4/11/05

MATHEMATICS COURSES AT THE CLAREMONT COLLEGES 2005-2006

This listing of all mathematics courses offered at the Claremont Colleges is prepared annually by Mary Solberg (CGU Math) and the members of the Mathematics Departments for the convenience of students and faculty. Since the preparation of this catalog is done many months in advance of the academic year, changes in scheduled times and/or instructors for some courses can occur. Revisions of this listing are not jointly prepared; instead, students should consult the list of changes issued by the individual colleges prior to each semester's registration.

Some remarks on the course numbering system are also appropriate. The course numbers are chosen by a subcommittee of the Field Committee. With very few exceptions, courses at different colleges having the same number have equivalent content. Courses which have numbers below 100 are usually lower division courses. For the most part, upper division courses are assigned numbers according to sub-fields of mathematics, and **there is no assumption that larger numbers indicate higher levels of difficulty.** Seminars on selected topics are listed at the ends of the 130-180 decades; e.g., 139. Courses which may be taken for either graduate or undergraduate credit are "double-numbered"; e.g., 151(251). A rough guide to the numbering system is:

110-119	Applied Analysis (see also 180's)
120-129	Foundations, Logic and Advanced Calculus
130-139	Analysis
140-149	Geometry and Topology
150-159	Probability, Statistics
160-169	Numerical Analysis and Related Courses
170-179	Algebra and Number Theory
180-189	Differential Equations, Applied Analysis, and Operations Research
190-199	Clinics, general seminars, reading courses, etc.
200,300's, 400's	Graduate courses

1 PIT

Mathematics, Philosophy, and the "Real World." Throughout history, mathematics has changed the way people look at the world. this course will focus on two examples: Euclidean geometry (which suggested to philosophers that certainty was achievable by human thought), and probability and statistics (which gave scientists a way of dealing with events that did not seem to follow any laws but those of chance). Readings and problems will be taken from three types of sources: (1) Euclid's elements of Geometry; (2) modern elementary works on probability and its applications to the study of society and to gambling; (3) the writings of philosophers whose views were strongly influenced by mathematics, such as Plato, Aristotle, Pascal, Spinoza, Kant, Laplace, Helmholtz, and Thomas Jefferson. Prerequisite: high school algebra and geometry. Enrollment is limited.

Fall: TTh 1:15 J. Grabiner (PIT)

6 PIT

Pencil and Paper Games. This class will focus on the analysis of games in which chance is not a factor. Familiar examples range from tic-tac-toe to chess. This analysis leads to direct applications in the social sciences, as well as to such mathematical oddities as *surreal numbers*. Offered in alternate years. Prerequisite: high school algebra.

Spring: TTh 9:40 Bachman

7 PIT

Mathematics of Games and Gambling. An introduction to probability and game theory. Topics will be drawn from combinations, permutations, probability, expected value, Markov chains, graph theory, and game theory. Specific games such as keno, roulette, craps, poker, bridge, and backgammon will be analyzed. The course will provide excellent preparation for statistics courses as well as for uses of game theory in the Social Sciences. Offered in alternate years. Prerequisite: 2 years of high school algebra.

Summer: MWF 4:00 Hoste

8 PIT

Mathematics, Art, and Aesthetics. Addresses topics in mathematics that have figured prominently in the history of art and architecture. Explores the role of aesthetics within mathematics and the concept of mathematics itself as an art form. Readings from material by philosophers, mathematicians, artists, and art historians ranging from the ancient Greeks to modern times. Students will solve mathematical problems, learn to write short mathematical expositions, and create art work in various media. Prerequisite: high school algebra and geometry.

Not offered in 2005-2006

10B PIT

The Mathematical Mystery Tour (PIT). Introduces students to beautiful topics in mathematics that do not require a great deal of sophistication or previous knowledge. While ideally suited to liberal arts students, the course should be of interest to science majors as well. Stresses the intuition, creativity and aesthetics involved in one area of mathematics. The area of focus will vary from year to year. No prerequisite.

Mathematics in Many Cultures. Mathematical ideas are found in many cultures, among both literate and non-literate peoples. We will study both the mathematics and the role it plays in the cultures. Examples will be chosen from the mathematical ideas of present-day peoples of Africa, Asia, Oceania, and the Americas, as well as historic Egypt, Mesopotamia, Greece, Islam, and China. Students will learn the modern mathematical concepts necessary to understand the examples. Offered jointly by Pitzer and Pomona.

Spring: TTh 1:15	J. Grabiner (PIT)

10H3 Topology
This course explores the shape of 1,2,3 and 4-dimensional space. Is the universe curved or flat? Could an astronaut return from a long journey as the mirror-image of her former self? How can space be ``constructed" from ``ordinary" space using knots? The course will be very visual—we will draw pictures and make paper and wire models to gain insight. Intended for the liberal arts student, there are no mathematical prerequisites.

Summer: MWF 1:15	Bachman (PIT)

10M. Topic (TBA)

Not offered in 2005-2006

11 HMC
Calculus of One Real or Complex Variable. Complex numbers, limits, formal epsilon-delta limit definition, derivatives and differentiation rules; proofs by contradiction and induction; infinite series; integration; applications of the calculus; introduction to calculus of complex-valued functions. Prerequisite: One year of calculus at the high school level. 2 credit hours. (First semester, first half.)

Fall: MTWF 10 (1st half)	Jacobsen
Fall: MTWF 11 (1st half)	Jacobsen
Fall: MTWF 10 (1st half)	Ward
Fall: MTWF 11 (1st half)	Ward

12 HMC
Intro. To Linear Alg I/Dynamical Systems. Matrix representation of systems of equations, matrix operations, determinants- linear independence and dependence, bases; inner products, eigenvalues and eigenvectors; examples of discrete dynamical systems, fixed points, chaos, stability, bifurcations, Sarkovskii's Theorem. Prerequisite: Mathematics 11, or the equivalent. 2 credit hours.

Fall: MTWF 10 (1st half)	Su
Fall: MTWF 11 (1st half)	Martonosi
Fall: MTWF 10 (2nd half)	Gu
Fall: MTWF 10 (2nd half)	Su
Fall: MTWF 11 (2nd half)	Gu
Fall: MTWF 11 (2nd half)	Su

13 HMC

Differential Equations I. Modeling physical systems, first order ordinary differential equations, existence-uniqueness, and long-term behavior of solutions; bifurcations, approximate solutions: second order ordinary differential equations and their properties, applications; first order systems of ordinary differential equations, applications. Prerequisite: Mathematics 11. 1.5 credit hours.

Fall: MWF 10 (2nd half)	Ward
Fall: MWF 11 (2nd half)	Ward
Spring: MWF 8 (1st half)	Bernoff
Spring: MWF 8 (1st half)	Castro
Spring: MWF 9 (1st half)	Bernoff
Spring: MWF 9 (1st half)	Castro

14 HMC

Multivariable Calculus I. Vectors, dot and cross products; vector descriptions of lines and planes-partial derivatives and differentiability; gradients and directional derivatives; chain rule; higher order derivatives and Taylor approximations- double and triple integrals in rectangular and other coordinate systems; line integrals; vector fields, curl, and divergence; introduction to Green's theorem, divergence theorem, and Stokes' theorem. Prerequisite: Mathematics 11. 1.5 credit hours.

Spring: MWF	(1st half)	Su
Spring: MWF	(1st half)	Su
Spring: MWF	(2nd half)	Gu
Spring: MWF	(2nd half)	Gu
Spring: MWF	(2nd half)	Yong
Spring: MWF	(2nd half)	Yong

20 PIT

Elementary Functions. Review of intermediate algebra and geometry. Linear, quadratic, higher degree polynomial, and rational functions and their graphs. Applications of these topics. The sequence Mathematics 20 and 23 is designed to prepare students for calculus. Prerequisite: a satisfactory score on the mathematics placement examination.

Not offered in 2005-2006

20 SCRIPPS

Elementary Functions. Review of geometry, algebra, trigonometry of triangles, polynomials, and algebraic functions. Mathematics 20, 23 sequence is designed to prepare students for standard calculus sequence. Prerequisite: Three years of high school mathematics or placement examination.

Fall: MWF 10	Chaderjian

21 CMC

Introductory Calculus with Computing. Introduction to the methods of single and multivariable calculus with applications to the social and behavioral sciences. Topics include graphical analysis, differentiation and integration of algebraic functions, partial differentiation, and an introduction to programming and the use of digital computers. Prerequisite: Placement. (Written permission of instructor required for non-CMC students in 1998-99).

Not offered in 2005-2006

23 PIT

Transcendental Functions and Introduction to Calculus. A continuation of Mathematics 20. Exponential, logarithmic, and trigonometric functions, and applications of these. Enrollment is limited. Prerequisite: a grade of C or above in Mathematics 20 or a satisfactory score on the mathematics placement examination.

Fall: MWF 10	Hoste
Spring: MWF 9	J. Grabiner

23 SCRIPPS

Transcendental Functions and Introduction to Calculus. Exponential, logarithmic and trigonometric functions. Introduction to limits and derivatives of polynomial functions. Prerequisite: Math 20 or placement examination.

Fall: MWF 9	Staff
Fall: MWF 10	Staff
Spring: TBA	Towse

29 POM

Problem Solving in the Sciences. This course will enhance students' problem solving skills. Students will learn to use mathematical reasoning and techniques to solve challenging problems that arise in the real world. Emphasis will be placed on the students developing their own approach to problem solving. No prerequisites. [PAC 3]

Fall: MWF 11	Flapan

30 CMC

Calculus I. Single variable calculus. Differentiation and integration of algebraic and transcendental functions, with applications to the social and physical sciences. Prerequisite: placement.

Fall: TTh 9:30 sec 1	Wilson
Fall: TTh 1:15 sec 2	Wilson
Fall: MWF 9 sec 3	Pinter-Lucke
Fall: MWF 9 Sec 4	Peterson
Fall: MWF 10 sec 5	Pinter-Lucke
Fall: MWF 10 sec 6	Peterson
Fall MWF 11 sec 7	Peterson
Fall: MWF 11 sec 8	Staff
Spring: TBA	Peterson

30 PIT

Calculus I. Introduction to the basic concepts of the calculus, including slopes, rates of change, limits, the derivative and the integral, and the relationships between these concepts, especially the Fundamental Theorem of Calculus, with applications to the natural and social sciences. Each concept will be treated from numerical, analytic, and geometric perspectives. Prerequisite: a grade of C or above in Mathematics 23 or a satisfactory score on the mathematics placement examination or permission of instructor. Enrollment is limited.

