Department of Mathematics

2020 - Spring Semester

*(**Disclaimer**: Be advised that some information on this page may not be current due to course scheduling changes. Please view either the **UH Class Schedule page** or your Class schedule in **myUH** for the **most current/updated information**.)*

(NEW) University of Houston Textbook Adoption login:

Please use this link to **Create your account** and **Submit** your textbook information for your course. This login is specifically designed to allow faculty to submit their own textbook information ***(PDF Instructions-screenshots)***.

GRADUATE COURSES - SPRING 2020

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

SENIOR UNDERGRADUATE COURSES

Course	Class #	Course Title	Course Day & Time	Rm #	Instructor
Math 4309	15605	Mathematical Biology	MW, 1—2:30PM	SEC 104	R. Azevedo
Math 4315	20638	Graph Theory w/Applications	TuTh, 4—5:30PM	CBB 118	K. Josic
Math 4323	28786	Data Science and Statistical Learning	MWF, 11AM—Noon	SEC 101	C. Poliak/W. Wang
Math 4332/6313	12497	Introduction to Real Analysis II	TuTh, 8:30—10AM	F 162	B. Bodmann
Math 4362	21796	Theory of Differential Equations and Nonlinear Dynamics	MWF, 10—11AM	AH 202	G. Jaramillo
Math 4364	18290	Intro. to Numerical Analysis in Scientific Computing	MW, 4—5:30PM	CBB 124	T. Pan
Math 4364	22419	Intro. to Numerical Analysis in Scientific Computing	Online	Online	J. Morgan
Math 4365	16883	Numerical Methods for Differential Equations	TuTh, 11:30AM—1PM	SEC 202	J. He
Math 4377/6308	17674	Advanced Linear Algebra I	TuTh, 10—11:30AM	F 154	G. Heier

Math 4378/6309	12498	Advanced Linear Algebra II	TuTh, 10—11:30AM	SEC 105	A. Mamonov
Math 4380	12499	A Mathematical Introduction to Options	MW, 1—2:30PM	SEC 203	I. Timofeyev
Math 4389	12500	Survey of Undergraduate Mathematics	MWF, Noon—1PM	CBB 124	D. Blecher
Math 4397	27738	Mathematical Methods for Physics	MW, 2:30—4PM	SW 219	L. Wood

GRADUATE ONLINE COURSES

Course	Class #	Course Title	Course Day & Time	Instructor
Math 5330	13701	Abstract Algebra	Arrange (online course)	K. Kaiser
Math 5332	12513	Differential Equations	Arrange (online course)	G. Etgen
Math 5344	22571	Introduction to Scientific Computing	Arrange (online course)	J. Morgan
Math 5397	23376	Data Science and Mathematics	Arrange (online course)	S. Ji
Math 5397	23377	Dynamical Systems	Arrange (online course)	A. Török

GRADUATE COURSES

Course	Class #	Course Title	Course Day & Time	Rm #	Instructor
Math 6303	12517	Modern Algebra II	TuTh, 11:30AM—1PM	AH 203	M. Kalantar
Math 6308	17675	Advanced Linear Algebra I	TuTh 10—11:30AM	F 154	G. Heier
Math 6309	13850	Advanced Linear Algebra II	TuTh, 10—11:30AM	SEC 105	A. Mamonov
Math 6313	13848	Introduction to Real Analysis	TuTh, 8:30—10AM	F 162	B. Bodmann
Math 6321	12532	Theory of Functions of a Real Variable	TuTh, 1—2:30PM	SW 423	W. Ott
Math 6327	23390	Partial Differential Equations	TuTh, 4—5:30PM	SEC 202	G.Auchmuty
Math 6361	13851	Applicable Analysis	TuTh, 2:30—4PM	CBB 124	A. Mamonov
Math 6367	12533	Optimization Theory	MW, 2:30—4PM	S 202	R. Hoppe
Math 6371	12534	Numerical Analysis	MW, 4—5:30PM	AH 7	M. Olshanskii
Math 6374	23391	Numerical Partial Differential Equations	MW, 1—2:30PM	SW 221	Y. Kuznetsov
Math 6378	30507	Basic Scientific Computing	MW, 4—5:30PM	AH 301	R. Sanders
Math 6383	12535	Probability Statistics	MWF, Noon—1PM	AH 7	W. Fu
Math 6385	20639	Continuous-Time Models in Finance	TuTh, 2:30—4PM	SEC 201	E. Kao
Math 6395	23392	Number Theory	MWF, 11AM—Noon	SEC 104	A. Haynes
Math 6397	*23394*	*Selected Topics in Math*	*TBD*	*TBD*	*TBD*
Math 6397	23396	Quantum Computation Theory	TuTh, 11:30AM—1PM	SW 229	A. Vershynina

