Department of Mathematics

2018 - Spring Semester

GRADUATE COURSE SPRING 2018

This schedule is subject to changes. Please contact the Course Instructor for confirmation.

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<tr>
<td>Math 4309</td>
<td>15452</td>
<td>Mathematical Biology</td>
<td>TuTh, 4—5:30pm</td>
<td>SEC 104</td>
<td>R. Azevedo</td>
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<tr>
<td>Math 4315</td>
<td>23485</td>
<td>Graph Theory w/Applications</td>
<td>TuTh, 4—5:30pm</td>
<td>C 104</td>
<td>K. Josic</td>
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<tr>
<td>Math 4332/6313</td>
<td>11974/13537</td>
<td>Introduction to Real Analysis II</td>
<td>TuTh, 8:30—10am</td>
<td>C 106</td>
<td>B. Bodmann</td>
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<tr>
<td>Math 4364</td>
<td>18808</td>
<td>Intro. to Numerical Analysis in Scientific Computing</td>
<td>MW, 4—5:30pm</td>
<td>SW 102</td>
<td>T.W. Pan</td>
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<tr>
<td>Math 4365</td>
<td>17019</td>
<td>Numerical Methods for Differential Equations</td>
<td>TuTh, 11:30am—1pm</td>
<td>AH 301</td>
<td>J. He</td>
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<td>Math 4377/6308</td>
<td>14343/13538</td>
<td>Advanced Linear Algebra I</td>
<td>MWF, Noon—1pm</td>
<td>GAR 201</td>
<td>M. Kalantar</td>
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<td>Math 4377/6308</td>
<td>18001/18002</td>
<td>Advanced Linear Algebra I (online)</td>
<td>Online</td>
<td>Online</td>
<td>J. Morgan</td>
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<td>Math 4378/6309</td>
<td>11975/13539</td>
<td>Advanced Linear Algebra II</td>
<td>TuTh, 1—2:30pm</td>
<td>F 154</td>
<td>A. Mamonov</td>
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<td>Math 4380</td>
<td>11976</td>
<td>A Mathematical Introduction to Options</td>
<td>TuTh, 1—2:30pm</td>
<td>CBB 108</td>
<td>M. Papadakis</td>
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<td>Math 4383</td>
<td>23486</td>
<td>Number Theory</td>
<td>TuTh, 10—11:30am</td>
<td>CV N115</td>
<td>M. Ru</td>
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<tr>
<td>Math 4389</td>
<td>11977</td>
<td>Survey of Undergraduate Mathematics</td>
<td>MWF, 11am—Noon</td>
<td>GAR 201</td>
<td>D. Blecher</td>
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<tr>
<td>Math 4397</td>
<td>26700</td>
<td>Mathematical Methods for Physics</td>
<td>TuTh, 5:30-7pm</td>
<td>SR 606</td>
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GRADUATE ONLINE COURSES

