Department of Mathematics

2022 - 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**.)*

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GRADUATE COURSES - SPRING 2022

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

UNDER CONSTRUCTION *(updated 10/11/21 - in progress)*

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day/Time	Rm #	Instructor
Math 4309	16170	Mathematical Biology	MW, 2:30—4PM (Hybrid)	**TBA**	R. Azevedo
Math 4310	25478	Biostatistics	**TBA** (F2F)	**TBA**	**TBA**
Math 4315	24531	Graph Theory with Applications	TTh, 8:30—10AM (F2F)	**TBA**	K. Josic
Math 4322	20817	Introduction to Data Science and Machine Learning	TTh, 11:30AM - 1PM (F2F)	**TBA**	C. Poliak
Math 4323	20026	Data Science and Statistical Learning	MW, 1—2:30PM (F2F)	**TBA**	W. Wang
Math 4331	14862	Introduction to Real Analysis I	**TBA** (F2F)	**TBA**	**TBA**
Math 4332/6313	14862	Introduction to Real Analysis II	MWF, 9—10AM (F2F)	**TBA**	A. Vershynina
Math 4335	25480	Partial Differential Equations I	**TBA** (F2F)	**TBA**	**TBA**
Math 4362	19102	Theory of Differential Equations and Nonlinear Dynamics	MWF, 11AM—Noon (F2F)	**TBA**	V. Climenhaga
Math 4364	17332	Intro. to Numerical Analysis in Scientific Computing	MW, 4—5:30PM (F2F)	**TBA**	T. Pan
Math 4364	25465	Intro. to Numerical Analysis in Scientific Computing	TTh, 4—5:30PM (F2F)	**TBA**	L. Cappanera
Math 4364	26286	Intro. to Numerical Analysis (Syllabus)	**TBA**	**TBA**	J. Morgan
Math 4365	16701	Numerical Methods for Differential Equations	TTh, 11:30AM—1PM (F2F)	**TBA**	J. He
Math 4377/6308	17019	Advanced Linear Algebra I	MWF, 10—11AM (F2F)	**TBA**	S. Ji
Math 4378/6309	14863	Advanced Linear Algebra II	TTh, 10—11:30AM (F2F)	**TBA**	A. Mamonov
Math 4380	14864	A Mathematical Introduction to Options	MW, 1—2:30PM (F2F)	**TBA**	E. Kao
Math 4383	24533	Number Theory and Cryptography	TTh, 2:30—4PM (F2F)	**TBA**	M. Ru
Math 4389	14865	Survey of Undergraduate Mathematics	TTh, 1—2:30PM (F2F)	**TBA**	M. Almus
Math 4397	TBD	TBD	**TBD**	**TBD**	**TBD**

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5330	15434	*Abstract Algebra*	***(Asynch.**/on-campus exams)*	M. Ru
Math 5332	14872	*Differential Equations*	***(Asynch.**/on-campus exams)*	*G. Etgen*
Math 5334	25508	*Complex Analysis*	***(Asynch.**/on-campus exams)*	S. Ji
Math 5344	26287	*Intro to Scientific Computing (Syllabus)*	***TBA***	J. Morgan
Math 5385	20868	*Statistics*	***(Asynch.**/on-campus exams)*	*M. Jun*

