CS 426  Computer-Assisted Interventions  3-3-0  
This course introduces students to the fundamentals of computer-aided intervention (CAI) in medicine. The use of computing technology before, during, and after interventions will be examined. Specifically, this course will teach students about tracking devices, coordinate systems, spatial transformations, rigid and non-rigid registrations (feature-based & intensity-based), calibration, digitization and imaging. Clinical applications will also be discussed. Basic knowledge of either C++, python or matlab is an asset.  
Prerequisites: Instructor’s permission 
Students cannot receive credits for both CS426 and CS526.

CS 454  Complements in Data Structures and Algorithms  3-3-0  
The aim of this course is to cover many concepts in Data Structures, Algorithms, and Programming to make up deficiencies in Computer Science background for entering graduate students.  
This course cannot be taken for credits by undergraduate students

CS 455  Theoretical Aspects of Computer Science  3-3-0  
The course will include several of the following topics: Computational models, Computational complexity; Finite-state machines; Context-free languages; Pushdown automata; Turing machines; Undecidable problems.  
Prerequisites: CS 211, MAT 200

CS 457  Database Software Design  3-3-0  
This course covers how one can implement a Database Management system. Major topics are storage management, Query processing, and Transaction management. As a basic assumption, data will not all fit in main memory, so algorithms and data structures appropriate for effective disk storage and quick access must be used. For example, one may use index structures such as B-trees or hash tables. We cover parsing of queries and optimizing of query plans. Finally, we cover durability of transactions using logging, and concurrency control for isolation of transactions. Additional topics in distributed databases are also presented.  
Prerequisites: CS 307

CS 462  Image Processing  3-3-0  
This course will introduce the area of Image Processing and present classical tools and algorithms in the field including: image perception, image acquisition and display, histogram techniques, image restoration, image enhancement, primitive operations for image analysis, segmentation, image transforms, and pattern and object recognition. Some examples of industrial applications of image processing and some important developments in image processing research will be also addressed.  
Prerequisites: CS 304, MAT 192, PHY 101 (or equivalent)

CS 463  Computer Vision  3-3-0  
This course is concerned with the computer acquisition and analysis of image data. Computer vision is the construction of explicit, meaningful descriptions of a physical object from images. Emphasis will be placed on: camera models and calibration, image representation, pattern recognition concepts, filtering and enhancing, segmentation, texture, motion from image sequences, deformable models, matching, stereovision, perceiving 3D from 2D images and tracking with dynamic models. The programming projects assigned in this course will make substantial use of the C and C++ programming languages.  
Prerequisites: CS 304, CS 318, MAT 192, PHY 101 (or equivalent)

CS 464  Network Programming  3-3-0  
This course presents computer networks at a functional level, with strong emphasis on programming distributed applications over a network. Discussion will be based on open networking and application standards such as the TCP/IP protocol suite and the Portable Operating System Interface (POSSIX). Topics normally covered are TCP/IP architecture and programming, the client-server model, network file systems, streaming, tunnelling. Programming distributed applications (in C or C++) is an integral part of the course.  
Prerequisite: CS 216

CS 467  Special Topics in Algorithms  3-3-0  
The course builds on the techniques covered in CS 317 to present some specialized algorithms in several areas, including Bioinformatics, Computational Geometry, and Network Flow.  
Prerequisite: CS 317 or permission of the instructor

CS 469  Special Topics in Computer Science  3-3-0  
The course will present topics of current interest or research directions in Computer Science. The course content is expected to vary from year to year to reflect the current interests of students and faculty. It will be offered by arrangement with the department.

CS 471  Graph Theory  3-3-0  
An introduction to the combinatorial, algorithmic and algebraic aspects of graph theory.  
Prerequisite: CS 304, MAT 200  
Note: See MAT 421. Students may not take this course for credit if they have received credit for MAT 421.