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<td>13363</td>
<td>Abstract Algebra</td>
<td>Arrange (online course)</td>
<td>K. Kaiser</td>
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<tr>
<td>Math 5332</td>
<td>11996</td>
<td>Differential Equations</td>
<td>Arrange (online course)</td>
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<td>12003</td>
<td>Modern Algebra II</td>
<td>MWF, 11am—Noon</td>
<td>SW 423</td>
<td>A. Haynes</td>
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<tr>
<td>Math 6308</td>
<td>13538</td>
<td>Advanced Linear Algebra I</td>
<td>MW, Noon—1pm</td>
<td>GAR 201</td>
<td>M. Kalantar</td>
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<tr>
<td>Math 6308</td>
<td>18002</td>
<td>Advanced Linear Algebra I (online)</td>
<td>Online</td>
<td>Online</td>
<td>J. Morgan</td>
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<tr>
<td>Math 6309</td>
<td>13539</td>
<td>Advanced Linear Algebra II</td>
<td>TuTh, 1—2:30pm</td>
<td>F 154</td>
<td>A. Mamonov</td>
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<tr>
<td>Math 6313</td>
<td>13537</td>
<td>Introduction to Real Analysis</td>
<td>TuTh, 8:30—10am</td>
<td>C 106</td>
<td>B. Bodmann</td>
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<tr>
<td>Math 6321</td>
<td>12020</td>
<td>Theory of Functions of a Real Variable</td>
<td>MWF, 9—10am</td>
<td>SEC 201</td>
<td>V. Climenhaga</td>
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<tr>
<td>Math 6327</td>
<td>23489</td>
<td>Partial Differential Equations</td>
<td>TuTh, 4—5:30pm</td>
<td>AH 15</td>
<td>G. Auchmuty</td>
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<td>Math 6357</td>
<td>23491</td>
<td>Design of Experiments</td>
<td>MW, 2:30—4pm</td>
<td>SW 423</td>
<td>B. Manandhar</td>
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<td>Math 6361</td>
<td>13541</td>
<td>Applicable Analysis</td>
<td>TuTh, 8:30—10am</td>
<td>AH 7</td>
<td>Y. Gorb</td>
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<tr>
<td>Math 6365</td>
<td>23493</td>
<td>Automatic Learning and Data Mining</td>
<td>TuTh, 11:30am—1pm</td>
<td>M 109</td>
<td>R. Azencott</td>
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<tr>
<td>Math 6367</td>
<td>12021</td>
<td>Optimization Theory</td>
<td>MW, 2:30—4pm</td>
<td>SEC 203</td>
<td>R. Hoppe</td>
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<tr>
<td>Math 6371</td>
<td>12022</td>
<td>Numerical Analysis</td>
<td>MW, 4—5:30pm</td>
<td>SW 229</td>
<td>M. Olshanskiy</td>
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<td>Math 6374</td>
<td>23490</td>
<td>Numerical Partial Differential Equations</td>
<td>MW, 1—2:30pm</td>
<td>SW 219</td>
<td>Y. Kuznetsov</td>
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<td>Math 6383</td>
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<td>Probability Statistics</td>
<td>MW, 4—5:30pm</td>
<td>SW 423</td>
<td>W. Fu</td>
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<td>Math 6385</td>
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<td>Continuous-Time Models in Finance</td>
<td>TuTh, 2:30—4pm</td>
<td>AH 301</td>
<td>E. Kao</td>
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<td>Math 6397</td>
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<td>Biomedical Modeling</td>
<td>TuTh, 2:30—4pm</td>
<td>SW 423</td>
<td>A. Skripnikov</td>
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<td>Math 6397</td>
<td>23498</td>
<td>Multivariate Statistical Analysis</td>
<td>TuTh, 4—5:30pm</td>
<td>AH 11</td>
<td>W. Fu</td>
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<td>Math 6397</td>
<td>23499</td>
<td>Financial &amp; Energy Time Series Analysis</td>
<td>TuTh, 10—11:30am</td>
<td>CV N115</td>
<td>E. Kao</td>
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<tr>
<td>Math 7352</td>
<td>23494</td>
<td>Riemannian Geometry</td>
<td>MW, Noon—1pm</td>
<td>C 102</td>
<td>V. Climenhaga</td>
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<tr>
<td>Math 7381</td>
<td>23495</td>
<td>Stochastic Process</td>
<td>TuTh, 11:30am—1pm</td>
<td>SEC 201</td>
<td>I. Timofeyev</td>
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--------------------------Course Details-------------------------------

**SENIOR UNDERGRADUATE COURSES**

**Math 4309 (15672) - Mathematical Biology**

**Prerequisites:**
MATH 3331 and BIOL 3306 or consent of instructor.

**Text(s):**
Topics in mathematical biology, epidemiology, population models, models of genetics and evolution, network theory, pattern formation, and neuroscience. Students may not receive credit for both MATH 4309 and BIOL 4309.

