

MATHEMATICS AND ENGINEERING

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This plan was developed at Queen's in response to the need for engineers who possess the skills and insights of applied mathematicians. In the second and third years of the plan, half of the curriculum consists of honours courses in pure and applied mathematics; the balance consists of engineering courses in one of three sub-plans offered in cooperation with the departments of Mechanical, Electrical and Computer Engineering, and the School of Computing. The sub-plans are developed with appropriate applications of mathematics to engineering in the final year. The sub-plans are:

Options available:

- (M6) **Applied Mechanics:** (mechanics, dynamics, fluid mechanics, thermodynamics)
- (M9) **Computing and Communications:** (computer science, software design, communication, information systems, and electrical engineering)
- (M11) **Systems and Robotics:** (electrical and mechanical engineering, control, communications, information systems, robotics, and mechanics)

Programs

- Mathematics and Engineering, B.A.Sc. (Class of 2024) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-basc-class-2023/>)
- Mathematics and Engineering, B.A.Sc. (Class of 2025) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-basc-class-2024/>)
- Mathematics and Engineering, B.A.Sc. (Class of 2026) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-basc-class-2026/>)
- Mathematics and Engineering, Applied Mechanics (M6): Technical Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-applied-mechanics-m6-technical-electives/>)

- Mathematics and Engineering, Computing and Communications (M9): Technical Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-computing-communications-m9-technical-electives/>)
- Mathematics and Engineering, Systems and Robotics (M11): Technical Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mathematics-engineering/mathematics-engineering-systems-robotics-m11-technical-electives/>)

Courses

MTHE 212 Linear Algebra Units: 3.50

Vector spaces, direct sums, linear transformations, eigenvalues, eigenvectors, inner product spaces, self-adjoint operators, positive operators, singular-value decomposition, minimal polynomials, Jordan canonical form, the projection theorem, applications to approximation and optimization problems.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 174 Corequisites:

Exclusions: MTHE 312 (MATH 312)

Offering Term: W

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Smith Engineering



MTHE 217 Algebraic Structures with Applications Units: 3.50

Introduction to algebraic systems and structures, and their engineering applications. Topics include symbolic logic; switching and logic circuits; set theory, equivalence relations and mappings; the integers and modular arithmetic; groups, cyclic groups, Lagrange's theorem, group quotients, group homomorphisms and isomorphisms; applications to error-control codes for noisy communication channels.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 174 Corequisites:

Exclusions:

Offering Term: F

CEAB Units:

Mathematics 18

Natural Sciences 0

Complementary Studies 0

Engineering Science 16

Engineering Design 8

Offering Faculty: Faculty of Arts and Science

MTHE 224 Applied Math For Civil Eng. Units: 4.20

The course will discuss the application of linear differential equations with constant coefficients, and systems of linear equations within the realm of civil engineering. Additionally, the course will explore relevant data analysis techniques including: graphical and statistical analysis and presentation of experimental data, random sampling, estimation using confidence intervals, linear regression, residuals and correlation.

(Lec: 3, Lab: 0.4, Tut: 0.8)

Requirements: Prerequisites: APSC 142 or APSC 143 or MNTC 313, APSC 172, APSC 174 Corequisites: Exclusions: MTHE 225 (MATH 225), MATH 226, MTHE 235 (MATH 235), MTHE 237 (MATH 237), STAT 267, MTHE 367 (STAT 367)

Offering Term: F

CEAB Units:

Mathematics 50

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 225 Ordinary Differential Equations Units: 3.50

First order differential equations, linear differential equations with constant coefficients, and applications, Laplace transforms, systems of linear equations.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 171, APSC 172, APSC 174

Corequisites: Exclusions:

Offering Term: FWS

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Course Equivalencies: MATH225;MTHE225

Offering Faculty: Faculty of Arts and Science

MTHE 227 Vector Analysis Units: 3.00

Review of multiple integrals. Differentiation and integration of vectors; line, surface and volume integrals; gradient, divergence and curl; conservative fields and potential. Spherical and cylindrical coordinates, solid angle. Green's and Stokes' theorems, the divergence theorem.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: APSC 171, APSC 172, APSC 174

Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 36

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 228 Complex Analysis Units: 3.50

Complex arithmetic, complex plane. Differentiation, analytic functions. Elementary functions. Elementary functions. Contour integration, Cauchy's Theorem and Integral Formula. Taylor and Laurent series, residues with applications to evaluation of integrals.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 171, APSC 172, APSC 174

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 235 Diff Equations For Elec & Comp Units: 3.50

Topics include developing and analyzing mathematical models describing physical and natural phenomena and those arising in electrical engineering applications (such as circuits), classification of differential equations, methods for solving differential equations, Laplace Transform method, systems of differential equations and connections with Linear Algebra, stability of systems.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 171, APSC 172, APSC 174

Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 18

Natural Sciences 11

Complementary Studies 0

Engineering Science 13

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 237 Differential Equations for Engineering Science Units: 3.50

Topics include developing and analyzing mathematical models describing physical and natural dynamical phenomena and those arising in various engineering system applications, classification of differential equations, methods for solving differential equations, Laplace Transform method, systems of differential equations and connections with Linear Algebra, stability of linear and nonlinear systems and Lyapunov's method.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 171, APSC 172, APSC 174

Corequisites: Exclusions: MATH 231, MTHE 232 (MATH 232)

Offering Term: F

CEAB Units:

Mathematics 16

Natural Sciences 11

Complementary Studies 0

Engineering Science 15

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 272 Applications Numerical Methods Units: 3.50

An introductory course on the effective use of computers in science and engineering. Topics include: solving linear and nonlinear equations, interpolation, integration, and numerical solution of ordinary differential equations. Extensive use is made of MATLAB, a high level interactive numerical package.

NOT OFFERED 2022-2023

(Lec: 3, Lab: 0.5, Tut: 0)

Requirements: APSC 174 or equivalent

Offering Term: W

CEAB Units:

Mathematics 20

Natural Sciences 0

Complementary Studies 0

Engineering Science 11

Engineering Design 11

Offering Faculty: Faculty of Arts and Science

MTHE 280 Advanced Calculus Units: 3.50

Limits, Continuity, C^1 , and linear approximations of functions of several variables. Multiple integrals and Jacobians, Line and surface integrals. The theorems of Green, Stokes, and Gauss.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 172, APSC 174

Corequisites: Exclusions: MATH 221, MTHE 227 (MATH 227)

Offering Term: F

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 281 Introduction To Real Analysis Units: 3.50

Taylor's theorem, optimization, implicit and inverse function theorems. Elementary topology of Euclidean spaces.

Sequences and series of numbers and functions. Pointwise and uniform convergence. Power series.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 172 Corequisites:

Exclusions:

Offering Term: W

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

**MTHE 326 Functions of a Complex Variable Units: 3.50**

Complex numbers, analytic functions, harmonic functions. Cauchy's theorem. Taylor and Laurent series. Calculus of residues. Rouché's theorem.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 280 (MATH 280), MTHE 281 (MATH 281) Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 42

Natural Sciences 0

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 328 Real Analysis Units: 3.00

Topological notions on Euclidean spaces, continuity and differentiability of functions of several variables, uniform continuity, extreme value theorem, implicit function theorem, completeness and Banach spaces, Picard-Lindelöf theorem, applications to constrained optimization and Lagrange multipliers, and existence/uniqueness of solutions to systems of differential equations.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 281 Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 28

Natural Sciences 8

Complementary Studies 0

Engineering Science 0

Engineering Design 0

Offering Faculty: Smith Engineering

MTHE 332 Introduction To Control Units: 4.00

Modeling control systems, linearization around an equilibrium point.

