+---------------------+------------------------------------------+-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+--------+------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+-----------+-----------+------------+---------------------+-----------+---------------+-------------------+--------------------------------+--------------+--------------+--------------------------------+--------------------------------+----------------+---------+

| EXTRACTED\_TIMESTAMP | CRS\_TITLE | CRS\_DESC | CRS\_NO | PREREQ | LOCATIONS | CRS\_NAME | COURSES\_ID | COURSES\_CHGDATE | ITEM\_TYPE | PATH | COURSE\_TYPES | DEPARTMENT\_1 | DEPARTMENT\_2 | DEPARTMENT\_3 | CRS\_SHORT\_TITLE | SUBJECT | ACADEMIC\_LEVEL | CREDITS |

+---------------------+------------------------------------------+-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+--------+------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+-----------+-----------+------------+---------------------+-----------+---------------+-------------------+--------------------------------+--------------+--------------+--------------------------------+--------------------------------+----------------+---------+

| 2018-01-31 03:00:21 | Mathematics of Finance | MATHEMATICS OF FINANCE This first course in the mathematics of finance includes topics such as measurement of interest; annuities and perpetuities; amortization and sinking funds; rates of return; bonds and related securities; life insurance. Three lecture hours a week plus a 2 hour lab per week. | 2160 | Math 1910 | NULL | AMS-2160 | 1196 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Mathematics of Finance | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Financial Mathematics and Investments | FINANCIAL MATHEMATICS & INVESTMENTS Advanced topics of Theory of Interest as initially covered in AMS 2160 including time value of money, annuities, loans, bonds, general cash flows, portfolios and immunization concepts, as well as an introduction to capital markets, analysis of equity and fixed income investments, and an introduction to derivative securities including futures, forwards, swaps and options. Three lecture hours plus a two hour lab per week | 2400 | AMS 2160; AMS 2400L | NULL | AMS-2400 | 1197 | 2017-06-06 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Financial Math and Investments | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Financial Economics I | FINANCIAL ECONOMICS I Introduction to mathematical techniques used to price and hedge derivative securities in modern finance. Modelling, analysis and computations for financial derivative products, including exotic options and swaps in all asset classes. Applications of derivatives in practice will also be discussed. Three lecture hours a week plus a two hour lab per week. | 2410 | AMS 2400; AMS 2410 Lab | NULL | AMS-2410 | 1198 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Financial Economics I | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Actuarial Science I | ACTUARIAL SCIENCE I This course will explore the future lifetime random variable, probability and survival functions, force of mortality; complete and curtate expectation of life, and Makeham and Gompertz mortality laws. Other topics will include: Life tables, characteristics of population and insurance life tables, selection, and fractional age assumptions. Life insurance payments and annuity payments: Present value random variables; expected present values; higher moments; actuarial notation, annual, 1/mthly and continuous cases, relationships between insurance and annuity functions. Premiums, expense loadings, present value of future loss random variables and distribution, net and gross cases, the equivalence principle and portfolio percentile principle will also be discussed. Three lecture hours plus a two hour lab per week. | 2510 | AMS 2400 and STAT 3210; AMS-2510L | NULL | AMS-2510 | 1199 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Actuarial Science I | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Actuarial Mathematics Lab I | ACTUARIAL MATHEMATICS LAB I This lab features problem-solving sessions for the professional examination on financial mathematics of the Society of Actuaries and the Casualty Actuarial Society. Semester hours of credit: 1 | 2860 | AMS 2160 | NULL | AMS-2860 | 1200 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Actuarial Mathematics Lab I | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Optimization | OPTIMIZATION An introduction to the methods and applications of linear programming. Topics include linear programming formulations, the simplex method, duality and sensitivity analysis, and integer programming basics. Applications to transportation, resource allocation and scheduling problems will be examined. Software will be used to illustrate topics and applications. Three lecture hours per week | 2940 | MATH 2610 | NULL | AMS-2940 | 1201 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Optimization | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Game Theory | GAME THEORY The course covers the fundamentals of game theory and its applications to the modeling of competition and cooperation in business, economics, biology and society. It will include two-person games in strategic form and Nash equilibria, extensive form games, including multi-stage games, coalition games and the core Bayesian games, mechanism design and auctions. PREREQUISITES: Math 192, Math 242 and Stat 222 Three lecture hours per week | 3160 | Math 1920, Math 2420 and Statistics 2220 | NULL | AMS-3160 | 1202 | 2017-03-28 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Game Theory | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Advanced Corporate Finance for Actuaries | ADVANCED CORPORATE FINANCE FOR ACTUARIES This course covers various advanced topics in corporate finance, with emphasis on theories of corporate incentives and asymmetric information. Illustrative applications using cases are provided. Topics include: capital budgeting, real options, investment decision using Markowitz and utility theory, the Capital Asset Pricing Model, Arbitrage Pricing Theory, market efficiency and capital structure and dividend policy. Other topics may include time value of money, capital budgeting, cost of capital, security issuance, capital structure, payout policy and dividends, short-term finance, and risk management. Where suitable, topics are treated from a mathematical and quantitative perspective. Three lecture hours per week | 3310 | AMS 2400 and BUS 2310 | NULL | AMS-3310 | 1203 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Adv. Corp. Actuary Finance | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Financial Economics II | FINANCIAL ECONOMICS II This course will discuss advanced mathematical techniques used to price and hedge derivative securities in modern finance. Topics include: modelling, analysis and computations for financial derivative products, including exotic options and swaps in all asset classes. Students will also have the opportunity to apply these derivatives in practice. Three lecture hours plus a two hour lab per week. | 3410 | AMS 2410; AMS 3410L | NULL | AMS-3410 | 1204 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Financial Economics II | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Actuarial Science II | ACTUARIAL SCIENCE II This course will discuss: policy values, annual, 1/mthly and continuous cases, Thiele's equation, policy alterations, modified policies and multiple state models. Other topics will include applications in life contingencies, assumptions, Kolmogorov equations, premiums, policy values, multiple decrement models, Joint Life Models, Valuation of insurance benefits on joint lives, and dependent and independent cases. Three lecture hours plus a two hour lab per week. | 3510 | AMS 2510 and STAT 3220; AMS-3510L | NULL | AMS-3510 | 1205 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Actuarial Science II | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Adv. Insurance and Actuarial Practices | ADVANCED INSURANCE AND ACTUARIAL PRACTICES This course is a study of cash flow projection methods for pricing, reserving and profit testing. Topics include: deterministic, stochastic and stress testing; pricing and risk management of embedded options in insurance products; mortality and maturity guarantees for equity-linked life insurance. Three lecture hours per week | 3730 | AMS 3510 | NULL | AMS-3730 | 1206 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Adv. Insur., Actuarial Pract. | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Combinatorial Optimization | COMBINATORIAL OPTIMIZATION In this course, various algorithms will be considered, including minimum spanning tree, shortest path, maximum flow, and maximum matching. The links with linear and integer programming will also be considered, with particular attention to duality. Three lecture hours per week | 3770 | MATH 2420 and AMS 2940 | NULL | AMS-3770 | 1207 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Combinatorial Optimization | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Mathematical Modelling | MATHEMATICAL MODELLING This course studies