Department of Mathematics

Fall 2014

I. GRADUATE COURSE CATALOG

II. GRADUATE COURSE Fall 2014 - (08/25/2014 - 12/18/2014)

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Math 4320 - Section# 15313 - Introduction to Stochastic Processes - by A. Torok
Math 4331 - Section# 22624 - Introduction to Real Analysis - by V. Paulsen
Math 4350 - Section# 22507 - Differential Geometry - by M. Ru
Math 4362 - Section# 20585 - Theory of Ordinary Differential Equations - by J. Qiu
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GRADUATE COURSES

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Math 6382 - Section# 15364 - Probability Models and Mathematical Statistics (H. Zhang)
Math 6384 - Section# 15365 - Discrete -Time Models in Finance (E. Kao)

Math 6397 - Section# 22615 - Mathematical Hemodynamics (S. Canic)
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SENIOR UNDERGRADUATE COURSES

Math 4310 Biostatistics (Section# 22623)

Time: TuTh 11:30AM - 1:00PM - Room: F 162
Instructor: R. Azencott
Prerequisites: MATH 3339 and BIOL 3306 or consent of instructor.
Text(s): Selected topics in "The analysis of biological data" (M. Whitlock, D. Schluter), Roberts and Co, 2009

Description:

Learning Objectives
This course covers key applications of statistical methods to biological and biomedical data. Statistical techniques will be motivated by typical case studies of actual data . Simple programming projects will allow students to become familiar with computer implementation of these methods with R, the free open source software package to be used in the course and homeworks.

Major Assignments/Exams
- **Homework**: Average grade of ALL homeworks will contribute 50% of final grade.
- **Exams**: Two midterm exams in class and one final exam. For all exams : Closed books and closed lecture notes.
- **Grades** : Final grade is a weighted average
10% Midterm1 + 15% Midterm2 + 25% Final exam + 50% AverageHomeworks
Conversion into letter grade using the standard scale
90%-100%: A, 80%-89%: B, 70%-79%: C, 60%-69% D; 0%-59%: F

List of discussion/lecture topics
Basic concepts of probability and statistics will be reviewed or outlined (means, variances, histograms, quantiles, density functions, Binomial, Poisson, and Normal distributions, independence, conditional probabilities). Concrete examples of Parameter estimation and Confidence intervals. Examples of hypothesis testing to evaluate impact of medical treatments. Comparative analysis of two populations. Non parametric rank tests. Contingency tables and their applications. Further applied topics to be selected from textbook.

Note: The information contained in this class syllabus is subject to change without notice. Students are expected to be aware of any additional course policies presented by the instructor during the course.

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Math 4320 Introduction to Stochastic Processes (Section# 15313)

Time: TuTh 1:00AM - 2:30PM - Room: AH2
Instructor: A. Torok
Prerequisites: Math 3338

Text(s):	"An Introduction to Stochastic Modeling" by Mark Pinsky, Samuel Karlin. Academic Press, Fourth Edition. ISBN-10: 9780123814166 ISBN-13: 978-0123814166
Description:	We study the theory and applications of stochastic processes. Topics include Markov chains, Poisson processes, renewal phenomena, Brownian motion, and an introduction to stochastic calculus.

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Math 4331 Introduction to Real Analysis (Section# 22624)

Time:	TuTh 10:00AM - 11:30AM - Room: CBB 104
Instructor:	V. Paulsen
Prerequisites:	Math 3333
Text(s):	None, lecture notes will be distributed.
Description:	Math 4331, Math 4332 courses provide a rigorous introduction to the deeper properties of the real numbers, continuous functions, and differentiability needed for advanced study in mathematics, science and engineering. It is assumed that the student is familiar with the material of Math 3333, including an introduction to the real numbers, basic properties of continuous and differentiable functions on the real line, and an ability to do epsilon-delta proofs. SUGGESTED SYLLABUS: Math 4331: Metric spaces, open and closed sets, compact and connected sets, convergence of sequences, Cauchy sequences and completeness, properties of continuous functions, contraction mapping principle, countable and uncountable sets, Riemann-Stieltjes integration. Math 4332: Sequences and series of functions, pointwise versus uniform convergence, convergence in metric spaces of functions, multivariable and single variable differentiable calculus, partial derivatives versus total derivative, mean value theorems, inverse and implicit function theorems, Taylor series, max-min and second derivative test.

