Core Courses

2018Fall

MATH 2243 Lin Alg & Diff Eqs

Text:

Edwards and Penney, DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA (4th edition).

Overview:

The course consists of two related parts, ***linear algebra*** and ***ODE***.

Prerequisites: [1272 or 1282 or 1372 or 1572]

Covered Contents:

Linear algebra*:* matrices and matrix operations, Gaussian elimination, matrix inverses, determinants, vector spaces and subspaces, dependence, Wronskian, dimension, eigenvalues, eigenvectors, diagonalization.

ODE*:* Separable and first-order linear equations with applications, 2nd order linear equations with constant coefficients, method of undetermined coefficients, simple harmonic motion, 2x2 and 3x3 systems of linear ODE's with constant coefficients, solution by eigenvalue/eigenvectors, non-homogenous linear systems; phase plane analysis of 2x2 nonlinear systems near equilibria.

MATH 2263 Multivariable Calc

Text:

James Stewart, Calculus: Early Transcendentals, Eighth ed. vol. 2. Cengage Learning, Boston 2016.

Overview:

Multivariable calculus.

Prerequisites: [1272 or 1372 or 1572]

Covered Contents:

Curves in space, arc length and curvature, velocity and acceleration. Limits and continuity, partial differentiation, local extrema, exact differentials, chain rule, directional derivative and gradient, Lagrange multipliers, 2nd derivative test. Double integration, volume and other applications, polar coordinates, triple integration, cylindrical and spherical coordinates. Vector analysis: Vector fields, line integrals, path independence, Green's Theorem, surface integrals, Theorems of Gauss and Stokes.

PHYS 1101W Intro College Phys I

Text:

Essentials of College Physics by Serway and Vuille, Publisher Thomson.

Overview:

Physics 1101 is the first semester of a two semesters introduction to physics. By the end of this semester, you should have a deeper understanding of the phenomena occurring in your surrounding physical world. You should have a clearer picture of the behavior of the universe on the largest (cosmic) scale, and on the smallest (subnuclear) scale. You should also understand a bit more about the physics of biological systems, including your own body. In addition, you should be more competent at measurement and quantitative reasoning concerning physical processes. Fundamental principles of physics in the context of everyday world. Use of kinematics/dynamics

principles and quantitative/qualitative problem-solving techniques to understand natural phenomena. Lecture, recitation, lab.
Prerequisites: Linear algebra, plane geometry, trigonometry.
Covered Contents:
The main emphasis will be on the branch of physics known as mechanics. This is the study of motion and the causes of motion through the applications of fundamental principles of physics.

We begin with kinematics, the quantitative description of the motion of particles. We then build on kinematics to learn how and why motion occurs, through the application of Newton's laws of dynamics. Many examples will be considered as we explore the properties of specific forces and the details of the motion they bring about.

The next step will be to describe physical processes in terms of energy and momentum, quantities that are always "conserved." Conservation laws allow us to solve problems in mechanics that would be very difficult by other techniques and provide a powerful approach to the analysis of physical systems in general.

We then will extend our understanding of motion to the kinematics and dynamics of rotation.

Finally, we will briefly study some of the physical properties of solids and fluids.

2019Spring

CSCI 1133 Intro to Programming Concepts

Overview & Covered Contents:
Fundamental programming concepts using **Python** language. Problem solving skills, recursion, object-oriented programming. Algorithm development techniques. Use of abstractions/modularity. Data structures/abstract data types. Develop programs to solve real-world problems.
Prerequisites: concurrent registration is required (or allowed) in MATH 1271 or MATH 1371 or MATH 1571H or instr consent.

MATH 3283W Foundations

Text:
Lay, Analysis: With an Introduction to Proof, 5th ed., Pearson.
Overview:
Introduction to reasoning used in advanced mathematics courses. Writing-intensive component. To introduce and practice techniques of mathematical proof. To develop rigorously the analysis of sequences and series.
Prerequisites: [concurrent registration is required (or allowed) in MATH2243, MATH2263, MATH2373, or MATH2374]
Covered Contents:
Logic, mathematical induction, real number system, general/monotone/recursively defined sequences, convergence of infinite series/sequences, Taylor's series, power series with applications to differential equations, Newton's method.

MATH 4242 Applied Lin Alg

Text:

Linear Algebra and Its Applications (4th Edition), by Gilbert Strang.

