DEPARTMENT OF MATHEMATICS

Undergraduate Courses:

MATH 001 Calculus I [3-1-0:4]
Calculus of one variable: function, limits, and continuity; elementary transcendental functions; composite functions; derivatives; L'Hospital's rule; maxima and minima; graphing; antiderivatives and integrals; techniques of integration; improper integrals; sequences; infinite series; Taylor series and radius of convergence. *Exclusions*: D or above in either AL Pure Mathematics or AL Applied Mathematics; any MATH course *Prerequisite*: HKCEE Additional Mathematics, or AS Mathematics and Statistics, or AS Applied Mathematics, or grade E in either AL Applied Mathematics or AL Pure Mathematics

MATH 003 Advanced Mathematics I [3-1-0:3]
Functions, limits, elementary transcendental functions, differential calculus and its applications, integral calculus and its applications, improper integrals, differential equations. *Exclusions*: AL Pure Mathematics or AL Applied Mathematics; any MATH course

MATH 004 Advanced Mathematics II [3-1-0:3]
Parametric equations and polar coordinates, infinite series, Taylor's series, dot and cross products, equations of lines and planes, 3D-surfaces, vector functions, partial derivatives, multiple integrals. *Exclusions*: AL Pure Mathematics or AL Applied Mathematics; any MATH course except MATH 003 *Prerequisite*: MATH 003

MATH 005 Fundamental Mathematics [3-1-0:4]
Algebra, exponents and radicals, algebraic expressions, rational expressions, word problems, functions, quadratic functions, logarithms, division algorithm, polynomial equations, remainder theorem, partial fractions, coordinate geometry, inequalities, trigonometry, systems of linear equations, sequences, series and business applications, meaning of derivatives-an introduction. *Exclusions*: B or better in HKCEE Mathematics; HKCEE Additional Mathematics; AS Mathematics and Statistics; AL/AS Applied Mathematics; AL Pure Mathematics; any MATH course

MATH 006 Algebra and Calculus [3-1-0:4]
Algebra, functions, slope, limit, continuity, derivatives, chain rule, implicit differentiation, concavity, optimization problems, curve sketching, asymptotes, elementary transcendental functions, business applications. Additional topics. *Exclusions*: AS Mathematics and Statistics; AL/AS Applied Mathematics; AL Pure Mathematics; any MATH course except MATH 005 *Prerequisite*: B or better in HKCEE Mathematics; or HKCEE Additional Mathematics; or MATH 005

MATH 008 Introduction to Calculus [3-1-0:3]
Algebra, functions, slope, limit, derivatives, chain rule, concavity, optimization problems, curve sketching, asymptotes, elementary transcendental functions, business applications. Integration and its applications. *Exclusions*: B or better in HKCEE Mathematics; HKCEE Additional Mathematics; AS Mathematics and Statistics; AL/AS Applied Mathematics; AL Pure Mathematics; any MATH course except MATH 005 *Prerequisite*: MATH 005

MATH 011 Mathematics for Physical Sciences I [3-1-0:3]
Numbers. Functions. Limits. Continuity. Differentiation. Integration. Sequences and series. Complex numbers. *Exclusions*: Grade D or above in either AL Pure Mathematics or AL Applied Mathematics; any MATH course

MATH 051 Introduction to Differential Calculus [1-1-0:1]
Limits, rates of change, derivates, chain rule, concavity, optimization problems, curve sketching, business applications. *Exclusions*: B or better in HKCEE Mathematics; HKCEE Additional Mathematics; AS Mathematics and Statistics; AL/AS Applied Mathematics; AL Pure Mathematics; any MATH course except MATH 005 *Prerequisite*: MATH 005

MATH 099 Information Technology Practical Training [0 credit]
For students in the Science School only. A practical training course for a total duration of two weeks covering basic PC hardware architecture, an introduction to Windows 2000/XP operating systems and web based learning application software. Graded P or F.

