# MATHEMATICS (MATH)

**MATH 1190 Fundamental Mathematics**
3 credit hours
**Prerequisite:** the equivalent of Nova Scotia Grade 12 Mathematics

Students develop their understanding of the essential functions of mathematics (lines and quadratics, polynomial and rational functions, exponential and logarithmic functions, trigonometric functions) and are provided with extensive contextual practice with algebraic manipulation, equation solving, and curve sketching. Students focus on those topics/skills that are known to be essential for subsequent study of calculus. Classes 3 hrs. plus recitation 1 1/2 hrs. per week.
**Note:** Credit will not be given for MATH 1190 following successful completion of a MATH course numbered 1210 or above or MGSC 1206 (exception: Certificate in Mathematical Sciences for Education Students).

**MATH 1202 Concepts and Topics in Mathematics**
3 credit hours
**Prerequisite:** Nova Scotia Grade 12 Academic Mathematics (or equivalent)

This course is intended for those who are teaching or who plan to teach at the elementary school level. Fundamental concepts and topics in mathematics provide the necessary background for elementary school teachers. Topics include: the axioms of arithmetic and algebra, the integer, rational, and real systems, sets and logic. Classes 3 hrs. and recitation 1.5 hrs. a week.
**Note:** This course may not be used as a Science elective by B. Sc. students to satisfy B. Sc. requirements 3.e., 6.e., 10.b., or 12.b.

**MATH 1203 Concepts in High School Mathematics**
3 credit hours
**Prerequisite:** MATH 1202

This course is designed for those who teach or who plan to teach at the junior high or high school level. Topics include: algebra, geometry, probability, and statistics. Material is taught in significantly greater depth than would actually be taught in the school classroom. Classes 3 hrs. a week plus recitations 1.5 hrs. a week
**Note:** This course may not be used as a Science elective by BSc students to satisfy BSc requirements 3e, 6e, 10b, or 12b.

**MATH 1204 Introduction to Geometry**
3 credit hours
**Prerequisite:** MATH 1203 or MATH 1208

This course is an introduction to Euclidean geometry, designed for those who teach or who plan to teach mathematics at the junior high or high school level. Topics include: coordinate, axiomatic, constructive, and transformational geometry with some emphasis on the concept of mathematical proof.
**Note:** This course may not be used as a Science elective by BSc students to satisfy BSc requirements 3e, 6e, 10b, or 12b.

**MATH 1208 Fundamental Calculus I**
3 credit hours
**Prerequisite:** MATH 1190

This is a first course in calculus, intended for students in the CMSE program. The course begins with an overview of essential notions concerning real numbers and functions (such as limits, continuity, sequences and series) before proceeding with a detailed study of the derivative and various applications (including rates of change, approximation, and optimization).
**Note:** Enrolment restricted to students in the CMSE program.

**MATH 1209 Fundamental Calculus II**
3 credit hours
**Prerequisite:** MATH 1208

This is a continuation of MATH 1208 and is intended for students in the CMSE program. The course focuses on the development of the Riemann integral and its applications. Core topics include the Fundamental Theorem of Calculus, techniques of integration, computation of areas/volumes, first-order differential equations, and power series.
**Note:** Enrolment restricted to students in the CMSE program.

**MATH 1210 Introductory Calculus I**
3 credit hours
**Prerequisite:** Nova Scotia Grade 12 Pre-Calculus or equivalent and either MATH 1190 or satisfactory performance on the MATH Placement Test.

This is a first course in calculus, intended for science and engineering students. Core topics include: functions, limits, continuity, differentiability; derivatives of algebraic and transcendental functions, applications of the derivative (e.g., curve sketching, optimization, L'Hôpital's Rule); antiderivatives; area under curves; and the fundamental theorem of calculus. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.
**Note:** Students whose performance on the MATH Placement Test does not indicate their readiness for MATH 1210 are directed to register for MATH 1190.

**MATH 1211 Introductory Calculus II**
3 credit hours
**Prerequisite:** MATH 1210

This is a continuation of MATH 1210, and is intended for science and engineering students. Core topics include: techniques of integration, applications of the definite integral (e.g. area, volume, arc length); improper integrals, separable differential equations; parametric equations, polar coordinates, sequences and series; power series; Taylor and Maclaurin series, elementary multivariate calculus. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 1216 Introduction to Mathematical Statistics**
3 credit hours
**Prerequisite:** MATH 1208 or MATH 1210 or MATH 1250.