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Math 4350 Differential Geometry (Section# 22507)

Time:	TuTh 11:30AM - 1:00PM - Room: SEC 205
Instructor:	M. Ru
Prerequisites:	Math 2433 Calculus of Functions of Several Variables Math 2431 Linear Algebra
Text(s):	I will use my own lecture notes. As a reference, I recommend an online book of Differential Geometry: A first course in curves and surfaces by Prof. Theodore Shifrin at the University of Georgia (http://www.math.uga.edu/~shifrin/ShifrinDiffGeo.pdf)
Description:	This year-long course will introduce the theory of the geometry of curves and surfaces in three-dimensional space using calculus techniques, exhibiting the interplay between local and global quantities. Topics include: curves in the plane and in space, global properties of curves and surfaces in three dimensions, the first fundamental form, curvature of surfaces, Gaussian curvature and the Gaussian map, geodesics, minimal surfaces, Gauss' Theorem Egregium, Gauss-Bonnet theorem etc.

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Math 4362 Theory of Ordinary Differential Equations (Section# 20585)

Time:	MoWeFr 11:00AM - 12:00PM - Room: CBB 214
Instructor:	J. Qiu
Prerequisites:	Calculus, Linear Algebra

Text(s): An Introduction to Ordinary Differential Equations by Earl A. Coddington.

Description: An elementary, thorough and systematic introduction of the subject on ordinary differential equations will be given.

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Math 4364 Numerical Analysis (Section# 15314)

Time: MoWe 4:00PM - 5:30PM - Room: SEC 206

Instructor: T. Pan

Prerequisites: Math 2431 (Linear Algebra), Math 3331 (Differential Equations). Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple. This is a first semester of a two semester course.

Text(s): Numerical Analysis (8th edition) by RL Burden and JD Faires

Description: We will develop and analyze numerical methods for approximating the solutions of common mathematical problems. The emphasis this semester will be on solving nonlinear equations, interpolation, numerical differentiation and integration, initial value problems of ordinary differential equations, and direct methods for solving linear systems of equations. This is an introductory course and will be a mix of mathematics and computing.

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Math 4377 Advanced Linear Algebra I (Section# 22627)

Time: TuTh 11:30AM - 1:00PM - Room: F 154

Instructor: J. He

Prerequisites: Math 2331 or equivalent, and at least 3 hours of 3000 level mathematics.

Text(s): "Linear Algebra, fourth Edition", by S.H. Friedberg, A.J Insel, L.E. Spence, Prentice Hall, ISBN 0-13-008451-4

Description: This will be a rigorous treatment of linear algebra. We will begin with the basic theory of vector spaces and subspaces, linear dependence and independence, bases and dimension (Chapter 1). We will then discuss linear transformations and their connection with matrices. (Chapter 2). In Chapter 3 we will discuss systems of linear equations, Gaussian elimination, and the connection between matrix rank and solvability of a system. Next we will discuss the determinant of an nxn matrix, beginning with the properties of the determinant. We will use the properties to derive several methods for computing a determinant. Finally we will discuss eigenvalues, eigenvectors, and diagonalization of an nxn matrix (Chapter 5). If time permits we will discuss Inner Product Spaces (Chapter 6).

Students will be expected to turn in homework weekly. Some of this homework will involve the writing of proofs, which will be graded for clear and logical thinking that is expressed with correct grammar. There will also be two midterm exams and a final exam.

Students who wish to learn more of this subject may enroll in Math 4378 for the Spring Semester.

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Math 4377 Advanced Linear Algebra I (Section# 22626)

Time: MoWe 1:00PM - 2:30PM - Room: F 154

Instructor: D. Wagner

Prerequisites: Math 2331 or equivalent, and at least 3 hours of 3000 level mathematics.

Text(s): "Linear Algebra, fourth Edition", by S.H. Friedberg, A.J Insel, L.E. Spence, Prentice Hall, ISBN 0-13-008451-4

Description:	This will be a rigorous treatment of linear algebra. We will begin with the basic theory of vector spaces and subspaces, linear dependence and independence, bases and dimension (Chapter 1). We will then discuss linear transformations and their connection with matrices. (Chapter 2). In Chapter 3 we will discuss systems of linear equations, Gaussian elimination, and the connection between matrix rank and solvability of a system. Next we will discuss the determinant of an nxn matrix, beginning with the properties of the determinant. We will use the properties to derive several methods for computing a determinant. Finally we will discuss eigenvalues, eigenvectors, and diagonalization of an nxn matrix (Chapter 5). If time permits we will discuss Inner Product Spaces (Chapter 6). Students will be expected to turn in homework weekly. Some of this homework will involve the writing of proofs, which will be graded for clear and logical thinking that is expressed with correct grammar. There will also be two midterm exams and a final exam. Students who wish to learn more of this subject may enroll in Math 4378 for the Spring Semester.

