Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

| UČNI NAČRT PREDMETA / COURSE SYLLABUS | |
|---|---|
| **Predmet:** | Sistemsko mišljenje |
| **Course title:** | System Thinking |

| Študijski program in stopnja<br>Study programme and level | Študijska smer<br>Study field | Letnik<br>Academic year | Semester<br>Semester |
|---|---|---|---|
| Fizika, 1. stopnja | | **1** | **1** |
| Physics, 1st cycle | | **1** | **1** |

**Vrsta predmeta / Course type** Obvezni / compulsory

**Univerzitetna koda predmeta / University course code:**

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Klinične vaje<br>work | Druge oblike študija | Samost. delo<br>Individ. work | ECTS |
|---|---|---|---|---|---|---|
| **45** | | **30** | | | **105** | **6** |

**Nosilec predmeta / Lecturer:** Marko MARHL

| **Jeziki / Languages:** | | |
|---|---|---|
| | **Predavanja / Lectures:** | **SLOVENSKO / SLOVENE** |
| | **Vaje / Tutorial:** | **SLOVENSKO / SLOVENE** |

| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | **Prerequisites:** |
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| Ni pogojev za vključitev v delo.<br><br>Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Opravljen seminar je pogoj za pristop k pisnemu in ustnemu izpitu. | There are no prerequisites to join the course.<br><br>Each of the listed obligations in the assessment methods must be completed with a positive grade. Completed seminar paper is a prerequisite for taking the written and oral exams. |

| **Vsebina:** | **Content (Syllabus outline):** |
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| 1. Struktura, dinamika in evolucija kompleksnih sistemov v naravi, tehniki in družbi.<br><br>2. Sistemsko mišljenje in modeliranje sistemske dinamike.<br><br>3. Analiza kompleksnega sistema: določitev sistema in njegove okolice, ki ima vpliv na dinamiko sistema (primeri iz fizike; npr. mehanike – izbor sistema in določitev njegove okolice). Razgradnja kompleksnega sistema; prepoznavanje komponent sistema, določitev povezav med deli sistema, medsebojnih vplivov in zunanjih vplivov na sistem.<br><br>4. Kvalitativni opis sistemske dinamike: kavzalni diagrami in diagrami stanj in tokov.<br><br>5. Aplikacije v fiziki in na drugih področjih: populacijska dinamika, okoljevarstvo, dinamika bioloških sistemov, .... | 1. Structure, dynamics and evolution of natural, technical and social complex system.<br><br>2. System Thinking and System Dynamics Modelling.<br><br>3. Analysis of complex system: system determination and taking into account the surrounding that influences the system (examples in Physics, e.g., mechanics – system determination and its surrounding). Decomposition of complex system into components, determining the interrelations between the components, influences between the components and external influences on the system.<br><br>4. Qualitative approaches in system dynamics: causal loop diagrams, stock-flow diagrams.<br><br>5. Applications in Physics and in other fields: population dynamics, environmental systems, biological systems, ... |

**Temeljni literatura in viri / Readings:**

- V. Grubelnik in M. Marhl, Dinamika enodimenzionalnih sistemov, Univerzitetna založba Univerze v Mariboru, Maribor (2024).
- G. Ossimitz, Entwicklung systemischen Denkens, Theoretische Konzepte und empirische Untersuchungen, Profil Verlag, München 2000.
- H. P. Schecker, Physik-Modellieren, Grafikorientierte Modellbildungssysteme im Physikunterricht, Ernst Klett Verlag, Stuttgart (1998).

Dodatna literatura / Additional Readings

- J. W. Forrester, World Dynamics, Wright-Allen Press, Cambridge 1971.
- P.M. Senge, The Fifth Discipline: The Art and Practice of the Learning Organisation. Doubleday, New York 1990.
- P.M. Senge, N. Cambron-McCabe, T. Lucas, B. Smith, J. Dutton, A. Kleiner, Schools that Leatn: A Fifth Discipline Fieldbook for Educators, Parents, and Everyone Who Cares About Education. Doubleday, New York 2000.
- Strokovni in znanstveni članki v revijah / Articles published in professional and scientific journals