the process of mathematical modeling, namely, formulating a "real-world" problem in mathematical terms, solving the resulting mathematical problem, and interpreting the solution. Major topics include the modeling of optimization problems (using the techniques of linear programming), and deterministic and probabilistic dynamical processes (with models formulated as differential and difference equations). Applications are taken from science, business and other areas, according to class interest. Three lecture hours per week | 3910 | MATH 2610 and MATH 3010; A statistics course | NULL | AMS-3910 | 1208 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Mathematical Modelling | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Financial Mathematics II | FINANCIAL MATHEMATICS II This course explores calculus in a stochastic environment. Topics include: random functions, derivative, chain rule, integral, integration by parts, partial derivatives, pricing forwards and options. Ito's lemma and financial applications, Hull-White, Artzner-Heath, and Brennan-Schwartz models Martingales, pricing methodology, and risk-neutral probability will also be discussed. Three lecture hours per week | 4080 | MATH 2610 and AMS 3410 | NULL | AMS-4080 | 1209 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Financial Mathematics II | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Financial Mathematics III | FINANCIAL MATHEMATICS III This course discusses forming risk-free portfolios, the Black-Scholes partial differential equation, constant dividend case, exotic options, drift adjustment, and equivalent martingale measures. Topics also include: Cox-Ross-Rubinstein, Merton and Vasicek's models, stochastic optimization, Hamilton-Jacobi-Bellman equation, and application to American options. Three lecture hours per week | 4090 | AMS 4080 and STAT 3220 | NULL | AMS-4090 | 1210 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Financial Mathematics III | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Loss Models I | LOSS MODELS I This course explores models for loss severity, parametric models, effect of policy modifications, and tail behaviour. Topics also include: models for loss frequency: (a, b, 0), (a, b, 1), mixed Poisson models; compound Poisson models, Aggregate claims models: moments and moment generating function: recursion and Classical ruin theory. Three lecture hours per week | 4540 | AMS 3510 and STAT 3220 | NULL | AMS-4540 | 1211 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Loss Models I | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Loss Models II | LOSS MODELS II This course is a study of the mathematics of survival models and includes some examples of parametric survival models. Topics include: tabular survival models, estimates from complete and incomplete data samples, parametric survival models, and determining the optimal parameters. Maximum likelihood estimators, derivation and properties, product limit estimators, Kaplan-Meier and Nelson-Aalen, credibility theory: limited fluctuation; Bayesian; Buhlmann; Buhlmann-Straub; empirical Bayes parameter estimation; statistical inference for loss models; maximum likelihood estimation; the effect of policy modifications; and model selection will also be discussed. Three lecture hours per week | 4550 | AMS 4540 | NULL | AMS-4550 | 1212 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Loss Models II | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Credibility Theory | CREDIBILITY THEORY This course is a credibility approach to inference for heterogeneous data; classical, regression and Bayesian models; with illustrations from insurance data. Three lecture hours per week | 4580 | AMS 3510 and STAT 3220 | NULL | AMS-4580 | 1213 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Credibility Theory | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Nonlinear Optimization | NONLINEAR OPTIMIZATION This course is a study of unconstrained optimization, optimality conditions (necessary, sufficient and Karush-Kuhn-Tucker), penalty functions, convex functions, and convex programming. Three lecture hours per week | 4680 | MATH 2910 and AMS 2940 | NULL | AMS-4680 | 1214 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Nonlinear Optimization | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Quantitative Risk Management | QUANTITATIVE RISK MANAGEMENT This course is an introduction to financial risk management. Topics include: risk measures, modeling for multivariate distributions and copulas, market, credit and operational risk. Advanced topics in quantitative risk management will also be discussed. Three lecture hours per week | 4780 | AMS 3310 | NULL | AMS-4780 | 1215 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Quantitative Risk Management | Applied Mathematical Sciences | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Introduction to Computer Programming Sci | INTRODUCTION TO COMPUTER PROGRAMMING FOR SCIENTISTS This course is an introduction to computer programming for non-computer science majors. Topics include problem-solving, algorithm design, data types, control structures, repetition, loops, nested structures, modular programming and arrays. Three lecture hours and 1.5 hours of laboratory session per week. NOTE: Credit will be allowed for only one of CS 1410 or Engineering 1320. As well, CS 1410 may not be taken concurrently with, or after, CS 1510. Prerequisite: Grade XII academic mathematics | 1410 | Computer Science 1410L | NULL | CS-1410 | 322 | 2017-03-24 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Intro Computer Programming | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Digital Systems | DIGITAL SYSTEMS This course provides an introduction to digital systems, beginning with elementary components such as logic gates, from which are constructed components such as adders and comparators, and progressing to more complex systems such as programmable logic devices, memory and processor units. Students acquire skills in the design and analysis of combinational and sequential digital systems, CAD design and simulation tools for complex systems, and construction of digital systems based upon a modular methodology. Three lecture hours and a three-hour laboratory session per week | 1610 | Computer Science 1520 or 1920 or Engineering 1310 or 1320, and three semester hours of Mathematics, or permission of the instructor (based on completion of CS 1510 with first class standing); Computer Science 1610L | NULL | CS-1610 | 325 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Digital Systems | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Computer Science I | COMPUTER SCIENCE I This course is an introduction to computer programming and is designed for both Computer Science majors and non-majors. Emphasis is on problem solving and software development using a modern high level object-oriented language. Topics include: the programming process; language syntax and semantics; data types; expressions; input and output; conditionals; loops; arrays; functions/methods and text files. The course follos an "objects late" strategy, deferring in-depth discussions of object-orientated concepts to Computer Science 192. PREREQUISITE: Grade XII academic mathematics | 1910 | Computer Science 1910L | NULL | CS-1910 | 3409 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Computer Science I | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Computer Science II | COMPUTER SCIENCE II This course continues the development of object-oriented programming. Topics include class design; inheritance; interfaces and polymorphism; collection classes; searching and sorting; recursion; exception handling; the Model-View-Controller pattern; and graphical user interfaces. | 1920 | Computer Science 1910;; Computer Science 1920L; | NULL | CS-1920 | 3411 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Computer Science II | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Web Development and Programming | WEB DEVELOPMENT AND PROGRAMMING In this course, students learn to create websites that involve server-side scripting and database operations. While one specific scripting language is used to acquire web development and programming skills, students are exposed to a spectrum of scripting languages, enabling them to easily adapt to others. Three hours per week | 2060 | Computer Science 1520 or Computer Science 1920 | NULL | CS-2060 | 326 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Web Development, Programming | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Mobile Device Development - iOS | MOBILE DEVICE DEVELOPMENT - iOS This course introduces the student to programming for mobile devices that use iOS. The course will present a study of the architecture, operating system, and programming for these devices. Three lecture hours per week | 2120 | Computer Science 1520 or Computer Science 1920 | NULL | CS-2120 | 327 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Mobile Device Development iOS | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Mobile Device Development - Android | MOBILE DEVICE DEVELOPMENT - ANDROID This course introduces the student to programming for