



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

| UČNI NAČRT PREDMETA / COURSE SYLLABUS                                                          |                    |                               |                              |                                                                                                     |                               |                      |
|------------------------------------------------------------------------------------------------|--------------------|-------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------|----------------------|
| Predmet:                                                                                       |                    | Teorija množic II             |                              |                                                                                                     |                               |                      |
| Course title:                                                                                  |                    | Set Theory II                 |                              |                                                                                                     |                               |                      |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Študijski program in stopnja<br>Study programme and level                                      |                    | Študijska smer<br>Study field |                              | Letnik<br>Academic year                                                                             |                               | Semester<br>Semester |
| Matematika                                                                                     |                    |                               |                              | 1.                                                                                                  |                               | 2.                   |
| Mathematics                                                                                    |                    |                               |                              | 1.                                                                                                  |                               | 2.                   |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Vrsta predmeta / Course type                                                                   |                    |                               |                              | Obvezni / Compulsory                                                                                |                               |                      |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Univerzitetna koda predmeta / University course code:                                          |                    |                               |                              |                                                                                                     |                               |                      |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Predavanja<br>Lectures                                                                         | Seminar<br>Seminar | Sem. vaje<br>Tutorial         | Lab. vaje<br>Laboratory work | Teren. vaje<br>Field work                                                                           | Samost. delo<br>Individ. work | ECTS                 |
| 30                                                                                             |                    | 30                            |                              |                                                                                                     | 90                            | 5                    |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Nosilec predmeta / Lecturer:                                                                   |                    | Iztok Banič                   |                              |                                                                                                     |                               |                      |
|                                                                                                |                    |                               |                              |                                                                                                     |                               |                      |
| Jeziki /<br>Languages:                                                                         |                    | Predavanja / Lectures:        |                              | SLOVENSKO/SLOVENE                                                                                   |                               |                      |
|                                                                                                |                    | Vaje / Tutorial:              |                              | SLOVENSKO/SLOVENE                                                                                   |                               |                      |
| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:                          |                    |                               |                              | Prerequisites:                                                                                      |                               |                      |
| Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno.  |                    |                               |                              | Each of the mentioned commitments must be assessed with a passing grade.                            |                               |                      |
| Pozitivni oceni pri ustni predstavitvi in pisnem izpitu sta pogoj za pristop k ustnemu izpitu. |                    |                               |                              | Passing grades of the oral presentation and the written exam are required for taking the oral exam. |                               |                      |
| Vsebina:                                                                                       |                    |                               |                              | Content (Syllabus outline):                                                                         |                               |                      |

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| <p><b>Števne in neštevne množice:</b> karakterizacije (ne)števnih množic; unije (ne)števnih množic; Kartezični produkti (ne)števnih množic; alef nič; moč kontinuuma; Cantorjev diagonalni potopek; hipoteza kontinuuma.</p>                                                                                                                                                                                    | <p><b>Countable, uncountable sets:</b> Characterizations of (un)countable sets; unions of (un)countable sets; Cartesian products of (un)countable; aleph-zero; cardinality of the continuum; Cantor's diagonalization method, the continuum hypothesis.</p>                                                                                                                                 |
| <p><b>Aritmetika kardinalnih števil:</b> seštevanje, množenje in potenciranje kardinalnih števil; urejenost kardinalnih števil.</p>                                                                                                                                                                                                                                                                             | <p><b>Arithmetic of Cardinal Numbers:</b> Addition, multiplication, and exponentiation of cardinal numbers; ordering of cardinal numbers.</p>                                                                                                                                                                                                                                               |
| <p><b>Urejene množice:</b> delno urejene množice; linearno urejene množice; monotone funkcije; izomorfizem urejenih množic; leksikografska in antileksikografska ureditev; minimalni in maksimalni elementi; minimum in maksimum; lastnosti linearno urejenih množic; omejene množice; infimum in supremum; verige; goste podmnožice urejenih množic; prerezi; ordinalni tipi; aritmetika ordinalnih tipov.</p> | <p><b>Ordered Sets:</b> Partially ordered sets; linearly ordered sets; monotone functions; isomorphism of ordered sets; lexicographic and antilexicographic order; minimal and maximal elements; minimum and maximum; properties of linearly ordered sets; bounded sets; infimum and supremum; chains; dense subsets of ordered sets; cuts; ordinal types; arithmetic of ordinal types.</p> |
| <p><b>Dobro urejene množice:</b> povezava med principom matematične indukcije in dobre urejenosti naravnih števil; metoda minimalnega protiprimera; regresija; karakterizacija dobro urejenih množic z regresijo; začetni del množice; princip transfinitne indukcije; ordinalna in kardinalna števila; Zermelov izrek in Zornova lema.</p>                                                                     | <p><b>Well-Ordered Sets:</b> connection between the principle of mathematical induction and the well-ordering of the natural numbers; method of the minimal counterexample; Regression; characterization of well-ordered sets via regression; initial segment of a set; principle of transfinite induction; ordinal and cardinal numbers; Zermelo's theorem and Zorn's Lemma.</p>           |