CS 499F  Honours Dissertation 6-0-0 
The student is required to complete a theoretical or applied project. The subject is arranged with the student’s supervisor during the first four weeks of term. A written dissertation is required as well as two seminar presentations.  
Note: This course is open only to final year Computer Science Honour Students in the dissertation stream, and only by permission of the department

Mathematics

Faculty
Madjid Allili,  B.Sc.(Algiers), M.Sc., Ph.D.(Sherbrooke);  Full Professor
Thomas Brüstle, B.Sc., (Ludwig-Maximilians), M.Sc., Ph.D. (Zurich), Full Professor, Maurice-Auslander Research Chair
François Huard, B.Sc., M.Sc., Ph.D. (Sherbrooke); Full Professor, Chair of the Department
Trevor H. Jones, B.Sc.H. (Acadia), M.Sc. (Dalhousie), Ph.D. (University of New Brunswick); Senior Instructor
Scosha Merovitz, B.Sc.(Bishop’s); M.Sc.(Dalhousie); Coordinator, Math/Stats Help Centre
David Smith, B.Sc., M.Sc., Ph.D. (Sherbrooke); Adjunct Professor
N. Brad Willms, B.Math. M.M., Ph.D. (Waterloo);  Associate Professor

Program Overview

Mathematics is the language of the sciences, a language which allows scientists to quantify, model, understand and predict behaviour in an enormously diverse range of phenomena of interest. Simultaneously, Mathematics is often regarded as an art, as it is the creative study of patterns and of problem solving. Mathematics covers a wide range of disciplines including algebra, analysis, combinatorics and discrete mathematics, and differential equations. In first-year courses, mathematics students are joined by other science students, particularly from Physics and Computer Science. In the advanced courses, classes are very small, and some are given on an individual or tutorial basis.

The highest level of specialization is Honours, and Honours programs prepare students for direct entry into graduate work leading to a Master’s or Ph.D. degree. All honours mathematics students have an opportunity to study independently and thus develop their reading and problem solving skills, and there is some chance to pursue special interests. The Majors programs provide students with an excellent general preparation for the career world,
while not preventing entrance into graduate school (sometimes after a qualifying year). The Majors programs have sufficient electives to allow students to combine their major with a second major or at least a minor (the least specialized type of program) in another discipline. Students are encouraged to add a minor or major and many do so. Popular choices include computer science, physics, music, English, French, Spanish, drama, and philosophy. The Department of Mathematics offers several specialized, interdisciplinary programs, jointly with other departments, including Hispanic Studies and the School of Education.

First-year Calculus requirement
All Mathematics students require six course credits of Calculus studies, normally in their first year. Students with a Québec collegial diploma (DEC) shall be granted advance credit for these courses if they have completed a course in Differential Calculus and a course in Integral Calculus at CEGEP. If one or both of these courses were not completed at CEGEP, they must be completed at Bishop’s and advanced credits shall be reduced accordingly. Students entering four-year programs in Mathematics with a grade 12 diploma (or equivalent) must register in MAT 191 and MAT 192 in their first year. These courses are included in the 120 total credit requirement. Students transferring into Mathematics programs may use credit for MAT 198 to replace MAT 191, and MAT 199 to replace MAT 192. Credit for MAT 197 with a grade of 80% or higher will also be accepted to replace MAT 191. Mathematical Contexts Minor program students normally complete MAT 198 and MAT 199 (instead of MAT 191 and MAT 192, although these are also acceptable), and do not need to do so in their first year.

First-year Physics requirement
Mathematics students pursuing the Bachelor of Science (B.Sc.) degree require six course credits of introductory physics studies in their first year. Students in the Bachelor of Arts (B.A.) degree program are exempt from this requirement. Students with any DEC are exempt from this requirement if they have completed two introductory Physics courses, Mechanics, and Electricity and Magnetism, at CEGEP. If one or both of these courses were not completed, they must be completed at Bishop’s and advanced credits shall be reduced accordingly. Students entering four-year B.Sc. programs in Mathematics with a grade 12 diploma (or equivalent) must register in PHY 191 and PHY 192 in their first year.

