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MEMORANDUM

ATTENTION	Senate	**DATE**	January 14, 2025
FROM	Dilson Rassier, Provost and Vice-President Academic, and Chair, SCUP	**PAGES**	1/21
RE:	Full Program Proposal for an Applied Mathematics Minor (SCUP 25-05)		

At its meeting on January 8, 2025, SCUP reviewed and approved the Full Program Proposal for the Applied Mathematics Minor in the Department of Mathematics within the Faculty of Science.

Motion: That Senate approve and recommend to the Board of Governors the Full Program Proposal for an Applied Mathematics Minor in the Department of Mathematics within the Faculty of Science.

C: Justin Gray, Associate Chair, Undergraduate Learning, Department of Mathematics

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MEMORANDUM

ATTENTION	Senate Committee on University Priorities	**DATE**	December 6, 2024
FROM	Paul Kingsbury, Vice-Chair Senate Committee on Undergraduate Studies	**PAGES**	1/1
RE:	Faculty of Science (SCUS 24-96)		

Action undertaken by the Senate Committee on Undergraduate Studies at its meeting of December 5, 2024, gives rise to the following recommendation:

Motion

That SCUP approves the Full Program Proposal for the Applied Mathematics Minor in the Department of Mathematics within the Faculty of Science.

The relevant documentation for review by SCUP is attached.

SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

Applied Mathematics Minor

Full Program Proposal

October 1, 2024

Department of Mathematics

[The executive summary is based on the structure and information provided in the Notice of Intent, from which details may be copied and pasted. Please update any information presented in the NOI where relevant. As with the NOI, the executive summary should be presented in a very succinct manner and should be no longer than 2 – 3 pages in length. Delete this paragraph and all explanatory questions on the final copy.]

1 Executive Summary

a) An overview of the institution's history, mission, and academic goals:

Please provide a brief summary (1-2 paragraphs) that links the proposed program to the SFU's vision and mission (use and add to the boilerplate institution detail below):

As Canada's engaged university, Simon Fraser University emphasizes the importance of innovative education and community involvement. The proposed applied math minor, with streams in biomathematics and scientific computing, exemplifies this commitment by offering students interdisciplinary opportunities that integrate mathematics, life sciences, and computational methods. These fields are increasingly vital for addressing real-world challenges in infectious disease, healthcare, climate science, and technology, aligning with SFU's vision of embracing bold, innovative approaches to learning and research. As well, the streams align with and leverage existing research strengths in the Department of Mathematics, ensuring students are taught by experts in these fields. Through this program, SFU continues to grow a culture of collaboration and intellectual growth by preparing students to apply mathematical techniques to pressing issues in society, science and industry, thereby fostering a deeper connection between academic study and societal impact.

b) Credential to be awarded:

Applied Mathematics Minor

c) Location of program:

SFU Burnaby, based on course offerings.

d) Faculty offering the proposed new program:

Department of Mathematics

e) Anticipated program start date:

Fall 2025

f) Anticipated completion time:

Students will be able to complete the Applied Mathematics Minor within the same time frame required to complete a parallel major, i.e., 4 years.

g) Summary of the proposed program

- **Aims, goals, and objectives:**

Describe the program and explain why it is being proposed.

Applied mathematics is a broad specialization of mathematics, most classically linked to application in the physical sciences and engineering but increasingly seeing high demand in fields including health and life sciences, computer science, engineering and data science. The Department of Mathematics has for decades offered a major program in applied mathematics, for those whose primary interests are mathematical sciences. Now, the proposed minor program aims to provide a solid mathematical background for students whose major interests lie in these diverse applications of applied mathematics.

This program will prepare students for the myriad of careers in which mathematical and computational training is highly in demand. In their minor courses, students will learn the robust mathematical theory behind modeling real-world problems such as the spread of infectious diseases, the impacts of climate change and shifting environments, the pace and direction of evolution, and the dynamics of complex systems. Students will be trained how to construct, analyze - both mathematically and computationally -, and interpret mathematical representations of real-world phenomena, with particular emphasis on developing interdisciplinary problem solving and communication skills.

