reliability for the particular application.

6. *Autonomy and Professional Capacity*
   Students will gain qualities and transferable skills necessary for further study, employment, and community involvement. In their project-based courses, and in the required course CSCI 4040U, students will demonstrate the ability to:

   - **assess** the ethical consequences of methodology and its application. Students will learn the roles and impacts of technology through **debates** and **reflection** on case studies, and
   - **demonstrate** an ability to independently acquire knowledge and technology including but not limited to new technologies, novel mathematical models and analytical techniques, and emerging applications.

Table 2 – Program Learning Outcomes

Degree Level Expectation	Learning Outcome	How the program instructional design & elements support the attainment of student learning outcomes	Method of assessment:
1) Depth and Breadth of Knowledge	**Use** critical thinking and analytical skills to **identify** problems in mathematical modeling, data analysis, programming and software design. **Articulate** problems and respective solutions that combine both mathematics and computer science.	Core MATH and CSCI required courses, as well as the Senior CSCI and MATH electives (CSCI 3XXXU, CSCI 4XXXU, MATH 3XXXU, MATH 4XXXU) Design project courses (Integrated Application I and II), as well as thesis project will ensure that students can integrate and apply their knowledge (IMCS 3010U/3020U, IMCS 4410U/4420U)	Core courses incorporate formative assessments, such as assignments and quizzes, as well as summative assessment methods, such as tests and exams, to measure breadth of knowledge Assessment methods in the Senior Elective courses ensure depth of knowledge and development of critical and analytical skills Problem identification and formulation will be observed through project

			reports and presentations in IMCS 3010U/3020U, CSM4410U/4420U
2) Knowledge of Methodologies	**Demonstrate** an understanding of fundamental principles and techniques of Mathematics and Computer Science. **Evaluate** and critically **examine** available experimental and observed data to draw valid conclusions.	Core MATH and CSCI courses, as well as the Senior CSCI and Math electives (CSCI 2010U, CSCI 2020U, CSCI 2040U, CSCI 3070U, MATH 2015U, MATH 2050U, MATH 2060U, MATH 2072U, MATH 3060U) Required statistics course (STAT 2010U) and the required Scientific Data Analysis course (CSCI 2000U)	Core courses incorporate formative and summative assessments, such as assignments, quizzes, tests and exams, to measure knowledge of methodologies and understanding of fundamentals Assignments and exams in STAT 2010U and CSCI 2000U will assess ability to evaluate and critically examine data
3) Application of Knowledge	**Integrate** principles of Mathematics and Computer Science in the problem solving process. **Apply** principles and skills in Mathematics and Computer Science to multidisciplinary problems as a productive member of a team.	Design project courses (Integrated Application I and II), as well as thesis project, will ensure that students can integrate and apply their knowledge (IMCS 3010U/3020U, IMCS 4410U/4420U)	Project presentations and comprehensive written reports in design and thesis courses, as well as specific application-based questions on exams, assess the student's ability to apply and integrate knowledge on interdisciplinary problems
4) Communication Skills	**Combine** the vocabularies of Mathematics and Computer Science to formulate effective **communication** methodology and findings to professionals from different disciplines and the general public.	Communications elective, projects and presentations in various core courses in MATH and CSCI. Design project courses (Integrated Application I and II), as well as thesis project (IMCS 3010U/3020U, IMCS 4410U/4420U)	Starting with their communication elective, students will have many opportunities to develop vocabulary and communication skills in a variety of settings, including through oral presentations, written reports, group interactions within projects and class participation. Through multiple presentations in the design courses students will be evaluated on their ability to present to differing

			audience.
5) Awareness of Limits of Knowledge	**Recognize** the limits of mathematics and computer science, especially in terms of limitations of computation and mathematical analysis, and their appropriateness and reliability for the particular application.	The required courses CSCI 2000U, CSCI 2010U, MATH 2072U, MATH 2060U, Senior MATH and CSCI electives Design project courses (Integrated Application I and II), as well as thesis project (IMCS 3010U/3020U, IMCS 4410U/4420U)	Core courses incorporate formative and summative assessments, such as assignments, quizzes, tests and exams, in addition to specific application-based questions on assignments and exams to ensure this learning outcome is met. Group projects in the design and thesis courses will further ensure awareness of the limits of knowledge
6) Autonomy and Professional Capacity	**Assess** the ethical consequences of methodology and its application. **Debate** the role and impacts of technology in society. **Demonstrate** an ability to independently acquire knowledge and technology including but not limited to new technologies, novel mathematical models and analytical techniques, and emerging applications.	The required course Ethics, Law and the Social Impacts of computing (CSCI 4040U) Design project courses (Integrated Application I and II), as well as thesis project (IMCS 3010U/3020U, IMCS 4410U/4420U)	Tests, essays, in-class discussion and participation in CSCI 4040U will ensure ability to assess ethical consequences and impacts of technology Self-directed projects in the design courses, which will require the incorporation of knowledge and techniques not covered in previous courses, will be used to assess independence

The integrated math and computer science program is designed in a manner that allows students to attain the desired learning outcomes and associated degree-level expectations (DLEs) through-out their four years. An example of this consideration would be the program learning outcome, "Demonstrate and understanding of fundamental principles and techniques of mathematics and computer science", which is aligned with the 'Knowledge of methodologies' DLE. To attain this outcome, students will have to participate in core courses to develop the foundational learning in year 1 and 2 (e.g. CSCI 1030U; MATH 2080U), but then will have the opportunity to become more proficient in their demonstration these understandings in upper-year core and discipline-specific electives (e.g. MATH 3060U). By appropriately integrating the PLO into core introductory courses and then senior courses, the intent is to have students be exposed to this PLO gradually with the goal of achieving the PLO by graduation.

In addition, PLOs have been developed to align with one another through-out the curriculum to allow for the integration of learning and skill development across the four-years of the program.