MATH 100 Introduction to Multivariable Calculus [2-1-0:2]
Differentiation in several variables, with applications in approximation, maximum and minimum and geometry. Integration in several variables, vector analysis. *Exclusions*: MATH 101, MATH 104, MATH 106, MATH 107 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001; or MATH 003 and MATH 004

MATH 101 Multivariable Calculus [3-1-0:4]
Sequences, series, gradients, chain rule. Extrema, Lagrange multipliers, line integrals, multiple integrals. Green's theorem, Stroke's theorem, divergence theorem, change of variables. *Exclusions*: MATH 100, MATH 104, MATH 106, MATH 107 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001; or MATH 003 and MATH 004

MATH 104 Calculus II [3-1-0:4]
Calculus of several variables: limits and continuity of functions of several variables; curvilinear coordinates; partial derivatives; maxima and minima; Lagrange multipliers; multiple integrals; vector functions; vector algebra; vector calculus; line and surface integrals; the Green's, divergence, and Stokes' theorems. *Exclusions*: MATH 100,

MATH 101, MATH 106, MATH 107 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001; or MATH 003 and MATH 004; or MATH 005 and grade B or above in ECON 117

MATH 106 Mathematics for Physical Sciences II [3-1-0:3]
Functions of several variables. Partial differentiation and multiple integrals. Vectors. Determinants. Matrices and linear transformations. Basic Probability and Statistics. *Exclusions*: MATH 100, MATH 101, MATH 104, MATH 107 *Prerequisite*: Grade D or above in either AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 107 Multivariable Differential and Integral Calculus [3-1-0:4]
Functions of several variables, limits and continuity, contour diagrams, partial derivatives, gradients, directional derivatives, maxima and minima, double integrals, triple integrals. *Exclusions*: MATH 100, MATH 101, MATH 104, MATH 106 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 110 Concepts in Mathematics [2-1-0:2]
Expository lectures and discussion on basic mathematical concepts and ideas, historical developments in various areas of mathematics, and selected trends and advances in mathematical sciences. Third year students require instructor's approval to take the course. *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 111 Linear Algebra [3-1-0:4]
Vector space, matrices and system of linear equations, linear mappings and matrix forms, inner product, orthogonality, eigenvalues and eigenvectors, symmetric matrix. *Exclusions*: MATH 111H, MATH 113, MATH 152 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 111H Linear Algebra [3-1-0:4]
Same as MATH 111 but more proofs and advanced materials are added under each topic. *Exclusion*: MATH 111 *Prerequisite*: Grade A in HKAL Pure Mathematics or its equivalence

MATH 113 Introduction to Linear Algebra [2-1-0:2]
Systems of linear equations; vector spaces; linear transformations; matrix representation of linear transformations; linear operators, eigenvalues and eigenvectors; similarity invariants and canonical forms. *Exclusions*: MATH 111, MATH 111H, MATH 152 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 132 Discrete Structures [3-1-0:4]
Logic: propositions, axiomatization of propositional calculus, deduction theorem, completeness and soundness. Combinatorics: permutations and combinations, generating functions. Set theory: basic operations on sets, relations, countable and uncountable sets. *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 150 Introduction to Ordinary Differential Equations [2-1-0:2]
First order equations, second order equations, Laplace transform method, numerical solution of initial value problems, boundary-value problems. *Exclusions*: MATH 151, MATH 152 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 151 Differential Equations and Applications [3-1-0:4]
First and second order differential equations, initial value problems, series solutions, Laplace transform, numerical methods, boundary value problems, eigenvalues and eigenfunctions, Sturm-Liouville theory. *Exclusions*: MATH 150, MATH 152 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 152 Applied Linear Algebra and Differential Equations [4-1-0:4]
First order equation, linear second order equations, Laplace transform, Euler and Runge-Kutta methods, introduction to partial differential equations, matrix, systems of linear equations, eigenvalue and eigenvector, systems of differential equations, orthogonal projection. *Exclusions*: MATH 111, MATH 111H, MATH 113, MATH 150, MATH 151 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 190 Mathematical Problem Solving [3-1-0:4]
Discussions on problem solving techniques. Basics materials in combinatorics, number theory, geometry and mathematical games. *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 192 Introductory Topics in Mathematical Sciences [1-4 credit(s)]
This is a general science course that introduces students to selected disciplines or topics of high popular interest. The crucial roles that mathematics play are emphasized. Materials are chosen to enrich and enhance students' appreciation of science and mathematics.