As well, we aim for this program to provide a strong pathway for undergraduate students to move to graduate programs, and in particular for our flagship courses (e.g. MATH 468, MATH 469 in the biomathematics stream, MACM 409, MACM 416 in the scientific computing stream) to be an excellent place for recruitment of students to remain at SFU for graduate studies. This has proven successful in the last 2 years, with several students enrolled in the biomathematics courses moving to undergraduate research positions or graduate programs at SFU.

- **Contribution to the mandate and strategic plan of the institution:**

Explain how the proposed program fits with the overall goals of the department, Faculty and university.

The proposed program aligns with SFU's mission to bring an interdisciplinary approach to learning, by specifically targeting students in programs from other departments and faculties who want to combine the development of quantitative skills with diverse applications. For example, the minor stream in biomathematics is designed to include courses at the lower division from target units such as Biological Sciences, Health Sciences and Statistics, as a flag to those students that the applied mathematics minor is designed for them. The biomathematics and scientific computing streams align with SFU's strategic initiative to link research to teaching and learning - through highlighting in undergraduate courses the research strengths of our department, and developing pathways to graduate studies at SFU.

The 2 streams proposed for the applied mathematics minor clearly align with SFU's 2023-2028 priority research areas. It specifically aligns with supporting the health and wellness of individuals, populations and communities (biomathematics stream) and transforming industry and economies through technology, management and policy (scientific computing stream).

SFU is an excellent location for this program, as a home-site of the Pacific Institute for the Mathematical Sciences (PIMS) whose mandate includes the application of mathematics "at the highest international caliber", and (given close links to statistics and biostatistics) the headquarters of The Canadian Statistical Sciences Institute (CANSSI) whose focus includes the application of statistics to science, engineering, and society. SFU recently launched a new research and training institute, the Pacific Institute on Pathogens, Pandemics and Society (PIPPS), which aims to build capacity to face emerging infectious disease threats in British Columbia, and has themes in pandemic data science, evolution and emerging infections, health communication and behavior and related areas. PIPPS is led by Ben Ashby, a mathematics faculty member. SFU is also launching a new medical school, and this minor would be an excellent opportunity for medical students to gain quantitative skills.

- **Linkages between program outcomes and curriculum design:**

Explain how the courses and curriculum requirements of the program contribute to the program educational goals and outcomes. If a work/practicum experience is required, provide a description of the purpose and role of the experience within the program.

The courses chosen for inclusion in both streams of the minor focus on the development of applied mathematical skills. Students grow both a solid theoretical

foundation of quantitative skills, and experience in how to apply them to diverse areas of application from biology to physics to healthcare to computing and engineering. This is designed to complement their major program, in order to produce well-rounded graduates with practical skills that are highly in demand by industry and academia. The program was designed to balance the inclusion of some required/recommended core courses for each stream, with free choice among existing MATH courses for students to target their remaining credits to their individualized training goals.

For example, MATH 360 was added in Fall 2023 and serves as a bridge between more general lower-division courses that introduce students to core mathematical topics such as calculus, linear algebra, and probability, and more specialized upper-division courses in biomathematics. MATH 468 covers modeling methods and applications, including topics like how to choose an appropriate model for a problem, how to decide how well it matches data, and how to simulate from models for real-world problems. This bridges theory and application and provides concrete quantitative skills (estimation, simulation, model design, model critique). MATH 469 covers applications of discrete mathematics in biology, which connects with key skills needed in computer and data science (for example working with tree and graph data structures), and an expanded repertoire for how mathematics can represent many phenomena (ancestry, gene trees, species trees, social networks) beyond simulating processes in time, as in the classic mathematical biology modeling curriculum. MACM 409 and MACM 416 covers the design and implementation of scientific computing methods that are widely used to analyze complex applied models in the physical sciences, environmental sciences and engineering.

One focus of the anchor minor courses is on effective communication of mathematics. MATH 360 and 348 for example include a project component, to assess students' communication, presentation and independent research skills. MATH 468 has students complete a literature review and presentation. Compared to the more traditional approach in mathematics of purely exam-based assessment, this allows our graduates to develop well-rounded skills in collaboration and scientific computation. MACM 316 puts an emphasis on the presentation of the results obtained through scientific computing methods.