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Math 4388 History of mathematics (online) (Section# 18649)

Time:	Online
Instructor:	S. Ji
Prerequisites:	Math 3333 Intermediate Analysis, or content of instructor.
Text(s):	Lecture notes provided. No textbook is required.
Description:	This course is designed to provide a college-level experience in history of mathematics. Students will understand some critical historical mathematics events, such as creation of classical Greek mathematics, and development of calculus; recognize notable mathematicians and the impact of their discoveries, such as Fermat, Descartes, Newton and Leibniz, Euler and Gauss; understand the development of certain mathematical topics, such as Pythagoras theorem, the real number theory and calculus. Aims of the course: To help students to understand the history of mathematics; to attain an orientation in the history and philosophy of mathematics; to gain an appreciation for our ancestor's effort and great contribution; to gain an appreciation for the current state of mathematics; to obtain inspiration for mathematical education, and to obtain inspiration for further development of mathematics. On-line course is taught through Blackboard Learn, visit http://www.uh.edu/webct/ for information on obtaining ID and password. The course will be based on my notes. Homework and Essays assignement are posted in Blackboard Learn weekly. All homework and essays, handwriting or typed, should be turned into PDF files and be submitted through Blackboard Learn. Late homework is not acceptable. There is one open-notes final exam in form of multiple choice. The final exam will take place on the campus, On December 8, Monday, 1:00-4:00 pm. Room will be announced. Since you need to have my lecture notes for the final exam, you need to print out all my lectures notes and bring it to the final exam.

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Math 4389 Survey of Undergraduate Mathematics (Online) (Section# 17050)

Time: Online
Instructor: C. Peters
Prerequisites:
Text(s):
Description:

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GRADUATE ONLINE COURSES

Math 5331 Linear algebra with applications (Section# 17608)

Time: Arrange (online course)
Instructor: K. Kaiser
Prerequisites:

Text(s):

Linear Algebra Using MATLAB, Selected material from the text *Linear Algebra and Differential Equations Using Matlab* by Martin Golubitsky and Michael Dellnitz)
The text will made available to enrolled students free of charge.

Software: Scientific Note Book (SNB) 5.5
(available through MacKichan Software, http://www.mackichan.com/)

Description:

Syllabus: Chapter 1 (1.1, 1.3, 1.4), Chapter 2 (2.1-2.5), Chapter 3 (3.1-3.8), Chapter 4 (4.1-4.4), Chapter 5 (5.1-5.2, 5.4-5-6), Chapter 6 (6.1-6.4), Chapter 7 (7.1-7.4), Chapter 8 (8.1)

Project: Applications of linear algebra to demographics. To be completed by the end of the semester as part of the final.

Course Description: Solving Linear Systems of Equations, Linear Maps and Matrix Algebra, Determinants and Eigenvalues, Vector Spaces, Linear Maps, Orthogonality, Symmetric Matrices, Spectral Theorem

Students will also learn how to use the computer algebra portion of SNB for completing the project.

Homework: Weekly assignments to be emailed as SNB file.

There will be two tests and a Final.

Grading: Tests count for 90% (25+25+40), HW 10%

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Math 5333 Analysis (Section# 19366)

Time: Arrange (online course)
Instructor: G. Egten
Prerequisites:
Text(s):
Text: ANALYSIS 5th edition
Author: Steven R. Lay
Publisher: Pearson

SYLLABUS

Chapter 3: The Real Numbers - The real number system, completeness of the real numbers, the topology of the real line, compactness.

Chapter 4: Sequences - Convergence of sequences, limit theorems, monotone sequences, Cauchy sequences, subsequences.

Chapter 5: Limits and Continuity - Limits of functions, continuous functions, uniform continuity.

Description: Chapter 6: Differentiation - The derivative, the mean-value theorem, L'Hopital's rule, Taylor's theorem, Taylor series.

Chapter 7: Integration - The Riemann integral, properties of the definite integral, the fundamental theorem of calculus.

EVALUATION
Students will be evaluated on:
1. Written homework assignments (20%)
2. Mid-term exam (40%)
3. Final exam (40%)

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Math 5341 Mathematical Modeling (Section# 26896)

Time: Arrange (online course)
Instructor: J. Morgan
Prerequisites: Three semesters of calculus or consent of instructor.
Text(s): A Concrete Approach to Mathematical Modelling John Wiley & Sons, Inc, 2007 ISBN 978-0-470-17107-3
Description: Proportionality and geometric similarity, empirical modeling with multiple regression, discrete dynamical systems, differential equations, simulation and optimization. Computing assignments require only common spreadsheet software and VBA programming. The latter will be explained in the course.