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Fall: MWF 10	Bachman
Spring: MWF 10	J. Grabiner

30 SCRIPPS

Calculus I. Mathematics 30 is the first course of a standard three course sequence in calculus. The topics covered include differentiation, integration, mean value theorem, transcendental functions and trigonometric functions. Prerequisite: Mathematics 23 or placement examination.

Fall: MWF 9	Chaderjian
Spring: TBA	Staff

30 POM

Calculus I. Mathematics 30, 31, and 32 comprise a standard course in the calculus of one and several variables. This course focuses on: limits, derivatives, integrals, mean-value theorems, and the Fundamental Theorem of Calculus. Prerequisite: Math 29 or satisfactory score on placement examination. [PAC 3]

Fall: MWF 10	Staff
Spring: MWF 10	Staff

30H POM

Honors Calculus I. This course provides a deeper look at the standard topics in Differential Calculus. Topics include limits, derivatives & their applications, integrals, and the Fundamental Theorem of Calculus. Prerequisite: satisfactory score on placement exam. [PAC3]

Fall: MWF 10	Flapan

31 CMC

Calculus II. A second course in single variable calculus with an introduction to vector methods in geometry and analysis. Techniques of integration; introduction to differential equations; vector algebra; polar coordinates and parametric representation of curves; improper integrals and indeterminate forms; infinite series and power series representation of a function. Applications to problems from the physical and social sciences. Prerequisite: Mathematics 30.

Fall: MWF 9 sec 1	Martelli
Fall: MWF 10 sec 2	Martelli
Fall: MWF 10 sec 3	Bradley
Fall: MWF 1:15 sec 4	Bradley
Spring: TBA sec 1	Pinter-Lucke
Spring: TBA sec 2	Peterson

31 POM

Calculus II. Transcendental functions, techniques of integration, infinite series, and related material. Prerequisite: Mathematics 30 or 30H, (C- or better) or satisfactory score on placement examination. [PAC 3]

Fall: MWF 10	Grabiner
Fall: MWF 11	Staff
Fall: MW 1:15	Staff
Spring: MW 1:15	Staff

31H POM

Honors Topics in Calculus II. Explores selected topics from Calculus II in greater depth than Math 31, and relates these topics to other areas of mathematics. This course is intended for students who have already seen some of the Calculus II material but are not yet ready for Calculus III. Prerequisite: Mathematics 30 or 30H, (C- or better) or satisfactory score on placement examination. [PAC 3]

Fall: MWF 11	Shahriari

31LS POM

Calculus II with Applications to the Life Sciences. This course presents the core topics of Math 31, as well as an introduction to modeling, differential equations, matrix algebra and computing, in the context of problems from the life sciences. It provides an excellent background for students who intend to go on to Math 32, and exposes students who intend to take no further mathematics courses to the depth and excitement of the discipline by showing them its relevance in the world around us. Prerequisite: Mathematics 30 or 30H, (C- or better) or satisfactory score on placement examination. [PAC 3]

Fall: MWF 10	Rumbos

31 PIT

Calculus II. Transcendental functions, techniques of integration, infinite series, related topics, and applications. Again, each concept will be treated from numerical, analytic, and geometric perspectives. Prerequisite: a grade of C or above in Mathematics 30. Enrollment is limited.

?Summer: MWF 4	Bachman
Fall: MWF 11	Hoste
Spring: MWF 10	Bachman

31 SCRIPPS

Calculus II. Topics covered include techniques and applications of integration, infinite series, and related material. Prereq: Math 30 or placement examination. Offered annually.

Fall: MWF 12	Staff
Spring: TBA	Staff

32 CMC

Calculus III. Multi-variable calculus and vector analysis with applications to physical and social sciences. Functions of several variables; partial differentiation; the method of Lagrange multipliers; multiple integration; calculus of vector functions. Prerequisite: Mathematics 31.

Fall: MWF 10	O'Neill
Spring: TBA	Bradley

32H CMC

Honors Seminar in Calculus III. Open by invitation only to freshmen, this course is an introduction to rigorous mathematics for students having a substantial background and demonstrated interest in mathematics. The topics covered will be those of Calculus III with more emphasis on rigor and deeper understanding of the underlying mathematics. First semester.

Fall: MWF 11	Aksoy

32 PIT

Calculus III. Vectors and vector functions, partial derivatives and differentiability of functions of several variables, multiple integrals. Prerequisite: Mathematics 31 or equivalent, or placement score.

Fall: MWF 1	Hoste
Spring: MWF 11	Bachman

32 POM

Calculus III. Vectors and vector functions, partial derivatives and differentiability of functions of several variables, multiple integrals. Prerequisite: Mathematics 31 or 31H or 31LS, (C- or better) or satisfactory score on placement examination. [PAC 3]

Fall: MWF 10	Staff
Fall: MWF 11	de Silva
Spring: MWF 11	Staff
Spring:TTh 1:15	Sarkis

32H POM

Honors Calculus III. This course builds on Calculus I and II (which study functions of a single variable) to develop calculus for functions of n variables. We start by studying n-dimensional space. We can then model our development of calculus of several variables on concepts from one-variable calculus. Prerequisite: Mathematics 31 or 31H or 31LS, (C- or better) or satisfactory score on placement examination. [PAC 3]

Fall: MWF 11	Grabiner

32 SCRIPPS

Calculus III. This is the third course of a standard three course sequencein calculus. The course covers calculus of multivariable and vector-valued functions.Topics include partial derivatives, the gradient, Lagrange multipliers, multiple integrals, change of variables, parameterized curves and surfaces, vector fields, line integrals, flux integrals, Green's Theorem, the Divergence Theorem, and Stokes' Theorem. Prerequisite: Math 31 or placement examination. Offered each semester.

Fall: MWF 10	Towse
Spring: TBA	Towse

36 POM

Mathematical and Computational Methods in the Life Sciences. Mathematical models motivated by problems in biology will provide the motivation for studying a suite of mathematical concepts. We will cover topics in probability, discrete models, differential equations, linear algebra and statistics. Some computational techniques will also be introduced to lend power to the theory. This course is not a substitute for full semester courses in any of these topics, but is intended to provide essential analytical and computational tools to the life scientist. Prerequisites: Two semesters of calculus (through Math 31), or advanced placement BC Calculus, or the equivalent (with permission instructor). [PAC 3]

Fall: MWF 10	Radunskaya

50 CMC

Discrete Mathematics. Topics include combinatorics, number theory, and graph theory with an emphasis on creative problem solving and learning to read and write rigorous proofs. Possible applications include probability, analysis of algorithms, cryptography, and mathematical magic tricks. 3 credit hours..

Spring: TBA	Valenza

55 HMC

Discrete Mathematics. Topics include combinatorics, number theory, and graph theory with an emphasis on creative problem solving and learning to read and write rigorous proofs. Possible applications include probability, analysis of algorithms, cryptography, and mathematical magic tricks. 3 credit hours. (Both semesters.) Prerequisite: Math 12 or permission of the instructor.

Fall: MW 1:15	Orrison
Spring: MW 1:15	Orrison

57 POM

Statistical Thinking. The application of statistics to real-world problems goes beyond the application of a few formulae to a body of data. Statisticians become involved in research problems at the initial stages of formulating the hypotheses to be addressed, and continue their involvement through the design and presentation of the results. This course, centered around a collection of projects, exposes the student to the complete spectrum of activities in which a statistician is involved. Not open to students who have taken Math 31, 31H, 31LS, 32, 32H, 36 or AP Statistics. [PAC 4]

Fall: TTh 1:15	Kloke

58 POM

Introduction to Statistics. An introduction to the methodology and tools which are vital to the researcher in both the sciences and social sciences. Topics include introduction to probability, binomial, normal, Student's-t, and chi-square distributions; testing hypotheses; confidence intervals; analysis of variance; and regression and correlation analysis. Concepts will be applied to current data using statistical computer software. Not open to students who have taken AP Statistics. Prerequisite: Math 30 or 30H or permission of instructor. [PAC 4]

Spring: TTh 9:35	Kloke
Spring: TTh 2:45	Kloke

60 PIT

Linear Algebra. Topics will include matrices, Gaussian elimination, vector spaces and subspaces, linear transformations, bases, octhogonality, determinants, eigenvalues and eigenspaces, and applications of linear algebra. Prerequisite: Math 32 or concurrent enrollment in Math 32.

Spring: MWF 1:15	Hoste

60 POM

Linear Algebra. A course in linear algebra emphasizing vector spaces and linear transformations. Topics will include: linear independence and bases, nullspaces and ranks of linear transformations, the algebra of linear transformations, and the representation of linear transformations by matrices. Additional topics may include: Gaussian elimination, inner product spaces; determinants, eigenvalues; and applications of linear algebra. Prerequisite: Mathematics 32, 32H, or permission of instructor. [PAC 3]

Fall: MWF 11	Staff
Fall: TTh 1:15	Sarkis
Spring: MWF 10	de Silva
Spring: MWF 11	Shahriari
Spring: MWF 11	Staff

60 SCRIPPS

Linear Algebra. This course emphasizes vector spaces and linear transformations. Topics include linear independence, bases, nullity andrank of a linear transformation, The Dimension Theorem, the representationof linear transformations as matrices, eigenvalues and eigenvectors, and determinants. Additional topics may include inner product spaces and Gram-Schmidt orthogonalization. Prerequisite: Math 32. Offered Fall semesters.

Fall: MWF 12	Chaderjian

61 HMC

Multivariable Calculus II. Review of basic multivariable calculus; optimization and the Second Derivative Test; constrained optimization using Lagrange multipliers; conservative and nonconservative vector fields-, Green's theorem; parametrized surfaces and surface integrals; divergence theorem, outline of proof, and applications; Stokes' theorem, outline of proof, and applications; unification of the major vector theorems. Prerequisite: Mathematics 14, 1.5 credit hours.