In terms of developing pathways to graduate study, courses such as the 4 courses at the core of the biomathematics stream (MATH 360, MATH 348, MATH 468, MATH 469) or MACM 409 and MACM 416 in the scientific computing stream provide a great base for student recruitment, and allow students with majors in e.g. biology, statistics, computer science to experience upper-division mathematics tailored to their interest, and perhaps consider graduate study incorporating both fields. The non-core courses provide complementary, more traditional, mathematical skills that solidify the quantitative skills acquired by the students and result in truly interdisciplinary training.

- **Potential areas/sectors of employment for graduates or opportunities for further study:**

Briefly state career possibilities and further educational options.

This minor program will produce graduates with strong quantitative, modeling, problem-solving and scientific computing skills, who are experienced in working in interdisciplinary environments. Such individuals will be qualified to work in a variety of careers and industries, including

- Biotech and biomedical careers
- Healthcare sector, e.g. healthcare data analytics, operations research
- Computational biology
- Engineering/Chemical companies
- Data science
- Modeling e.g. healthcare, climate science, geoscience
- Software engineering/machine learning/AI
- Pharmaceutical research

and many more.

- **Delivery methods:**

Will the program be delivered as lecture/tutorial/lab, or will it include online delivery methods?

The requirements for the minor program will all be existing department of mathematics courses, as well as some existing courses from other departments. These are primarily lecture-based courses delivered in-person, with some computing tutorials/labs.

- **Program strengths:**

The strength of the program is to offer a unique interdisciplinary training in applied mathematics, allowing students to acquire robust quantitative skills in mathematical modeling, analysis of mathematical models and computational mathematics, with specializations in two fields in high demand, biomathematics and scientific computing.

- **Level of support and recognition:**

Provide a brief explanation of the nature of the consultations that have occurred in the development of this program. Summarize comments received from other post-secondary institutions, potential employers, any regulatory or professional bodies where applicable, advisory committees, and experts in the field of study. In the appendices, attach any supporting documents.

Consultations for the biomathematics stream first took place within the Department of Mathematics MAGPIE research group, with the Associate Chair for Undergraduate Learning. Over several months, a proposal was prepared for wider groups in the Department of Mathematics, culminating with Departmental ratification in September 2024. Along the way, Mathematics faculty members consulted with faculty and staff in related departments (Biological Sciences, Health Sciences, Statistics) to ensure alignment for students in e.g. course requirements and avoid potential overlaps with existing courses offered by other units. This minor program proposal was developed simultaneously with a major concentration in biomathematics, and with consideration to a possible future graduate program in the same area.

Similarly, consultations for the scientific computing stream took place within the Department of Mathematics APMA research group, with the Associate Chair for Undergraduate Learning, and followed a similar process to the biomathematics stream.

- **Related programs:**

Include related programs at SFU, other B.C. post-secondary institutions and outside of BC. Provide rationale for duplication (e.g. will this proposed program meet the needs of students or employers not met by similar programs?).

At SFU, an applied math major exists and has run for many years. The proposed minor has been designed to align well with the major, and concurrently a biomathematics concentration is being proposed for the applied mathematics major program and a scientific computing concentration is being prepared.

An SFU mathematics minor program also has been successfully established for many years. This program primarily attracts Computing Science majors (more than half of students registered as of August 2024). Particularly relevant for the proposed biomathematics stream, the mathematics minor currently attracts very few students in the biological or health sciences. Generally, the applied mathematics minor seeks to reach out to a wider array of students from other programs with some emphasis on quantitative skills (e.g. biology, health sciences, business, economics, engineering), and meet the needs of employers for more graduates with practical quantitative and computational skills.