MATH 201 Introduction to Analysis [3-1-0:4]
Sets and functions, real numbers, limits of sequences and series, limits of functions, continuous functions, differentiation, Riemann integration, additional topics. *Exclusion*:

MATH 201H *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 201H Introduction to Analysis [3-1-0:4]
Same as MATH 201 but more proofs and advanced materials are added under each topic. *Exclusion*: MATH 201 *Prerequisite*: Grade A in HKAL Pure Mathematics or its equivalence

MATH 230 Introduction to Numerical Methods [2-1-0:2]
Computer arithmetric, matrix computation, interpolation and approximation, numerical integration, solution of nonlinear equations. *Exclusion*: MATH 231 *Pre-/Co-requisites*: MATH 100/101/104/106/107

MATH 231 Numerical Analysis [3-1-0:4]
Basic numerical analysis, including stability of computation, linear systems, eigenvalues and eigenvectors, nonlinear equations, interpolation and approximation, numerical integration and solution of ordinary differential equations, optimization. Fortran may also be taught. *Exclusion*: MATH 230 *Prerequisites*: COMP 102/104 and MATH 111/111H/113/152; and MATH 201/201H

MATH 241 Probability [3-1-0:4]
Sample spaces, conditional probability, random variables, independence, discrete and continuous distributions, expectation, correlation, moment generating function, distributions of function of random variables, law of large numbers and limit theorems. *Exclusion*: MATH 246 *Pre-/Co-requisite*: MATH 100/101/104/106/107

MATH 243 Statistical Inference [3-1-0:4]
Sampling theory, order statistics, limiting distributions, point estimation, confidence intervals, hypothesis testing, non-parametric methods. *Prerequisite*: MATH 241

MATH 244 Applied Statistics [3-1-0:4]
A systematic introduction to statistical inference, including the necessary probabilistic background, point and interval estimation, hypothesis testing. *Exclusions*: BISC 215, IEEM 151, ISMT 111 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 246 Probability and Random Processes [3-1-0:4]
An introduction to random processes, including the necessary background. Random variables, distributions and density functions, expectations, limit theorems, discrete and continuous time random processes, stationary random processes, ergodic theorems, power spectral density, response of linear systems to random signals. *Exclusions*: MATH 241, ELEC 210 *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 300 Special Topics [1-4 credit(s)]
Focuses on a coherent collection of topics selected from a particular branch of mathematics. A student may repeat the course for credit if the topics studied are different each time.

MATH 301 Real Analysis [3-1-0:4]
Functions of several variables, implicit and inverse function theorem, uniform convergence measure and integral on the real line. *Prerequisites*: MATH 100/101/104/106/107 and MATH 111/111H/113/152 and MATH 201/201H

MATH 303 Theory of Ordinary Differential Equations [3-1-0:4]
Existence and uniqueness theorems of ordinary differential equations, theory of linear systems, stability theory, study of singularities, boundary value problems. *Prerequisites*: MATH 150/151/152 and MATH 301

MATH 304 Complex Analysis [3-1-0:4]
Complex differentiability; Cauchy-Riemann equations; contour integrals, Cauchy theory and consequences; power series representation; isolated singularities and Laurent series; residue theorem; conformal mappings. *Exclusion*: MATH 351 (prior to 2000-01) *Prerequisites*: MATH 100/101/104/106/107 and MATH 201/201H

MATH 306 Partial Differential Equations [3-1-0:4]
Derivatives of the Laplace equations, the wave equations and diffusion equation; Methods to solve equations: separation of variables, Fourier series and integrals and characteristics; maximum principles, Green's functions. *Exclusion*: MATH 352 (prior to 2000-01) *Prerequisites*: MATH 100/101/104/106/107 and MATH 111/111H/113/152 and MATH 150/151