References: Peter J. Olver and Chehrzad Shakiban, Applied Linear Algebra, 2nd edition (MIT OpenCourseWare).

Overview:

This is a second, advanced course in Linear Algebra, which assumes the student has already mastered a one semester course in the subject.

Prerequisites: 2243 or 2373 or 2573.

Covered Contents:

In this course, systems of linear equations, Gaussian elimination, determinants, vector spaces, linear independence, basis and dimension, the Cramer's rule, the row, column spaces, linear transformations, inner product, orthogonality, the Gram-Schmidt algorithm, eigenvalues and eigenvectors, diagonalization, Hermitian matrices, the singular value decomposition, quadratic forms, positive definite matrices, and the Jordan canonical forms. The lectures follow the text fairly closely.

STAT 3032 Regression and Correlated Data

Text:

Applied Linear Regression (4th Ed.), by Weisberg, S.

Overview:

This is a second course in statistics with a focus on linear regression and correlated data. The intent of this course is to prepare statistics, economics and actuarial science students for statistical modeling needed in their discipline.

Prerequisites: STAT 3011 or STAT 3021.

Covered Contents:

The course covers the basic concepts of linear algebra and computing in R, linear regression, multiple linear regression, statistical inference, model diagnostics, transformations, model selection, model validation, and basics of time series and mixed models. Numerous datasets will be analyzed and interpreted using the open-source statistical software R.

2019Fall

CSCI 2011 Disc. Structures

Text:

Rosen: *Discrete Mathematics and Its Applications* 7th edition. ISBN-13: 978-0073383095

Overview:

Much of the basic mathematical machinery useful in computer science will be presented, with applications. Students will learn **actively** the art of creating real-world proofs in these areas, preparing them for diverse regions of computer science such as architecture, algorithms, automata, programming languages, cryptography, etcetera, as well as increasing their general problem-solving abilities in all areas.

Prerequisites: [MATH 1271 or MATH 1371 or MATH 1571H], honors student.

Covered Contents:
Sets, sequences and summation, growth of functions, big-O, relations, formal logic, number theory, induction & recursion, counting, finite probability, enumeration & relations, graph, modeling computation.

MATH 5485 Numerical Methods I

Text:
Burden et al., 2016. Numerical analysis (10th), Boston, MA: Cengage Learning.
Overview:
Fall semester will cover solution of equations and systems, numerical linear algebra and eigenvalues, interpolation and approximation, as well as numerical differentiation and integration.
Prerequisites: [2243 or 2373 or 2573 or 4242], familiarity with some programming language.
Covered Contents:
Algorithm and convergence (chapter 1):
Big-O, Review of Calculus, Bisection Method.
Solutions of nonlinear equations in one variable (Chapter 2):
Bisection Method, Fixed-Point Iteration, Fixed-Point Iteration, Newton's Method, Error Analysis.
Interpolation and polynomial approximation (Chapter 3):
Interpolation, Lag rang Polynomial, Neville's Method, Divided Differences, Cubic Spline.
Numerical differentiation and integration (Chapter 4):
Numerical Differentiation, Richardson's Extrapolation, Numerical Integration, Composite Numerical Integration, Romberg Integration, Adaptive Quadrature, Gaussian Quadrature, Multiple Integrals, and Improper Integrals.
Numerical solutions of initial-value problems (Chapter 5):
Elementary IVP, Euler's Method, Higher-Order Taylor Method, Runga-Kutta Methods, Error Control, Multi-step Methods, Higher-Order / System of DE, Stability.

MATH 5651 Prob-Stat Theory

Text:
Probability and Statistics by DeGroot and Schervish, Pearson 4th Edition (University of Minnesota Edition). We will cover chapters 1- 7.3 of the text.
Reference:
Introduction to Probability, 1st ed, by D. Anderson, T. Sepp¨al¨ainen, and B. Valk´o.
Introduction to Probability by C. M. Grinstead and J. L. Snell. This book can be downloaded through our school online library.
Overview:
Logical development of probability, basic issues in statistics. Probability spaces, random variables, their distributions/expected values. Law of large numbers, central limit theorem, generating functions, sampling, sufficiency, estimation.
Prerequisites: [2263 or 2374 or 2573], [2243 or 2373]; [2283 or 2574 or 3283 or 4242].
Covered Contents:
§1.4 Set Theory
§1.5 Probability
§1.6 Finite sample spaces