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Math 5350 Differential Geometry (Section# 22514)

Time: Arrange (online course)
Instructor: M. Ru
Prerequisites: Math 2433(or equivalent) or consent of instructor.
Text(s): A set of notes on curves and surfaces will be written and distributed by Dr. Ru.
Description: The course will be an introduction to the study of Differential Geometry-one of the classical (and also one of the more appealing) subjects of modern mathematics. We will primarily concerned with curves in the plane and in 3-space, and with surfaces in 3-space. We will use multi-variable calculus, linear algebra, and ordinary differential equations to study the geometry of curves and surfaces in R3. Topics include: Curves in the plane and in 3-space, curvature, Frenet frame, surfaces in 3-space, the first and second fundamental form, curvatures of surfaces, Gauss's theorem egrigium, Gauss-Bonnet theorem, minimal surfaces.

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Math 5385 Statistics (Section# 16270)

Time:	Arrange (online course)
Instructor:	C. Peters
Prerequisites:	
Text(s):	
Description:	

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GRADUATE COURSES

Math 6302 Modern Algebra (Section#15327)

Time:	TuTh 2:30PM - 4:00PM - Room: AH 301
Instructor:	K. Kaiser
Prerequisites:	Graduate Standing
Text(s):	Thomas W. Hungerford, Algebra, Springer Verlag (required). I will also circulate my own classroom notes.
Description:	During the first semester we will cover the basic theory of groups, rings and fields with strong emphasis on principal ideal domains. We will also discuss the most important algebraic constructions from a universal algebraic as well as from a categorical point of view. The second semester will be mainly on modules over principal ideal domains, Sylow theory, free algebras and co-products and ultraproducts. Course Organization and Grading: Students will receive on a regular basis homework assignments. There will be a midterm and a final. Homework counts for 30%, midterm for 30% and final for 40% of the final grade.

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Math 6308 Advanced Linear Algebra I (Section# 22629)

Time:	TuTh 11:30AM - 1:00PM - Room: F 154
Instructor:	J. He
Prerequisites:	Math 2331 or equivalent, and at least 3 hours of 3000 level mathematics.
Text(s):	"Linear Algebra, fourth Edition", by S.H. Friedberg, A.J Insel, L.E. Spence, Prentice Hall, ISBN 0-13-008451-4
Description:	This will be a rigorous treatment of linear algebra. We will begin with the basic theory of vector spaces and subspaces, linear dependence and independence, bases and dimension (Chapter 1). We will then discuss linear transformations and their connection with matrices. (Chapter 2). In Chapter 3 we will discuss systems of linear equations, Gaussian elimination, and the connection between matrix rank and solvability of a system. Next we will discuss the determinant of an nxn matrix, beginning with the properties of the determinant. We will use the properties to derive several methods for computing a determinant. Finally we will discuss eigenvalues, eigenvectors, and diagonalization of an nxn matrix (Chapter 5). If time permits we will discuss Inner Product Spaces (Chapter 6). Students will be expected to turn in homework weekly. Some of this homework will involve the writing of proofs, which will be graded for clear and logical thinking that is expressed with correct grammar. There will also be two midterm exams and a final exam. Students who wish to learn more of this subject may enroll in Math 4378 for the Spring Semester.

Remark: There is a limitation for counting graduate credits for Math 6308, 6309, 6312, or 6313.

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Math 6308 Advanced Linear Algebra I (Section# 22628)

Time:	MoWe 1:00PM - 2:30PM - Room: F 154
Instructor:	D. Wagner
Prerequisites:	Math 2331 or equivalent, and at least 3 hours of 3000 level mathematics.
Text(s):	"Linear Algebra, fourth Edition", by S.H. Friedberg, A.J Insel, L.E. Spence, Prentice Hall, ISBN 0-13-008451-4
Description:	This will be a rigorous treatment of linear algebra. We will begin with the basic theory of vector spaces and subspaces, linear dependence and independence, bases and dimension (Chapter 1). We will then discuss linear transformations and their connection with matrices. (Chapter 2). In Chapter 3 we will discuss systems of linear equations, Gaussian elimination, and the connection between matrix rank and solvability of a system. Next we will discuss the determinant of an nxn matrix, beginning with the properties of the determinant. We will use the properties to derive several methods for computing a determinant. Finally we will discuss eigenvalues, eigenvectors, and diagonalization of an nxn matrix (Chapter 5). If time permits we will discuss Inner Product Spaces (Chapter 6). Students will be expected to turn in homework weekly. Some of this homework will involve the writing of proofs, which will be graded for clear and logical thinking that is expressed with correct grammar. There will also be two midterm exams and a final exam. Students who wish to learn more of this subject may enroll in Math 4378 for the Spring Semester.
Remark:	There is a limitation for counting graduate credits for Math 6308, 6309, 6312, or 6313.

