Department of Mathematics

Fall 2016

GRADUATE COURSE FALL 2016

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 4310	20821	Biostatistics	MWF, 11:00am-Noon	CBB 104	C. Peters
Math 4320	15799	Intro to Stochastic Processes	TuTh, 11:30am-1pm	GAR 118	W. Ott
Math 4331	20822	Introduction to Real Analysis I	TuTh, 10-11:30am	F 154	D. Labate
Math 4350	29195	Differential Geometry	MW, 1-2:30pm	C 106	M. Ru
Math 4364	22454	Introduction to Numerical Analysis in Scientific Computing	MW, 4-5:30pm	SEC 202	T-W Pan
Math 4366	28114	Numerical Linear Algebra	TuTh, 11:30am-1pm	SEC 202	J. He
Math 4377	20824	Advanced Linear Algebra I	MWF, 10-11am	F 154	A. Mamonov
Math 4377	20825	Advanced Linear Algebra I	TuTh, 1-2:30pm	CBB 120	A. Török
Math TBD	TBD	TBD	TBD	TBD	TBD
Math 4388	18577	History of Mathematics	(online)	(online)	S. Ji
Math 4389	17365	Survey of Undergraduate Mathematics	MWF, 9-10am	AH 104	M. Almus

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5331	17818	Linear Algebra with Applications	Arrange (online course)	K. Kaiser
Math 5333	19131	Analysis	Arrange (online course)	G. Etgen
Math 5350	27317	Intro. to Differential Geometry	Arrange (online course)	M. Ru
Math 5385	16710	Statistics	Arrange (online course)	C. Peters
Math 5334	29194	Complex Analysis	Arrange (online course)	S. Ji
Math 5397	27319	Numerical Computing with Python	Arrange (online course)	J. Morgan

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6302	15811	Modern Algebra I	MWF, 10-11am	AH 204	M. Tomforde
Math 6308	20826	Advanced Linear Algebra I	MWF, 10-11am	F 154	A. Mamonov
Math 6308	20827	Advanced Linear Algebra I	TuTh, 1-2:30pm	CBB 120	A. Török
Math 6312	20823	Introduction to Real Analysis	TuTh, 10-11:30am	F 154	D. Labate
Math 6320	15840	Theory of Functions of a Real Variable	MWF, 11am-Noon	C 113	M. Kalantar
Math 6324	27314	Differential Equations	TuTh, 10-11:30am	AH 301	A. Török

Math 6342	15841	Topology	MWF, Noon-1pm	AH 2	D. Blecher
Math 6352	27315	Complex Analysis and Geometry	MW, 1-2:30pm	C 109	G. Heier
Math 6360	16690	Applicable Analysis	TuTh, 4-5:30pm	AH 301	G. Auchmuty
Math 6366	15842	Optimization Theory	TuTh, 11:30am-1pm	AH 12	R. Glowinski
Math 6370	15843	Numerical Analysis	MW, 1-2:30pm	SW 219	Y. Kuznetsov
Math 6382	15844	Probability and Statistics	MW, 1-2:30pm	AH 301	W. Fu
Math 6384	15845	Discrete Time Model in Finance	TuTh, 2:30-4pm	CBB 122	E. Kao
Math 6397	27332	Massive Data Analysis for Large Sets of Interacting Time Series	TuTh, 11:30am-1pm	AH 301	R. Azencott
Math 6397	27331	Design of Experiments	MW, 4-5:30pm	SEC 206	W. Fu
Math 6397	28751	Multilevel/Multiscale Methods	MWF, Noon-1pm	C 113	M. Olshanskii
Math 6397	27333	Stochastic Models in Biology	TuTh, 2:30-4pm	AH 301	K. Josic
Math 6397	29550	Scientific Computing with Python	TuTh, 2:30-4pm	M 105	I. Timofeyev
Math 7320	27327	Functional Analysis	TuTh, 1-2:30pm	AH 301	B. Bodmann
Math 7374	27329	Finite Element Methods	MW, 1-2:30pm	MH 129	R. Hoppe
Math 7397	27330	Levy Processes for Pricing Financial Derivatives	TuTh, 10-11:30am	AH 16	E. Kao

---Course Details---

SENIOR UNDERGRADUATE COURSES

Math 4310 - Biostatistics

Prerequisites: MATH 3339 and BIOL 3306 or consent of instructor.