mobile devices that use the Android platform. The course will present a study of the architecture, operating system and programming language of these devices. Three lecture hours per week | 2130 | Computer Science 1520 or 1920 | NULL | CS-2130 | 328 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Mobile Device, Android | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Computer Organization and Architecture | COMPUTER ORGANIZATION AND ARCHITECTURE This course provides a basic understanding of the organization and architecture of modern computer systems. It examines the function and design of major hardware components both from a designer's perspective and through assembly language programming. Topics include components and their interconnection, internal/external memory, input/output subsystems, processors, computer arithmetic, instruction sets, addressing modes, and pipelining. Three hours per week | 2520 | Computer Science 1520 or Computer Science 1920 | NULL | CS-2520 | 329 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Computer Org. and Architecture | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Comparative Programming Languages | COMPARATIVE PROGRAMMING LANGUAGES This course examines the principal features of major types of programming languages, including procedural, logical, functional and object-oriented languages. Features include parameter-passing mechanisms, control structures, scope, and binding rules. Each language type is illustrated by considering a specific language. Three lecture hours per week | 2620 | Computer Science 2610 | NULL | CS-2620 | 331 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Comp Programming Languages | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Practical Embedded Systems | PRACTICAL EMBEDDED SYSTEMS This course introduces students to the concept of embedded systems architectures, the interconnection of sensors and actuators to such systems, and the usage of such platforms for data acquisition and control of automated systems. Popular microcontroller units and system-on-chip platforms will be examined. Three lecture hours per week | 2710 | Computer Science 1210 or Computer Science 1410 or Computer Science 1510 or Engineering 1310 or CS-1910 | NULL | CS-2710 | 332 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Practical Embedded Systems | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Programming Practices | PROGRAMMING PRACTICES This course introduces the student to development in the Unix/Linux environment. Topics include development tools, shell programming, common utility programs, processes, file/directory management, IDEs, testing/debugging, version control, and an introduction to software engineering. Three lecture hours per week | 2820 | Computer Science 1520 or Computer Science 1920 permission of the instructor (based on completion of CS 1510 with first class standing) | NULL | CS-2820 | 333 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Programming Practices | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Video Game Design | VIDEO GAME DESIGN This course focuses on the process from initial idea to final design of a video game. Students will craft a game document from an original concept of their own creation and create a prototype of the game based on that document. Three lecture hours per week | 3110 | Computer Science 2610 | NULL | CS-3110 | 334 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Video Game Design | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Human-Computer Interface Design | HUMAN-COMPUTER INTERFACE DESIGN This course is an introduction to the design and evaluation of software interfaces and webpages. The course focuses on user-centered design and includes topics such as user analysis and modelling, iterative prototyping, usability testing, designing for the web, internationalization and localization. Three hours per week | 3210 | Computer Science 1520 or 1920 | NULL | CS-3210 | 335 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Human Computr Interface Design | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Introduction to Bioinformatics | INTRODUCTION TO BIOINFORMATICS This course is an introduction to bioinformatics, with a focus on a practical guide to the analysis of data on genes and proteins. It familiarizes students with the tools and principles of contemporary bioinformatics. Students acquire a working knowledge of a variety of publicly available data and computational tools important in bioinformatics, and a grasp of the underlying principles enabling them to evaluate and use novel techniques as they arise in the future. Cross-listed with Biology, Pathology/Microbiology, Human Biology (cf. Biology 3220, VPM 8850, HB 8850). Three lecture hours and a one-hour laboratory session per week. NOTE: No student can be awarded more than one course credit among HB 8850, VPM 8850, CS 3220 and BIO 3220. | 3220 | Computer Science 2610 or Biology 2230 or permission of instructor. If taken as VPM 8850 or HB 8850 - Admission to the graduate program and permission of the instructor.; Computer Science 3220L | NULL | CS-3220 | 336 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Introduction to Bioinformatics | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Computer Communications | COMPUTER COMMUNICATIONS This course introduces the basic principles of modern computer communication: protocols, architectures and standards. Topics include layered architectures, data transmission, error and flow control, medium access, routing, congestion control and common internet application protocols. Three lecture hours per week | 3420 | Computer Science 2520 and Computer Science 2820 | NULL | CS-3420 | 337 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Computer Communications | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Operating Systems | OPERATING SYSTEMS This course introduces the student to the major concepts of modern operating systems. Topics covered include: process management, memory management, file systems, device management and security. Three lecture hours per week | 3520 | Computer Science 2520, Computer Science 2610, and Computer Science 2820 | NULL | CS-3520 | 338 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Operating Systems | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Analysis and Design of Algorithms | ANALYSIS AND DESIGN OF ALGORITHMS This course, which introduces the study of algorithm design and measures of efficiency, is a continuation of CS 2610. Topics include algorithm complexity and analysis; techniques such as divide and conquer, greedy and dynamic programming; searching and sorting algorithms; graph algorithms; text processing; efficient algorithms for several common computer science problems and NP-completeness. Three lecture hours per week | 3610 | Computer Science 2610 and Math 2420 | NULL | CS-3610 | 339 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Analysis, Design of Algorithms | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Software Design and Architecture | SOFTWARE DESIGN AND ARCHITECTURE This course examines the principles and best practices in object-oriented (OO) software design. Topics include a review of foundational OO concepts, OO design principles, classic design patterns, and software architectures. Three lecture hours per week | 3620 | Computer Science 2610 | NULL | CS-3620 | 340 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Software Design, Architecture | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Database Systems | DATABASE SYSTEMS This course introduces the fundamental concepts necessary for the design, use and implementation of database systems. Topics discussed include logical and physical organization of data, database models, design theory, data definition and manipulation languages, constraints, views, and embedding database languages in general programming languages. Three lecture hours per week | 3710 | Computer Science 2610 | NULL | CS-3710 | 341 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Database Systems | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Tech. Management and Entrepreneurship | TECHNOLOGY MANAGEMENT & ENTREPRENEURSHIP This course provides an overview on how to start and sustain a technology-oriented company. Topics discussed will include the role of technology in society, intellectual property, patents, business plans, financial planning, sources of capital, business structure, liability, tax implications, sales, marketing, operational and human resource management. This course will be taught using problem-based and experiential learning strategies with involvement from real life entrepreneurs as motivators and facilitators. (Cross-listed with Engineering 4430. Three lecture hours per week. | 3840 | Computer Science 2520, Computer Science 2620, and Computer Science 2820 | NULL | CS-3840 | 342 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Tech Mngmt, Entrepreneurship | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Cloud Computing | CLOUD COMPUTING This course examines: the critical technology trends that are enabling cloud computing, the architecture and the design of existing deployments, the