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Math 6312 Introduction to Real Analysis (Section# 22625)

Time:	TuTh 10:00AM - 11:30AM - Room: CBB 104
Instructor:	V. Paulsen
Prerequisites:	Math 3333
Text(s):	None, lecture notes will be distributed.
Description:	Math 4331, Math 4332 courses provide a rigorous introduction to the deeper properties of the real numbers, continuous functions, and differentiability needed for advanced study in mathematics, science and engineering. It is assumed that the student is familiar with the material of Math 3333, including an introduction to the real numbers, basic properties of continuous and differentiable functions on the real line, and an ability to do epsilon-delta proofs. SUGGESTED SYLLABUS: Math 4331: Metric spaces, open and closed sets, compact and connected sets, convergence of sequences, Cauchy sequences and completeness, properties of continuous functions, contraction mapping principle, countable and uncountable sets, Riemann-Stieltjes integration. Math 4332: Sequences and series of functions, pointwise versus uniform convergence, convergence in metric spaces of functions, multivariable and single variable differentiable calculus, partial derivatives versus total derivative, mean value theorems, inverse and implicit function theorems, Taylor series, max-min and second derivative test.
Remark:	There is a limitation for counting graduate credits for Math 6308, 6309, 6312, or 6313.

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Math 6320 Theory of Functions of a Real Variable (Section# 15360)

Time:	TuTh 4:00PM - 5:30PM - Room: SEC 204
Instructor:	W. Ott
Prerequisites:	Math 4331 or consent of instructor

Text(s):	Textbooks (recommended): 1) Real Analysis: Modern Techniques and Their Applications by Gerald Folland 2) Real Analysis: A Focused Approach by Mark Tomforde
Description:	Math 6320 introduces students to modern real analysis. The core of the course will cover measures, Lebesgue integration, and L^p spaces. We will study elements of functional analysis, Fourier analysis, ergodic theory, and probability theory.

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Math 6324 Differential Equations(Section# 22519)

Time:	TuTh 11:30AM - 1:00PM - Room: SEC 204
Instructor:	M. Nicol
Prerequisites:	
Text(s):	Instructor's lecture note Recommended Texts: • Differential Equations, Dynamical Systems and Linear Algebra by M. Hirsch and S. Smale (available at Amazon or in the library) • Ordinary Differential Equations by V. I. Arnold, M.I.T press, 1998 (paperback) • Geometrical Methods in the Theory of Ordinary Differential Equations by V. I. Arnold, Springer Verlag, 2nd Edition 1988. • Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields by J. Guckenheimer and P. Holmes (Applied Mathematical Sciences Vol 42) Springer Verlag. • Mathematical Methods of Classical Mechanics by V. I. Arnold, Springer Verlag, 2nd It is not necessary to buy anything of the references, though Ordinary Differential Equations by V. I. Arnold and Differential Equations, Dynamical Systems and Linear Algebra by M. Hirsch and S. Smale would be most useful to own. The books are useful for reference and lecture notes will be based on these texts and a variety of sources.
Description:	This course is an introduction to differential equations. We cover linear theory: existence and uniqueness for autonomous and non-autonomous equations; stability analysis; stable and unstable manifolds and floquet theory. We will also cover topics such as quasiperiodic motion; normal form theory; perturbation theory and classical mechanics. Assessment: There will be one midterm (worth 20 points), a final exam (30 points) as well as 2 to 4 take-home problem sheets (to make up 50 points in total).

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Math 6342 Topology (Section# 15361)

Time:	MoWeFr 10:00AM - 11:00AM - Room: C 102
Instructor:	V. Climenhaga
Prerequisites:	Senior undergraduate course in real analysis (such as Math 4331 at UH)
Text(s):	James R. Munkres, "Topology", second edition.
Description:	An introduction to topology. Topics in point set topology will include compactness, connectedness, quotient spaces, separation axioms, and the theorems of Urysohn, Tietze, and Tychonoff. We will also cover elementary homotopy theory and the fundamental group.

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Math 6352 Complex Analysis and Geometry (Section# 26505)

Time:	TuTh 1:00PM - 2:30PM - Room: M 104
Instructor:	G. Heier
Prerequisites:	Math 6322-6323, or equivalent, or consent of instructor
Text(s):	Positivity in Algebraic Geometry I, by Lazarsfeld (not required) Principles of Algebraic Geometry, by Griffiths-Harris (not required) Diophantine Geometry--An Introduction, by Hindry-Silverman (not required)
Description:	This is the first semester of a two semester introductory course in complex algebraic geometry. We will approach the matter from the point of view of line bundles, linear series and positivity. We will also discuss applications in complex differential geometry and diophantine geometry. The treatment will be complementary to the course Math 6395 Complex Geometry taught by the same instructor in Spring 2013, i.e., an interested student should enroll regardless of whether he or she has taken that previous course. Likely topics include: projective varieties, divisors, line bundles, linear series, positivity, curvature, vanishing theorems, classification and structure theorems based on curvature, rational and integral points.