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 or consent of instructor. 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 4350 - Differential Geometry

Prerequisites:	MATH 2433 and MATH 2331. Math 2433 Calculus of Functions of Several Variables
Text(s):	Instructor's notes will be provided.
Description:	**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 4364 - 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 4366 - Numerical Linear Algebra

Prerequisites:	MATH 2331 , or equivalent, and six additional hours of 3000-4000 level Mathematics.
Text(s):	TBD
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 (20824) - 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 - 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 4388 - History of Mathematics

Prerequisites:	Math 3333 Intermediate Analysis, or content of instructor.
Text(s):	No textbook is required.

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.

Description:

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 and consent of instructor.

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/)

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.

Description:

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. Two semesters of calculus or consent of instructor.

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 5350 - Differential Geometry

Prerequisites: Graduate standing. 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, geodesics, Gauss-Bonnet theorem, and minimal surfaces.

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MATH 5385 - Statistics

Prerequisites: Graduate standing and consent of instructor.

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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MATH 5334 - Complex Analysis

Prerequisites: Graduate Standing. Credit for Math 5333 or 3333, or consent of instructor.

Text(s): Instructor's lecture notes.

This course is an introduction to complex analysis. It will cover the theory of holomorphic functions, Cauchy theorem and Cauchy integral formula, residue theorem, harmonic and subharmonic functions, and other topics.

On-line course is taught through Blackboard Learn, visit http://www.uh.edu/webct/ for information on obtaining ID and password.

Description: The course will be based on my notes.

In each week, some lecture notes will be posted in Blackboard Learn, including homework assignment.

Homework will be turned in by the required date through Blackboard Learn. It must be in pdf file. There are two exams. Homework and test problems are mostly computational in nature.

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MATH 5397 (27319) - Numerical Computing with Python

Prerequisites: Graduate Standing, and basic familiarity with calculus, matrices, vectors and introductory statistics.

Text(s): "Numerical Methods in Engineering with Python 3", by Jaan Kiusalaas. ISBN: 978-1107033856. Cambridge University Press; 3rd edition.

Description:	**Course Overview:** This course is an introduction to scientific computing with Python, which will include an introduction to the Python programming language, approximate differentiation and integration, roots of equations, solutions to systems of linear equations, least squares solutions and multiple regression, solutions to nonlinear systems of equations, optimization, and solutions to discrete dynamical systems and differential equations. All computations will be done in Python, and consequently, the course will also include instruction associated with programming in Python. Students are not expected have experience with the Python programming language. **Discussion Forum Activity:** All students are expected to discuss the course material via the discussion forum, linked from the course homepage. 10% of the final grade will be based upon discussion board activity, and questions are just as important as answers (correct or incorrect). All discussion forum questions and comments will be read within 24 hours, and responses will be given if your classmates have not already given good feedback. **Additional Communication:** Students will receive emails from the instructor during most weekdays of the course, reminding students of current material, upcoming topics, reading assignments, available help materials, and coming due dates. All of these emails will also be posted in a special thread within the discussion forum. Email can also be used to communicate with the instructor, although students are encouraged to use the discussion forum when the questions are not of a student specific nature. **Homework:** Written homework will be given several times during the semester, with the due dates noted on the course calendar. Students will upload their work to the course website. Instructions will be given. **Exams:** A midterm and final exam will be given. The dates and times of the exams will be announced later in the semester. Remote proctoring will be arranged for students who do not live in the Houston area. **Online Meetings:** The class will have an OPTIONAL online live meeting on Tuesday evenings from 8-10:00pm. Notes and a video of the sessions will be posted for students who cannot attend. **Additional Information:** A link to course materials will appear by August 15, 2016 at http://www.math.uh.edu/~jmorgan .