Arts and Science requirement
In addition to the Humanities requirement above, all students are required to complete at least three credits in either the Division of Humanities or the Division of Social Sciences. Students with program combinations which require more than 72 credits are exempt from this requirement.

Please refer to the Natural Sciences Division page for information on Divisional Requirements.

Computer Science requirement
All Mathematics majors and honours students (except those in the Mathematics Education double major program) are required to complete the course CS 211 Programming Methodology.

Science Elective requirement
Mathematics students pursuing a Bachelor of Science degree must complete three courses (at least nine course credits) of science electives in their degree program. Students in any B.A. degree program are exempt from this requirement.

Mathematics Electives
Mathematics students (in any program) may not include courses from the list: MAT 190, MAT 191, MAT 192, MAT 196, MAT 197, MAT 198, MAT 199, as mathematics elective credits. Courses at the 460 level are only open to Honours students. The courses MAT 190, MAT 196, MAT 197 are not accepted as credits for any Science or Mathematics degree. Mathematics courses MAT 190, MAT 191, MAT 192, MAT 196, MAT 197, MAT 198, MAT 199 may not be taken for credit by students who have already passed equivalent course(s) elsewhere. The course MAT 190 may not be taken for credit by any student without permission from their department chair. Students in Science programs, including Mathematics B.A., may receive a maximum of three credits in elementary statistics courses.

Matemáticas en Español
This is a unique program combining a Major in Mathematics, a Minor in Hispanic Studies as well as one year of Spanish immersion at the Universidad San Francisco de Quito in Ecuador. Contact the Chair of the department for more details.
Mathematics Honours
(99 credits for B.Sc.,
84 credits for B.A.)

Normally a student is admitted to an Honours program after completing a minimum of 12 credits in Mathematics courses with an average of at least 70% and having achieved an average of 65% in all courses taken at Bishop’s.

To continue in an Honours program the student must obtain an average of at least 70% in Mathematics courses in each academic year.

In order to graduate with a Mathematics Honours degree, the student must have an overall average of 70% in all Mathematics courses.

**Requirements:**

- **U1 (normally):** MAT 191, MAT 192, ENG 116*, Humanities 1xx option*, PHY 191 & PHY 192 (for B.Sc. only).
- MAT 108, MAT 200, MAT 206, MAT 207, MAT 209, MAT 220, CS 211, MAT 310, MAT 313, MAT 314, MAT 315, MAT 317, MAT 322, MAT 323
- 6 optional credits of Mathematics courses at the 100 level or higher,
- 9 optional credits of Mathematics courses at the 300 level or higher,
- 6 optional credits of Mathematics courses at the 400 level or higher,
- 6 optional credits of Mathematics courses at the 460 level,
- 3 credits to satisfy the Arts and Science requirement.
- B.Sc. students must include at least 9 additional Science credits among their options.

*Students with a CEGEP DEC or mature students will be granted exemption credits for these courses.*
Mathematics Major
(81 credits for B.Sc.,
66 credits for B.A.)

Requirements:
U1 (normally) : MAT 191, MAT 192, ENG 116*, Humanities
1xx option*, PHY 191 & PHY 192 (for B.Sc. only)
MAT 108, MAT 200, MAT 206, MAT 207, MAT 209, CS 211,
MAT 310, MAT 313, MAT 314, MAT 315, MAT 322
3 credits from the list {MAT 202, MAT 203 OR MAT 220}
6 optional credits of Mathematics courses at the 100 level or
higher,
9 optional credits of Mathematics courses at the 300 level or
higher.
3 credits to satisfy the Arts and Science requirement.
B.Sc. students must include at least 9 additional Science credits
among their options.
*Students with a CEGEP DEC and mature students will be
granted exemption for these courses.

Total credits:
B.Sc.: 54 Mathematics, 3 Computer Science, 6 Physics,
6 Humanities,
9 Science options, 3 Arts and Science options, 39
credits of free electives.
B.A.: 54 Mathematics, 3 Computer Science,
6 Humanities, 3 Arts and Science options, 54
credits of free electives.