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Math 6360 Applicable Analysis (Section# 16241)

Time:	MoWeFr 11:00AM - 12:00PM - Room: AH 11
Instructor:	Y. Gorb
Prerequisites:	MATH 4331 or equivalent or consent of instructor.
Text(s):	John Hunter, Bruno Nachtergaele, Applied Analysis, World Scientific Publishing Company, 2005
Description:	This course treats topics related to the solvability of various types of equations, and also of optimization and variational problems. The first half of the semester will concentrate on introductory material about norms, Banach and Hilbert spaces, etc. This will be used to obtain conditions for the solvability of linear equations, including the Fredholm alternative. The main focus will be on the theory for equations that typically arise in applications. In the second half of the course the contraction mapping theorem and its applications will be discussed. Also, topics to be covered may include finite dimensional implicit and inverse function theorems, and existence of solutions of initial value problems for ordinary differential equations and integral equations Instructor's course website: http://www.math.uh.edu/~gorb/math6360_f14.html

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Math 6366 Optimization and Variational Methods (Section# 15362)

Time:	MoWe 1:00PM - 2:30PM - Room: AH 304
Instructor:	R. Hoppe
Prerequisites:	Graduate standing or consent of the instructor
Text(s):	L.D. Berkovitz; Convexity and Optimization in R n . Wiley-Interscience, New York, 2001 I. Ekeland and R. Temam; Convex Analysis and Variational Problems. SIAM, Philadelphia, 1999
Description:	This course focuses on convex optimization in the framework of convex analysis, including duality, minmax, and Lagrangians. The course consists of two parts. In part I, we consider convex optimization in a finite dimensional setting which allows an intuitive, geometrical approach. The mathematical theory will be introduced in detail and on this basis efficient algorithmic tools will be developed and analyzed. In part II, we will be concer ned with convex optimization in function space. We will provide the prerequisites from the Calculus of Variations and generalize the concepts from part I to the infinite dimensional setting.

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Math 6370 Numerical Analysis (Section# 15363)

Time:	MoWe 4:00PM - 5:30PM - Room: AH 15
Instructor:	A. Quaini
Prerequisites:	Calculus, Linear Algebra, ability to do computer assignments in one of FORTRAN, C, Pascal, Matlab, etc.
Text(s):	A. Quarteroni, R. Sacco, F. Saleri, Numerical Mathematics, 2nd edition, Texts in Applied Mathematics, V.37, Springer, 2010.
Description:	The course introduces to the methods of scientific computing and their application in analysis, linear algebra, approximation theory, optimization and differential equations. The purpose of the course is to provide mathematical foundations of numerical methods, analyze their basic properties (stability, accuracy, computational complexity) and to discuss performance of particular algorithms. This first part of the two-semester course spans over the following topics: (i) Principles of Numerical Mathematics (Numerical well-posedness, condition number of a problem, numerical stability, complexity); (ii) Direct methods for solving linear algebraic systems; (iii) Iterative methods for solving linear algebraic systems; (iv) numerical methods for solving eigenvalue problems; (v) non-linear equations and systems, optimization.

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Math 6382 Probability Models and Mathematical Statistics (Section# 15364)

Time:	TuTh 4-5:30pm - Room: C 109
Instructor:	H. Zhang
Prerequisites:	
Text(s):	Instructor's lecture note Recommended Texts: • Mathematical Statistics with Applications, Sixth Edition, by Wackerly, Menden- hall III and Scheaffer, Duxbury Press • Elementary Probability for Applications (Cambridge U. Press, 2009) by Richard Durrett. • A First Look at Rigorous Probability Theory by Jeffrey Rosenthal, 2000. • An Introduction to Probability Theory and Its Applications, Vol 1, 3rd edition, 1968 by William Feller (any edition would be fine). • Probability by Leo Breiman, 1968, Addison- Wesley. • An Introduction to Stochastic Modeling, 3rd Edition, by H Taylor and SKarlin, Academic Press. • A First Course in Probability, Sixth Edition by Sheldon Ross, 2002, Prentice Hall There is no core text and the lectures are based on a variety of sources Mathematical Statistics by Wackerly, Mendenhall and Scheaffer cover some of the material but at a more elementary level. Durrett is a good resouce for probability theory. Ross also is a standard text that treats many of these topics. An Introduction to Stochastic Modeling is useful for Markov Chain theory. Rosenthal's book is good as an introduction to measure theory for students of probability. Feller's book is a classic text and worth looking at. Breiman's book is slightly more advanced than the other texts. There are many other texts that may be useful for reference and the library has a wide selection of books on probability.

