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	**Linear programming**	
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 + 30 + 0
Lecturer	***Name and surname***	**Ana jurasić**
	Office	O-304
	Office hours	Upon request
	Phone number	584-662
	E-mail	ajurasic@math.uniri.hr
Teaching assistant	***Name and surname***	**Nina Mostarac**
	Office	O-525
	Office hours	Tuesdays from 14:15-15:45
	Phone number	584-666
	E-mail	nmavrovic@math.uniri.hr

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students familiar with:

- basic types of the linear programming problems
- basic principles and algorithms for solving problems of finding minimum and maximum values
- notions of dual problems of linear programming
- basic notions of the matrix game theory
- basics of convex programming
- basics of integer programming.

1.2. Course prerequisites

None

1.3. Learning outcomes

After completing this course, the students are expected to:

- classify basic convex sets of points in n-dimensional Euclidean space and proper analytical methods of solving linear programming problems (A6, B6, C6, D6, E6, F6)
- apply properties of a linear (affine) function to a linear programming problem with understanding (A6, B6, C6, D6, E6, F6)
- define the goal function in simple linear programming problems (A6, B6, C6, D6, E6, F6)
- apply and understand various algorithms for finding extreme values of a linear function on a convex set (A6, B6, C6, D6, E6, F6)
- solve the dual problem of linear programming (A6, B6, C6, D6, E6, F6)

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- apply and understand the Simplex algorithm (A6, B6, C6, D6, E6, F6)
- analyse the concept of matrix games (A6, B6, C6, D6, E6, F6)
- solve problems of integer programming (A6, B6, C6, D6, E6, F6)
- analyse the basics of convex programming (A6, B6, C6, D6, E6, F6)
- apply the appropriate software package for solving the problems of linear programming (A6,B6,C6,D6,E6,F6).

1.4. Course content

Convex sets in R^n. Polyhedral sets. Gauss-Jordan method for solving system of equations. Basic linear programming problems. Fourier-Motzkin method and some graphical methods for solving linear programming problems. Simplex method. Degeneracy case. Dual simplex method. Parametric linear programming. Duality. Integer linear programming. Transportation problems. Basics of matrix game theory. Basics of convex programming.

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. Exercises from this course will be performed in an auditory form (10 hours) and on computers (20 hours).

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 60.** To gain access to the final exam, students are required to earn at least 50% of the total points during the semester, that is, **30 out of 60 points**. Moreover, in order to gain access to the final exam, students have to fulfill the minimal requirements described in the table below. **The maximal number of points that can be achieved on the final exam is 40**, with the passing score being 50%, that is, **20 out of 40 points**. The final exam is a written 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 within the three attempts offered during the examination period.

METHODS OF EVALUATION AND ASSESMENT OF STUDENTS' WORK DURING THE SEMESTER

MIDTERM EXAMS (48 points total):
During the semester, two 90-minutes long written exams will be conducted, one approximately in the middle of the semester, and one near the end of the semester (we shall refer to both of these exams as "midterms"). On each of these exams a student can achieve at most 24 points. If the necessity arises, there will be one make-up midterm, in the very end of the semester, on which a student can attempt to achieve a better score, replacing a bad score on only one of the above mentioned midterms. Note, however, that if a student decides to use the make-up midterm exam, the grade on the make-up exam will be considered as the final one for that exam, regardless whether it is better or worse than the grade the student was trying to repair.

TESTS (12 points total):
Twice in the semester, there will be homework problems assigned, that students should work on, but they need not submit it. Instead, there will be two short written tests, 20 minutes in duration, containing a problem to solve, either taken directly from the previously assigned homework, or very much like a problem from the previously assigned homework. Each student can earn at most 12 points for their tests in total. **There are no make-ups for missed or low-scoring tests** (even if you miss a quiz for a very legitimate reason), **but there are also no**

minimal requirements for tests, that is, if a student misses all of the quizzes, this student can still qualify for access to final exam if they achieve at least 30 points in total on their two midterm exams.

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

ACTIVITY	MINIMAL NUMBER OF POINTS REQUIRED
Midterm exams	at least 24 (out of 48 points)
Tests	(maximal score of 12 points) there is no minimal requirement, but the points you do not earn on tests (up to a total passing score of 30) must be earned on the two midterm exams
TOTAL:	at least 30
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. R. J. Vanderbei, Linear programming: foundations and extensions, 2nd edition, Princeton University, Princeton, 2001.
2. P. R. Thie, G. E. Keough, An Introduction to Linear Programming and Game Theory, John Wiley & Sons, New Jersey, 2008.

