Department of Mathematics

Fall 2022

*(**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**.)*

GRADUATE COURSES - FALL 2022

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day/Time	Rm #	Instructor
Math 4310-01	16365	Biostatistics	MWF, 11AM—Noon, (F2F)	AH 301	D. Labate
Math 4320-01	11630	Intro. To Stochastic Processes	TTh, 10—11:30AM, (F2F)	SEC 105	E. Kao
Math 4322-02	17199	Intro. to Data Science and Machine Learning	TTh, 11:30AM—1PM, (F2F)	GAR 201	C. Poliak
Math 4323-01	17145	Data Science and Statistical Learning	TTh, 10—11:30AM, (F2F)	CBB 106	W. Wang
Math 4331-02	13140	Introduction to Real Analysis I	TTh, 1—2:30PM, (F2F)	F 154	M. Kalantar
Math 4335-01	15291	Partial Differential Equations I	MWF, 9—10AM, (F2F)	SEC 201	G. Jaramillo
Math 4339-02	16536	Multivariate Statistics	TTh, 1—2:30PM, (F2F)	SEC 201	C. Poliak
Math 4350-01	24420	Differential Geometry I	MW, 1—2:30PM, (F2F)	S 102	M. Ru

Math 4364-01	13590	Intro. to Numerical Analysis in Scientific Computing	MW, 4—5:30PM, (F2F)	SEC 202	T. Pan
Math 4364-02	*16887*	*Intro. to Numerical Analysis in Scientific Computing*	*Asynchronous/* ***On Campus Exams***	*Online*	*J. Morgan*
Math 4366-01	14942	Numerical Linear Algebra	TTh, 11:30AM—1PM, (F2F)	CBB 214	J. He
Math 4370-01	25580	Mathematics for Physicists	MWF, 11AM—Noon, (F2F)	SR 606	A. Barato
Math 4377-01	13142	Advanced Linear Algebra I	MWF, Noon—1PM, (F2F)	F 154	A. Haynes
Math 4388-01	*12472*	*History of Mathematics*	*Asynchronous/* ***On Campus Exams***	*Online*	*S. Ji*
Math 4389-01	12090	Survey of Undergraduate Mathematics	MWF, 11AM—Noon, (F2F)	SEC 203	D. Blecher
Math 4397-01	24332	Classical & Quantum Information Theory *(syllabus)*	MWF, Noon—1PM, (F2F)	S 116	L. Gao
Math 4397-02	24334	Selected Topics in Mathematics	MWF, 11AM—Noon, (F2F)	TBD	TBD

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5310-01	*24331*	*History of Mathematics*	*Asynchronous/On-campus Exams;* ***Online***	*S. Ji*
Math 5333-01	*24321*	*Analysis*	*Asynchronous/On-campus Exams;* ***Online***	*G. Etgen*
Math 5344-01	*24330*	*Intro. to Scientific Computing*	*Asynchronous/On-campus Exams;* ***Online***	*J. Morgan*
Math 5382-01	*16953*	*Probability*	*Asynchronous/On-campus Exams;* ***Online***	*A. Török*

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6302-01	11631	Modern Algebra I	TuTh, 2:30—4PM (F2F)	**CBB 214**	G. Heier
Math 6308-04	13143	Advanced Linear Algebra I	MWF, Noon—1PM	**F 154**	A. Haynes
Math 6312-02	13141	Introduction to Real Analysis	TuTh, 1—2:30PM	**F 154**	M. Kalantar
Math 6320-01	11658	Theory of Functions of a Real Variable	MWF, 10—11AM	**CBB 214**	A. Vershynina
Math 6322-01	24322	Function Complex Variable	MWF, 9—10AM	**AH 301**	S. Ji
Math 6324-01	24323	Differential Equations	TuTh, 11:30AM—1PM	**SEC 203**	M. Nicol
Math 6342-01	11659	Topology	TuTh, 11:30AM—1PM	**S 102**	A. Török
Math 6360-01	18340	Applicable Analysis	TuTh, 1—2:30PM	**CBB 214**	D. Onofrei
Math 6366-01	11660	Optimization Theory	TuTh 2:30—4PM	**AH 301**	A. Mang
Math 6370-01	11661	Numerical Analysis	TuTh 5:30PM—7PM	**S 115**	M. Olshanskii
Math 6382-02	15367	Probability	TuTh, 1—2:30PM	**S 202**	W. Ott
Math 6397-01	24324/24325	Spatial Statistics	TuTh, 10—11:30AM (F2F)	**S 119**	M. Jun
Math 6397-05	24333	Classical & Quantum Information Theory *(syllabus)*	MWF, Noon—1PM	**S 116**	L. Gao
Math 6397-09	26531	Pattern Recognition *(syllabus)*	TuTh, 4—5:30PM	**SEC 204**	K. Josic
Math 7320-01	24328	Functional Analysis	TuTh, 10—11:30AM	**MH 129**	B. Bodmann