Description:	Emphasis will be placed on a thorough understanding of the basic concepts of modern probability as well as developing problem solving skills. Topics covered include: combinatorial analysis, independence and the Markov property, introduction to Markov chain theory, the major discrete and continuous distributions, joint distributions and conditional probability, modes of convergence. These notions will be examined through examples and applications. Topics covered: • Combinatorial analysis (sampling with, without replacement etc) • Introduction to measure theory probability spaces, random variables, random variables. Expectation and integration of random variables. Markov and Chebychev's inequality. • Distribution of a random variable, distribution function, probability density function • Major discrete distributions- Bernoulli, Binomial, Poisson, Geometric. Modeling with the major discrete distributions. • De Moivre-Laplace limit theorem. Normal approximation to the Binomial, Poisson approximation ('law of rare events'). Modeling with continuous distributions. • Modes of convergence: in probability, in L p , almost surely, in distribution. Weak and strong law of large numbers, Moment generating functions and central limit theorem. • Conditional probability- Bayes theorem. Discrete conditional distributions, continuous conditional distributions, conditional expectations and conditional probabilities. Conditional expectations, Martingales.

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Math 6384 Discrete -Time Models in Finance (Section#15365)

Time:	TuTh 2:30PM - 4:00PM - Room: C 105
Instructor:	E. Kao
Prerequisites:	Math 6382, or concurrent registration
Text(s):	Required Texts: 1. Introduction to mathematical Finance: Discrete-Time Models, by Stanley R. Pliska, Blackwell, 1997. 2. Investment Science, 2nd edition, by David Luenberger, Oxford University Press, 2014.
Description:	The course is an introduction to discrete-time models in finance. We start with single-period securities markets and discuss arbitrage, risk-neutral probabilities, complete and incomplete markets. We survey consumption investment problems, mean-variance portfolio analysis, and equilibrium models. These ideas are then explored in multiperiod settings. Valuation of options, futures, and other derivatives on equities, currencies, commodities, and fixed-income securities will be covered under discrete-time paradigms.

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Math 6397 Mathematical Hemodynamics (Section# 22615)

Time:	MoWeFr 10:00AM - 11:00AM - Room: CBB 214
Instructor:	S. Canic
Prerequisites:	
Text(s):	
Description:	

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Math 6397 Math Principles in Imaging with Applications to Radar and Seismic Imaging (Section# 22616)

Time: TuTh 1:00PM - 2:30PM - Room: C 108

Instructor: D. Onofrei

Prerequisites: The ideal prerequisites are MA5332 or MA6324-MA6325, MA5350 and MA6374 or MA6377 but the course will be so designed that any interested student with some background in linear algebra and partial differential equations will benefit from it.

Text(s): Lecture notes

Description:

Some initial questions for a student before joining this class may be:
- How do waves propagate and how is this phenomenon modelled and analyzed?
- What is an inverse problem in the context of wave propagation?
- How are inverse problems related to imaging, i.e., how do we image with waves?

It is the aim of this class to introduce the students to the mathematical and physical principles behind wave propagation and to discuss how the understanding of the associated inverse problems may be used to address questions from seismic imaging, radar/sonar imaging, or medical imaging.

An inverse problem is the “dual” to a direct problem associated to the same model. The simplest example of such dual pair, i.e., direct/inverse problems, is associated to a linear system: here the direct problem will be, for a given mxn matrix A and a given nx1 vector v determine the product Av while the inverse problem will be, for known Av, determine v. Thus, every time you solved a linear system you solved in fact an inverse problem! In another example, in various imaging modalities the direct problem is the analysis of propagation of input waves in the known host media while the inverse problem will be the determination of an unknown host media from the characteristics of an echo (reflected wave).

For medical imaging, the practical question will be to detect cancerous tumors, or other abnormalities present in a part of the human body by non-invasive methods, i.e., by using only data collected without direct contact with the patient. Thus, from the acquired data the scientist would like to invert and obtain information about the source of this data. The same scenario is valid for the problem of mapping the inner structure of the earth or the problem of oil exploration and recovery problems, where the engineer would like to be able to map the inner structure of the earth (thus detecting potential oil resources and their size) only from inexpensive data acquired at the surface of the earth.

For the radar/sonar imaging arena one needs first to understand that a radar or sonar form an image based on echoes received after initial impulses are generated towards a target. Then an interesting question is: how can one make certain objectives (aircrafts, buildings, ships) invisible to radar or sonar. A possible inverse problem approach to this question will inquire into the possibility to design suitable antennas to achieve the desired nulling around the object of interest while maintaining its communication capability.

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Math 6397 Information theory with Applications (Section# 22617)

Time: TuTh 10:00AM - 11:30AM - Room: CBB 106

Instructor: B. Bodmann

Prerequisites: Graduate standing or consent of instructor. Knowledge of Matlab useful, but not a strict prerequisite.