§1.7 Counting methods
§1.8 Combinatorial Methods
§1.9 Multinomial coefficients
§1.10 The Probability of a Union of Events
§2.1 Conditional Probability
§2.2 Independence of Events & Independent trials
§2.3 Bayes' Theorem
§2.4 Gambler's Ruin Problem
§3.1 Random Variables
§3.2 Continuous distributions
§3.3 The Cumulative distribution function
§3.4 Bivariate distributions
§3.5 Marginal Distributions
§3.6 Conditional distributions
§3.7 Multivariate distributions
§3.8 Functions of a random variable
§3.9 Functions of two or more random variables
§3.10 Markov Chains
§4.1 The Expectation of a random variable
§4.2 Properties of expectation
§4.3 Variance
§4.5 Median and Mean
§4.6 Covariance and Correlation
§4.7 Conditional expectations
§5.2 The Bernoulli and Binomial Distributions
§5.4 The Poisson Distributions
§5.6 The Normal Distribution
§5.7 The Gramma Distribution
§5.9 The Multinomial Distributions
§5.10 The Bivariate Normal Distributions
§6.2 Law of Large Numbers
§6.3 Central Limit Theorem
§6.4 The Correction for Continuity

2020Spring

CSCI 4011 Form Lang & Autom.

Text:
Michael Sipser "Introduction to the Theory of Computation" 3rd Edition Cengage, 2013.
Overview:
Logical/mathematical foundations of computer science. Formal languages, their correspondence to machine models. Lexical analysis, string matching, parsing. Decidability, undecidability, limits of computability. Computational complexity.
Prerequisites: 2041 or instr consent, students are expected to have knowledge of computer science principles and programming.
Covered Contents:

§1: Finite automata and regular languages.
§2: Languages, grammars, pushdown automata, and Context-free.
§3: Turing machines and the formal definition of an algorithm.
§4: Decidability, and the Halting Problem.
§5: Reductions and unsolvable problems.
§6.2: Decidability of Logical Theories.
§7: Time complexity and NP-completeness.
§8: Space complexity.
§9.3: Circuit Complexity
§10.5: Parallel Computation
§10.6: Cryptography

CSCI 4041 Algs. & Data Str.

Text:
Cormen, Leiserson, Rivest, and Stein: *Introduction to Algorithms* 3rd edition. ISBN-13: 978-0262033848.
References:
[1] Algorithms, 4th Edition
[2] Computer Science, An Interdisciplinary Approach, Chapter 4
[3] E. Horowitz and S. Sahni, "Fundamentals of Computer Algorithms", Computer Science Press, Rockville, MD, 1984.
[4] C.H. Papadimitriou and K. Steiglitz, "Combinatorial Optimization: Algorithms and Complexity", Dover Publications, Mineola, NY, 1998.
[5] D.E. Knuth, "The Art of Computer Programming", Addison-Wesley, Reading, MA, Volumes 1-4, Addison-Wesley, Reading, MA, 2011.
[6] U. Manber, "Introduction to Algorithms: A Creative Approach", Addison-Wesley, Reading, MA, 1989.
[7] A. Aho, J.E. Hopcroft, and J.D. Ullman, "Data Structures and Algorithms", Addison-Wesley, Reading, MA, 1983.
[8] R. Lafore, "Data Structures and Algorithms in Java", Sams Publishing, Indianapolis, IN, 2002.
[9] M. Goodrich, R. Tamassia, and M. Goldwasser, "Data Structures and Algorithms in Java", Wiley, Hoboken, NJ, 2014.
[10] R. Sedgewick and K. Wayne, "Algorithms", Addison-Wesley, Reading, MA, 2011.
Overview:
The course objective is to provide fundamental paradigms for algorithm design with the supporting data structures. Rigorous analysis of algorithms/implementation. Algorithm analysis, sorting algorithms, binary trees, heaps, priority queues, heapsort, dynamic programming, greedy algorithms, graphs, graph traversal, single source shortest path, minimum cost spanning trees, binary search trees, hash tables and hashing.
Prerequisites: [(1913 or 1933) and 2011] or instr consent.
Covered Contents:
Lecture 1: Asymptotic Runtime
Lecture 2: Big-O, Big-Theta, and Big-Omega

