

Tentative Syllabus

Week 1 – Logic

- Formalization.
- A Review of Propositional logic
- Predicate Logic
- Quantifiers and Their Properties.
- Mention Some Modal Operators

Week 2 – Proofs.

- Methods of Proofs.
- Rules of Inference
- Basic Proofs

Week 3 - – Abstract Algebra.

- Groups. Definitions, Examples, and Elementary Properties.
- Homomorphisms, Isomorphisms.
- Rings. Definitions, Examples, and Elementary Properties.
- Homomorphisms, Isomorphisms.
- Fields. Definitions, Examples, and Elementary Properties.
- Homomorphisms, Isomorphisms.

Week 4 - Matroids.

- Examples.
- Definitions and Elementary Properties
- Graphs and Trees.
- Greedy Algorithms

Week 5 - Linear Algebra, Vector Spaces

- Vector Spaces, Examples and Basic Properties
- Subspaces and Spanning Sets
- Linear Combinations, Systems of Linear Equations, And Their General Solutions.
- Linear Dependence and Linear Independence
- Bases and Dimension
- Maximal Linearly Independent Subsets.

Week 6 - Linear Algebra, Vector Geometry

- Vectors
- Dot Product
- Planes and Cross Product
- Inner Product Spaces
- An Application to Least Squares Approximations.

Week 7 - Midterm.

Week 8 - Linear Algebra, Linear Transformations

- Examples and Elementary Properties
- Kernals and Images
- Ranks
- The Matrix of a Linear Transformation
- Change of Bases

Week 9 - Linear Algebra, Eigenvectors and Eigenvalues

- Basic Definitions
- The Characteristic Polynomial
- Diagonalization
- Spectrum Theorem

Week 10- Week 11 - Discrete Random Variables and Their Probability Distributions.

- Basic Definitions.
- The Probability Distribution for Discrete Random Variable.
- The Expected Value of Random Variable or a Function of Random Variable.
- The Binomial Probability Distribution.
- The Geometric Probability Distribution.
- The Negative Binomial Probability Distribution.
- The Hypergeometric Probability Distribution.
- Moments and Moment-Generating Functions.
- Tchebysheff's Theorem.

Week 12-Week 14 --- Additional advanced topics.

Topics might include

- Relations and Orders (partial, total, etc)
- Basic Cryptography
- Generating Functions

- Boolean Algebras
- Modal Logic
- Temporal Logic
- Continuous Random Variable Distributions
- Basics of Stochastic Processes

Outcomes Objectives:

At the end of the course students will be able to

- Formulate and analyze a problem from the mathematical point of view.
- Use propositional and predicate logic to describe and reason about fundamental mathematical structures.
- evaluate elementary mathematical arguments and identify fallacious reasoning
- Design and formulate basic proofs.
- Learn basic structures of abstract algebra and see the many different applications and their interconnectedness through these structures.
- Use matroids in different areas and see the connections between different areas that use matroids.
- Apply the basics of vector spaces and see the underlying geometry of the inherent concepts.
- Apply principles of discrete probability to calculate probabilities and expectations of simple random processes.
- Be able to tell what type of probability distribution will correspond to a problem