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6303	14873	Modern Algebra II	MWF, 11AM—Noon (F2F)	**TBA**	A. Haynes
Math 6308	17020	Advanced Linear Algebra I	MWF, 10—11AM (F2F)	**TBA**	S. Ji
Math 6309	15500	Advanced Linear Algebra II	TTh, 10—11:30AM (F2F)	**TBA**	A. Mamonov
Math 6313	15499	Introduction to Real Analysis	MWF, 9—10AM (F2F)	**TBA**	A. Vershynina
Math 6321	14878	Theory of Functions of a Real Variable	MW, 1—2:30PM (F2F)	**TBA**	M. Nicol
Math 6361	24535	Applicable Analysis	TTh, 11:30AM—1PM (F2F)	**TBA**	B. Bodmann
Math 6367	14879	Optimization Theory	TTh, 1—2:30PM (F2F)	**TBA**	R. Hoppe
Math 6371	14880	Numerical Analysis	MW, 1—2:30PM (F2F)	**TBA**	Y. Kuznetsov
Math 6374	24536	Numerical Partial Differential Equations	MW, 4—5:30PM (F2F)	**TBA**	M. Olshanskii
Math 6383	14881	Probability Statistics	TTh, 10—11:30AM (F2F)	**TBA**	W. Fu
Math 6395	24537	Select Topics Analysis	MWF, 10—11AM (F2F)	**TBA**	D. Blecher
Math 6397	TBD	TBD	TBD	**TBD**	M. Olshanskii
Math 6397	TBD	TBD	TBD	**TBD**	D. Labate
Math 6397	TBD	TBD	TBD	**TBD**	M. Ru
Math 7352	24538	Riemannian Geometry	TTh, 1—2:30PM (F2F)	**TBA**	G. Heier

MSDS Courses *(MSDS Students Only)*

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6359	19697	Applied Statistics & Multivariate Analysis	F, 1—3PM (F2F)	**TBA**	C. Poliak
Math 6359	20885	Applied Statistics & Multivariate Analysis	F, 1—3PM (Synch./on-campus exams)	**TBA**	C. Poliak
Math 6373	19698	Deep Learning and Artificial Neural Networks	MW, 1—2:30PM (F2F)	**TBA**	R. Azencott
Math 6381	20129	Information Visualization	F, 3—5PM (F2F)	**TBA**	D. Shastri
Math 6397	24420	Selected Topics in Math	W, 5:30—8:30PM (F2F)	**TBA**	L. Arregoces
Math 6397	24421	Selected Topics in Math	MW, 2:30—4PM (F2F)	**TBA**	C. Poliak
Math 6397	24994	Selected Topics in Math	W, 5:30—8:30PM (F2F)	**TBA**	J. Ryan

--Course Details---

SENIOR UNDERGRADUATE COURSES

Math 4309 - 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.

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Math 4322 - Introduction to Data Science and Machine Learning

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

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Math 4323 - 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.

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Math 4332 - 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 - 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).

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Math 4355 - Mathematics of Signal Representation

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

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Math 4362 - 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.

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Math 4364 - 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.

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Math 4365 - 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.

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Math 4377 - 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.

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Math 4378 - 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.

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Math 4380 - 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.

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

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Math 4397 - Selected Topics in Mathematics

Prerequisites: **Catalog Prerequisite**: MATH 3333 or approval of the instructor.
Text(s): **TBA**

Description: TBA

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ONLINE GRADUATE COURSES

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MATH 5330 - 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.*

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MATH 5332 - Differential Equations

Prerequisites:	Graduate standing. 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 5350 - Intro To Differential Geometry

Prerequisites: **Graduate standing**
Text(s): TBA

Description: TBA

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MATH 5385 - Statistics

Prerequisites: **Graduate standing**
Text(s): TBA

Description: TBA

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MATH 5386 - Regression & Linear Models

Prerequisites:	**Graduate standing**. Math 5385 *(introductory Statistics or an equivalent course)*, one semester of linear algebra at or above the undergraduate level, and two semesters of calculus.

Text(s):

Required Text: Introduction to Linear Regression Analysis, 5th Edition, by Montgomery, Peck and Vining, Wiley 2012.

Additional Required Resources: In addition to the textbook, students need a computer with a high-speed internet connection, and the open-source software package R, and R Studio. R Studio can be downloaded free from www.r-project.org . To download it, go to the web site, click on the download link, select your platform (Windows, Mac etc.), select a CRAN (Comprehensive R Archive Network) mirror site in the U.S. and follow the instructions. Downloading and installation are straightforward. RStudio facilitates importing and exporting of data and text files, and makes it easy to integrate R with other applications. It is available at www.rstudio.com , and can be installed after R is installed.

