Univerza v Mariboru

Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Teorija grafov**
Course title:	Graph theory

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Izobraževalna matematika – enopredmetna, 2. Stopnja		**2.**	**3.**
Educational mathematics - single-major, 2nd degree		**2.**	**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**
30	**15**	**30**			**105**	**6**

Nosilec predmeta / Lecturer: Boštjan BREŠAR

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Jih ni.	None.

Vsebina: **Content (Syllabus outline):**

- Osnovni pojmi in primeri: graf, stopnja, izomorfizem grafov, podgrafi, povezanost, poti in cikli, dvodelni grafi, drevesa, tetivni grafi.
- Prirejanja: prirejanja in pokritja, prirejanja v dvodelnih grafih, prirejanja v splošnih grafih, Hallov poročni izrek.
- Ravninski grafi: risbe grafov, zemljevidi, dualni graf, Eulerjeva formula, izrek Kuratowskega
- Barvanja grafov: barvanja vozlišč, Brooksov izrek, barvanja povezav, barvanja zemljevidov, izrek 4 barv.
- Eulerjevi in Hamiltonovi grafi: problem Konnigsbergških mostov in Eulerjev izrek, Fleuryjev postopek, Hamiltonovi cikli in poti, potrebni in zadostni pogoji za hamiltonskost, usmerjeni grafi in turnirji, problem trgovskega potnika, problem kitajskega poštarja.
- Dodatna poglavja iz barvanja grafov: dokaz Brooksovega izreka, kritični grafi, sodobni koncepti barvanj.
- Druge grafovske invariante: povezanost in k-povezani grafi (dokaz Mengerjevega izreka); omrežja in pretoki v omrežjih; neodvisne in dominirajoče množice.
- Osnove Ramseyeve teorije: število monokromatičnih trikotnikov; Ramseyev izrek; grafovska Ramseyeva števila.

Del snovi bo prilagojen interesom in pobudam študentov ali sproti se porajajočim trendom v teoriji grafov in razvedrilni diskretni matematiki.

- Basic concepts and examples: graph, degree, graph isomorphism, subgraphs, paths and cycles, trees, bipartite graphs, chordal graphs.
- Matchings: matchings and covers, matchings in bipartite graphs, matchings in general graphs, Hall's marrriage theorem,
- Planar graphs: graph drawings, maps, graph dual, Euler's formula, Kuratowski theorem;
- Colourings of graphs: vertex colourings, Brooks' theorem, edge colourings, map colourings, 4 colour theorem.
- Eulerian and hamiltonian graphs: bridges of Konnigsberg problem and Euler's theorem, Fleury's procedure, Hamilton cycles and paths, necessary and sufficient conditions for hamiltonicity, digraphs and tournaments, traveling salesman problem, Chinese postman problem.
- Additional graph colouring topics : proof of Brooks' theorem, critical graphs, modern colouring concepts.
- Other graph invariants: connectivity and k-connected graphs (proof of Menger's theorem); networks and flows in networks; independent and dominating sets.
- Basic Ramsey theory: number of monochromatic triangles; Ramsey theorem; graph Ramsey numbers.

A part of the contents will be adjusted to interests and initiative of students or to newly appearing trends in graph theory and recreational discrete mathematics.

Temeljni literatura in viri / Readings:

- D.B. West: *Introduction to Graph Theory*, Prentice Hall, New Jersey, 2001.
- R. J. Wilson, J. J. Watkins: Uvod v teorijo grafov, DMFA, Ljubljana, 1997.
- R. J. Wilson: *Introduction to graph theory*, Longman, New York, 1987.
- J.A. Bondy and U.S.R. Murty: *Graph Theory*, Springer, London, 2008.

Cilji in kompetence:

Objectives and competences:

Cilj predmeta je seznaniti študente z najpomembnejšimi koncepti teorije grafov in njene uporabe. V okviru seminarja se študent samostojno nauči izbrano snov in pripravi seminarsko predstavitev.	The objective of this course is to acquaint students with the most important concepts in graph theory and its application. For the seminar a student self-reliantly learns a chosen topic and prepares a presentation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku tega predmeta bo študent sposoben izkazati poglobljeno razumevanje osnov teorije grafov, reševati probleme, ki se v teoriji grafov pojavljajo ter pridobljeno znanje uporabljati. Prenesljive/ključne spretnosti in drugi atributi: • *Spretnosti komuniciranja*: ustno izražanje in javni nastop pri seminarju, ustno in pisno izražanje na izpitih • *Reševanje problemov:* reševanje kombinatoričnih in ekstremalnih problemov v teoriji grafov.	Knowledge and Understanding: On completion of this course the student will be able to demonstrate deepened understanding of graph theory basics, solve problems that appear in graph theory and apply the obtained knowledge. Transferable/Key Skills and other attributes: • *Communication skills:* public performance at seminar presentation, manner of expression at exams. • *Problem solving:* solving combinatorial and extremal problems in graph theory.
Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Seminar • Individualno delo	• Lectures • Seminar • Individual work
Načini ocenjevanja:	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt)	Delež (v %) / Weight (in %)	Type (examination, oral, coursework, project):
Seminar Pisni izpit (naloge) Izpit (teorija) Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno. Pozitivna ocena pri seminarju in pisnem izpitu sta pogoja za pristop k izpitu iz teorije	30% 30% 40%	Seminar Written Exam (exercises) Exam (theory) Each of the mentioned commitments must be assessed with a passing grade. Passing grade of the seminar and of the written are required for taking the exam.
Reference nosilca / Lecturer's references:		
1. BOKAL, Drago, BREŠAR, Boštjan, JEREBIC, Janja. A generalization of Hungarian method and Hall's theorem with applications in wireless sensor networks. *Discrete appl. math.*. [Print ed.], 2012, vol. 160, iss. 4-5, str. 460-470. http://dx.doi.org/10.1016/j.dam.2011.11.007. [COBISS.SI-ID		

16191577]

2. BREŠAR, Boštjan, CHALOPIN, Jérémie, CHEPOI, Victor, GOLOGRANC, Tanja, OSAJDA, Damian. Bucolic complexes. *Preprint series*, 2012, vol. 50, št. 1171, str. 1-24. http://www.imfm.si/preprinti/PDF/01171.pdf. [COBISS.SI-ID 16207961]

3. BALAKRISHNAN, Kannan, BREŠAR, Boštjan, CHANGAT, Manoj, KLAVŽAR, Sandi, PETERIN, Iztok, SUBHAMATHI, Ajitha R. Almost self-centered median and chordal graphs. *Taiwan. j. math.*, 2012, vol. 16, no. 5, str. 1911-1922. http://journal.taiwanmathsoc.org.tw/index.php/TJM/article/view/2393/1403. [COBISS.SI-ID 16376409]

4. BREŠAR, Boštjan, KARDOŠ, František, KATRENIČ, Ján, SEMANIŠIN, Gabriel. Minimum k-path vertex cover. *Discrete appl. math.*. [Print ed.], 2011, vol. 159, iss. 12, str. 1189-1195. http://dx.doi.org/10.1016/j.dam.2011.04.008. [COBISS.SI-ID 15929689]

5. BREŠAR, Boštjan, KRANER ŠUMENJAK, Tadeja, TEPEH, Aleksandra. The geodetic number of the lexicographic product of graphs. *Discrete math.*. [Print ed.], 2011, vol. 311, iss. 16, str. 1693-1698. http://dx.doi.org/10.1016/j.disc.2011.04.004. [COBISS.SI-ID 15929945]