Recommended schedule:

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<td>Year 1</td>
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<td>MAT 191</td>
<td>MAT 192</td>
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<td>PHY 191 (B.Sc. students)</td>
<td>PHY 192 (B.Sc. students)</td>
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<td>ENG 116eature (B.A. students)</td>
<td>Humanities elective (B.A. students)</td>
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<td>MAT 315</td>
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This schedule is provided as a recommendation only. The order
in which the courses are taken is subject to change. Students are
encouraged to consult the Chair of the department before register-
ing for their course. The code MAT nxx refers to any 3-credit
MAT course at the n-hundred level or higher.

Mathematics Minor; B.Sc., B.A.
(30 credits)

U1 (normally): MAT 191, MAT 192.
MAT 206, MAT 207, MAT 108, MAT 209 or MAT 200 plus 12
additional mathematics credits, including at least 6 credits at the
300 level or higher.

Minor in Mathematical Contexts;
B.A. (30 credits)

The ancient, rich, and universal endeavor which is mathematics
underlies all of science and engineering. Increasingly however,
mathematical contexts are entwined in the fabric of modern
humanistic studies.

The mathematics of social choice is enlightening the study of
politics, sociology, and anthropology. The modern mathematics
of management science is essential not only in the world of Business
and Economics, but also to the work of human geographers who
rely on mathematical modeling. Mathematical contexts reach even
to the creative arts. Here new geometries, elliptic, hyperbolic, and
most recently, fractal, are providing fresh and exciting sources of
pattern and inspiration, the raw materials of the visual artist.

Statistics are encountered daily in every media, while statis-
tical analyses have invaded every facet of modern life. Indeed,
if for no other reason, educated persons today must understand
mathematical concepts for the critical evaluation of data. Such is
required in order to avoid deception and bogus claims based on
false or misleading representations of statistics. Finally, the infor-
mation age has given new context to an ancient mathematics: cod-
ing theory. From data encryption to internet security, mathematics
is the context of modern human communication.

Many students of the Liberal Arts and Humanities, Education,
and the Social Sciences, come to the discipline of Mathematics
relatively late. Recently convinced of the necessity of broaden-
ing the mathematical context of their education, they nevertheless
now face a language barrier. Not having pursued mastery of the
high-school “advanced math” curriculum, or having gone “rusty”
from lack of recent use, they now find the language of mathemat-
ics, that of quantitative reasoning, unfamiliar, foreign, and even
intimidating.

It is for such students that the Minor in Mathematical Contexts
is intended. Here mathematical concepts are developed and ana-
lytical thinking is employed to systematically study patterns (the
raw materials of mathematics) discovered in diverse fields of
study. The emphasis will be on mathematical context and think-
ing; not on techniques, computations, and prerequisite skills. An
adult willingness to think deeply, and academic admission to
Bishop’s University, are the only prerequisites. In no way should
these courses be confused with the “remediation” courses of oth-
er institutions: rectifying shortcomings in algebraic skills is not the goal. Rather, developing analytical problem solving skills in mathematical contexts is the objective. Successful students will find, incidentally, that their Bishop’s B.A. degree has been significantly enhanced by this innovative program of study for citizens of the 21st century.

The minor in Mathematical Contexts can be added to any degree program and consists of the following courses:

MAT 200  Discrete Mathematics
MAT 108  Matrix Algebra
PHY 101  Statistical Methods
MAT 191  Calculus I, prerequisite: MAT 190 recommended
MAT 192  Calculus II, prerequisite: MAT 191

*(Remedial Precalculus and Algebra courses are available)*

An additional 15 course lecture credits in Mathematics must be chosen from among:

MAT 100  Excursions in Modern Mathematics*
MAT 101  Further Excursions in Modern Mathematics**
MAT 104  History of Mathematics
MAT 209  Linear Algebra, prerequisite: MAT 108
MAT 202  Modern Geometry: Euclidean to Fractal, prerequisite: MAT 200
MAT 220  Further Discrete Mathematics, prerequisite: MAT 200
MAT 203  Number Theory
MAT 322  Introduction to Modern Algebra I, prerequisite: MAT 200, MAT 209
MAT 323  Introduction to Modern Algebra II, prerequisite: MAT 322

Notes: The two courses, PMA 260 and PMA 360 may replace PHY 101 in the required list of courses. A student may not graduate with a double minor in mathematics.

