

Computational and Applied Mathematics 3305 -- Discrete Mathematics II

Student Learning Outcomes

- 1. Students will demonstrate factual knowledge of the mathematical notation and terminology used in this course.** Students will demonstrate the ability to read, interpret, and use the vocabulary and methods related to weak and strong induction, algorithms, combinatorics, probability, graph theory, and decision trees.
- 2. Students will demonstrate knowledge of fundamental principles used in decision making and problem solving.** Students will demonstrate the ability to read and comprehend combinatoric methods applied to problems in decision making and graph theory. Students will also demonstrate the ability to apply combinatoric methods as well as weak and strong induction to develop algorithms and basic mathematical proofs.
- 3. Students will apply course material along with techniques and procedures covered in this course to solve problems.** Students will use the knowledge gained in this course to determine appropriate techniques for specific problems in decision theory, and graph theory and to develop and apply algorithms to those problems.
- 4. Students will develop specific skills, competencies, and thought processes sufficient to support further study or work in this field or related fields.** Students will acquire proficiency in the fundamental concepts of graph theory, induction, and combinatorics, at a level necessary for more advanced mathematics courses such as Numerical Analysis, and Probability & Statistics.

Course Content

Textbook: *Foundations of Combinatorics with Applications* Edward A. Bender and S. Gill Williamson, Dover Publications Inc., 2006. (ISBN 0-486-44603-4). This book is also available for free at the following website.

<http://www.math.ucsd.edu/~ebender/CombText/index.html>

1 Basic Counting

1.1 Lists with Repetitions Allowed : Orderings, Using the Rules of Sum and Product

1.2 Lists with Repetitions Forbidden : Stirling's Formula, Anagrams

1.3 Sets : Binomial Coefficients, Card Problems, Error Correcting Codes

1.4 Recursions : Set Partitions

1.5 Multisets : Multiset Formula

2 Functions

2.1 Some Basic Terminology : Terminology for Sets, What are Functions?

2.2 Permutations : Cycle Notation, Parity

2.3 Other Combinatorial Aspects of Functions : Monotonic Functions and Unordered Lists, Image and Coimage, The Pigeonhole Principle

3 Decision Trees

3.1 Basic Concepts of Decision Trees : Rank, Transposition Order

4 Sieving Methods

4.1 The Principle of Inclusion and Exclusion : Bonferroni's Inequalities, Partially Ordered Sets

5 Basic Concepts in Graph Theory

5.1 What is a Graph? : Computer Networks, Simple Graphs

5.2 Equivalence Relations and Unlabeled Graphs

5.3 Paths and Subgraphs

5.4 Trees

5.5 Directed Graphs (Digraphs) : Digraphs and Binary Relations, The Number of Labeled Trees

7 Induction and Recursion

7.1 Inductive Proofs and Recursive Equations : Fibonacci Numbers, Ramsey Theory

7.2 Thinking Recursively : The Induction Theorem, Merge Sorting

9 Rooted Plane Trees

9.1 Traversing Trees : Depth First Traversals

Additional Topics: The following topics can be explored as time permits.

Matrices, 6.1 Spanning Trees, 6.2 Coloring Graphs, 6.3 Planar Graphs, 6.4 Flows in Networks, 6.5 Probability and Simple Graphs, 6.6 Finite State Machines, Turing Machines, Finite State Machines and Digraphs