

IE 512 – Graph Theory and Network Flows

Spring 2025

Instructor: Duygu TAŞ KÜTEN

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Office: FENS 1077

Office hours: T 14:40-15:30

Class meeting times and locations: T 11:40-12:30 (FENS L030), R 11:40-13:30 (FASS 1075)

Number of credits: 3 SU credits (10 ECTS credits)

Course Content: Theory and applications of graphs and networks; properties of graphs; Hamiltonian and Eulerian walk problems; travelling salesman problem and variants; design and analysis of shortest path, maximum flow and minimum cost network flow algorithms; matching and assignment; network simplex algorithm.

Objectives: In this course, students will be exposed to various network flow problems. Mainly, applications, basic algorithms and strongly polynomial algorithms will be presented for each type of problem. This course may be interesting for Industrial Engineering, and Computer Science and Engineering graduate students depending on their research interests.

Learning Outcomes: Upon completion of this course the learner is expected to be able to: (i) describe a problem by using graphs and/or networks as an abstract model, (ii) distinguish the main aspects of different network representation approaches, (iii) develop a network representation of the problem by using the abstract graph/network based model, (iv) among shortest path, maximum flow and minimum cost flow problems, identify the type of network flow problem to be solved for the network representation of the problem, (v) analyze the computational complexity of the algorithms for network flow problems, (vi) compare the use of different data structures with respect to their effect on the complexity of the algorithms, and observe the theoretical and empirical differences among the complexities, (vii) associate graph-theoretic problems with their combinatorial structures.

Recommended Textbook: Ahuja, R.K., Magnanti, T.L., and Orlin, J.B. (1993). *Network Flows: Theory, Algorithms and Applications*. Prentice-Hall.

Supplementary Reading Material:

- Aldous, J.M., and Wilson, R.J. (2003). *Graphs and Applications: An Introductory Approach*. Springer Science & Business Media.
- Balakrishnan, V. (1995). *Network Optimization*. Chapman and Hall.
- Bertsekas, D.P. (1998). *Network Optimization: Continuous and Discrete Methods*. Athena Scientific.
- Bertsekas, D.P. (1991). *Linear Network Optimization: Algorithms and Codes*. MIT Press.
- Winston, W.L., and Goldberg, J.B. (2004). *Operations Research: Applications and Algorithms*. Duxbury Press.

Grading:

- Project: 15%
- Midterm Exam: 30%
- Final Exam: 40%
- Assignments: 10%
- Participation: 5%

Rules for attendance: Class participation contributes to 5% of the final grade.

Exams: Closed book and closed notes.

Make-up Policy: A single comprehensive make-up exam will be offered after the final exam to those who have missed the midterm exam or the final exam. A medical report must be e-mailed to the instructor from the Health Center to be eligible for the make-up.

Academic Integrity: Each student in this course is expected to abide by the Sabancı University Academic Integrity Statement (available at <http://www.sabanciuniv.edu/en/academic-integrity-statement>).

Tentative Outline:

- Introduction to networks and graphs
- Review on computational complexity
- Shortest path problem and applications
- Algorithms for shortest path problem
- Maximum flow problem and applications
- Max Flow-Min Cut theorem and Ford Fulkerson algorithm
- Other algorithms for maximum flow problem
- Minimum cost network flow problem and applications
- Optimality conditions and basic algorithms
- Other algorithms for solving minimum cost network flow problems
- Assignment and matching problems
- Minimum spanning trees
- Project/paper presentations

Disclaimer: The instructor reserves the right, when necessary, to alter the grading policy, and modify the syllabus and course content. Modifications will be announced in class and via SUCourse. Students are responsible for the announced changes.