Department of Mathematics

Fall 2017

GRADUATE COURSE FALL 2017

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 4310	18937	Biostatistics	TuTh, 2:30-4pm	F 162	W. Fu
Math 4320	14875	Intro to Stochastic Processes	TuTh, 4-5:30pm	F 154	W. Ott
Math 4331	18938	Introduction to Real Analysis I	TuTh, 10-11:30am	F 154	B. Bodmann
Math 4335	23785	Partial Differential Equations I	MW, 1-2:30pm	CAM 101	D. Wagner
Math 4364	20077	Introduction to Numerical Analysis in Scientific Computing	MW, 4-5:30pm	F 154	T-W Pan
Math 4364	26923	Introduction to Numerical Analysis in Scientific Computing	Arrange (online course)	(online)	J. Morgan
Math 4366	21335	Numerical Linear Algebra	TuTh, 11:30am-1pm	CV N115	J. He
Math 4377	18940	Advanced Linear Algebra I	MWF, 11am-Noon	GAR 201	W. Fitzgibbon
Math 4377	18941	Advanced Linear Algebra I	TuTh, 1-2:30pm	F 154	G. Heier
Math 4378	26513	Advanced Linear Algebra II	MWF, Noon-1pm	TBA	K.Kaiser
Math 4383	26738	Number Theory	MW, 4-5:30pm	F 162	M. Ru
Math 4388	17192	History of Mathematics	(online)	(online)	S. Ji
Math 4389	16229	Survey of Undergraduate Mathematics	MW, 1-2:30pm	F 162	M. Almus

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5331	16585	Linear Algebra with Applications	Arrange (online course)	K. Kaiser
Math 5333	17557	Analysis	Arrange (online course)	G. Etgen
Math 5344	23788	Scientific Computing w/Excel	Arrange (online course)	J. Morgan
Math 5385	15731	Statistics	Arrange (online course)	C. Peters

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6302	14880	Modern Algebra I	MWF, 11am-Noon	AH 301	A. Haynes
Math 6308	18942	Advanced Linear Algebra I	MWF, 11am-Noon	GAR 201	W. Fitzgibbon
Math 6308	18943	Advanced Linear Algebra I	TuTh, 1-2:30pm	F 154	G. Heier
Math 6312	18939	Introduction to Real Analysis	TuTh, 10-11:30am	F 154	B. Bodmann
Math 6320	14909	Theory of Functions of a Real Variable	TuTh, 10-11:30am	SW 423	M. Papadakis
Math 6322	26736	Functions of a Complex Variable	MW, 1-2:30pm	SW 423	M.Ru
Math 6326	23789	Partial Differential Equations	TuTh, 2:30-4pm	AH 301	G. Auchmuty
Math 6342	14910	Topology	TuTh, 1-2:30pm	SW 221	A. Török
Math 6358	27022	Linear Models & Applications	MW, 4-5:30pm	C 105	B. Manandhar
Math 6359	27023	Statistical Computing	TuTh, 1-2:30pm	SW 423	A.V. Skripnikov
Math 6360	15711	Applicable Analysis	TuTh, 8:30-10am	AH 301	Y. Gorb
Math 6366	14911	Optimization Theory	MW, 1-2:30pm	AH 301	R. Hoppe
Math 6370	14912	Numerical Analysis	MW, 4-5:30pm	CBB 214	A. Quaini
Math 6376	23791	Numerical Linear Algebra	MWF, Noon-1pm	AH 301	M. Olshanskiy
Math 6382	26064	Probability and Statistics	TuTh, 8:30-10am	C 108	R. Azencott
Math 6384	23794	Discrete Time Model in Finance	TuTh, 2:30-4pm	CAM 105	E. Kao
Math 6395	27106	Representation Theory Infinite Group	MW, 4-5:30pm	AH 203	M. Kalantar
Math 6395	23800	Stochastic Differential Equations	TuTh, 10-11:30am	AH 203	A. Török
Math 6397	23867	Multiscale Analysis & Sparse Representation	MWF, 10am-11am	AH 301	D. Labate

Math 6397	23868	Mathematical Hemodynamics	TuTh, 11:30am-1pm	AH 203	S. Canic

---Course Details--

SENIOR UNDERGRADUATE COURSES

	Math 4310 - Biostatistics
Prerequisites:	MATH 3339 and BIOL 3306
Text(s):	Biostatistics: A Methodology for the Health Sciences | Edition: 2, Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, 9780471031857
Description:	Statistics for biological and biomedical data, exploratory methods, generalized linear models, analysis of variance, cross-sectional studies, and nonparametric methods. Students may not receive credit for both MATH 4310 and BIOL 4310.