Math 6397	28397	Mathematics of Machine Learning	MWF, 10—11AM	AH 2	D. Labate
Math 7352	23397	Reimannian Geometry	MW, 1—2:30PM	SW 423	M. Ru

MSDS Courses *(MSDS Students Only)*

Course	Class #	Course Title	Course Day & Time	Rm #	Instructor
Math 6359	23928	Applied Statistics & Multivariate Analysis	Fr, 1—3PM	CBB 214	C. Poliak
Math 6373	23929	Deep Learning & Artificial Neural Networks	MW, 1—2:30PM	SEC 202	R. Azencott/W. Wang
Math 6381	29756	Information Visualization	Fr, 3—5PM	CBB 214	D. Shastri
Math 6387	23937	Biomedical Data Analysis & Computing	MW, 4—5:30PM	AH 15	W. Fu
Math 6388	24083	Genome Data Analysis	MW, 2:30—4PM	SW 423	R.Meisel/W. Wang
Math 6397	23898	Selected Topics in Mathematics	We, 5:30—8:30PM	SEC 103	L. Arregoces

--Course Details---

SENIOR UNDERGRADUATE COURSES

Math 4309 (15605) - Mathematical Biology

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

Text(s):

Required texts: A Biologist's Guide to Mathematical Modeling in Ecology and Evolution, Sarah P. Otto and Troy Day; (2007, Princeton University Press)
ISBN-13:9780691123448

Reference texts*: (excerpts will be provided)*

- An Introduction to Systems Biology, 2/e, U. Alon (an excellent, recently updated text on the "design principles of biological circuits")
- Random Walks in Biology, H.C. Berg (a classic introduction to the applicability of diffusive processes and the Reynolds number at the cellular scale)
- Mathematical Models in Biology, L. Edelstein-Keshet (a systematic development of discrete, continuous, and spatially distributed biological models)
- Nonlinear Dynamics and Chaos, S.H. Strogatz (a very readable introduction to phase-plane analysis and bifurcation theory in dynamical systems with an emphasis on visual thinking; contains numerous applications in biology)
- Thinking in Systems, D.H. Meadows (a lay introduction to control systems and analyzing parts-to-whole relationships, their organizational principles, and sensitivity in their design)
- Adaptive Control Processes: A Guided Tour, R. Bellman (a classic, more technical introduction to self-regulating systems, feedback control, decision processes, and dynamic programming)

Description:	**Catalog description**: Topics in mathematical biology, epidemiology, population models, models of genetics and evolution, network theory, pattern formation, and neuroscience. Students may not receive credit for both MATH 4309 and BIOL 4309. **Instructor's description**: An introduction to mathematical methods for modeling biological dynamical systems. This course will survey canonical models of biological systems using the mathematics of calculus, differential equations, logic, matrix theory, and probability. Applications will span several spatial orders-of-magnitude, from the microscopic (sub-cellular), to the mesoscopic (multi-cellular tissue and organism) and macroscopic (population-level: ecological, and epidemiological) scales. Specific applications will include biological-signaling diffusion, enzyme kinetics, genetic feedback networks, population dynamics, neuroscience, and the dynamics of infectious diseases. Optional topics (depending on schedule and student interest) may be chosen from such topics as: game theory, artificial intelligence and learning, language processing, economic multi-agent modeling, Turing systems, information theory, and stochastic simulations. The course will be taught from two complementary perspectives: (1) critical analysis of biological systems' modeling using applicable mathematical tools, and (2) a deeper understanding of mathematical theory, illustrated through biological applications. Relevant mathematical theory for each course section will be reviewed from first principles, with an emphasis on bridging abstract formulations to practical modeling techniques and dynamical behavior prediction. The course will include some programming assignments, to be completed in Matlab or Python programming languages (available free through UH Software and public domain, respectively). However, advanced programming techniques are not required, and resources for introduction to these languages will be provided.