An example of this is scaffolding of the above PLO, "Demonstrate and understanding of fundamental principles and techniques of mathematics and computer science", with the PLO, "Integrate principles of Mathematics and Computer Science in the problem-solving process" which aligns with the 'Application of knowledge' DLE. In the design of the PLOs, Faculty considered the usage of Bloom's taxonomy when building them to ensure that students were moving up the tiers progressively in the hopes of limiting the 'gaps' of learning achievement. The intention behind this scaffolding is to build student achievement in the knowledge of the methodologies they need and then the application of these methodologies. This allows students the opportunity to demonstrate that they know the 'principles of math and computer science' and then apply these principles to problem solving activities in their senior years (e.g. IMCS 3010U, IMCS 4410U).

The intentionally of the program design and scaffolding of the PLOs is also embedded into the proposed methods of assessment for student achievement. Again, taking into consideration Bloom's taxonomy and the associated verbs that were chosen, assessment methods have been scaled in to allow students to achieve their learning at an introductory phase, then to develop that learning with the aim to become proficient. An example of this would be the PLO, "Apply principles and skills in Mathematics and Computer Science to multidisciplinary problems as a productive member of a team" which has multiple learning activities that will assess the application of the principles and skills. This PLO will be assessed through application-based, team-based questions on exams but also through project presentations and written reports; allowing student learning to be assessed through various activities and methods.

The plan for assessing and monitoring program effectiveness, in addition to the cyclical program review process, will be in accordance with the requirements laid out by the institution's Academic Resource Committee. Currently this requires a report one-year after start-up and if there are areas of concern a subsequent 18-month report will be required. The one-year report will ask the program to review enrolment data, admission averages, and provide an analysis of successes and challenges encountered in the first year. After the first year of the program being implemented, it will be internally assessed by this committee and, if needed, recommendations will be made to enhance program effectiveness and student success. If required, the 18-month report will address key curricular and student data (e.g. student evaluations, GPA, retention data, etc.) as well as any outstanding recommendations from the one-year report. Pending the committee's review, further documentation may be required of the program for ongoing monitoring.

b. Admission Requirements

The admission requirements will be as follows:

> Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and *two* of the following: Calculus and Vectors (MCV4U), Computer Science (ICS4U), Physics (SPH4U). In addition, a combined minimum 70 per cent average in prerequisite computer science, math and science courses is required. It is recommended

that all three MCV4U, ICS4U and SPH4U be taken. All other applicants should refer to Admissions for the requirements for their specific category of admission.

These are similar to the current requirements for the Computer Science program at UOIT, except that we are proposing that two, instead of one, of Calculus and Vectors (MCV4U), Computer Science (ICS4U) or Physics (SPH4U), be required. With the extra load in Mathematics required in the proposed program relative to Computer Science majors, we feel that familiarity with two instead of only one of the three topics will enhance the probability of student success. We are recommending that the students have all three of these courses.

c. Program Structure

Overview

The program structure is more defined during the first two years of study, during which students are covering the fundamental principles of Mathematics and Computer Science. In years 3 and 4, there is more flexibility for the students to acquire a depth of knowledge in specific topics which are of interest to them. Also in years 3 and 4, the students will integrate Mathematics and Computer Science via experiential learning in the project-based courses and required thesis project.

The Integrated Mathematics and Computer Science program curriculum can be divided into the following subcategories:

Fundamentals of Mathematics and Computer Science

In the first two years of the program, the fundamentals of both Mathematics and Computer Science are covered. Core Mathematics courses cover a broad range of the fundamentals of Mathematics; they provide the basic tools and concepts, and develop the analytical skills, which are necessary for further study in all areas of Applied Mathematics. Core Computer Science course cover the basics of programming, computation, design of algorithms and software development. The students are also introduced to the basic methods for manipulating and analysing scientific data in CSCI 2000U (Scientific Data Analysis).

In third year, higher-level fundamentals are augmented with one Mathematics course (Complex Analysis --MATH 3060U) and one Computer Science course (Analysis and Design of Algorithms -- CSCI 3070U). In a final required course (CSCI 4040U), students discuss the impact developing technology may have on society, as well as the associated moral issues and implications.

The required courses provide the students with a comprehensive background in both Mathematics and Computer Science. With the exception of introductory courses in Biology and Chemistry and one course in computer hardware, students in the Integrated Mathematics and Computer Science

program complete all courses core to the first two years of both the existing BSc in Applied and Industrial Mathematics and the existing BSc in Computer Science.

Depth in Mathematics and Computer Science

In years 3 and 4 of the program, Integrated Mathematics and Computer Science students are required to complete MATH 3060U – Complex Analysis, CSCI 3070U – Analysis and Design of Algorithms, and CSCI 4040U – Ethics, Law and the Social Impacts of Computing. These, together with the required courses taken in years 1 and 2, are the primary prerequisites for the majority of the upper-level CSCI and MATH Courses. Further to these specific courses, students will be required to take 4 senior electives in both Mathematics (MATH) and Computer Science (CSCI). These electives can be chosen from any 3000- or 4000-level courses in the respective discipline. This breadth in upper year courses encourages integrated higher-level learning, and allows students the freedom to choose courses which fit with their particular interests and career goals.

There is not a single post-graduation path that graduates of this program will follow. Students may wish to focus their course selection to maximize their exposure to a particular sector in industry. However, they may wish to pursue graduate studies, e.g. in Computational Mathematics or Computer Vision, which may result in a very different selection of elective courses. We feel that the program's flexibility will give the program the broadest appeal, and allow students to mold the program to their needs, while still achieving the program learning outcomes. Although not the main consideration, a side benefit of the flexibility will be that the new program will not impose any restrictions on the course offerings of the Applied and Industrial Mathematics and Computer Science programs.