services and the applications they offer, and the challenges that need to be addressed to help cloud computing to reach its full potential. The format of this course will be a mix of lectures, seminar-style discussions, and student presentations. Three lecture hours per week | 4060 | Computer Science 2060 | NULL | CS-4060 | 343 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Cloud Computing | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Artificial Intelligence/Automated Reason | ARTIFICIAL INTELLIGENCE AND AUTOMATED REASONING This course introduces general problem-solving methods associated with automated reasoning and simulated intelligence. Topics include problem abstraction, state space heuristic search theory, pathfinding, flocking behaviour, knowledge representation, propositional logic, reasoning with uncertainty, machine learning and connectionism. Three lecture hours per week | 4110 | Computer Science 2610 | NULL | CS-4110 | 344 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | A.I. and Automated Reasoning | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Machine Learning and Data Mining | MACHINE LEARNING AND DATA MINING Machine learning is the study of mechanisms for acquiring knowledge from large data sets. This course examines techniques for detecting patterns in sets of uncategorized data. Supervised and unsupervised learning techniques are studied, with particular application to real-world data. Three lecture hours per week | 4120 | Computer Science 3710 and Statistics 2210 | NULL | CS-4120 | 345 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Machine Learning, Data Mining | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Computer Graphics Programming | COMPUTER GRAPHICS PROGRAMMING This course introduces the student to the principles and tools of applied graphics programming including graphical systems, input and interaction, object modeling, transformations, hidden surface removal, and shading and lighting models. Languages, graphics libraries and toolkits, and video game engines are introduced, as well as relevant graphics standards. Three lecture hours per week | 4350 | Computer Science 2620 and Math 2610 | NULL | CS-4350 | 346 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Computer Graphics Programming | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Advanced Computer Graphics Programming | ADVANCED COMPUTER GRAPHICS PROGRAMMING This course builds on the computer graphics programming concepts introduced in CS 4350. Students are given a deeper understanding of the components of the 3D graphics pipeline, and how they are used in modern graphical applications. Topics include advanced texture mapping, practical uses of vertex and pixel shaders, screen post-processing, particle systems, and graphics engine design. Three lecture hours per week | 4360 | Computer Science 4350 | NULL | CS-4360 | 347 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Adv Computer Graphics Program. | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Data Science | DATA SCIENCE Data science is an interdisciplinary and emerging field where techniques from several areas are used to solve problems using data. This course provides an overview and hands-on training in data science, where students will learn to combine tools and techniques from computer science, statistics, data visualization and the social sciences. The course will focus on: 1) the process of moving from data collection to product, 2) tools for preparing, manipulating and analyzing data sets (big and small), 3) statistical modelling and machine learning, and 4) real world challenges. Three lecture hours per week | 4440 | Computer Science 3710 and Statistics 2210 | NULL | CS-4440 | 348 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Data Science | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Wireless Sensor Networks | WIRELESS SENSOR NETWORKS This course is an introduction to Wireless Sensor Networks. It includes the following topics: single-node architecture, wireless sensor network architecture, physical layer, MAC protocols, link-layer protocols, naming and addressing, time synchronization, localization and positioning, topology control, routing protocols, transport layer, and quality of service. Three lecture hours per week | 4610 | Computer Science 2520 and Computer Science 2610 | NULL | CS-4610 | 349 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Wireless Sensor Networks | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Video-Game Architecture | VIDEO-GAME ARCHITECTURE This programming-driven course aims to explore the various systems that comprise a typical video-game project, including event systems, state machines, rendering, scripting and AI programming. Students will implement these components throughout the course with the end goal of building a small game. Three lectures hours per week | 4650 | Computer Science 4350; Computer Science 4360 | NULL | CS-4650 | 350 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Video-Game Architecture | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Compiler Design | COMPILER DESIGN This is a first course in compiler design. The course covers: compilation phases, lexical analysis, parsing, scope rules, block structure, symbol tables, run-time heap and stack management, code generation, pre-processing, compiler-compilers, and translation systems. | 4720 | MCS 3320 | NULL | CS-4720 | 351 | 2017-10-26 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Compiler Design | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Software Engineering | SOFTWARE ENGINEERING This course emphasizes the theory, methods and tools employed in developing medium to large-scale software which is usable, efficient, maintainable, and dependable. Project management is a major focus. Topics include traditional and agile process models, project costing, scheduling, team organization and management, requirements modelling/specification, software design, software verification and testing, and re-engineering. Three lecture hours per week. Restriction: Student must have fourth year standing in Computer Science | 4810 | NULL | NULL | CS-4810 | 352 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Software Engineering | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Software System Project | SOFTWARE SYSTEMS DEVELOPMENT PROJECT In this course, students propose, complete and present a significant software project in a group setting using the system development skills learned in CS 4810. The course applies object-oriented design principles through the use of UML. Students are encouraged to select (with the consent of the instructor) a project with a real-world client. One lecture hour per week plus significant project time | 4820 | Computer Science 4810 (May be taken concurrently in exceptional circumstances) | NULL | CS-4820 | 1419 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Software System Project | Computer Science | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Video Game Programming Project | VIDEO GAME PROGRAMMING PROJECT In this course, students work as a group to develop a single design into a fully functioning video game. This course applies the project management skills learned in CS 4810 to the development of a professional quality video game based upon a single design and prototype emerging from CS 3110. One lecture hour per week plus significant project time. | 4830 | Computer Science 3110, Computer Science 4810 and enrolment in the Computer Science with Video Game Programming major. | NULL | CS-4830 | 353 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Video Game Programming Project | Computer Science | Undergraduate | 6 |

| 2018-01-31 03:00:21 | Prototype Systems Development | PROTOTYPE SYSTEMS DEVELOPMENT This course is for student teams who wish to develop an early prototype of a product which they hope to pitch to an external start-up accelerator program post-graduation. Student teams may be inter-disciplinary, but students must register for this course (or its equivalent) within their home school/department. Entry into the course is dependent upon a pitch for the product being judged as economically viable by a team of project mentors. Pitches are made at the conclusion of CS 3840. One lecture hour per week plus significant project time. | 4840 | Computer Science 3840 and permission of the instructor | NULL | CS-4840 | 354 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Prototype Systems Development | Computer Science | Undergraduate | 6 |