Block diagrams, impulse response, transfer function, frequency response. Controllability and observability, LTI realizations. Feedback and stability, Lyapunov stability criterion, pole placement, Routh criterion. Input/output

stability, design of PID controllers, Bode plots, Nyquist plots, Nyquist stability criterion, robust controllers. Laboratory experiments illustrate the control concepts learned in class.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0.5, Tut: 0.5)

Requirements: Prerequisites: MTHE 326 (MATH 326)

Corequisites: MTHE 335 Exclusions:

Offering Term: W

CEAB Units:

Mathematics 15

Natural Sciences 5

Complementary Studies 0

Engineering Science 23

Engineering Design 5

Offering Faculty: Faculty of Arts and Science

MTHE 334 Math Methods For Engrg & Phys Units: 3.50

Banach and Hilbert spaces of continuous- and discrete-time signals; spaces of continuous and not necessarily continuous signals; continuous-discrete Fourier transform; continuous-continuous Fourier transform; discrete-continuous Fourier transform; discrete-discrete Fourier transform; transform inversion using Fourier series and Fourier integrals.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 212 (MATH 212), MTHE 281 (MATH 281) Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 28

Natural Sciences 0

Complementary Studies 0

Engineering Science 14

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 335 Mathematics of Engineering Systems Units: 3.50

Review of signal spaces arising in systems theory and applications, such as linear spaces, Banach and Hilbert spaces, and distributions. Approximation and representation of signals. Discrete and continuous Fourier Transforms, Laplace and Z transforms. Linear input/output systems and their stability and regularity analysis. Frequency-domain and time-domain analysis of linear time-invariant systems. Applications to modulation of communication signals, linear filter design, system design, control design, and digital sampling.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 326 or MTHE 228

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 8

Natural Sciences 6

Complementary Studies 0

Engineering Science 14

Engineering Design 14

Offering Faculty: Faculty of Arts and Science

MTHE 337 Intro. To Operations Research Units: 3.00

Topics include Markov chains, Introduction to dynamic programming and Markov Decision Processes, simulation, queuing theory, inventory theory, and introduction to reinforcement learning.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 351 or permission of the instructor

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 18

Natural Sciences 0

Complementary Studies 0

Engineering Science 9

Engineering Design 9

Offering Faculty: Faculty of Arts and Science

MTHE 338 Fourier Methods for Boundary Value Problems Units: 3.50

Methods and theory for ordinary and partial differential equations; separation of variables in rectangular and cylindrical coordinate systems; sinusoidal and Bessel orthogonal functions; the wave, diffusion, and Laplace's equation; Sturm-Liouville theory; Fourier transform techniques. NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 227 (MATH 227) or MTHE 280 (MATH 280), MTHE 237 (MATH 237) or MTHE 225 (MATH 225), or permission of the instructor

Corequisites:

Offering Term: W

CEAB Units:

Mathematics 28

Natural Sciences 0

Complementary Studies 0

Engineering Science 14

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 339 Evolutionary Game Theory Units: 3.00

This course highlights the usefulness of game theoretical approaches in solving problems in the natural sciences and economics. Basic ideas of game theory, including Nash equilibrium and mixed strategies; stability using approaches developed for the study of dynamical systems, including evolutionary stability and replicator dynamics; the emergence of co-operative behaviour; limitations of applying the theory to human behaviour.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: APSC 172 or MATH 120 (or MATH 121); APSC 174 or MATH 110 (or MATH 111)

recommended Corequisites: Exclusions: MATH 239

Offering Term: W

CEAB Units:

Mathematics 18

Natural Sciences 9

Complementary Studies 9

Engineering Science 0

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

**MTHE 351 Probability I Units: 3.50**

Introduction to probability theory and its applications in engineering science: basic concepts of probability, counting, conditional probability, Bayes' rule, independence; probability models; random variables, distribution functions, probability mass functions, probability density functions; expectation, variance, moments; jointly distributed random variables; transformations of random variables. Distributions: Bernoulli, binomial, geometric, negative binomial, Poisson, uniform, exponential, normal. Applications: elementary stochastic processes, noisy communication channels.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: Corequisites: MTHE 280

Exclusions: STAT 251

Offering Term: F

CEAB Units:

Mathematics 20

Natural Sciences 0

Complementary Studies 0

Engineering Science 22

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 353 Probability II Units: 3.00

Intermediate probability theory as a basis for further study in mathematical statistics and stochastic processes and applications; probability measures, expectations; modes of convergence of sequences of random variables; conditional expectations; independent systems of random variables; Gaussian systems; characteristic functions; Law of large numbers, Central limit theory; some notions of dependence.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: STAT 251 or MTHE 351

(STAT 351), APSC 174, MTHE 281 (MATH 281) Corequisites:

