Department of Mathematics

Fall 2021

*(**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 2021

SENIOR UNDERGRADUATE COURSES

Course	Section	Course Title	Course Day/Time	Rm #	Instructor
Math 4310	17727	Biostatistics	TTh, 8:30—10AM	**CBB 214**	W. Fu
Math 4320	12312	Intro to Stochastic Processes	MW, 4—5:30PM	**AH 108**	K. Josic
Math 4322	19167	Introduction to Data Science and Machine Learning	TTh, 11:30AM—1PM	**CBB 118**	C. Poliak
Math 4323	19063	Data Science and Statistical Learning	TTh, 10—11:30AM	**CBB 118**	W. Wang
Math 4331	14374	Introduction to Real Analysis I	MWF, 9—10AM	**SEC 104**	A. Vershynina
Math 4335	16097	Partial Differential Equations I	TTh, 10AM—11:30AM	**S 120**	L. Cappanera
Math 4339	17962	Multivariate Statistics	TTh, 1—2:30PM	**CBB 214**	C. Poliak
Math 4364	14952	Introduction to Numerical Analysisin Scientific Computing	MW, 4—5:30PM	**CBB 110**	T. Pan
Math 4364	18549	Introduction to Numerical Analysisin Scientific Computing	TTh, 10AM—11:30AM	**SEC 202**	A. Mamonov
Math 4366	15497	Numerical Linear Algebra	TTh, 11:30AM—1PM	**S 119**	J. He

Math 4377	14376	Advanced Linear Algebra I	TTh, 1—2:30PM	**F 154**	M. Kalantar
Math 4388	13501	History of Mathematics	Online	**Online**	S. Ji
Math 4389	13003	Survey of Undergraduate Mathematics	MW, 1—2:30PM	**SEC 202**	M. Almus

GRADUATE ONLINE COURSES

Course	Section	Course Title	Course Day & Time	Instructor
Math 5331	*13189*	*Linear Algebra with Applications*	***Online***	*G. Etgen*
Math 5333	*13698*	*Analysis*	***Online***	*S. Ji*
Math 5382	*18688*	*Probability*	***Online***	*A. Török*

GRADUATE COURSES

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6302	12313	Modern Algebra I	MWF, Noon—1PM	**SEC 201**	A. Haynes
Math 6308	14377	Advanced Linear Algebra I	TTh, 1—2:30PM	**F 154**	M. Kalantar
Math 6312	14375	Introduction to Real Analysis	MWF, 9—10AM	**SEC 104**	A. Vershynina
Math 6320	12340	Theory of Functions of a Real Variable	TTh, 11:30AM—1PM	**S 207**	M. Nicol
Math 6326	24995	Partial Diff Equations	MWF, 10—11AM	**S 207**	G. Jaramillo
Math 6342	12341	Topology	MWF, 11AM—Noon	**S 202**	D. Blecher
Math 6360	26762	Applicable Analysis	TTh, 11:30AM—1PM	**S 116**	B. Bodmann
Math 6366	12342	Optimization Theory	TTh, 2:30—4PM	**S 119**	A. Mang
Math 6370	12343	Numerical Analysis	MW, 1—2:30PM	**S 207**	Y. Kuznetsov
Math 6382	16240	Probability and Statistics	TTh, 1—2:30PM	**SEC 202**	W. Ott

Math 6384	23926	Time-series analysis	TTh, 2:30—4PM	**S 201**	E. Kao
Math 6397	23837	Spatial Statistics	MW, 4—5:30PM	**SEC 201**	M. Jun
Math 6397	23925	Spatial Statistics	MW, 4—5:30PM	**SEC 201**	M. Jun

MSDS Courses

(MSDS Students Only)

Course	Section	Course Title	Course Day & Time	Rm #	Instructor
Math 6350	17740	Statistical Learning and Data Mining	MW, 1—2:30PM	**F 154**	R. Azencott
Math 6357	17960	Linear Models & Design of Experiments	MW, 2:30—4PM	**AH 301**	W. Wang
Math 6358	16423	Probability Models and Statistical Computing	F, 1—3PM	**AH 301**	C. Poliak
Math 6380	18166	Programming Foundation for Data Analytics	F, 3—5PM	**AH 301**	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.

