MI001	**Graphs and Applications**	L	P	S	ECTS
		2	2	0	6

Course objectives. Introduce students with basic concepts of graph theory with special attention to application in various areas of science and in everyday life. Students will adopt notions and basic results in graph theory through a practical applications. They will model different real-world problems by using special types of graphs.

Prerequisites. Undergraduate university study programme of mathematics and/or computer science.

Course content.

1. Introduction. Graphs: undirected, directed, weighted. Degree of a graph. Subgraph. Special graphs. Graph modeling with application in computer science, physics, chemistry, biology, sociology. Complex networks.
2. Graph isomorphism. Walks. Connectivity. Matrices associated to graphs. Bipartite graphs. Trees. Dijkstra's algorithm. Spanning tree. Kirchhoff's matrix tree theorem. Prim's and Kruskal's algorithms.
3. Vertex and edge cut in a graph. K-connectivity. Menger's theorem. Fan lemma. Eulerian and Hamiltonian graphs. Dirac's and Ore's theorem. Closure of a graph.
4. Matchings in graphs. Berge's , Hall's and Tutte's theorem.
5. Graph vertex and edge coloring. Chromatic polynomial.
6. Planar graphs. Dual graph. Kuratowski graph. Euler's formula. Planar graph coloring. The four color problem. Genus.
7. Directed graphs. The flow network problem.

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Describe basic notions and statements in graph theory.
2.	Connect graph theory to fundamental results from mathematics and computer science.
3.	Recognize various real-world problems that can be modelled by a graph.
4.	Integrate graph theory into problems that arise in different areas of science and in everyday life.
5.	Justify the role of graph theory in complex network analysis.

RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES

TEACHING ACTIVITY	ECTS	LEARNING OUTCOME **	STUDENT ACTIVITY*	EVALUATION METHOD	POINTS	
					min	max
Attending lectures and exercises	0.5	1-5	Lecture attendance, discussion, teams work, independent work on given tasks and short written exams	Attendance lists, tracking activities, closed form exercises	0	4
Homework assignments	1	1-5	Independent work on given problems	Evaluation	0	10

Written exam (Mid-terms)	1.5	1-5	Preparing for written exam	Evaluation	25	43
Final exam	3	1-5	Revision	Oral exam	25	43
TOTAL	6				50	100

Teaching methods and student assessment. Lectures and exercises are obligatory. The exam consists of a written and an oral part. Upon completion of the course, students can take the exam. Successful midterm exam scores replace the written exam. Exercises are both auditory and laboratory. Laboratory exercises include the usage of computers. Students can improve their grades by writing homework assignments and seminars.

Can the course be taught in English: Yes

Basic literature:

1. R. Diestel, Graph Theory, Electronic Edition 2005.
2. D. Veljan, Kombinatorika s teorijom grafova, Školska knjiga, Zagreb, 1989.
3. T. Harju, Lecture Notes on Graph Theory, Department of Mathematics University of Turku, 2011. (available online)
4. M. E. J. Newman, Networks – An Introduction, Oxford University Press, 2010.

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. E. Estrada, The Structure of Complex Networks – Theory and Applications, Oxford University Press, 2012.