Fall: MWF 8 (1^{st} half)	Nanda
Fall: MWF 9 (1^{st} half)	Nanda
Fall: MWF 10 (1^{st} half)	Raugh
Fall: MWF 11 (1^{st} half)	Raugh

62 HMC

Introduction to Probability and Statistics: Sample spaces, events, axioms for probabilities; conditional probabilities and Bayes' theorem; random variables and their distributions, discrete and continuous; expected values, means and variances; covariance and correlation; law of large numbers and central limit theorem; point and interval estimation; hypothesis testing; X^2 goodness of fit; simple linear regression; introduction to analysis of variance; applications to analyzing real data sets. Prerequisite; Mathematics 11. 1.5 credit hours.

Fall: MWF 8 (2^{nd} half)	Martonosi
Fall: MWF 9 (2^{nd} half)	Martonosi
Fall: MWF 10 (2^{nd} half)	Orrison
Fall: MWF 11 (2^{nd} half)	Orrison

63 HMC

Linear Algebra II. Review of basic linear algebra; vector spaces; row and column spaces of matrices, rank-nullity theorem; orthogonal bases and Gram-Schmidt procedure, orthogonal expansion and Fourier coefficients; projections and Bessel's inequality; linear transformations; change of basis and similarity, eigenvalues, eigenvectors and characteristic polynomials; diagonalization of symmetric matrices; applications of eigenvalues to systems of ordinary differential equations. Prerequisite: Mathematics 12. 1.5 credit hours.

Spring: MWF 8 (1st half)	Raugh
Spring: MWF 9 (1st half)	Raugh
Spring: MWF 10 (1st half)	dePillis
Spring: MWF 11 (1st half)	dePillis

64 HMC

Differential Equations II. Review of basic ordinary differential equations, especially systems; undriven linear systems; orbital portraits; stability and conservative systems; Lyapunov functions; cycles and long term behavior of solutions, Sturm-Liouville problems; series solutions near ordinary and regular singular points; Bessel functions; chaos. Prerequisite: Mathematics 13 and 63. 1,5 credit hours.

Spring: MWF 8 (2nd half)	Castro
Spring: MWF 9 (2nd half)	Castro
Spring: MWF 10 (2nd half)	Raugh
Spring: MWF 11 (2nd half)	Raugh

80 PIT

Science and Technology in the Ancient Medieval World

Not offered in 2005-2006

81 PIT

Science and Technology in the Early Modern World

Not offered in 2005-2006

82 PIT

Science and Technology in the Modern World

Not offered in 2005-2006

90 CMC

Linear Algebra. An introduction to the methods of linear algebra with applications to the physical and social sciences. Topics will include: linear equations and matrices, determinants, vector spaces, linear transformations, inner product spaces and quadratic forms, eigenvalues and canonical forms. Prerequisite: Mathematics 32.

Fall: TTh 9:35	Aarao
Spring: TBA	Bradley

101 POM

Introduction to Analysis. This course will help students improve their ability to understand and develop methods of proof in an analytic setting. Topics chosen from: properties of the real numbers, sequences, series, continuity, differentiation, and integration of functions of a single real variable. Emphasis on exposition as well as construction of proofs. This course prepares students for Math 131. Prerequisite: Mathematics 60.

Spring: MWF 10 Flapan

102 POM

Differential Equations and Modeling. Introduction to theory of ordinary differential equations, with applications to modeling in physical, biological, and social sciences. Emphasis is placed on qualitative study of differential equations via analytic methods or numerical techniques using standard mathematical software packages. A good understanding of theory of vector spaces, and linear transformations is assumed. Prerequisite; Math 32 and 60. [PAC 3]

Fall: MWF 11 Rumbos
Spring: MWF 11 de Silva

102 SCRIPPS

Differential Equations. This course is an introduction to the theory of ordinary differential equations with applications to modeling in physical, biological, and social sciences. Analytical methods as well as numerical techniques will be emphasized. Prerequisite: Math 32. Offered Spring semesters.

Spring: TBA Staff

103 POM

Combinatorial Mathematics. An introduction to the techniques and ideas of Combinatorics including counting methods, generating functions, Ramsey theory, graphs, networks, and extremal combinatorics. Prerequisite: Mathematics 60 or permission of the instructor.

Fall: MW 2:45 de Silva

103 SCRIPPS

Combinatorial Mathematics. An introduction to the techniques and ideas of Combinatorics including counting methods, generating functions, Ramsey theory, graphs, networks, and extremal combinatorics. Prerequisite: Mathematics 60 or permission of the instructor. Offered alternate Spring semesters

Not offered in 2005-2006.

104 HMC

Graph Theory.

An introduction to Graph Theory with applications. Theory and applications of trees, matchings, graph coloring, planarity, graph algorithms, and other topics. Prerequisite: Math 12. Credits 3.

Spring: TBA (2^{nd} half) Orrison

105 CMC

Discrete and Continuous Modeling.

Basic Modeling, Discrete Deterministic Models, Discrete Stochastic Models, Stages, States and Classes, Empirical Modeling, Continuous Models, Continuous Stochasticity. Prerequisite: Math 31.

Spring: TBA Martelli

105 POM

Introduction to Number Theory. Covers important ideas in elementary number theory and applications. Topics include divisibility and primes, modular arithmetic, Fermat's Little Theorem, quadratic residues and Gaussian integers. Exciting recent applications will be explored. Prerequisite: Math 60.

Not offererd 2005-06

106 HMC

Combinatorics. Counting methods, generating functions, and partially ordered sets. Prerequisite: Math 55 or permission of the instructor. 2 credit hours.

Spring: MW 4:15 Benjamin

108 PIT

History of Mathematics. A survey of the history of mathematics from antiquity to the present. Topics emphasized will include: the development of the idea of proof, the "analytical method" of algebra, the invention of the calculus, the psychology of mathematical discovery, and the interactions between mathematics and philosophy. Prerequisite: A year of university-level calculus: Math 31 or equivalent. [PAC 3]

Not offered in 2005-2006.

109 CMC

Introduction to the Mathematics of Finance. This course emphasizes the math used in the valuation of derivative securities. Topics will include among others partial differential equations (diffusion equation), mathematical modeling of financial derivatives (calls, puts, etc.), and numerical methods for solving differential equations. These topics will aim at understanding the Black-Scholes Model. Prerequisite: Math 90.

Spring: TBA Aarao

110 CMC

Introduction to Engineering Mathematics: Ordinary differential equations, line and surface integrals, elementary linear algebra, systems of differential equations, and Fourier analysis. Continuous modeling with applications to mechanics, electricity and magnetism, heat, and sound.

Not offered in 2005-2006

111 CMC

Differential Equations: An introduction to the general theory and applications of differential equations. Linear systems, nonlinear systems, and stability. (Prerequisite: Math 32)

Fall: MWF 11 Bradley
Spring: TBA Aarao

112 CMC

Introduction to Dynamical Discrete Systems and Chaos.

Qualitative analysis of discrete dynamical systems in dimensions one and higher is motivated and presented with examples taken from the recent research literature. These include mathematical models of biological processes, such as the 1988 Siphonious fillyrae - ash whitefly- infestation in Southern California and its control with Hymenoptera Aphelinide, and the Hopfield model of Neural Networks. Quantitative analysis if the systems is preformed using the symbolic manipulator Mathematica.

Spring: TBA Martelli

112 POM

Discrete Dynamical Systems & Chaos.

The studies of discrete dynamical systems in dimensions one and higher is motivated and presented with examples taken from the recent research literature, including mathematical models of biological processes, and neural networks. Among the mathematical topics introduced will be routes to chaos, bifurcation analysis, and Sarkovskii's Theorem. Prerequisites: Mathematics 32 and 60.

Not offered in 2005-2006

113 POM

Cryptography. This course will provide an overview of private and public key ciphers, including RSA, DES, & NTRU, digital signatures, and protocols. Topics from complexity, probability, & number theory will be developed as needed. Prerequisite: Math 60 or permission of instructor.

Not offered in 2005-2006.

115 HMC

Fourier Series and Boundary Value Problems. Sturm-Liouville theory, orthogonal expansions, convergence properties of Fourier series, separation of variables for partial differential equations, regular singular point theory, Bessel functions and Legendre polynomials. (May not be included in a mathematics major program.) Students may not receive credit for both Mathematics 115 and 180. Prerequisite: Mathematics 64.

Fall: MW 2:45 Yong

118 HMC

Mathematical Biology I. Topics in Mathematical Biology I. Mathematical models of biological processes emphasizing continuous models. May include models in epidemiology, population dynamics, cancer modeling, and disease treatment modeling. Prerequisite: One semester linear algebra (Math 12 & 63) and one semester ordinary DEs (Math 13 & 64). 2 units.

Spring: TTh 2:45 (1^{st} half) dePillis

119 HMC

Mathematical Biology II. Mathematical models of biological processes emphasizing discrete and continuous models. May include one- and two-locus population genetics, meta-populations, and matrix population models as well as models in physiology and neurobiology. Prerequisites: Introduction to probability and statistics (Math 62), one semester linear algebra (Math 12 & 63) and one semester ordinary Des (Math 13 & 64). 2 units.

Spring: TTh 2:45 (2^{nd} hald) dePillis

120 POM

Symmetry and Chirality. A molecular structure is chiral if it's different from its mirror image. This interdisciplinary Mathematics/Chemistry course introduces students to topological and geometric symmetry and provides descriptions of chirality in molecular systems. Connections will be made between the chemical and mathematical theories of chirality. Molecules with interesting topological features will be introduced and their structural behavior discussed. Prerequisite: Chemistry 110a or Math 60. Half-course.

Not offered in 2005-2006.

122 **Seminar in Logic**. Selected topics from the general area of logic. Prerequisite: permission of the instructor.

Not offered in 2005-2006.

123 HMC

Logic. Propositional and first order predicate logic. The completeness, compactness and Loewenheim-Skolem theorems. Decidable theories. Application to other areas of mathematics (e.g., nonstandard analysis). Prerequisite: Mathematics 12 or 60.

Not offered in 2005-2006

131 CMC, HMC, POM (CGU 231)

Principles of Real Analysis I. Countable sets, least upper bounds, and metric space topology including compactness, completeness, connectivity, and uniform convergence. Related topics as time permits. Prerequisite: HMC Prerequisite: Mathematics 12 and 14 (Math 55 recommended). Pomona Prerequisites; Math 32 and 60, a proof-based mathematics course above 100 is strongly recommended.