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Math 4320 - Intro to Stochastic Processes	
Prerequisites:	**MATH 3338**

Text(s): An Introduction to Stochastic Modeling" by Mark Pinsky, Samuel Karlin. Academic Press, Fourth Edition.
ISBN-10: 9780123814166
ISBN-13: 978-0123814166

Description: We study the theory and applications of stochastic processes. Topics include discrete-time and continuous-time Markov chains, Poisson process, branching process, Brownian motion. Considerable emphasis will be given to applications and examples.

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Math 4322 - Introduction to Data Science and Machine Learning

Prerequisites: MATH 3339

Text(s): While lecture notes will serve as the main source of material for the course, the following book constitutes a great reference:
”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.

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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.

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Math 4335 - Partial Differential Equations I

Prerequisites:	**MATH 3331** or equivalent, and three additional hours of 3000-4000 level Mathematics. Previous exposure to Partial Differential Equations (Math 3363) is recommended.
Text(s):	"Partial Differential Equations: An Introduction (second edition)," by Walter A. Strauss, published by Wiley, ISBN-13 978-0470-05456-7
Description:	**Description**:Initial and boundary value problems, waves and diffusions, reflections, boundary values, Fourier series. **Instructor's Description:** will cover the first 6 chapters of the textbook. See the departmental course description.

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Math 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. <u>Course Objectives:</u> • 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 <u>Course Topics:</u> • 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)

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Math 4364 (14952) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *(2018—2019 Catalog)* *Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.

Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	This is an one semester course which introduces core areas of numerical analysis and scientific computing along with basic themes such as solving nonlinear equations, interpolation and splines fitting, curve fitting, numerical differentiation and integration, initial value problems of ordinary differential equations, direct methods for solving linear systems of equations, and finite-difference approximation to a two-points boundary value problem. This is an introductory course and will be a mix of mathematics and computing.

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Math 4364 (18549) - Introduction to Numerical Analysis in Scientific Computing

Prerequisites:	**MATH 3331** or **MATH 3321** or equivalent, and three additional hours of 3000-4000 level Mathematics *(2018—2019 Catalog)* *Ability to do computer assignments in FORTRAN, C, Matlab, Pascal, Mathematica or Maple.
Text(s):	Numerical Analysis (9th edition), by R.L. Burden and J.D. Faires, Brooks-Cole Publishers, 9780538733519
Description:	This is an one semester course which introduces core areas of numerical analysis and scientific computing along with basic themes such as solving nonlinear equations, interpolation and splines fitting, curve fitting, numerical differentiation and integration, initial value problems of ordinary differential equations, direct methods for solving linear systems of equations, and finite-difference approximation to a two-points boundary value problem. This is an introductory course and will be a mix of mathematics and computing.

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Math 4366 - Numerical Linear Algebra

Prerequisites:	**MATH 2331**, or equivalent, and six additional hours of 3000-4000 level Mathematics.
Text(s):	Instructor will use his own notes.
Description:	Conditioning and stability of linear systems, matrix factorizations, direct and iterative methods for solving linear systesm, computing eigenvalues and eigenvectors, introduction to linear and nonlinear optimization

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Math 4377 - 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.

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Math 4388 - History of Mathematics

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

This course is designed to provide a college-level experience in history of mathematics. Students will understand some critical historical mathematics events, such as creation of classical Greek mathematics, and development of calculus; recognize notable mathematicians and the impact of their discoveries, such as Fermat, Descartes, Newton and Leibniz, Euler and Gauss; understand the development of certain mathematical topics, such as Pythagoras theorem, the real number theory and calculus.

Aims of the course: To help students
to understand the history of mathematics;
to attain an orientation in the history and philosophy of mathematics;
to gain an appreciation for our ancestor's effort and great contribution;
to gain an appreciation for the current state of mathematics;
to obtain inspiration for mathematical education,
and to obtain inspiration for further development of mathematics.

Description:

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

The course will be based on my notes.

Homework and Essays assignement are posted in Blackboard Learn. There are four submissions for homework and essays and each of them covers 10 lecture notes. The dates of submission will be announced.

All homework and essays, handwriting or typed, should be turned into PDF files and be submitted through Blackboard Learn. Late homework is not acceptable.

There is one final exam in multiple choice.

Grading: 35% homework, 45% projects, 20 % Final exam.

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Math 4389 - Survey of Undergraduate Mathematics

Prerequisites: **MATH 3331**, **MATH 3333**, and three hours of 4000-level Mathematics.
Text(s): *No textbook is required. Instructor notes will be provided*

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

ONLINE GRADUATE COURSES

MATH 5331 - Linear Algebra with Applications

Prerequisites: **Graduate standing**.