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	Math 4320 - Intro to Stochastic Processes
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 discrete-time and continuous-time Markov chains, Poisson process, branching process, Brownian motion. Considerable emphasis will be given to applications and examples.

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	Math 4331 - Introduction to Real Analysis
Prerequisites:	MATH 3334. In depth knowledge of Math 3325 and Math 3333 is required.

Text(s):	K. Davidson and A. P. Donsig. Real Analysis and Applications: Theory in Practice (Undergraduate Texts in Mathematics) 2010th Edition, SpringerISBN-13: 9780387980973 ISBN-10: 9780387980973
Description:	This first course in the sequence Math 4331-4332 provides a solid introduction to deeper properties of the real numbers, continuous functions, differentiability and integration 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. **Topics**: Open and closed sets, compact and connected sets, convergence of sequences, Cauchy sequences and completeness, properties of continuous functions, fixed points and the contraction mapping principle, differentiation and integration.

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Math 4335 - Partial Differential Equations I

Prerequisites:	MATH 3331 or equivalent, and three additional hours of 3000-4000 level Mathematics. Previous exposure to Partial Differential Equations (Math 3363) is recommended.
Text(s):	"Partial Differential Equations: An Introduction (second edition)," by Walter A. Strauss, published by Wiley, ISBN-13 978-0470-05456-7
Description:	**Description**:Initial and boundary value problems, waves and diffusions, reflections, boundary values, Fourier series. **Instructor's Description:** will cover the first 6 chapters of the textbook. See the departmental course description.

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Math 4364 (20077) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	MATH 2331, In depth knowledge of Math 3331 (Differential Equations) or Math 3321 (Engineering Mathematics) *Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	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.

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Math 4364 (26923) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	MATH 2331, In depth knowledge of Math 3331 (Differential Equations) or Math 3321 (Engineering Mathematics) *The students in this online section will be introduced to scientific computing in Excel. All computations in this course will be done either directly in the Excel spreadsheet, or via VBA programming. Consequently, the course will also include instruction associated with the use of Excel and programming in VBA. Students are expected to have access and basic familiarity with Excel, but they are not expected to know advanced spreadsheet functionality or have programming experience with VBA. Excel and VBA will be incorporated into nearly every lesson and assignment
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519

Description:	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.

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Math 4366 - Numerical Linear Algebra

Prerequisites:	MATH 2331 , or equivalent, and six additional hours of 3000-4000 level Mathematics.
Text(s):	Instructor will use his own notes.
Description:	Conditioning and stability of linear systems, matrix factorizations, direct and iterative methods for solving linear systesm, computing eigenvalues and eigenvectors, introduction to linear and nonlinear optimization

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Math 4377 (18940) - Advanced Linear Algebra I

Prerequisites:	Math 2331 and minimum 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:	The course covers the following topics: vector spaces, subspaces, linear combinations,systems of linear equations, linear dependence and linear independence, bases and dimension,linear transformations, null spaces, ranges, matrix rank, matrix inverse and invertibility,determinants and their properties, eigenvalues and eigenvectors, diagonalizability.

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Math 4377 (18941) - Advanced Linear Algebra I

Prerequisites:	MATH 2331 and a minimum of three semester hours of 3000-level mathematics.
Text(s):	Matrix Analysis and Applied Linear Algebra by Carl D. Meyer, 9780898714548
Description:	Linear systems of equations, matrices, determinants, vector spaces and linear transformations, eigenvalues and eigenvectors, spectral theory, matrix inequalities, linear mappings, Perron-Frobenius theory, applications including ranking algorithms and kinematics.

