IE 512 - Graph Theory and Network Flows
Spring 2022 Syllabus

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Office hours: TBA

Catalog Description
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, computer science and telecommunications engineering graduate students depending on their research interests.

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

Supplementary Reading Material
- Aldous, Joan M., and Robin J. Wilson. Graphs and Applications: An Introductory Approach. Springer Science & Business Media, 2003.
- Balakrishnan V. Network Optimization, Chapman and Hall, 1995.
- Bertsekas, Dimitri P. Network Optimization: Continuous and Discrete Methods, Athena Scientific, 1998.
- Bertsekas, Dimitri P. Linear Network Optimization: Algorithms and Codes, MIT Press, 1991.
- Winston, Wayne L., and Jeffrey B. Goldberg. Operations Research: Applications and Algorithms, Duxbury Press, 2004.

Course Outline
1. Introduction to networks and graphs
2. Review on computational complexity
3. Shortest path problem and applications
4. Algorithms for shortest path problem
5. Maximum flow problem and applications
6. Max Flow-Min Cut theorem and Ford Fulkerson algorithm
7. Other algorithms for maximum flow problem
8. Minimum cost network flow problem and applications
9. Optimality conditions and basic algorithms
10. Other algorithms for solving minimum cost network flow problems
11. Assignment and matching problems
12. Minimum spanning trees

Learning Outcomes

Upon completion of this course, students should be able to:

- Describe a problem by using graphs and/or networks as an abstract model.
- Distinguish the main aspects of different network representation approaches.
- Develop a network representation of the problem by using the abstract graph/network based model.
- 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.
- Analyze the computational complexity of the algorithms for network flow problems.
- 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.
- Associate graph-theoretic problems with their combinatorial structures.

Grading

Homework	**15%**
Midterm Exam 1	**25%**
Midterm Exam 2	**25%**
Final Exam	**35%**

This syllabus is approximate and can be altered at the discretion of the instructor. Regular attendance is highly recommended. Assignments will be given out on a regular basis.