Department of Mathematics

Fall 2018

GRADUATE COURSE FALL 2018

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 4310	18242	Biostatistics	TuTh, 2:30—4pm	MH 129	W. Fu
Math 4320	14680	Intro to Stochastic Processes	MWF, 10—11am	SEC 104	I. Timofeyev
Math 4331	18243	Introduction to Real Analysis I	TuTh, 2:30—4pm	SEC 104	M. Kalantar
Math 4335	21357	Partial Differential Equations I	TuTh, 8:30—10am	SEC 201	Y. Gorb
Math 4350	23058	Differential Geometry I	TuTh, 1—2:30pm	C 110	M. Ru
Math 4364	19207	Introduction to Numerical Analysis in Scientific Computing	MW, 4-5:30pm	SEC 103	T-W. Pan
Math 4364	22149	Introduction to Numerical Analysis in Scientific Computing	Arrange (online course)	(online)	J. Morgan
Math 4366	20139	Numerical Linear Algebra	TuTh, 11:30am-1pm	FH 219	J. He
Math 4377	18245	Advanced Linear Algebra I	MWF, 11am-Noon	CBB 104	W. Fitzgibbon
Math 4377	18246	Advanced Linear Algebra I	TuTh, 4-5:30pm	CEMO 109	A. Mamonov
Math 4388	16729	History of Mathematics	(online)	(online)	S. Ji
Math 4389	15859	Survey of Undergraduate Mathematics	MW, 1-2:30pm	CBB 108	M. Almus
Math 4397	26829	Statistical and Machine Learning	MWF, 11am-Noon	SEC 202	A. Skripnikov/C.Poliak

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5331	16178	Linear Algebra with Applications	Arrange (online course)	K. Kaiser
Math 5333	17045	Analysis	Arrange (online course)	G. Etgen
Math 5344	21359	Scientific Computing w/Excel	Arrange (online course)	J. Morgan
Math 5350	23059	Intro To Differential Geometry	Arrange (online course)	M. Ru
Math 5385	15529	Statistics	Arrange (online course)	C. Peters

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6302	14685	Modern Algebra I	MW, 1—2:30pm	N115	G. Heier
Math 6308	18247	Advanced Linear Algebra I	MWF, 11am—Noon	CBB 104	W. Fitzgibbon
Math 6308	18248	Advanced Linear Algebra I	TuTh, 4—5:30pm	CEMO 109	A. Mamonov

Math 6312	18244	Introduction to Real Analysis	TuTh, 2:30—4pm	SEC 104	M. Kalantar
Math 6320	14714	Theory of Functions of a Real Variable	MWF, Noon-1pm	AH 301	M. Tomforde
Math 6322	25638	Functions of a Complex Variable	MW, 9—10am	AH 301	S. Ji
Math 6342	14715	Topology	TuTh, 11:30am—1pm	FH 215	W. Ott
Math 6360	15509	Applicable Analysis	MWF, 10—11am	AH 201	B. Bodmann
Math 6366	14716	Optimization Theory	TuTh, 4—2:30pm	AH 15	A. Mang
Math 6370	14717	Numerical Analysis	MW, 1—2:30pm	CAM 105	Y. Kuznetsov
Math 6378	26188	Basic Scientific Computing	MW, 4—5:30pm	AH 11	R. Sanders
Math 6382	22207/21800	Probability and Statistics	TuTh, 10—11:30am	AH 205	M. Nicol
Math 6384	21364	Discrete Time Model in Finance	TuTh, 2:30-4pm	SW 423	E. Kao
Math 6395	23066	Quantum Information Science	TuTh, 10—11:30am	M 119	A. Vershynina
Math 6397	26980	Agent-based Modeling	TuTh, 10—11:30am	SW 423	M. Perepelitsa
Math 7320	23068	Functional Analysis	MWF, 11am—Noon	AH 303	D. Blecher
Math 7374	23069	Finite Element Methods	MW, 4—5:30pm	AH 15	M. Olshanskiy

--Course Details---

SENIOR UNDERGRADUATE COURSES

Math 4310 - Biostatistics

Prerequisites:	**MATH 3339** and **BIOL 3306**
Text(s):	TBD
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 3333**. In depth knowledge of Math 3325 and Math 3333 is required.
Text(s):	Real Analysis, by N. L. Carothers; Cambridge University Press (2000), ISBN 978-0521497565