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Math 4378 (26513) - Advanced Linear Algebra II

Prerequisites:	MATH 4377
Text(s):	Linear Algebra, Fourth Edition, by S.H. Friedberg, A.J Insel, L.E. Spence,Prentice Hall, ISBN 0-13-008451-4
Description:	Similarity of matrices, diagonalization, Hermitian and positive definite matrices, normal matrices, and canonical forms, with applications

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Math 4383 - Number Theory

Prerequisites:	MATH 3330
Text(s):	Instructor's lecture notes. The reference book will be "Elementary Number Theory" by David M. Burton 7th Edition McGraw-Hill

Description: This course will cover the topics in the standard one semester introduction to number theory: Divisibility theory, primes and their distribution, theory of congruences, Fermat's Little Theorem, number theoretic functions, Euler's Phi-function and Euler?s Theorem, primitive roots, quadratic reciprocity, and introduction to cryptography. There'll be no specific prerequisites beyond, Math 3330, algebra and some ability in reading and writing mathematical proofs.

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Math 4388 - History of Mathematics

Prerequisites: Math 3333

Text(s): 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. There are four submissions for homework and essays and each of them covers 10 lecture notes. The dates of submission will be announced. 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 final exam in multiple choice. Grading: 35% homework, 45% projects, 20 % Final exam.

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Math 4389 - Survey of Undergraduate Mathematics

Prerequisites:	MATH 3330, MATH 3331, MATH 3333, and three hours of 4000-level Mathematics.
Text(s):	Instructor will use her own notes

Description: A review of some of the most important topics in the undergraduate mathematics curriculum.

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ONLINE GRADUATE COURSES

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MATH 5331 - Linear Algebra with Applications

Prerequisites: Graduate standing.

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.

Description:

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

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

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.

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MATH 5344 - Scientific Computing w/Excel

Prerequisites:	Graduate standing. MATH 2331, In depth knowledge of Math 3331 (Differential Equations) or Math 3321 (Engineering Mathematics) *The students in this online section will be introduced to scientific computing in Excel. All computations in this course will be done either directly in the Excel spreadsheet, or via VBA programming. Consequently, the course will also include instruction associated with the use of Excel and programming in VBA. Students are expected to have access and basic familiarity with Excel, but they are not expected to know advanced spreadsheet functionality or have programming experience with VBA. Excel and VBA will be incorporated into nearly every lesson and assignment
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	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.

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MATH 5385 - Statistics

Prerequisites:	Graduate standing.

Text(s): instructor will use his own notes/text. This text will be made available to students.

Description: Data collection and types of data, descriptive statistics, probability, estimation, model assessment, regression, analysis of categorical data, analysis of variance. Computing assignments using a prescribed software package (e.g., EXCEL, Minitab) will be given.

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GRADUATE COURSES

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MATH 6302 - Modern Algebra I

Prerequisites: Graduate standing.

Text(s):

Required Text: Abstract Algebra by David S. Dummit and Richard M. Foote, ISBN: 9780471433347

This book is encyclopedic with good examples and it is one of the few books that includes material for all of the four main topics we will cover: groups, rings, field, and modules. While some students find it difficult to learn solely from this book, it does provide a nice resource to be used in parallel with class notes or other sources.

Description: We will cover basic concepts from the theories of groups, rings, fields, and modules. These topics form a basic foundation in Modern Algebra that every working mathematician should know. The Math 6302--6303 sequence also prepares students for the department's Algebra Preliminary Exam.

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MATH 6308 (18942)- Advanced Linear Algebra I

Prerequisites: Graduate standing. MATH 2331 and minimum of 3 semester 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: The course covers the following topics: vector spaces, subspaces, linear combinations,systems of linear equations, linear dependence and linear independence, bases and dimension,linear transformations, null spaces, ranges, matrix rank, matrix inverse and invertibility,determinants and their properties, eigenvalues and eigenvectors, diagonalizability.

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MATH 6308 (18943)- Advanced Linear Algebra I

Prerequisites: Graduate standing. MATH 2331 and minimum of 3 semester 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: The course covers the following topics: vector spaces, subspaces, linear combinations,systems of linear equations, linear dependence and linear independence, bases and dimension,linear transformations, null spaces, ranges, matrix rank, matrix inverse and invertibility,determinants and their properties, eigenvalues and eigenvectors, diagonalizability.

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MATH 6312- Introduction to Real Analysis

Prerequisites: Graduate standing and MATH 3334. In depth knowledge of Math 3325 and Math 3333 is required.

Text(s): K. Davidson and A. P. Donsig, Real Analysis and Applications: Theory in Practice (Undergraduate Texts in Mathematics) 2010th Edition, SpringerSBN-13: 978-0387980973 ISBN-10: 9780387980973

Description:	This first course in the sequence Math 4331-4332 provides a solid introduction to deeper properties of the real numbers, continuous functions, differentiability and integration 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. **Topics**: Open and closed sets, compact and connected sets, convergence of sequences, Cauchy sequences and completeness, properties of continuous functions, fixed points and the contraction mapping principle, differentiation and integration.

