

M011	FIN - obligatory – Semester 1	Graphs	L+P+S 2+2+0	ECTS 5
------	----------------------------------	---------------	----------------	-----------

Course objectives. The main objectives are to teach students of mathematics the fundamental concepts in graph theory and to make them understand basic enumerative ideas and methods in graph theory. Moreover, the course will focus on mathematical definitions and elementary properties related to graphs and their applications.

Course prerequisites. Elementary Mathematics I and II, Combinatorial and Discrete Mathematics.

Syllabus.

1. Introduction. Graphs and their graphic representations. Subgraphs. Paths. Cycles. Graph isomorphism. Graph representations. Special graphs. Graph operations.
2. Connectivity in graphs. Bipartite graphs and trees. Bridges. Spanning trees. Minimum spanning trees (Prim, Kruskal). Separating sets. Menger's theorem.
3. Tours and matchings. Eulerian graphs. Hamiltonian graphs. Closure. Chvatal's condition. Hall's theorem. Tutte's theorem. Stable marriages.
4. Graph colourings. Edge colourings. Chromatic number. Ramsey's theorem. Vertex colouring.
5. Planar graphs. Euler's theorem. Colouring planar graphs. Genus of a graph.
6. Directed graphs. Shortest paths (Dijkstra). Network flows. Max-Flow Min-Cut theorem.

Expected learning outcomes.

After completing the course, students are expected to:

- demonstrate the knowledge and intelligence as the basis for the original work and development of ideas;
- apply their knowledge, understanding and ability to problem solving in a wider context in the area of graph theory;
- be capable of integrating new knowledge in the area of graph theory;
- be able to communicate their conclusions and supporting arguments to both experts and non-experts;
- possess the learning ability for continuing education and lifelong learning in this area.

Teaching methods and student assessment. Lectures will provide analysis and illustration of fundamental concepts in graph theory. Exercises are partially auditory and partially laboratory, with the use of computers. Lectures and exercises are obligatory. The exam consists of two parts. The first part is a hand-written exam. The second part is auditory. The exams are held upon the completion of all lectures and exercises. Acceptable mid-term exam scores replace the written examination. Students can influence their final grade by doing homework or by writing seminar papers.

Can the course be taught in English: Yes.

Basic literature:

1. D. Veljan, *Kombinatorika s teorijom grafova*, Školska knjiga, Zagreb, 1989.
2. T. Harju, *Lecture Notes on Graph Theory*, Department of Mathematics, University of Turku, 2011. (available online)

Recommended literature:

1. J. Gross, J. Yellen, Graph Theory and its Applications, CRC Press, Washington, 1999.
2. G. Chartrand, L. Lesniak, Graphs & Digraphs, Chapman & Hall, London, 1996.
3. F.S. Roberts, Graph Theory and Its Applications to Problems of Society, Society for Industrial and Applied Mathematics, Philadelphia, Pennsylvania, 1978.