Fall: MWF 9	Grabiner (POM)
Spring: MW 1:15	Ward (HMC)
Spring: TBA	Aksoy (CMC)

131 SCRIPPS (CGU 231S)

Mathematical Analysis I. By looking carefully at the concept of distance and the notion of an abstract metric space, we will gain a deeper understanding of the Real numbers and of what makes calculus work. Topics will include uncountability, connectedness, and compactness. We will look at continuity in terms of open and closed sets. Offered alternate Fall semesters.

Not offered in 2005-2006.

132 CMC, HMC, POM (CGU 232)

Principles of Real Analysis II. A rigorous study of calculus in Euclidean Spaces including multiple Riemann Integrals, derivatives of transformations, and the inverse function theorem. Prerequisite: Mathematics 131.

Fall: MW 2:45	Castro (HMC)
Spring: MWF 9	Grabiner (POM)

134 HMC (CGU 334)

Advanced Complex Analysis. Normal families and the Riemann Mapping Theorem: Weierstrass Product Theorem; harmonic functions; analytic continuation. Additional topics as time permits. Prerequisite: Mathematics 135 or 136, and concurrent enrollment in Mathematics 132.

Not offered in 2005-2006

135 CMC (CGU 235)

Functions of Complex Analysis. Complex numbers and functions. Complex differentiation. Cauchy-Riemann equations. Holomorphic and harmonic functions. Complex power series, elementary functions. Cauchy's theorem and the deformation theorem. Consequences of Cauchy's theorem: Cauchy's integral formula, Liouville's theorem, fundamental theorem of algebra, Cauchy's formula for derivatives and Morera's theorem. Taylor series, uniqueness and maximum principle. Laurent series, singularities. Residue theorem, calculation of residues. Estimation of integrals. Prerequisite: Mathematics 131 or permission of the instructor.

Spring: TBA Aksoy (CMC)

136 HMC (CGU 236)

Complex Variables and Applications. Complex differentiation, Cauchy-Riemann equations, Cauchy integral formula, Taylor and Laurent expansions, residue theory, contour integration including branch point contours, uses of Jordan's lemma, Fourier and Laplace transform integrals, conformal mapping. Prerequisite: Mathematics 60 or 64.

Fall: MW 1:15 Jacobsen (HMC)

137 CMC, HMC, POM (CGU 331)

Real and Functional Analysis I. Abstract measures, Lebesgue measure on R^n, and Lebesgue-Stieljes measures on R. The Lebesgue integral and limit theorems. Product measures and the Fubini theorem. Additional related topics as time permits. Prerequisite: Mathematics 132.

Fall: MWF 1:15 Aksoy (CMC)

138 CMC, HMC, POM, (CGU 332)

Real and Functional Analysis II. Continuation of Mathematics 137. Some of the topics covered are: Banach and Hilbert spaces; L^P-spaces; complex measures and the Radon-Nikodym theorem. Prerequisite: Mathematics 137 (CGU 331).

Not offered in 2005-2006.

141 PIT (CGU 241)

Hyperbolic Geometry. An introduction to hyperbolic geometry in dimensions two and three. Topics will include: Poincaré disk model, upper half-space model, hyperbolic isometries, linear fractional transformations, hyperbolic trigonometry, cross-ratio, hyperbolic manifolds, and hyperbolic knots. Prerequsite: Math 60.

Spring: MWF 11 Hoste (PIT)

142 HMC (CGU 242)

Differential Geometry. Curves and surfaces, Gaussian curvature, isometries, tensor analysis, covariant differentiation with applications to physics and geometry (intended for physicists and mathematicians). Prerequisite: Math 64 Pomona Prerequisite Math 102. (Math 131 recommended).

Fall: TTh 1:15 Gu (HMC)

143 HMC (CGU 243)
Topics in Geometry. Selected topics in Riemannian and pseudo-Riemannian geometry, low dimensional manifold theory, contemporary applications in mathematics and physics. Prerequisite: permission of instructor.

Spring: MW 2:45 Gu (HMC)

144 SCRIPPS (CGU 244s)
Classical and Modern Geometries
Do two lines always intersect in exactly one point? We begin with classic Euclidean Geometry, but quickly move to Hyperbolic and Spherical Geometry, where our intuition is challenged. Poincaré model is featured. Next, we use abstract algebra to study projective and finite geometries. Bezout's Theorem leads to Elliptic Curves and modern day research. Prerequisite: Math 60.

Not offered in 2005-2006.

144 CMC (CGU 244C)
Fourier Analysis.

Not offered in 2005-2006.

145P PIT (CGU 245P)
Surface Topology and Combinatorial Group Theory. This course will serve as an introduction to both topology and group theory. The main theme will be that knowledge of each of these subjects can inform the other. Topics will range from the classification of surfaces to Dehn's algorithm. Prerequisite: Math 60 or permission of instructor.

Fall: TTh 9:40 Bachman

145 POM (CGU 245)
Topics in Geometry and Topology. Topic varies from year to year and will be chosen from: Differential Topology, Euclidean and Non-Euclidean Geometries, Knot Theory, Algebraic Topology, and Projective Geometry. Prerequisites: Varies from year to year, usually Math 60 and either a Math course numbered above 100 or permission of the instructor. Pre-requisite is Math 131 or permission of the instructor.

Not offered in 2005-2006.

146 PIT
Differential forms and Cohomology. This course begins with Differential Forms, the modern equivalent of vector calculus. We will then define manifolds and look at applications. These include foliations and contact structures, Maxwell's equations, and most notably, DeRham cohomology. Prerequisite: Math 32 or permission of instructor.

Not offered in 2005-2006.

147 HMC, POM, (CGU 247)
Topology. Topological spaces, product spaces, quotient spaces, Hausdorff spaces, compactness, connectedness, path connectedness, fundamental groups, homotopy of maps, and covering spaces. Corequisite: Mathematics 131 or permission of instructor. Offered jointly by Harvey Mudd and Pomona Colleges.

Spring: MWF 11 Flapan (POM)

148 PIT (CGU 248)

Knot Theory. An introduction to the theory of knots and links from combinatorial, algebraic, and geometric perspectives. Topics will include knot diagrams,p-colorings, Alexander, Jones, and HOMFLY polynomials, Seifert surfaces, genus, Seifert matrices, the fundamental group, representations of knot groups, covering spaces, surgery on knots, and important families of knots. Prerequisite: Topology (Mathematics 147), or Algebra (Mathematics 171), or permission of instructor.

Not offered in 2005-2006.

149 HMC (CGU 449)

Seminar in Topology. Selected topics from the general area of topology. Prerequisite: Mathematics 147 and permission of the instructor.

Not offered in 2005-2006

151 CMC, POM, (CGU 251)

Probability. Probability spaces, discrete and continuous random variables, conditional and marginal distributions, expectation, independence, generating functions, transformations, central-limit theorem. Prerequisite or Co-requisite for CMC: Mathematics 90 or permission of instructor. Prerequisites for Pomona: Math 32 and 60.

Fall: Th 7-10:50 pm	Henri Schellhorn (CGU)
Fall: Sec 1 MWF 10	Aksoy (CMC)
Fall: Sec 2 MW 2:45	O'Neill (CMC)
Spring: MWF 9	Rumbos (POM)

152 CMC, HMC, POM, (CGU 252)

Statistical Theory. Introduction to statistical inference. Sufficiency, estimation of parameters, confidence intervals, and tests of hypotheses. Prerequisite: Mathematics 151 (251) or permission of instructor. [PAC 4]

Fall: TTh 9:35	Kloke (POM)
Spring: TBA	O'Neill (CMC)
Spring: T 7-9:50pm	Raval (CGU)

153 CMC (CGU 253)

Advanced Topics in Statistical Inference. Selected topics in statistical inference, such as Bayesian inference, bootstrapping, and distribution-free methods. Prerequisite: Mathematics 152. Offered jointly by Claremont Graduate University,Claremont McKenna, and Pomona colleges. Offered in 2004-05.

Not offered in 2005-2006.

156 CMC, HMC (CGU 256)

Stochastic Processes. Continuation of Mathematics 151. Properties of independent and dependent random variables, conditional expectation. Topics chosen from Markov processes, second order processes, stationary processes, ergodic theory, Martingales, and renewal theory. Prerequisite: Mathematics 63 and 151 or permission of instructor. Pomona prerequisite: Math 151.

Fall: TTh 1:15	Staff (CMC)
Fall: M 7-9:50 pm	Henri Schellhorn (CGU)

157 HMC

Intermediate Probability. Continuous random variables, distribution functions, joint density functions, marginal and conditional distributions, functions of random variables, conditional expectation, covariance and correlation, moment generating functions, law of large numbers, Chebyshev's theorem and central limit theorem. Prerequisite: Math 62, or permission of instructor. 2 credit hours.

Spring: MWF 10 Benjamin (HMC)

158 CMC,HMC, POM (CGU 258)

Statistical Linear Models. An introduction to analysis of variance (including one-way and two-way fixed effects ANOVA) and linear regression (including simple linear regression, multiple regression, variable selection, stepwise regression and analysis of residual plots). Emphasis will be on both methods and applications to data. Statistical software will be used to analyze data. Prerequisites: Mathematics 58 or 152, or Economics 57, or Psychology 158, or AP Statistics, or permission of instructor. Offered each spring. [PAC 4].

Spring: TTh 1:15 Kloke (POM)

159 HMC

Probability and Measure. Problems of current research in the area of probability and stochastic process. 2 units. Prerequisite: Mathematics 151 or permission of instructor. (Jointly offered; Spring at HMC).

Spring: TBA (2^{nd} half) Krieger

159 POM (CGU 259)

Applied Nonparametric Analysis. *C*overing both traditional and modern techniques in nonparametrics, this course will focus on analyzing data under appropriate assumptions, by investigating the mathematical derivations as well as the computational aspects of various techniques including sign & rank tests, goodness-of-fit tests, Fisher's exact test, bootstrapping, and permutation tests. Programming skills needed to run these tests will also be developed. Prerequisite: Mathematics 30 or 30H and one of the following: Mathematics 58 or 152, or Economics 57, or Psychology 158, or AP Statistics or Permission of Instructor. [PAC 4]

Not offered in 2005-2006.