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	MATH 6320 - Theory Functions of a Real Variable
Prerequisites:	Graduate standing and Math 4332 (Introduction to real analysis).
Text(s):	Real Analysis: Modern Techniques and Their Applications | Edition: 2, by: Gerald B. Folland, G. B. Folland. ISBN: 9780471317166
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 6322 - Functions of a Complex Variable
Prerequisites:	Graduate Standing and MATH 4331. In depth knowledge of Math 3333 required.
Text(s):	No textbook required. Lecture notes provided

Description: This is a year-long course. The first semester part is an introduction to complex analysis. This two semester course will cover the theory of holomorphic functions, residue theorem, harmonic and subharmonic functions, Schwarz's lemma, Riemann mapping theorem, Casorati-Weterstrass theorem, infinite product, Weierstrass' (factorization) theorem, little and big Picard Theorems and compact Riemann surfaces theory

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MATH 6326 - Partial Differential Equations

Prerequisites: Graduate standing and MATH 4331.

Text(s):

Required: The instructor will provide notes on much of the material for the course and there is no prescribed text.

Recommended Texts: The course will cover the material in the first three chapters of ”Hilbert Space Methods in Partial Differential Equations” by Ralph E. Showalter (Dover or free online) and some of the text ”Elliptic Equations: An Introductory Course”,by Michel Chipot, Birkhauser, 2009. The Universitext ”Functional Analysis, Sobolev Spaces and Partial Differential Equations” by Haim Brezis, Springer 2011 provides a thorough treatment of the functional analysis used. These three texts may be good reference texts for the material treated in the course.

Course Outline: This course will provide an introduction to the modern theory of elliptic partial differential equations using Sobolev space methods. The prerequisite is competence in multivariable calculus and real analysis. Ideally a student should have done well in M6320- 21 and having a working knowledge of Lebesgue integration and some Fourier analysis. The basic constructions of linear analysis in Hilbert and Banach spaces will be assumed known.

Description:

The first lectures will provide an introduction to boundary value problems for elliptic PDEs and describe the types of results that will be obtained. In particular weak formulations of various boundary problems and the background to finite element modeling of the problems will be described. Some results about the formulations typically used for numerical simulations will be treated in the course.

To do this the calculus of weak derivatives and the associated Sobolev function spaces needed for weak formulations of boundary value problems will be studied. Various results needed for the existence and properties of solutions of partial differential equations will be proved.

There will be an emphasis on important examples from applications involving equations posed on bounded subsets of RN with $1 \leq N \leq 3$.

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MATH 6342 - Topology

Prerequisites: Graduate standing and MATH 4331, or consent of the instructor.

Text(s):

(Recommended) Topology, A First Course, J. R. Munkres, Second Edition, Prentice-Hall Publishers.

V. Runde A taste of topology , Springer Universitext (paperback, inexpensive).

Topology is the perfect course to take as a first year graduatestudent, since it does not contain too much material, or material that is too sophisticated(the typed notes for the course are about 47 pages). It is a central and fundamental course and one which graduate students usually enjoy very much!

Thetopic is basically point-set topology, we will discuss a little algebraic topology at the end. We begin by discussing a little set theory, the basic definitions of topology and basis, and go on to discuss separation properties, compactness, connectedness, nets, continuity, local compactness, Urysohn's lemma, local compactness, Tietze's theorem, the characterization of separable metric spaces, paracompactness, partitions of unity, and basic constructions such as subspaces, quotients, and products and the Tychonoff theorem. At the end we will discuss a little algebraic topology, like simple connectedness and the fundamental group.

Description:

You do not need a textbook, although I recommend the Munkres or the Rundebooks. You are expected to read the classnotes carefully each week, line by line, and bring to me the things you don't understand there. Classnotes will be put on the web. You are also expected to do most of the homework sets, and turn in selected homework problems for grading.

You are encouraged to work with others, form study groups, and so on, however copied turned in homework will not help you assimilate the material, and will not be graded. The final grade is aproximately based on a total score of 300 points consisting of homework and other assignments (100 points), a semester test (100 points), and a final exam (100 points). That is, the final exam will count as much as the semester test; and it may be a take-home exam due a different date than the officially scheduled time listed on the UH website for the final exam for this course. In the final week of the semester you will be given time to work on a project, which you will be able to choose.

