



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Fizika kompleksnih sistemov
Course title: Physics of complex systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 2. st.		1	1
Physics 2 nd degree		1	1

Vrsta predmeta / Course type

obvezni/compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		30			120	6

Nosilec predmeta / Lecturer:

Samo Kralj

Jeziki /

Languages:

Predavanja /

Lectures:

slovenski/Slovenian in/and angleški/English

Vaje / Tutorial:

slovenski/Slovenian in/and angleški/English

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

Pogojev ni.

Priporočljiva znanja so: predznanje iz mehanike, elektromagnetizma, matematične fizike, moderne fizike in iz kompleksnih sistemov

Prerequisites:

None.

Recommended: preknowledge of mechanics, electromagnetism, mathematical physics, modern physics, complex systems.

Vsebina:

Content (Syllabus outline):

- Zlom simetrije in vzročnost
- Naključje in nered
- **Fraktali:** fraktalna geometrija, metode določanja fraktalnih dimenzij, modeli rasti fraktalnih vzorcev
- **Samo-organizirana kritičnost:** modelni sistemi, primeri iz narave
- **Fizika mrež:** neprilagodljive in prilagodljive mreže, strukturni prehodi, dinamična rast, primeri mrež v živih in neživih sistemih
- **Fizika vzorcev:** modelni sistemi, analogije med mehanskimi sistemi in živimi organizmi
- **Evolucijska dinamika:** modelni sistemi, teorija iger, univerzalnosti in robustne rešitve, izbrani primeri

- Symmetry breaking and causality
- Uncertainty and disorder
- **Fractals:** fractal geometry, determination of fractal dimensions, models of fractal growth
- **Selforganized criticality:** model systems, examples from the nature
- **Physics of networks:** nonadaptive and adaptive networks, structural transitions, examples
- **Physics of patterns:** model systems, analogies between mechanical and biological systems
- **Evolution dynamics:** model systems, game theory, universalities and robust solutions, examples

Temeljni literatura in viri / Readings:

1. B. Mandelbrot, The Fractal Geometry of Nature, Freeman, San Francisco, 1982.
2. J.F.F. Mendes and N.S. Dorogovtsev, Evolution of Networks: From Biological Nets to the Internet and WWW, Oxford University Press, Oxford, 2003
3. J. M. Smith, Evolution and the Theory of Games, Cambridge Univ. Press, Cambridge, 1982.

Dodatna literatura /Additional Readings:

1. P. Bak, How Nature Works: The Science of Self-Organized Criticality, Springer Verlag, 1996.
2. T. Vicsek, Fractal Growth Phenomena, World Scientific, Singapore, 1992.
3. Članki v Science, Nature, Scientific American

Cilji in kompetence:

Študenti poglobijo znanje s področja fizike kompleksnih sistemov.

Objectives and competences:

Students acquire advanced knowledge on physics of complex systems.

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje in matematično modeliranje ključnih mehanizmov, ki narekujejo obnašanje kompleksnih sistemov.

Prenesljive/ključne spretnosti in drugi atributi:
Rešitev problemov z matematičnimi orodji in celosten pristop k reševanju problemov.

Intended learning outcomes:

Knowledge and Understanding:
Understanding and mathematical modelling of key mechanisms that dominate behavior of complex systems.

Transferable/Key Skills and other attributes:
Solving of problems with mathematical tools and gained global approach on solving a problem.

Metode poučevanja in učenja:

Metodika obsega: teoretičen uvod v problematiko in numerično reševanje posameznih problemov.

Learning and teaching methods:

They are based on: theoretical introduction and numerical solving of specific problems.

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Pisni izpit.	50	Written exam.
Ustni izpit.	50	Oral exam.

Reference nosilca / Lecturer's references:

- 1) 1. HÖLBL, Arbresha, MESAREC, Luka, POLANŠEK, Juš, IGLIČ, Aleš, KRALJ, Samo. Stable assemblies of topological defects in nematic orientational order. ACS omega. 2023, vol. 8, iss. 1, str. 169-179, ilustr. ISSN 2470-1343. DOI: 10.1021/acsomega.2c07174. [COBISS.SI-ID 137430275]
- 2) 2. DOBOVIŠEK, Andrej, AMBROŽIČ, Milan, KUTNJAK, Zdravko, KRALJ, Samo. Liquid crystal based active electrocaloric regenerator. Heliyon. Mar. 2023, vol 9, iss. 3, [article no.] e14035, str. 1-12, ilustr. ISSN 2405-8440.
<https://www.sciencedirect.com/science/article/pii/S2405844023012422?via%3Dihub>, DOI: 10.1016/j.heliyon.2023.e14035. [COBISS.SI-ID 143422211]
3. PAL, Kaushik, ASTHANA, Nidhi, ALJABALI, Alaa AA, BHARDWAJ, Sheetal K., KRALJ, Samo, PENKOVA, Anastasia, THOMAS, Sabu, ZAHEER, Tean, SOUZA, Fernando Gomes de. A critical review on multifunctional smart materials "nanographene" emerging avenue : nano-imaging and biosensor applications. Critical reviews in solid state and materials sciences. 2022, vol. 47, no. 5, str. 691-707, ilustr. ISSN 1040-8436. DOI: 10.1080/10408436.2021.1935717. [COBISS.SI-ID 68095491]