Text(s): Linear Algebra Using MATLAB, Selected material from the text *Linear Algebra and Differential Equations Using Matlab* by Martin Golubitsky and Michael Dellnitz)
The text will made available to enrolled students free of charge.

Description:

Software: Scientific Note Book (SNB) 5.5 (available through MacKichan Software, http://www.mackichan.com/)

Syllabus: Chapter 1 (1.1, 1.3, 1.4), Chapter 2 (2.1-2.5), Chapter 3 (3.1-3.8), Chapter 4 (4.1-4.4), Chapter 5 (5.1-5.2, 5.4-5-6), Chapter 6 (6.1-6.4), Chapter 7 (7.1-7.4), Chapter 8 (8.1)

Project: Applications of linear algebra to demographics. To be completed by the end of the semester as part of the final.

Course Description: Solving Linear Systems of Equations, Linear Maps and Matrix Algebra, Determinants and Eigenvalues, Vector Spaces, Linear Maps, Orthogonality, Symmetric Matrices, Spectral Theorem

Students will also learn how to use the computer algebra portion of SNB for completing the project.

Homework: Weekly assignments to be emailed as SNB file.

There will be two tests and a Final.

Grading: Tests count for 90% (25+25+40), HW 10%

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MATH 5333 - Analysis

Prerequisites:	**Graduate standing** and two semesters of Calculus.
Text(s):	Analysis with an Introduction to Proof | Edition: 5, Steven R. Lay, 9780321747471
Description:	A survey of the concepts of limit, continuity, differentiation and integration for functions of one variable and functions of several variables; selected applications.

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MATH 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

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MATH 6302 - Modern Algebra I

Prerequisites:	Graduate standing.
Text(s):	**Required Text**: Abstract Algebra by David S. Dummit and Richard M. Foote, ISBN: 9780471433347 This book is encyclopedic with good examples and it is one of the few books that includes material for all of the four main topics we will cover: groups, rings, field, and modules. While some students find it difficult to learn solely from this book, it does provide a nice resource to be used in parallel with class notes or other sources.
Description:	We will cover basic concepts from the theories of groups, rings, fields, and modules. These topics form a basic foundation in Modern Algebra that every working mathematician should know. The Math 6302--6303 sequence also prepares students for the department's Algebra Preliminary Exam.

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MATH 6308 - Advanced Linear Algebra I

Prerequisites:	**Catalog Prerequisite**: Graduate standing, MATH 2331 and a minimum of 3 semester hours transformations, eigenvalues and eigenvectors. Instructor's Prerequisite: **MATH 2331**, or equivalent, and a minimum of three semester hours of 3000-4000 level Mathematics.
Text(s):	Linear Algebra, Fourth Edition, by S.H. Friedberg, A.J Insel, L.E. Spence,Prentice Hall, ISBN 0-13-008451-4
Description:	**Catalog Description**: An expository paper or talk on a subject related to the course content is required. **Instructor's Description:** The course covers the following topics: vector spaces, subspaces, linear combinations,systems of linear equations, linear dependence and linear independence, bases and dimension,linear transformations, null spaces, ranges, matrix rank, matrix inverse and invertibility,determinants and their properties, eigenvalues and eigenvectors, diagonalizability.

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MATH 6312 - Introduction to Real Analysis

Prerequisites: Graduate standing and **MATH 3334**.

In depth knowledge of Math 3325 and Math 3333 is required.

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

Description: This first course in the sequence Math 4331-4332 provides a solid introduction to deeper properties of the real numbers, continuous functions, differentiability and integration needed for advanced study in mathematics, science and engineering. It is assumed that the student is familiar with the material of Math 3333, including an introduction to the real numbers, basic properties of continuous and differentiable functions on the real line, and an ability to do epsilon-delta proofs.

Topics: Open and closed sets, compact and connected sets, convergence of sequences, Cauchy sequences and completeness, properties of continuous functions, fixed points and the contraction mapping principle, differentiation and integration.

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MATH 6320- Theory Functions of a Real Variable

Prerequisites: Graduate standing and Math 4332 (Introduction to real analysis).

Text(s): Real Analysis: Modern Techniques and Their Applications | Edition: 2, by: Gerald B. Folland, G. B. Folland. ISBN: 9780471317166

Description: Math 6320 / 6321 introduces students to modern real analysis. The core of the course will cover measure, Lebesgue integration, differentiation, absolute continuity, and L^p spaces. We will also study aspects of functional analysis, Radon measures, and Fourier analysis.

