MATHEMATICS 338
COMBINATORICS

I. Introduction

A. Catalog Description

The study of the basic principles of combinatorial analysis. Topics will include combinations, permutations, inclusion-exclusion, recurrence relations, generating functions and graph theory. Additional material will be chosen from among the following topics: latin squares, Hadamard matrices, designs, coding theory, and combinatorial optimization. *Prerequisite: Math 232*. Satisfies the proof-based requirement in major contracts.

B. Objectives

This course is designed to introduce the student to the basic principles and techniques of combinatorics. After completing the basic material, the instructor can choose from among several topics to use as vehicles for displaying in-depth applications of the basic concepts. In addition to mathematics majors, this course should be useful for computer science majors, and those interested in elementary or secondary education.

C. Prerequisites

The prerequisite is Math 232.

II. Required Topics

A. Basic counting, product and sum rules
B. Combinations and permutations, with repeated or distinct elements
C. Inclusion-Exclusion
D. Recurrence relations, Generating functions
E. Graph Theory
   1. Euler circuits
   2. Hamiltonian paths
   3. Connectivity
   4. Trees
   5. Planar Graphs
   6. Coloring

III. Additional Topics

A. Latin Squares
B. Hadamard Matrices
C. Designs
D. Coding Theory
E. Sphere Packing
F. Systems of Distinct Representatives
G. Combinatorial Optimization
H. Network Flows

IV. Bibliography

The books listed below have been chosen as possible textbooks for the course. Each has a different point of view, emphasizes different topics and they are written at differing levels of difficulty, but most of them cover all the topics listed above as core topics.

Berman, G., Fryer, K.D., Introduction to Combinatorics
Bogart, Kenneth P., Introductory Combinatorics
Brualdi, Richard A., Introductory Combinatorics
Bryant, Victor, Aspects of Combinatorics
Straight, M. Joseph, Combinatorics, An Invitation
Even, Shimon, Algorithmic Combinatorics
Jackson, B.W., Thoro, D., Applied Combinatorics with Problem Solving
Liu, C.L., Introduction to Combinatorial Mathematics
Street, A.P., Wallis, W.D., Combinatorics: A First Course
Tucker, Alan, Applied Combinatorics

The texts below have been chosen as books that a student or instructor of this course might be interested in consulting. Some, like Wilson, are excellent textbooks but their scope is too narrow for this course. Others, like Aigner, are reference texts for researchers and would be beyond the ability of an undergraduate to comprehend. Others are inbetween these two extremes. Vilenkin is noteworthy in that it contains over 400 word problems with solutions.

Aigner, M., Combinatorial Theory
Aigner, M., Graph Theory, A Development from the 4--Color Problem
Balakrishnan, V. K. Combinatorics (Schaum's Outline)
Behzad, M., G. Chartrand, L. Lesniak-Foster, Graphs and Digraphs
Blake & Mullin, An Introduction to Algebraic & Combinatorial Coding Theory
Bollobás, Béla, Modern Graph Theory
Bondy & Murty, Graph Theory and Realted Topics
Cameron & VanLint, Graph Theory, Coding Theory & Block Designs
Capobianco & Molluzzo, Examples and Counterexamples in Graph Theory
Constantine, Gregory M., Combinatorial Theory & Statistical Design
Cohen, D.A., Basic Techniques of Combinatorial Theory
Denes, J., A.D. Keeowell, Latin Squares and Their Applications
Diestel, Reinhard, Graph Theory
Even, Shimon, Graph Algorithms
Foulds, Combinatorial Optimization for Undergraduates
Gross & Tucker, Topological Graph Theory
Hall, Marshall, Combinatorial Theory, 2nd Edition
Harary, F., Graph Theory
Hill, R., A First Course in Coding Theory
MacWilliams, F. & N. Sloane, Theory of Error-Correcting Codes
Polya, G., R.Tarjan, D.Woods, Notes on Introductory Combinatorics
Stanley, R.P., Enumerative Combinatorics
Stanton, W., Constructive Combinatorics
VanLint, Coding Theory
VanLint, J. H. & R. M. Wilson, A Course in Combinatorics
Vilenkin, Combinatorics
Wallis, W.D., Combinatorial Designs
Wells, Elements of Combinatorial Computing
Williamson, S.G., Combinatorics for Computer Science
Wilson, R., Introduction to Graph Theory

V. Requirements

Written exams and homework.