Lecture 3: Loop Invariants, Bubble Sort Correctness Proof
Lecture 5: Merge Sort
Lecture 6: Quicksort
Lecture 7: Heaps
Lecture 8: Priority Queues
Lecture 9: Counting Sort
Lecture 10: Radix and Bucket Sort
Lecture 11: Hash Tables
Lecture 12: Open Addressing, Binary Search Trees
Lecture 13: Binary Search Trees: Overview
Lecture 14: Binary Search Trees: Insertion/Deletion
Lecture 15: B-Trees
Lecture 16: Red-Black Trees
Lecture 17: Dynamic Programming
Lecture 18: Matrix Chain Multiplication
Lecture 19: Greedy Algorithms
Lecture 20: Huffman Coding
Lecture 21: Graphs
Lecture 22: Breadth-First Search
Lecture 23: Depth-First Search
Lecture 24: Shortest Paths and Bellman-Ford
Lecture 25: Dijkstra's Algorithm
Lecture 26: Floyd-Warshall Algorithm
Lecture 27: Minimum Spanning Trees
Lecture 28: Disjoint Sets and MSTs

CSCI 4511W Intro: Artificial Intelligence

Text:
Stuart Russell and Peter Norvig, Artificial Intelligence. A modern approach. 3rd Edition, Prentice-Hall, 2010. ISBN: 9780136042594

Overview:
The course provides a technical introduction to artificial intelligence (AI). Topics include: agents, search (search spaces and algorithms, game playing, constraint satisfaction), planning, knowledge representation, and an introduction to neural networks. The course is suitable to gain a solid technical background and as a preparation for more advanced work in AI.

Prerequisites: Students are expected to have knowledge of basic computer science principles and programming; data structures (graphs and trees); and formal logic (propositional and predicate logic).

Covered Contents:
§2: Intro, intelligent agents
§3: Problem solving and search
§4: Other search algorithms
§5: Constraint satisfaction
§6: Game playing
§7: Propositional logic

§8: First-order logic and resolution
§9: Planning
§11: Planning
§12: Neural networks and deep learning
§12: Knowledge representation

MATH 5248 Cryptology and Number Theory

Text:

Cryptology and Number Theory by Paul Garrett.
Other useful texts: A Computational Introduction to Number Theory and Algebra, by Victor Shoup.
Elementary Number Theory: Primes, Congruences, and Secrets, by William Stein.

Overview:

This is an introductory course in number theory. The primary application of the number theory we learn in this course will be cryptology, the subject of how to make ciphers and break them. Both symmetric and public key cryptosystems will be introduced. The math in this course will be heavy on "modular arithmetic," which will be introduced and covered in depth. It also makes some use of elementary counting and probability, plus a tiny bit of linear algebra and matrices.

Prerequisites: Two semesters of sophomore level mathematics.

Covered Contents:

The Affine Cipher,
The Vigenere Cipher,
The Hill Cipher,
Friedman Attack,
Chinese Remainder Theorem,
Hensel's Lemma,
Fermat's little Theorem,
Euler's Criterion,
Principal Square roots,
Primitive Roots,
RSA,
Square root oracles,
Discrete logs,
Diffie-Hellman Key Exchange,
ElGamal Cipher,
Superincreasing Vectors,
Knapsack Ciphers,
The Legendre Symbol,
Arithmetic Convolutions,
Mobius inversion,
Quadratic Reciprocity.

2020Summer

CSCI 5994 Directed Research

This is an independent research advised by Prof. Maria Gini. I would like to thank my insightful advisor Prof. Maria Gini. She gives me the freedom to work on whatever I wanted, but also ensures that my research was always going somewhere useful. She lets me to find the beauty and power of NLP and develop my interests in this field.

The primary goal of this research was to study on NLP especially sentiment analysis. After completing the necessary part, I was curious about people's perception toward COVID-19 pandemic. How does it affect the spread of COVID-19? I extended the research field to topic extraction and sequential prediction. In the end, I submitted a research paper on *How Personal Perceptions of COVID-19 Have Changed Over Time* in AAAI2021.

2020Fall

CSCI 5521 Intro to Machine Learning

Text:

Introduction to Machine Learning; by Ethem Alpaydin (3rd ed) 2014.