Applied mathematics is a large and important area of mathematics, and as such similar programs are represented at other Canadian universities. The University of

Toronto has specialist programs in "Applied Mathematics" and "Mathematics & Its Applications (Probability/Statistics)", although neither are offered as a minor. University of Waterloo offers an applied mathematics major program with specialization in biology, economics or physics. They also offer an applied mathematics minor, although this does not offer any option to specialize in a particular stream. Similarly, currently none of the BC universities included in the Times Higher Education global rankings offers any kind of specialized applied mathematics minor program, nor the opportunity to specialize in streams such as biomathematics and scientific computing. In introducing the proposed applied mathematics minor, SFU will therefore be offering a unique and innovative option for students.

h) Contact information:

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[The sections below expand on the details for the proposed program and/or new credential. Explanatory comments are there to assist in providing the relevant information required by the Ministry of Advanced Education and SFU. Supporting documents should be attached as appendices. Delete this paragraph and all explanatory comments/questions on the final copy.]

2 Credential Recognition and Nomenclature

2.1 Post-secondary recognition

Explain how the design of the program facilitates credential recognition by other post-secondary institutions, such that graduates may pursue further studies at other institutions. Is the proposed program name and degree designation appropriate to program content and consistent with current usage in the discipline? Include evidence of consultation or research undertaken to ensure recognition if the credential is new (e.g. Bachelor of Environment). In the Appendices, attach letters of support or other supporting documentation.

Applied mathematics is the globally used term for the areas of mathematics this program will focus on, and the proposed minor aligns with the SFU Department of Mathematics existing major program in this area.

2.2 Industry/employer recognition

Where applicable, describe consultations undertaken to ensure the credential and learning outcomes will be recognized and meet the standards of industry/employers and regulatory, licensing or credentialing bodies. In the Appendices, provide current requirements or standards of those bodies and any copies of letters of recognition.

Given the differences compared to the existing mathematics minor program, we have no reason to believe that the applied mathematics minor will cause challenges with industry/employers. 'Related programs' above describes many other Canadian programs (not all Minor) that use similar namings.

3 Curriculum/Program Content

3.1 Program structure

Describe in detail the program structure (e.g. length of program, number of units, requirements, options, methods of evaluation etc.).

The proposed minor program will require 15 lower division (LD) units and 15 upper division (UD) units. The intended length of the minor will align with the student's major program. Each stream was designed to cover the key concepts/methodology required for success in that field, whilst also offering choice to students to refine the program to their interests. In the biomathematics stream, students are able to take at most 3 units at the LD and 3 units at the UD from a list of pre-approved, quantitatively-focused courses outside of the Department of Mathematics.

3.2 Core courses

Provide information on the core courses (i.e. course number, title, calendar description, pre-requisites).

Core courses for the biomathematics stream:

Stochastic Modelling and Simulation MATH 348 (3)

Modelling of real-life systems as Markov chains, including transient behaviour, limiting behaviour and classification of states, and using the exponential distribution and Poisson processes. Computational topics include generating and sampling random numbers, combinatorial objects and probability functions. Applications may include queueing systems, chemical kinetics, infectious diseases, and statistical physics. Prerequisite: STAT 270 and (MATH 232 or MATH 240), all with a minimum grade of C-. Strongly Recommended: Experience with a computing platform such as R, MATLAB, or Python. Quantitative.

Introduction to Biomathematics MATH 360 (3)

Key ideas and mathematical methods used in applications of mathematics to various biological, ecological, physiological, and medical problems. The course derives, interprets, solves and simulates models of biological systems. Topics could include population models, evolution from trait and genetic perspectives and qualitative analysis of ODEs. Prerequisite: MATH 260 with a minimum grade of C- OR MATH 155 with a minimum grade of A-. Strongly Recommended: Experience with a computing platform such as R, MATLAB, or Python. Quantitative.

Topics in Biomathematics MATH 468 (3)

Methods and applications of mathematical models in biology, focusing on understanding, analyzing, and applying scientific literature using models and integrating real data. Topics may include parameter estimation in biological models, stochastic simulation of disease outbreaks, age structured population models, and others. Course may be repeated for credit under a different topic. Prerequisite: MATH 360 and (MATH 348 or STAT 380), both with a minimum grade of C-. Strongly Recommended: Experience with a computing platform such as R, MATLAB, or Python.