This course provides a mathematically rigorous introduction to statistics, based on calculus. Introductory probability theory is covered, including probability distributions and densities, random variables, the central limit theorem, and counting methods. Statistical inference is then covered, including estimation and confidence intervals, hypothesis tests. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 1250 Calculus for Life Sciences I**
3 credit hours
**Prerequisite:** Nova Scotia Grade 12 Pre-Calculus Mathematics (or equivalent)

Students are introduced to applied calculus intended for students interested in the life sciences. Topics include: differentiation and antidifferentiation of common functions, general differentiation rules, curve sketching, limits at infinity, growth of functions, implicit differentiation, related rates, and optimization. Classes 3 hrs. and recitation 1.5 hrs. per week.
**Note:** Credit will not be given for MATH 1250 taken concurrently with or after successful completion of MATH 1210; and only one of MATH 1210 or MATH 1250 may be used to satisfy B.Sc. requirements 3.b or 6 b.

**MATH 1251 Calculus for Life Sciences II**
3 credit hours
**Prerequisite:** MATH 1250 or MATH 1210

This course is a continuation of MATH 1250. Topics include: the integral; methods and applications of integration; differential equations; and an introduction to multivariable calculus (functions of several variables, partial derivatives). Classes 3 hrs. and recitation 1.5 hrs. per week.
**Note:** Credit will not be given for MATH 1251 taken concurrently with or after successful completion of MATH 1211; and only one of MATH 1211 or MATH 1251 may be used to satisfy B.Sc. requirements 3.b or 6.b

**MATH 1800 – 1825 Special Topics in Mathematics**
6 credit hours
Course content varies from year to year.

**MATH 1826 – 1849 Special Topics in Mathematics**
3 credit hours
Course content varies from year to year.

**MATH 2301 Applied Linear Algebra**
3 credit hours
**Prerequisite:** Nova Scotia Grade 12 Pre-calculus Mathematics or equivalent

This is a first course in linear algebra intended for students in Science or Engineering. Topics include: complex numbers, geometric vectors in three dimensions, equations of line and planes, systems of equations, Gaussian elimination, matrix algebra, vector spaces, linear transformations: definition and examples, null space and range, eigenvalues and eigenvectors, and orthogonality. Classes 3 hours plus recitation 1 1/2 hours a week.
**Note:** Credit will not be given for both MATH 2301 and MATH 2320.

**MATH 2303 Differential Equations I**
3 credit hours
**Prerequisite:** MATH 1211

First order differential equations: separable equations; exact equations; integral equations; integrating factors; linear differential equations; modelling electric circuits. Second order differential equations: homogeneous linear equations; constant coefficient equations; Euler-Cauchy equations; Wronskian; non-homogeneous equations; undetermined coefficients; variation of parameters; modelling forced oscillations and resonance modelling electric circuits phasor methods for particular solutions. Power series solutions. Legendre's equation. Laplace transform, inverse transform. Linearity; transforms of derivatives and integral; s-shifting; t-shifting; unit step. Differentiation and integration of Laplace Transforms. Partial fractions method for inverse Laplace Transform. Applications to systems of differential equations, convolutions, the delta function, impulse response, transfer function. Periodic driving functions and Laplace Transforms. Fourier series; even and odd functions; half range expressions; Complex Fourier series; applications to systems driven by various periodic functions (e.g., square, wave, saw tooth, etc.). The line spectrum. Classes 3 hours plus recitation 1 1/2 hours a week.

**MATH 2305 Survey of Discrete Mathematics**
3 credit hours
**Prerequisite:** Nova Scotia Grade 12 Pre-Calculus Mathematics or equivalent.

This course provides an overview of a number of topics in discrete mathematics including sets, set operations, basic number theory, modular arithmetic, logic, proof techniques such as mathematical induction and proof by contradiction, elementary counting techniques, and a brief introduction to probability and networks. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 2307 Theoretical Foundations of Computing Science CSCI 2307**
3 credit hours
**Prerequisite:** CSCI 1228 and MATH 2305

Students use various mathematical concepts to define tools and address problems of fundamental status in Computing Science. Topics include automata, formal languages, formal logic and computability. Other topics may be considered, such as information coding, complexity, knowledge modelling, and automated reasoning.
**Note:** Classes 3 hrs. and recitation 1.5 hrs. per week.

**MATH 2308 Introduction to Numerical Analysis CSCI 2308**
3 credit hours
**Prerequisite:** MATH 1211 and CSCI 1226 or equivalent programming experience

Students discuss errors in numerical analysis, theoretical and practical considerations of numerical methods for approximations of derivatives, systems of linear equations, systems of non-linear equations, and approximation of functions using polynomial and piece-wise polynomial interpolation. Classes 3 hrs. and recitation 1.5 hrs. per week.