Math 4315 (23485) - Graph Theory w/Applications
Prerequisites: Either MATH 3330 or MATH 3336 and three additional hours of 3000-4000 level Mathematics
Text(s): Networks, Crowds, and Markets: Reasoning About a Highly Connected World. By David Easley and Jon Kleinberg. This text is available at this link: https://www.cs.cornell.edu/home/kleinber/networks-book/

Description:
Introduction to basic concepts, results, methods, and applications of graph theory.

Additional Description: How does information propagate between friends and acquaintances on social media? How do diseases spread, and when do epidemics start? How should we design power grids to avoid failures, and systems of roads to optimize traffic flow? These questions can be addressed using network theory. Students in the course will develop a sound knowledge of the basics of graph theory, as well as some of the computational tools used to address the questions above. Course topics include basic structural features of networks, generative models of networks, centrality, random graphs, clustering, and dynamical processes on graphs.

Math 4332 (11974) - Introduction to Real Analysis II
Prerequisites: MATH 4331 or consent of instructor

Description:
Further development and applications of concepts from MATH 4331. Topics may vary depending on the instructor's choice. Possibilities include: Fourier series, point-set topology, measure theory, function spaces, and/or dynamical systems.

Math 4364 (18808) - Numerical Analysis in Scientific Computing
**Prerequisites:**

MATH 3331 and COSC 1410 or equivalent or consent of instructor.

**Instructor's Prerequisite Notes:**

1. MATH 2331, In depth knowledge of Math 3331 (Differential Equations) or Math 3321 (Engineering Mathematics)

2. Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.

**Text(s):**


This is an one semester course which introduces core areas of numerical analysis and scientific computing along with basic themes such as solving nonlinear equations, interpolation and splines fitting, curve fitting, numerical differentiation and integration, initial value problems of ordinary differential equations, direct methods for solving linear systems of equations, and finite-difference approximation to a two-points boundary value problem. This is an introductory course and will be a mix of mathematics and computing.

Math 4365 (17019) - Numerical Methods for Differential Equations

**Prerequisites:**

MATH 3331, or equivalent, and three additional hours of 3000–4000 level Mathematics.

**Text(s):**


**Description:**

Numerical differentiation and integration, multi-step and Runge-Kutta methods for ODEs, finite difference and finite element methods for PDEs, iterative methods for linear algebraic systems and eigenvalue computation.

Math 4377 (14343) - Advanced Linear Algebra I

**Prerequisites:**

MATH 2331 or equivalent, and three additional hours of 3000–4000 level Mathematics.

**Text(s):**


**Description:**

Linear systems of equations, matrices, determinants, vector spaces and linear transformations, eigenvalues and eigenvectors.

**Additional Notes:** This is a proof-based course. It will cover Chapters 1-4 and the first two sections of Chapter 5. Topics include systems of linear equations, vector spaces and linear transformations (developed axiomatically), matrices, determinants, eigenvectors and diagonalization.

Math 4377 (18001) - Advanced Linear Algebra I (Online)

**Prerequisites:**

MATH 2331 or equivalent, and six additional hours of 3000–4000 level Mathematics.

**Text(s):**

Linear systems of equations, matrices, determinants, vector spaces and linear transformations, eigenvalues and eigenvectors.

Additional Description: In addition to the material listed, I will cover diagonalization, inner products and norms, orthogonality, the Gram-Schmidt process and orthogonal projection.

Syllabus

Math 4378 (11975) - Advanced Linear Algebra II
Prerequisites: MATH 4377
Text(s):

Similarity of matrices, diagonalization, Hermitian and positive definite matrices, normal matrices, and canonical forms, with applications.

Instructor's Additional notes: This is the second semester of Advanced Linear Algebra. I plan to cover Chapters 5, 6, and 7 of textbook. These chapters cover Eigenvalues, Eigenvectors, Diagonalization, Cayley-Hamilton Theorem, Inner Product spaces, Gram-Schmidt, Normal Operators (in finite dimensions), Unitary and Orthogonal operators, the Singular Value Decomposition, Bilinear and Quadratic forms, Special Relativity (optional), Jordan Canonical form.

