

# STOR 215: Course Overview

## Logic I

- simple and compound propositions, truth tables
- basic operations: and, or, not, conditional and biconditional statements
- translation: from logical expressions to English sentences, and vice versa
- logical equivalence, contradiction, tautology

## Logic II

- predicates and quantifiers (universal and existential)
- logical equivalence and De Morgan's rules
- nested quantifiers, negation, and translation
- proofs: direct, contrapositive, contradiction, exhaustive, existence, and equivalence
- formal definitions and basic properties of even and odd integers, rational numbers,

## Inequalities

- basic definitions
- absolute value, minima and maxima

## Sets

- description, subset, element of, emptyset
- basic set operations: union, intersection and complement; disjoint sets.
- De Morgan and distributive laws

## Functions

- domain, range
- image, pre-image
- one-to-one, onto, bijection
- increasing, decreasing
- composition
- addition, and multiplication of functions
- floor and ceiling functions

## Series and summations

- harmonic, geometric, arithmetic series
- recursively defined sequences
- formulas for specific sums
- double sums

## Cardinality of sets:

- finite, countably infinite, and uncountably infinite sets
- examples

## Basic number theory

- divisibility
- the division algorithm, integers modulo  $m$
- modular arithmetic
- prime numbers, the fundamental theorem of arithmetic
- greatest common divisors, least common multiples
- Bezout's Theorem

## Induction

- basic principle, and method of proof
- examples of proofs by induction
- strong induction

## Basic rules of counting

- product rule
- sum rule
- inclusion-exclusion

## Pigeon hole principle

- basic PHP and well ordering principle
- applications
- generalized PHP

## Permutations and combinations

- definitions
- factorial representations

## Binomial coefficients

- basic properties
- binomial theorem
- identities for binomial coefficients (Pascal and Vandermonde)

## More Permutations and Combinations

- dealing hands of cards
- bars and stars: counting solutions of integer equations

## Graph Basics

- definition, directed and undirected graphs, multi-graphs
- adjacency and degree
- handshaking theorem
- special graphs, bipartite graphs
- subgraphs
- unions of graphs
- adjacency

## Matching

- definition
- the “marriage” theorem

## More on Graphs

- graphs isomorphism
- isomorphism invariants

## Connected graphs

- paths and circuits
- connected graphs
- connected components
- counting paths with adjacency matrix

## Majority and Friendship Paradoxes

- discussion and proofs

## Special Paths and Circuits

- Euler paths and circuits
- necessary and sufficient conditions for Euler paths and circuits
- Hamilton paths and circuits
- sufficient conditions for Hamilton circuits

## Planar Graphs

- definition, regions of a planar graph
- Euler's formula
- degree of a region

## Graph Coloring

- chromatic number
- examples
- The Four Color Theorem