



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

|                      |                                       |
|----------------------|---------------------------------------|
| <b>Predmet:</b>      | <b>Izbrana poglavja iz topologije</b> |
| <b>Course title:</b> | <b>Selected Topics in Topology</b>    |

| Študijski program in stopnja<br>Study programme and level | Študijska smer<br>Study field | Letnik<br>Academic year | Semester<br>Semester |
|---|-------------------------------|-------------------------|----------------------|
| Matematika, 2. stopnja                                    |                               | 1. ali 2.               | 1. ali 3.            |
| Mathematics, 2 <sup>nd</sup> cycle                        |                               | 1. or 2.                | 1. or 3.             |

**Vrsta predmeta / Course type**

**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 |
|------------------------|--------------------|-----------------------|------------------------------|---------------------------|-------------------------------|------|
| 45                     |                    | 30                    |                              |                           | 135                           | 7    |

**Nosilec predmeta / Lecturer:**

**Jeziki / Languages:**

|                               |                     |
|-------------------------------|---------------------|
| <b>Predavanja / Lectures:</b> | SLOVENSKO/SLOVENIAN |
| <b>Vaje / Tutorial:</b>       | SLOVENSKO/SLOVENIAN |

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

**Prerequisites:**

**Vsebina:**

Vsebina predmeta se prilagaja aktualnim potrebam in razvoju.

- Poglavja iz splošne topologije:
  - Evklidski prostor. Evklidska topologija.
  - Uryshnonova lema. Tietzejev razširitveni izrek.
  - Mnogoterost. Notranja točka. Robna točka. Notranjost. Rob mnogoterosti.

**Content (Syllabus outline):**

The contents of this subject is adjusted to the current needs and development.

- Topics from general topology:
  - Euclidean space. Euclidean topology.
  - Urysohn lemma. Tietze extension theorem.
  - Manifold. Internal point. Boundary point. Interior. Boundary of a manifold.

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| <p>Sklenjena mnogoterost.</p> <ul style="list-style-type: none"> <li>- Kompaktne mnogoterosti. Povezane mnogoterosti.</li> <li>- Osnovne lastnosti mnogoterosti. Konstrukcije.</li> <li>- Klasifikacija sklenjenih 2-mnogoterosti.</li> </ul> <p>2. Poglavja iz teorije kontinuumov</p> <ul style="list-style-type: none"> <li>- Kontinuumi. Zgledi kontinuumov. Vgnezdjeni preseki. Verige.</li> <li>- Osnovne lastnosti.</li> <li>- Kompozanti.</li> <li>- Posebni primeri kontinuumov. Knasterjev kontinuum, psevdolok, pahljače, grafi.</li> <li>- Hiperprostori. Konvergenca množic.</li> <li>- Inverzna zaporedja. Inverzne limite.</li> </ul> | <p>Closed manifold.</p> <ul style="list-style-type: none"> <li>- Compact manifold. Connected manifold.</li> <li>- Basic properties of manifolds. Constructons.</li> <li>- Classification of closed 2-manifolds.</li> </ul> <p>2. Topics from continuum theory</p> <ul style="list-style-type: none"> <li>- Continua. Examples of continua. Nested intersections. Chains.</li> <li>- Basic properties</li> <li>- Composants.</li> <li>- Special examples. Knaster continuum, pseudoarc, fans, graphs.</li> <li>- Hyperspaces. Convergence of sets.</li> <li>- Inverse sequences. Inverse limits.</li> </ul> |
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#### Temeljni literatura in viri / Readings:

J.R.Munkres: Topology: a first course, Englewood Cliffs, NJ, Prentice-Hall, 1975  
E.H.Spanier: Algebraic topology, New York (etc.), McGraw-Hill, 1966  
S.Lipschutz: Schaum's outline of theory and problems of general topology, New York (etc.), McGraw-Hill, 1965  
P.Pavešić, A.Vavpetič: Rešene naloge iz topologije, Ljubljana, Društvo matematikov, fizikov in astronomov Slovenije, 1997  
M.Cencelj, D.Repovš: Topologija, Ljubljana, Pedagoška fakulteta, 2001  
J. Mrčun: *Topologija*. Izbrana poglavja iz matematike in računalništva 44, Društvo matematikov, fizikov in astronomov - založništvo, Ljubljana, 2008  
S .B. Nadler: Continuum theory: an introduction, Marcel Dekker, New York, 1992  
A. Illanes, S. B. Nadler: Hyperspaces. Fundamentals and recent advances, Marcel Dekker, Inc., New York, 1999  
J. Vrabec: Metrični prostori. Ljubljana: DMFA, 1993.

#### Cilji in kompetence:

Cilj in kompetence tega predmeta so, da študentje usvojijo pojme in metode izbranih poglavij iz topologije (temeljito spoznati klasične izreke evklidskih prostorov; topološke mnogoterosti, njihove lastnosti in konstrukcije; kontinuumov in njihove lastnosti; inverzna zaporedja in inverzne limite kontinuumov), in jih spretno uporabljajo pri raziskovalnem delu in nadaljnjem študiju topologije.

#### Objectives and competences:

The objectives and competences of this course are for students to acquire knowledge of selected topics in topology (to know thoroughly classical theorems of Euclidean spaces; topological manifolds, their properties and constructions; continua and their properties; inverse sequences and inverse limits of continua), and to thoroughly apply it in the further study of topology.

