

Course Outline for MATH 4052, Combinatorics II

MATH 4052 Combinatorics II (3 units)

Prerequisite: Graduate standing in Mathematics, MATH 334, or [MATH 3051](#).

Methods of discrete mathematics. Formal power series and generating functions, the exponential formula, integer partitions, permutation statistics, q-analogues, Polya theory, posets, Möbius inversion. Additional concepts may include asymptotics, Lagrange inversion, symmetric functions, rook theory, hypergeometric series, the probabilistic method. 3 lectures. Formerly MATH 435.

Course Learning Objectives	
1	Apply multivariate generating functions to investigate statistics on combinatorial objects.
2	Construct generating functions using the exponential formula.
3	Prove integer partition identities.
4	Interpret q-analogues in the context of permutation statistics.
5	Solve counting problems using Polya theory.
6	Apply Möbius inversion to standard posets.

Expanded Course Content

Textbooks, materials, and/or other resources
1. “generatingfunctionology”, by Herbert Wilf 2. “Combinatorial Enumeration”, by Ian Goulden and David Jackson 3. “Foundations of Combinatorics with Applications”, by Edward Bender and Gill Williamson 4. "The Theory of Partitions", by George E. Andrews 5. “Enumerative Combinatorics, Vol. 1 & 2”, by Richard Stanley 6. “A Course in Combinatorics”, by J.H. van Lint & R. M. Wilson 7. “Counting with Symmetric Functions”, by Anthony Mendes and Jeff Remmel

Week	Readings	Topics of Discussion
1	generatingfunctionology: Chapter 1	Recurrence relations via generating functions, multivariable generating functions
2	generatingfunctionology: Chapter 2	Formal power series
3	generatingfunctionology: Chapter 3	The exponential formula

Week	Readings	Topics of Discussion
4	generatingfunctionology: Chapter 4	Applications of generating functions
5	Enumerative Combinatorics, Vol. 2 Chapter 5.4	Lagrange Inversion
6	Foundations of Combinatorics with Applications: Chapter 11.4	Basic asymptotics of generating functions
7	The Theory of Partitions: Chapter 1	Elementary theory of partitions
8	The Theory of Partitions: Chapter 2	Infinite series generating functions
9	The Theory of Partitions: Chapter 3	q-analogues, permutation statistics
10	A Course in Combinatorics: Chapter 37	Polya theory
11	Enumerative Combinatorics, Vol. 1 Chapter 3.1-3.5	Basic concepts, lattices
12	Enumerative Combinatorics, Vol. 1 Chapter 3.6-3.10	Incidence algebra, Mobius inversion
13	Counting with Symmetric Functions Chapter 2.1, 2.2	Symmetric functions, combinatorial interpretations and combinatorial proofs of symmetric function identities
14	Counting with Symmetric Functions Chapter 2.3, 2.5	Transition matrices
15	Counting with Symmetric Functions Chapter 3	Permutation enumeration and ring homomorphisms

Method of Assessment

The possible methods of assessment are written individual examinations, quizzes, in-class worksheets and presentations, projects, and homework. One or more midterms and a cumulative final exam are required.

Instructional Mode

The instructional mode for this class is face-to-face. This designation means that the essential academic standards of the course require in-class student engagement, and thus remote instruction is not appropriate.