Integration of Computer Science and Mathematics via Experiential Learning

As noted in the learning objectives and consistent with Ontario Tech's mission, this program puts a high priority on practical application of academic knowledge. In years 3 and 4, Integrated Mathematics and Computer Science students will be required to complete IMCS 3010U and IMCS 3020U (Integrated Application Project I and II) and IMCS 4410U and IMCS 4420U (Undergraduate Thesis Project I and II). Through these courses, students have an opportunity to integrate and apply the comprehensive knowledge from both disciplines, and work on projects that are directly relevant to industry examples.

The Co-operative education program is another option for applied learning experiences in the Integrated Mathematics and Computer Science program. *Co-op is available for students in all existing science programs, and students in the Integrated Mathematics and Computer Science program will be able to apply to the five-year Co-operative Education option as well. The Co-op program combines an Honours Bachelor of Science program with embedded work terms. Co-op provides students with opportunities to apply classroom and lab concepts to real-work situations and gain valuable, relevant work experience. Studies have shown that university students who graduate with a Co-op degree have lower debt loads, are employed faster, and have higher starting salaries.*

Students with a minimum cumulative GPA of 2.7 can apply for the co-operative education option as early as the Fall of their second year. At this point in their program, students will have acquired

some theoretical knowledge and developed some fundamental technical skills. The first opportunity for a student to go out on a co-op placement is the summer between 2nd and 3rd year. Placements can begin in May, September, or January. Students are able to be on co-op placements for four, eight, 12, or 16 consecutive months, and can work at one employer location or work for different employers. Students are able to go on placement for up to 16 consecutive months at one location. Many employers prefer students to be on location for 8-16 months.

In order to receive a "Co-operative Education" designation on their parchment, students must successfully complete a minimum of three work terms, with a maximum of five available.

Electives

There are seven courses allocated as electives. Of these seven courses, at least four must be courses outside the Faculty of Science (non-science electives), and two must be courses within the Faculty of Science, but outside of Mathematics and Computer Science. Of the non-science electives, at least one course must be in Business, and one must be a Communications course (see prescribed list below). The remaining elective course is an open elective, and can be from any discipline.

This elective complement is designed to provide a breadth component to the degree program, outside of Science, Computer Science and Mathematics. Similarly, in addition to theories, practices and applications, the learning outcomes of the Integrated Mathematics and Computer Science program include that students are able to "communication methodology and findings to professionals from different disciplines and the general public". The inclusion of required Communications and Business electives will provide an introduction to the soft skills and industry-relevant knowledge that will be necessary for the students to succeed upon graduation.

d. Calendar Copy

Program Information: Bachelor of Science (Honours) in Integrated Mathematics and Computer Science

Admission requirements

Admission is competitive. The specific average or standing required for admission varies from year to year. Students are selected by taking into consideration a wide range of criteria including school marks, distribution of subjects taken, and performance in subjects relevant to the academic program. Possession of the minimum requirements does not guarantee acceptance. Preference will be given to applicants with the best qualifications.

Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and two of the following: Calculus and Vectors (MCV4U), Computer Science (ICS4U), Physics (SPH4U). In addition, a combined minimum 70 per cent average in prerequisite computer science, math and science courses is required. It is recommended that all three MCV4U, ICS4U and SPH4U be taken. All other applicants should refer to Admissions for the requirements for their specific category of admission.

Program details and degree requirements

The requirements for the four-year Integrated Mathematics and Computer Science program are detailed in the following program map. In addition to the regular program, a co-op program is also available. Students interested in the co-op program should contact the Faculty of Science Co-op Coordinator as early as the fall of their second year.

Although reasonable efforts will be made to adhere to the following program map, course requirements and term offerings may change.

Year 1

Semester 1 (15 credit hours)

- Elective*
- CSCI 1030U – Introduction to Computer Science
- CSCI 1060U – Programming Workshop I

One of:

- MATH 1000U – Introductory Calculus [+] **or**
- MATH 1010U – Calculus I [+]

One of:

- PHY 1010U – Physics I [+] **or**
- PHY 1030U – Introductory Physics [+]

[+]All students who have completed Grade 12 Advanced Functions (MHF4U) and Calculus and Vectors (MCV4U) should take MATH 1010U and PHY 1010U. Students without one of these high school courses or equivalent are directed to take MATH 1000U and PHY 1030U.

Semester 2 (15 credit hours)

- Elective*
- CSCI 1061U – Programming Workshop II
- MATH 1020U – Calculus II
- MATH 2050U – Linear Algebra
- PHY 1020U – Physics II

Year 2

Semester 1 (15 credit hours)

- CSCI 2000U – Scientific Data Analysis
- CSCI 2010U – Data Structures
- CSCI 2110U/MATH 2080U – Discrete Mathematics
- MATH 2015U – Calculus III
- STAT 2010U – Statistics and Probability for Physical Science

Semester 2 (15 credit hours)

- CSCI 2020U – Software Systems Development and Integration
- CSCI 2040U – Software Design and Analysis
- CSCI 2072U/MATH 2072U – Computational Science I

- MATH 2055U – Advanced Linear Algebra
- MATH 2060U – Differential Equations

Year 3 and 4 (60 credit hours)

- Five electives*
- Four Senior Computer Science electives**
- Four Senior Mathematics electives**
- IMCS 3010U – Integrated Application Project I
- IMCS 3020U – Integrated Application Project II
- CSCI 3070U – Analysis and Design of Algorithms
- CSCI 4040U – Ethics, Law and the Social Impacts of Computing
- MATH 3060U – Complex Analysis
- IMCS 4410U – Integrated Mathematics and Computer Science Undergraduate Thesis Project I
- IMCS 4420U – Integrated Mathematics and Computer Science Undergraduate Thesis Project II

Note:

No more than 42 credit hours may be taken at the first-year level.