Math 4380 (12062) - A Mathematical Introduction to Options
Prerequisites: MATH 2433 and MATH 3338.
Text(s):
An Introduction to Financial Option Valuation: Mathematics, Stochastics and Computation | Edition: 1; Desmond Higham; 9780521547574

Arbitrage-free pricing, stock price dynamics, call-put parity, Black-Scholes formula, hedging, pricing of European and American options.

Math 4383 (23486) - Number Theory
Prerequisites: MATH 3330
Text(s):

Perfect numbers, quadratic reciprocity, quadratic residues, algebraic numbers, and continued fractions.

Math 4389 (11977) - Survey of Undergraduate Mathematics
Prerequisites: MATH 3330, MATH 3331, MATH 3333, and three hours of 4000-level Mathematics.
Text(s):
Instructor will use his own notes

Description: A review of some of the most important topics in the undergraduate mathematics curriculum.
Math 4397 (26700) - Mathematical Methods for Physics
Prerequisites: MATH 3333 or consent of instructor
Text(s): TBD
Description: Selected topics in Mathematics. May be repeated with approval of chair.

ONLINE GRADUATE COURSES

MATH 5330 (13363) - Abstract Algebra
Prerequisites: Graduate standing.
(You can use the first edition. The second edition contains additional chapters that cannot be covered in this course.)
Description: Groups, rings and fields; algebra of polynomials, Euclidean rings and principal ideal domains. Does not apply toward the Master of Science in Mathematics or Applied Mathematics.

Other Notes: This course is meant for students who wish to pursue a Master of Arts in Mathematics (MAM). Please contact me in order to find out whether this course is suitable for you and/or your degree plan. Notice that this course cannot be used for MATH 3330, Abstract Algebra.

MATH 5332 (11996) - Differential Equations
Prerequisites: Graduate standing, MATH 5331.
Text(s): TBA
Description: Linear and nonlinear systems of ordinary differential equations; existence, uniqueness and stability of solutions; initial value problems; higher dimensional systems; Laplace transforms. Theory and applications illustrated by computer assignments and projects. Applies toward the Master of Arts in Mathematics degree; does not apply toward the Master of Science in Mathematics or the Master of Science in Applied Mathematics degrees.

MATH 5333 (23487) - Analysis
Prerequisites: Graduate standing, and two semesters of calculus.
Text(s): Analysis with an Introduction to Proof | Edition: 5, Steven R. Lay, 9780321747471
Description: A survey of the concepts of limit, continuity, differentiation and integration for functions of one variable and functions of several variables; selected applications.
MATH 5386 (15109) - Regression and Linear Models (VEE approved course)

Prerequisites: Graduate standing. Two semesters of calculus, one semester of linear algebra, and MATH 5385, or consent of instructor.

Text(s):

Description:
Simple and multiple linear regression, linear models, inferences from the normal error model, regression diagnostics and robust regression, computing assignments with appropriate software. Applies toward Master of Arts in Mathematics degree; does not apply toward the Master of Science in Mathematics or the Master of Science in Applied Mathematics degrees.

Note: This course is VEE approved for the regression component only. Approval Code: 4458-11008. For more information on VEE approved courses, click here.

MATH 5397 (23488) - Dynamical Systems

Prerequisites: Graduate standing. Three semesters of Calculus or consent of instructor. Basic knowledge of ODE's is helpful, but not required

Text(s):

Description:
We will discuss applications of nonlinear dynamics, following the book by Strogatz. Topics that will be considered include (for more details, check the book's table of contents): an introduction to Ordinary Differential Equations (ODE's), one-dimensional ODE's and their bifurcations; two-dimensional ODE's (linear case, limit cycles and the Poincare-Bendixson Theorem, the Hopf bifurcation), chaotic systems (logistic family, Lorenz equations, Henon map). For visualization we will use tools that do not require programming, with the option to additionally run/write Matlab code.