| 2018-01-31 03:00:21 | Elements of Mathematics | ELEMENTS OF MATHEMATICS This course provides an introduction to several mathematical topics at the university level, and is intended for students majoring in a discipline other than Mathematical and Computational Sciences, or the Natural Sciences. The course consists of four modules: (1) Sets and Logic, (2) Number Theory, (3) Geometry, (4) Mathematical Systems. NOTE: Credit will not be given jointly for this course and any other 1000-level Mathematics course. PREREQUISITE: Grade XII academic Mathematics. | 1010 | NULL | NULL | MATH-1010 | 729 | 2017-11-15 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Elements of Mathematics | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Finite Mathematics | FINITE MATHEMATICS This course introduces students to finite mathematical techniques and to mathematical models in business, life and the social sciences. The course begins with an introduction to mathematical models, types of models, and conversion of verbal models to mathematical models. Topics covered include systems of linear equations and matrices, linear inequalities and linear programming, sets, counting and probability. NOTE: Credit for Mathematics 1110 will not be allowed if taken concurrent with or subsequent to Mathematics 2610. PREREQUISITE: Grade XII academic Mathematics. | 1110 | NULL | NULL | MATH-1110 | 730 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Finite Mathematics | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Calc for Mangerial, Social, Life Science | CALCULUS FOR THE MANAGERIAL, SOCIAL AND LIFE SCIENCES This course provides an introduction to calculus for students in the managerial, social and life sciences. The main emphasis of the course is the development of techniques of differentiation and integration of algebraic, exponential and logarithmic functions. Applications of derivatives and integrals are also discussed. NOTE: Credit will not be given jointly for this course and Math 1910 PREREQUISITE: Grade XII academic Mathematics. | 1120 | NULL | NULL | MATH-1120 | 731 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Calculus Social, Life Sciences | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Single Variable Calculus I | SINGLE VARIABLE CALCULUS I This course is an introduction to differential and integral calculus of functions of a single variable. The course is intended primarily for majors in the Mathematical and Computational Sciences, Engineering and the Physical Sciences, as well as those planning to continue with further Mathematics courses. The concepts of limits, continuity and derivatives are introduced and explored numerically, graphically and analytically. The tools of differential calculus are applied to problems in: related rates; velocity and acceleration; extrema of functions; optimization; curve sketching; and indeterminate forms. The concepts of definite and indefinite integrals are introduced, and the relation between the two integrals is discovered via the Fundamental Theorem of Calculus. PREREQUISITE: Grade XII academic Mathematics[and a passing grade on the Assessment Test] | 1910 | Math-1910T | NULL | MATH-1910 | 733 | 2018-01-18 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Single Variable Calculus I | Mathematics | Undergraduate | 4 |

| 2018-01-31 03:00:21 | Single Variable Calculus II | SINGLE VARIABLE CALCULUS II This course is a continuation of integral calculus of functions of a single variable and an introduction to sequences and series. Techniques of integration are studied, including improper integrals and numerical integration, and the tools of integral calculus are used to compute areas, volumes and arc lengths; and are applied to problems in physics and differential equations. Sequences, series, tests for convergence, Taylor series and Taylor polynomials are studied. | 1920 | Math 1910; Math-1920T | NULL | MATH-1920 | 734 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Single Variable Calculus II | Mathematics | Undergraduate | 4 |

| 2018-01-31 03:00:21 | Combinatorics I | COMBINATORICS I This course offers a survey of topics in discrete mathematics that are essential for students majoring in the Mathematical and Computational Sciences. Topics include: logic, proof techniques such as mathematical induction, recursion, counting methods, and introductory graph theory. Three lecture hours per week | 2420 | Math 1920 | NULL | MATH-2420 | 735 | 2017-12-15 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Combinatorics I | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Linear Algebra I | LINEAR ALGEBRA I This course introduces some of the basic concepts and techniques of linear algebra to students of any major. The emphasis is on the interpretation and development of computational tools. Theory is explained mainly on the basis of two or three-dimensional models. Topics covered are: matrices; determinants; systems of equations; vectors in two and three-dimensional space including dot and cross products, lines, and planes; concepts of linear independence, basis, and dimension explained with examples; linear transformations and their matrices; eigenvectors and eigenvalues. Three lecture hours per week PREREQUISITE: Grade XII academic Mathematics. | 2610 | NULL | NULL | MATH-2610 | 736 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Linear Algebra I | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Linear Algebra II | LINEAR ALGEBRA II This course continues MATH 2610 with further concepts and theory of linear algebra. Topics include vector spaces, orthogonality, Gram-Schmidt Process, canonical forms, spectral decompositions, inner product spaces and the projection theorem. Three lecture hours a week | 2620 | Math 1910 and Math 2610 | NULL | MATH-2620 | 737 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Linear Algebra II | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Mathematical Reasoning | MATHEMATICAL REASONING This course provides students with experience in writing mathematical arguments. It covers first-order logic, set theory, relations, and functions. The ideas and proof techniques are considered in the context of various mathematical structures such as partial orders, graphs, number systems, and finite groups. Three lecture hours per week | 2720 | NULL | NULL | MATH-2720 | 738 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Mathematical Reasoning | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Foundations of Geometry | FOUNDATIONS OF GEOMETRY This course presents an axiomatic base for Euclidean geometry and an insight into the interdependence of the various theorems and axioms of that geometry and non-Euclidean geometries. Topics include: incidence and separation properties for points, lines, planes and space; congruence properties; geometric inequalities; similarity properties; and geometric constructions. Three lecture hours per week | 2810 | Six credit hours of First Year Mathematics | NULL | MATH-2810 | 739 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Foundations of Geometry | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Multivariable and Vector Calculus | MULTIVARIABLE AND VECTOR CALCULUS This course continues from Math 1920 and is an introduction to multivariable differentiation and integration and vector calculus. Topics include parametric representation of curves; polar coordinates; vectors; dot and cross products; curves and surfaces in space; calculus of vector-valued functions; functions of several variables; partial differentiation; directional derivatives; tangent planes; local and constrained maxima and minima; double and triple integrals; changes of variables in multiple integrals; vector fields; line and surface integrals; gradient, divergence and curl; Green's, Stokes' and Divergence Theorems. | 2910 | Math 1920 | NULL | MATH-2910 | 741 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Multivariable, Vector Calculus | Mathematics | Undergraduate | 4 |

| 2018-01-31 03:00:21 | Differential Equations | DIFFERENTIAL EQUATIONS This course introduces the basic theory of differential equations, considers various techniques for their solution, and provides elementary applications. Topics include linear equations; separable equations; linear independence and Wronskian; second-order equations with constant coefficients; nonhomogeneous equations; applications of first- and second-order equations; Laplace and inverse Laplace transforms, and their application to initial-value problems; series solutions about ordinary and singular points; and Fourier series. Three lecture hours per week | 3010 | Math 1920 | NULL | MATH-3010 | 742 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Differential Equations | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Complex Variables | COMPLEX VARIABLES This is a first course in complex variables. The aim is to acquaint students with the elementary complex functions, their properties and derivatives, and with methods of integration. Topics covered include: definition and development of complex numbers as ordered pairs; geometric representation; basic formulas and inequalities involving argument and conjugates; roots of complex numbers, limit, continuity, and derivative; Cauchy Riemann conditions; harmonic functions; properties of trigonometric, hyperbolic, logarithmic, exponential, and inverse trigonometric functions; bilinear transformation; integration; Cauchy Integral Theorem and Formula; residues and poles; Laurent and Taylor's series; and improper integrals. Three lecture hours per week | 3310 | Math 2910 | NULL | MATH-3310 | 743 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Complex Variables | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Number Theory | NUMBER THEORY This first course in number theory will include the following topics: equivalence