***Electives and breadth requirements**

Students must complete a total of 21 credit hours such that the following elective requirements are satisfied:

- 12 credit hours must be in courses from outside the Faculty of Science, among which at least 3 credit hours must be in business electives++, and at least 3 credit hours in communications electives+++.
- 6 credit hours must be in courses offered by the Faculty of Science, outside of Computer Science and Mathematics.
- the remaining 3 credit hours as a general elective (offered by the Faculty of Science or outside the Faculty of Science)

++Business electives:

- BUSI 1020U – Business Communications
- BUSI 1600U – Management of the Enterprise
- BUSI 1700U – Introduction to Entrepreneurship
- BUSI 2000U – Collaborative Leadership

+++Communication electives:

- COMM 1050U – Technical Communications
- COMM 1100U – Introduction to Communication Studies
- COMM 1320U – Public Speaking
- COMM 2311U – Writing and Publishing in the Digital Age
- COMM 2620U – Interpersonal Communication

****Senior Computer Science and Senior Mathematics Electives**

Students must complete a total of 24 credit hours such that the following elective requirements are satisfied:

- 12 credit hours must be in Senior Computer Science electives, or in Mathematics courses from the following list +**. Only 3 credit hours in Mathematics courses may be applied toward the Senior Computer Science elective requirement, and may not be double counted toward any other elective requirement. A Senior Computer Science elective is defined as a 3000- or 4000-level Computer Science course.

+Also eligible as Senior Computer Science electives:**

- MATH 4020U – Computational Science II
- MATH 4041U – Topics in Applied Mathematics I
- MATH 4042U – Topics in Applied Mathematics II

- 12 credit hours must be in Senior Mathematics electives, or in Computer Science courses from the following list ++*. Only 3 credit hours in Computer Science courses may be applied towards the Senior Mathematic elective requirement, and may not be double counted toward any other elective requirement. A Senior Mathematics elective is defined as a 3000- or 4000-level Mathematics course.

++*Also eligible as Senior Mathematics electives:

- CSCI 3010U – Simulation and Modelling
- CSCI 4050U – Machine Learning, Theory and Application

3. RESOURCE REQUIREMENTS

a. Enrollment projections

We anticipate an initial cohort of 10 students with a steady state of 20 students per year, by the fourth year of offering. Total enrolment throughout years 1-4 of the program are as follows and has taken into account a retention rate of 80% between year 1 and 2.

Table 3 - Projected enrolment by year of operation and program year.

YEAR OF OPERATION	Yr1	Yr 2	Yr 3	Yr 4	Yr5	Yr6	Yr7	TOTAL ENROLMENT
2021-22	10							10
2022-23	15	8						23
2023-24	15	12	8					35
2024-25	20	12	12	8				52
2025-26	20	16	12	12				60

We expect that many of the students who enter the program will have a primary interest in Computer Science. There were more than 700 applicants to the Computer Science program in 2018-19, with a current incoming cohort capacity of 130. The Integrated Mathematics and Computer Science program will have a small cohort due to its specialized nature, and while it will draw from Computer Science applicants, we anticipate that it will not negatively affect the overall enrolment in Computer Science.

We also expect that there will be students who will wish to transfer into the Integrated

Mathematics and Computer Science program from other Faculty of Science programs. In particular, students who have completed their first year of the Computer Science program will only be missing a single required course (MATH 2050U – Linear Algebra). Required first and second year courses for the Integrated Mathematics and Computer Science program are outlined in the table below, and those required in the Computer Science and/or the Applied and Industrial Mathematics programs have been highlighted. Currently, MATH 2050U is offered during the Spring session, which would allow Computer Science students transferring into the proposed program to pick up the missing course. Students transferring after the second year of the Computer Science program will also be able to graduate in four years. However, unless they have taken one of the required Math courses as an elective during their second year, they will have a restricted choice of senior level Math electives. As with any program change, students would be recommended to meet with their academic advisor to develop an individualized course plan.

Students transferring from the Applied and Industrial Mathematics or Physics programs after first year, may be able to complete the program without a delay, if they have obtained at least a B+ in CSCI 1040U – Introduction to Programming for Scientist. In this instance, CSCI 1040U can be considered a course substitution for CSCI 1030U. Students meeting this requirement would have the prerequisites for all second year core courses. Working with their academic advisor to judiciously select courses for second year, students should be able to develop a course plan that allows them to complete all missing first core courses as well as ensures they have the necessary prerequisites to move forward in their desired upper year courses. In order to complete the Integrated Mathematics and Computer Science program within four years, students transferring after first year from the Applied and Industrial Mathematics and Physics programs, would need to take one or two elective courses, respectively, in a Spring or Summer session. Students transferring from these programs after second year would likely require at least an additional year to complete their program requirements, as there is less overlap in core courses after first year.

Table 4 - Years 1 and 2 Course Comparison between programs

UOIT Honours BSc in Integrated Mathematics and Computer Science	
Blue: Courses required in both the Computer Science and Applied and Industrial Math programs Red: Courses required in the Computer Science program Orange: Courses required in the Applied and Industrial Math program	
Semester 1	
CSCI 1030U	Introduction to Computer Science
CSCI 1060U	Programming Workshop I
PHY 1010U or PHY 1030U	Physic I or Introductory Physics
MATH 1010U or MATH 1000U	Calculus I or Introductory Calculus
	Elective
Semester 2	
CSCI 1061U	Programming Workshop II
MATH 1020U	Calculus II
MATH 2050U	Linear Algebra
PHY 1020U	Physics II

	Elective
Semester 3	
CSCI 2000U	Scientific Data Analysis
CSCI 2010U	Data Structures
CSCI 2110U/ MATH 2080U	Discrete Mathematics
MATH 2015U	Calculus III
STAT 2010U	Statistics and Probability for Physical Science
Semester 4	
CSCI 2020U	Software Systems Development and Integration
CSCI 2040U	Software Design and Analysis
CSCI 2072U/ MATH 2072U	Computational Science I
MATH 2055U	Advanced Linear Algebra
MATH 2060U	Differential Equations

This program has been developed with consideration of the teaching expertise of the Mathematics and Computer Science faculty members, and the courses currently offered by each discipline.

