



UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Kombinatorična optimizacija
Course title:	Combinatorial optimization

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Matematika	Modul R2	1 ali 2	1 ali 3
Mathematics	Module R2	1 or 2	1 or 3

Vrsta predmeta / Course type

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
45		30			135	7

Nosilec predmeta / Lecturer:

Jeziki / Languages:	Predavanja / Lectures:	SLOVENSKO/SLOVENE
	Vaje / Tutorial:	SLOVENSKO/SLOVENE

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:
Prerequisites:

Vsebina:
Obvezna vsebina, ki pri študentih vzpostavi temeljni nabor znanj s področja kombinatorične optimizacije:

- Večkriterijska linearna optimizacija. Ciljno programiranje. Celoštevilsko programiranje.
- Problem nahrbtnika in njegove različice.
- Pretoki v omrežjih. Ford-Fulkersonov algoritem.
- Problem maksimalnega prirejanja.
- Problem maksimalnega prereza.

Content (Syllabus outline):
Mandatory content, that familiarizes the students with fundamentals of operations research and mathematical programs:

- Multicriteria linear optimization. Goal programming. Integer programming.
- Knapsack problems and its variants.
- Network flows. Ford-Fulkerson's algorithm.
- Maximum matching problem.
- Maximum cut problem.
- Transport problem. Chinese postman problem.

- Transportni problem. Problem kitajskega poštarja. Problem trgovskega potnika.
- Aproksimacijski algoritmi.
- Hevristike in metahevristike. Lokalna optimizacija. Tabu search. Simulirano ohlajanje. Genetski algoritmi. Nevronske mreže. Samo-organizirajoče mreže.

V okviru vsebine študentje izberejo zahtevnejši problem, s katerimi se poglobljeno ukvarjajo pri seminarski nalogi. Problem je povezan z njihovo bodočo kariero (praktični problemi iz gospodarstva, teoretični problemi iz teorije matematičnega programiranja in pripadajočih numeričnih algoritmov). Preostala predavanja se prilagodijo problemom, ki so jih izbrali študentje, in obsegajo vsebine z naslednjega seznama:

- Optimalni portfelj celoštevilskih lotov in celoštevilsko programiranje.
- Problem delovnega zaporedja.
- Problem urnika.
- Problem razporejanja nalog enega in več strojev.
- Problem optimizacije zalog.
- Problemi rezanja in pakiranja.

- Travelling salesman problem.
- Approximation algorithms.
- Heuristics and metaheuristics. Local optimization. Tabu search. Simulated annealing. Genetic algorithms. Neural nets. Self-organized maps.

Within the coursework, the students select smaller problems whose result are coursework reports. The problems are related to their future career (practical problems from industry and business, theoretical problems from the areas of optimization, algorithms, modelling). The content of the remaining lectures is selected according to these projects from the following list:

- Optimal portfolio of integer lots and integer programming.
- Employee timetabling problem.
- School timetabling problems.
- Scheduling tasks of one or several processors.
- Stock optimization.
- Cutting and packing problems.

Temeljni literatura in viri / Readings:

J. Žerovnik: Osnove teorije grafov in diskretne optimizacije, (druga izdaja), Fakulteta za strojništvo, Maribor 2005.

R. Wilson, M. Watkins, Uvod v teorijo grafov, DMFA, Ljubljana 1997.

B. Robič: Aproksimacijski algoritmi, Založba FRI, Ljubljana 2002.

E. Zakrajšek: Matematično modeliranje, DMFA, Ljubljana 2004.

B. Korte, J. Vygen: Combinatorial Optimization, Theory and Algorithms, Springer, Berlin 2000.

D. Cvetković, V. Kovačević-Vujčić: Kombinatorna optimizacija, DOPIS Beograd 1996.

S. Zlobec, J. Petrić: Nelinearno programiranje, Naučna knjiga, Beograd 1989.

E. Kreyszig: Advanced Engineering Mathematics, (seventh edition), Wiley, New York 1993.

Cilji in kompetence:

Usvojiti proces matematičnega modeliranja na diskretnih optimizacijskih problemih.

Razviti kompetenco samostojnega apliciranja matematičnih metod na probleme iz finančne optimizacije, ekonomije, ter širše iz gospodarstva.

Spoznati tehnološka orodja, s katerimi se srečujemo pri reševanju optimizacijskih

Objectives and competences:

Familiarize the students with the process of mathematical modelling of continuous optimization problems.

Develop competent skills of independent application of mathematical methods to the problems from financial optimization, economics, and broader from industry.

Familiarize the students with technological tools

problemov in problemov matematičnega modeliranja.

that assist solving optimization problems and problems related to mathematical modelling.