GRADUATE COURSES

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	MATH 6302 - Modern Algebra I
Prerequisites:	Graduate standing or consent of instructor
Text(s):	Course notes will be provided. There is no required text, but if you wish to have something to supplement the notes, I recommend the book Abstract Algebra by David S. Dummit and Richard M. Foote. 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 (20826)- Advanced Linear Algebra I

Prerequisites:	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 (20827)- Advanced Linear Algebra I

Prerequisites:	TBA
Text(s):	TBA
Description:	TBA

TBD**<< back to top >>**

MATH 6312- Introduction to Real Analysis

Prerequisites:	Graduate standing. MATH 3334 or consent of instructor. 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. Math 4332 (Introduction to real analysis) or consent of instructor
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 6324 - Differential Equations

Prerequisites:	Graduate standing. MATH 4331

Text(s):	**Required**: Instructor's lecture notes **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 **Special notes:* 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

Prerequisites:	Graduate standing. MATH 4331 and MATH 4337 or consent of 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).

Description:

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.

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 6352 - Complex Analysis and Geometry

Prerequisites: Graduate Standing. Math 6322-6323, or equivalent, or consent of instructor

Text(s):

Positivity in Algebraic Geometry I, by Lazarsfeld. ISBN: 9783540225331 (not required)

Principles of Algebraic Geometry, by Griffiths-Harris. ISBN: 9780471050599 (not required)

Description:

This is the first semester of a two semester introductory course in complex algebraic geometry. Topics to be discussed are: basics of complex analysis, complex manifolds, cohomology, line bundles and divisors, rational and birational maps, compact complex surfaces, intersection theory, Riemann-Roch theorem.

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MATH 6360 - Applicable Analysis

Prerequisites: Graduate standing. MATH 4331 or equivalent or consent of instructor.

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 or consent of the instructor. 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 in mathematics, Calculus, Linear Algebra, consent of instructor.

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 6382 - Probability and Statistics

Prerequisites: Graduate standing. MATH 3334, MATH 3338 and MATH 4378, or consent of instructor

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. MATH 6382 or consent of instructor.

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 6397 (28751) - Multilevel/Multiscale Methods

Prerequisites: Graduate standing. The course complements standard numerical analysis (Math 4364),Partial Differential Equations (Math 4335), Advanced LinearAlgebra I & II (Math 4377 - 4378). The latter two courses are desirable, but not pre-requested though, since elementary introduction to necessary concepts will be given

Text(s):

1) Y.Efendiev, Th. Y. Hou, Multiscale finite element methods, Springer, 2009

2) M.A.Olshanskii, Lecture notes on multigrid methods. (Available free online).

Description: The course surveys and studies the main concepts and recent advances in multiscale finite element methods (FEM) and multilevel algebraic solvers. A broad range of scientific and engineering problems involve multiple scales. Large disparities in the modeled scales appear in virtually all areas of modern sciences engineering, for example, composite materials, porous media, turbulent transport and so on. The direct numerical solution of multiple scale problems is difficult even with the advent of supercomputers. Multiscale FEM are designed to capture the mutiscale structure of the solution. The notion of different scales is also of key importance for multilevel/multigrid methods to solve large systems of algebraic equationsarising in many applications. Pioneered in the 70s multigrid soon become a crucial ingredient in engineering software and is known to be among a few methods to provide an optimal complexity in terms of arithmetic operations per unknown. Nowadays, every researcher working with the numerical solution of partial differential equations should at least be familiar with this powerful approach. This course introduces to multigrid methods and their applications in computational physics. Applications will be considered to basic PDEs as well as to various fluids models, and Maxwell equations.

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MATH 6397 (27332) - Massive Data Analysis for Large Sets of Interacting Time Series

Prerequisites:

Graduate Standing.

