

# ISE 581 - Graph Theory

Istanbul Bilgi University, Department of Computer Engineering,  
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## Description

Graphs is an excellent tool to represent relational phenomenon in the real world. Modeling of a real world scenario with graph based structure and applying graph algorithms to solve the actual problem opens up important new avenues for solving engineering problems, as well as enabling research considerably. This course covers subjects starting from basic definitions and graph representation, to proofs of essential theorems and analysis of established algorithms, and invites students to abstract over graphs. Students will learn to make judgements about how to represent graphs, possibilities and limitations of graph methods for solving engineering problems. The course has an hands-on component in which students learn to use analysis tools to apply graph based methods to real worlds data sets.

## Learning Objectives

On successful completion of this course, the student should be able to:

- define and classify graphs,
- make judgements about how to represent real world relational systems with a graph,
- understand local and global graph measures and their interpretation,
- learn essential algorithms for analysis and searching of graphs, and complexity of these algorithms,
- apply algorithms and measurements using existing software libraries or by building computer programs on top of them,
- Learn methods for graph visualization, and use existing software to visualize graphs.

## Learning Outcomes

- Ability to develop a representation of a real world phenomenon using a graph, and apply it for use in common graph analysis software.
- Choose appropriate and effective methods and measures to answer questions about graph structure, and apply them with software tools.
- Design and implement algorithms for engineering problems that require graph representations.

## Resources

- Voloshin V. Introduction To Graph Theory. New York: Nova Science Publishers. 2009. Available at: <http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=393233>
- Aldous, Joan M., and Robin J. Wilson. Graphs and applications: an introductory approach. Vol. 1. Springer, 2000.

## Assessment

Quiz x 2 % 40, coursework/assignments %60

## Tentative weekly outline

- Introduction: basic definitions and examples
- Representation and basic graph classes. Paths, trails/walks.
- Adjacency and incidence matrices, bipartite graphs.
- Eulerian and Hamiltonian graphs, in relation to engineering problems.
- Trees and their properties.
- Greedy algorithms for graph search.
- Path algorithms and connectivity.
- Local and global structural measures, information flows in graphs.
- Planarity.
- Graph visualization.
- Groups, and grouping analysis algorithms.