164 HMC (CGU 264)

Scientific Computing. (Same as Computer Science 144.) Computational techniques applied to problems in the sciences and engineering. Modeling of physical problems, computer implementation, analysis of results; use of mathematical software; numerical methods chosen from: solutions of linear and nonlinear algebraic equations, solutions of ordinary and partial differential equations, finite elements, linear programming, optimization algorithms, and fast-Fourier transforms. Prerequisites: Mathematics 64, Computer Science 60. 3 credit hours. (Second semester.)

Spring: MW 2:45 Yong (HMC)

165 CMC, HMC (CGU 265)

Numerical Analysis. An introduction to the theory and methods for numerical solution of mathematical problems. Core topics include: analysis of error and efficiency of methods; solutions of linear systems by Gaussian elimination and iterative methods; calculation of eigenvalue and eigenvectors; interpolation and approximation; numerical integration; solution of ordinary differential equations. Prerequisite: Mathematics Math 64 and a knowledge of elementary computer programming, or permission of the instructor. Pomona prerequisite: Math 102.

Fall: TTh 2:45 dePillis (HMC)

167 HMC (See HMC, POM CS142) (CGU CS267)
Theory of Computation. Specific topics include finite automata, pushdown automata, Turing machines, and their corresponding languages and grammars; undecidability; and complexity classes, reductions, and hierarchies. Prerequisites: Computer Science 52.

Not offered in 2005-2006.

168 HMC (See CS140) (CGU CS268)
Computer Algorithms. Algorithm design, computer implementation, and analysis of efficiency. Discrete structures, sorting and searching, parsing, pattern-matching, and data management. Reducibility and theoretical limitations. Prerequisite: Computer Science 60 and Mathematics 55. 3 credit hours. (First semester.)

Not offered in 2005-2006.

170 CMC
Finite Fields and Applications. Designed to appeal to students in mathematics, computer science, and electrical engineering, the course will introduce students to the elementary theory of finite fields, as well as an introduction to more basic algebraic structures, such as groups and rings. Students will also be exposed to some of the more common applications of finite fields in coding theory, cryptography, computational complexity, and finite geometry.

Not offered in 2005-2006.

171 CMC, HMC, POM (CGU 271)
Abstract Algebra I. Groups and isomorphism theorems. Rings and other structures. HMC Prerequisite: Mathematics 55 and Math 12. Prereq's for POM – Math 60; a proof-based math course above 100 is strongly recommended.

Fall: MW 1:15 Benjamin (HMC)
Fall: MWF 11 Valenza (CMC)
Spring: TTh 2:45 Sarkis (POM)

171 SCRIPPS (CGU 271)
Abstract Algebra I. We study some basic structures which appear throughout mathematics including Groups, Rings, and Fields. Topics in group theory will include isomorphism theorems, orbits and stabilizers, and coset partitions. Topics in ring theory will include ideals, quotient rings, and prime and maximal ideals. Ring and field extensions will also be introduced. Prerequisite: Mathematics 60.
Offered alternate Spring semesters.

Spring: TBA Towse (Scripps)

172 HMC, POM (CGU 272)
Abstract Algebra II. Continuation of Math 171. Selected topics in the theories of rings, modules, groups, and fields. Typical specific topics include Galois theory of equations and the structure of finitely-generated modules over Euclidean and/or principal ideal domains with applications to linear algebra and finitely-generated Abelian groups. Prerequisite: Math 171.

Spring: MW 1:15 Orrison (HMC)

173 HMC (CGU 273)

Advanced Linear Algebra. Topics will be chosen from among: Similarity of matrices and the Jordan form; the Cayley Hamilton Theory, limits of sequences and series of matrices: iterative solutions of large systems of linear algebraic equations; the Perron-Frobenius theory of nonnegative matrices; estimating eigenvalues of matrices. Prerequisites: Math 131.

Not offered 2005-2006.

175 CMC, HMC (CGU 275)

Number Theory. Properties of integers, congruences, Diophantine problems, quadratic reciprocity, number theoretic functions, primes. Prerequisite: Math 55. Pomona prerequisite: Math 60.

Fall: MWF 11 Benjamin (HMC)

175 SCRIPPS (CGU 275S)

Number Theory. Number Theory is often considered one of the most beautiful and elegant topics in mathematics. We will study properties concerning the integers, such as divisibility, congruences, and prime numbers. More advanced topics include encryption, quadratic reciprocity, and Diophantine approximation. Finally we will introduce elliptic curves and see how these curves relate to the proof of Fermat's last theorem. Prerequisite: Math 60. Offered alternate Fall semesters.

Fall: MW 1:15 Towse (Scripps)

177 POM (CGU 277)

Advanced Topics in Algebra. Topic varies from year to year and will be chosen from: Representation Theory, Algebraic Geometry, Commutative Algebra, Algebraic Number Theory, Coding Theory, Algebraic Combinatorics, Algebraic Graph Theory, Matroid Theory. Topic for Fall 2005: Introduction to Computational Algebraic Geometry. Prerequisite: Math 171 or permission of instructor.

Fall: MW 1:15 Shahriari

180 HMC, (CGU 280)

Applied Analysis. Orthogonal series and Sturm-Liouville problems, Fourier series and boundary value problems for partial differential equations, special functions of mathematical physics, integral transforms. Prerequisite: Mathematics 131. (Students may not receive credit for both Mathematics 115 and 180).

Fall: MWF 9 Bernoff (HMC)

181 HMC, POM, (CGU 281)

Dynamical Systems. This course will consider both discrete and continuous dynamics. In any given year it will include most of the following topics: Linear and nonlinear systems; Bifurcation theory, routes to chaos, symbolic dynamics, Sharkovii's theorem and chaos. Existence and uniqueness theory and dependence on data; Hartman-Grobman and Poincaré-Bendixson theorems, Lyapunov stability theory and stable manifold theory. HMC Prerequisite: Math 115 or 180. Pomona Prerequisite: Math 102 and 101 or 131, or permission of the instructor. Offered jointly with CGU and HMC. First semester.

Spring: MW 1:15 Su (HMC)

182 HMC, CMC (CGU 282)
Partial Differentiation Equations. Theory and applications of quasi-linear and linear equations of first order, including systems, higher order linear and non-linear equations, including classical methods of solutions of the wave, heat and potential equations, Green's function, similarity solutions, variational techniques, etc. Prerequisite: Mathematics 180, or 115, or permission of the instructor.

Fall: TTh 2:45 Aarao (CMC)

183 POM (CGU 283P)
Mathematical Modeling. Introduction to the construction and interpretation of deterministic and stochastic models in the biological, social, and physical sciences, including simulation studies. Students are required to develop a model in an area of their interest. Prerequisite: Mathematics 102.

Spring: MW 2:45 Rumbos (POM)

185 HMC (CGU 285)
Introduction to Wavelets and their Applications. An introduction to the mathematical theory of wavelets, with applications to signal processing, data compression and other areas of science and engineering. Prerequisite: Math 115 or Math 180 .

Not offered in 2005-2006..

186 CMC, HMC, POM (CGU 286)
Stochastic Operations Research. Stochastic models of inventory, reliability, queuing, sequencing, and transportation. Applications of these models to problems arising in industry, government, and business. Prerequisite: Mathematics 151(251).

Not offered in 2005-2006.

187 CMC, HMC, POM, (CGU 287)
Deterministic Operations Research. Linear, integer, nonlinear and dynamic programming, classical optimization problems, network theory.

CGU Prerequisite: Multivariable calculus and linear algebra.
CMC Prerequisite: Mathematics 32 or 36, and 174.
POM Prerequisite: Mathematics 32 and 60
HMC Prerequisite: Mathematics 12.

Spring: TBA Staff (CMC)
Spring: MW 1:15 Shahriari (POM)

188 HMC (CGU288H)
Social Choice and Decision-Making. This course focuses on the modeling of individual and group decisions using techniques from game theory. Topics will include: basic concepts of game theory and social choice theory, representations of games, Nash equilibria, utility theory,non-cooperative games, cooperative games, voting games, paradoxes, impossibility theorems, Shapley value, power indices, fair division problems, and applications. This course meets the "Integrative Experience" requirement for Harvey Mudd students. . Prerequisite: Math 63 and (recommended) Math 55 or permission of instructor.

Not offered 2005-2006.

188 CMC (CGU 288C)

Game Theory. Games in extensive form, combinatorial games, strategic equilibrium, matrix games and minimax theorem, computation of optimal strategies, co-operative and non-cooperative solutions of bi-matrix games, coalitional games and the core, indices of power, bargaining set, nonatomic games. Prerequisite: Linear algebra (Math 90). Recommended: Probability (Math 151).

Not offered in 2005-2006

189 HMC

Special Topics in Mathematics. A course devoted to exploring topics of current interest to faculty or students. Prerequisites: permission of instructor. 1-3 credit hours.

Spring: MW 2:45 Nonlinear Boundary Value Problems Castro
Spring: MW 2:45 Nonlinear Functional Analysis Jacobsen

190 POM

Seminar in Mathematical Exposition. Directed study for majors. Seminar will discuss how to do a literature search in mathematics, how to read research papers in mathematics, how to write a mathematics paper, and how to present a mathematics talk. Students will give oral presentations on the background material and major questions in the area of their senior research. Attendance is required. Required for senior majors. Half-course. Letter Grade only

Fall: F 1:15 Radunskaya

191 HMC

Putnam Seminar.

Fall: Tu 6 pm Su

191 POM

Senior Thesis. Preparation and presentation of senior theses for completion of the major. Attendance is required. Required for Senior majors. Half-Course. Letter Grade Only

Fall: F 1:15 Shahriari

192 HMC

Problem Solving Seminar.

Spring: TBA Bernoff, Krieger

192-193 CMC

Mathematics Clinic. Applied mathematical modeling of current unsolved problems proposed by government and industry. Students will work together in small groups under faculty direction and will have contact with the industry or governmental agency for which the mathematical solution is relevant. Prerequisite: permission of the department. 192 first semester. 193 second semester.

Spring: tba Myhre

193 HMC
Mathematics Clinic. Participation in applied mathematics projects involving student teams and a faculty supervisor. Prerequisite: permission of the Director of the Mathematics Clinic.