- Linear Algebra: matrices, eigenvectors and eigenvalues, diagonalization, determinants, quadratic forms associated to symetric matrices

- Basic Probability and Statistics: random variables, independence, probability distributions, CDF’s and densities, histograms, quantiles, correlations and covariances

- Hilbert Spaces: background knowledge and basic examples

Text(s):	No single textbook. Reading assignments will be a small set of scientific papers. Some background information and concepts will be referred to the following book: The Elements of Statistical Learning, Data Mining: Freedman, Hastie, Tibshirani
Description:	**Summary:** Automatic learning has been widely extended to the analysis of high dimensional data sets and in particular to smart data mining of massive data sets of time series. The course will focus first on applications of machine learning to automated clustering, modeling, and forecasting of time series in multiple application domains where data are naturally indexed by time : economic and financial data, multi-sensors recordings, brain activity recordings, climate data recordings, etc. We will present and study key techniques such as entropy based distances, kernel based non linear clustering, spectral compression of networks dynamics, kernel based nonlinear forecasting, reconstruction of networks connctivity. Emphasis will be on understanding importants concepts and their mathematical formalization, with a strong focus on software implementation of algorithms and intensive testing on actual or simulated data sets. **Homework and exams**: Homework assignments will mostly involve computational implementation on several applied projects. Students will have to use either Matlab or R or equivalent scientific softwares. Projects Reports will have to be typed (using LaTeX or Word scientific). Two midterm exams will be held in class (1h30 without notes or books), and will require only answering conceptual or theoretical questions, with no mathematical proof requested . Final exam will involve in depth reading of one scientific paper and preparation of a set of slides. Actual presentation of the slides will not be requested **Final grade** = 20% final + 10% midterm1 + 10% midterm2 + 60% homeworks

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MATH 6397 (27331) - Design of Experiments

Prerequisites:	Graduate Standing. Consent of instructor. Two years of Calculus, Math 6308 Advanced Linear Algebra I, Math 5386 Regression and Linear Models, and Mathematical Statistics, Biostatistics or equivalent.
Text(s):	Recommended books: Douglas C. Montgomery: Design and Analysis of Experiments, Wiley ISBN-13: 978-1118146927 ISBN-10: 1118146921 Edition: 8th

This course is designed for graduate students who have been exposed to basic probability and statistics and would like to learn more advanced topics of design and analysis of experiments with applications to biological studies, public health and industries. The selected topics will include review of linear regressions, completely randomlized design, randomized block design, factorial designs, etc.. The instructor reserves the right to exclude certain topics from the textbook and add other topics not covered in the textbook.

Description: **Grading.** Final grades will be based on class attendance and in-class discussion (10%), assignment (30%), midterm exams (30% each), the final research project (written report,30%).

R software
R is a open source statistical analysis software, and can be downloaded for free
At http://www.r-project.org/ .
SAS is an industry-standard software that are used and recommended by pharmaceutical companies for analzing clinical trial data for reports to the FDA.

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MATH 6397 (27333) - Stochastic Models in Biology

Prerequisites: Graduate standing. Students taking the course should be comfortable with undergraduate probability,multivariate calculus, differential equations, and linear algebra.

Text(s): Instructor's notes will be provided.

Description: Randomness and variability which are fundamental features of nearly all biological systems. In this course we will use the theory of probability and stochastic processes to develop models of biological systems. We will discuss models of chemical reactions, gene regulatory networks, epidemics, and neuronal networks. Students taking the course should be comfortable with undergraduate probability, multivariate calculus, differential equations and linear algebra. Topics to be covered include: a review of probability, including numerical techniques for generating random samples, Markov processes with discrete and continuous space variables, diffusion processes, Wiener and Ornstein-Uhlenbeck processes, point processes, Gillespie’s algorithm and other algorithms for simulating stochastic processes and their application in biology, statistical analysis of time series, power spectra of random processes. A portion of the course will be devoted to numerical simulations of stochastic systems using MATLAB.