of the principles of induction and the well-ordering principle; division algorithm; positional notation and repeating decimals; greatest common divisor; Euclidean Algorithm; Fundamental Theorem of Arithmetic; Pythagorean Triplets; Prime Numbers Theorem; Mersenne and Fermat Numbers; congruences; Euler's Phi-function; Chinese Remainder Theorem; Diophantine Equations; Theorems of Lagrange and Wilson; Quadratic Reciprocity Law of Gauss; Legendre symbol and primitive roots; perfect numbers; multiplicative number- theoretic functions; Moebius inversion. Three lecture hours per week | 3420 | Six credit hours of Mathematics at the 2000 level or higher | NULL | MATH-3420 | 744 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Number Theory | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Combinatorics II | COMBINATORICS II This course continues MATH 2420, with the examination of advanced counting techniques, binomial coefficients, and generating functions. Other topics include relations, partial orders, and Steiner Triple systems. Three lecture hours per week | 3430 | Math 2420 | NULL | MATH-3430 | 745 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Combinatorics II | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Real Analysis | REAL ANALYSIS This is a first course in real analysis. Topics include: the reals as a complete ordered field; closed and open sets; Bolzano-Weierstrass and Heine-Borel Theorems; Cauchy Sequences; limits and continuity; derivative; Mean Value Theorem; Riemann Integral; and the Fundamental Theorem of Calculus. Three lecture hours per week | 3510 | Math 1920 and Math 2720 | NULL | MATH-3510 | 746 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Real Analysis | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Group Theory | GROUP THEORY An introduction to group theory, including: cyclic groups, symmetric groups, subgroups and normal subgroups, Lagrange's theorem, quotient groups and homomorphisms, isomorphism theorems, group actions, Sylow's theorem, simple groups, direct and semidirect products, fundamental theorem on finitely generated Abelian groups. Three lecture hours per week | 3610 | Math 2720 | NULL | MATH-3610 | 747 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Group Theory | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Graph Theory | GRAPH THEORY This course is an introduction to the ideas, methods, and applications of graph theory. Topics include graph connectivity, graph factors and factorizations, planar graphs, and colourings. Three lecture hours per week | 3710 | Math 2420 or Math 2720 | NULL | MATH-3710 | 748 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Graph Theory | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Point-Set Topology | POINT-SET TOPOLOGY A first course in topology, covering some review of set theory; cardinal numbers; binary relations; metric spaces, convergence and continuity in metric spaces; topological spaces, bases, sub- spaces; continuity in general; homeomorphism; product spaces; separation axioms; compactness; connectedness. Three lecture hours per week | 4020 | Math 3510 | NULL | MATH-4020 | 749 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Point-Set Topology | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Measure Theory and Integration | MEASURE THEORY AND INTEGRATION A first course in measure theory, covering measure as a generalization of length, outer measure, sigma-algebras, measurability, construction of measures, Lebesgue measure on the real line, measurable functions and the Lebesgue integral. Additional topics may include and convergence theorems, product measures and Fubini Theorem. Three lecture hours per week | 4520 | Math 3510 | NULL | MATH-4520 | 750 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Measure Theory and Integration | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Functional Analysis | FUNCTIONAL ANALYSIS This first course in functional analysis covers topics like: metric spaces, Banach spaces, function spaces, Hilbert spaces, generalized Fourier series and linear operators. Three lecture hours per week | 4530 | Math 2620 and Math 3510 | NULL | MATH-4530 | 751 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Functional Analysis | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Ring and Field Theory | RING AND FIELD THEORY Introduction to ring and field theory, including: polynomial rings, matrix rings, ideals and homomorphisms, quotient rings, Chinese remainder theorem, Euclidean domains, principal ideal domains, unique factorization domains, introduction to module theory, basic theory of field extensions, splitting fields and algebraic closures, finite fields, introduction to Galois theory. Three lecture hours per week | 4620 | Math 3610 | NULL | MATH-4620 | 752 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Ring and Field Theory | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Partial Differential Equations | PARTIAL DIFFERENTIAL EQUATIONS This course is an introduction to the theory and application of partial differential equations. Topics include: first-order equations and characteristic curves; classification of second-order equations as parabolic, hyperbolic or elliptic; Laplace, wave and diffusion equations, and their physical origins; solution using Fourier series; and separation of variables. Three lecture hours per week | 4710 | Math 2910 and Math 3010 | NULL | MATH-4710 | 753 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Partial Differential Equations | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Dynamical Systems | DYNAMICAL SYSTEMS This course is a study of the long-term qualitative behaviour of solutions of systems of differential or difference equations. Topics include: non-linear systems, linearization, numerical and graphical methods, equilibria, phase space, stability, bifurcations, strange attractors, and chaos. Applications to physics, biology and other sciences are studied. Three lecture hours per week | 4720 | Math 2610, Math 2910, and Math 3010 | NULL | MATH-4720 | 754 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Dynamical Systems | Mathematics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Maple Technology Lab | MAPLE TECHNOLOGY LAB An introduction to the software package MAPLE. Topics include the basic functions and commands, mathematical problem solving using MAPLE, and programming in the internal MAPLE language. Two lab hours per week for 6 weeks. Two lab hours per week for 6 weeks Semester hours of credit: 1 | 2010 | Computer Science 1510 and Math 1920 | NULL | MCS-2010 | 755 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Maple Technology Lab | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | Matlab Technology Lab | MATLAB TECHNOLOGY LAB An introduction to the software package Matlab. Topics include the basic functions and commands, programming and problem-solving using Matlab. Two lab hours per week for 6 weeks Semester hours of credit: 1 | 2020 | Computer Science 1510 and Math 2610 | NULL | MCS-2020 | 756 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Matlab Technology Lab | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | R Technology Lab | R TECHNOLOGY LAB An introduction to the software package R. Topics include the basic functions and commands, programming and problem-solving using R. Two lab hours per week for 6 weeks Semester hours of credit: 1 | 2030 | Computer Science 1510 and Statistics 2220 | NULL | MCS-2030 | 757 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | R Technology Lab | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | Visual Basic in Excel Technology Lab | VISUAL BASIC IN EXCEL TECHNOLOGY LAB An introduction to the software package Excel and Visual Basic in the Excel environment. Topics include the basic functions and commands, programming and problem-solving using Excel and Visual Basic. Two lab hours per week for 6 weeks Semester hours of credit: 1 | 2040 | Computer Science 1510 and AMS 2400 | NULL | MCS-2040 | 758 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Visual Basic in Excel Tech Lab | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | GGY Axis Technology Lab | GGY AXIS TECHNOLOGY LAB An introduction to the software package GGY AXIS. Topics include the basic functions and commands, programming and problem-solving using GGY AXIS. Two lab hours per week for 6 weeks Semester hours of credit: 1 | 2050 | Computer Science 1510 and AMS 2510 | NULL | MCS-2050 | 759 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | GGY Axis Technology Lab | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | Co-op Work Term I | CO-OP WORK TERM I This course is a co-op students' first work term. A work term report related to a technical problem/issue within the organization where the student is working is required. Students are assessed on a pass/fail basis. Three semester hours of credit | 2850 | MCS 2840 or permission of the Academic Director of Co-operative Education. | NULL | MCS-2850 | 761 | 2017-12-19 00:00:00 | Item | Lists/Courses | Work Term | Mathematical/Computational Sc. | NULL | NULL | Co-op Work Term I | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Tutoring in Math. and Comput. Sciences | TUTORING IN MATHEMATICAL AND COMPUTATIONAL SCIENCES Students are introduced to techniques for facilitating learning in the Mathematical and Computational Sciences, and then put these techniques into practice by mediating student group learning either in introductory Mathematical and Computational Sciences courses, Mathematical and Computational Science Help Centre or in outreach programs to High Schools. Semester hours of credit: 1 | 3050 | At least 36 credit hours completed in courses in the School of Mathematical and Computational Sciences | NULL | MCS-3050 | 762 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Tutoring in Math, Comp. Sci | Mathematical Computational Sci | Undergraduate | 1 |

