## GRADUATE COURSES - FALL 2021

### SENIOR UNDERGRADUATE COURSES

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<tr>
<td>Math 4310</td>
<td>17727</td>
<td>Biostatistics</td>
<td>TTh, 8:30—10AM</td>
<td>CBB 214</td>
<td>W. Fu</td>
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<tr>
<td>Math 4320</td>
<td>12312</td>
<td>Intro to Stochastic Processes</td>
<td>MW, 4—5:30PM</td>
<td>AH 108</td>
<td>K. Josic</td>
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<tr>
<td>Math 4322</td>
<td>19167</td>
<td>Introduction to Data Science and Machine Learning</td>
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<td>Math 4323</td>
<td>19063</td>
<td>Data Science and Statistical Learning</td>
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<tr>
<td>Math 4331</td>
<td>14374</td>
<td>Introduction to Real Analysis I</td>
<td>MWF, 9—10AM</td>
<td>SEC 104</td>
<td>A. Vershynina</td>
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<tr>
<td>Math 4335</td>
<td>16097</td>
<td>Partial Differential Equations I</td>
<td>TTh, 10AM—11:30AM</td>
<td>S 120</td>
<td>L. Cappanera</td>
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<td>Math 4339</td>
<td>17962</td>
<td>Multivariate Statistics</td>
<td>TTh, 1—2:30PM</td>
<td>CBB 214</td>
<td>C. Poliak</td>
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<tr>
<td>Math 4364</td>
<td>14952</td>
<td>Introduction to Numerical Analysis in Scientific Computing</td>
<td>MW, 4—5:30PM</td>
<td>CBB 110</td>
<td>T. Pan</td>
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<tr>
<td>Math 4364</td>
<td>18549</td>
<td>Introduction to Numerical Analysis in Scientific Computing</td>
<td>TTh, 10AM—11:30AM</td>
<td>SEC 202</td>
<td>A. Mamonov</td>
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<tr>
<td>Math 4366</td>
<td>15497</td>
<td>Numerical Linear Algebra</td>
<td>TTh, 11:30AM—1PM</td>
<td>S 119</td>
<td>J. He</td>
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<td>Course</td>
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<tr>
<td>Math 4377</td>
<td>14376</td>
<td>Advanced Linear Algebra I</td>
<td>TTh, 1—2:30PM</td>
<td>F 154</td>
<td>M. Kalantar</td>
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<tr>
<td>Math 4388</td>
<td>13501</td>
<td>History of Mathematics</td>
<td>Online</td>
<td>Online</td>
<td>S. Ji</td>
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<tr>
<td>Math 4389</td>
<td>13003</td>
<td>Survey of Undergraduate Mathematics</td>
<td>MW, 1—2:30PM</td>
<td>SEC 202</td>
<td>M. Almus</td>
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<td>Math 5331</td>
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<td>Linear Algebra with Applications</td>
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<td>G. Etgen</td>
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<tr>
<td>Math 5333</td>
<td>13698</td>
<td>Analysis</td>
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<tr>
<td>Math 5382</td>
<td>18688</td>
<td>Probability</td>
<td>Online</td>
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<td>A. Török</td>
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<tr>
<td>Math 6302</td>
<td>12313</td>
<td>Modern Algebra I</td>
<td>MWF, Noon—1PM</td>
<td>SEC 201</td>
<td>A. Haynes</td>
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<tr>
<td>Math 6308</td>
<td>14377</td>
<td>Advanced Linear Algebra I</td>
<td>TTh, 1—2:30PM</td>
<td>F 154</td>
<td>M. Kalantar</td>
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<tr>
<td>Math 6312</td>
<td>14375</td>
<td>Introduction to Real Analysis</td>
<td>MWF, 9—10AM</td>
<td>SEC 104</td>
<td>A. Vershynina</td>
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<tr>
<td>Math 6320</td>
<td>12340</td>
<td>Theory of Functions of a Real Variable</td>
<td>TTh, 11:30AM—1PM</td>
<td>S 207</td>
<td>M. Nicol</td>
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<tr>
<td>Math 6326</td>
<td>24995</td>
<td>Partial Diff Equations</td>
<td>MWF, 10—11AM</td>
<td>S 207</td>
<td>G. Jaramillo</td>
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<td>Math 6342</td>
<td>12341</td>
<td>Topology</td>
<td>MWF, 11AM—Noon</td>
<td>S 202</td>
<td>D. Blecher</td>
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<tr>
<td>Math 6360</td>
<td>26762</td>
<td>Applicable Analysis</td>
<td>TTh, 11:30AM—1PM</td>
<td>S 116</td>
<td>B. Bodmann</td>
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<tr>
<td>Math 6366</td>
<td>12342</td>
<td>Optimization Theory</td>
<td>TTh, 2:30—4PM</td>
<td>S 119</td>
<td>A. Mang</td>
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<tr>
<td>Math 6370</td>
<td>12343</td>
<td>Numerical Analysis</td>
<td>MW, 1—2:30PM</td>
<td>S 207</td>
<td>Y. Kuznetsov</td>
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<tr>
<td>Math 6382</td>
<td>16240</td>
<td>Probability and Statistics</td>
<td>TTh, 1—2:30PM</td>
<td>SEC 202</td>
<td>W. Ott</td>
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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