**MATH 2310 Introductory Analysis**
3 credit hours
**Prerequisite:** MATH 2305 and MATH 2311

This course is a rigorous study of the metric topology of the real line, sequences of real numbers, continuity of functions on the real line, and sequences of functions on real line. Compactness in higher-dimensional Euclidean spaces and the concept of a metric will also be discussed. Additional topics may include: elementary asymptotics; power series; uniform convergence and uniform continuity; and Riemann sums and integration. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 2311 Intermediate Calculus**
3 credit hours
**Prerequisite:** MATH 1211

Topics include: limits and continuity of functions of several variables, partial derivatives, and the chain rule, directional derivatives and gradient vector, the total differential, tangent planes and normals to a surface, higher order partial derivatives, extrema of functions of two variables, Lagrange multipliers, double integrals, iterated integrals, double integrals in polar coordinates, applications of double integrals, the triple integral, triple integrals in cylindrical and spherical coordinates, applications of triple integrals vector fields, divergence and curl of vector fields, line integrals, path-independent line integrals. Green's theorem, Stokes' theorem, and the divergence theorem. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 2315 Introduction to Probability Theory**
3 credit hours
**Prerequisite:** MATH 1210 and MATH 2305

This course covers the probability theory which underlies fundamental statistical concepts. It assumes a good knowledge of first-year calculus, and may cover the following topics: probability, conditional probability, Bayes' Theorem, random variables, order statistics, discrete distributions, continuous distributions, expected values, moments, and special distributions including the Poisson, normal, binomial, exponential, and gamma distributions. Classes 3 hrs. plus recitation 1 1/2 hrs. a week.

**MATH 2321 Linear Algebra II**
3 credit hours
**Prerequisite:** MATH 2301 or MATH 2320 and MATH 2305

This course continues MATH 2301 with further concepts and theory of linear algebra. Topics include inner product spaces, orthogonality, Gram-Schmidt Process, linear transformations and their matrix representation, change of basis and similarity, further study of eigenvalues and eigenvectors, canonical forms, with applications to linear differential equations and quadratic forms. Classes 3 hrs. plus recitation 1.5 hrs. a week.

**MATH 2800 – 2825 Special Topics in Mathematics**
6 credit hours
Course content varies from year to year.

**MATH 2826 – 2849 Special Topics in Mathematics**
3 credit hours
Course content varies from year to year.

**MATH 3309 Advanced Numerical Analysis CSCI 3309**
3 credit hours
**Prerequisite:** CSCI 2308 [MATH 2308] or permission of instructor

This is a continuation of CSCI 2308 [MATH 2308]. Students engage with advanced topics in numerical methods for approximations of derivatives, systems of linear equations, systems of non-linear equations, and approximation of functions using polynomial and piece-wise polynomial interpolation, numerical integration, and approximation of functions by linear least squares. Classes 3 hrs. and recitation 1.5 hrs. per week.

**MATH 3406 Differential Equations II**
3 credit hours
**Prerequisite:** MATH 2311; MATH 2303 or MATH 3405; MATH 2301 or MATH 2320

Theory of systems of linear differential equations, linear systems with constant coefficients, solution by matrix methods, applications. Nonlinear differential equations: existence and uniqueness of solutions, stability and the phase plane, Liapunov Method. Various equations occurring in applications are qualitatively analyzed, Chaos and bifurcation.

**MATH 3415 Mathematical Statistics**
3 credit hours
**Prerequisite:** MATH 2311 and a course in computer programming language

Students study mathematical foundations of statistics, including both parametric and non-parametric inferences. Emphasis is placed on the properties of random variables and their distributions. The estimation of parameters by using sample statistics and tests of related hypotheses are included. Applications to computer science are studied.

**MATH 3434 Geometry**
3 credit hours
**Prerequisite:** MATH 2305, MATH 2310, MATH 2311, and MATH 2321

Many important ideas of modern mathematics, such as the axiomatic method, emerged from the study of geometry. Students examine topics in geometry from Euclid to the present day, which may include axiomatic geometry, constructive geometry, inversive geometry, projective geometry, non-Euclidean geometry, and combinatorial geometry.

**MATH 3441 Real Analysis I**
3 credit hours
**Prerequisite:** MATH 2305, MATH 2310 and MATH 2311

Topics include; open and closed sets in metric spaces, boundedness, total boundedness, compactness, sequences, completeness, continuity, uniform continuity, sequences of functions, pointwise and uniform convergence, metric spaces of functions, theorems of Baire, Arzela-Ascoli, and Stone-Weierstrass.