MATH 308 Introduction to Fluid Dynamics [3-1-0:4]
Lagrangian and Eulerian methods for the flow description; derivation of the Euler and Navier-Stokes equations; sound wave and Mach number; 2D irrotational flow; elements of aerofoil theory; water wave dispersion relation; shallow water waves; ship wave pattern; dynamics of real fluid, stokes flow and boundary layer theory. *Exclusions*: CIVL 151, CIVL 252 *Prerequisites*: MATH 304/351 (prior to 2000-01) and MATH 306/352 (prior to 2000-01)

MATH 309 Student Seminars [0-2-0:1]
Working in small teams, students are required to select a topic they are interested in, discuss, write up their learning and present it at the seminars. The level of the topics can range from simple calculus to advanced topology or geometry. Graded P or F.

Students may repeat the course for credit at most three times. *Prerequisite*: AL Pure Mathematics/AL Applied Mathematics; or MATH 001/006/011; or MATH 003 and MATH 004

MATH 310 Game Theory [3-1-0:4]
Zero-sum games; minimax theorem; games in extensive form; strategic equilibrium; bi-matrix games; repeated Prisonner's Dilemma; evolutionary stable strategies; games in coalition form; core; Shapley Value; Power Index; two-side matching games. *Exclusions*: ECON 360, SOSC 141, SOSC 541 *Prerequisite*: MATH 100/101/104/106/107/ and MATH 111/111H/113/152

MATH 311 Algebra I [3-1-0:4]
Polynomials; Jordan canonical form, minimal polynomials, rational canonical form; equivalence relation; group, coset, group action; introduction to rings and fields. *Prerequisite*: MATH 111/111H/113/152

MATH 312 Algebra II [3-1-0:4]
Sylow theorem, finitely generated abelian group, composition series; integral domain, ideals, principal ideal domain, unique factorization; modules; field extension, ruler and compass, finite fields, Galois group. *Prerequisite*: MATH 311

MATH 313 Advanced Linear Algebra [3-1-0:4]
Jordan canonical form, the minimal polynomials, positive definite matrices, symmetric matrices, quadratic forms, unitary matrics, multi-linear maps, alternating maps and determinants. *Prerequisite*: B+ or above in MATH 111/111H/113/152

MATH 315 Number Theory and Applications [3-1-0:4]
Prime numbers, unique factorization, modular arithmetic, quadratic number fields, finite fields, p-adic numbers, coding theory, computational complexity. *Prerequisite*: MATH 311

MATH 320 Euclidean and Non-Euclidean Geometries [3-1-0:4]
Axioms and models, Euclidean geometry, Hilbert axioms, neutral (absolute) geometry, hypernbolic geometry, Poincare model, independence of parallel postulate. *Prerequisite*: MATH 110/111/111H/201/201H

MATH 321 Differential Geometry [3-1-0:4]
Curve theory; curvature and torsion, Frenet-Serret frame; surface theory: Weingarten map, first and second fundamental forms, curvatures, Gaussian map, ruled surface, minimal surface; instrinsic geometry: Theorema Egregium, Coddazi-Mainardi equations, parallel transport, geodesics, exponential map, Gauss-Bonnet theorem. *Prerequisite*: MATH 100/101/104/106/107

MATH 323 Topology [3-1-0:4]
Metric, topology, continuous map, Hausdorff, connected, compact, graph, Euler number, CW-complex, classification of surfaces. *Prerequisite*: MATH 201/201H

MATH 328 Geophysical Fluid Dynamics [3-1-0:4]
Astmospheric thermodynamics, thermal wind balance, atmospheric waves, planetary boundary layer and turbulence, barotropic and baroclinic instabilities, Earth's circulations. *Prerequisites*: MATH 100/101/104 and CIVL 151/MATH 308/MECH 221