MSDS Courses

(MSDS Students Only)

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6350-01	16374	Statistical Learning and Data Mining	MW, 1—2:30PM (F2F)	**SEC 203**	R. Azencott
Math 6357-01	16534	Linear Models & Design of Experiments	MW, 2:30—4PM (F2F)	**SEC 203**	W. Wang
Math 6358-02	15515	Probability Models and Statistical Computing	Fr., 1—3PM (F2F)	**CBB 120**	C. Poliak
Math 6358-03	19160	Probability Models and Statistical Computing	Fr., 1—3PM, Synchronous/On-campus Exams	**Online**	C. Poliak
Math 6358-04	19243	Probability Models and Statistical Computing	Fr., 1—3PM, Asynchronous	**Online**	C. Poliak
Math 6380-01	16670	Programming Foundation for Data Analytics	Fr., 3—5PM (F2F)	**CBB 120**	D. Shastri
Math 6380-02	19159	Programming Foundation for Data Analytics	Fr., 3—5PM, Synchronous/On-campus Exams	**Online**	D. Shastri
Math 6380-03	19249	Programming Foundation for Data Analytics	Fr., 3—5PM, Asynchronous	**Online**	D. Shastri

SENIOR UNDERGRADUATE COURSES

Math 4310 Biostatistics	
Prerequisites:	**MATH 3339** and **BIOL 3306**

Text(s):	"Biostatistics: A Foundation for Analysis in the Health Sciences, Edition (TBD), by Wayne W. Daniel, Chad L. Cross. **ISBN**: (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.

<< back to top >>

Math 4320 - Intro to Stochastic Processes

Prerequisites:**MATH 3338**

Text(s):

- An Introduction to Stochastic Processes, by Edward P. C. Kao, Dover 2019, Duxbury Press, 1997; ISBN **9780486837925**
- An Introduction to Probability with Mathematica, by Edward P. C. Kao, World Scientific, May 2022; ISBN: **9789811246784**

Description:

Catalog 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.

Instructor's description: This course provides a overview of stochastic processes. We cover Poisson processes, discrete-time and continuous-time Markov chains, renewal processes, diffusion process and its variants, marttingales. We also study Markov chain Monte Carlo methods, and regenerative processes. In addition to covering basic theories, we also explore applications in various areas such as mathematical finance.

Syllabus can be found here:
https://www.math.uh.edu/~edkao/MyWeb/doc/math4320_fall2022_syllabus.pdf

<< back to top >>

Math 4322 - Introduction to Data Science and Machine Learning

Prerequisites: MATH 3339

	While lecture notes will serve as the main source of material for the course, the following book constitutes a great reference:
Text(s):	”An Introduction to Statistical Learning (with applications in R)” by James, Witten et al. ISBN: 978-1461471370 ”Neural Networks with R” by G. Ciaburro. ISBN: 978-1788397872

Description:

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.

Learning Objectives: By the end of the course a successful student should:

- Have a solid conceptual grasp on the described statistical learning methods.
- Be able to correctly identify the appropriate techniques to deal with particular data sets.
- Have a working knowledge of R programming software in order to apply those techniques and subse- quently assess the quality of fitted models.
- Demonstrate the ability to clearly communicate the results of applying selected statistical learning methods to the data.

Software: Make sure to download R and RStudio (which can't be installed without R) before the course starts. Use the link https://www.rstudio.com/products/rstudio/download/ to download it from the mirror appropriate for your platform. Let me know via email in case you encounter difficulties.

Course Outline:
Introduction: What is Statistical Learning?