Description:

Course Content:

Course Site: This course will be hosted on Space (https://space.uh.edu). You will be able to go to this site and access the course beginning January 15, 2021.

Additional Learning Materials: Note and videos will be posted regularly to supplement the material in the text, and the discussion forum on https://space.uh.edu will be an important resource for students who need help, and for those wanting to reinforce concepts by providing help

Course Material: The subjects of this course are the theory, computational methods and applications of multiple linear regression, linear models, generalized linear models, and related topics. By the end of the course you should have gained an understanding of the mathematical underpinnings of linear model theory, experience with the use of a sophisticated data analysis package, and an appreciation of some of the problems and experimental situations the methods apply to. The course covers most of chapters 2-8, 10 and 13 in the text.

Resources for Online Learning: The University of Houston is committed to student success, and provides information to optimize the online learning experience through our website at https://uh.edu/power-on. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet and AccessUH, requesting a laptop through the Laptop Loaner Program, using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

Click this **link** to access the syllabus as a PDF.

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MATH 5397 - Data Science and Mathematics

Prerequisites: Graduate standing. *Note that for a student in the MA program, this course is counted toward the MA degree in the group III "Probability and Statistics" or in the group IV: "Applied Mathematics".*

Text(s): No required textbook. Notes will be provided. **Online video course**: 10:00—11:00 am, Saturday and Sunday by **Microsoft Teams.** Videos are posted in **Microsoft Stream**.

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 allow the students to take higher level courses in data science, or have basic skills to work in industry, or to lay down background to teach related courses, or to organize extracurricular activities in high schools.

Description:

The course will have the following sections:

- Introduction
- Regression
- Regularization
- Bias-Variance Trade-off
- Bayesian Analysis
- Logistic regression
- Support Vector Machines
- Convex Optimization
- Ensemble Learning
- Clustering and k-NN Learning
- Dimensionality reduction
- Artificial Neural Network
- Convolutional Neural Network
- Application

Without requiring have any previous computer background, the students should be able to learn Python to write codes for algorithms in each section. Matlab codes are also provided for most problems.

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MATH 5397 - TBD

Prerequisites: Graduate standing.

Text(s): TBD

Description: TBD

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GRADUATE COURSES

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MATH 6303 - 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.

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MATH 6308 - 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.

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MATH 6309 - 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.

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MATH 6313 - 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.

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MATH 6321 - 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.

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MATH 6359 (24286) & (27727) - 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.

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MATH 6367 - 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.

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MATH 6371 - 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.

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MATH 6373 - 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.

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MATH 6381- 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.

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MATH 6383 - 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

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MATH 6397 (27373) - Pattern Recognition Machine Learning, Dynamical Systems, and Control

Prerequisites: Graduate standing. Instructor prerequisite: Students attending this course are expected to have a solid background in linear algebra, undergraduate real analysis and basic probability. This is class is targeted to graduate students interested in gaining experience in learning modern data analysis techniques, and how to implement them. While neural networks will be mentioned, they will not be the focus of the course.

Text(s): Text will be taken from several sources:

- Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control by Steven L. Brunton, J. Nathan Kutz
- Pattern Recognition and Machine Learning by C. Bishop

Description: This is a practical introduction to the mathematical methods that are making the current revolution in data-driven science possible. We will cover select topics in dimensionality reduction, machine learning, dynamics, and control. The emphasis will be on implementing the different methods in Python, following the examples provided in the references. Grades will be primarily based on class participation and project completion. There will be no exams.

I will be selecting material from several sources:

- Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control by Steven L. Brunton, J. Nathan Kutz
- Pattern Recognition and Machine Learning by C. Bishop

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MATH 6397 (27452) - Linear Algebra and L from Data

Prerequisites: Graduate standing.

Text(s): The course is largely based on the 2019 book "Linear algebra and learning from data'' by G.Strang and correlates with the corresponding MIT course.

Description: The course covers fundamental topics and essential tools of linear algebra required to understand and analyze big data. It also reviews basics of optimization for data analysis and corresponding linear algebra. Altogether this introduces a student to some mathematical fundamentals of data science and machine learning.

