Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Diskretna matematika**
Course title:	**Discrete Mathematics**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Matematika, 3. stopnja		**1.**	**2.**
Mathematics, 3rd cycle		**1st**	**2nd**

Vrsta predmeta / Course type izbirni / elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45					**225**	**9**

Nosilec predmeta / Lecturer: Boštjan Brešar

Jeziki / Languages:		
	Predavanja / Lectures:	Slovenski jezik; Slovene
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Poznanje temeljnih konceptov diskretne matematike: klasične in algebraične kombinatorike, teorije grafov, teorije načrtov. Poznavanje osnov linearne algebre, teorije grup, kombinatorike delno urejenih množic.	Basic knowledge of fundamental concepts of discrete mathematics: classical and algebraic combinatorics, graph theory, design theory. Knowledge of basic linear algebra, group theory, combinatorics of partially ordered sets.

Vsebina:

Teorija grafov: hamiltonskost, ravninskost, povezanost, podgrafi, neodvisnost, barvanja, dominacija.

Metrična teorija grafov: konveksnost, produkti in metrične škatle, metrično definirani razredi (delne kocke, ...), kanonična metrična reprezentacija. Algebraični vidiki diskretne matematike: faktorizacije in lastnost krajšanja, razlikovalno število, avtomorfizmi in homomorfizmi.

Uporabe diskretne matematike: matematična kemija, biologija, računalništvo.

Nekatere izmed teh tem so obdelane podrobneje, druge pa le na osnovni ravni. Pri izboru se upoštevajo interesi in raziskovalne usmeritve študentov.

Content (Syllabus outline):

Graph theory: hamiltonicity, planarity, connectivity, subgraphs, independence, colorings, domination.

Metric graph theory: convexity, products and metric boxes, metrically defined classes (partial cubes, ...), canonical metric representation.

Algebraic aspects of discrete mathematics: factorization and cancelation propery, distinguishing number, automorphisms and homomorphisms.

Applications of discrete mathematics: mathematical chemistry, biology, computer science.

Some of these topics are treated in greater details and the others just at a basic level. The selection depends on students' interests and their research orientation.

Temeljni literatura in viri / Readings:

- M. Aigner, Discrete Mathematics, American Mathematical Society, Providence, 2007.
- R. Diestel, Graph Theory, Third Edition, Springer, Berlin, 2005.
- P. Hell, J. Nešetril, Graphs and Homomorphisms, Oxford University Press, Oxford, 2004.
- W. Imrich, S. Klavžar, Product Graphs : Structure and Recognition, Wiley-Interscience, New York, 2000.
- J. Matoušek, J. Nešetril, Invitation to Discrete Mathematics, Oxford University Press, Oxford, 1998.

Dodatna literatura / Additional Readings:

- B. Brešar, M. A. Henning, S. Klavžar, D. F. Rall, Domination games played on graphs, SpringerBriefs in Mathematics, Springer, Cham, 2021.
- J. H. van Lint, R. M. Wilson, A Course in Combinatorics, Cambridge University Press, Cambridge, 2001.
- D. B. West, Introduction to Graph Theory, Second Edition, Prentice Hall, Upper Saddle River, 2001.

Cilji in kompetence:

- Doseči poglobljeno razumevanje teoretskih in metodoloških konceptov s področja diskretne matematike
- Razviti sposobnost samostojnega razvijanja novega znanja s področja diskretne matematike
- Razviti sposobnost za samostojno reševanje najzahtevnejših problemov iz diskretne matematike
- Razviti sposobnost izboljševanja znanih in odkrivanja novih rezultatov s področja diskretne matematike
- Zmožnost razvijanja kritične refleksije na področju diskretne matematike
- Razviti zmožnost vodenja najzahtevnejših znanstvenoraziskovalnih projektov s širšega področja diskretne matematike.

