

Course Topics

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1 Course Topics

There are some topics that we may cover. Some of the topics at the end of the class (probability theory and number theory,) we cover only if we're lucky.

- Course introduction and objectives
- How to be an A student
- Motivating problems for course
- Puzzles motivating course

- Modular arithmetic
- Symbolic logic
- Quantifiers
- The satisfiability problem
- Propositions and predicates
- Sets (subsets, powersets, set constructor notation)
- union/intersection/set difference, k-tuples, cross product, empty set)

- Relations
- Properties of binary relations (transitive, symmetric, reflexive, closures)
- Functions (bijective, surjective, injective)
- Cardinality of sets (finite, countably infinite, uncountable)
- How to prove that a set is countable
- How to prove that a set is uncountable—diagonalization
- How to write and structure proofs
- Proving implications
- Why reasoning backwards doesn't work
- Proofs by contradiction
- Induction
- Strong induction
- Summing common series
- Recursion
- Solving recurrences

- Introduction to graphs
- Types of graphs
- Eulerian and Hamiltonian tours

- Introduction to counting

- Bijection, sum, product, and generalized product rules
- Counting one thing by counting another
- Pigeonhole principle and generalizations.
- “Bookkeeper” rule and “stars and bars”
- “Choose” notation
- Approximations of choose notation
- Binomial theorem

- Introduction to probability
- Monty Hall problem
- Definitions: sample spaces and events
- Strange dice
- Conditional probability and Bayes theorem
- Disjoint events versus independent events
- Random variables
- Expectation
- Linearity of expectation
- Coupon collector problem

- Possibly (but probably not): some number theory