| **Cilji in kompetence:** | **Objectives and competences:** |
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| Cilj tega predmeta je, da bodo študenti razumeli osnove delovanja in kompleksnosti sistemov.<br><br>Operativni cilji so:<br><br>• ponazoriti zvezo med strukturo, dinamiko in evolucijo kompleksnih sistemov;<br>• predstaviti odnos med sistemskim mišljenjem in modeliranjem sistemske dinamike;<br>• obdelati celotno kvalitativno analizo dinamike kompleksnih sistemov na enostavnih fizikalnih primerih;<br>• prenos uporabe univerzalnih metod analize s fizikalnih primerov na področja populacijske dinamike, okoljevarstva, bioloških sistemov, ... | The objective of this course is for students to be able to understand the basics of functioning and complexity of systems.<br><br>The operative objectives are:<br><br>• presenting the relationship between the structure, dynamics, and evolution of complex systems;<br>• establishing the relationship between the system thinking and system dynamics modelling;<br>• carrying out the qualitative analysis of system dynamics for simple physical systems;<br>• transfer of using general methods for the analysis of physical systems to other fields, e.g., population dynamics, environment, biological systems, ... |
| **Predvideni študijski rezultati:**<br><br>**Znanje in razumevanje:**<br><br>Po uspešnem zaključku tega predmeta bo študent zmožen:<br><br>• definirati strukturo, dinamiko in evolucijo izbranega kompleksnega sistema;<br>• razložiti strukturo sistema kot posledico sistemske dinamike;<br>• zapisati ključne tokove fizikalnih količin, ki opisujejo dinamiko sistema;<br>• zapisati energijske tokove, ki spremljajo osnovne tokove ekstenzivnih količin;<br>• uporabiti metode za kvalitativno analizo dinamike kompleksnih sistemov na enostavnih fizikalnih primerih.<br><br>**Prenesljive/ključne spretnosti in drugi atributi:**<br><br>Po uspešnem zaključku tega predmeta bo študent zmožen: | **Intended learning outcomes:**<br><br>**Knowledge and understanding:**<br><br>On completion of this course the student will be able to:<br><br>• define the structure, dynamics, and evolution of a given complex system;<br>• explain the structure of a system as a consequence of the system dynamics;<br>• define the key fluxes of physical quantities that are part of the system dynamics;<br>• define the energy fluxes related to the basal fluxes of the extensive quantities;<br>• implement methods for qualitative analysis of system dynamics for simple physical systems.<br><br>**Transferable/Key Skills and other attributes:**<br><br>On completion of this course the student will be able to: |

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| • boljšega komuniciranja na področju naravoslovja;<br>• uporabljati nove informacijske tehnologije: uporaba računalniških programov za modeliranje sistemov;<br>• učinkovitega reševanja problemov: reševanje problemov z uporabo modeliranja dinamike sistemov;<br>• prenesti znanja s primerov iz fizike na področja populacijske dinamike, okoljskih problemov, bioloških sistemov, … | • better communicate in the field of natural sciences;<br>• use modern information technology; in particular, use of computer programs for systems modelling.<br>• effectively solve problems: problem solving with the modelling of systems dynamics.<br>• transfer of knowledge from the examples in physics to other fields, e.g., population dynamics, environment, biological systems, … |

| **Metode poučevanja in učenja:** | **Learning and teaching methods:** |
|---|---|
| • Predavanja<br>• Teoretične vaje<br>• Vaje na računalniku<br>• Eksperimentalne vaje | • Lectures<br>• Theoretical exercises<br>• Computer exercises<br>• Experiments |

| **Načini ocenjevanja:** | Delež (v %) / Weight (in %) | **Assessment:** |
|---|---|---|
| ustni izpit | **40** | Oral exam |
| pisni izpit | **40** | written exam |
| seminarska naloga | **20** | seminar paper |

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

**1.** GRUBELNIK, Vladimir, ZMAZEK, Jan, MARHL, Marko. The synergistic impact of glycolysis, mitochondrial OxPhos, and PEP cycling on ATP production in beta cells. *International journal of molecular sciences*. 2025, vol. 26, iss. 4, 17 str., ilustr. ISSN 1422-0067. https://doi.org/10.3390/ijms26041454, DOI: 10.3390/ijms26041454, DOI: 20.500.12556/DKUM-91817. [COBISS.SI-ID 225604099],
**2.** MANCE KRISTAN, Romana, JURGEC, Staša, POTOČNIK, Uroš, MARHL, Marko, GAŠPERŠIČ, Rok. The association between periodontal inflamed surface area (PISA), inflammatory biomarkers, and mitochondrial DNA copy number. *Journal of clinical medicine*. 2025, vol. 14, iss. 1, [article no.] 24, str. 1-19, ilustr. ISSN 2077-0383. https://www.mdpi.com/2077-0383/14/1/24, DOI: 10.3390/jcm14010024. [COBISS.SI-ID 221396995]
**3.** MARHL, Marko, MARKOVIČ, Rene, GRUBELNIK, Vladimir, PERC, Matjaž. The changing world dynamics of research performance. *Scientometrics*. 2025, vol. 130, str. 469-488. ISSN 1588-2861. DOI: 10.1007/s11192-024-05199-6, DOI: 20.500.12556/DKUM-91828. [COBISS.SI-ID 225609219]
**4.** GRUBELNIK, Vladimir, ZMAZEK, Jan, GOSAK, Marko, MARHL, Marko. The role of anaplerotic metabolism of glucose and glutamine in insulin secretion : a model approach. *Biophysical chemistry*. [Print ed.]. 2024, vol. 311, [article no.] 107270, 16 str., ilustr. ISSN 0301-4622. https://www.sciencedirect.com/science/article/pii/S0301462224000991?via%3Dihub, DOI: 10.1016/j.bpc.2024.107270, DOI: 20.500.12556/DKUM-89024. [COBISS.SI-ID 197803779]
**5.** MARHL, Marko. What do stimulated beta cells have in common with cancer cells?. *Biosystems*. [Print ed.]. Aug. 2024, vol. 242, [article no.] 105257, 11 str. ISSN 0303-2647. DOI: 10.1016/j.biosystems.2024.105257, DOI: 20.500.12556/DKUM-89336. [COBISS.SI-ID 200576771]