Text(s): A. I. Khinchin, Mathematical Foundations of Information Theory, Dover, 2001, reprint of 1957 edition (approx. \$10); optional texts: T. S. Han and K. Kobayashi, Mathematics of Information and Coding, Translations of mathematical monographs, v. 203, American Mathematical Society, 2002 (approx. \$80 for AMS members); I. Csiszár and J. Körner, Information Theory, 2nd edition, Cambridge University Press, Cambridge, 2011 (approx. \$100).

Description:	The first part of the course is dedicated to the traditional, statistical formulation of source and channel coding (compression and noise-insensitive transmission) of scalar sources. The second part concerns the generalization for high-dimensional vector-valued sources, which is fundamental for modern sensor and communications technology. Apart from mathematics, this course has relevance for applications in physics, statistics, computer science and electrical engineering. The emphasis will be on understanding the main ideas with a view to applications. The grade will be based on course notes prepared by the students (40%) and 4 additional take-home problem sets (60%). As part of the homework, small homework projects involving simulations will be given, but no extensive computer programming experience will be assumed.

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Math 6397 Duality, Operator spaces, and von Neumann algebras (Section# 22618)

Time:	MoWeFr 12:00PM - 1:00PM - Room: AH 302
Instructor:	D. Blecher
Prerequisites:	Math 6320/21. A functional analysis course would be great, although strong students without this could read up on it concurrently. We expect that some students will have taken Dr Tomforde's Spring C*-algebras course, but this is not a prerequisite.
Text(s):	Complete typed notes will be provided.
Description:	The purpose is to offer analysis graduate students a course in topics which are not currently covered in the functional analysis course, but which many of them need to know for their research, and others may be interested in for general knowledge. Tentative outline of the syllabus: I. Review of duality and weak topologies. - We quickly cover the theory of duality in locally convex vector spaces (for example the Krein-Smulian and Mazur's theorems), and some basic results in convexity theory (e.g.\ Choquet's lemma). II. Review of some basic results about C*-algebras. III. Von Neumann algebras--Murray-von Neumann equivalence, Characterizations of von Neumann algebras, The trace and finite von Neumann algebras, Examples. IV. Basic theory of operator spaces. V. Duality for operator spaces. VI. Noncommutative L^p-spaces (tracial case) and noncommutative integration. There will be one test during the semester.

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Math 6397 Mixed Finite Element Methods (Section# 22619)

Time:	MoWe 1:00PM - 2:30PM - Room: SEC 101
Instructor:	Y. Kuznetsov
Prerequisites:	Undergraduate courses on Partial Differential Equations and Numerical Analysis

Text(s):	None

Mixed Finite Element Methods are among the most efficient discretization techniques for elliptic partial differential equations with numerous applications in science and engineering.

In the beginning of the course, we consider the differential and mixed variational formulations for a number of important practical problems governed by equations with the second order elliptic partial differential operators. We investigate the properties of these operators which are needed to understand the mixed finite element methods.

Description: In the second part of the course, we introduce and investigate the most common variants of the mixed and mixed-hybrid finite element methods ,and consider the practical aspects of their implementation. The details of the algorithms will be illustrated by examples from the mathematical simulation of diffusion and convection -diffusion processes, flows in porous media and electromagnetics. We shall compare the mixed finite element method with other important discretization techniques ,in particular with the classical nodal finite element and finite volume methods.

The final part of the course is devoted to the algebraic aspects of the method. We investigate the basic properties of algebraic systems with saddle-point matrices and iterative methods for their numerical solution.

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Math 7320 Functional Analysis I (Section# 22621)

Time:	MoWeFr 10:00AM - 11:00AM - Room: AH 301
Instructor:	M. Tomforde
Prerequisites:	Point-Set Topology
Text(s):	A Course in Functional Analysis (2nd Edition) by John B. Conway
Description:	This course provides an introduction to the methods and language of functional analysis, including Hilbert spaces, Banach spaces, and linear operators on theses spaces. This course is part of a two semester sequence. The second semester will be a more technical development of the theory of linear operators on Hilbert spaces and the study of operator algebras and C*-algebras.

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Math 7397 Monte Carlo Methods (Section# 22622)

Time:	TuTh 10:00AM - 11:30AM - Room: F 162
Instructor:	E. Kao
Prerequisites:	Math 6383
Text(s):	Monte Carlo Statistical Methods, by Christian P. Roberts and George Casella, Springer, 2004
Description:	The course is an introduction to Monte-Carlo Methods in statistics. Topics include generating of random samples and sample paths,various reduction techniques, statistical analysis of simulation experiments, quasi-Monte Carlo, and sensitivity analysis. We also study Markov chain Monte Carlo, Gibbs sampling, and Bayesian statistical method. This course will serve as a prelude to Monte-Carlo methods in Finance to be offered in the spring semester.