MATH 331 Numerical Solutions of Partial Differential Equations [3-1-0:4]
Introduction to finite difference and finite element methods for the solution of elliptic, parabolic and hyperbolic partial differential equations; including the use of computer software for the solution of differential equations. *Prerequisites*: MATH 150/151/152 and MATH 230/231 and MATH 306

MATH 333 Introduction to Scientific Computation [3-1-0:4]
Case studies drawn from different areas of science to illustrate the use of computers as a problem-solving tool. Each integrates physical principles and mathematical models, as well as numerical techniques and computer implementations, into a coherent perspective. *Prerequisites*: MATH 150/151/152 and MATH 230/231

MATH 335 Mathematical Software [2-2-0:4]
This course teaches mathematical software such as Mathematica, Maple, or alike, as a means of doing mathematics by computer. The topics include: functions and their graphs; polynomials; rational functions; trigonmetric expressions; manipulation and simplification of expressions; computing limits, derivatives and integrals; series; vectors and matrices; parametric curves and surfaces; linear systems; vector spaces; eigenvalues and enigenvectors. *Prerequisites*: COMP 102/104 and MATH 100/101/104/106/107 and MATH 111/111H/113/152

MATH 336 Mathematical Modeling [3-1-0:4]
Introduction to fundamental principles and spirit of applied mathematics. Emphasis on manner in which mathematical models are constructed for physical problems. Illustrations from many fields of endeaver, e.g. physical science, biology, economics, traffice dynamics. *Prerequisite*: MATH 150/151/152

MATH 337 High Performance Scientific Computation [3-1-0:4]
Fundamentals of computer organization; overview of high performance computer architectures; parallel programming tools: PVM, Paragon-NX; issues in high performance numerical computations; computer graphics and scientific visualization. *Prerequisites*: COMP 103/104 and MATH 230/231/331

MATH 341 Stochastic Modeling [3-1-0:4]
Discrete time Markov chains and the Poisson processes. Additional topics include birth and death process, elementary renewal process and continuous-time Markov chains. *Prerequisite*: MATH 241/246

MATH 342 Regression Analysis [3-1-0:4]
Estimation and hypothesis testing in linear regression, residual analysis, multicollinearity, indicator variables, variable selection, nonlinear regression. *Exclusion*: ISMT 552 *Prerequisite*: MATH 243

MATH 343 Data Analysis [3-1-0:4]
Computer-oriented statistical analysis including generalized linear models, classification, principal component analysis, survival analysis, binary data. Real data sets presented for analysis using statistical packages such as SAS, Minitab and S-plus. *Prerequisites*: MATH 243/244 and MATH 342

MATH 345 Nonparametric Statistics [3-1-0:4]
[Previous Course Code: MATH 393E] The sign test; Wilcoxon signed rank test; Wilcoxon rank-sum test; Kruskal-Wallis test; rank correlation; order statistics; robust estimates; Kolmogorov-Smirnov test; nonparametric curve estimation. *Prerequisite*: MATH 243 or MATH 244

MATH 346 Sampling [3-1-0:4]
Basic and standard sampling design and estimation methods. Particular attention given to variance estimation in sampling procedures. Topics include: simple random sampling, unequal probability sampling, stratified sampling, ratio and subpopulation and multistage designs. *Prerequisite*: MATH 243/244

MATH 347 Multivariate Analysis [3-1-0:4]
Inferences of means and covariance matrices, canonical correlation, discriminant analysis, multivariate ANOVA, principal components analysis, factor analysis. *Exclusion*: ISMT 553 *Prerequisites*: MATH 243 and MATH 342

MATH 348 Introductory Time Series [3-1-0:4]
Stationarity, (partial) auto-correlation function, ARIMA modeling, order selection, diagnostic, forecasting, spectral analysis. *Prerequisites*: MATH 243 and MATH 342

MATH 361 Quantitative Methods for Fixed Income Derivatives [3-1-0:4]
Random walk models for asset price and interest rate processes. Risk neutral valuation principle, binomial model. Lattice tree algorithms for pricing options. Monte Carlo simulation techniques. Yield curve fitting, no-arbitrage interest rate models. Pricing algorithms for embedded features in fixed income instruments. *Prerequisite*: MATH 101 or MATH 111/111H

