

**APPLIED COMBINATORICS
MATH 3100/8105**

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1.0 Course Objectives

- 1.1 Overview of Content and Purpose:** (3 hours) The purpose of this course is to present fundamental counting techniques in mathematics with an emphasis on applications to computer science problems, basic counting methods, generating functions, recurrence relations, principle of inclusion-exclusion. Polya's formula. Elements of graph theory, trees and searching network algorithms. (Same as CSCI 3100/8105)
- 1.2 For whom Intended:** This course is intended for mathematic and computer science students.
- 1.3 Prerequisites:** MATH 2030 or MATH 2040 or MATH 2230
- 1.3 Unusual Circumstances:** None

2.0 Objectives

- 2.1 Performance Objectives for the Students:** The student should be able to solve combinatorial problems using basic counting techniques, generating functions, recurrence relations, inclusion-exclusion, and Polya's Formula. In addition the student should be able to write computer programs involving combinatorial applications in graph theory, trees and searching, and networks.

3.0 Content and Organization

3.1 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

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- 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 Algorithms
 - d) Tree Analysis of Sorting Algorithms
- 8) Networks Algorithms
 - a) Paths
 - b) Minimal Spanning Trees
 - c) Network Flows
 - d) Matching

4.0 Teaching Method

- 4.1 Methods To be Used:** The class will be presented in a lecture-discussion with students' questions encouraged. Graduate students will be given assignments involving work not expected of undergraduate students.

5.0 Evaluation

- 5.1 Basis for Evaluating Student Performances:** Evaluation will be based on examination, homework (both hand problems and solutions using available computer routines,) and computer projects.

6.0 Resource Material

- 6.1 Textbook(s) Or other Required Readings:** Grimaldi, *Discrete and Combinational Mathematics*, Addison Wesley publisher.
- 6.2 Current Bibliography Or resources:** Cohen, D., *Basic Techniques of Combinatorial Theory*, John Wiley, 1978
Knuth, D. E., *The Art of Computer Programming*, Addison-Wesley, 1973
Liu, C.L., *Introduction to Combinatorial Algorithms*, Academic Press, 1968
Nijenhuis, A., and Wilf, H.S., *Combinatorial Analysis*, John Wiley, 1978

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Reinglod, E.M. and Nivergelt, J and Deo, N., *Combinatorial Algorithms*, Hall, 1977.

Riodan, J., *An Introduction to Combinatorial analysis*, John Wiley, 1958.

Tucker, Alan, *Applied Combinatorics*, John Wiley, 1980.