Overview:

Neural networks, non-parametric windowing, and Bayes statistical theory are three popular methods for recognizing and classifying patterns - the process of Pattern Recognition. These are the basic machine learning algorithms applicable to high-dimensional numerical data. We introduce the fundamental concepts of these various approaches, including the classification phase and the learning phase. Part of the class will be devoted to methods for unsupervised learning and classification. We assume just some knowledge of elementary statistics, calculus, and elementary linear algebra at the upper division undergraduate level. A combination of written assignments and programming projects will be used to illustrate the concepts. Most if not all programming will be done in Matlab and/or python. For those familiar with one but not the other, side-by-side comparisons will be provided. material showing how to for those unfamiliar with it.

Prerequisites: [2031 or 2033], STAT 3021, and knowledge of partial derivatives

Covered Contents:

Intro: What is Machine Learning (Chap 1)
Supervised Learning: Some basic concepts (Chap 2)
Bayes Decision Theory: Conditional Probability (Chap 3)
Discriminant Functions, Normal Dist. (Chap 3)
Estimating Unknown Probability Densities, (Chap 4)
Parametric Classification (Chap 4)
Multivariate Methods: estimation and classification (Chap 5)
Dimensionality Reduction: feature selection PCA (Chap 6)
Unsupervised Clustering: K-means EM (Chap 7)
Support Vector Machines, (Linear and Kernel) (chap 13)
Linear Discriminant - the Perceptron (Chap 10)
Multilayer Perceptrons (Chap 11)
Decision trees, random forests (Chap 9)

MATH 5165 Math Logic I

Text:
A Mathematical Introduction to Logic *Second Edition*, Herbert B. Enderton.
Overview:
Theory of computability: notion of algorithm, Turing machines, primitive recursive functions, recursive functions, Kleene normal form, recursion theorem. Propositional logic.
Prerequisites: 2283 or 3283 or Phil 5201 or CSci course in theory of algorithms or instr consent
Covered Contents:
CHAPTER ONE Sentential Logic
1.1 The Language of Sentential Logic
1.2 Truth Assignments
1.3 A Parsing Algorithm
1.4 Induction and Recursion
1.5 Sentential Connectives
1.7 Compactness and Effectiveness
CHAPTER TWO First-Order Logic
2.1 First-Order Languages
2.2 Truth and Models
2.3 A Parsing Algorithm
2.4 A Deductive Calculus
2.6 Models of Theories
CHAPTER THREE Undecidability
3.0 Number Theory
3.2 Other Reducts of Number Theory
3.3 A Subtheory of Number Theory

STAT 5102 Theory of Statistics II

Text: Introduction to Mathematical Statistics, latest edition by Hogg, McKean and Craig.
Overview:
Sampling, sufficiency, estimation, test of hypotheses, size/power. Categorical data. Contingency tables. Linear models.
Prerequisites: 5101 or Math 5651
Covered Contents:
Point estimation,
confidence intervals,
order statistics,
first principles of hypothesis testing,
convergence in probability,
convergence in distributions,
Central Limit Theorem,
Maximum likelihood estimations,
Likelihood ratio tests,
Likelihood methods for multivariate parameters,

Sufficiency,
Hypothesis testing theory,
Bayesian Statistics.

CSCI 5994 Directed Research

This is an independent research on semantic parsing and word representation advised by Prof. Maria Gini. The report is currently in the process of grading.

2021Spring

MATH 5486 Numerical Methods II

Text:

The course will be primarily based on lecture notes (available via Moodle).
References: Burden and Faires, Numerical Analysis, 10th edition.
References: Ascher, First Course In Numerical Methods.
Prerequisites: 5485
Overview:
Math 5485-6, is an introductory two-semester course about numerical methods. We will learn about basic mathematical principles for devising and analyzing of numerical methods. Spring semester will cover numerical solution of ordinary differential equations, boundary value problems, and partial differential equations, including finite elements.

CSCI 1933 Intro Algs & Data Str.

Overview & Covered Contents:

Advanced object oriented programming to implement abstract data types (stacks, queues, linked lists, hash tables, binary trees) using Java language. Inheritance. Searching/sorting algorithms. Basic algorithmic analysis. Use of software development tools. Weekly lab.
Prerequisites: 1133 or instr consent