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MATH 6358 - Linear Models & Applications

Graduate standing.

Prerequisites: Two years of Calculus, MATH 6308 (Advanced Linear Algebra I), and MATH 6383 (Probability Statistics), or consent of instructor

Text(s): Applied Linear Statistical Models 5th Edition, by Michael Kutner, Christopher Nachtsheim, John Neter, William Li

978-0073108742; Publisher: McGraw-Hill/Irwin

Description: This graduate level course is designed for students who have been exposed to basic probability and statistics classes. It will cover simple linear regression: Linear regression, Prediction, Inferences, Diagnostics, Matrix approach to simple linear regression (Chapter 1 - 5). Multiple linear regres- sion, Regression models for qualitative and quantitative predictors, Building the regression model, Stepwise methods (Chapter 6 - 9). Generalized linear models and some recent advances.

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MATH 6359 - Statistical Computing

Graduate standing.

Prerequisites: Being familiar with at least one programming language. An undergraduate-level understanding of probability, statistics, calculus and linear algebra is assumed.

Text(s):

- Introductory Statistics with R, 2nd ed., Authors: Dalgaard, Peter, ISBN: 9780387790534

- Statistical Computing with R, Maria L. Rizzo, ISBN: 9781584885450

Description:

Objectives: Course will consist of two parts: 1) getting acquainted with R statistical programming (introducing syntax, writing functions, making graphs, conducting basic statistical analysis), 2) outlining the most renown statistical computing methods and implementing them via R. The first part serves an introductory purpose and may prove useful for any student having to deal with data in his or her research (be it medicine, marketing, agricultural/biological engineering, etc), as it touches upon such popular topics in statistical analysis as t-tests, group comparisons, linear and logistic regression, among others. Second part is tilted slightly more towards the graduate students from technical fields (e.g. statistics, computer science, engineering, mathematics) who want to familiarize themselves with some statistical computing techniques that may aid them in research. In particular, methods are introduced for numerical integration and hypothesis testing (e.g. Monte Carlo approach), random variable generation, probability density estimation (e.g kernel methods), constructing confidence intervals (bootstrap, jackknife). All-in-all, at the end of the course, a successful student should be able to:

- use R statistical programming as a tool for conducting research and data analysis
- comprehend and implement the main statistical computing techniques for their research goals
- writing their own R functions and potentially developing new computational methods in the future

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MATH 6360 - Applicable Analysis

Prerequisites: Graduate standing and MATH 4331 or equivalent.

Text(s):

J.K. Hunter and B. Nachtergaele, Applied Analysis, World Scientific, (2005). ISBN: 9789812705433

A.W. Naylor and G.R. Sell, Linear Operator Theory in Engineering and Science, Springer. ISBN: 9780387950013

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

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MATH 6366 - Optimization Theory

Prerequisites:	Graduate standing. Students are expected to have a good grounding in basic real analysis and linear algebra.
Text(s):	Introduction to Nonlinear Optimization Theory, Algorithms, and Applications with MATLAB; by Amir Beck, SIAM. ISBN: 9781611973648
Description:	The focus is on key topics in optimization that are connected through the themes of convexity, Lagrange multipliers, and duality. The aim is to develop a analytical treatment of finite dimensional constrained optimization, duality, and saddle point theory, using a few of unifying principles that can be easily visualized and readily understood. The course is divided into three parts that deal with convex analysis, optimality conditions and duality, computational techniques. In Part I, the mathematical theory of convex sets and functions is developed, which allows an intuitive, geometrical approach to the subject of duality and saddle point theory. This theory is developed in detail in Part II and in parallel with other convex optimization topics. In Part III, a comprehensive and up-to-date description of the most effective algorithms is given along with convergence analysis.