Supervised and unsupervised learning. Regression and classification.
Linear and Logistic Regression. Continuous response: simple and multiple linear regression. Binary response: logistic regression. Assessing quality of fit.
Model Validation. Validation set approach. Cross-validation.
Tree-based Models. Decision and regression trees: splitting algorithm, tree pruning. Random forests: bootstrap, bagging, random splitting.
Neural Networks. Single-layer perceptron: neuron model, learning weights. Multi-Layer Perceptron: backpropagation, multi-class discrimination

Math 4323 - Introduction to Data Science and Machine 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 4331 - Introduction to Real Analysis I

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.

<< back to top >>

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.

<< back to top >>

Math 4339 - Multivariate Statistics

Prerequisites:	**MATH 3349**
Text(s):	- Applied Multivariate Statistical Analysis (6th Edition), Pearson. Richard A. Johnson, Dean W. Wichern. **ISBN**: 978-0131877153 (Required) - Using R With Multivariate Statistics (1st Edition). Schumacker, R. E. SAGE Publications. **ISBN**: 978-1483377964 (recommended)

Description:	Course Description: Multivariate analysis is a set of techniques used for analysis of data sets that contain more than one variable, and the techniques are especially valuable when working with correlated variables. The techniques provide a method for information extraction, regression, or classification. This includes applications of data sets using statistical software. Course Objectives: • Understand how to use R and R Markdown • Understand matrix algebra using R • Understand the geometry of a sample and random sampling • Understand the properties of multivariate normal distribution • Make inferences about a mean vector • Compare several multivariate means • Identify and interpret multivariate linear regression models Course Topics: • Introduction to R Markdown, Review of R commands (Notes) • Introduction to Multivariate Analysis (Ch.1) • Matrix Algebra, R Matrix Commands (Ch.2) • Sample Geometry and Random Sampling (Ch.3) • Multivariate Normal Distribution (Ch.4) • MANOVA (Ch.6) • Multiple Regression (Ch.7) • Logistic Regression (Notes) • Classification (Ch.11)

Math 4350 - Differential Geometry I

Prerequisites:	**MATH 2415** and six additional hours of 3000-4000 level Mathematics.
Text(s):	Instructor's Notes. **Reference book**: Differential Geometry: A first course in curves and surfaces, Preliminary Version Summer 2016 by Prof. Theodore Shifrin.

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.

<< back to top >>

Math 4364 (13590) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	This is an one semester course which introduces core areas of numerical analysis and scientific computing along with basic themes such as solving nonlinear equations, interpolation and splines fitting, curve fitting, numerical differentiation and integration, initial value problems of ordinary differential equations, direct methods for solving linear systems of equations, and finite-difference approximation to a two-points boundary value problem. This is an introductory course and will be a mix of mathematics and computing.

<< back to top >>

Math 4364 (16887) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.
Text(s):	Instructor's notes
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 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

Math 4370 - Mathematics for Physicists

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

Description:

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

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.

<< back to top >>

Math 4377 - 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

Description:

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

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.

<< back to top >>

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.

<< back to top >>

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.

Math **4397** (24332) / Math **6397** (24333) - Classical & Quantum Information Theory

Prerequisites:

Math 4397 Prerequisites**:** MATH 3333. **Instructor's prerequisites**: Math 3338 (Probablity), Math 4377 (Advanced Linear Algebra), and Math 4331 (Real Analysis)

Math 6397 Prererequisites: **Graduate standing.** Quantum Mechanics will be appreciated but not required.

Text(s):

- Quantum Computation and Quantum Information, by I. Chuang and M. Nielsen
- The Theory of Quantum Information, by John Watrous
- Quantum information theory, by Mark Wilde

Description:

Information theory is the scientific study of the quantification, storage, and communication of digital information. It has been widely used in the communication and cryptography in our daily life. In last several decades, motivated by quantum computation, quantum information theory has been a rapid growing area studying how information can be processed, transmit and stored in quantum mechanics system.

The aim of this course is to give a minimal introduction to both classical and quantum information theory in a unified manner. We will start with some basics in Shannon's classical information theory and then study their counterpart in quantum mechanics model. After that, we will focus on the quantum side and covers some selected topics such as entanglement, Bell's inequality, Shor's algorithm, Quantum Teleportation and Superdense coding, etc.

Math 4397 (24334) - Selected Topics in Mathematics

Prerequisites: **MATH 3333** or consent of instructor.

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

Description: Selected topics in Mathematics

ONLINE GRADUATE COURSES

MATH 5310 - History of Mathematics

Prerequisites: **Graduate standing**.

