SVEUČILIŠTE U RIJECI
ODJEL ZA MATEMATIKU

Sveučilište u Rijeci •Odjel za matematiku
Radmile Matejčić 2 • 51 000 Rijeka • Hrvatska
T: (051) 584-650 • F: (051) 584-699
http://www.math.uniri.hr• e-adresa: math@math.uniri.hr

COURSE SYLLABUS

General information		
Course title	Graph theory	
Study programme	Graduate course Discrete Mathematics and Its Applications	
Year of study	1st	
Course status	Compulsory	
Course homepage	https://moodle.srce.hr/	
Language of instruction	English	
Credit values and modes of instruction	***ECTS credits / student workload***	6
	Hours (L+E+S)	30 + 15 + 15
Lecturer	***Name and surname***	Dean Crnković
	Office	O-310
	Office hours	Upon request
	Phone number	584-651
	E-mail	deanc@math.uniri.hr
Teaching assistant	***Name and surname***	Marina Šimac
	Office	O-525
	Office hours	Tuesday, 8:30-10:00
	Phone number	584-671
	E-mail	msimac@math.uniri.hr

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students acquainted with basic concepts in graph theory and applications of graph theory. For this purpose it is necessary within the course to:

- define basic concepts in graph theory and describe their basic properties,
- define Eulerian and Hamiltonian graph, prove some of their properties and describe its applications,
- define concepts of graph connectivity, analyse properties of connected graphs and the application in constructing reliable communication networks,
- define matching and perfect matching in graphs and elaborate corresponding statements and applications,
- define basic concepts in Ramsey theory for graphs,
- define basic concepts in directed graph theory, elaborate basic properties and some applications,
- analyse and compare certain algorithms.

1.2. Course prerequisites

Discrete Mathematics.

1.3. Learning outcomes

After completing the course, the students are expected to:

- differentiate the concepts and graphs properties, and apply and understand appropriate properties and statements in solving exercises (A7, B7, C7, D7, E5, F7, G7),
- analyse problems of graph connectivity and related properties (A7, B7, C7, D7, E5, F7, G7),
- analyse Eulerian and Hamiltonian graphs and apply and understand the definitions and properties in solving exercises (A7, B7, C7, D7, E5, F7, G7),
- solve problems related to a matching of graphs (A7, B7, C7, D7, E5, F7, G7),
- apply statements and algorithms elaborated within the course (A7, B7, C7, D7, E5, F7, G7),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

1.4. Course content

Concepts and basic properties of graphs. Eulerian tours and Hamiltonian cycles. Chinese postman problem and Fleury's algorithm. Travelling salesman problem. Graph connectivity. Reliable communication networks. Matching in graphs. Perfect matchings. Employment problem and Hungarian matching algorithm. Optimal employment problem and Kuhn-Munkres algorithm. Independent sets, coverings and cliques. Ramsey theory for graphs. Directed graphs. Application to ranking for tournament graphs. Application to one-way street traffic flow. Transport networks. Ford-Fulkerson algorithm. Topological sorting.

1.5. Modes of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☒ e-learning ☐ field work	☒ independent work ☒ multimedia and the internet ☐ laboratory ☒ tutorials ☒ mentoring work ☒ consultative teaching ☐ other
1.6. Comments		

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam.

2. GRADING POLICY

2.1. Grading of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester and on the final exam. The total number of points a student can achieve during the semester is 70. To gain access to the final exam, students are required to achieve at least 50% of the points on each conducted evaluation activity during the semester. Moreover, in order to gain access to the final exam, students have to fulfill the minimal requirements described below. The maximum number of points that can be achieved on the final exam is 30, with the passing score being 50%. The final exam is an oral exam.

Students who achieve between 0% and 49.9%, through all of the activities evaluated, will receive the grade F (Insufficient), they cannot get the ECTS credits and will have to enroll in the course again. The same is true for students who do not pass the final exam during the examination period.

Test (30 points)
During the semester, a test in which students can achieve a maximum of 30 points, will be conducted.

Homework (20 points)
Each student will be assigned four problems to solve. Each homework problem will be scored with 5 points.

Seminar (20 points)

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During the semester students will be assigned a topic for which they should prepare and present a seminar paper. The maximum number of points that can be achieved for this activity is 20.
Final exam (30 points)
The final exam is an oral exam and the maximum number of points that can be achieved on the test is 30. Passing score is 50%.

2.2. Minimal requirements for access to the final exam / passing grade

ACTIVITY	MINIMAL NUMBER OF POINTS REQUIRED
For each activity students are required to achieve at least 50% of the points.	
TOTAL:	
OTHER REQUIREMENTS:	

2.3. Final grade – grading scale

According to the total number of points achieved during the semester and on the final exam, the final grade is determined using the following scale:

GRADE	POINTS
Excellent (5) , A	90% - 100%
Very good (4), B	75% - 89,9%
Good (3), C	60% - 74,9%
Sufficient (2), D	50% - 59,9%
Insufficient (1), F	0% - 49,9%

3. LITERATURE

3.1. Required literature

1. D.Veljan, Kombinatorna i diskretna matematika, Algoritam, Zagreb, 2001.
2. D.Veljan, Kombinatorika s teorijom grafova, Školska knjiga, Zagreb, 1989.