Two new Integrated Applications courses will have to be developed, as well as the creation of undergraduate thesis courses specific to Integrated Mathematics and Computer Science. We currently have a strong group of faculty that will directly contribute to teaching these courses, as well as supervising thesis projects. Most of the Faculty listed as core to this program are also graduate faculty in the Modelling and Computational Science (MCSC) and/or Computer Science programs.

b. Faculty Members

As the proposed program draws on the existing expertise in Computer Science and Mathematics, in the Faculty of Science, no new faculty members are required for this program. The majority of courses (>95%) in this program are taught by core Computer Science and Mathematics faculty members. The core faculty that will teach the courses in the program and/or provide thesis supervision are as follows.

All the faculty members listed in Table 5 below are tenured, tenure-track, or teaching faculty with continuing contracts. (Teaching faculty are considered essentially permanent faculty, having been through a probationary period of three years and a summative review process.) Those listed as Professor and Associate Professor are tenured; two professors are tenure-track Assistant Professor (one in Math, one in Computer Science). All of the teaching faculty listed are Associate Teaching Professors, with continuing contracts. (We are also in the process of bringing onboard a new teaching faculty member in Computer Science, who would start as an Assistant Teaching Professor in a probationary role for three years.)

Table 5 – Computer Science and Mathematics Faculty members

Name	Affiliated Discipline	Rank	Expertise	*Courses Taught *,***
Mihai Beligan, PhD	Mathematics	Associate Teaching Professor	Linear Algebra, Algebraic Structures, Calculus, Discrete Mathematics	*· MATH 1010U – Calculus I* ***· MATH 1020U – Calculus II*** *· MATH 2050U – Linear Algebra* ***· MATH 2015U – Calculus III*** ***· MATH 2055U – Adv. Linear Algebra & Applications*** *· MATH 2060U – Differential Equations* ***· MATH 2080U/CSCI 2110U – Discrete Mathematics*** ***· MATH 3020U – Real Analysis*** ***· MATH 3070U – Algebraic Structures***
Sean Bohun, PhD	Mathematics	Associate Professor	Mathematical Modelling, Data Driven Decision Making, Stochastic Modelling, Simulation and Numerics	*· MATH 1010U – Calculus I* *· MATH 1020U – Calculus II* *· MATH 3040U – Optimization* ***· MATH 3050U – Mathematical Modelling*** *· MATH 4030U – Applied Functional Analysis* ***· MATH 4050U – Partial Differential Equations*** ***· MATH 4060U – Industrial Mathematics***
Jeremy Bradbury, PhD	Computer Science	Associate Professor	Software Engineering, Software Quality Assurance, Multicore Software, Software Visualization	***· CSCI 1060U – Programming Workshop I*** *· CSCI 2010U – Data Structures* *· CSCI 2050U – Computer Architecture I* *· CSCI 3060U – Software Quality Assurance* ***· CSCI 4060U – Massively Parallel Programming*** *· CSCI 4100U – Mobile Devices*
Jane Breen, PhD	Mathematics	Assistant Professor	Matrix analysis, linear algebra and combinators	***· MATH 3030U – Introduction to Probability Theory*** ***· MATH 4020U – Computational Science II*** ***· MATH 4042U – Topics in Applied Math II***

Christopher Collins, PhD	Computer Science	Associate Professor, and Canada Research Chair in Linguistic Information Visualization	Data Analytics, Human-computer Interaction, Interaction Design, Visualization	*· CSCI 3090U – Computer Graphics and Visualization* ***· CSCI 4210U – Information Visualization*** ***· CSCI 4620U – Human-Computer Interaction***
Heidar Kourosh Davoudi, PhD	Computer Science	Assistant Professor	Machine Learning, Business Intelligence, Data Analytics and Big Data	***· CSCI 1061U – Programming Workshop I*** ***· CSCI 3070U – Analysis and Design of Algorithms***
Paula DiCato, MSc	Mathematics	Associate Teaching Professor	Statistics, Probability, Calculus, Biostatistics	*· MATH 1000U – Introductory Calculus* ***· MATH 1010U – Calculus I*** ***· MATH 1020U – Calculus II*** ***· STAT 2010U – Statistics & Probability for Physical Science*** ***· STAT 3010U Biostatistics***
Mehran Ebrahimi, PhD	Mathematics	Associate Professor	Medical Image Analysis, Image Processing, Machine Learning, Mathematical Imaging, Inverse Problems, Numerical Analysis	*· MATH 1020U – Calculus II* ***· MATH 3020U – Real Analysis*** ***· MATH 3040U – Optimization*** *· MATH 3050U – Mathematical Modelling* *· MATH 3060U – Complex Analysis* ***· MATH 4020U – Computational Science II*** *· MATH 4041U – Topics in Applied Math I* ***· MATH 4042U – Topics in Applied Math II***
Randy Fortier, MSc	Computer Science	Associate Teaching Professor	Networking, Web Development, Mobile Development, Graphics, Game Development, Artificial Intelligence	***· CSCI 1030U – Introduction to Computer Science*** *· CSCI 1060U – Programming Workshop I* ***· CSCI 2010U – Data Structures*** *· CSCI 2020U – Software Systems Development & Integration* *· CSCI 2040U – Software Design and Analysis* ***· CSCI 2050U – Computer Architecture I*** *· CSCI 3010U – Simulation and Modelling*