MATH 6303 (12003) - Modern Algebra II

Prerequisites: Graduate standing. MATH 4333 or MATH 4378

Additional Prerequisites: students should be comfortable with basic measure theory, groups rings and fields, and point-set topology

Text(s):
No textbook is required.
Topics from the theory of groups, rings, fields, and modules.

**Additional Description:** This is primarily a course about analysis on topological groups. The aim is to explain how many of the techniques from classical and harmonic analysis can be extended to the setting of locally compact groups (i.e. groups possessing a locally compact topology which is compatible with their algebraic structure). In the first part of the course we will review basic point set topology and introduce the concept of a topological group. The examples of p-adic numbers and the Adeles will be presented in detail, and we will also spend some time discussing \( SL_2(R) \). Next we will talk about characters on topological groups, Pontryagin duality, Haar measure, the Fourier transform, and the inversion formula. We will focus on developing details in specific groups (including those mentioned above), and applications to ergodic theory and to number theory will be discussed.

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**Math 6308 (13538) - Advanced Linear Algebra I**

**Prerequisites:** Graduate standing, MATH 2331 and a minimum of 3 semester hours transformations, eigenvalues and eigenvectors.


**Description:**

**Additional Notes:** This is a proof-based course. It will cover Chapters 1-4 and the first two sections of Chapter 5. Topics include systems of linear equations, vector spaces and linear transformations (developed axiomatically), matrices, determinants, eigenvectors and diagonalization.

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**Math 6308 (18002) - Advanced Linear Algebra I (online)**

**Prerequisites:** Graduate standing, MATH 2331 and a minimum of 3 semester hours transformations, eigenvalues and eigenvectors.


**Description:**

Transformations, eigenvalues and eigenvectors. An expository paper or talk on a subject related to the course content is required.

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**Math 6309 (13539) - Advanced Linear Algebra II**

**Prerequisites:** Graduate standing and MATH 6308


**Description:**

Similarity of matrices, diagonalization, hermitian and positive definite matrices, canonical forms, normal matrices, applications. An expository paper or talk on a subject related to the course content is required.
**MATH 6313 (13537)** - Introduction to Real Analysis II

**Prerequisites:**
Graduate standing and MATH 6312.

**Text(s):**
TBA

Properties of continuous functions, partial differentiation, line integrals, improper integrals, infinite series, and Stieltjes integrals. An expository paper or talk on a subject related to the course content is required.

**Description:**

**MATH 6321 (12020)** - Theory of Functions of a Real Variable II

**Prerequisites:**
Graduate standing. MATH 4332 or consent of instructor.

**Instructor's Prerequisite Notes:**
MATH 6320

**Text(s):**

- Primary (Required): Real Analysis for Graduate Students, Richard F. Bass


Lebesque measure and integration, differentiation of real functions, functions of bounded variation, absolute continuity, the classical Lp spaces, general measure theory, and elementary topics in functional analysis.

**Description:**

**Instructor's Additional Notes:** Math 6321 is the second course in a two-semester sequence intended to introduce the theory and techniques of modern analysis. The core of the course covers elements of functional analysis, Radon measures, elements of harmonic analysis, the Fourier transform, distribution theory, and Sobolev spaces. Additional topics will be drawn from potential theory, ergodic theory, and the calculus of variations.

**MATH 6327 (23489)** - Partial Differential Equations

**Prerequisites:**
Graduate standing. MATH 4331

*No required text.*

**Text(s):**

Some topics are covered in:


Existence and uniqueness theory in partial differential equations; generalized solutions and convergence of approximate solutions to partial differential systems.

**Additional Description:** This course will develop the basic tools needed to prove existence uniqueness results for weak solutions of linear evolution problems. The results will be obtained using Galerkin and spectral methods in a Hilbert space setting. This will be used to study linear initial boundary value problems for parabolic equations (heat and diffusion equations). Also some properties of the solutions including regularity results and maximum principles.

If time permits, some results on linear hyperbolic equations will also be described.