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MATH 6370 - Numerical Analysis

Prerequisites:	Graduate standing. Students should have knowledge in Calculus and Linear Algebra.
Text(s):	Numerical Mathematics (Texts in Applied Mathematics), 2nd Ed., V.37, Springer, 2010. By A. Quarteroni, R. Sacco, F. Saleri. ISBN: 9783642071010

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 to provide mathematical foundations of numerical methods, analyse their basic properties (stability, accuracy, computational complexity) and 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 6376 - Numerical Linear Algebra

Prerequisites:	Graduate standing.
Text(s):	Required: L.N.Trefethen, D.Bau, "Numerical Linear Algebra" SIAM, 1997 Additional: M.A.Olshanskii, E.E. Tyrtyshnikov, "Iterative methods for linear systems: theory and applications" SIAM, 2014.
Description:	The aim of the course is to develop understanding of modern methods of numerical linear algebra for solving linear systems, least squares problems and the eigenvalue problem. This course treats the main classes of problems in numerical linear algebra and covers famous matrix decompositions, theorems, and algorithms including singular value decomposition, LU decomposition, the QR method for eigenvalues, and Krylov subspace methods. It provides analysis of the problems along with algorithms for their solution. It also uses MATLAB as tool for expressing and implementing algorithms.

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MATH 6382 - Probability and Statistics

Prerequisites:	Graduate standing and MATH 3334, MATH 3338 and MATH 4378.

Text(s):	**Recommended Texts :** - A First Look at Rigorous Probability Theory by Jeffrey Rosenthal, 2000.. - An Intermediate Course in Probability Theory by Allan Gut, Springer 2009 (any edition) **Review of Undergraduate Probability:** - A First Course in Probability, 6th Edit. by Sheldon Ross, 2002, Prentice Hall **Complementary Texts for further reading:** - Probability: theory and Examples, 3rd Edit., Richard Durrett, Duxbury Press - An Introduction to Probability Theory and Its Applications, Vol 1, by William Feller - Probability by Leo Breiman, 1968, Addison-Wesley

Description:	**General Background (A).** (1) Combinatorial analysis and axioms of probability (2) Elementary random variables theory: expectation, variance, moments, distribution function, probability density functions, impact of change of variable on density functions (3) Major discrete probability distributions: Bernoulli, Binomial, Poisson, Geometric Major continuous probability distributions: Uniform, Normal, Exponential (4) Basic Modelling Applications (5) Conditional probability: Bayes formula, Independence, Conditional Expectation, Conditional density function, Conditional Probability distribution, Independent identically distributed random variables (6) Joint distributions, joint density functions, marginal distributions, marginal densities, covariances and correlation coefficients (7) Moment generating functions, Characteristic functions, **Measure theory (B).** (1) Elementary measure theory : Boolean algebras, probability spaces , continuity of probabilities, Borel-Cantelli lemma, Chebychevs inequality, (2) Convergence of random variables: Almost sure convergence, Convergence in distribution, Law of Large Numbers, Central Limit theorem **Markov chains and random walks (C).** Markov chain theory for finite or countable state spaces (1) Markov property and Transition matrix, Irreducibility (2) First hitting times, Transience, Recurrence , (3) Stationary distributions : existence theorems and computation (4) Random walks on Z and Z2 as Markov chains; Gambler's ruin problem

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MATH 6384 - Discrete Time Model in Finance

Prerequisites:	Graduate standing and MATH 6382.

Text(s):	Introduction to Mathematical Finance: Discrete-time Models, by Stanley Pliska, Blackwell, 1997.
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 6395 (23796) - Representation Theory Infinite Group

Prerequisites:	Graduate standing.
Text(s):	There is no official textbook for this course. Relevant references for each topic will be suggested during lectures
Description:	Topological groups; continuous unitary representations; positive definite functions; representations of compact groups; Peter-Weyl theorem; unitary representations of discrete groups; weak containment; amenability; property T.

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MATH 6395 (23800) - Stochastic Differential Equations

Prerequisites:	Graduate standing.
Text(s):	We will begin with "An Introduction to Stochastic Differential Equations" by L. C. Evans (UC Berkeley), that used to be available on his web-page. Additional material will be handed out or placed on reserve in the library during the course.

Description:

Stochastic differential equations arise when some randomness is allowed in the coefficients of a differential equation. They have many applications, including mathematical finance, mathematical biology, theory of partial differential equations and differential geometry. One emphasis of the course is understanding how the theory of stochastic integration can be used in modeling processes that have randomness.

This course is an introduction to the theory and applications of stochastic differential equations. Special attention will be devoted to their applications in mathematical finance.

We will review probability spaces, random variables and stochastic processes. We introduce Brownian motion, Ito integration and relevant aspects of martingale theory, Ito's change of variable formula. We then formulate and solve stochastic differential equations.