Text(s): TBA

Description: Mathematics of the ancient world, classical Greek mathematics, the development of calculus, notable mathematicians and their accomplishments.

<< back to top >>

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.

<< back to top >>

MATH 5344 - Introduction to Scientific Computing

Prerequisites: **Graduate Standing** and Math 2318 (Linear Algebra) or equivalent.

Text(s): TBA

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.

MATH 5350 - Introduction to Differential Geometry

Prerequisites: **Graduate Standing** and MATH 2415 (Calculus III) or equivalent

Text(s): TBA

Description: Curves, arc-length, curvature, Frenet formula, surfaces, first and second fundamental forms, Guass’ theorem egregium, geodesics, minimal surfaces. Does not apply toward the Master of Science in Mathematics or Applied Mathematics.

MATH 5382 - Probability

Prerequisites: **Graduate Standing. Instructor's prerequisite:** Calculus 3 (multi-dimensional integrals), very minimal background in Probability.

Text(s): Sheldon Ross, A First Course in Probability (10th Edition)

Description: This course is for students who would like to learn about Probability concepts; I’ll assume very minimal background in probability. Calculus 3 (multi-dimensional integrals) is the only prerequisite for this class. This class will emphasize practical aspects, such as analytical calculations related to conditional probability and computational aspects of probability. No measure-theoretical concepts will be covered in this class. This is class is intended for students who want to learn more practical concepts in probability. This class is particularly suitable for Master students and non-math majors.

GRADUATE COURSES

<< back to top >>

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.

<< back to top >>

MATH 6308 - 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.

<< back to top >>

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.

<< back to top >>

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.

<< back to top >>

MATH 6322- Function Complex Variable

Prerequisites:	**Graduate standing** and MATH 4331
Text(s):	TBD
Description:	Geometry of the complex plane, mappings of the complex plane, integration, singularities, spaces of analytic functions, special function, analytic continuation, and Riemann surfaces.

<< back to top >>

MATH 6324- Differential Equations

Prerequisites:	**Graduate standing** and MATH 4331
Text(s):	TBD

Description:	General theories, topics in ordinary and partial differential equations, and boundary value problems.

<< back to top >>

MATH 6342 - Topology

Prerequisites:	**Catalog prerequisite**: Graduate standing. **MATH 4331**. **Instructor's prerequisite**: Graduate standing. **MATH 4331** or consent of instructor
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.

<< back to top >>

MATH 6350 - Statistical Learning and Data Mining

Prerequisites:	**Graduate Standing** and must be in the **MSDS Program.** Undergraduate Courses in basic Linear Algebra and basic descriptive Statistics
Text(s):	**Recommended text**: Reading assignments will be a set of selected chapters extracted from the following reference text: • Introduction to Statistical Learning w/Applications in R, by James , Witten, Hastie, Tibshirani (This book is freely available online). **ISBN**: 9781461471370 • "Neural Networks with R" by G. Ciaburro. **ISBN**: 978-1788397872

Summary: A typical task of Machine Learning is to automatically classify observed "cases" or "individuals" into one of several "classes", on the basis of a fixed and possibly large number of features describing each "case". Machine Learning Algorithms (MLAs) implement computationally intensive algorithmic exploration of large set of observed cases. In supervised learning, adequate classification of cases is known for many training cases, and the MLA goal is to generate an accurate Automatic Classification of any new case. In unsupervised learning, no known classification of cases is provided, and the MLA goal is Automatic Clustering, which partitions the set of all cases into disjoint categories (discovered by the MLA).

Description:

Numerous MLAs have been developed and applied to images and faces identification, speech understanding, handwriting recognition, texts classification, stock prices anticipation, biomedical data in proteomics and genomics, Web traffic monitoring, etc.

This MSDSfall 2019 course will successively study :

1) Quick Review (Linear Algebra) : multi dimensional vectors, scalar products, matrices, matrix eigenvectors and eigenvalues, matrix diagonalization, positive definite matrices

2) Dimension Reduction for Data Features : Principal Components Analysis (PCA)

3) Automatic Clustering of Data Sets by K-means algorithmics

3) Quick Reviev (Empirical Statistics) : Histograms, Quantiles, Means, Covariance Matrices

4) Computation of Data Features Discriminative Power

5) Automatic Classification by Support Vector Machines (SVMs)

Emphasis will be on concrete algorithmic implementation and testing on actual data sets, as well as on understanding importants concepts.