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**MATH 6357 (23491) - Design of Experiments**

**Prerequisites:** Graduate standing. MATH 2433, MATH 3338, MATH 3339, and MATH 6308


**Description:** Linear regressions, model adequacy, completely randomized design, randomized complete block design, fixed effects and random effects design and analysis, Latin square design, factorial designs, etc.

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**MATH 6361 (13541) - Applicable Analysis**

**Prerequisites:** Graduate standing. MATH 4332 or consent of instructor.

**Text(s):** The instructor will provide lecture notes on the material. A reference text is L.D. Berkowitz, Convexity and Optimization in R^n, Wiley-Interscience 2002.

**Description:** This course provides an introduction to the mathematical analysis of finite dimensional optimization problems. Topics to be studied include the existence of, and the extremality conditions that hold at, solutions of constrained and unconstrained optimization problems. Elementary theory of convex sets, functions and constructions from convex analysis will be introduced and used. Concepts include subgradients, conjugate functions and some duality theory. Specific problems to be studied include energy and least squares methods for solving linear equations, important inequalities, eigenproblems and some nonlinear programming problems from applications.

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**MATH 6365 (23493) - Automatic Learning and Data Mining**

**Prerequisites:** Graduate standing. MATH 3338 and MATH 3339.

**Text(s):** The instructor will provide lecture notes on the material. A reference text is L.D. Berkowitz, Convexity and Optimization in R^n, Wiley-Interscience 2002.

**Description:** Automatic learning and data mining cluster high-dimension inputs to predict their impact on decision outputs. Kernel based Clustering and Learning enable dictionary generation, pattern classification, non linear regression. Applications: shape recognition, genes expression analysis, etc.
MATH 6367 (12021) - Optimization Theory
Prerequisites: Graduate standing, MATH 4331 and MATH 4377.


Additional Description: This course consists of two parts. The first part is concerned with an introduction to Stochastic Linear Programming (SLP) and Dynamic Programming (DP). As far as DP is concerned, the course focuses on the theory and the application of control problems for linear and nonlinear dynamic systems both in a deterministic and in a stochastic framework. Applications aim at decision problems in finance. In the second part, we deal with continuous-time systems and optimal control problems in function space with emphasis on evolution equations.

MATH 6371 (12022) - Numerical Analysis
Prerequisites: Graduate standing.


Description: Ability to do computer assignments. Topics selected from numerical linear algebra, nonlinear equations and optimization, interpolation and approximation, numerical differentiation and integration, numerical solution of ordinary and partial differential equations.

MATH 6374 (23490) - Numerical Partial Differential Equations
Prerequisites: Graduate standing, MATH 6371

Text(s): Instructor will provide his own notes.

Description: Finite difference, finite element, collocation and spectral methods for solving linear and nonlinear elliptic, parabolic, and hyperbolic equations and systems with applications to specific problems.

MATH 6383 (12023) - Probability Statistics
Prerequisites: Graduate standing, MATH 3334, MATH 3338 and MATH 4378.


**Reference Texts:**

**Description:**
A survey of probability theory, probability models, and statistical inference. Includes basic probability theory, stochastic processes, parametric and nonparametric methods of statistics.

**Instructor's Description:** This course is designed for graduate students who have been exposed to basic probability and statistics and would like to learn more advanced statistical theory and techniques in modelling data of various types, including continuous, binary, counts and others. The selected topics will include basic probability distributions, likelihood function and parameter estimation, hypothesis testing, regression models for continuous and categorical response variables, variable selection methods, model selection, large sample theory, shrinkage models, ANOVA and some recent advances.

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**MATH 6385 (23492) - Continuous-Time Models in Finance**

Prerequisites: Graduate Standing, MATH 6384

**Text(s):**

**Description:**
Stochastic calculus, Brownian motion, change of measures, Martingale representation theorem, pricing financial derivatives whose underlying assets are equities, foreign exchanges, and fixed income securities, single-factor and multi-factor HJM models, and models involving jump diffusion and mean reversion.