MATH 362 Fundamentals of Mathematical Finance [3-1-0:4]
Discrete securities models. Concept of arbitrage. Risk neutral probability measures, valuation of continge claims, complete and incomplete markets. Optimal consumption and investment problems. Actuarial stochastic investment models, insurance and pension applications. Risk theory, value at risk, ruin probability. *Prerequisite*: MATH 101 or MATH 111/111H

MATH 391 Special Topics in Pure Mathematics [1-4 credit(s)]
Supplementary study of specialized topics for students of pure mathematics.

MATH 392 Special Topics in Applied Mathematics [1-4 credit(s)]
Supplementary study of specialized topics for students of applied mathematics.

MATH 393 Special Topics in Statistics [1-4 credit(s)]
Supplementary study of specialized topics for students of statistics.

MATH 395 Scientific Computation Project I [0-0-9:3]
A scientific computation project under the supervision of a faculty member from any department. Projects may be in fluid mechanics, structural dynamics, chemistry, statistics, etc. May be graded PP.

MATH 396 Scientific Computation Project II [0-0-18:6]
Continuation of MATH 395. *Prerequisite*: MATH 395

MATH 398 Independent Study [1-3 credit(s)]
Under the guidance of a faculty member. A written report and presentations are required. Scope may include (i) identifying a non-reference problem and proposing methods of solutions, and (ii) acquiring a specific research skill. May be repeated for credit, but the total credit may not exceed six.

MATH 399 Undergraduate Project [2-3 credits]
Work in any area of mathematics under the guidance of a faculty member. The project either surveys a research topics or describes a small project completed by the student. *Prerequisite*: MATH 398

Postgraduate Courses:

MATH 501 Advanced Real Analysis I [3-0-0:3]
Basic topology, continuous function spaces, abstract measure and integration theory, Lp spaces, convexity and inequalities, Hilbert spaces, Banach spaces, Complex measure. *Background*: MATH 301
References: W. Rudin, *Real and Complex Analysis*
Royden, *Real Analysis*

MATH 502 Advanced Real Analysis II [3-0-0:3]
Continuation of MATH 501.

MATH 503 Complex Function Theory [3-0-0:3]
Review of basic properties of analytic functions. Phragmen-Lindelof principle, normal family, Riemann mapping theorem. Weierstrass factorization theorem, Schwarz reflection principle, analytic continuation, harmonic function, entire function, Hadamard factorization theorem, Picard theorem. *Background*: MATH 301 and MATH 304
References: W. Rudin, *Real and Complex Analysis*
J. B. Conway, *Functions of One Complex Variable*

MATH 511 Advanced Algebra I [3-0-0:3]
Advanced theory of groups, linear algebra, rings, modules, and fields, including Galois theory. *Background*: MATH 311 and MATH 312
References: N. Jacobson, *Basic Algebra*
S. Lang, *Algebra*
B. L. van der Waerden, *Algebra*

MATH 512 Advanced Algebra II [3-0-0:3]
Advanced topics in algebra: group representations, associative algebras, commutative algebra, homological algebra, algebraic number theory. *Background*: MATH 511
References: N. Jacobson, *Basic Algebra*
S. Lang, *Algebra*
B. L. van der Waerden, *Algebra*

MATH 523 Differential Topology [3-0-0:3]
Manifolds, embedding and immersion, Sard's theorem, transversality, degree, vector fields, Euler number, Euler-Poincare theorem, Morse functions. *Background*: MATH 323
Reference: V. Guillemin and A. Pollack, *Differential Topology*

MATH 524 Algebraic Topology [3-0-0:3]
Fundamental group, covering space, Van Kampen theorem, (relative) homology, exact sequences of homology, Mayer-Vietoris sequence, excision theorem, Betti numbers and Euler characteristic.
References: J. R. Munkres, *Elements of Algebraic Topology*
M. J. Greenberg and J. R. Harper, *Algebraic Topology: A First Course*

MATH 531 Advanced Numerical Methods I [3-0-0:3]
Numerical solution of differential equations, finite difference method, finite element methods, spectral methods and boundary integral methods. Basic theory of convergence, stability and error estimates.