Topics in Graphs and Trees in Biomathematics MATH 469 (3)

A survey of contemporary methods and applications of discrete mathematical models focusing on graphs, networks, and trees in evolutionary biology, ecology, and epidemiology. Using discrete models and integrating real data, students will focus on understanding, analyzing, and applying recent scientific literature. Course may be repeated for credit under a different topic. Prerequisite: MACM 201 with a minimum grade of C- and at least 60 units. Strongly Recommended: Experience with a computing platform such as R, MATLAB, or Python.

Core courses for the scientific computing stream:

Numerical Analysis I MACM 316 (3)

A presentation of the problems commonly arising in numerical analysis and scientific computing and the basic methods for their solutions. Prerequisite: MATH 152 or 155 or 158, and MATH 232 or 240, and computing experience. Quantitative.

Introduction to Fourier Methods and Partial Differential Equations MATH 314 (3)

Fourier series, ODE boundary and eigenvalue problems. Separation of variables for the diffusion wave and Laplace/Poisson equations. Polar and spherical co-ordinate systems. Symbolic and numerical computing, and graphics for PDEs. Prerequisite: MATH 260 or MATH 310, with a minimum grade of C-; and one of MATH 251 with a grade of B+, or one of MATH 252 or 254, with a minimum grade of C-. Quantitative.

Introduction to Analysis II MATH 320 (3)

Sequences and series of functions, topology of sets in Euclidean space, introduction to metric spaces, functions of several variables. Prerequisite: MATH 242 and 251, with a minimum grade of C-. Quantitative.

Complex Variables MATH 322 (3)

Functions of a complex variable, differentiability, contour integrals, Cauchy's theorem, Taylor and Laurent expansions, method of residues. Prerequisite: MATH 251 with a minimum grade of C-. Students with credit for MATH 424 may not take this course for further credit. Quantitative.

Partial Differential Equations MATH 418 (3)

First-order linear equations, the method of characteristics. The wave equation. Harmonic functions, the maximum principle, Green's functions. The heat equation. Distributions and transforms. Higher dimensional eigenvalue problems. An introduction to nonlinear equations. Burgers' equation and shock waves. Prerequisite: (MATH 260 or MATH 310) and one of MATH 314, MATH 320, MATH 322, PHYS 384, all with a minimum grade of C-. An alternative to the above prerequisite is both of (MATH 252 or MATH 254) and (MATH 260 or MATH 310), both with grades of at least A-. Quantitative.

3.3 Existing and new courses

Outline any existing and/or new courses required for the program. In the Appendices, attach sample course outlines and approved new course forms for any new courses.

No new courses are required for the program. The full program requirements are included in Appendix 8.1.

3.4 Curriculum and program goals

What are the educational goals of this program and how are they achieved by the courses and the curriculum structure? Describe how the learning environment and methodologies will help achieve the intended outcomes for this program.

The educational goals of the applied mathematics minor is to provide to students enrolled in a major program in other units than Mathematics to acquire quantitative skills in applied mathematics that can be applied in a wide range of fields such as life and health sciences, engineering, computer science, data science, economics. The biomathematics stream aims to develop specialized skills in modeling and analyzing models related to life and health sciences. The scientific computing stream aims to develop specialized skills in computational mathematics applicable in engineering sciences, physical sciences, environmental and climate sciences.

The program is structured to achieve these goals by offering a complement of traditional mathematics and applied mathematics courses, both at the lower division and upper division levels, together with specialized upper division courses in the biomathematics and scientific computing streams. This structure will allow the students to both develop solid general mathematics and applied mathematics skills and specialized quantitative interdisciplinary skills.

3.5 Work experience/field/practicum placement

If there is a work experience/field/practicum placement component to this program, provide some details on placement opportunities and the level of support the institution will provide to students seeking placements. Describe any anticipated outcomes, how the experience ties into the curricular outcomes and goals, and how students will be evaluated.

No work experience/field/practicum placements are involved.

4 Program Resources

4.1 Target audience and enrolment plan

What is the anticipated enrolment over the first three years? Provide data to support the expected enrolment.

Given that this will be a new program, with flagship courses that are also new/redeveloped, we recognize that enrolment may be smaller in the first several years. We will focus on strong recruitment to target departments, and tracking of student success/roadblocks. Since the minor streams will be a unique program for (at least) Western Canada, championed by faculty members with successful research programs in these areas, we are confident that this minor will be successful in attracting new students to SFU who seek a fulfilling interdisciplinary education.