Exclusions:

Offering Term: W

CEAB Units:

Mathematics 26

Natural Sciences 0

Complementary Studies 0

Engineering Science 10

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 367 Engineering Data Analysis Units: 3.50

Exploratory data analysis -- graphical and statistical analysis and presentation of experimental data. Random sampling. Probability and probability models for discrete and continuous random variables. Process capability. Normal probability graphs. Sampling distribution of means and proportions. Statistical Quality Control and Statistical Process Control. Estimation using confidence intervals. Testing of hypothesis procedures for means, variances and

proportions -- one and two samples cases. Linear regression, residuals and correlation. ANOVA. Use of statistical software. NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: APSC 171, APSC 172

Corequisites: Exclusions: STAT 261, STAT 263, STAT 266, STAT 267

Offering Term: W

CEAB Units:

Mathematics 31

Natural Sciences 0

Complementary Studies 0

Engineering Science 11

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 393 Engineering Design and Practice for Mathematics and Engineering Units: 4.00

This is a project-based design course where methods of applied mathematics are used to solve a complex open-ended engineering problem. The projects involve using system theoretic methods for modeling, analysis, and design applied to engineering problems arising in a variety of engineering disciplines. Students will work in teams and employ design processes to arrive at a solution. The course will include elements of communications, economic analysis, impacts of engineering, professionalism, and engineering ethics.

K4(Lec: Yes, Lab: Yes, Tut: Yes)

Requirements: Prerequisites: APSC 200 or APSC 202

Corequisites: MTHE 335 Exclusions:

Offering Term: W

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 12

Engineering Science 0

Engineering Design 36

Offering Faculty: Faculty of Arts and Science

MTHE 406 Introduction To Coding Theory Units: 3.00

Construction and properties of finite fields. Polynomials, vector spaces, block codes over finite fields. Hamming distance and other code parameters. Bounds relating code parameters. Cyclic codes and their structure as ideals. Weight distribution. Special codes and their relation to designs and projective planes. Decoding algorithms.

NOT OFFERED 2023-2024.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 217 (MATH 217)

Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 14

Natural Sciences 0

Complementary Studies 0

Engineering Science 12

Engineering Design 10

Offering Faculty: Faculty of Arts and Science

MTHE 418 Number Theory & Cryptography Units: 3.00

Time estimates for arithmetic and elementary number theory algorithms

(division algorithm, Euclidean algorithm, congruences),

modular arithmetic,

finite fields, quadratic residues. Simple cryptographic

systems; public key,

RSA. Primality and factoring: pseudoprimes, Pollard's rho-

method, index

calculus. Elliptic curve cryptography.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 217 (MATH 217) or

MATH 210 or MATH 211 with permission of the instructor

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 18

Natural Sciences 0

Complementary Studies 0

Engineering Science 9

Engineering Design 9

Offering Faculty: Faculty of Arts and Science

MTHE 430 Control Theory Units: 4.00

This course covers core topics in both classical and modern control theory. Overview of classical control theory using frequency methods. Linear and nonlinear controlled differential systems and their solutions. Stabilization and stability methods via Lyapunov analysis or linearization. Controllability, observability, minimal realizations, feedback stabilization, observer design. Optimal control theory, the linear quadratic regulator, dynamic programming.

(Lec: 3, Lab: 0.5, Tut: 0.5)

Requirements: Prerequisites: MTHE 237, MTHE 212,

MTHE 326, or permission of the instructor Corequisites:

Exclusions:

Offering Term: F

CEAB Units:

Mathematics 6

Natural Sciences 6

Complementary Studies 0

Engineering Science 18

Engineering Design 18

Offering Faculty: Faculty of Arts and Science

MTHE 433 Continuum Mechanics with**Applications Units: 3.50**

Continuum mechanics lays the foundations for the study of the mechanical behavior of solids and fluids. After a review of vector and tensor analysis, the kinematics of continua are introduced. Emphasis is given to the concepts of stress, strain and deformation. The fundamental laws of conservation of mass, balances of (linear and angular) momentum and energy are presented together with the constitutive models. Applications of these models are given in the theory of linearized elasticity and fluid dynamics.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 237, MTHE 280, or

permission of the instructor Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 6