*The science version of this course, MAT 110 is also accepted.

**The science version of this course, MAT 111 is also accepted.

Mathematics Electives

Mathematics students (in any program) may not include courses from the list: MAT 190, MAT 191, MAT 192, MAT 196, MAT 197, MAT 198, MAT 199, as mathematics elective credits. Courses at the 460 level are only open to Honours students.

The courses MAT 190, MAT 196, MAT 197 are not accepted as credits for any Science or Mathematics degree. Mathematics courses MAT 190, MAT 191, MAT 192, MAT 196, MAT 197, MAT 198, MAT 199 may not be taken for credit by students who have already passed equivalent course(s) elsewhere. The course MAT 190 may not be taken for credit by any student without permission from their department chair. Students in Science programs, including Mathematics B.A., may receive a maximum of three credits in elementary statistics courses.

List of Courses

Note: See also the list of cognate courses at the end of this section.

MAT 081  Enriched Calculus Lab I 1-0-3
A series of problems sessions and/or Calculus laboratory projects utilizing Computer Algebra Systems (CAS) technology. This course is designed to enhance the material covered in Mathematics 191a, and must be taken concurrently
Corequisite: MAT 191

MAT 100  Excursions in Modern Mathematics 3-3-0
An introduction to modern applied mathematics: social choice, management science, growth, symmetry, and descriptive statistics. Not intended as a numeracy course, nor for the remediation of algebraic shortcomings: computational complexity is minimal, and math prerequisites are absent. Instead, the methodology of mathematics is addressed: the use of unambiguous language and simplification to model practical problems, the types of answers the discipline can provide, and the notions of generalization and “open” problems. The course will allow the student to develop a sense of the nature of mathematics as a discipline, and an appreciation of its role in the modern world.

Note: Science students must enrol in MAT 110 instead of this course. Students may only receive credit for one of MAT 100 or MAT 110.

MAT 101  Further Excursions in Mathematics 3-3-0
Further topics in modern applied mathematics. A continuation of the style and subjects in MAT 100, this course is also not intended to redress deficiencies in numeracy, nor does it have any mathematical prerequisites. Topics may include growth models, game theory, linear programming, fractal geometry, coding theory, non-Euclidean geometry and selected current readings.

Note: Science students must enrol in MAT 111 instead of this course. Students may only receive credit for one of MAT 101 and MAT 111.

MAT 103  Environmental Modeling 3-3-0
The course will teach students to apply mathematical modeling principles and techniques to problems arising in the environmental sciences. Students will gain some understanding of basic mathematical models and techniques employed in the environmental sciences, and will practice the important skill of interpreting the results obtained from these models. The course will consist of a topics based, interdisciplinary approach to basic mathematical modeling. Topics covered may include ground water transport, air pollution such as modeling of ground-level ozone, hazardous materials disposal modeling, mathematical models for population growth, environmental economics, oil spill mitigation and avoidance, micro-climate weather predication, or others. The mathematics involved will be largely elementary, at a level suitable for a high-school graduate with credit for a university-preparatory level mathematics course.

MAT 104  History of Mathematics 3-3-0
This course is designed to help history, philosophy, and education students come to a deeper understanding of the mathematical side of culture by means of writing short essays. Mathematics majors acquire a philosophical and cultural understanding of their subject by means of doing actual mathematics problems from different eras. Topics may include perfect numbers, Diophantine equations, Euclidean construction and proofs, the circle area formula, the Pell equation, cubic equations, the four square theorem, quaternions, and Cantor’s set theory. The philosophical themes of infinity and Platonism recur repeatedly throughout the course.