**Predvideni študijski rezultati:**

## Znanje in razumevanje:

Po zaključku tega predmeta bo študent sposoben

- razumeti pojme izbranih poglavij iz topologije.
- razložiti in uporabljati izreke izbranih poglavij iz topologije.
- za reševanje problemov uporabiti izkušnje iz izbranih poglavij topologije.
- razumeti in uporabljati klasične izreke evklidskih prostorov.
- obvladati osnovne koncepte topoloških mnogoterosti in se zavedati pomena odprtih množic v mnogoterosti in njihovih lastnosti.
- razumeti in uporabljati lastnosti kontinuumov.
- razumeti in uporabljati konstrukcijske metode za konstrukcijo novih primerov kontinuumov.

## Prenosljive/ključne spretnosti in drugi atributi:

- Spretnosti komuniciranja: ustni zagovor izpita, pisno izražanje pri pisnem izpitu.
- Uporaba informacijske tehnologije: uporaba računalna ali računalniških aplikacij pri reševanju problemov.
- Reševanje problemov: reševanje problemov s pomočjo metod iz izbranih poglavij iz topologije.
- Uporaba znanja pri samostojnem raziskovalnem delu.
- Prenos znanja obravnavanih metod na druga področja, predvsem na področja analize, kompleksne analize, teorije grafov, geometrije in topologije.

**Metode poučevanja in učenja:**

- Predavanja
- Seminarske vaje
- Individualno delo

**Intended learning outcomes:**

## Knowledge and understanding:

On completion of this course the student will be able to

- understand concepts of selected topics in topology.
- explain and use theorems from selected topics of topology,
- apply experience from selected topics in topology for problem solving.
- understand concepts of classical theorems of Euclidean spaces and know their applications.
- understand concepts of topological manifolds and to be aware of the importance of open sets in manifolds and their properties.
- .be able to understand different properties of continua.
- be able to understand and implement construction methods for constructions of new examples of continua.

## Transferable/Key skills and other attributes:

- Communication skills: oral exam, manner of expression at written examination.
- Use of information technology: use of a calculator or computer applications for problem solving.
- Problem solving: problem solving using methods from selected topics in topology.
- To apply the knowledge and skills to individual research work.
- Knowledge transfer of treated methods into other fields, to analysis, complex analysis, graph theory, geometry and topology.

**Learning and teaching methods:**

- Lectures
- Tutorial
- Individual work

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

|  |                       |   |
|--|-----------------------|---|
| <p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):<br/> <u>Izpit:</u><br/>         Pisni izpit – problemi<br/>         Ustni izpit – teorija</p> <p>Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.</p> <p>Opravljen pisni izpit – problemi je pogoj za pristop k ustnemu izpitu – teorija.</p> <p>Pisni izpit – problemi se lahko nadomesti z enim testom (sprotne obveznosti).</p> | <p>50%</p> <p>50%</p> | <p>Type (examination, oral, coursework, project):<br/> <u>Exam:</u><br/>         Written exam – problems<br/>         Oral exam – theory</p> <p>Each of the mentioned assessments must be assessed with a passing grade.</p> <p>Passing grade of written exam – problems is required to take the oral exam – theory.</p> <p>Written exam – problems can be repalced with one mid-term test.</p> |
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**Reference nosilca / Lecturer's references:**

1. BANIČ, Iztok, TARANENKO, Andrej. Span of a graph : keeping the safety distance. *Discrete mathematics & theoretical computer science*. 2023, vol. 25, no. 1, 19 str. ISSN 1365-8050. DOI: [10.46298/dmtcs.9859](https://doi.org/10.46298/dmtcs.9859). [COBISS.SI-ID [148408835](https://www.cobiss.si/id/148408835)]
2. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A. A transitive homeomorphism on the Lelek fan. *Journal of difference equations and applications*. 2023, 26 str. ISSN 1023-6198. DOI: [10.1080/10236198.2023.2208242](https://doi.org/10.1080/10236198.2023.2208242). [COBISS.SI-ID [151598851](https://www.cobiss.si/id/151598851)]
3. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A. The Lelek fan as the inverse limit of intervals with a single set-valued bonding function whose graph is an arc. *Mediterranean journal of mathematics*. Jun. 2023, vol. 20, iss. 3, article no. 159, 24 str. ISSN 1660-5446. DOI: [10.1007/s00009-023-02323-3](https://doi.org/10.1007/s00009-023-02323-3). [COBISS.SI-ID [148424195](https://www.cobiss.si/id/148424195)]
4. BANIČ, Iztok, ERCEG, Goran, GREENWOOD, Sina, KENNEDY, Judy A. Transitive points in CR-dynamical systems. *Topology and its Applications*. [Print ed.]. 2023, vol. 326, [article no.] 108407, 31 str. ISSN 0166-8641. DOI: [10.1016/j.topol.2023.108407](https://doi.org/10.1016/j.topol.2023.108407). [COBISS.SI-ID [150126083](https://www.cobiss.si/id/150126083)]
5. BANIČ, Iztok, ERCEG, Goran, KENNEDY, Judy A. Mapping theorems for inverse limits with set-valued bonding functions. *Bulletin of the Malaysian Mathematical Sciences Society*. Nov. 2022, vol. 45, iss. 6, str. 2905-2940. ISSN 0126-6705. DOI: [10.1007/s40840-022-01307-y](https://doi.org/10.1007/s40840-022-01307-y). [COBISS.SI-ID [111923203](https://www.cobiss.si/id/111923203)]