MATH 532 Advanced Numerical Methods II [3-0-0:3]
Direct and iterative methods. Programming techniques and softwares libaries. Sparse solvers, Fast algorithms, multi-grid and domain decomposition techniques. *Prerequisite*: MATH 531

MATH 535 Computational Fluid Dynamics for Inviscid Flows [3-0-0:3]
Derivation of the Navier-Strokes equations; the Euler equations; Lagriangian vs. Eulerian methods of description; nonlinear hyperbolic conservation laws; characteristics and Riemann invariants; classification of discontinuity; weak solutions and entropy condition; Riemann problem; CFL condition; Godunov method; artificial dissipation; TVD methods; and random choice method.

MATH 536 Computational Fluid Dynamics for Viscous Flows [3-0-0:3]
Numerical methods for viscous incompressible and compressible flows, boundary layer flow, shock-boundary interaction, free-surface flow, turbulence modeling, LES and DNS simulations, combustion modeling, heat transfer, hydraulics.

MATH 541 Advanced Probability Theory I [3-0-0:3]
Probability spaces and random variables, distribution functions, expectations and moments, independence, convergence concepts, law of large numbers and random series.
References: K.L. Chung, *A Course in Probability Theory*
Y. S. Chow and H. Teicher, *Probability Theory: Independence, Interchangeability, Martingales*
B. Fristedt and L. Gray, *A Modern Approach to Probability Theory*

MATH 542 Advanced Probability Theory II [3-0-0:3]
Characteristic functions, limit theorems, law of the iterated logarithm, stopping times, conditional expectation and conditional independence, introduction to Martingales.
References: K.L. Chung, *A Course in Probability Theory*
Y. S. Chow and H. Teicher, *Probability Theory: Independence, Interchangeability, Martingales*
B. Fristedt and L. Gray, *A Modern Approach to Probability Theory*

MATH 543 Advanced Mathematical Statistics I [3-0-0:3]
Theory of statistical inference in estimation. Topics include: sufficiency, ancillary statistics, completeness, UMVU estimators, information inequality, efficiency, asymptotic maximum likelihood theory. Other topics may include Bayes estimation and conditional inference.
References: E.L. Lehmann, *Theory of Point Estimation*
D.R. Cox and D.V. Hinkley, *Theoretical Statistics*

MATH 544 Advanced Mathematical Statistics II [3-0-0:3]
Theory of statistical inference in hypothesis testing. Topics include: uniformly most powerful tests, unbiasedness, invariance, minimax principle, large-sample parametric significance tests. Concept of decision theory also covered.
References: E.L. Lehmann, *Testing Statistical Hypotheses*
D.R. Cox and D.V. Hinkley, *Theoretical Statistics*

MATH 545 Stochastic Processes [3-0-0:3]
Theory of Markov processes, second order stationary theory, Poisson and point processes, Brownian motion, Martingales and queueing theory.
References: S. Karlin and H. Taylor, *A First Course in Stochastic Processes*
S. Karlin and H. Taylor, *A Second Course in Stochastic Processes*

MATH 546 Time Series Analysis [3-0-0:3]
Basic idea of time series analysis in both the time and frequency domains. Topics include: autocorrelation, partial ACF, Box and Jerkins ARIMA modeling, spectrum and periodogram, order selection, diagnostic and forecasting. Real life examples will be used throughout the course.
Reference: P. J. Brockwell and R. A. Davis, *Time Series: Theory and Methods*

MATH 551 Mathematical Methods in Science and Engineering I [3-0-0:3]
Perturbation Methods: Regular and singular perturbation. Boundary layer analysis. Calculus of variations, Hamiltonian theory. Stability and bifurcation, Hydrodynamic stability. Invariant variational problems, Noether theorem, Invariant PDEs, Self-similar solutions.