During the 2023/2024, there were 106 students declared as a Mathematics Minor. We expect the Applied Mathematics Minor to attract a similar number of students. We anticipate enrollment of 100 students over the first 3 years.

4.2 Resources

Summarize the resources required for this program (i.e. faculty, staff, classrooms, labs, equipment, software, hardware, funds, library, etc.). If there will be no new faculty hires, explain the impact on existing programs. Are any programs being modified or displaced as a result? What is the schedule for securing the required resources? Describe the plans for program implementation (i.e. course development, program promotion, hiring of staff, instructional space, software, equipment purchasing, etc.). In the Appendices, attach any supporting documents.

The program will not require additional facilities, classrooms etc., since it will not involve introducing any new courses. Several courses have been recently introduced/adapted to reflect a biomathematics focus in the last several years, and this is now complete.

This program will also not require new faculty hires.

The biomathematics stream utilizes expertise from the Department of Mathematics MAGPIE research group, founded in 2018 with the hire of Prof. C. Colijn and expanded with the recent hires of several new faculty (A. MacPherson, B. Ashby, J. Stockdale). The core biomathematics courses are already being regularly taught by these faculty.

The scientific computing stream utilizes expertise from the Department of Mathematics APMA research group, founded decades ago and a flagship research group in the department, one of the best in Canada in computational applied mathematics. The core scientific computing courses are already taught by APMA faculty, whose complement is growing with the on-going search for an Assistant Professor in Scientific Machine-Learning and Partial Differential Equations (position number 131427).

Some students joining the applied mathematics minor program may otherwise have taken the mathematics minor program, but for the biomathematics stream we primarily target students in departments who do not traditionally do this. For example, as of August 2024 only 18% of mathematics minor students have their major program in the Faculty of Science, and 0% are from the Faculty of Health Sciences.

5 Program Review and Academic/Administrative Oversight

Indicate plans for ensuring adequate depth and breadth of ongoing review and evaluation once the program has been implemented (regular program reviews are mandated by Senate on a 7-year cycle). If applicable, describe how membership on advisory committees for this program will be maintained to ensure that the program will remain current in future years. If any external accreditation is required, explain the evaluation cycle.

This program will follow the standard review and evaluation procedures of SFU. The department will monitor both minor streams closely in their early stages, to ensure a good fit to students needs and e.g. resolve any pre-requisite or course-scheduling roadblocks as far as possible.

6 Program Consultation

Detail the timeline and nature of the consultations that have occurred within the university and externally with students, program advisory committees, other BC post-secondary institutions and institutions outside of BC, professional associations, employers, etc. Attach any documents (emails, letters) in the Appendices.

During the 2023/2024 academic year, the Department of Biological Sciences and the Department of Statistics and Actuarial Science were consulted on the proposed program.

7 Evidence of Student Interest and Labour Market Demand

Provide evidence supporting the expected student interest in this program, both domestic and international. What is the industry/employment demand for students who

obtain this credential? What occupations/careers will graduates be able to compete for in the job market? (See the occupation resource links in the NOI template.) Update and attach any student survey results and occupational data and documentation from the Notice of Intent in the Appendices.

The 2023 B.C. Labour Market Outlook identified the top 2 growing industry groups for the next 10 years as health care, and professional, scientific and technical services. This review highlighted that "natural and applied sciences and related occupations will expand their workforce faster than other occupational groups … driven by increasing demand for artificial intelligence (AI), automation and other technologies". Through our focus in the minor program on biomathematics and scientific computing, we train students for some of the most in-demand roles in BC and in Canada.

8 Appendices

8.1 Calendar entry

A complete proposed Calendar entry must be attached.

8.2 New Courses

Attach new course approval forms, sample course outlines, and library reviews for each course.

8.3 Market analysis – student interest and labour market demand

Include any data, student surveys, and letters of support from industry, employers, or accrediting bodies, that provide evidence of student and labour demand.

8.4 Consultation comments and letters of support

Attach any written endorsements or comments, from both internal and external sources.

