

## IE 455 Introduction to Combinatorial Analysis - Spring 2024

**Instructor:** Mustafa Kemal Tural ([tural@metu.edu.tr](mailto:tural@metu.edu.tr))  
IE 335

**Assistants:** TBA

**Lecture Hours**  
TBA

**Office Hours**  
TBA

### **Overview:**

Combinatorics is concerned with the existence, enumeration, analysis, and optimization of discrete structures. This course will be an introduction to various topics in combinatorics including but not limited to permutations, combinations, the principle of inclusion-exclusion, recurrences, generating functions, and basic graph theory with applications to problems arising in computer science and operations research. We will also investigate a number of combinatorial games, such as the game of Nim and the Shannon switching game.

### **Course Topics\*:**

- Introduction
  - Combinatorics
  - Counting, existence and optimization problems
- Basics and Counting
  - Pigeonhole principle
  - Permutation and combination
  - Binomial coefficients
- Graph Theory
  - Basics
  - Tree and tree applications
  - Graph coloring and its applications
  - Connectivity
- Generating Functions
  - Models and calculations
  - Partition
  - Exponential generating functions
- Recurrence Relations
  - Models
  - Homogeneous and non-homogeneous recurrence relations
  - Divide-and-conquer relations
- Inclusion-Exclusion
  - Inclusion-exclusion formula
  - Restricted positions
- Existence Problems in Graph Theory
  - Connectedness
  - Eulerian and Hamiltonian structures
- Combinatorial Optimization
  - Matching and covering problems
  - Spanning trees
  - Routing problems

\*This syllabus is subject to change. Changes, if any, will be announced in class. Students will be held responsible for all the changes.

### **Reference books:**

- (1) R.A. Brualdi, *Introductory Combinatorics*, 5<sup>th</sup> edition, Prentice Hall, 2009
- (2) F.S. Roberts, *Applied Combinatorics*, Prentice Hall, 1984
- (3) A. Tucker, *Applied Combinatorics*, 5<sup>th</sup> edition, John Wiley & Sons, NY, 2006

### **Grade Allocation:**

▪ Homework and Quizzes	25%
▪ Attendance	5%
▪ Midterm	30%
▪ Final Exam	40%

### **Attendance**

- Attendance will be taken. Students are required to attend at least 60% of the classes in order to be able to take the final exam.

### **Homework**

- Each homework will carry equal weight. Your semester average for homework will count as 25% of the course grade.
- Each homework will be strictly due at the beginning of class on the due date. **No late homework will be accepted.** Missing homework will receive a grade of zero.
- To receive full credit on homework, you must show all your work neatly, clearly label each problem, and submit a single pdf file with your name and HW # printed on every page. Improperly formatted or illegible scans will not be accepted.

### **Course Website**

The course website is hosted in the 'METU Class' course environment (<https://odtuclass.metu.edu.tr/>).

### **METU Honour Code**

Every member of METU community adopts the following honour code as one of the core principles of academic life and strives to develop an academic environment where continuous adherence to this code is promoted.

"The members of the METU community are reliable, responsible and honourable people who embrace only the success and recognition they deserve, and act with integrity in their use, evaluation and presentation of facts, data and documents."

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