**MATH 3800 – 3825 Special Topics in Mathematics**
6 credit hours
**Prerequisite:** permission of instructor
Approved seminar courses dealing with specialized subject-matter that are announced from time to time by the Department.

**MATH 3826 – 3849 Special Topics in Mathematics**
3 credit hours
**Prerequisite:** permission of instructor
Approved seminar courses dealing with specialized subject-matter that are announced from time to time by the Department.

**MATH 4408 Numerical Solution of Initial Value Ordinary Differential Equations CSCI 4408**
3 credit hours
**Prerequisite:** CSCI 2308 [MATH 2308] or permission of instructor

Students consider the numerical solution of initial value ordinary differential equations. Topics may include multi-step methods, Runge-Kutta methods, stability, stiffness, step-size selection, local error, etc.

**MATH 4409 Numerical Solution of Boundary Value Ordinary Differential Equations CSCI 4409**
3 credit hours
**Prerequisite:** MATH 2308 [CSCI 2308] or permission of instructor

This course is concerned with the numerical solution of boundary value ordinary differential equations. Topics may include finite difference methods, shooting methods, collocation methods, conditioning, mesh selection, error estimation, etc.

**MATH 4420 Abstract Algebra I**
3 credit hours
**Prerequisite:** MATH 2321 and MATH 2305

The study of algebraic structures, such as groups, rings, fields, posets, graphs, or universal algebras. The major emphasis is on derivation of theory, with inclusion of applications and examples.

**MATH 4421 Abstract Algebra II**
3 credit hours
**Prerequisite:** MATH 4420 or permission of instructor

This course is a further study of algebraic structures and their applications.

**MATH 4426 Introduction to Combinatorics**
3 credit hours
**Prerequisite:** MATH 2305

Students are introduced to various enumeration techniques and will include such topics as permutations and combinations, recurrence relations and generating functions. Various finite structures and their applications are also studied.

**MATH 4427 Computational Methods in Graph Theory CSCI 4427**
3 credit hours
**Prerequisite:** MATH 2311 or MATH 2320 or MATH 2301 or permission of instructor

Various graph theoretic algorithms and their application to different problems are discussed. Topics are chosen from the following: the connector problem, the shortest path problem, the Chinese Postman problem and Euler trails, matchings and their applications to the personnel and optimal

**MATH 4432 Elementary Topology**
3 credit hours
**Prerequisite:** MATH 3441

This course will begin with a study of the topology of ordering and ordinals, and indexed unions, intersections, and products. Topics will include bounded and totally bounded sets, completeness and fixed point theorems. Following this, abstract topological spaces will be studied.

**MATH 4436 Theory of Functions of a Complex Variable I**
3 credit hours
**Prerequisite:** MATH 2310 and 2311

The complex plane. Elementary transformations and mappings, analytic functions, infinite series and uniform convergence. Differentiation and integration in the complex plane, residue. Harmonic functions, entire and meromorphic functions. Some principles of conformal mapping theory.

**MATH 4437 Theory of Functions of a Complex Variable II**
3 credit hours
**Prerequisite:** MATH 4436

A continuation of MATH 4436. Further study of analytic functions and conformal mapping theory.

**MATH 4442 Real Analysis II**
3 credit hours
**Prerequisite:** MATH 3441 (formerly 4441)

This course includes further topics on metric spaces. Topics include: Baire category theorem, the space of continuous functions, fixed points and integral equations, Arzela-Accoli theorem, the Stone-Weierstrass theorem, Picard existence theorem for differential equations, Riemann Integrability, sets of measure zero, and Lebesgue Theorem.

**MATH 4500 Thesis MATH**
6 credit hours
**Prerequisite:** permission of Department

Research project in the mathematical sciences carried out by the student under the supervision of any member of the Department. The student will submit a thesis and present it orally. This course is open to 4th year honours students. Directed study 6 hrs. a week. 2 semesters.

**MATH 4800 – 4825 Special Topics in Mathematics**
6 credit hours
**Prerequisite:** permission of instructor
Approved seminar courses dealing with specialized subject-matter that are announced from time to time by the Department.

**MATH 4826 – 4849 Special Topics in Mathematics**
3 credit hours
**Prerequisite:** permission of instructor
Approved seminar courses dealing with specialized subject-matter that are announced from time to time by the Department.

**MATH 4876 - 4899 Directed Study in Mathematics**
3 credit hours
**Prerequisite:** permission of instructor.
This course is intended to supplement or provide an alternative to the regular mathematics courses in order to meet the special needs and interests of students. The course provides an opportunity to study a particular subject in detail and requires from the student some measure of independence and initiative.