8.5 Resources

Include any supportive memos indicating that sufficient space and other resources (such as confirmation from the Dean's Office, library reports, etc.) are available for the program.

8.6 Financial plan (only if additional resources required)

Outline the initial start-up costs, such as curriculum development and online design, as well as anticipated costs in offering the program (instructional salaries and benefits, administrative overhead, student services, and online support).

8.7 Abbreviated curriculum vitae for faculty

(needed only for new programs requiring Ministry of Advanced Education final approval) Include a CV for each faculty member in the program. In the case of cross-disciplinary programs, include a CV for each member of the steering committee and for faculty members likely to be teaching core courses. It is strongly suggested that short (e.g. 2 pages), standardized CVs be submitted, providing brief information on: current position; credentials; research interests; publications, grants and graduate supervision over a defined period (e.g. last seven years).

Applied Mathematics Minor

Applied mathematics is a broad specialization of mathematics, most classically linked to application in the physical sciences and engineering, but increasingly seeing high demand in fields including health and life sciences, computer science, engineering and data science.

Program Requirements

Lower Division Requirements

Students complete the common core courses and either the scientific computing stream courses or the biomathematics stream courses.

Core Courses

Students complete

one of

MATH 150 – Calculus I with Review (4)
MATH 151 – Calculus I (3)
MATH 154* - Mathematics for the Life Sciences I (3)
MATH 157 – Calculus I for the Social Sciences (3)

and one of

MATH 152 – Calculus II (3)
MATH 155* - Mathematics for the Life Sciences II (3)
MATH 158 – Calculus II for the Social Sciences (3)

and one of

MATH 232* - Applied Linear Algebra (3)
MATH 240 – Algebra I: Linear Algebra (3)

*recommended for students in the biomathematics stream

Scientific Computing Stream

Students who choose the scientific computing stream will complete

MATH 251 – Calculus III (3)

and at least one of

MATH 242 – Introduction to Analysis I (3)
MATH 260 – Introduction to Ordinary Differential Equations (3)

Biomathematics Stream

Students who choose the biomathematics stream will complete

at least one of

MATH 251 – Calculus III (3)
MATH 260 – Introduction to Ordinary Differential Equations (3)

and

at least one additional 100 or 200 level MATH or MACM course (excluding MATH 100, MATH 190) or any pre-approved quantitative lower division course. This course, if other than MATH or MACM, must be pre-approved by a department advisor. Any of the following courses can be used to satisfy this requirement: BISC 202, BISC 204, HSCI 207, HSCI 230, STAT 270.

Upper Division Requirements

Students complete either the upper division requirements for the scientific computing stream or the biomathematics stream.

Scientific Computing Stream

Students who choose the scientific computing stream complete 15 upper division MATH or MACM units, including

two of

MACM 316 – Numerical Analysis I (3)
MATH 314 – Introduction to Fourier Methods and Partial Differential Equations (3)
MATH 320 – Introduction to Analysis II (3)
MATH 322 – Complex Variables (3)
MATH 418 – Partial Differential Equations (3)

and one of

MACM 409 – Numerical Linear Algebra: Algorithms, Implementation and Applications (3)
MACM 416 – Numerical Analysis II (3)
MACM 476 or CMPT 476 – Introduction to Quantum Algorithms (3)
MATH 425 – Real Analysis (3)
MATH 462 – Fluid Dynamics (3)
MATH 467 – Dynamical Systems (3)
MATH 495 – Selected Topics in Applied Mathematics (3)

Biomathematics Stream

Students who choose the biomathematics stream complete 15 upper division units, including

one of

MATH 348 – Introduction to Probabilistic Models (3)
MATH 360 – Introduction to Biomathematics (3)

At least 12 of the 15 upper division units must be from MATH or MACM courses. The following courses are recommended: MATH 468, MATH 469, MATH 495 (for suitable topic). The remaining 3 units can be from any pre-approved quantitative upper division course. This course, if other than MATH or MACM, must be pre-approved by a department advisor. Any of the following courses can be used to satisfy this requirement: EVSC 445, HSCI 341, HSCI 410, REM 412, STAT 305, STAT 330, STAT 485.