**Additional Description:** The course is an introduction to continuous-time models in finance. We first cover tools for pricing contingency claims. They include stochastic calculus, Brownian motion, change of measures, and martingale representation theorem. We then apply these ideas in pricing financial derivatives whose underlying assets are equities, foreign exchanges, and fixed income securities. In addition, we will study models involving jump diffusion and mean reversion and the use of Levy processes in finance.
MATH 6397 (23497) - Biomedical Modeling

Graduate standing.

Prerequisites:

Additional Prerequisite: Basic probability and statistics understanding, familiarity with R programming is encouraged.

Text(s):


May be repeated with approval of chair.

Additional Description: Course will deal with a select variety of statistical methodologies used in medical research. Just to name a few - survival analysis, longitudinal data modeling, logistic regression, sample size calculation, analysis of DNA microarray data. It won't be overly heavy on medical terminology, predominantly focusing on description of main ideas and applications for most ubiquitous statistical techniques and models. Course may come in handy for both the math/statistics/engineering students in order to acquaint themselves with medical applications, and for biology/chemistry students to better understand the statistical approaches used in medical research. The main software used throughout the course will be R Statistical Computing language, for which there will be a brief introduction during the first couple of lectures. All-in-all, at the end of the course, a successful student should:

- have a conceptual grasp of most popular statistical techniques used in medical research problems
- be able to use R statistical programming as a tool for conducting research and data analysis
- feel relatively comfortable when given a data file and asked to carry out particular analysis (be it comparison of medical treatments or performing logistic regression, among others

Software: Make sure to download R and RStudio (which can't be installed without R) before the course starts. Use the link https://www.rstudio.com/products/rstudio/download/ to download it from the mirror appropriate for your platform. Let me know via email in case you encounter difficulties.

Syllabus (PDF)

MATH 6397 (23498) - Multivariate Statistical Analysis

Graduate standing.

Prerequisites:

Additional Prerequisite: Two years of Calculus, Math 6308 Advanced Linear Algebra I, Math 5386 Regression and Linear Models, or equivalent.

Text(s):

TBD
MATH 6397 (23499) - Financial & Energy Time Series Analysis

**Prerequisites:**
Graduate standing.

**Text(s):**

**Description:**
May be repeated with approval of chair.

**Additional Description:**
The course is about time analysis with special emphases on financial and energy data. The course covers ARIMA models, ARCH/GARCH models, nonlinear models, high frequency data analysis, parameter estimation for diffusion and related processes, multivariate time series, extreme value analysis, Copulas, Levy processes, and an introduction of Markov chain Monte Carlo Methods. We will use R for computing.

MATH 7352 (23494) - Riemannian Geometry

**Prerequisites:**
Graduate standing.

**Text(s):**

**Description:**
Differentiable Manifolds, tangent space, tangent bundle, vector bundle, Riemannian metric, connections, curvature, completeness geodesics, Jacobi fields, spaces of constant curvature, and comparison theorems.

**Additional Description:**
This course is an introduction to the theory of smooth manifolds, with an emphasis on their geometry. The first third of the course will cover the basic definitions and examples of smooth manifolds, smooth maps, tangent spaces, and vector fields. Later in the semester we will use Euclidean, spherical, and hyperbolic geometry to introduce the notion of a Riemannian metric; we will study parallel transport, geodesics, the exponential map, and curvature. Other topics will include Lie theory and differential forms, including exterior differentiation and Stokes theorem.

The textbook highlights connections of this theory to dynamical systems; these may be mentioned in lectures but are not the focus of this course: this is first and foremost a course in differential geometry, which is oriented towards the associated preliminary exam.
**MATH 7381 (23499) - Selected Topics in Mathematics**

**Prerequisites:**
Graduate standing, MATH 6382

**Text(s):**
TBD

**Description:**
Discrete-time and continuous-time Markov chains, poisson process, diffusions and analysis of multiscale systems