Predvideni študijski rezultati:

Znanje in razumevanje:

- Razumevanje zahtevnejših principov kombinatorične optimizacije.
- Poglobi znanje iz sodobnih metod za reševanje problemov kombinatorične optimizacije.
- Poglobiti znanje iz diskretnih modelov in drugih zahtevnih aplikacij kombinatorične optimizacije v finančni matematiki, optimiranju virov, in širše

Prenesljive/ključne spretnosti in drugi atributi:

- Direktne aplikacije v finančni matematiki, ekonomiji, poslovnih vedah, inženirstvu, fiziki in številnih drugih družboslovnih in naravoslovnih vedah.
- Suvereno obvladovanje procesa matematičnega modeliranja in uporabe tehnik kombinatorične optimizacije v problemih s področja finančne optimizacije, ekonomije in širše.

Intended learning outcomes:

Knowledge and Understanding:

- To be able to understand advanced principles of combinatorial optimization.
- To deepen the knowledge of modern methods for solving combinatorial optimization problems.
- To deepen the knowledge of details of discrete models and other advanced applications of combinatorial optimization in financial optimization, resource optimization, and wider.

Transferable/Key Skills and other attributes:

- Direct applications in financial mathematics, economy, business, engineering, physics, and numerous other social and natural sciences.
- Competent mastering of the process of mathematical modelling and applications of the techniques of combinatorial optimization in problems from financial optimization, economics, and wider.

Metode poučevanja in učenja:

- Pri predavanjih študentje spoznajo snov predmeta.
- V okviru seminarskih vaj študentje razumevanje snovi utrjujejo na večjem projektu, povezanem z njihovo bodočo kariero. Razporejeni so v večje skupine, ki po metodah problemskega učenja obravnavajo izbrani problem od zbiranja podatkov, preko razvoja modela, izbora in prilagajanja ustreznih tehnoloških rešitev do razmisleka o implementaciji rešitve. Koncept poučevanja je podrobneje predstavljen kot ciljni aplikativni predmet.

Learning and teaching methods:

- At the lectures, the students are familiarized with the course content.
- At the tutorials, the student deepen their understanding of the material by working on an extensive problem related to their future career. They are organized in larger groups who research the chosen problem guided by methodologies of problem-based learning. Within solving the problem, they experience all the stages from requirements and data gathering, model development, selecting and adapting technological solutions to discussing various aspects of implementation of the results.

Načini ocenjevanja:**Assessment:**

<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt) Seminarska naloga Ustni izpit Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.</p> <p>Pozitivna ocena pri seminarski nalogi je pogoj za pristop k izpitu.</p>	<p>Delež (v %) / Weight (in %) 80%, 20%</p>	<p>Type (examination, oral, coursework, project): Coursework report Oral exam</p> <p>Each of the mentioned commitments must be assessed with a passing grade.</p> <p>Passing grade of the seminar exercise is required for taking the exam.</p>
<p>Reference nosilca / Lecturer's references:</p>		
<p>1. ŠPARL, Petra, WITKOWSKI, Rafał, ŽEROVNIK, Janez. 1-local 7/5-competitive algorithm for multicoloring hexagonal graphs. <i>Algorithmica</i>, in press, doi: 10.1007/s00453-011-9562-x. [COBISS.SI-ID 7055123]</p> <p>2. ERVEŠ, Rija, ŽEROVNIK, Janez. Mixed fault diameter of Cartesian graph bundles. <i>Discrete appl. math.</i>. [Print ed.], Available online 10. December 2011, doi: 10.1016/j.dam.2011.11.020. [COBISS.SI-ID 15997718]</p> <p>3. SAU WALLS, Ignasi, ŠPARL, Petra, ŽEROVNIK, Janez. Simpler multicoloring of triangle-free hexagonal graphs. <i>Discrete math.</i>. [Print ed.], str. 181-187. http://dx.doi.org/10.1016/j.disc.2011.07.031. [COBISS.SI-ID 6917907] tipologija 1.08 -> 1.01</p> <p>4. ŠPARL, Petra, WITKOWSKI, Rafał, ŽEROVNIK, Janez. A linear time algorithm for 7-[3]coloring triangle-free hexagonal graphs. <i>Inf. process. lett.</i>. [Print ed.], 2012, vol. 112, iss. 14-15, str. 567-571. http://dx.doi.org/10.1016/j.ipl.2012.02.008. [COBISS.SI-ID 7018003]</p> <p>5. HRASTNIK LADINEK, Irena, ŽEROVNIK, Janez. Cyclic bundle Hamiltonicity. <i>Int. j. comput. math.</i>, 2012, vol. 89, iss. 2, str. 129-136, doi: 10.1080/00207160.2011.638375. [COBISS.SI-ID 15651862]</p>		