				· ***CSCI 3070U – Analysis and Design of Algorithms*** · ***CSCI 3090U – Computer Graphics and Visualization*** · ***CSCI 3230U – Web Application Development*** · ***CSCI 4100U – Mobile Devices*** · ***CSCI 4110U – Advanced Computer Graphics*** · ***CSCI 4160U – Interactive Media***
Mark Green, PhD	Computer Science	Professor	Computer Graphics, Computational Holography, Virtual Reality, 3D Displays	· *CSCI 3055U – Programming Languages* · ***CSCI 3090U – Computer Graphics and Visualization*** · ***CSCI 3310U – Systems Programming*** · *CSCI 4020U – Compilers* · *CSCI 4100U – Mobile Devices* · ***CSCI 4110U – Advanced Computer Graphics*** · *CSCI 4160U – Interactive Media*
Ilona Kletskin, MSc	Mathematics	Senior Teaching Professor	Mathematical Modelling, Mathematics Education, Online Assessment in Mathematics	· ***MATH 1000U – Introductory Calculus*** · *MATH 1010U – Calculus I* · ***MATH 1020U – Calculus II*** · ***MATH 2050U – Linear Algebra*** · *MATH 2060U – Differential Equations* · *MATH 3050U – Mathematical Modelling*
Greg Lewis, PhD	Mathematics	Associate Professor	Applied Dynamical System, Numerical Bifurcation Analysis, Geophysical Fluid Dynamics	· *MATH 2050U – Linear Algebra* · ***MATH 2060U – Differential Equations*** · *MATH 2072U – Computational Science I* · *MATH 3050U – Mathematical Modelling* · *MATH 3060U – Complex Analysis* · ***MATH 4010U – Dynamical Systems and Chaos*** · ***MATH 4041U – Topics in Applied Math I***

				· MATH 4042U – Topics in Applied Math II *· MATH 4060U – Partial Differential Equations*
Ken Pu, PhD	Computer Science	Associate Professor	Database, Programming Languages, Cloud Computing, Machine Learning,	*· **CSCI 2000U – Scientific Data Analysis*** *· CSCI 2010U – Data Structures* *· CSCI 2020U – Software Systems Development and Integration* *· CSCI 2050U – Computer Architecture I* *· CSCI 3030U – Database Systems and Concepts* *· **CSCI 3055U – Programming Languages*** *· CSCI 3070U – Analysis and Design of Algorithms* *· **CSCI 4020U – Compilers*** *· **CSCI 4050U – Machine Learning, Theory and Applications***
Faisal Qureshi, PhD	Computer Science	Associate Professor	Computer Vision, Machine Learning, Low-level Vision, Camera Networks	*· **CSCI 1061U – Programming Workshop II*** *· CSCI 2010U – Data Structures* *· CSCI 2050U – Computer Architecture I* *· **CSCI 3010U – Simulation and Modelling*** *· CSCI 3070U – Analysis & Design of Algorithms* *· CSCI 4040U – Ethics, Law & the Social Impacts of Computing* *· CSCI 4110U – Advanced Computer Graphics* *· **CSCI 4220U – Computer Vision***
Azar Shakoori, PhD	Mathematics	Assistant Teaching Professor	Numerical Methods, Differential Equations, Calculus, Linear Algebra	*· MATH 1000U – Introductory Calculus* *· **MATH 1010U – Calculus I*** *· **MATH 1020U – Calculus II*** *· **MATH 2050U – Linear Algebra*** *· MATH 2080U – Discrete Mathematics*

				· *MATH 3040U – Optimization* · ***MATH 3060U – Complex Analysis*** · *MATH 4010U – Dynamical Systems and Chaos* · *MATH 4020U – Computational Science II*
Jarek Szlichta, PhD	Computer Science	Assistant Professor	Big Data Analytics, Data Quality, Data Discovery, Query Performance Problem Determination	· *CSCI 2000U – Scientific Data Analysis* · ***CSCI 2040U – Software Design and Analysis*** · ***CSCI 3030U – Database Systems and Concepts*** · ***CSCI 4030U – Big Data Analytics***
Lennaert van Veen	Mathematics	Associate Professor	Dynamical Systems, Scientific Computing, Fluid Dynamics, Mathematical Biology	· ***CSCI 2072U/MATH 2072U – Computational Science I*** · *MATH 4020U – Computational Science II* · ***MATH 4041U – Topics in Applied Math I*** · *MATH 4050U – Partial Differential Equations*

*Service and Graduate level courses not included.
** Course taught in the last two years bolded.

c. Additional Academic and Non-academic Human Resources

The current courses offered in the program have the capacity to absorb the projected student enrollments. Marginal increases in various areas would be required to accommodate the increased enrolments, primarily in the Computer Science courses that include a lab component. The main impact to resource areas include teaching assistantships in the laboratories and tutorials, and increased administrative and faculty supervisory workload resulting from thesis supervisions.

d. Academic and Non-Academic Supports

All undergraduate students have access to an extensive support system that ensures a quality student experience. In addition to the outlined services below, students may also take advantage of the Campus Childcare Centre, Campus Bookstores, Housing and Living Resources as well as the Student Association. Further information can be found at: https://studentlife.ontariotechu.ca/

Information Technology Resources

IT Services strives to provide quality services to students at Ontario Tech. To support these objectives, the following components are included:

- Wireless network
- Wired network
- IT Service Desk

- General workstations
- Printing services

Wireless network
Wireless internet connection is available in public areas and open-air locations around the Ontario Tech campus where students congregate (North Oshawa and Downtown locations).

Wired network
To ensure the success of the technology-enriched learning environment, a comprehensive data network has been installed on campus. This includes a network drops in lecture halls and designated areas as well as network drops for each residence suite.

Ontario Tech students benefit from networked classrooms and learning spaces. Each ergonomically-designed space has data network connection access and electrical connections to ensure battery regeneration. In addition, classrooms include electronic projection equipment and full multimedia support.