<< back to top >>

MATH 6357- Linear Models and Design of Experiments

Prerequisites: **Graduate Standing** and must be in the **MSDS Program.** MATH 2433, MATH 3338, MATH 3339, and MATH 6308

Text(s): Required Text: ”Neural Networks with R” by G. Ciaburro. **ISBN**: 9781788397872

Description: Linear models with L-S estimation, interpretation of parameters, inference, model diagnostics, one-way and two-way ANOVA models, completely randomized design and randomized complete block designs.

<< back to top >>

MATH 6358- Probability Models and Statistical Computing

Prerequisites: **Graduate Standing** and must be in the **MSDS Program.** MATH 3334, MATH 3338 and MATH 4378

Text(s):

- **Required:** Probability with Applications in Engineering, Science, and Technology, by Matthew A. Carlton and Jay L. Devore, 2014.
- *Recommended:* Introductory Statistics in R, Peter Dalgaard, 2nd ed., Springer, 2008
- *Recommended:* Introduction to Probability Models by Sheldon Axler 11th edition
- Lecture Notes

Description:

Course Description: Probability, independence, Markov property, Law of Large Numbers, major discrete and continuous distributions, joint distributions and conditional probability, models of convergence, and computational techniques based on the above.

Topics Covered:

- Probability spaces, random variables, axioms of probability.
- Combinatorial analysis (sampling with, without replacement etc)
- Independence and the Markov property. Markov chains- stochastic processes, Markov property, first step analysis, transition probability matrices. Longterm behavior of Markov chains: communicating classes, transience/recurrence, criteria for transience/recurrence, random walks on the integers.
- Distribution of a random variable, distribution functions, probability density function. Independence.
- Strong law of large numbers and the central limit theorem.
- Major discrete distributions- Bernoulli, Binomial, Poisson, Geometric. Modeling with the major discrete distributions.
- Important continuous distributions- Normal, Exponential. Beta and Gamma.
- Jointly distributed random variables, joint distribution function, joint probability density function, marginal distribution.
- Conditional probability- Bayes theorem. Discrete conditional distributions, continuous conditional distributions, conditional expectations and conditional probabilities. Applications of conditional probability.

Software Used:

- Make sure to download R and RStudio (which can't be installed without R) before the course starts. Use the link RStudio download to download it from the mirror appropriate for your platform.
- **New: Rstudio is in the cloud: RStudio.cloud.

MATH 6360 - Applicable Analysis

Prerequisites:	Graduate standing.
Text(s):	**No obligatory text.** Part of the material will be collected from Ken Davidson and Alan Donsig, “Real Analysis with Applications: Theory in Practice”, Springer, 2009. Other sources on Applied Functional Analysis will complement the material.

Description:

This course covers topics in analysis that are motivated by applications.

1. Review of metric spaces, completeness, characterization of compactness, extreme value theorem.
2. Contraction mappings and fixed points. Applications of contractions mappings: integral equations, solutions to initial value problems. Local existence and uniqueness of solutions, stability.
3. Lp spaces as metric completions. Extending the Riemann integral to Lp spaces. Banach spaces.
4. Dual spaces. Uniform boundedness.
5. Consequences of uniform boundedness for Fourier series and polynomial interpolation.
6. Uniform convexity, best approximation property and duality for Lp-spaces. Bounded inverse, closed graph theorem.
7. Hilbert spaces. Orthonormal bases and their characterization. Characterization of best approximation by orthogonal projection. Fourier series.
8. Convergence in L2 and pointwise convergence. Weak convergence.
9. Nonlinear best approximations and (approximate) sparsity.
10. Relationships between weak and norm convergence. Weak compactness in Hilbert spaces. Linear and convex programming in Hilbert spaces.
11. Operators and bilinear forms. The Lax-Milgram theorem.
12. Linear inverse problems. Sparse recovery by norm minimization.
13. The Hilbert-Schmidt norm and Hilbert-Schmidt operators. Compact self-adjoint operators. The spectral theorem for compact, self-adjoint operators.
14. Diagonalizing normal operators. Solutions to Schrodinger's eigenvalue problem and compact integral operators. Introduction to the Calculus of Variations.
15. Other topics in coordination with faculty.

MATH 6366 - Optimization Theory

Graduate standing and **MATH 4331** and **MATH 4377**

Prerequisites: 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.

<< back to top >>

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.