Course Content: Main topics we plan to cover in the course include matrices, matrix factorizations, low rank approximations, SVD and principal components analysis, least square problems and regression, matrix low norm and low rank perturbations, Krylov methods, computing eigenvalues and singular values, interlacing eigenvalues and low rank signals, convexity and Newton method, constrained optimization, saddle point systems, accelerated gradient descent, non-linear least squares, stochastic Gradient Descent, and some other topics. The class is given in the unsynchronized online mode: the video lectures are uploaded each week and a student has access to them throughout the semester.

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MATH 6397 (27721) - Mathematics of Data Science: From signal processing to Convolutional Neural Networks

Prerequisites: Graduate standing. **Instructor's prerequisite**: Students attending this course are expected to have a solid background in linear algebra, undergradu (MATH 4331-4332) and basic probability.

There is **no** official/required textbook:

Material will be selected from the several sources listed below:

Text(s):

1. Damelin & Miller's "The Mathematics of Signal Processing" Cambridge University Press ISBN-13: 9781107601048. *This is a mathematically rigorous topics from advances and modern signal processing that useful for practitioners in data-driven fields such as imaging and time series.*

2. Blum, Hopcroft & Kannan's "Foundations of Data Science" available free online at: https://urldefense.com/v3/__https://www.cs.cornell.edu/jeh/book2016June9.pdf__;!!LkSTlj0I!VYOkFuH0176_wnKzRNr9ffPUE_-vUWVxrx1AW2OCO6xyG2NOMCOpe7UsZp4GPpZlGSRn$

It includes material on the Curse of Dimensionality and various topics in machine learning.

3. Hastie, Tibshirani & Friedman "The Elements of Statistical Learning" Springer 2017. The authors have made this book freely available on the website: https://urldefense.com/v3/__https://web.stanford.edu/*hastie/ElemStatLearn/printings/ESLII_print12_toc.pdf__;fg!!LkSTlj0I!VYOkFuH017 vUWVxrx1AW2OCO6xyG2NOMCOpe7UsZp4GPoUkWZ2c$

This classical treatise covers a broad range of topics in statistical learning theory and neural networks.

Course Objectives:

Description:

This is a course of mathematics exploring foundational and theorical concepts underlying the development and applications of intelligent systems a algorithms. One major emphasis of this course is the connection between topics from classical and advanced signal processing on one hand and de on the other hand. For instance, convolution operators underpin the design and development of convolutional neural networks; multiresolution ana several neural network designs such as the Inception module; manifold learning and sparse approximations provide powerful theoretical tools for th interpretation of deep learning architectures.

Topics of the course include: Fourier transform and convolution, multiresolution analysis, sparse approximations, manifold learning, statistical learn dimensionality reduction and spectral clustering, convolutional neural networks.

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 ignored and exploration of algorithmic issues will be assigned for individual or group proje not duplicate existing courses on machine learning or data science offered in the Computer Science Department that are focused on algorithmic imp computation.

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MATH 6397 (27650) - Case Studies in Data Analysis

Prerequisites: Graduate standing.
Text(s): TBA

Description: Apply multiple techniques for exploratory data analysis, visualize and understand the data using Inferential Statics, Descriptive Statistics, and probability Distributions.

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MATH 6397 (27653) - Topics in Data Science

Prerequisites: Graduate standing.
Text(s): TBA

Description: TBA

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MATH 6397 (31150) - Differential Geometry

Prerequisites:	Graduate standing.
Text(s):	Instructor's notes
Description:	he basic notions of differential geometry of curves and surfaces in R^3 will be reviewed. Then several selected topics will be covered, including: Connections, holonomy and the Gauss-Bonnet theorem, surface theory with differential forms, calculus of variations and minimal surfaces, introduction to hyperbolic geometry, and abstract surfaces (2D Riemannian manifolds). It will be offered combined with Math. 4351 through asynchronous online

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MATH 7321 - Functional Analysis

Prerequisites:	Graduate standing.
Text(s):	TBA
Description:	**TBA**

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