APPLIED COMBINATORICS

MATH/CSCI 3100/8105

Course Description:

Basic counting methods, generating functions, recurrence relations, principle of inclusion-exclusion. Polya's formula. Elements of graph theory, trees and searching network algorithms. **3 credits**

Prerequisites:

MATH 2030 with a C- or better or MATH 2040 with a C- or better or MATH 2230 with a C- or better. Mathematical logic Set theory Relations Functions Congruences Inductive and recursive definitions Discrete probability Basic knowledge of sets, graphs, trees, and matrices Ability to develop algorithmic solutions and express those solutions in a high-level programming language.

Anticipated Audience/Demand:

The course is designed primarily for third or fourth year majors in computer science or mathematics.

Major Topics:

1) **Basic Counting Techniques**
   a. Fundamental Counting Principles
   b. Permutations and Combinations
   c. Binomial Coefficients

2) **Generating Functions**
   a. Ordinary Generating Functions
   b. Calculating Coefficients of Generating Functions
   c. Partitions
   d. Exponential Generating Functions

3) **Recurrence Relations**
   a. Linear Recurrence Relations
   b. Solutions with Generating Functions
   c. More Recurrence Relations

4) **Principle of Inclusion-Exclusion**
   a. Set-Theoretic Counting Principles
   b. Inclusion-Exclusion Formula
   c. Applications

5) Polya's Theorem
    a. Equivalence Relations
    b. Burnside's Lemma
    c. Polya's Formula

6) Graph Theory
    a. Graph Models
    b. Enumeration of Graphs
    c. Planar Graphs
    d. Representation of Graphs

7) Trees and Searching
    a. Properties of Trees
    b. Enumeration of Trees
    c. Spanning Trees and Graph Algorithm
    d. Tree Analysis of Sorting Algorithms

8) Networks Algorithms
    a. Paths
    b. Minimal Spanning Trees
    c. Network Flows
    d. Matching

Methods:

The class will be presented in a lecture-discussion with student's questions encouraged. Graduate students will be given assignments involving work not expected of undergraduate students.

Student Role:

Students must attend and participate in class and must complete the course requirements.

Textbook:

Grimaldi, Ralph P. *Discrete & Combinatorial Mathematics, 5th ed*. London: Pearson, 2003.

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