<< back to top >>

Math 4315 (20638) - Graph Theory w/Applications

Prerequisites:	Either MATH 3330 or MATH 3336 and three additional hours of 3000-4000 level Mathematics
Text(s):	TBA
Description:	Introduction to basic concepts, results, methods, and applications of graph theory. **Additional Description**: How does information propagate between friends and acquaintances on social media? How do diseases spread, and when do epidemics start? How should we design power grids to avoid failures, and systems of roads to optimize traffic flow? These questions can be addressed using network theory . Students in the course will develop a sound knowledge of the basics of graph theory, as well as some of the computational tools used to address the questions above. Course topics include basic structural features of networks, generative models of networks, centrality, random graphs, clustering, and dynamical processes on graphs.

<< back to top >>

Math 4323 (28786) - Data Science and Statistical Learning

Prerequisites:	MATH 3339
Text(s):	TBA
Description:	Theory and applications for such statistical learning techniques as maximal marginal classifiers, support vector machines, K-means and hierarchical clustering. Other topics might include: algorithm performance evaluation, cluster validation, data scaling, resampling methods. R Statistical programming will be used throughout the course.

<< back to top >>

Math 4332 (12497) - Introduction to Real Analysis II

Prerequisites:	MATH 4331 or consent of instructor
Text(s):	Real Analysis with Real Applications | Edition: 1; Allan P. Donsig, Allan P. Donsig; ISBN: 9780130416476
Description:	Further development and applications of concepts from MATH 4331. Topics may vary depending on the instructor's choice. Possibilities include: Fourier series, point-set topology, measure theory, function spaces, and/or dynamical systems.

Math 4351 (TBD) - Differential Geometry II

Prerequisites:	MATH 4350.
Text(s):	Instructor's notes will be provided.
Description:	Continuation of the study of Differential Geometry from MATH 4350. Holonomy and the Gauss-Bonnet theorem, introduction to hyperbolic geometry, surface theory with differential forms, calculus of variations and surfaces of constant mean curvature, abstract surfaces (2D Riemannian manifolds).

<< back to top >>

Math 4362 (21796) - Theory of Differential Equations an Nonlinear Dynamics

Prerequisites:	MATH 3331, or equivalent, and three additional hours of 3000-4000 level Mathematics.
Text(s):	Nonlinear Dynamics and Chaos (2nd Ed.) by Strogatz. ISBN: 978-0813349107
Description:	ODEs as models for systems in biology, physics, and elsewhere; existence and uniqueness of solutions; linear theory; stability of solutions; bifurcations in parameter space; applications to oscillators and classical mechanics.

<< back to top >>

Math 4364 (18290)- Introduction to Numerical Analysis in Scientific Computing

Prerequisites:

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

Instructor's Prerequisite Notes:

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

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

Text(s):

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

<< back to top >>

Math 4364 (22419)- Introduction to Numerical Analysis in Scientific Computing

Prerequisites:

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

Instructor's Prerequisite Notes:

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

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

Text(s):

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

<< back to top >>

Math 4365 (16883) - Numerical Methods for Differential Equations

Prerequisites:

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

Text(s): TITLE:TBA, AUTHOR:TBA, ISBN:TBA

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

<< back to top >>

Math 4377 (17674) - Advanced Linear Algebra I

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

Text(s): Linear Algebra | Edition: 4; Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; ISBN: 9780130084514

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

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

<< back to top >>

Math 4378 (12498) - 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; 9780130084514

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

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

<< back to top >>

Math 4380 (12499) - A Mathematical Introduction to Options

Prerequisites: MATH 2433 and MATH 3338.

Text(s): An Introduction to Financial Option Valuation: Mathematics, Stochastics and Computation | Edition: 1; Desmond Higham; 9780521547574

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

<< back to top >>

Math 4389 (12500) - Survey of Undergraduate Mathematics

Prerequisites: MATH 3330, MATH 3331, MATH 3333, and three hours of 4000-level Mathematics.

Text(s): Instructor will use his own notes
Description: A review of some of the most important topics in the undergraduate mathematics curriculum.

<< back to top >>

Math 4397 (27738) - Selected Topics in Mathematics

Prerequisites: **Catalog Prerequisite**: MATH 3333 or approval of the instructor.

Text(s): **Textbook**: Mathematical Methods in the Physical Sciences by Mary Boas, Third edition, Wiley.

