

# Combinatorics and Graph Theory Course

## Sample Syllabus

### Day 1

- Honor Code
- Pretest
- Addition and Multiplication Principles
- Combinations and Permutations

### Day 2

- Patterns in Pascal's triangle
- Non-attacking rook configurations
- Counting paths in a grid

### Day 3

- Bijections
- Counting poker hands
- Counting "trains"

### Day 4

- The Pigeon Hole Principle
- Combinatorial Proofs
- Nim

### Day 5

- Combinatorial Interpretations of Fibonacci numbers
- Recurrence Relations
- Towers of Hanoi

### Day 6

- Introduction to graphs
- Regular Graphs and Almost Irregular graphs
- Counting Leaves on Tree Graphs
- Eulerian tours
- Hamiltonian cycles

### Day 7

- Applications of Graph Planarity
- Kuratowski's Theorem
- Euler Characteristic for Connected Planar Graphs
- Edge Bound for Planar Graphs
- Embedding Graphs on the Torus

### Day 8

- Map Coloring
- Proof of the Five-Color Theorem
- Description of Proof, History, and Significance of Four-Color Theorem

### Day 9

- General Graph Coloring
- Scheduling Problems

- Minimum Weight Spanning Trees

#### Day 10

- Set Theory Notation
- Principle of Inclusion-Exclusion
- Chromatic Polynomials of Graphs

#### Day 11

- Counting the Combinations for a 5-Button Simplex Lock
- Stirling numbers of the second kind
- The 12-Fold Way of Combinatorics

#### Day 12

- De Bruijn Sequences
- 12-Fold Way Continued
- Group projects on counting "trains" and presentations

#### Day 13

- Ramsey Numbers
- Matchings
- Augmenting paths
- Chromatic Number of the Plane
- Stable Matchings

#### Day 14

- post test
- Shortest Paths
- Closed Formula for Fibonacci Numbers.

#### Day 15

- Farewells