MAT 108  Matrix Algebra 3-3-0

MAT 110  Excursions in Modern Mathematics 3-3-0
This is the same course as MAT 100 but it is intended that science students would enrol in this course and complete assignments that are more appropriate to their needs.

NOTE: Students may only receive credit for one of MAT 100 or MAT 110.

MAT 111  Further Excursions in Mathematics 3-3-0
This is the same course as MAT 101 but it is intended that science students would enrol in this course and complete assignments that are more appropriate to their needs.

Note: See MAT 101. Students may only receive credit for one of MAT 101 and MAT111.
MAT 190  Precalculus Mathematics  3-3-0
Review of algebra (fractions, exponents, radicals, etc.). Sets, linear functions, quadratic functions, polynomial functions, rational functions and their graphs. Factorization and simplification. Exponential and logarithmic functions with applications. Introduction to trigonometry. Students who have received credit for an equivalent course may not receive credit for this course. Students who have received credit for any math class numbered MAT 19X or higher may not receive credit for this course. Students may only receive credit for this course with consent of their Departmental Chair.

MAT 191  Calculus I  3-3-0
Elementary functions, limits, continuity. The derivative, differentiability, mean value theorem. Maxima and minima. Fermat's theorem, extreme value theorem, related rates, L'Hopital's rule. Applications. Riemann sums, definite integral. Emphasis is on an analytical understanding. This course is for students who lack Collegial MAT 103 or the equivalent. This course is required for all students in Mathematics, Physics and Computer Science. Students who have received credit for an equivalent course taken elsewhere may not register for this course. Credit will be given for only one of MAT 191, MAT 197 or MAT 198.

MAT 192  Calculus II  3-3-0
Area. The definite integral. The Fundamental Theorem of Calculus. Techniques of integration. Volumes, centres of mass, moments of inertia, arclength and other applications of integration. Mean value theorem for integrals. Emphasis is on an analytical understanding. Prerequisite: MAT 191 or a grade of at least 70% in MAT 198 or 80% in MAT 197. This course is for students who lack Collegial Mathematics NYB or the equivalent. This course is required for all students in Mathematics, Physics and Computer Science. Students who have received credit for an equivalent course taken elsewhere may not register for this course.

MAT 196  Finite Mathematics for Business Students  3-3-0
This course aims to familiarize business students with the fundamentals of linear algebra required by disciplines such as Statistics, Finance, Management, Economics, and others. Topics covered in this course include: review of high school algebra, arithmetic and geometric sequences, sums of sequences, inequalities in one and two variables, linear equations, introduction to matrices, matrix algebra: addition, multiplication, inverses, and Gaussian elimination. Prerequisite: MAT 190 or equivalent or permission of instructor.

MAT 197  Calculus for Business Students  3-3-0
This course aims to familiarize business students with the fundamentals of calculus required by disciplines such as Statistics, Finance, Management, Economics, and others. Topics covered in this course include: introduction to limits, differential calculus with one variable with applications, functions with several variables, partial derivatives, area under a curve. Prerequisite: MAT 196 or the equivalent or consent of the instructor.

MAT 198  Calculus I (for Life Sciences)  3-3-0
Elementary functions, limits, tangent line approximations. The derivative, differentiation rules. Continuous optimization in one variable. Applications to Biology, Chemistry, Medicine and Environmental Science. The emphasis is on an analytical understanding and computational competency. This course is intended for students who lack Collegial Mathematics NYA or the equivalent. Students who have received credit for an equivalent course taken elsewhere may not register for this course. Credit will be given for only one of MAT 191, MAT 197 or MAT 198.