| 2018-01-31 03:00:21 | Theory of Computing | THEORY OF COMPUTING This course introduces automata theory, formal languages and computability. Topics include: finite automata; regular expressions; regular, context-free, and context-sensitive languages; computability models; algorithmic decidable and undecidable problems. Three lecture hours per week | 3320 | Computer Science 2610 and Math 2420 | NULL | MCS-3320 | 763 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Theory of Computing | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Quantum Information | QUANTUM INFORMATION Introduction to quantum information science; the field of studying, storing, processing and communicating information using quantum systems. Topic include quantum mechanics for Qubit Systems, foundations of Quantum Computing, algorithms, communication and cryptography. Three lecture hours per week. | 3500 | Math 2620 | NULL | MCS-3500 | 764 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Quantum Information | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Co-op Career Skills II | CO-OP CAREER SKILLS II This course offers career skills training to strengthen co-op students' readiness for their second work term. Students are assessed on a pass/fail basis. Cross-listed with Business (cf. Business 3920) Semester hours of credit: 0 | 3840 | MCS 2850 | NULL | MCS-3840 | 765 | 2018-01-16 00:00:00 | Item | Lists/Courses | Work Term | Mathematical/Computational Sc. | NULL | NULL | Co-op Career Skills II | Mathematical Computational Sci | Undergraduate | 0 |

| 2018-01-31 03:00:21 | Co-op Work Term II | CO-OP WORK TERM II This course is a co-op students' second work term. Students will submit a report summarizing their work term achievements. Students are assessed on a pass/fail basis. Three semester hours of credit | 3850 | MCS 3840 or permission of the Academic Director of Co-operative Education. | NULL | MCS-3850 | 766 | 2018-01-16 00:00:00 | Item | Lists/Courses | Work Term | Mathematical/Computational Sc. | NULL | NULL | Co-op Work Term II | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Numerical Analysis | NUMERICAL ANALYSIS Approximate solution of equations, various interpolative or iterative methods, especially Newton's; convergence tests and rates of convergence; roundoff and truncation errors; propagation of error in calculations; interpolating polynomials; Gauss-Jordan and other methods for simultaneous linear equations; inversion of matrices; determinants and eigenvalues; simultaneous nonlinear equations; evaluation of definite integrals; approximate derivatives; initial-value ordinary differential equations; least-squares curve fitting. Three lecture hours per week | 3920 | Math 3010 and Computer Science 1510 or equivalent | NULL | MCS-3920 | 767 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Numerical Analysis | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Special Topics in Mathematical and Compu | SPECIAL TOPICS IN MATHEMATICAL AND COMPUTATIONAL SCIENCES This course provides students with an opportunity to pursue special topics in Mathematical and Computational Science. Content varies from year to year. Three lecture hours per week. Restriction: Student must have permission of the instructor. | 3950 | NULL | NULL | MCS-3950 | 2566 | 2017-12-20 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Special Topics | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Professional Communication and Practice | PROFESSIONAL COMMUNICATION AND PRACTICE This course aims to build students' oral and written communications skills, and to prepare them for a professional environment. Using examples from their discipline, students will focus on such aspects as description of processes, presentation of data, extended abstracts, correct use of terminology, and sensitivity to language and tone. Discussions of topics relevant to the professional Mathematical and Computational Scientist are also a key part of the course. Three hours per week | 4210 | At least 36 credit hours completed in the School of Mathematical and Computational Sciences | NULL | MCS-4210 | 768 | 2018-01-16 00:00:00 | Item | Lists/Courses | Writing Intensive | Mathematical/Computational Sc. | NULL | NULL | Professional Comm and Practice | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Cryptography and Codes | CRYPTOGRAPHY AND CODES This course is a study of classic and modern methods of encryption, applications to public-key ciphers, random number generators, attacks on encryption systems, error correcting codes; and computational number theory. Three lecture hours per week | 4420 | Math 3420 | NULL | MCS-4420 | 769 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Cryptography and Codes | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Co-op Work Term III | CO-OP WORK TERM III This course is a co-op students' third work term. Students will submit a report summarizing their work term achievements. Students are assessed on a pass/fail basis. Three semester hours of credit | 4850 | MCS 4840 or permission of the Academic Director of Co-operative Education. | NULL | MCS-4850 | 771 | 2018-01-16 00:00:00 | Item | Lists/Courses | Work Term | Mathematical/Computational Sc. | NULL | NULL | Co-op Work Term III | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Co-op Work Term IV | CO-OP WORK TERM IV This optional work term is only available to co-op students in the School of Mathematical and Computational Sciences, who elect for a fourth work term. The goal is to add further value for the student, integrating classroom theory with professional skills acquired during the work term. Semester hours of credit: 0 | 4860 | MCS 4850 | NULL | MCS-4860 | 772 | 2018-01-16 00:00:00 | Item | Lists/Courses | Work Term | Mathematical/Computational Sc. | NULL | NULL | Co-op Work Term IV | Mathematical Computational Sci | Undergraduate | 0 |

| 2018-01-31 03:00:21 | Honours Project | HONOURS PROJECT This course is intended to give research experience to students planning to pursue graduate studies in an area of Mathematical and Computational Sciences, or planning a career where research experience would be an asset. It provides students with the opportunity to do an independent research project on Mathematical or Computational Sciences topic, under the supervision of a faculty member. Some or all of the work may be done during the summer months. Semester hours of credit: 6 Restriction: Student must be accepted to an Honours program in the School of Mathematical and Computational Sciences | 4900 | NULL | NULL | MCS-4900 | 773 | 2018-01-16 00:00:00 | Item | Lists/Courses | Honours | Mathematical/Computational Sc. | NULL | NULL | Honours Project | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Directed Studies | DIRECTED STUDIES IN MATHEMATICAL AND COMPUTATIONAL SCIENCES These courses are designed and recommended for students in the Mathematical and Computational Sciences to encourage independent initiative and study. Reading and research will be conducted in one or more specialized areas. (See Academic Regulation 9 for Regulations Governing Directed Studies.) Three semester hours of credit. Restriction: Student must have permission of the instructor. | 4910 | NULL | NULL | MCS-4910 | 1467 | 2017-12-20 00:00:00 | Item | Lists/Courses | Directed Study | Mathematical/Computational Sc. | NULL | NULL | Directed Studies | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Advanced Topics in MCS | ADVANCED TOPICS IN MATHEMATICAL AND COMPUTATIONAL SCIENCES This course provides students with an opportunity to pursue advanced topics in Mathematical and Computational Sciences. Content varies from year to year but is always at a fourth-year level. Prospective students should contact the School of Mathematical and Computational Sciences for a more detailed description of any particular year's offering. Three lecture hours per week. Restriction: Student must have permission of the instructor. | 4950 | NULL | NULL | MCS-4950 | 774 | 2017-06-19 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Adv Math, Computer Sciences | Mathematical Computational Sci | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Introductory Statistics I | INTRODUCTORY STATISTICS I The main objective of this course is to introduce the basic concepts of descriptive statistics, statistical inference, and the use of statistical software such as MINITAB to students in any discipline. More time is spent on statistical inference than on descriptive