IT Service Desk
The IT Service Desk is equipped with certified technicians and experienced IT professionals offering technical support services on a drop-in, call-in or email basis.

GUWs
Ontario Tech undergraduate students are able to use general workstations available at the library and have access to BYOD TELE model course-specific software.

Printing services
Printing services are available to students in the following areas: labs, classrooms, study common areas, the Learning Commons and the Library. All Ontario Tech students receive print credits every year, more Printpacks can be purchased through the Campus Bookstore if students require additional printing services.

Teaching & Learning Centre
The mission of the Teaching and Learning Centre (TLC) at Ontario Tech University is to empower faculty to reach their potential as educators and to create a culture where effective teaching is valued. We champion the scholarship of teaching and implementation of pedagogy. We create valuable teaching and learning professional development experiences. We move Ontario Tech towards being a leader in teaching excellence, ultimately leading to greater student success.
The TLC provides faculty with a range of tools and facilities to assist them in providing a rich learning experience for students. Experts at the TLC provide support in various areas including curriculum development, multimedia design, learning technology and in the overall improvement of teaching practice.

In addition, the TLC funds teaching-related projects from the Teaching Innovation Fund (TIF) for proposals by faculty members aimed at developing new methods in teaching and learning. The TLC

facilitates teaching awards at the University and supports faculty in their application for external awards and funding opportunities that focus on teaching and learning.

Student services
All undergraduate students have access to an extensive support system that ensures a quality student experience. In addition to the outlined services below, students may also take advantage of the Campus Childcare Centre, Campus Bookstores, Housing and Living Resources as well as the Student Association. Further information can be found at: https://studentlife.ontariotechu.ca/

Academic Advising
The Faculty of Science Academic Advising Office is committed to assisting students in developing and reaching their academic and personal goals. Academic Advising serves as the undergraduate students' main point of contact within the Faculty of Science *for students in Science programs or taking core courses in Science*. The Science Academic Advising team assists students by:

- Addressing questions and concerns related to all aspects of student life;
- Helping establish realistic educational goals and future planning;
- Assessing and discussing academic progress and standing;
- Discussing program and course selections;
- Helping to address academic difficulties;
- Interpreting academic policies and procedures;
- Discussing issues affecting academic performance;
- Providing advice regarding withdrawing from, adding or dropping courses;
- Providing guidance for successful progression towards graduation;
- Providing tips for academic success;
- Connecting students with appropriate campus services (e.g. Student Learning Center, Accessibility Services, etc.) for additional assistance.

The Science Cafe
The Science Café is a program developed by the Faculty of Science at Ontario Tech University to provide additional study space, academic support and mentorship to undergraduate students. The Science Café is open to students looking for a relaxed space to study and complete their school work. This space is also for students looking to connect with upper-year Science students and teaching assistants (TAs) and/or students who require academic support with Science courses. T.A.s are able to provide support with undergraduate Science courses in the areas of Biology, Chemistry, Math, Physics and Computer Science, at any year level. Run as a weekly drop-in, students are provided with an opportunity to review and stay on top of course material, with the advantage of having TAs to guide and provide support as needed. The Science Cafe also offers various study tools/resources and complimentary hot beverages during the sessions. No registration is required, so students can stop by at any point during the sessions and take advantage of the study space and resources even if they don't require academic support. The Science Café TAs are available to provide assistance as needed, whether it is on a one-on-one basis or in small collaborative groups.

Student Learning Centre

The Student Learning Centre fosters a high level of academic excellence in the Ontario Tech University community by working with all Ontario Tech students, undergraduate and graduate, to achieve educational success. Foundational knowledge and prerequisite skills are essential to all university level courses, and competency with these skills is vital for strong academic performance. The subject specialists offer support services in mathematics, writing, study skills, ESL an physics. With the additional support of peer tutors and workshops, the Centre can further accommodate the needs of a specific course or program.
https://studentlife.ontariotechu.ca/services/academic-support/index.php

Student Accessibility Services
The staff work as a collaborative team to ensure students with disabilities have equal opportunities for academic success. The SAS operates under the Ontario Human Rights Code (OHRC) and the Accessibility for Ontarians with Disabilities Act (AODA). Services are provided for students with documented disabilities. Accommodation supports include but are not limited to:

- Adaptive technology training;
- Alternate format course material;
- Learning skills support;
- Testing support; and
- Transition support for incoming students.

Careers and Internships
The Career Centre offers comprehensive career service assistance and a variety of valuable resources to help students along their career paths:

- Assistance with creating effective job-search documents;
- Career Counselling;
- Interview preparation;
- Job market information; and
- Job search strategies.

A variety of events hosted on campus during the academic year including employer information and networking sessions, job fairs, and interviews conducted by leading employers.

Student Engagement and Equity
The Student Engagement and Equity supports students' successful transition into the university and provides opportunities for them develop your leadership and professional skills throughout their university career. Services provided through Student Engagement and Equity includes:

- Orientation and events through first year
- Specialized programming for first generation, graduate, indigenous, international, mature, online, transfer, and diploma-to-degree pathways students
- Equity and inclusivity programming
- Assistance and advice for living off campus
- Peer mentoring to help students through first year

- Opportunities to grow and develop leadership skills through the Ambassador program.

Student Mental Health Services
Student Mental Health Services helps students learn how to better manage the pressures of student life. Students can:

- Attend a drop-in session;
- Participate in events and activities that promote positive health and well-being;
- Access tools and resources online to learn about mental health and how to maintain good health and wellness;
- Work with a mental health professional to address concerns;
- Contact the Student Lifeline for immediate help and assistance; and
- Get answers to frequently asked questions about mental health.