References: Mathematics for Physicists by Susan M. Lea, Advanced Engineering Mathematics by Greenberg, Mathematical Methods for Physics and Engineering by Riley, Hobson, and Bence, Mathematical Physics; A Modern Introduction to Its Foundations by Sadri Hassani, and An Introduction to Mathematical Methods of Physics by Lorella Jones.

V. Software: You may use any mathematical assistant to check your work, but my recommendation is that you NEVER as a computer to do anything that you do not know how to do. You will have to do the work by hand on the examinations. UH recently purchased some licenses for Maple, and you may use it if you wish. You may purchase Maple at a 25% discount at the Maplesoft web store.

Description: Selected topics in Mathematics. May be repeated with approval of chair.

Course Content:

A. Tensor analysis: Coordinate system construction, nonorthogonal coordinate systems, covariant and contravariant vector components, rotations and orthogonal transformations, coordinate system transformations, Cartesian tensors, general tensors, and higher rank tensors, metric tensors, covariant derivatives, Christoffel symbols, applications of tensors in mechanics, electromagnetic theory, special relativity, quantum mechanics, and general relativity.

B. Complex variable algebra review, complex differentiation and Cauchy-Riemann equations, complex integration and Cauchy's theorem, Cauchy integral formulas, Taylor and Laurent series

C. Residue theorem, evaluation of integrals, branch cuts, conformal mapping and applications, applications to Fourier transforms and Green functions

<< back to top >>

ONLINE GRADUATE COURSES

<< back to top >>

MATH 5330 (13701) - Abstract Algebra

Prerequisites: Graduate standing.

Text(s): *Abstract Algebra , A First Course* by Dan Saracino. Waveland Press, Inc. ISBN 0-88133-665-3
(You can use the first edition. The second edition contains additional chapters that cannot be covered in this course.)

Description:	Groups, rings and fields; algebra of polynomials, Euclidean rings and principal ideal domains. Does not apply toward the Master of Science in Mathematics or Applied Mathematics. **Other Notes:** This course is meant for students who wish to pursue a Master of Arts in Mathematics (MAM). Please contact me in order to find out whether this course is suitable for you and/or your degree plan. *Notice that this course **cannot** be used for MATH 3330, Abstract Algebra.*

<< back to top >>

MATH 5332 (12513) - Differential Equations

Prerequisites:	<u>Graduate standing.</u> MATH 5331.
Text(s):	The text material is posted on **Blackboard Learn**, under "**Content**".
Description:	Linear and nonlinear systems of ordinary differential equations; existence, uniqueness and stability of solutions; initial value problems; higher dimensional systems; Laplace transforms. Theory and applications illustrated by computer assignments and projects. Applies toward the Master of Arts in Mathematics degree; does not apply toward the Master of Science in Mathematics or the Master of Science in Applied Mathematics degrees.

MATH 5344 (22571) - Introduction to 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.

<< back to top >>

MATH 5397 (23376) - Data Science and Mathematics

Prerequisites: Graduate standing. ***Notice****: This course belongs to the group IV. Applied Math,which meets the requirement for MA degree. Students must submit a general petition to count this course towards the Applied Math requirement for the MA degree.*

Text(s): Lecture Notes will be provided

Description:

Instructor's Course description: In this course, we introduce basics for data science with their mathematical proofs or details. The purpose of this course is to allow the students for further study or research in this area, or have basic skills to work in industry, or able to organize extracurricular activities (on data science) in high schools.

The course will have the following sections:

- Introduction
- Least Square Regression
- Regularization and Cross Validation
- Bias-Variance Trade-off
- Bayesian Analysis
- Logistic regression
- Support Vector Machines
- Convex Optimization
- Ensemble Learning
- Clustering and k-NN Learning
- Robustness, Outlier Detection and Sparseness
- Dimensionality Reduction
- Artificial Neural Network
- Convolutional Neural Network
- Fisher’s Linear Discriminant and Neural

Without requiring have any previous computer background, the students should be able to learn MATLAB and Python to write codes for algorithms in each section.