**Temeljni literatura in viri / Readings:**

N.Prijatelj: Matematične strukture I, Ljubljana, Društvo matematikov, fizikov in astronomov Slovenije, 1996

R.R.Stoll: Set theory and logic, New York, Dover Publications, 1979

S.Lipschutz: Schaum's outline of theory and problems of set theory and related topics, New York (etc.), McGraw-Hill, 1998

**Dodatna literatura/Additional Readings:**

V. Matijević, Uvod u Teoriju skupova; Prirodoslovno-matematički fakultet Sveučilišta u Splitu, 2013

D. Goldrei, Classic Set Theory, Chapman & Hall, 1996.

P.Papić. ,Uvod u teoriju skupova, HMD, Zagreb, 2000.

**Cilji in kompetence:**

Obvladati naprednejše pojme in rezultate iz matematične logike in teorije množic in jih uporabljati širše v drugih vejah matematike.

**Objectives and competences:**

Students learn how to use the advanced notions and results of mathematical logic and set theory and how to apply them in other fields of mathematics.

**Predvideni študijski rezultati:**

Znanje in razumevanje:

- Uporaba pojmov matematične logike (izjava, predikat, logične operacije, kvantifikatorja) v teoriji množic
- Uporaba pojmov in rezultatov iz teorije množic (števne in neštevne množice, urejene množice, kardinalna in ordinalna števila ter kardinalna in ordinalna aritmetika, aksiom izbire in njemu ekvivalentni rezultati).

Prenesljive/ključne spretnosti in drugi atributi:

- Pridobljena znanja so osnova za vse druge matematične predmete.

**Intended learning outcomes:**

Knowledge and Understanding:

- Be able to use notions of mathematical logic (propositions, predicates, logical operations, quantifiers) in set theory.
- Be able to use notions and results of set theory (countable and uncountable sets, ordered sets, cardinal and ordinal numbers, cardinal and ordinal arithmetic, axiom of choice and equivalent results)

Transferable/Key Skills and other attributes:

- The obtained knowledge forms a foundation for all the other mathematical subjects.

**Metode poučevanja in učenja:**

- Predavanja
- Teoretične vaje

**Learning and teaching methods:**

- Lectures
- Theoretical exercises

**Načini ocenjevanja:****Assessment:**

|             | Delež (v %) /<br>Weight (in %) |              |
|-------------|--------------------------------|--------------|
| Ustni izpit | 50%                            | Oral exam    |
| Pisni izpit | 50%                            | Written exam |

**Opombe:**

Pisni izpit se lahko nadomesti s kolokviji v enakem deležu 50%.

**Comments:**

Written exam can be replaced by written midterm examination in the weight of 50%.

**Reference nosilca / Lecturer's references:**

1. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A., MOURON, Christopher, NALL, Van. Transitive mappings on the Cantor fan. *Ergodic theory & dynamical systems*. 2025, 35 str. ISSN 0143-3857. <https://doi.org/10.1017/etds.2025.6>, DOI: 10.1017/etds.2025.6.
2. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A., MOURON, Christopher, NALL, Van. Chaos and mixing homeomorphisms on fans. *Journal of difference equations and applications*. 2025, vol. 31, no. 1, 31 str. ISSN 1023-6198. Digitalna knjižnica Univerze v Mariboru – DKUM, DOI: 10.1080/10236198.2024.2384947, DOI: 20.500.12556/DKUM-90072.
3. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A. An embedding of the Cantor fan into the Lelek fan. *Rad Hrvatske akademije znanosti i umjetnosti. Razred za matematičke, fizičke i kemijske znanosti. Matematičke znanosti*. 2025, vol. 29 = 564, str. 221-229. ISSN 1845-4100. <https://doi.org/10.21857/m8vqrt3lk9>, Digitalna knjižnica Univerze v Mariboru – DKUM, DOI: 10.21857/m8vqrt3lk9, DOI: 20.500.12556/DKUM-91938.
4. BANIČ, Iztok, GRIL ROGINA, Rene, KENNEDY, Judy A., NALL, Van. Sufficient conditions for non-zero entropy of closed relations. *Ergodic theory & dynamical systems*. Nov. 2024, vol. 44, iss. 11, str. 3091-3119. ISSN 0143-3857. DOI: 10.1017/etds.2024.11.
5. BANIČ, Iztok, ČREPNIJAK, Matevž, KAC, Teja. Markov set-valued functions on compact metric spaces. *Glasnik matematički. Serija 3*. 2024, vol. 59, no. 1, str. 193-212. ISSN 0017-095X. [https://web.math.pmf.unizg.hr/glasnik/59.1/59\(1\)-09.pdf](https://web.math.pmf.unizg.hr/glasnik/59.1/59(1)-09.pdf), DOI: 10.3336/gm.59.1.09.