Fall: Tu 11	Raugh
Spring: Tu 11	Raugh (Castro, Gu, Krieger)

196 HMC
Independent Study

Fall: Arr:	Staff

196 POM
Clinic in Applied Mathematics. Mathematical modeling and analysis of current unsolved problems proposed by government or industry. Small groups of students work together under faculty direction and in communication with a client from industry or government. Mathematical content is determined, ad hoc, by the problem. Literature search, computer simulation, and written reports are usually required. Frequent cooperation with mathematics clinics of other Claremont Colleges. Prerequisite: permission of the department chair.

Not offered in 2005-2006.

197 HMC
Senior Thesis. A research or expository paper based on independent work done under the supervision of a faculty member. The paper must be submitted to the Mathematics Department in a form suitable for publication in a mathematics journal. Prerequisites: permission of the department.

Fall: Tu 11	Ward
Spring: Tu 11	de Pillis

197 POM
Selected Topics.

198 POM
Summer Reading and Research.

198 HMC
Math Forum. The goal of this course is to improve students' ability to communicate mathematics, both to a general and technical audience. Students will present material on assigned topics and have their presentations evaluated by students and faculty. This format simultaneously exposes students to a broad range of topics from modern and classical mathematics. Required of all math majors; recommended for all joint cs-math majors and mathematical biology majors, typically in the junior year. One credit hour.

Fall: M 4:15	Jacobsen
Spring: M 4:15	Jacobsen

199 CMC
Independent Study in Mathematics.

199 HMC
Math Colloquium. Students will attend the weekly Claremont Math Colloquium, offered through the cooperative efforts of the mathematics faculty at the Claremont Colleges. Most of the talks discuss current research in mathematical sciences, and are accessible to undergraduates.

Fall: W 4:15	Jacobsen
Spring: W 4:15	Jacobsen

199 POM
Independent Study: Reading and Research.

199 PIT
Directed Reading in Mathematics. Reading and research in selected topics. Full- or half-course. May be repeated for credit. By permission of instructor only. Each semester Staff

215 CGU (HMC 115)
Fourier Analysis

Fall: MWF 2:45	Yong (HMC)

231 (CMC, HMC, POM 131)
Principles of Real Analysis I. Countable sets, least upper bound, and metric space topology including compactness, completeness, connectivity, and uniform convergence. Related topics as time permits. Prerequisite: HMC Prerequisite: Mathematics 12 and 14 (Math 55 recommended). Pomona Prerequisite: Math 32 and 60, a mathematical course above 100 is strongly recommended.

Fall: MWF 9	Grabiner, S. (POM)
Spring: MW TBA	Ward (HMC)
Spring: TBA	Aksoy (CMC)

231S (SCRIPPS 131)
Principles of Real Analysis I.

Not offered in 2005-2006

232 CGU, (CMC, HMC, POM 132)
Principles of Real Analysis II

Fall: MW 2:45	Castro (HMC)
Sp.: MWF 9:00	Grabiner (POM)

234 (HMC 134)
Advanced Complex Analysis.

Not offered in 2005-2006

235 CGU, (CMC, HMC 135)
Functions of Complex Analysis. Same as 135.

Spring: TBA	Aksoy (CMC)

236 CGU, (HMC 136)
Complex Variables and Integral Transforms. Same as 136.

Fall: MW 1:15	Jacobsen (HMC)

241 CGU (PIT 141)
Hyperbolic Geometry. Same as 141.

Fall: MWF 11	Hoste (PIT)

242 CGU, (HMC 142)
Differential Geometry. Same as 142.

Fall: TTh 1:15	Gu (HMC)

243 (HMC 143)
Topics in Geometry.

Not offered in 2005-2006

244 (CMC 144)
Fourier Analysis

Not offiered in 2005-2006.

247 CGU, (HMC, POM 147)
General Topology. Same as 147.

Spring: TBA	Jacobsen (HMC)
Spring: MWF 11	Flapan (POM)

248P (PIT 148)
Knot Theory.

Not offered in 2005-2006

248 CGU
Algebraic Topology I. Selected topics from homotopy theory and homology theory. Prerequisite: Mathematics 147 or permission of the instructor.

Not offered in 2005-2006

251 CGU, (CMC, POM 151)
Probability and Its Applications. Same as 151.

Fall: Th 7-9:50 pm	Schellhorn (CGU)
Fall: MWF 10 – Sec 1	Aksoy (CMC)
Fall: MW 2:45 – Sec 2	O'Neill (CMC)
Spring: MWF 9	Rumbos (POM)

252 CGU, (CMC, HMC, POM 152)
Statistical Theory. Same as 152.

Fall: TTh 9:35	Kloke (POM)
Spring: TBA	O'Neill (CMC)
Spring: Tu 7-9:50	Ravel (CGU)

253 (CMC 153)
Advanced Topics in Statistical Inference.

Not offered in 2005-2006

256 CGU, (CMC, HMC 156)
Stochastic Processes. Same as 156.

Fall: M 7-9:50 pm	Schellhorn (CGU)
Fall: TTh 1:15	O'Neill (CMC)

258 CGU (CMC,HMC, POM 158)
Statistical Linear Models

Spring: TTh 1:15	Kloke (POM)

259 CGU (POM 159)
Applied Nonparametric Analysis.

Not offered in 2005-2006.

264 (HMC 164)
Scientific Computing.

Spring: TBA	Yong (HMC)

265 CGU (CMC, HMC 165)
Numerical Analysis. Same as 165.

Fall: MW 2:45	de Pillis (HMC)

268 CGU (HMC 168)
Computer Algorithms. Same as 168

Not offered in 2005-2006

271 CGU (CMC, HMC, POM 171)
Abstract Algebra. Same as 171

Fall: MW 1:15	Benjamin (HMC)
Fall: MWF 11	Valenza (CMC)
Spring: TTh 2:45	Sarkis (POM)

271S (SCRIPPS 171)
Abstract Algebra I.

Not offered in 2005-2006

272 (HMC, POM 172)
Abstract Algebra II.

Not offered in 2005-2006.

273 CGU, (HMC 173)
Advanced Linear Algebra. Same as 173.

Spring: TB — Gu (HMC)

275 CGU, (CMC, HMC 175)
Number Theory. Same as 175.

Fall: MWF 11 — Benjamin (HMC)

275S (175 SCRIPPS)
Number Theory.

Not offered in 2005-2006

277 (POM 177)
Advanced Topics in Algebra

Fall: MW 1:15 — Shahriari (POM)

280 CGU (HMC 180)
Applied Analysis. Same as 180.

Fall: MWF 9 — Bernoff (HMC)

281 CGU, (HMC,POM 181)
Dynamical Systems

Not offered in 2005-2006.

282 CGU, (HMC 182)
Partial Differential Equations. Same as 182.

Fall: TTh 2:45 — Aarao (CMC)
Spring: TBA — Jacobsen (HMC)

283H (HMC 183)
Discrete Models in Mathematical Biology.

Not offered in 2005-2006

283P POM 183
Mathematical Modeling.

Spring: MW 2:45 Rumbos (POM)

284 CGU
Topics in Applied Analysis

Not offered in 2005-2006

286 CGU, (CMC, HMC 186)
Stochastic Operations Research. Same as 186.

Not offered in 2005-2006.

287 CGU, (CMC, HMC, POM 187)
Deterministic Operations Research. Same as 187.

Spring: TBA Staff (CMC)
Spring: MW 1:15 Shahriari (POM)

288H (HMC 188)
Social Choice and Decisions. Same as 188**.**

Not offered in 2005-2006.

288C CMC (CGU 288C)
Game Theory. Same as 188.

Not offered in 2005-2006.

289 CGU, (HMC 189)
Special Topics in Mathematics. Same as 189.

Spring: MW 2:45 Nonlinear Boundary Value Problems Castro
Spring: MW 2:45 Nonlinear Functional Analysis Jacobsen

306 CGU
Optimization. The course emphasizes nonlinear programming. It covers numerical methods for finite-dimensional optimization problems with fairly smooth functions. Both non-constrained and constrained optimizations will be discussed. Certain degree of emphasis will be given to the convergence analysis of the numerical methods. Prerequisite: multivariable calculus and numerical linear algebra.

Not offered in 2005-2006

331 CGU, (CMC, HMC, POM 137)
Real & Functional Analysis I.

Fall: MWF 1:15 Aksoy (CMC)

332 CGU, (CMC, HMC, (POM 138)
Real & Functional Analysis II.

Not offered in 2005-2006.

333 CGU
Differential Equations and Complex Analysis in Applied Mathematics
This will be a survey course encompassing the areas of ordinary differential equations, partial differential equations, and complex analysis. The level will be at that met in a full semester undergraduate class, and the emphasis will be on solution techniques.

Not offered in 2005-2006.

334 CGU, (HMC 134)
Complex Analysis II.

Not offered in 2005-2006

335 CGU
Integral Transforms and Applications. Transforms covered will include: Fourier, Laplace, Hilbert, Hankel, Mellin, Radon and Z. The course will be relevant to mathematicians and engineers working in communications, signal and image processing, continuous and digital filters, wave propagation in fluids and solids, etc.

Not offered in 2005-2006.

336 CGU
Image Processing. In fields ranging from entertainment to medicine, computational image processing methods are having major impact. Computer graphics can provide stunning visual effects. Quantitative image analysis allows for accurate identification of features and tracking of motion. A wide variety of problems can be understood and analyzed with the mathematical, statistical, and numerical techniques developed in this course. Basic mathematical structures for representing and manipulating image data will be discussed, leading the way for tackling problems of filtering and image reconstruction, warping and compositing, feature detection, motion capture and tracking, and tomography. Computational implementation and application of the image processing methods will be emphasized throughout the course. Prerequisites: BS in computer science, engineering, mathematics, or physics. Undergraduate level courses in probability and statistics and/or linear systems theory would be helpful.

Not offered in 2005-2006.

337 CGU
Control Systems I. This is an introductory course. The intention is to expose math-major students to control systems theory and design - the well-established field of applied mathematics. Today, control systems specialists are in great demand in both industry and academia. The course is self-contained and assumes no prior knowledge of control from the students (see the course prerequisites). Throughout the course both theoretical and application aspects of control systems will be presented and discussed. Homework will be given every two weeks. Students will be required to perform computer simulation experiments using MATLAB. A mid-term and a final exam will be given. Final grades will depend on the following 4 factors: lecture attendance (10%), homework (30 %), mid-term exam (30 %), and final exam (30%). Prerequisites: Linear algebra, Ordinary differential / difference equations, Numerical analysis (basic understanding), MATLAB.