Objectives and competences:

- To achieve a deeper understanding of theoretical and methodological concepts of discrete mathematics
- To develop the ability to independently develop new knowledge in the field of discrete mathematics
- To develop the ability for solving the most challenging problems in discrete mathematics
- To develop the ability of improving known results as well as obtaining new results in discrete mathematics
- Ability to develop critical reflection in discrete mathematics
- To develop the ability to lead the most challenging scientific research projects in the wider field of discrete mathematics

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent bo sposoben: • opredeliti ključne pojme teorije grafov (grafovske invariante, operacije nad grafi…); • navesti glavne definicije in izreke iz metrične in algebraične teorije grafov ; • opisati odnose med različnimi strukturami v diskretni matematiki; • pojasniti vlogo posameznih pojmov pri modeliranju realnih sistemov (kemija, biologija, omrežja); • uporabiti znane izreke in metode za reševanje novih matematičnih problemov v teoriji grafov; • analizirati kompleksne grafovske strukture in ugotavljati njihove lastnosti, • oblikovati nove trditve, izreke ali raziskovalne ideje v teoriji grafov in diskretni matematiki. Prenesljive/ključne spretnosti in drugi atributi: Predmet krepi vrsto spretnosti, ki so uporabne tudi zunaj teoretične matematike, zlasti v računalništvu, podatkovnih znanostih, kemiji, biologiji in inženirstvu: analitično in kritično razmišljanje, abstraktno razmišljanje in formalizacija, raziskovalne in projektne kompetence, komunikacijske veščine.	Knowledge and understanding: The student will be able to: • define the key concepts of graph theory (graph invariants, graph operations…); • state main definitions and theorems from metric and algebraic graph theory; • describe the relations between various structures in discrete mathematics; • explain the role of individual concepts in modelling real-world systems (chemistry, biology, networks); • apply known theorems and methods to solve new mathematical problems in graph theory; • analyse complex graph structures and determine their properties; • formulate new propositions, theorems, or research ideas in graph theory and discrete mathematics. Transferable/Key Skills and other attributes: The course strengthens a variety of skills that are applicable beyond theoretical mathematics, particularly in computer science, data science, chemistry, biology, and engineering: analytical and critical thinking, abstract reasoning and formalisation, research and project-management competencies, and communication skills.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Razlaga, • predavanje, • razgovor, • delo z besedilom, • reševanje problemov.	• Explanation, • lecture, • discussion, • text-based work, • problem solving.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga Teoretični izpit	50 % 50 %	Seminar paper Theoretical exam

Reference nosilca / Lecturer's references:

1. BREŠAR, Boštjan, HEDŽET, Jaka. Bootstrap percolation in strong products of graphs. *The Electronic journal of combinatorics*. [Online ed.]. 2024, vol. 31, iss. 4, article no. p4.35, 22 str. ISSN 1077-8926. https://www.combinatorics.org/ojs/index.php/eljc/article/view/v31i4p35, DOI: 10.37236/11826. [COBISS.SI-ID 215693827], [Odprti dostop, JCR,
kategorija: 1A2

2. BREŠAR, Boštjan, YERO, Ismael G. Lower (total) mutual-visibility number in graphs. *Applied mathematics and computation*. [Print ed.]. Mar. 2024, vol. 465, [article no.] 128411, 11 str., ilustr. ISSN 0096-3003. https://www.sciencedirect.com/science/article/pii/S0096300323005805, DiRROS - Digitalni repozitorij raziskovalnih organizacij Slovenije, DOI: 10.1016/j.amc.2023.128411. [COBISS.SI-ID 169849091], [JCR]
kategorija: 1A1

3. BREŠAR, Boštjan, HENNING, Michael A. Best possible upper bounds on the restrained domination number of cubic graphs. *Journal of graph theory*. Aug. 2024, vol. 106, iss. 4, str. 763–815, graf. prikazi. ISSN 0364-9024. https://onlinelibrary.wiley.com/doi/10.1002/jgt.23095, DiRROS - Digitalni repozitorij raziskovalnih organizacij Slovenije, DOI: 10.1002/jgt.23095. [COBISS.SI-ID 199137795], [JCR]
kategorija: 1A2

4. BREŠAR, Boštjan, JAKOVAC, Marko, ŠTESL, Daša. Indicated coloring game on Cartesian products of graphs. *Discrete applied mathematics*. [Print ed.]. Jan. 2021, vol. 289, str. 320-326. DOI: 10.1016/j.dam.2020.11.007. [COBISS.SI-ID 41803267], [JCR]
kategorija: 1A3

5. BREŠAR, Boštjan, ŠTESL, Daša. The independence coloring game on graphs. *Quaestiones mathematicae*. [Print ed.]. 2021, vol. , no. , str. 1-22. DOI: 10.2989/16073606.2021.1947919. [COBISS.SI-ID 70914307], [JCR]
kategorija: 1A1