Natural Sciences 0

Complementary Studies 0

Engineering Science 24

Engineering Design 12

Offering Faculty: Faculty of Arts and Science



MTHE 434 Optimization Theory with Applications to Machine Learning Units: 3.50

Theory of convex sets and functions; separation theorems; primal-dual properties; geometric treatment of optimization problems; algorithmic procedures for solving constrained optimization programs; applications of optimization theory to machine learning.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 281 (MATH 281), MTHE 212 (MATH 212), or permission of the instructor

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 15

Natural Sciences 0

Complementary Studies 0

Engineering Science 15

Engineering Design 12

Offering Faculty: Smith Engineering

MTHE 437 Topics In Applied Mathematics Units: 3.50

Topic: An Introduction to Stochastic Differential Equations (with Applications to Mathematical Finance and Engineering)

The aim of this course is to provide a rigorous introduction to the theory of stochastic calculus and stochastic differential equations, and to survey some of its most important applications, especially in Mathematical Finance. The Ito stochastic integral and its associated Ito Calculus will be derived in the general framework of continuous semimartingales, leading to a detailed treatment of stochastic differential equations (SDEs) and their properties. The theory thus developed will be applied to selected problems in Mathematical Finance (option pricing and hedging, trading strategies and arbitrage) and Engineering (boundary-value problems, filtering, optimal control). Numerical aspects of SDEs will also be discussed.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 328 and MTHE 351, or permission of the instructor Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 18

Natural Sciences 0

Complementary Studies 0

Engineering Science 12

Engineering Design 12

Offering Faculty: Faculty of Arts and Science

MTHE 439 Lagrangian Mechanics, Dynamics

Control Units: 3.50

Geometric modelling, including configuration space, tangent bundle, kinetic energy, inertia, and force. Euler-Lagrange equations using affine connections.

The last part of the course develops one of the following three applications: mechanical systems with nonholonomic constraints; control theory for mechanical systems; equilibria and stability.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 280 (MATH 280), MTHE 281 (MATH 281), MTHE 237 (MATH 237) or MATH 231, or permission of the instructor Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 20

Natural Sciences 0

Complementary Studies 0

Engineering Science 11

Engineering Design 11

Offering Faculty: Faculty of Arts and Science

MTHE 454 Statistical Spectrum Estimation Units: 3.00

Many systems evolve with an inherent amount of randomness in time and/or space. The focus of this course is on developing and analyzing methods for analyzing time series. Because most of the common time--domain methods are unreliable, the emphasis is on frequency--domain methods, i.e. methods that work and expose the bias that plagues most time--domain techniques.

Slepian sequences (discrete prolate spheroidal sequences) and multi--taper methods of spectrum estimation are covered in detail.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 353 (STAT 353), MTHE 312 (MATH 312); or MTHE 338 (MATH 338), STAT 251; or STAT 261, MATH 321; or permission or the instructor Corequisites:

Exclusions:

Offering Term: W

CEAB Units:

Mathematics 12

Natural Sciences 0

Complementary Studies 0

Engineering Science 12

Engineering Design 12

Offering Faculty: Faculty of Arts and Science

MTHE 455 Stochastic Processes & Applications Units: 3.50

Markov chains, birth and death processes, random walk problems, elementary renewal theory, Markov processes, Brownian motion and Poisson processes, queuing theory, branching processes.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 353 (STAT 353) or one of STAT 251, MTHE 351 (STAT 351), ELEC 326 with permission of the instructor Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 28

Natural Sciences 0

Complementary Studies 0

Engineering Science 14

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 457 Statistical Learning Units: 3.00

Introduction to the theory and application of statistical algorithms. Topics include classification, smoothing, model selection, optimization, sampling, supervised and unsupervised learning.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 351 or equivalent Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 12