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MATH 6397 (29550) - Scientific Computing with Python

Prerequisites: Graduate Standing.

Text(s): Instructor's notes

Description: This class is designed for graduate students who would like to learn python programming with an emphasis on scientific computing. First, we will discuss standard python constructions. Then, we will discuss data structures which are relevant for scientific computing. We will also discuss various computing algorithms (e.g. ODE integration and computation of statistical quantities, optimization, data processing and machine learning) and implementation in python. Background mathematical material on computational algorithms will be given in class. We will also discuss some computer science algorithms (sorting, graph search, etc.) and implementations.

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MATH 7320 - Functional Analysis

Prerequisites: Graduate Standing. Linear algebra (Math 4377) and Real Analysis (Math 4331/4332).

Text(s): Functional Analysis (2nd Edition) by Walther Rudin, McGraw Hill, 1991. ISBN: 9780070542365

Description:

This course is part of a two semester sequence covering the main results in functional analysis, includingHilbert spaces, Banach spaces, topological vector spaces such as distributions, and linear operators on thesesspaces.

Functional analysis combines two fundamental branches of mathematics: analysis and linear algebra. Limitingarguments from analysis become essential in order to resolve questions from linear algebra ininfinite-dimensional spaces. In addition, there are close connections between algebraic and topologicalproperties in such spaces that deepen our understanding even in the finite dimensional case.

Topics covered in this first part of the course sequence include: Topological vector spaces (linear mappings,metrizability, bounded operators and continuity, seminorms and local convexity, quotient spaces); Completeness(Baire category and the Banach-Steinhaus theorem, an application to Fourier series, open mapping theorem,closed graph theorem);Convexity (Hahn-Banach theorem, weak topology and separation theorems,compactness and duality, subspaces and quotients); Spectral theory (Banach algebras and their representation,commutativity, resolutions of the identity, spectral theorem,eigenvalues of normal operators, positivity); Distributions (linear functionals on topological vector spaces,working with distributions localization theorems).

The grade will be based on notes prepared by the students.

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MATH 7374 - Finite Element Methods

Prerequisites: Graduate Standing. Students must have a good background in Calculus, Linear Algebra, Numerical Analysis

Text(s):	D. Braess; Finite Elements. Theory, Fast Solvers and Applications in Solid Mechanics. 3rd Edition.Cambridge Univ. Press, Cambridge, 2007. C. Brenner and L. Ridgway Scott; The Mathematical Theory of Finite Element Methods. 3rd Edition. Springer, New York, 2008
Description:	Finite Element Methods are widely used discreti-zation techniques for the numerical solution ofPDEs based on appropriate variational formu-lations. We begin with basic principles for theconstruction of Conforming Finite Elements andFinite Element Spaces with respect to triangu-lations of the computational domain. Then, westudy in detail a priori estimates for the globaldiscretization error in various norms of the un-derlying function space. Nonconforming and Mi-xed Finite Element Methods will be addressed aswell. A further important issue is adaptive gridrefinement on the basis of efficient and reliablea posteriori error estimators for the global dis-cretization error.

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MATH 7397 - Levy Processes for Pricing Financial Derivatives

Prerequisites:	Graduate Standing and Math 6385
Text(s):	1. Financial Modeling with Jump Processes, Second Edidition, By Rama Cont and Peter Tankov, Chapman and Hall, 2016. 2. Levy Processes in Finance: Pricing Financial Derivatives, by Wim Schoutens, Wiley, 2003.
Description:	This course is about using Levy processes in modelling financial time series and valuation of contingenct claims. We start with a revew of diffusion processes, jump processes, point processes, and random measures. we cover Ito calculus for semimartingales and Girsanov measure transformation. We then expore the building Levy processes, parameter estimation and valuation of financial derivatives. We also address issues relating to pricing and hedging in incomplete markets.

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