statistics. Topics include frequency distributions, descriptive statistics, rules of probability, discrete and continuous probability distributions, random sampling and sampling distributions, confidence intervals, one- and two-tail tests of hypotheses, and correlation and linear regression. NOTE: Credit will not be allowed for Statistics 2210 if a student has received credit for any of the following courses: Business 2510, Education 4810, Psychology 2710 and Sociology 3320. Prerequisite: Grade XII academic Mathematics. | 2210 | NULL | NULL | STAT-2210 | 1168 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Introductory Statistics I | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Introductory Statistics II | INTRODUCTORY STATISTICS II The course builds upon the knowledge developed in Introductory Statistics I and introduces students to statistical techniques commonly used in research. Topics include linear regression and multiple linear regression, residual analysis, simple ANOVA models, categorical data analysis, simple sampling models, and common distributions (including binomial, Poisson, and exponential). Three lecture hours per week | 2220 | Statistics 2210 | NULL | STAT-2220 | 1169 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Introductory Statistics II | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Probability and Math Statistics I | PROBABILITY AND MATHEMATICAL STATISTICS I This course is an introduction to the theoretical basis of statistics for students who have completed Introductory Statistics. The study concentrates on the mathematical tools required to develop statistical methodology. Topics covered include: probability, continuous and discrete random variables, moment generating functions, multivariate probability distributions and functions of random variables. Three lecture hours per week | 3210 | Math 2910 and Stat 2220 or permission of the instructor | NULL | STAT-3210 | 1170 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Probability and Math Stats I | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Probability and Math Statistics II | PROBABILITY AND MATHEMATICAL STATISTICS II This course builds on the mathematical foundation developed in Statistics 3210 and introduces the student to the theory of statistical inference. Topics covered include: sampling distributions and central limit theory, methods of estimation, hypothesis testing, least squares estimation of linear models, and an introduction to Bayesian inference. Three lecture hours per week | 3220 | Statistics 3210 | NULL | STAT-3220 | 1171 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Probability and Math Stats II | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Applied Regression Analysis | APPLIED REGRESSION ANALYSIS This course builds upon the basis of inference studied in Statistics 2210 and provides students with an advanced knowledge of regression techniques. Topics covered are simple and multiple linear regression techniques, matrix notation, the design matrix, model building techniques, residual analysis, and non-linear regression. Three lecture hours per week | 3240 | Statistics 2210 and Math 2610 | NULL | STAT-3240 | 1172 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Applied Regression Analysis | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Statistical Simulation | STATISTICAL SIMULATION This course introduces statistical simulation, and its use as a tool to investigate stochastic phenomena and statistical methods. Topics include the building and validation of stochastic simulation models useful in computing, operations research, engineering and science; related design and estimation problems; variance reduction; and the implementation and the analysis of the results. Three lecture hours per week | 4110 | Statistics 3220 | NULL | STAT-4110 | 1173 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Statistical Simulation | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Experimental Design | EXPERIMENTAL DESIGN This course builds upon the basis of inference studied in Statistics 2210 and Statistics 3240 to include statistical techniques commonly used in experimental studies. Students will study topics such as analysis of variance models, hypothesis testing in ANOVA models, randomization, and blocking techniques. Three lecture hours per week | 4240 | Statistics 3240 | NULL | STAT-4240 | 1174 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Experimental Design | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Generalized Linear Models | GENERALIZED LINEAR MODELS This course covers the basic theory, methodology and applications of generalized linear models. Topics include logistic regression, probit regression, binomial regression, Poisson regression, overdispersion, quasi-likelihood, and the exponential family. Three lecture hours per week | 4280 | Statistics 3220 and Statistics 3240 | NULL | STAT-4280 | 1175 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Generalized Linear Models | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Time Series I | TIME SERIES I This course is an introduction to Time Series methods, including: stationary models, trends and seasonality, stochastic Time Series models, autoregressive and moving average processes and an introduction to Time Series forecasting. ARIMA models. Seasonal Time Series and Spectral Analysis are also covered. Three lecture hours per week | 4330 | Statistics 3240 | NULL | STAT-4330 | 1176 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Time Series I | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Time Series II | TIME SERIES II This course includes topics from Time Series Econometrics, including Maximum Likelihood and Least Squares Estimation of ARIMA Models and GARCH Models, Wavelets and Financial Models. Non-stationary Time Series, multivariate Time Series and panel cointegration analysis are also covered. Three lecture hours per week | 4340 | Statistics 4330 | NULL | STAT-4340 | 1177 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Time Series II | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Stochastic Processes | STOCHASTIC PROCESSES This course is an introduction to the branch of probability theory that deals with the analysis of systems that evolve over time. Topics include random walks, Markov chains, Poisson processes, continuous time Markov chains, birth and death processes, exponential models, and applications of Markov chains. Three lecture hours per week | 4410 | Statistics 3220 | NULL | STAT-4410 | 1178 | 2018-01-16 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Stochastic Processes | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Data Analysis and Inference | DATA ANALYSIS AND INFERENCE This course is an introduction to data analysis with a focus on regression. Topics include: initial examination of data, correlation, and simple and multiple regression models using least squares. Inference for regression parameters, confidence and prediction intervals, diagnostics and remedial measures interactions and dummy variables, variable selection, least squares estimation and inference for non-linear regression will also be discussed. Three lecture hours per week | 4550 | Statistics 3240 | NULL | STAT-4550 | 1179 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Data Analysis and Inference | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Data Visualization and Mining | DATA VISUALIZATION AND MINING This course introduces students to the statistical methods involved in visualization of high dimensional data, including interactive methods directed at exploration and assessment of structure and dependencies in data. Topics include methods for finding groups in data including cluster analysis, dimension reduction methods including multi-dimensional scaling, pattern recognition, and smoothing techniques. Three lecture hours per week | 4660 | Math 2620, Math 2910, and Statistics 3210 | NULL | STAT-4660 | 1180 | 2017-05-03 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Data Visualization and Mining | Statistics | Undergraduate | 3 |

| 2018-01-31 03:00:21 | Multivariate Analysis | MULTIVARIATE ANALYSIS This course deals with the statistics of observation and analysis of more than one output variable. Topics include estimation and hypothesis testing for multivariate normal data, principal component analysis and factor analysis, discriminant analysis, cluster analysis, and correspondence analysis. Three lecture hours per week | 4740 | Statistics 3240 | NULL | STAT-4740 | 1181 | 2017-03-01 00:00:00 | Item | Lists/Courses | NULL | Mathematical/Computational Sc. | NULL | NULL | Multivariate Analysis | Statistics | Undergraduate | 3 |

+---------------------+------------------------------------------+-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+--------+------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------+-----------+-----------+------------+---------------------+-----------+---------------+-------------------+--------------------------------+--------------+--------------+--------------------------------+--------------------------------+----------------+---------+

111 rows in set (0.00 sec)