Student Mental Health Services offers short-term counselling and therapy services to students. Students in distress will also be provided support and counselling as needed. There is no cost and services are confidential. For students who need long-term counselling support or specialized mental health services, Ontario Tech will provide referrals to assist the student in accessing resources in the local community or in the student's home community.

Athletics and Recreation Faculties
Ontario Tech University offers a number of recreation facilities and fitness opportunities to meet all lifestyles and needs. On-campus facilities include the state-of-the-art FLEX Fitness Centre which overlooks Oshawa Creek, five gymnasiums, a 200-metre indoor track, two aerobic/dance studios, the Campus Ice Centre, Campus Fieldhouse , a soccer pitch, a fastball diamond, squash courts and an indoor golf-training centre.

Campus Health Centre
The Campus Health Centre provides assistance in numerous confidential health-care options including:

- A medical clinic with daily access to physician and nursing staff;
- Allergy injections, immunizations and influenza injections;
- An on-site laboratory (blood work, STI testing, throat swabs, etc.);
- Complementary Health Services featuring acupuncture, chiropractic, custom orthotics, massage therapy, nutritional counselling and physical therapy;
- Gynaecological health-care and prescriptions; and
- Treatment of disease, illness and injury.

Student Awards and Financial Aid
Student Awards and Financial Aid (SAFA) is dedicated to helping students understand the variety of options available to finance their education. Budgeting and financial planning are essential to their success and Student Awards and Financial Aid is on hand to help create the right financial plan. Financial assistance can be in the form of bursaries, employment (both on-campus and off),

parental resources, scholarships, student lines of credit and the Ontario Student Assistance Program (OSAP).

e. Physical Resource Requirements

To accommodate the increase in enrolment, additional lab tutorial/sections will be made available. The primary impact will be in the Computer Science courses, where an additional lab section will be required to accommodate an increase in the number of students. We currently have the teaching laboratory space to accommodate this increase in student enrolment, and no additional physical lab space is anticipated. There is sufficient capacity in the Mathematics courses, particularly in the upper years, to accommodate the additional 20 students per year.

No significant increased resource requirements are anticipated in terms of library holdings, information technology support and student services.

4. BUSINESS PLAN

a. Statement of Funding Requirement

Only limited additional resources will be required to support this program. The direct costs will be course assignments for IMCS 3010U and CSCMA 3020U, as well as additional TA time.

We are estimating the main financial needs to be the creation of the two new Integrated Applications courses, and additional lab and tutorial sections needed to accommodate the new students. Please refer to the attached Proposal Budget for additional information.

Table 6 - Projected revenue and expenses by year.

PROGRAM FINANCIAL SUMMARY

Enrollment	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Year 1	10	15	15	20	20	20
Year 2	0	8	12	12	16	15
Year 3	0	0	8	12	12	15
Year 4	0	0	0	8	12	12
Year 5	0	0	0	0	8	12
TOTAL New Students	**10**	**23**	**35**	**52**	**68**	**76**

Revenue	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Domestic Tuition	$67,213	$159,228	$249,572	$381,917	$514,413	$592,180
International Tuition	$12,870	$30,488	$47,786	$73,127	$98,496	$113,387
Grant	$27,288	$102,058	$193,746	$299,079	$421,330	$467,174
Total Revenue	**$107,371**	**$ 291,774**	**$ 491,105**	**$ 754,123**	**$ 1,034,239**	**$ 1,172,741**

Course Summary	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
# of lecture sections	0	1	2	2	2	2
# of labs	5	7	11	12	12	12
# of tutorials	5	10	10	10	10	10

Required Hires	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27

# of TTT	0	0	0	0	0	0
# of TF	0	0	0	0	0	0
# of PT Faculty	0	0	0	1	1	1

Expenses						
Academic Salaries	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
FT Faculty	$ -	$ -	$ -	$ -	$ -	$ -
FT Benefits (18.5%)	$ -	$ -	$ -	$ -	$ -	$ -
FT Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

PT Faculty	$ -	$ -	$ -	$ 9,702	$ 10,187	$ 10,697
Additional TAships	$ 1,411	$ 5,926	$ 9,334	$ 6,334	$ 7,151	$ 18,008
TAs	$ 28,220	$ 59,262	$ 62,225	$ 65,336	$ 68,603	$ 72,033
Lab Instructors	$ 29,705	$ 43,667	$ 72,050	$ 82,530	$ 86,656	$ 90,989
PT Benefits (11%)	$6,527	$11,974	$15,797	$19,129	$20,086	$21,090
PT Total	**$ 65,863**	**$ 120,829**	**$ 159,406**	**$ 193,032**	**$ 202,683**	**$ 212,817**
Total Academic Salaries	**$ 65,863**	**$ 120,829**	**$ 159,406**	**$ 193,032**	**$ 202,683**	**$ 212,817**

Support Staff Salaries	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0
Benefits (18.5%)	$0	$0	$0	$0	$0	$0
Total Support Staff Salaries	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Operational Expense	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Instructional Supplies	$1,950	$2,925	$4,225	$4,875	$4,875	$4,875
Start-up	$0	$0	$0	$0	$0	$0
PD ($2,000/ faculty)	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0
Recruitment/Moving Expenses	$0	$0	$0	$0	$0	$0
Promotion	$1,000	$500	$500	$500	$500	$500
Telecommunication	$0	$0	$0	$0	$0	$0
Office Supplies	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0
TOTAL Operating	**$2,950**	**$3,425**	**$4,725**	**$5,375**	**$5,375**	**$5,375**

Capital	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
TOTAL Capital	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Total Expenses	**$68,813**	**$124,254**	**$164,131**	**$198,407**	**$208,058**	**$218,192**

NET Income with Grant	**$38,558**	**$167,520**	**$326,975**	**$555,716**	**$826,181**	**$954,548**
NET Income without Grant	**$11,270**	**$65,462**	**$133,228**	**$256,637**	**$404,851**	**$487,374**