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 2nd 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			150	7

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:	**Prerequisits:**
Pogojev ni. Priporočljiva znanja so:predznanje iz mehanike, elektromagnetizma, matematične fizike, moderne fizike in iz kompleksnih sistemov	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, anlogies between mechanical and biological systems • **Evolution dynamics**: model systems, game theory, universalities and roboust solutions, examples

Temeljni literatura in viri / Readings:

1. B. Mandelbrot, The Fractal Geometry of Nature, Freeman, San Francisco, 1982.
2. P. Bak, How Nature Works: The Science of Self-Organized Criticality, Springer Verlag, 1996.
3. T. Vicsek, Fractal Growth Phenomena, World Scientific, Singapore, 1992.
4. J.F.F. Mendes and N.S. Dorogovtsev, Evolution of Networks: From Biological Nets to the Internet and WWW, Oxford University Press, Oxford, 2003
5. J. M. Smith, Evolution and the Theory of Games, Cambridge Univ. Press, Cambridge, 1982.
6. http://www.nd.edu/~networks/

Članki v Science, Nature, Scientific American

Cilji in kompetence:	**Objectives and competences:**
Študenti poglobijo znanje s področja fizike kompleksnih sistemov.	Students acquire advanced knowledge on physics of complex systems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
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.	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:	Learning and teaching methods:
Metodika obsega: teoretičen uvod v problematiko in numerično reševanje posameznih problemov.	They are based on: theoretical introduction and numerical solving of specific problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni izpit.	50	Written exam.
Ustni izpit.	50	Oral exam.

Reference nosilca / Lecturer's references:

1) AMBROŽIČ, Milan, KRALJ, Samo. Field percolation-switching in soft ternary anisotropic system. Physica. A, Statistical mechanics and its applications, 2019, vol. 520, str. 11-25, doi: 10.1016/j.physa.2018.12.044 [COBISS.SI-ID 24324104].
2) KLEMENČIČ, Eva, TRČEK, Maja, KUTNJAK, Zdravko, KRALJ, Samo. Giant electrocaloric response in smectic liquid crystals with direct smectic-isotropic transition. Scientific reports, 2019, vol. 9, art. no. 1721, str. 1721-1-1721-10, doi: 10.1038/s41598-019-38604-9 [COBISS.SI-ID 32102951].
3) KURIOZ, Pavlo, KRALJ, Marko, MURRAY, Bryce S., ROSENBLATT, Charles, KRALJ, Samo. Nematic topological defects positionally controlled by geometry and external fields. Beilstein journal of nanotechnology, 2018, vol. 9, str. 109-118, https://www.beilstein-journals.org/bjnano/content/pdf/2190-4286-9-13.pdf, doi: 10.3762/bjnano.9.13 [COBISS.SI-ID 23661832].
4) KRAŠNA, Marjan, KLEMENČIČ, Eva, KUTNJAK, Zdravko, KRALJ, Samo. Phase-changing materials for thermal stabilization and thermal transport. Energy, 2018, vol. 162, str. 554-563 [COBISS.SI-ID 24002824].
5) DUBTSOV, Alexander, PASECHNIK, Sergey V., SHMELIOVA, Dina V., SAIDGAZIEV, Ayvr Sh., GONGADZE, Ekaterina, IGLIČ, Aleš, KRALJ, Samo. Liquid crystalline droplets in aqueous environments: electrostatic effects. Soft matter, 2018, vol. 14, iss. 47, str. 9619-9630, doi: 10.1039/C8SM01529E [COBISS.SI-ID 24177416].
6) MESAREC, Luka, KURIOZ, Pavlo, IGLIČ, Aleš, GÓŹDŹ, Wojciech, KRALJ, Samo. Curvature-controlled topological defects. Crystals, 2017, vol. 7, no. 6, str. 1-11, http://www.mdpi.com/2073-4352/7/6/153, doi: 10.3390/cryst7060153 [COBISS.SI-ID 11753556].