Not offered in 2005-2006.

338 CGU/KGI

Systems Analysis Techniques: This course provides the basic skills and analysis tools of Classical Control Theory for continuous and discrete-time linear systems. Linearization of nonlinear systems, convolution and matrix transforms, and solution of dynamic equations will be reviewed. Focus will be on state space approaches. Key concepts of duality, controllability, and observability will be discussed in detail. Pole placement and state variable feedback controller design and implementation. Basic observer design and Kalman Filtering will be covered. Prerequisites: Calculus through multivariate, elementary Complex Analysis, Linear Algebra, Statistics and MATLAB programming are recommended.

Not offered in 2005-2006.

341 CGU

Applied Stochastic Methods for Computational Biology I.

This is a 2-semester course involving the application of methods in probability, statistical theory, and stochastic processes to problems of interest to computational biologists. The course is designed to be accessible to students with a mathematical background roughly at the level of undergraduate engineering mathematics. It is expected that students who have taken both semesters of the course will have mastered the basic set of ideas required in order to carry out further research in computational biology methods and algorithms, or to use these ideas in industrial applications. While this is not a course in computer programming, algorithms that implement probabilistic/statistical approaches to computational biology will be discussed. **The course is designed for students from KGI, CGU Math, and Computational Science. Pre-requisites**: Basic understanding of elementary probability and statistics, calculus, linear algebra, and some knowledge of computing, i.e., a reasonable comfort level with at least one computer language used for numerical computation (or the ability to quickly achieve it!) - examples include C/C++, Matlab etc. No knowledge of molecular biology will be assumed - such knowledge will be introduced as part of the course where necessary.

Fall: M 7-9:50 pm Raval

342 CGU

Applied Stochastic Methods in Bioinformatics

This is a the second in a 2-semester course involving the application of methods in probability, statistical theory, and stochastic processes to problems of interest to computational biologists. The course is designed to be accessible to students with a mathematical background roughly at the level of undergraduate engineering mathematics. It is expected that students who have taken both semesters of the course will have mastered the basic set of ideas required in order to carry out further research in computational biology methods and algorithms, or to use these ideas in industrial applications. While this is not a course in computer programming, algorithms that implement probabilistic/statistical approaches to computational biology will be discussed. ***The course is designed for students from KGI, CGU Math, and Computational Science.*** **Prerequisites**: Basic understanding of elementary probability and statistics, calculus, linear algebra, and some knowledge of computing, i.e., a reasonable comfort level with at least one computer language used for numerical computation (or the ability to quickly achieve it!) - examples include C/C++, Matlab etc. No knowledge of molecular biology will be assumed - such knowledge will be introduced as part of the course where necessary.

Spring: M 7-9:50pm Raval

350 CGU

Kalman Filtering. Linear dynamical systems; random processes and stochastic systems; optimal linear filters, predictors, and smoothers; nonlinear applications; implementation issues and applications to problems in engineering, economics, and time series. Prerequisites: Calculus, Probability (math 251 or equivalent), Linear Algebra.

Not offered in 2005-2006..

351 CGU

Time Series Analysis. Analysis of time series data by means of particular models such as ARIMA. Associated methods of inference and applications. Additional topics may include spectral analysis and state-space models. Prerequisite: A course in probability and at least concurrent enrollment in statistics.

Not offered in 2004-2205.

352 CGU

Nonparametric Statistical Inference. Treatment of statistical questions which do not depend on specific parametric models. Examples are testing for symmetry of a distribution and testing for equality of two distributions. Topics may include bootstrapping and other computer intensive methods. Elementary combinatorial methods will play a major role in the course. Prerequisite: a statistics course at the level of 252 or permission of the instructor.

Fall: M 4-6:50 Angus

353 CGU

Asymptotic Methods in Statistics with Applications. Modes of convergence for random variables and their distributions; central limit theorems; laws of large numbers; statistical large sample theory of functions of sample moments, sample quantiles, rank statistics, and extreme order statistics; asymptotically efficient estimation and hypothesis testing. Prerequisites: Math 251 and 252; linear algebra; undergraduate analysis (Math 131 and 132 or equivalent).

Spring: M 4-6:50 Angus

354 CGU

Reliability Theory. Structural properties and reliability of complex systems; classes of life distributions based on aging; maintenance and replacement models; availability, reliability, and mean time between failures for complex systems; Markov models for systems; elementary renewal theory. Prerequisite: Math 251. Math 256 would be helpful but not essential.

Not offered in 2005-2006..

355 CGU

Linear Statistical Analysis. A discussion of linear statistical models in both the full and less-than-full rank cases, the Gauss-Markov theorem, and applications to regression analysis, analysis of variance, and analysis of covariance. Topics in design of experiments and multivariate analysis. Prerequisite: linear algebra and a year course in probability and statistics.

Not offered in 2005-2006.

356 CGU

Game Theory. Models of conflict and/or cooperation. Equilibrium outcomes for non-cooperative games, and cooperative solution concepts for coalitional games: core theory, stable sets, value theories, the nucleolus, and bargaining sets. Applications to economic markets, voting power, bargaining, joint cost allocation. Prerequisites: Graduate student standing (or permission of instructor).

Not offered in 2005-2006.

357 CGU

Advanced Topics and Applications in Probability Theory. Probability spaces, expectation as integration in a probability space, independence, laws of large numbers, central limit theorems, dependent sequences, conditional expectation and probability, Markov and Martingale properties. Applications to the fields of engineering, computer and information science, reliability, statistics, economics and finance, games and gambling, physics, number theory, optimization/numerical analysis, and partial differential equations. Prerequisite: Math 251 (probability) and undergraduate analysis through advanced calculus, or with consent of instructor. Math 331 is recommended.

Not offered in 2005-2006.

358 CGU

Mathematical Finance. This course emphasizes the mathematics used in the valuation of derivative securities. It will cover the necessary tools for modeling price fluctuations in the stock market including Brownian motion, simple stochastic differential equations, Ito's lemma, Arbitrage theory, and the Black-Scholes equation. Students will learn how to solve the basic parabolic partial differential equations arising in finance both explicitly and numerically. Prerequisites: Mature understanding of advanced calculus and probability (at the level of Math 251) and permission of instructor. Math 256 and some familiarity with simple partial differential equations would be helpful.

Spring: Th 7-9:50pm Schellhorn

358B CGU

Advanced Financial Mathematics. First and foremost, this is a course in mathematics that requires a background from the theory of measure and integration sufficient to work with modern developments in probability and stochastic processes. In addition, some familiarity with more classical analysis will help in relating these stochastic ideas to results involving partial differential equations. The focus will be in providing you with a deeper understanding of the mathematics that has produced many important applications to finance in general and, in particular, to the pricing of contingent claims. To quote from the preface of our text: "The Wharton School course that forms the basis for this book is designed for energetic students who have had some experience with probability and statistics but have not had advanced courses in stochastic processes. Although the course assumes only a modest background, it moves quickly, and in the end, students can expect to have tools that are deep enough and rich enough to be relied on throughout their professional careers. **PREREQUISITES:** CGU Mathematics 358A Financial Mathematics, or equivalent preparation. In addition, sufficient analysis and probability background, as explained on the summer reading list that is included with this course information sheet.

Not offered in 2005-2006.

359 CGU

Simulation. This course will introduce the students to the general concepts and tools of simulation analysis using pseudo random numbers generated on a computer. Starting with a background in calculus-based probability theory, the students will learn how to combine the mathematics of probability with the utility of the computer to find approximate solutions to a variety of mathematical problems arising in analysis, probability and statistics, stochastic processes, optimization, and general modeling. In undertaking this study, students will discover that many otherwise intractable problems can often be attacked using simulation techniques that are relatively easy to implement, thus adding to their general problem solving capabilities. Prerequisite: Mastery of Math 251 (Probabilty) or the equivalent

Not offered in 2005-2006.

361 CGU

Numerical Methods for Finance

This course covers the computational methods commonly used in mathematical finance, particularly those relating to the pricing of derivative securities and bonds and the management of dynamic portfolios. Content varies, but typically includes binomial (and higher order) tree methods, numerical linear algebra, finite difference and other methods for solving PDEs, simulation, and Monte Carlo methods. Prerequisites: Math 364 or competency using a high level computing language (preferably, MATLAB), Math 358

Spring: M 1-3:50 Schellhorn

362 CGU

Numerical Methods for Partial Differential Equations. Finite difference, finite element, and spectral methods for elliptic, parabolic and hyperbolic partial differential equations; discussion of discretization schemes, truncation error, consistency, stability, accuracy and convergence; explicit vs. implicit schemes; implementation of Dirichlet, Neumann and Robin boundary conditions; operator splitting; Godunov methods for hyperbolic systems; direct and iterative methods for elliptic systems; Gauss-Seidel, SOR and multigrid methods; Fourier and Chebyshev based spectral and pseudo-spectral methods. Prerequisites: partial differential equations and numerical analysis.

Fall: M 9-11:50am Nadim

364 CGU

Introduction to Computing. This 2 unit module is intended to help students develop a basic competence in scientific computing in a PC/workstation environment, thus preparing them for the mathematics clinic and other work in industrial applied mathematics. Students will be given a high level introduction to computing in MATLAB and compiled high-level languages such as C and FORTRAN. A broad collection of basic numerical techniques will be presented including iterative methods for solving nonlinear equations, approximate integration and differentiation, interpolation, and numerical linear algebra. Additional topics will be covered depending on the interests of the students. By working examples on the computer that illustrate these techniques, students will develop proficiency in the basics of MATLAB and at least one high-level programming language under both Windows and LINUX environments.

Fall: Tu 7-10pm Rangel

368 CGU

Advanced Numerical Analysis. Numerical linear algebra including LU decomposition, Jacobi, Gauss-Seidel and SOR iterations, Krylov subspace methods (Conjugate Gradient, GMRES), QR and SVD factorization of matrices, eigenvalue problems via power, inverse, QR and Arnoldi iterations, error analysis, forward and backward stability; numerical integration of ODEs including Runge-Kutta and Adams formulas, predictor-corrector methods, stiff equation solvers and shooting method for BVPs; other numerical methods including interpolation via Lagrange and Chebyshev polynomials and cubic splines, integration and quadrature with trapezoidal and Simpson rules, Newton-Cotes formulae, Gaussian quadrature, and singular integrals, root-finding via one-point iteration, bisection, Newton and secant methods, numerical differentiation using finite differences, spectral and pseudo-spectral methods. Prerequisites: advanced calculus and elementary numerical analysis.