MAT 199  Calculus II (for Life Sciences)  3-3-0
The definite integral, area, integration by substitution and parts. Applications to Biology, Chemistry, Medicine and Environment Science. Separable and linear differential equations. The emphasis is on practical understanding and computational competency. Prerequisite: MAT 198 or MAT 191 or the equivalent, or a grade of at least 80% in MAT 197. This course is intended for students who lack Collegial Mathematics NYB or the equivalent. Students who have received credit for an equivalent course taken elsewhere may not register for this course.

MAT 200  Introduction to Discrete Mathematics  3-3-0

MAT 202  Modern Geometry: Euclidean to Fractal  3-3-0
Particularly recommended for elementary and high-school teachers. Euclidean, elliptic and hyperbolic geometries, and applications: modern graphics, fractal images and the work of analytical artists like M.C. Escher. This course must be taken concurrently with Mathematics laboratory 202 (MAL 202). Prerequisite: MAT 200. Corequisite: MAL 202.
MAT 314  Introduction to Mathematical Statistics  3-3-0
Prerequisite: MAT 313

MAT 315  Real Analysis I  3-3-0
Prerequisite: MAT 207

MAT 316  Real Analysis II  3-3-0
Prerequisite: MAT 315

MAT 317  Complex Analysis  3-3-0
Prerequisite: MAT 207

MAT 321  Introduction to Modern Algebra I  3-3-0
Introduction to the theory of groups. Symmetries of a square. The dihedral groups. Cyclic groups, permutation groups. Isomorphisms, external and internal direct sums. Cosets and Lagrange’s theorem. Factor groups.
Prerequisite: MAT 200 and MAT 209

MAT 322  Introduction to Modern Algebra II  3-3-0
Prerequisite: MAT 322

MAT 323  Cryptography  3-3-0
Cryptography is a key technology in electronic security systems. The aim of this course is to explain the basic techniques of modern cryptography and to provide the necessary mathematical background. Topics may include: the classical encryption schemes, perfect secrecy, DES, prime number generation, public-key encryption, factoring, digital signatures, quantum computing.
Prerequisite: MAT 200, MAT 108

MAT 325  Numerical Methods  3-3-0
Prerequisites: CS 211, MAT 207, MAT 108.
Note: See CS 375 and PHY 375
Students may not take this course for credit if they have received credit for CS 375 or PHY 375.

MAT 326  Mathematical Problem Solving  3-3-0
A course designed to foster problem solving abilities in mathematics. New mathematical concepts will be introduced to the student through solving specific problems. Problems will be taken from Putnam and Mathematics Olympiad competitions and from actuarial examinations.
Prerequisites: MAT 200, MAT 207, MAT 108

MAT 401  Vector Analysis  3-3-0
Prerequisite: MAT 207

MAT 402  Tensor Analysis  3-3-0
Prerequisite: MAT 401

MAT 405  Calculus of Variations  3-3-0
Prerequisites: MAT 207, MAT 310
See PHY 376
Students may not take this course for credit if they have received credit for PHY 376

MAT 406  Differential Geometry  3-3-0
Curves in 3-space. Euclidean motions, surface theory. Introduction to differential manifold, Gaussian and mean curvature, imbedding conditions. Geodesics, parallel transport and the Gauss-Bonnet Theorem.
Prerequisite: MAT 207, MAT 310

MAT 414  Regression and Analysis of Variance  3-3-0
Topics in this course will include simple, multiple, polynomial and other nonlinear regression; Analysis of variance and covariance. The course may include data sets from case studies. Students will gain some facility with certain mathematics software packages.
Prerequisite: MAT 314

MAT 421  Graph Theory  3-3-0
This course provides an introduction to the combinatorial, algorithmic and algebraic aspect of graph theory. There will be a brief refresher of mathematical proof techniques. Topics will include paths and circuits, graph trees, planar graphs, graph colourings, and the Max Floss-Min Cut Theorem. Programming Assignments to implement graph algorithms (in Maple or Octave for example) will be required. An introduction to the combinatorial, algorithmic and algebraic aspects of graph theory.
Prerequisite: MAT 200
See CS 571. Credit will be given for only one of MAT 421 and CS 571.