MATH 552 Mathematical Methods in Science and Engineering II [3-0-0:3]
Partial differential equations of mathematical physics. Series and transform methods, method of characteristics. Soboley spacesand energy methods. Burger's equations, KdV equation and NLS equation. Soliton and nonlinear waves. *Prerequisite*: MATH 551

MATH 560 Weather, Climate and Pollution [3-0-0:3]
Composition and structure of the atmosphere; atmospheric thermodynamics; radiation balance; basic atmospheric dynamics, energy, momentum and water cycle of the earth; weather and climate of the Asian Pacific region; weather and pollution; variability of the climatic system; current issues (El-Nino, greenhouse warming).

MATH 565 Waves in Fluids [3-0-0:3]
This course is designed as a comprehensive introduction to the mathematical theory of wave motion. Topics include: linear and nonlinear dispersive waves and Whitham's variational principle, solitons and soliton wave groups, hyperbolic waves and shock waves. Applications include: water waves, wind wave generation and propagation, floor waves, traffic waves, sound waves and sonic booms. Model equations include: The wave equation in 2 and 3 dimensions, Burgers equation, Korteweg-de Vries equation, Stokes waves and singular perturbation, and the three-dimensional nonlinear Schršdinger equation.
References: G. B. Whitham, *Linear and Non-Linear Waves,* or
M. J. Lighthill, *Waves in Fluids*, and
M. A. Donelan and W. H. Hui, *"Mechanics of Ocean Surface Waves"*, *in "Surface Waves and Fluxes" (Eds)*
G. L. Geernuert and W. J. Plant, *Reidel Publishing, 1990, pp. 209-246*

MATH 571 Mathematical Models of Financial Derivatives [3-0-0:3]
Black-Scholes-Merton framework, dynamic hedging, replicating portfolio. Martingale theory of option pricing, risk neutral measure. Exotic options: barrier options, lookback options and Asian options. Free boundary value pricing models: American options, reset options.

MATH 572 Interest Rate Models [3-0-0:3]
Theory of interest rates, yield curves, short rates, forward rates. Short rate models: Vasicek model and Cox-Ingersoll-Ross models. Term structure models: Hull-White fitting procedure. Heath-Jarrow-Morton pricing framework. LIBOR and swap market models, Brace-Gatarek-Musiela approach. Affine models.

MATH 600 Mathematics Seminars [0-1-0:1]
This course will expose our PG students to the current mathematical research and development and provide them with opportunities to make mathematical and social contacts with the speakers and with local and international mathematical communities in general. Graded P or F.

MATH 601-604 Reading Course [1-6 credit(s)]
For individual students or a group of students. Specific topics under the supervision of a faculty member.

MATH 605 Topics in Analysis [2-4 credits]
Advanced topics of current interest in analysis.

MATH 606 Topics in Complex Function Theory [2-4 credits]
Advanced topics of current interest in complex function theory.

MATH 615 Topics in Algebra [2-4 credits]
Advanced topics of current interest in algebra.

MATH 617 Topics in Number Theory [2-4 credits]
Advanced topics of current interest in number theory.

MATH 625 Topics in Geometry [2-4 credits]
Advanced topics of current interest in geometry.

MATH 635 Topics in Numerical Analysis [2-4 credits]
Advanced topics of current interest in numerical analysis.

MATH 645 Topics in Probability and Statistics [2-4 credits]
Advanced topics of current interest in probability and statistics.

MATH 665 Topics in Fluid Mechanics [2-4 credits]
Advanced topics of current interest in fluid mechanics.

MATH 685 Topics in Applied Mathematics [2-4 credits]
Advanced topics of current interest in applied mathematics.

MATH 698 MSc Project [1-6 credit(s)]
An independent project carried out under the supervision of a faculty member.

MATH 699 MPhil Thesis Research
Master's thesis research supervised by a faculty member. A successful defense of the thesis leads to the grade Pass. No course credit is assigned.

MATH 799 Doctoral Thesis Research
Original and independent doctoral thesis research. A successful defense of the thesis leads to the grade Pass. No course credit is assigned.