<< back to top >>

MATH 5397 (23377) - Dynamical Systems

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

Notice*: This course belongs to the group IV. Applied Math,which meets the requirement for MA degree. Students must submit a general petition to count this course towards the Applied Math requirement for the MA degree.*

Text(s):	Steven H. Strogatz: Nonlinear Dynamics and Chaos (with Applications to Physics, Biology, Chemistry, and Engineering) Second Edition, 2014. **Print ISBN**: 9780813349107 **E-book ISBN**: 9780813349114
Description:	We will discuss applications of nonlinear dynamics, following the book by Strogatz. Topics that will be considered include (for more details, check the book's table of contents): an introduction to Ordinary Differential Equations (ODE's), one-dimensional ODE's and their bifurcations; two-dimensional ODE's (linear case, limit cycles and the Poincare-Bendixson Theorem, the Hopf bifurcation), chaotic systems (logistic family, Lorenz equations, Henon map). For visualization we will use tools that do not require programming, with the option to additionally run/write Matlab or Python code.

<< back to top >>

GRADUATE COURSES

<< back to top >>

MATH 6303 (12517) - Modern Algebra II

Prerequisites:	Graduate standing. MATH 4333 or MATH 4378 **Additional Prerequisites**: students should be comfortable with basic measure theory, groups rings and fields, and point-set topology
Text(s):	No textbook is required.
Description:	Topics from the theory of groups, rings, fields, and modules. **Additional Description:** This is primarily a course about analysis on topological groups. The aim is to explain how many of the techniques from classical and harmonic analysis can be extended to the setting of locally compact groups (i.e. groups possessing a locally compact topology which is compatible with their algebraic structure). In the first part of the course we will review basic point set topology and introduce the concept of a topological group. The examples of p-adic numbers and the Adeles will be presented in detail, and we will also spend some time discussing SL_2(R). Next we will talk about characters on topological groups, Pontryagin duality, Haar measure, the Fourier transform, and the inversion formula. We will focus on developing details in specific groups (including those mentioned above), and applications to ergodic theory and to number theory will be discussed.

<< back to top >>

MATH 6308 (17675) - Advanced Linear Algebra I

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

Text(s):	Linear Algebra | Edition: 4; Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; ISBN: 9780130084514
Description:	Transformations, eigenvalues and eigenvectors. **Additional Notes:** This is a proof-based course. It will cover Chapters 1-4 and the first two sections of Chapter 5. Topics include systems of linear equations, vector spaces and linear transformations (developed axiomatically), matrices, determinants, eigenvectors and diagonalization.

<< back to top >>

MATH 6308 (TBD) - Advanced Linear Algebra I *(online)*

Prerequisites:	Graduate standing. MATH 2331 and a minimum of 3 semester hours transformations, eigenvalues and eigenvectors.
Text(s):	Linear Algebra | Edition: 4; Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; ISBN: 9780130084514
Description:	Transformations, eigenvalues and eigenvectors. An expository paper or talk on a subject related to the course content is required Syllabus

<< back to top >>

MATH 6309 (13850) - Advanced Linear Algebra II

Prerequisites:	Graduate standing and MATH 6308
Text(s):	Linear Algebra, Fourth Edition, by S.H. Friedberg, A.J Insel, L.E. Spence,Prentice Hall, ISBN 0-13-008451-4; 9780130084514
Description:	Similarity of matrices, diagonalization, hermitian and positive definite matrices, canonical forms, normal matrices, applications. An expository paper or talk on a subject related to the course content is required.

<< back to top >>

MATH 6313 (13848) - Introduction to Real Analysis II

Prerequisites:	Graduate standing and MATH 6312.
Text(s):	Kenneth Davidson and Allan Donsig, “Real Analysis with Applications: Theory in Practice”, Springer, 2010; or (out of print) Kenneth Davidson and Allan Donsig, “Real Analysis with Real Applications”, Prentice Hall, 2001.
Description:	Properties of continuous functions, partial differentiation, line integrals, improper integrals, infinite series, and Stieltjes integrals. An expository paper or talk on a subject related to the course content is required.

<< back to top >>

MATH 6321 (12532) - Theory of Functions of a Real Variable II

Prerequisites:	Graduate standing. MATH 4332 or consent of instructor. **Instructor's Prerequisite Notes:** MATH 6320

Text(s):	Primary (Required): Real Analysis for Graduate Students, Richard F. Bass Supplementary (Recommended): Real Analysis: Modern Techniques and Their Applications, Gerald Folland (2nd edition); ISBN: 9780471317166.
Description:	Lebesque measure and integration, differentiation of real functions, functions of bounded variation, absolute continuity, the classical Lp spaces, general measure theory, and elementary topics in functional analysis. **Instructor's Additional Notes:** Math 6321 is the second course in a two-semester sequence intended to introduce the theory and techniques of modern analysis. The core of the course covers elements of functional analysis, Radon measures, elements of harmonic analysis, the Fourier transform, distribution theory, and Sobolev spaces. Additonal topics will be drawn from potential theory, ergodic theory, and the calculus of variations.

