



SYLLABUS

Course Code	Course Num.	Course Name	Credit Hours	Lec.	Lab.	Tut.	Private study	Pre-requisites	Course Level	Teaching Language
MAT	354	Combinatorics and Graphs	4	3	0	2	6	MAT 102 ¹ & MAT 223 ²	6 ³	English

A. Course Description

This course serves to introduce the basic combinatorial techniques such as counting, recursion and linear recurrence equations with emphasis on pigeonhole principle, binomial coefficients, recursive functions, generating functions and homogeneous and non-homogeneous linear recurrences with constant coefficients. It will introduce also the students to graph theory, with emphasis on simple graphs, Euler and Hamiltonian graphs, trees, networks, paths and cycles, graph colorings, and planar graphs and graphs isomorphism.

B. Course Outcomes

At the end of this course the student will be able to:

- Be familiar with Combinatorics and Graph theory.
- Use basics of counting, recursion and recurrence relations.
- Be familiar with graph theory, especially Euler and Hamiltonian graphs, planar graphs, coloring graphs, shortest paths, isomorphism of graphs, spanning trees and network flows.

C. References:

Required Textbook

Discrete Mathematics and its Applications, K. Rosen, McGraw-Hill, 6th Edition, 2006.

Other references:

- *Applied Combinatorics*, Alan Tucker, Wiley; 5th Edition, 2006.
- *Graph Theory*, V. Balakrishnan, Schaum's Outline, McGraw-Hill; 1st Edition, 1997.
- *Graph Theory*, A. Bondy and U. S. R. Murty, Springer, 1st Edition (2007). A free draft version (*Graph Theory with Applications* 1982) is available in Internet.

¹ For the College of Science B.Sc. in Applied Mathematics.

² For the College of Science B.Sc. in Applied Mathematics.

³ For the B.Sc. in Applied Mathematics.



D. Topics Outline

1. **Counting:** Product rule, Sum rule, Inclusion-Exclusion principle, Tree diagrams; Pigeonhole principle, Binomial coefficients.
2. **Recursion:** Recurrence definitions, Set defined recursively, Recursive functions. Recurrence relations, Generating functions, multiplication of generating functions; generalized binomial theorem.
3. **Linear recurrence equations:** Homogeneous and non-homogeneous linear recurrences with constant coefficients.
4. **Introduction to Graph Theory:** Graph terminology, degree of a vertex, simple graphs, paths, cycles, subgraphs, isomorphism of graphs, adjacency matrix, incidence matrix.
5. **Euler & Hamiltonian graphs:** Euler cycle, characterization of Euler graphs. Hamiltonian cycle, properties, Traveling Salesman Problem.
6. **Planar graphs:** Euler's Formula, Kuratowski's theorem. Genus of a graph. Ringel-Youngs theorem.
7. **Graph colorings:** Vertex colorings. Greedy algorithm.
8. **Shortest path:** Shortest path problems; Optimality principle, Dijkstra's algorithm.
9. **Isomorphism of graphs:** Homomorphisms, embedding, and isomorphism of graphs, invariant properties.
10. **Trees:** Spanning trees, minimum spanning trees, Kruskal's algorithm, Prim's algorithm, Greedy algorithm.
11. **Networks flow:** Definitions, flow augmenting paths, cut sets, maximum flow, Ford-Fulkerson algorithm, Minimum cost capacited flow problem.

E. Office Hours

Office hours give students the opportunity to ask in-depth questions and to explore points of confusion or interest that cannot be fully addressed in class.

F. Exams & Grading System

The semi-official dates of the exams for this course are:

- **Midterm 1:** 6th or 7th week.
- **Midterm 2:** 11th or 12th week.
- **Quizzes & Homeworks:** During the semester.
- **Final Exam:** 16th week.

Your course grade will be based on your semester work as follows:

Midterm 1: 20 %	Midterm 2: 20 %	Final Exam: 40 %
Quizzes, Homework, Attendance & Participation: 20 %		



The grading distribution:

A ⁺	A	B ⁺	B	C ⁺	C	D ⁺	D	F
[95, 100]	[90, 95]	[85, 90]	[80, 85]	[75, 80]	[70, 75]	[65, 70]	[60, 65]	[0, 60]

G. Student Attendance/Absence

Only three situations will be considered as possible excused absences:

- Occurrence of a birth or death in the immediate family will be excused. ("Immediate family" is defined by the University as spouse, grandparents, parents, brother, or sister).
- Severe illness in which a student is under the care of a doctor and physically unable to attend class will be excused. Students are not excused for a doctor's appointment. Do not make appointments that conflict with rehearsals. Notes from the University Health Center will be accepted.

Executive Rules for Study Regulations and Exams

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