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MATH 6326 - Partial Differential Equations

Prerequisites: Graduate Standing. Introduction to Real Analysis (Math 4331) or equivalent. Instructor's recommended prerequisite: Math 6320-21

Text(s):	• Robert McOwen, "Partial Differential Equations, Methods and Applications", 2nd Ed. (2004) • Lawrence C. Evans, "Partial Differential Equations, Graduate studies in Mathematics 19.2 (1998)
Description:	This course introduces four main types of partial differential equations: parabolic, elliptic, hyperbolic and transport equations. The focus is on existence and uniqueness theory. Maximum principles and regularity of solutions will be considered. Other concepts that will be explored include weak formulations and weak solutions, distribution theory, fundamental solutions. The course will touch on applications and a brief introduction to numerical methods: finite differences, finite volume, and finite elements. Syllabus (**PDF**)

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MATH 6342 - Topology

Prerequisites:	Graduate standing and **MATH 4331** and **MATH 4337**.
Text(s):	(Required) Topology, A First Course, J. R. Munkres, Second Edition, Prentice-Hall Publishers. link to text

Description:

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

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

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

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MATH 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).

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.

Description:

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.

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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.

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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

Prerequisites:	Graduate standing and **MATH 4331** and **MATH 4377** Students are expected to have a good grounding in basic real analysis and linear algebra.
Text(s):	"Convex Optimization", Stephen Boyd, Lieven Vandenberghe, Cambridge University Press, ISBN: 9780521833783 *(This text is available online. Speak to the instructor for more details)*
Description:	The focus is on key topics in optimization that are connected through the themes of convexity, Lagrange multipliers, and duality. The aim is to develop a analytical treatment of finite dimensional constrained optimization, duality, and saddle point theory, using a few of unifying principles that can be easily visualized and readily understood. The course is divided into three parts that deal with convex analysis, optimality conditions and duality, computational techniques. In Part I, the mathematical theory of convex sets and functions is developed, which allows an intuitive, geometrical approach to the subject of duality and saddle point theory. This theory is developed in detail in Part II and in parallel with other convex optimization topics. In Part III, a comprehensive and up-to-date description of the most effective algorithms is given along with convergence analysis.

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MATH 6370 - Numerical Analysis

Prerequisites:	**Graduate standing**. Students should have knowledge in Calculus and Linear Algebra.
Text(s):	Numerical Mathematics (Texts in Applied Mathematics), 2nd Ed., V.37, Springer, 2010. By A. Quarteroni, R. Sacco, F. Saleri. ISBN: 9783642071010

Description:	The course introduces to the methods of scientific computing and their application in analysis, linear algebra, approximation theory, optimization and differential equations. The purpose of the course to provide mathematical foundations of numerical methods, analyse their basic properties (stability, accuracy, computational complexity) and discuss performance of particular algorithms. This first part of the two-semester course spans over the following topics: (i) Principles of Numerical Mathematics (Numerical well-posedness, condition number of a problem, numerical stability, complexity); (ii) Direct methods for solving linear algebraic systems; (iii) Iterative methods for solving linear algebraic systems; (iv) numerical methods for solving eigenvalue problems; (v) non-linear equations and systems, optimization.

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MATH 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.

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MATH 6382- Probability and Statistics

Prerequisites:	Graduate standing and **MATH 3334**, **MATH 3338** and **MATH 4378**.
Text(s):	**Recommended Texts :** - A First Look at Rigorous Probability Theory, by Jeffrey Rosenthal, 2000. **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

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MATH 6384- Discrete Time Models in Finance

Prerequisites: Graduate standing and **MATH 6382**.

Text(s):	Introduction to Mathematical Finance: Discrete-time Models, by Stanley Pliska, Blackwell, 1997. **ISBN**: 9781557869456
Description:	The course is an introduction to discrete-time models in finance. We start with single-period securities markets and discuss arbitrage, risk-neutral probabilities, complete and incomplete markets. We survey consumption investment problems, mean-variance portfolio analysis, and equilibrium models. These ideas are then explored in multiperiod settings. Valuation of options, futures, and other derivatives on equities, currencies, commodities, and fixed-income securities will be covered under discrete-time paradigms.

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MATH 6397 (23837) - Selected Topics in Math

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

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MATH 6397 (23925) - Selected Topics in Math

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

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