<< back to top >>

MATH 6380 - Programming Foundation for Data Analytics

Prerequisites:	**Graduate Standing** and must be in the **MSDS Program.** **Instructor prerequisites:** The course is essentially self-contained. The necessary material from statistics and linear algebra is integrated into the course. Background in writing computer programs is preferred but not required.
Text(s):	• "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", by Wes McKinney, 2 edition, 2017, O'Reilly. (PD) Paper Book. **ISBN 13**: 9781491957660. *Available for free on **Safari** through **UH library**.* • "Python for Everybody (Exploring Data in Python3)", by Dr. Charles Russell Severance, 2016, 1 edition, CreateSpace Independent Publishing Platform (PE) Paper Book. **ISBN 13**: 9781530051120 *Free online copy: https://books.trinket.io/pfe/index.html*

Description:

Instructor's Description: The course provides essential foundations of Python programming language for developing powerful and reusable data analysis models. The students will get hands-on training on writing programs to facilitate discoveries from data. The topics include data import/export, data types, control statements, functions, basic data processing, and data visualization.

<< back to top >>

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. **ISBN**: 9789812703705
- 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. **ISBN:** 9780321794772

Complementary Texts for further reading:
- Probability: Theory and Examples, 3rd Ed., Richard Durrett, Duxbury Press. **ISBN**: 9787506283403
- An Introduction to Probability Theory and Its Applications, Vol 1, by William Feller. **ISBN**: 9780471257080
- Probability, by Leo Breiman, 1968, Addison-Wesley. **ISBN**: 9780898712964

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

<< back to top >>

MATH 6397 (24324) - Spatial Statistics

Prerequisites:	**Graduate standing**.

Text(s):	TBA
Description:	TBA

<< back to top >>

Math **6397** (24333) - Classical & Quantum Information Theory

Prerequisites:	**Graduate standing.** Quantum Mechanics will be appreciated but not required.
Text(s):	• Quantum Computation and Quantum Information, by I. Chuang and M. Nielsen • The Theory of Quantum Information, by John Watrous • Quantum information theory, by Mark Wilde
Description:	Information theory is the scientific study of the quantification, storage, and communication of digital information. It has been widely used in the communication and cryptography in our daily life. In last several decades, motivated by quantum computation, quantum information theory has been a rapid growing area studying how information can be processed, transmit and stored in quantum mechanics system. The aim of this course is to give a minimal introduction to both classical and quantum information theory in a unified manner. We will start with some basics in Shannon's classical information theory and then study their counterpart in quantum mechanics model. After that, we will focus on the quantum side and covers some selected topics such as entanglement, Bell's inequality, Shor's algorithm, Quantum Teleportation and Superdense coding, etc.

MATH 6397 (25841) - Pattern Recognition

Prerequisites:	**Graduate standing.** Undergraduate calculus sequence, undergraduate probability (MATH 3338), differential equations (MATH 3331) and two semesters of linear algebra.

Text(s):

We will use the following two books:

- Data-Driven Science and Engineering by Steven L. Brunton and J. Nathan Kutz
- Pattern Recognition and Machine Learning by Christopher M. Bishop.

The first book is a useful resource and is highly recommended. However, since online lectures will be mostly followed, it is not necessary to purchase.

Description:

Course Format: This course is being offered in the Synchronous Online format. Synchronous online class meetings will take place according to the class schedule. There is no face-to-face component to this course. All lectures and discussions will be delivered online.

Topics Covered: This course is devoted to the mathematical methods of finding patterns in data.

MATH 7320 - Functional Analysis

Prerequisites:

Graduate standing. MATH 6320, Linear Algebra (MATH 4377) and Real Analysis (MATH 4331/4332). Knowledge of Lebesgue integration is desirable.

Text(s):

Walter Rudin, Functional Analysis, 2nd edition. McGraw Hill, 1991

Catalog description: Linear topological spaces, Banach and Hilbert spaces, duality, and spectral analysis.

Instructor's description: This course is part of a two semester sequence covering the main results in functional analysis, including Hilbert spaces, Banach spaces, topological vector spaces such as distributions, and linear operators on these spaces.

Description:

Functional analysis combines two fundamental branches of mathematics: analysis and linear algebra.

Topics covered in this first part of the course sequence include: Topological vector spaces; Completeness; Convexity; Spectral theory; Distributions.

Course requirement: Assignments will consist of the student taking notes and they must be typeset in LaTeX.

back to top