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 4350 - Differential Geometry I

Prerequisites:	**MATH 2433** and six additional hours of 3000-4000 level Mathematics.
Text(s):	Calculus of Functions of Several Variables
Description:	**Description**: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, The Codazzi and Gauss Equations, Covariant Differentiation, Parallel Translation. **Instructor's 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 (19207) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** and COSC 1410 or equivalent. *(2017—2018 Catalog)* **MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *(2018—2019 Catalog)* *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 (22149) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** and COSC 1410 or equivalent. *(2017—2018 Catalog)* **MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *(2018—2019 Catalog)* *(see the description for more prerequisite details)*
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	The students in this online section will be introduced to topics in scientific computing, including numerical solutions to nonlinear equations, numerical differentiation and integration, numerical solutions of systems of linear equations, least squares solutions and multiple regression, numerical solutions of nonlinear systems of equations, numerical optimization, numerical solutions to discrete dynamical systems, and numerical solutions to initial value problems and boundary value problems. Computations in this course will primarily be illustrated directly in an Excel spreadsheet, or via VBA programming, but students who prefer to do their computations using Matlab, Julia, Python or some other programming language are also welcome. For students who want to do their computing in Excel, there will be tutorials associated with the use of Excel, and programming in VBA. Students who decide to use Excel 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. Students will not be tested over Excel or VBA, and students using Matlab, Julia or Python will also receive some help materials

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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 (18245) - Advanced Linear Algebra I

Prerequisites:	MATH 2331, or equivalent, and a minimum of three semester hours of 3000-4000 level Mathematics.
Text(s):	Linear Algebra, 4th Edition, by S.H. Friedberg, A.J Insel, L.E. Spence,Prentice Hall, ISBN 0-13-008451-4

	Catalog Description: Linear systems of equations, matrices, determinants, vector spaces and linear transformations, eigenvalues and eigenvectors.
Description:	**Instructor's 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 (18246) - Advanced Linear Algebra I

Prerequisites:	MATH 2331, or equivalent, and a minimum of three semester hours of 3000-4000 level Mathematics.
Text(s):	Linear Algebra, 4th Edition, by S.H. Friedberg, A.J Insel, L.E. Spence,Prentice Hall, ISBN 0-13-008451-4
	Catalog Description: Linear systems of equations, matrices, determinants, vector spaces and linear transformations, eigenvalues and eigenvectors.
Description:	**Instructor's 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, rank, inverse and invertibility, determinants, eigenvalues and eigenvectors.

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Math 4388 - History of Mathematics

Prerequisites:	**MATH 3333**
Text(s):	*No textbook is required. Instructor notes will be provided*

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 3331**, **MATH 3333**, and three hours of 4000-level Mathematics.
Text(s): *No textbook is required. Instructor notes will be provided*
Description: A review of some of the most important topics in the undergraduate mathematics curriculum.

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Math 4397 (26829) - Statistical and Machine Learning

Prerequisites: **Instructor's Prerequisite:** MATH 3339

Text(s):

- An Introduction to Statistical Learning (with Applications in R), by James, Witten, Hastie, and Tibshirani

- Neural Networks with R, by G. Ciaburro, B. Venkateswaran, ISBN: 9781788397872

Description:

Description: Linear and logistic regression, fit quality assessment, model validation, decision trees, bootstrap, random forests, neural networks.

Details: Course will deal with theory and applications for such statistical learning techniques as linear and logistic regression, classification and regression trees, random forests, neural networks. Other topics might include: fit quality assessment, model validation, resampling methods. R Statistical programming will be used throughout the course.

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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** and three semesters of Calculus.

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

(see the description for more prerequisite details)

Text(s): Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519

Description: The students in this online section will be introduced to topics in scientific computing, including numerical solutions to nonlinear equations, numerical differentiation and integration, numerical solutions of systems of linear equations, least squares solutions and multiple regression, numerical solutions of nonlinear systems of equations, numerical optimization, numerical solutions to discrete dynamical systems, and numerical solutions to initial value problems and boundary value problems. Computations in this course will primarily be illustrated directly in an Excel spreadsheet, or via VBA programming, but students who prefer to do their computations using Matlab, Julia, Python or some other programming language are also welcome. For students who want to do their computing in Excel, there will be tutorials associated with the use of Excel, and programming in VBA. Students who decide to use Excel 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. Students will not be tested over Excel or VBA, and students using Matlab, Julia or Python will also receive some help materials

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MATH 5350 - Introduction to Differential Geometry

Prerequisites: **Graduate standing** and **MATH 2433**

Text(s): A set of notes on curves and surfaces will be written and distributed by Dr. Ru.