3.2. Recommended literature

1. N.Biggs: Discrete Mathematics, Clarendon Press, Oxford, 1989.
2. R.Diestel: Graph Theory, Fourth edition, Springer-Verlag, New York, 2010.
3. R.Balakrishnan, K.Ranganathan: A Textbook of Graph Theory, Springer-Verlag, Heidelberg, 2000.
4. R.Balakrishnan: Schaum's outline of Graph Theory: Included Hundreds of Solved Problems, McGraw-Hill, New York, 1997.

4. ADDITIONAL INFORMATION

4.1. Class attendance

Students are required to inform themselves about the lectures they did not attend. No disturbance of classes will be tolerated, and usage of cell-phones during classes is forbidden.

4.2. Informing students

All relevant course information will be posted on the course homepage. It is the student's personal responsibility to be regularly informed.

4.3. Other relevant information

Students are expected to have a high degree of independence and responsibility in their work. During the course, an active aproach to learning will be encouraged.

While performing the tasks specified within the course curriculum, students must represent their own work, and they are not allowed to use someone else's text as their own. Submitting work that incorporates someone else's ideas without citation is considered as stealing intellectual property and can be punished according to the university regulations. Students should prepare their work according to the instructions given during the classes.

4.4. Assessment of quality and performance for the course

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Quality of the lectures is assessed in accordance with the regulations of Department of Mathematics and the University of Rijeka. At the end of the semester, an anonymous survey will be conducted, in which students will evaluate the quality of the lectures. Additionally, the department will conduct the analysis of the examination results.

4.5. Examination period

Final exam (1st examination period)	June 16, 2021, 10 a.m.
Final exam (2nd examination period)	July 2, 2021, 10 a.m.
Final exam (3rd examination period)	September 2, 2021, 10 a.m.

5. COURSE OUTLINE*

DATE	*TIME*	*MODE OF INSTRUCTION*	*TOPIC*	*GROUP*	*LECTURE HALL*
2.3.2021.	10:15 – 11:45	E	Introduction to GAP		O-334
5.3.2021.	11:15 – 12:45	L	Concept and basic properties of graphs. Matching in graphs		O-360
9.3.2021.	10:15 – 11:45	E	Concept and basic properties of graphs.		O-334
12.3.2021.	11:15 – 12:45	L	Matching in graphs		O-360
16.3.2021.	10:15 – 11:45	E	Eulerian tours and Hamiltonian cycles		O-334
19.3.2021.	11:15 – 12:45	L	Matching in bipartite graphs		O-360
23.3.2021.	10:15 – 11:45	E	Graph connectivity		O-334
26.3.2021.	11:15 – 12:45	L	Matching in bipartite graphs		O-360
30.3.2021.	10:15 – 11:45	E	Matching in graphs		O-334
6.4.2021	10:15 – 11:45	E	Hungarian matching algorithm. Kuhn-Munkres algorithm		O-334
9.4.2021	11:15 – 12:45	L	Perfect matchings		O-360
13.4.2021	10:15 – 11:45	E	Independent sets, covers and cliques.		O-334
16.4.2021	11:15 – 12:45	L	Employment problem. Hungarian matching algorithm		O-360
20.4.2021	10:15 – 11:45	E	Directed graphs		O-334
23.4.2021	11:15 – 12:45	L	Optimal employment problem		O-360
27.4.2021	10:15 – 11:45	E	Tournaments. Transport networks		O-334
30.4.2021	11:15 – 12:45	L	Kuhn-Munkres algorithm		O-360
4.5.2021.	10:15 – 11:45	E	Ford-Fulkerson algorithm		O-334
7.5.2021.	11:15 – 12:45	L	Independent sets, covers and cliques.		O-360

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			Ramsey theory for graphs		
11.5.2021.	10:15 – 11:45		Test		O-334
14.5.2021.	11:15 – 12:45	L	Directed graphs		O-360
18.5.2021.	10:15 – 11:45	S	Seminars		O-334
21.5.2021.	11:15 – 12:45	L	Tournaments		O-360
25.5.2021.	10:15 – 11:45	S	Seminars		O-334
28.5.2021.	11:15 – 12:45	L	Ranking the tournament players		O-360
1.6.2021.	10:15 – 11:45	S	Seminars		O-334
4.6.2021.	11:15 – 12:45	L	One-way street trafic		O-360
8.6.2021.	10:15 – 11:45	S	Seminars		O-334
11.6.2021.	11:15 – 12:45	L	Transport networks		O-360

**Minor changes are possible.*

L – lectures
E – exercises
S – seminars