<< back to top >>

MATH 6327 (23390) - Partial Differential Equations

Prerequisites:	Graduate standing. MATH 4331
Text(s):	There is no prescribed text and other texts that may be of interest include some material from E. Zeidler, **Nonlinear Functional Analysis and its Applications**, Vol IIA, Springer, and chapter 7 of L. C. Evans, P**artial Differential Equations**, American Math.Society. Handouts for some background material will be provided.
Description:	**Course Description**: Existence and uniqueness theory in partial differential equations; generalized solutions and convergence of approximate solutions to partial differential systems. **Additional Description**: This course will provide an introduction to the analysis of parabolic initial boundary value problems and related evolution (time-dependent) equations. It is independent of Math 6326, and involves quite different considerations although it requires a similar background. The prerequisite is a good knowledge of multivariable calculus, the basic constructions of Hilbert and Banach spaces and some linear operator theory as covered in the first semester of Applicable analysis, M6360 The emphasis is on the use of Hilbert space methods and weak formulations of the problems, especially Galerkin methods for the approximation and representation of solutions of the problems. Some examples from applications will be treated including various diffusion problems that arise in a wide variety of applications including biology, chemistry, engineering and finance. Issues regarding the asymptotics of the solution, dependence on boundary conditions and the approximation of solutions will be treated.

<< back to top >>

MATH 6359 (23928) - Applied Statistics and Multivariate Analysis

Prerequisites:	Graduate standing. MATH 3334, MATH 3338 or MATH 3339, and MATH 4378. Students must be in the Statistics and Data Science, MS Program
Text(s):	*Speak to the instructor for textbook information.*
Description:	Linear models, loglinear models, hypothesis testing, sampling, modeling and testing of multivariate data, dimension reduction.

<< back to top >>

MATH 6361 (13851) - Applicable Analysis

Prerequisites:	Graduate standing. MATH 4332 or consent of instructor.
Text(s):	The instructor will provide lecture notes on the material. A reference text is L.D. Berkowitz, Convexity and Optimization in Rn, Wiley-Interscience 2002.
Description:	This course provides an introduction to the mathematical analysis of finite dimensional optimization problems. Topics to be studied include the existence of, and the extremality conditions that hold at, solutions of constrained and unconstrained optimaization problems. Elementary theory of convex sets, functions and constructions from convex analysis will be introduced and used. Concepts include subgradients, conjugate functions and some duality theory. Specific problems to be studied include energy and least squares methods for solving linear equations, important inequalities, eigenproblems and some nonlinear programming problems from applications.

<< back to top >>

<< back to top >>

MATH 6367 (12533) - Optimization Theory

Prerequisites:	Graduate standing. MATH 4331 and MATH 4377.
Text(s):	- D.P. Bertsekas; Dynamic Programming and Optimal Con- trol, Vol. I, 4th Edition. Athena Scientific, 2017, ISBN-10: 1-886529-43-4 - J.R. Birge and F.V. Louveaux; Introduction to Stochastic Programming. Springer, New York, 1997, ISBN: 0-387-98217-

Description: Constrained and unconstrained finite dimensional nonlinear programming, optimization and Euler-Lagrange equations, duality, and numerical methods. Optimization in Hilbert spaces and variational problems. Euler-Lagrange equations and theory of the second variation. Application to integral and differential equations.

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

<< back to top >>

MATH 6371 (12534) - Numerical Analysis

Prerequisites: Graduate standing.

Text(s): **Numerical Mathematics (Texts in Applied Mathematics)**, 2nd Ed., V.37, Springer, 2010. By A. Quarteroni, R. Sacco, F. Saleri. ISBN: 9783642071010

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

<< back to top >>

MATH 6373 (23929) - Deep Learning and Artificial Neural Networks

Prerequisites: Graduate standing. Probability/Statistic and linear algebra or consent of instructor. Students must be in the Statistics and Data Science, MS Program.