Spring: M 9-11:50am Nadim

369 CGU

Monte Carlo & Quasi-Monte Carlo Methods. This is an advanced course in which stochastically-motivated mathematical methods are applied to problems of various kinds (e.g., radiation transport, semiconductor, geological and financial modeling, or statistical mechanics) that can be solved by simulations carried out on a computer. Problems studied in this way include those most naturally formulated as integral equations over relatively high dimensional phase spaces, as well as those in which estimates of integrals of functions of a large number of variables are sought. This should be regarded as an advanced course in the applications of probability theory to numerical analysis. Prerequisites include miminally a graduate course in probability theory, a basic course in numerical methods, and facility in programming a computer using a language such as Fortran, C, Basic, or Matlab.

Not offered in 2005-2006.

374 CGU

Encoding and Encryption. The mathematical theory of data encoding and encryption, with much of the necessary abstract algebraic background developed in the course. Topics include: finite groups, rings, and fields; residue arithmetic, the Chinese Remainder Theorem, polynomial algebras over finite fields; basic notions of encoding and error correcting capabilities; (n,k)-linear codes with parity check: the Hamming code; cyclic codes: the BCH code; complexity-theoretic foundations of cryptography; one-way and trapdoor functions; secret key and public key encoding: the Data Encryption Standard, the RSA algorithm; the factorization problem: computer implementation of the arithmetic of large numbers, elementary algorithms, the quadratic sieve method; theory of zero-knowledge protocols. Prerequisites: linear algebra and a substantial course in programming, preferably C++.

Not offered in 2005-2006.

377 CGU

Algebra I. The Sylow theorems, normal series, and other topics from group theory. Topics from ring theory, including projective and injective modules, rings of quotients and localization, chain conditions, primary decomposition of noetherian modules, and the Wedderburn-Artin theorem for semi-simple rings. Prerequisite: a year course in algebra equivalent to undergraduate Mathematics 171, 172 at HMC or at Pomona.

Not offered in 2005-2006.

378 CGU

Algebra II. Topics in algebra selected according to the interests of the instructor and students. Prerequisite: Mathematics 377 or permission of the instructor.

Not offered in 2005-2006.

380 CGU (HMC 189)

Topics in Applied Mathematics: Fluid Dynamics. This course will cover the main components of theoretical fluid mechanics: introduction of the continuum description of a Newtonian fluid, viscous / inviscid flows, boundary-layer theory, compressible / incompressible flows, free-surface hydrodynamics and waves, linear / non-linear acoustics, shock waves. The prerequisites are undergraduate courses in vector calculus, complex analysis, ordinary and partial differential equations.

Not offered in 2005-2006.

381 CGU/(KGI ALS423)

Topics in Applied Mathematics: Microfluidics and Nanotechnology .Examination of trends in miniaturization in the laboratory including microfluidic valves, pumps, mixers, heat exchangers, dispensers (ink-jets and microarray pins), and reactors. Fundamentals of electrokinetic flows, the role of surface tension, microfluidic separation methods, and label-free molecular detection methods. (Note: This course is a 4 unit KGI course but is offered at CGU as a joint effort.)

Not offered in 2005-2006.

382 CGU

Perturbation and Asymptotic Analysis. Non-dimensionalization and scaling, regular and singular perturbation problems, asymptotic expansions; asymptotic evaluation of integrals with Laplace's approximation, Watson's lemma, steepest descents and stationary phase; perturbation methods in ordinary and partial differential equations; boundary layers and matched asymptotic expansions; method of multiple time scales; homogenization; WKB method, rays and geometrical optics. Prerequisite: differential equations.

Spring: TTh 2:45-4 Cumberbatch

386 CGU

Graph Modeling. Basics of theory and application, covering simple graphs through planar graphs, Euler's formula, Platonic graphs, coloring, the genus of a graph, Euler walks, and Hamilton walks. Applications will include Transportation Problems, Connection Problems, Party Problems, Diagraphs and Mathematical Models, Games and Puzzles, Graphs and Social Psychology.

Spring: TBA Bachman (PIT)

388 CGU

Continuous Mathematical Modeling. A course aimed at the construction, simplification, analysis, interpretation and evaluation of mathematical models that shed light on problems arising in the physical, biological and social sciences. Derivation and methods for solution of model equations, heat conduction problems, simple random walk processes, simplification of model equations, dimensional analysis and scaling, perturbation theory, and a discussion of self-contained modular units that illustrate the principal modeling ideas. Students will normally be expected to develop a modeling project as part of the course requirements. Prerequisite: Permission of the instructor.

Not offered in 2005-2006

389 CGU

Discrete Mathematical Modeling. A companion course to Mathematics 388 with emphasis on discrete, rather than continuous models. Mathematical topics will normally be drawn from combinatorics, probability, statistics, and operations research and algorithms. Prerequisite: Permission of the instructor.

Not offered in 2005-2006

392-393 CGU

Mathematics Clinic. Participation in projects or problems with a substantial mathematical and/or computational content. Students will typically work in teams of 2-4 persons, with appropriate faculty supervision. Problems will vary considerably depending upon student interest and program of study, but will normally require computer implementation and documentation. Prerequisite: permission of the instructor.

Fall/Spring: TBA Cumberbatch/Morris

397 CGU
Tutorial Reading

398 CGU
Independent Study.

438 CGU
Seminar in Chaotic Dynamics.

Not offered in 2005-2006.

439 CGU, (HMC 139)
Seminar in Analysis. Same as 139.

Not offered in 2005-2006

449 (HMC 149)
Seminar in Topology.

Not offered in 2005-2006

460 CGU
Geometric Modeling. Geometric modeling evokes a curious mix of the visual and the analytic in the eyes and minds of those of us who study and apply it. The visual response arises from its association with the simulation of shapes that define objects in the real world, from its association with the potential reality of the designer's work, and from its symbiosis with computer graphics. The analytical response arises from an awareness of the elegant and often subtle mathematics that is its foundation. Computer Aided Geometric Modeling (CAGM) plays a significant role in the construction designing and manufacturing of various objects. In addition to its critical importance in the traditional fields of automobile and aircraft manufacturing, shipbuilding, and general product design, more recently, the CAGM methods have also proven to be indispensable in a variety of modern industries, including computer vision, robotics, medical imaging, visualization, and even media. The topics in this course will include the following four parts: 1. How to represent elementary forms (for example, curves, surfaces, and solids)? 2. How to shape and assemble those forms into more complex objects? 3. How to process the necessary geometry (for example, computation of intersections, offsets, and fillets) concurrently? 4. What are the applications? (We are going to use real world applications to motivate each of the above three topics through out the course.) Prerequisites: Calculus, Linear Algebra, Analytic Geometry, and Vector and Matrix Methods. Recommended but not necessary: Differential Geometry, and Programming Skills.

Fall: M 1-3:50 Gu (HMC)

461 CGU

Level-Set Methods. This course provides an introduction to level-set methods and dynamic implicit surfaces for describing moving fronts and interfaces in a variety of settings. Mathematical topics include: construction of signed distance functions, the level-set equation, Hamilton-Jacobi equations, motion of a surface normal to itself, re-initialization, extrapolation in the normal direction, and the particle level-set method. Applications will include image processing and computer vision, image restoration, de-noising and de-blurring, image segmentation, surface reconstruction from unorganized data, one- and two-phase fluid dynamics (both compressible and incompressible), solid/fluid structure interaction, computer graphics simulation of fluids (e.g., smoke, water), heat flow, and Stefan problems. Appropriate for students in applied and computational mathematics, computer graphics, science, or engineering. Prerequisite: Advanced Calculus, Numerical Methods, Computer Programming

Not offered in 2005-2006.

462 CGU

Bayesian Inference and Machine Learning, Spring 2005.
This is a one-semester 4-unit course covering selected topics in Bayesian inference and machine learning. In the first half of the course, students will learn about exact Bayesian inference methods as well as approximate, heuristic methods, such as Monte Carlo sampling and variational methods. The second half of the course will focus on machine learning techniques, primarily neural networks and Gaussian processes. The course is expected to be useful for students with a broad array of backgrounds, including Applied Mathematics, Computational Science, Computational Biology, and Financial Engineering. **Pre-requisites:** The desired pre-requisites for the course are elementary probability theory and the ability to program in Matlab/Octave/C/C++ or any other numerical programming language.

Not offered in 2005-2006.

469 CGU

Seminar in Neural Networks and Exotic Algorithms. We study neural networks and other methods such as genetic algorithms and simulated annealing that are highly parallel in nature and deal with problems of optimization that are global in character.

Not offered in 2005-2006

470 CGU

Research Seminar in Monte Carlo & Quasi-Monte Carlo Methods. Research Seminar in Monte Carlo & Quasi-Monte Carlo Methods. A research-level seminar dealing with selected current topics, drawn from relevant Clinic projects, student and faculty research. (0-4 units - arr. with instructor).

Not offered in 2005-2006.

473 CGU, (POM)

Seminar in Combinatorics. The seminar will consist of weekly talks given by participants on a wide range of combinatorial topics. Possible topics are Combinatorics of Finite Sets, Graph Theory, Game Theory, Enumerative Combinatorics, Combinatorial Matrix Theory, and Ramsey Theory. Students who register for the course will be expected to give one or two talks during the semester. Prerequisite: Consent of instructor. Grading: Satisfactory/Unsatisfactory (P/NC).

Not offered in 2005-2006.

489 CGU

Seminar in Partial Differential Equations.

Not offered in 2005-2006.

495 CGU

Dissertation Research.

497 CGU
Tutorial Reading. Available to advanced students of proven ability with the permission of the instructor. Tutorials are normally not available in areas where courses or seminars are offered, unless the student has taken the seminar and wishes to do further study in that area.

498 CGU
Independent Study.

499 CGU
Doctoral Study.

400M CGU
Continuous Registration (Master)