As applications to mathematical finance we will discuss the Girsanov theorem, arbitrage and option pricing (including the Black-Scholes equation), portfolio optimization, stochastic integrals with jumps, the Heston model. We will also discuss relations between SDE's and PDE's.

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MATH 6397 (23867) - Multiscale Analysis & Sparse Representation

Prerequisites:

Graduate standing.

It is strongly encouraged that students have a background in Linear Algebra and Real Analysis. Some programming experience or some willingness to learn. Prior knowledge of Matlab not required.

Text(s):

- There is no official textbook.
- I will select material from: A basis theory primer, by C. Heil, 2011, A wavelet tour of signal processing, by S. Mallat, Third edition, 2009 A First Course on Wavelets , by E. Hernandez and G. Weiss, 1996, Fourier analysis and applications, by C. Gasquet and P. Witomski
- Notes and papers will be provided by the instructor.

Description:

We live in a data-intensive age which is bringing significant changes in the process of scientific discovery. During the last decade, sparsity has emerged as a leading theme in connection with the goal to produce faster and simpler algorithms for a wide range of signal processing applications. By enabling to accurately approximate functions in a certain class using a relatively small number of nonzero coefficients, sparse representations are able to reveal the essential information we are looking for in the data. Therefore, sparsity implies not only data compression. Understanding the sparsity of a given data type entails a precise knowledge of the modelling and approximation of that data type. This knowledge is essential to design the most efficient algorithms for a tasks such as classification, denoising, interpolation, and segmentation. Multiscale techniques based on wavelets and their generalizations have emerged in the last decade as the most successful approach for sparse signal representations, as testified, for example, by their use in the new FBI fingerprint database and in JPEG2000, the new standard for image compression. Multiscale techniques were also extended beyond the traditional setting of physical spaces allowing for the efficient analysis of general structures, such as manifolds, graphs and point clouds in Euclidean space. The aim of this course is to provide the mathematical tools to understand multiscale representations starting from the setting of traditional wavelets up to more advanced and emerging constructions such as curvelets, shearlets and diffusion wavelets. Applications of these ideas will also be presented.

This course will provide an introduction to the theory of wavelets and its applications in mathematics.

Background: Orthonormal bases and frames: A basic problem in mathematics and engineering is to represent a function or a signal as superposition of elementary components. I will introduce the theory of frames and show that it provides the general framework to address this problem. Orthonormal bases are a special example of frames.

Background: Elements of Fourier analysis: I will review basic elements of Fourier analysis, including Fourier series and Fourier transforms,

Wavelet bases: The first wavelet basis, the Haar basis, was discovered in 1909 before wavelet theory was born. Unfortunately, the elements of this basis are not continuous. The success of the wavelet theory is due to the ability to construct a variety of wavelet bases with very nice mathematical properties such as smoothness, compact support, vanish moments, etc. I will present several examples of wavelet bases and describe what kind of features are desirable in such a basis.

Multiresolution Analysis: Multiresolution analysis is a general method for constructing wavelet bases. I will describe how to use this approach to construct Shannon wavelets, Daubechies wavelets and Meyer wavelets.

Sparse compression and approximation theory: One striking feature of wavelets is their ability to represent function with discontinuities. In fact wavelets have optimal approximation properties for several classes of functions and signals. I will introduce linear and nonlinear approximations, examine the approximation properties of wavelets and compare them to Fourier methods.

Wavelets and signal processing: Wavelets appear today in a variety of advanced signal processing applications, including analysis and diagnostics, quantization and compression, transmission and storage, noise reduction and removal. I will describe the connection between wavelet theory and filter banks theory in signal processing. I will present applications of wavelets to data/image compression and denoising. Some of this applications will be further explored by the students as individual or group projects.

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MATH 6397 (23868) - Mathematical Hemodynamics

Prerequisites:	Graduate standing.
Text(s):	S. Canic "Mathematical Hemodynamics" lecture notes *(will be distributed in class).*

Description:

1. Basic anatomy and physiology of the cardiovascular system;
2. Elements of fluid dynamics and modeling blood flow
3. Elements of elasticity theory and modeling arterial walls;
4. Fluid-structure interaction;
5. 1D reduced models of blood flow;
6. 2D and 3D fluid-structure interaction;
7. Overview of numerical schemes for FSI modeling cardiovascular flow.

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