Description: This course can be viewed as an advanced (continuation of) calculus (and vector calculus). We'll extend the theory of calculus to curves and surfaces in R^3. The standard topics in basic Differential Geometry will be covered: 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. It is hoped, after this course, you will gain a much deeper understanding of the classical calculus, as well as a higher view of this subject.

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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 (18247)- Advanced Linear Algebra I

Prerequisites:

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

Instructor's Prerequisite: **MATH 2331**, or equivalent, and a minimum of three semester hours of 3000-4000 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:

Catalog Description: An expository paper or talk on a subject related to the course content is required.

Instructor's 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 (18248)- Advanced Linear Algebra I

Prerequisites:

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

Instructor's Prerequisite: **MATH 2331**, or equivalent, and a minimum of three semester hours of 3000-4000 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:

Catalog Description:An expository paper or talk on a subject related to the course content is required.

Instructor's 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, rank, inverse and invertibility, determinants, eigenvalues and eigenvectors.

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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):

Real Analysis, by N. L. Carothers; Cambridge University Press (2000), ISBN 978-0521497565

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 / 6321 introduces students to modern real analysis. The core of the course will cover measure, Lebesgue integration, differentiation, absolute continuity, and L^p spaces. We will also study aspects of functional analysis, Radon measures, and Fourier analysis.

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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 6342 - Topology

Prerequisites: Graduate standing and **MATH 4331** and **MATH 4337**.

Text(s): (Required) Topology, A First Course, J. R. Munkres, Second Edition, Prentice-Hall Publishers.

link to text

Description:

Catalog Description: Point-set topology: compactness, connectedness, quotient spaces, separation properties, Tychonoff's theorem, the Urysohn lemma, Tietze's theorem, and the characterization of separable metric spaces

Instructor's Description: Topology is a foundational pillar supporting the study of advanced mathematics. It is an elegant subject with deep links to algebra and analysis. We will study general topology as well as elements of algebraic topology (the fundamental group and homology theories).

Though traditionally viewed as a pure subject, algebraic topology has experienced a renaissance in recent years with the emergence of applied algebraic topology. To wit, SIAM has recently launched a new journal on applied algebra and geometry.

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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 and **MATH 4331** and **MATH 4377**

Students are expected to have a good grounding in basic real analysis and linear algebra.

Text(s):

"Convex Optimization", Stephen Boyd, Lieven Vandenberghe, Cambridge University Press, ISBN: 9780521833783 *(This text is available online. Speak to the instructor for more details)*

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 6378 - Basic Scientific Computing

Prerequisites:

Catalog Prerequisites:Graduate standing. **MATH 4364** and **MATH 4365** or equivalent, and either **COSC 1304** or **COSC 2101** or equivalents, or consent of instructor

Instructor Prerequisites: Knowledge of C and/or Fortran.

Text(s):

Instructor's notes will be provided.

Recommended text/Optional: Elementary Numerical Analysis, ISBN: 9780471433378

Description:

Description: A project-oriented course in fundamental techniques for high performance scientific computation. Hardware architecture and floating point performance, code design, data structures and storage techniques related to scientific computing, parallel programming techniques, applications to the numerical solution of problems such as algebraic systems, differential equations and optimization. Data visualization.

Instructor's Description: Fundamental techniques in high performance scientific computation. Hardware architecture and floating point performance. Pointers and dynamic memory allocation. Data structures and storage techniques related to numerical algorithms. Parallel programming techniques. Code design. Applications to numerical algorithms for the solution of systems of equations, differential equations and optimization. Data visualization. This course also provides an introduction to computer programming issues and techniques related to large scale numerical computation.

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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 (23066) - Quantum Information Science

Prerequisites:

Graduate standing.