Text(s): *Speak to the instructor for textbook information.*

Description: Artificial neural networks for automatic classification and prediction. Training and testing of multi-layers perceptrons. Basic Deep Learning methods. Applications to real data will be studied via multiple projects.

<< back to top >>

MATH 6374 (23391) - Numerical Partial Differential Equations

Prerequisites: Graduate standing. Instructor's prerequisite: Undergraduate courses on partial differential equations and numerical analysis

Text(s): **None**

Description: Upon completion of the course,students will be able to apply Finite Difference,Finite Volume and Finite Element methods for the numerical solution of elliptic and parabolic partial differential equations.
The course consits in three major parts.In the begining of the course, we will discuss the differential and variational formulations of the most typical boundary value problems for the diffusion and convection- diffusion equations.In the second part of the course,a systematic description of finite difference,finite volume and nodal finite element methods will be given. In the third part, We consider the most important variants of the mixed finite element method which currently is very popular in many applications.Finally,we will study explicit and implicit dinite difference methods for the time dependent diffusion and convection- diffusion equations with applications in geosciences and fluid mechanics.

<< back to top >>

MATH 6378 (30507) - Basic Scientific Computing

Prerequisites: Graduate standing.

Text(s): *Speak to the instructor for textbook information.*

Description: *Speak to the instructor for the course description.*

<< back to top >>

MATH 6381 (29756) - Information Visualization

Prerequisites: Graduate standing. Students must be in the Statistics and Data Science, MS Program

Text(s): *Speak to the instructor for textbook information.*

Description: The course presents comprehensive introduction to information visualization and thus, provides the students with necessary background for visual representation and analytics of complex data. The course will cover topics on design strategies, techniques to display multidimensional information structures, and exploratory visualization tools.

<< back to top >>

MATH 6383 (12535) - Probability Statistics

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

Text(s):	**Recommended Text**: John A. Rice : Mathematical Statistics and Data Analysis, 3rd editionBrooks / Cole, 2007. ISBN-13: 978-0-534-39942-9. **Reference Texts:** -P. MuCullagh and J.A. Nelder: Generealized Linear Models, 2nd ed. 1999 Chapman Hall/CRC. ISBN: 978-0412317606 -Raymond H. Myers, Douglas C. Montgomery, G. Geoffrey Vining, Timothy J. Robinson, Generalized Linear Models: with Applications in Engineering and the Sciences, 2nd ed. Wiley, 2010. ISBN: 978-0-470-45463-3.
Description:	**Catalog Description**: A survey of probability theory, probability models, and statistical inference. Includes basic probability theory, stochastic processes, parametric and nonparametric methods of statistics. **Instructor's Description**: This course is designed for graduate students who have been exposed to basic probability and statistics and would like to learn more advanced statistical theory and techniques in modelling data of various types, including continuous, binary, counts and others. The selected topics will include basic probability distributions, likelihood function and parameter estimation, hypothesis testing, regression models for continuous and categorical response variables, variable selection methods, model selection, large sample theory, shrinkage models, ANOVA and some recent advances

<< back to top >>

MATH 6385 (20639) - Continuous-Time Models in Finance

Prerequisites:	Graduate Standing. MATH 6384
Text(s):	**Primary Text**: The Heston Model and Its Extensions in Matlab and C#, by Fabrice Douglas Rouch, Wiley, 2013. **Supplementary Text**: Arbitrage Theory in Continuous Time, 3rd edition, by Tomas Bjork, Oxford University Press, 2009.

Description:	Stochastic calculus, Brownian motion, change of measures, Martingale representation theorem, pricing financial derivatives whose underlying assets are equities, foreign exchanges, and fixed income securities, single-factor and multi-factor HJM models, and models involving jump diffusion and mean reversion. **Additional Description:** The course is an introduction to continuous-time models in finance. We use the stochastic volatility model of Heston as the principal paradigm and choose Fourier transform and its variants as the tools for pricing. We introduce stochastic calculus, Brownian motion, Levy processes, change of measures, martingale ans semi-martingale and the notion of time change of a stochastic process. We then apply these ideas in pricing financial derivatives whose underlying assets are equities, foreign exchanges, and fixed income securities. The use of MATLAB is expected. **Detailed syllabus (PDF)**

MATH 6387 (23937) - Biomedical Data Analysis and Computing

Prerequisites:	Graduate standing. Linear algebra, probability, statistics, or consent of instructor. Students must be in the Statistics and Data Science, MS Program
Text(s):	*Speak to the instructor for textbook information.*
Description:	Longitudinal data and correlated data analysis, growth-curve models, mixed effects models, correlation structure, analysis of time-to-event data, hazard and survival functions, Kaplan-Meier estimate, log-rank test.