MAT 431  Metric Spaces and Topology  3-3-0
Sets, functions, images and preimages. Topological spaces, metric spaces. Open and closed sets, accumulation points, continuous functions, homeomorphisms. Some topological properties, particularly connectedness and compactness.
Pre-requisite: MAT 315, or consent of the instructor.

MAT 446  Independent Study  3-3-0
This course aims to familiarize mathematics students with fundamental knowledge, skills and techniques in a chosen field of mathematics. A presentation will constitute a portion of the final grade.
Offered by arrangement

46x level courses are for Honours students only

MAT 460  Topics in Algebra I  3-3-0
A selection is made to suit the interests of students from such topics as: ring theory, introduction to homological algebra, introduction to group representations or commutative algebra.
Prerequisite: MAT 209, MAT 323 or consent of instructor.
Offered by arrangement.

MAT 461  Topics in Algebra II  3-3-0
A selection is made to suit the interests of students from such topics as: ring theory, introduction to homological algebra, introduction to group representations or commutative algebra.
Prerequisite: MAT 209, MAT 323 or consent of instructor.
Offered by arrangement.

MAT 462  Topics in Analysis I  3-3-0
Prerequisite: MAT 316

MAT 463  Topics in Analysis II  3-3-0
Prerequisite: MAT 316
Offered by arrangement.

MAT 464  Topology  3-3-0
Offered by arrangement.

MAT 465  Topology  3-3-0
Offered by arrangement.
Physics & Astronomy

Faculty
Ariel Edery,
B.Sc. (McGill), M.Sc. (Queen’s), Ph.D. (Montréal);
Full Professor

Chair of the Department
Valerio Faraoni,
B.Sc. (University of Pavia, Italy), M.Sc., Ph.D. (International
School for Advanced Studies, Italy); Full Professor

Faycal Hammad,
B.Sc., M.Sc., Ph.D. (A. Mira-Bejaia);
Adjunct Full Professor

Anca Nedelcescu,
B.Sc. (West University of Timisoara), M.Sc.,
Ph.D. (Sherbrooke); Adjunct Professor

Jason Rowe,
B.Sc. (Toronto), M.Sc., Ph.D. (UBC); Associate Professor

Canada Research Chair (Tier II)

Lorne Nelson,
B.Sc. (McGill), M.Sc., Ph.D. (Queen’s); Full Professor

John Ruan,
B.Sc.(Columbia), M.Sc., Ph.D.(University of Washington)

Assistant Professor, Canada Research Chair (Tier II)

Sylvain Turcotte,
B.Sc., M.Sc., Ph.D. (Montreal); Adjunct Professor

Program Overview

Physics is often regarded as the cornerstone of the Natural Sciences. It encompasses a diverse range of disciplines including astronomy and astrophysics, photonics, electronics, classical and quantum mechanics, statistical mechanics, particle physics, and solid state physics.

The BSc Honours program provides students with a fundamental understanding of physics. The highest level of specialization at the undergraduate level is the BSc Honours program. It prepares students for direct entry into graduate work in physics (leading to an MSc or PhD degree). Students may be admitted into the Honours program after one year is completed in the Physics Major program.

The Master of Science (MSc) program is designed to give students a much deeper appreciation of physics while at the same time training them to become independent researchers and scientists. Graduate supervision is available in a wide variety of disciplines including astronomy, astrophysics, exoplanetary science, theoretical cosmology and gravitational theory, and particle physics.

First-year Science Core requirements

All Physics students are required to take six course credits of Introductory Physics (PHY 191, PHY 192), six course credits of Introductory Calculus (MAT 191, MAT 192), and six course credits of Introductory Chemistry (CHM 191, CHM 192), normally in their first year. Students with a Québec collegial diploma (DEC) shall be granted advanced credit for these courses if they have completed the Pure Science program. If any of these equivalent courses were not completed at CEGEP, they must be completed at Bishop’s and advanced credits shall be reduced accordingly.