(MLS Students Only)

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<td>Math 6350</td>
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<td>Statistical Learning and Data Mining</td>
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<td>R. Azencott</td>
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<tr>
<td>Math 6357</td>
<td>17960</td>
<td>Linear Models &amp; Design of Experiments</td>
<td>MW, 2:30—4PM</td>
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<td>W. Wang</td>
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<tr>
<td>Math 6358</td>
<td>16423</td>
<td>Probability Models and Statistical Computing</td>
<td>F, 1—3PM</td>
<td>AH 301</td>
<td>C. Poliak</td>
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<tr>
<td>Math 6380</td>
<td>18166</td>
<td>Programming Foundation for Data Analytics</td>
<td>F, 3—5PM</td>
<td>AH 301</td>
<td>D. Shastri</td>
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SENIOR UNDERGRADUATE COURSES

Math 4310 Biostatistics

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<tr>
<th>Prerequisites:</th>
<th>MATH 3339 and BIOL 3306</th>
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<tr>
<td>Description:</td>
<td>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.</td>
</tr>
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ISBN-10: 9780123814166

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.

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
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 subsequently 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?


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.

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.


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.

Math 4339 - Multivariate Statistics

Prerequisites: MATH 3349

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 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.*
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.

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.

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 4366 - Numerical Linear Algebra

Text(s):


Description:
Math 4377 - Advanced Linear Algebra I

Prerequisites: MATH 2331, or equivalent, and a minimum of three semester hours of 3000-4000 level Mathematics.


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.

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 assignment 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.

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.
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.

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%
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.

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

MATH 6302 - Modern Algebra I
Prerequisites: Graduate standing.

**Required Text:** Abstract Algebra by David S. Dummit and Richard M. Foote, ISBN: 9780471433347

**Text(s):**

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.
Prerequisites:
Graduate standing and MATH 3334.

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

Text(s):

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.

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

Text(s):

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.

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

**Graduate Standing** and must be in the **MSDS Program**. Undergraduate Courses in basic Linear Algebra and basic descriptive Statistics.

**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.

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 Review (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 important concepts.
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.

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):**
- **Recommended:** Introduction to Probability Models by Sheldon Axler 11th edition
- Lecture Notes
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)
- 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.
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.
This course covers topics in analysis that are motivated by applications.

1. Review of metric spaces, completeness, characterization of compactness, extreme value theorem.
5. Consequences of uniform boundedness for Fourier series and polynomial interpolation.
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.

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

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.

MATH 6370 - Numerical Analysis

Prerequisites: Graduate standing. Students should have knowledge in Calculus and Linear Algebra.


Text(s):
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 is 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.

MATH 6380 - Programming Foundation for Data Analytics

**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.


*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.

Prerequisites:

MATH 6382- Probability and Statistics

Graduate standing and **MATH 3334, MATH 3338 and MATH 4378**.

Recommended Texts:


Review of Undergraduate Probability:


Complementary Texts for further reading:

**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
(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

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

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.

MATH 6397 (23837) - Selected Topics in Math

Prerequisites: Graduate standing.

Text(s): TBA

Description: TBA