Instructor's prerequisites: Linear Algebra, basics of Probability, basics of Functional Analysis

Text(s):

-Michael Nielsen and Isaac Chuang, "Quantum computation and quantum information", Cambridge university press, 2010

-Mark Wilde, "From Classical to Quantum Shannon Theory" arXiv:1106.1445

Description:

Description: May be repeated with approval of chair.

Instructor's description: Quantum Information Theory is the study of the information processing tasks (such as storing, manipulating, transmitting, encoding, decoding) that can be accomplished using quantum mechanical systems. The course will start with the introduction to quantum mechanics, and will briefly cover basic aspects of quantum information theory, such as quantum algorithms, error-correction, complexity theory, quantum entropy, entanglement theory, noisy and noiseless quantum channels. Besides rigorously going over these topics, we will informally discuss applications of quantum information and quantum mechanics to the real world, as well as their appearance in the real world and popular culture. The work load will include a weekly list of practice problems and weekly research assignment on a general topic. Active participation is class is required. No quizzes, exams or a final will be given.

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MATH 6397 (26980)- Agent-based Modeling

Prerequisites: **Graduate standing**.

Text(s):

Interacting Multiagent Systems: Kinetic equations and Monte Carlo methods, by Lorenzo Pareschi, Giuseppe Toscani
ISBN-13: 978-0199655465
ISBN-10: 0199655464

Description:

This course is focused on the derivation and analysis of the kinetic equations governing the evolution of interacting multi-agent systems. The following are the examples of kinetic PDEs that will considered in this course: backward and forward Kolmogorov equations, Boltzmann-type equations for agent systems interacting through binary collisions, linear kinetic equations for agent-backgound interation, Vlassov and Vlassov-Poisson equations for mean-field type interactions.

Kinetic equations of these types appear in diverse applications. We consider the examples of multi-agent systems that arise in Classical Physics (radiative transfer, rarefied gas dynamics), Life Sciences (birth and death processes, growth of mutant cells, self-organized systems and swarming models), Economics and Social Sciences (models for wealth distribution, trading goods and opinion formation).

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MATH 7320 (23068) - Functional Analysis

Prerequisites: Graduate standing and **MATH 6320**

Text(s): there will be a xeroxed set of lecture notes available. There are several good books on the market, such as: Pedersen's ``Analysis Now" or Conway's "A course in Functional Analysis".

Description:

Catalog 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.

Instructor's Description: You will be asked from time to time (maybe once every week or two) to make a presentation at the board from the typed notes. If you need help with this please ask. We will be starting with a little topology - so you might glance through any good basic book on topology to familiarize yourself with `compactness' , `locally compact', continuous functions between topological spaces, the basic theory of metric spaces. The reason I review some topology is to familiarize the students with the use of `nets'(=generalized sequences) in topology.

We will mostly avoid measure theory, so don't be too concerned if you lack that background. After each chapter we will schedule a problem solving workshop, based on the homework assigned for that chapter.

Final grade is aproximately based on a total score of 200 points consisting of homework (100 points) and class presentations (100 points). The instructor may change this at his discretion.

The first semester will be a general presentation, of the basic facts in Linear Analysis, Banach space theory, and Hilbert spaces and compact operators. The second semester will be a more technical development of the theory of linear operators on Hilbert space. We will also cover topics which the students request. We will probably only make it through section III in the first semester.

Outline of the 2-semester syllabus:

I. General topology.

A very short section emphasizing nets.

II. Banach Space Theory.

Normed spaces and their operators. Review of basic principles like the Hahn-Banach theorem (pillars of functional analysis). Banach space theory. Dual spaces. Locally convex and weak topologies.

III. Hilbert spaces.

Deeper facts about Hilbert spaces. Bounded linear operators on Hilbert spaces. Compact operators and thir spectral theorem.

IV. Algebras and spectral theory.

Banach algebras. The Gelfand transform. Stone-Weierstrass. The spectral theorem. The Fourier Transform for locally compact groups.

V. Special topics/Students requests.

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MATH 7374 - Finite Element Methods

Prerequisites: Graduate standing and **MATH 6326, MATH 6327**

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:

Description: Introduction to variational formulations of boundary value operators, construction of finite element spaces, existence and convergence of finite element solutions, mixed and hybrid finite element methods, algebraic formulation of finite element equations, iterative methods for large scale finite element systems, applications in fluid mechanics and electromagnetics

Instructor's 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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