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

Course objectives. Introduce students with the concept of graph theory by giving special attention to various applications in different scientific fields and in everyday life. Students will adopt basic definitions and theorems in graph theory through their practical application. They will model real problems by using various types of graphs.

Prerequisities. Undergraduate mathematics or computer science study programme.

Course content.

1. Introduction. Undirected, directed and weighted graphs. Graph degree. Subgraph. Special graphs. Graph as a model with applications in computer science, physics, chemistry, biology, sociology. Complex networks.
2. Graph isomorphism. Walks. Connectivity. Matrices associated to graphs. Bipartite graphs. Trees. Dijsktra algorithm. Spanning tree. Kirchhoff's matrix-tree theorem. Prim's and Kruskal's algorithm.
3. Vertex and edge cut. K-connectivity of a graph. Menger's theorem. Fan lemma. Eulerian and Hamiltonian graph. Dirac's and Ore's theorem. Hamiltonian closure.
4. Matchings in graphs. Berge's, Hall's and Tutte's theorem.
5. Vertex and edge coloring of graphs. Chromatic polynomial.
6. Planar graphs. Dual. Kuratowski graph. Euler's formula. Coloring planar graphs. Four color theorem. Genus.
7. Directed graphs. Maximum flow problem.

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Adopt basic definitions and theorems from graph theory.
2.	Train for integration of new knowledge from graph theory together with some fundamental results from various branches of mathematics and computer science which were previously adopted during undergarduate study programme.
3.	Recognize various real world problems that can be modelled by graphs.
4.	Use graph theory to solve problems arising from different scientific fields and from everyday life.
5.	Understand the importance of graphs in complex system 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	1.5	1-5	Lecture and exercise	Attendance sheets, activities on class,	0	4

			attendance, discussion, team work, independent work on given tasks and short written exams	assigning closed problems		
Homework	1	1-5	Independent work on homework assignments	Checking the correctness of solution	0	10
Written exam (Mid-terms)	1.5	1-5	Preparation for written exam	Checking the correctness of solution	25	43
Final exam	2	1-5	Revision of subject matter	Oral exam	25	43
TOTAL	5				50	100

Teaching methods and knowledge assessment. Attending lectures and exercises is obligatory. The exam consists of written and oral part, and can be taken after completion of lectures and exercises. During the semester students can take preliminary exams that replace the written examination. Exercises are auditory and laboratory. Students can increase their grades by solving homework assignments or by writing seminar papers during semester.

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. (dostupno online)
4. M. E. J. Newman, Networks – An Introduction, Oxford University Press, 2010.

Recomended 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.