<< back to top >>

MATH 6388 (24083) - Genome Data Analysis

Prerequisites:	Graduate standing. Linear algebra, probability, statistics, or consent of instructor. Students must be in the Statistics and Data Science, MS Program
Text(s):	*Speak to the instructor for textbook information.*
Description:	Estimation of allele frequency, Hardy-Weinberg equilibrium, testing on differentially expressed genes, multiple comparison.

<< back to top >>

MATH 6395 (23392) - Number Theory

Prerequisites: Graduate standing.

Text(s): *Speak to the instructor for textbook information.*

Description: TBA

<< back to top >>

MATH 6397 (23394) - *TBD*

Prerequisites: Graduate standing.

Text(s): TBD

Description: TBD

<< back to top >>

MATH 6397 (23396) - Quantum Computation Theory

Prerequisites: Graduate standing. **Instructor's Prerequisites**: Linear Algebra, Basics of Probability, Basics of Functional Analysis. It will not be expected that you know any quantum mechanics, computer science, of information theory.

Text(s): - Lecture notes will be provided to you every class.

For personal reference, you may look at the following books:
-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

You do not need to purchase either of these books. I can recommend any additional books if you request it, which you may borrow from my office.

Description:

Course Overview:

During the course we aim to cover the following topics:
-Basics of quantum mechanics
-Universal quantum computation
-Quantum teleportation and other protocols
-Quantum error-correction
-Noisy quantum channels
-Quantum complexity
-Quantum algorithms

<< back to top >>

MATH 6397 (23898) - Selected Topics in Math

Prerequisites:	Graduate standing. Students must be in the Statistics and Data Science, MS Program
Text(s):	TBA
Description:	Case Studies in Data Analysis: Apply multiple techniques for exploratory data analysis, visualize and understand the data using Inferential Statics, Descriptive Statistics, and probability Distributions.

<< back to top >>

MATH 6397 (28397) - Mathematics of Machine Learning

Prerequisites:	Graduate standing. **Instructor's Prerequisite**: Students attending this course are expected to have a solid background in linear algebra, undergraduate real analysis (MATH 4331-4332) and basic probability.
Text(s):	- There is no official textbook. - I will select material from: "Support Vector Machines", by Ingo Steinwart and Andreas Christmann, Springer 2008; "Learning Theory: An Approximation Theory Viewpoint" by F Cucker and D. Zhou, Cambrigde 2007; "Learning with Kernels", by B Schlkopf and A. Smola, The MIT Pres 2001 - Notes and reference papers will be provided by the instructor.

Machine Learning refers to a set of methods designed to extract information from data with the goal to make predictions or perform various types of decisions. This area has witnessed a remarkable growth during the last decade as machine learning is central to the development of intelligent systems and the analysis of massive and complex data found in science or social media. Machine learning algorithms currently enable systems such as Siri, the Google self driving car, or PathAI for medical diagnostics.

Description:

This course is an introduction to the theoretical foundations of machine learning and will be focused on the underlying mathematical concepts needed to understand the methods used in modern data science, without neglecting the algorithmic and computational aspects of the subject.

Topics of the course include Support Vector Machines, Reproducing Kernel Hilbert Spaces, the Vapnik-Chervonenkis theory, concentration inequalities, dimensionality reduction and spectral clustering.

This is class is targeted to graduate students interested in mastering theoretical tools underlying machine learning and data science.
Even though algorithmic aspects of the topics will not be neglected, this course will not duplicate existing courses on machine learning or data science offered in the Computer Science Department that are focused on algorithmic implementation and computation.

<< back to top >>

MATH 7352 (23397) - Riemannian Geometry

Prerequisites: Graduate standing.

Text(s): Differential Geometry and Topology: With a View to Dynamical Systems" by Keith Burns and Marian Gidea. (CRC Press, 2005). ISBN: 9781584882534

Description:

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

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

The textbook highlights connections of this theory to dynamical systems; these may be mentioned in lectures but are not the focus of this course: this is first and foremost a course in differential geometry, which is oriented towards the associated preliminary exam.

<< back to top >>