3.2. Recommended literature

1. Korte Bernhard, Combinatorial Optimization: theory and algorithm, Springer-Verlag, Berlin, 2006.
2. P. D. Straffin, Game Theory and Strategy, The Mathematical Association of America, 1993.

4. ADDITIONAL INFORMATION

4.1. Class attendance

Students may be absent from at most 30% of the lectures and at most 30% of exercises. They are required to inform themselves about all classes that they missed. No disturbance of classes will be tolerated, and **the usage of calculators, cell phones or electronic devices of any kind is absolutely forbidden during class.**

4.2. Informing students

All relevant course information will be posted on the course homepage, on merlin.srce.hr. It is the student's personal responsibility to be regularly informed, by checking the course web page and their official email.

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

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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 classes.

4.4. Assessment of quality and performance for the course

Quality of the lectures is assessed in accordance with the regulations of the 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)	**Friday, 26 June 2020**
Final exam (2nd examination period)	**Friday, 10 July 2020**
Final exam (3rd examination period)	**Wednesday, 2 September 2020**

5. COURSE OUTLINE*

DATE	*TIME*	*MODE OF INSTRUCTION*	*TOPIC*	*GROUP*	*LECTURE HALL*
2.3.	***10:15-11:45***	***L***	*Linear Programming and Convexity. The General Problem.*		***O-363***
5.3.	***12:15-13:45***	***E***	*Linear Programming and Convexity. The General Problem.*		***O-335***
9.3.	***10:15-11:45***	***E***	*Introduction to Python*		***O-363***
12.3.	***12:15-13:45***	***L***	*Fourier Motzkin elimination method. Geometry of Linear Programming.*		***O-335***
16.3.	***10:15-11:45***	***E***	*Geometry of Linear Programming.*		***O-363***
19.3.	***12:15-13:45***	***L***	*Equational standard form of linear programming problem.*		***O-335***
23.3.	***10:15-11:45***	***E***	*Fourier Motzkin elimination method. Equational standard form of linear programming problem.*		***O-363***
26.3.	***12:15-13:45***	***L***	*Basic Feasible Solutions and extreme points. Introduction to the Simplex method.*		***O-335***
30.3	***10:15-11:45***	***E***	*Basic Feasible Solutions and extreme points.*		***O-363***
2.4.	***12:15-13:45***	***L***	*Gaus-Jordan elimination. The Simplex method.*		***O-335***
6.4.	***10:15-11:45***	***E***	*Introduction to the Simplex method. Gaus-Jordan elimination.*		***O-363***
9.4.	***12:15-13:45***	***E***	*The Simplex method.*		***O-335***
16.4.	***12:15-13:45***	***L***	*Duality.*		***O-335***
20.4.	***10:15-11:45***	***E***	*Duality.*		***O-363***
23.4.	***12:15-13:45***	***L***	*Dual Simplex.*		***O-335***
27.4.	***10:15-11:45***		**First midterm exam**		***O-363***
30.4.	***12:15-13:45***	***L***	*Sensitivity analisys.*		***O-335***

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4.5.	***10:15-11:45***	***E***	*Dual Simplex.*		***O-363***
7.5.	***12:15-13:45***	***L***	*Integer linear programming. Combinatorial optimization problems.*		***O-335***
11.5.	***10:15-11:45***	***E***	*Sensitivity analisys.*		***O-363***
14.5.	***12:15-13:45***	***L***	*The Transportation problem.*		***O-335***
18.5.	***10:15-11:45***	***E***	*Integer linear programming.*		***O-363***
21.5.	***12:15-13:45***	***L***	*Introduction to Game Theory.*		***O-335***
25.5.	***10:15-11:45***	***E***	*Introduction to Game Theory.*		***O-363***
28.5.	***12:15-13:45***	***L***	*The Fundamental theorem of Game theory.*		***O-335***
1.6.	***10:15-11:45***	***E***	*Game Theory.*		***O-363***
4.6.	***12:15-13:45***	***L***	*Basics of convex programming.*		***O-335***
8.6.	***10:15-11:45***		**Second midterm exam**		***O-363***

**Minor changes are possible.*

L – lectures
E – exercises
S – seminars