Natural Sciences 0

Complementary Studies 0

Engineering Science 24

Engineering Design 0

Offering Faculty: Smith Engineering

MTHE 472 Optimization and Control of Stochastic Systems Units: 3.50

This course concerns the optimization, control, and stabilization of dynamical systems under probabilistic uncertainty with applications in engineering systems and applied mathematics. Topics include: controlled and control-free Markov chains and stochastic stability; martingale methods for stability and stochastic learning; dynamic programming and optimal control for finite horizons, infinite horizons, and average cost problems; partially observed models, non-linear filtering and Kalman Filtering; linear programming and numerical methods; reinforcement learning and stochastic approximation methods; decentralized stochastic control, and continuous-time stochastic control.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MTHE 351 or permission of the instructor Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 6

Natural Sciences 0

Complementary Studies 0

Engineering Science 18

Engineering Design 18

Offering Faculty: Faculty of Arts and Science

MTHE 474 Information Theory Units: 3.50

Topics include: information measures, entropy, mutual information, modeling of information sources, lossless data compression, block encoding, variable-length encoding, Kraft inequality, fundamentals of channel coding, channel capacity, rate-distortion theory, lossy data compression, rate-distortion theorem.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: STAT 251 or MTHE 351 (STAT 351) or ELEC 326 Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 6

Natural Sciences 0

Complementary Studies 0

Engineering Science 23

Engineering Design 13

Offering Faculty: Faculty of Arts and Science



MTHE 477 Data Compression and Source Coding: Theory and Algorithms Units: 3.00

Topics include: arithmetic coding, universal lossless coding, Lempel-Ziv and related dictionary based methods, rate-distortion theory, scalar and vector quantization, predictive and transform coding, applications to speech and image coding.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 474 (MATH 474)

Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 0

Engineering Science 21

Engineering Design 15

Offering Faculty: Faculty of Arts and Science

MTHE 478 Topics In Communication Theory Units: 3.00

Subject matter will vary from year to year. Possible subjects include: constrained coding and applications to magnetic and optical recording; data compression; theory and practice of error-control coding; design and performance analysis of communication networks; and other related topics.

NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: Permission of the instructor

Corequisites: Exclusions:

Offering Term: FW

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 0

Engineering Science 18

Engineering Design 18

Offering Faculty: Faculty of Arts and Science

MTHE 484 Data Networks Units: 3.00

This course covers performance models for data networking, delay models and loss models; analysis of multiple access systems, routing, and flow control; multiplexing; priority systems; satellite multiple access, wireless networking, wireless sensor networks. Knowledge of networking protocols is not required. NOT OFFERED 2023-2024

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: MTHE 455 (STAT 455) or permission of the instructor Corequisites: Exclusions:

Offering Term: W

CEAB Units:

Mathematics 10

Natural Sciences 0

Complementary Studies 0

Engineering Science 26

Engineering Design 0

Offering Faculty: Faculty of Arts and Science

MTHE 493 Engineering Math Project Units: 7.50

This is the capstone design course for Mathematics and Engineering. Students must work in groups. Projects are selected early in the year from a list put forward by Mathematics and Engineering faculty members who will also supervise the projects. There is a heavy emphasis on engineering design and professional practice. All projects must be open-ended and design oriented, and students are expected to undertake and demonstrate, in presentations and written work, a process by which the design facets of the project are approached. Projects must involve social, environmental, and economic factors, and students are expected to address these factors comprehensively in presentations and written work. Students are assessed individually and as a group on their professional conduct during the course of the project.

K7.5(Lec: No, Lab: Yes, Tut: Yes)

Requirements: Prerequisites: MTHE 393 and must be registered in BSCE or BASC program. Corequisites:

Exclusions:

Offering Term: FW

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 10

Engineering Science 10

Engineering Design 70

Offering Faculty: Faculty of Arts and Science

**MTHE 494 Mathematics and Engineering Seminar Units:
3.00**

This is a seminar and course, with an emphasis on communication skills and professional practice. A writing module develops technical writing skills. Students give an engineering presentation to develop their presentation skills. Seminars are given by faculty from the Mathematics and Engineering program, by Mathematics and Engineering alumni on the career paths since completing the program, and by visiting speakers on a variety of professional practice matters, on topics such as workplace safety, workplace equity and human rights, and professional organizations. Open to Mathematics and Engineering students only.

(Lec: 3, Lab: 0, Tut: 0)

Requirements: Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 26

Engineering Science 10

Engineering Design 0

Offering Faculty: Faculty of Arts and Science