Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Nelinearna dinamika**
Course title:	**Nonlinear dynamics**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali 2.	**1., 2. ali 4.**
PHYSICS, 3rd cycle		1. or 2.	**1., 2. or 4.**

Vrsta predmeta / Course type	Izbirni za vse module

Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
10	**5**				**165**	**6**

Nosilec predmeta / Lecturer:	**Marko Robnik**

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Ni posebnih zahtev.	No special prerequisites.

Vsebina:	**Content (Syllabus outline):**

Uvod v dinamiko:

- Avtonomni dinamični sistemi prvega reda
- Linearne transformacije ravnine
- Avtonomni dinamični sistemi drugega reda
- Konservativni hamiltonski sistemi z eno prostostno stopnjo
- Lagrangiani
- Teorije transformacij
- Kotne in akcijske spremenljivke
- Teorije motenj
- Adiabatični in hitri oscilirajoči pogoji
- Linearni sistemi
- Kaotično gibanje in nelinearne preslikave

Uvod v nelinearno dinamiko:

- Uvod in pregled
- Enodimenzionalne preslikave
- Čudni atraktorji (strange attractors) in fraktalna dimenzija
- Dinamične lastnosti kaotičnih sistemov
- Kaotične množice, ki niso atraktorji
- Kvaziperiodičnost
- Kaos v hamiltonskih sistemih
- Kaotični prehodi
- Multifraktali
- Kvantni kaos

Introduction to dynamics:

- Autonomous dynamical systems of first order
- Linear transformations in the plane
- Autonomous dynamical systems of second order
- Conservative Hamiltonian systems with one degree of freedom
- Langragians
- Theory of transformations
- Angle and action variables
- Perturbation theory
- Adiabatic and fast oscillations conditions
- Linear systems
- Chaotic motion and nonlinear mapping

Introduction to nonlinear dynamics:

- Introduction and overview
- Onedimensional mappings
- Strange attractors and fractla dimension
- Dynamical properties of chaotic systems
- Chaotic sets, which are not strange atractors
- Quasiperidodicity
- Chaos in Hamiltonian systems
- Chaotic transitions
- Multifractals
- Quantum chaos

Temeljni literatura in viri / Readings:

1) Percival, I., & Richards, D. (1991). *Introduction to Dynamics* (Repr., str. 228). Cambridge University Press. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/3471112 2) Ott, E. (19932000, cop.). *Chaos in dynamical systems* (Reprinted, str. XII, 385). Cambridge University Press. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/11369224

Dodatna:

Lichtenberg, A. J., & Lieberman, M. A. (1983). *Regular and stochastic motion*. Springer.

LOZEJ, Črt, LUKMAN, Dragan, ROBNIK, Marko. Effects of stickiness in the classical and quantum ergodic lemon billiard. Physical review. E., ISSN 2470-0053, 2021, vol. 103, issue 1, str. 1-12, graf. prikazi, tabele, doi: 10.1103/PhysRevE.103.012204

Cilji in kompetence:

Objectives and competences:

• Razumeti osnove nelinearne dinamike • Pridobiti osnovne izkušnje pri uporabi metod nelinearne dinamike • Rešiti nekaj osnovnih problemov s področja nelinearne dinamike v okviru seminarske naloge	• Understanding the fundamentals of nonlinear dynamics • Gaining the basic experience in applying the methods of nonlinear dyanamics • Solving some fundamental problems in the field of nonlinear dynamics as a seminar report

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • Znanje osnov nelinearne dinamike • Poglobljeno razumevanje principov nelinearne dinamike Prenesljive/ključne spretnosti in drugi atributi: • Sposobnost uporabe metod nelinearne dinamike • Uporaba metod na drugih aplikativnih področjih • Samostojno razvijanje fizikalnega znanja	Knowledge and understanding: • Knowledge of the fundamentals of nolinear dynamics • Understanding the principles of nonlienar dynamics Transferable/Key Skills and other attributes: • Capability of applying the methods of nonlinear dynamics • Application of methods in other applied fields • Development of knew knowledge

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar	Lectures, seminar

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
• Ustni izpit	**50%**	• Oral exam
• Pisni izpit	**50%**	• Written exam

Reference nosilca / Lecturer's references:

1. GRUBELNIK, Vladimir, LOGAR, Marjan, ROBNIK, Marko. Quantum Fermi acceleration in the resonant gaps of a periodically driven one-dimensional potential box. *Journal of physics. A, Mathematical and theoretical*, ISSN 1751-8113, 2014, vol. 47, no. 35, str. 355103-1 - 355103-17, doi: 10.1088/1751-8113/47/35/355103. [COBISS.SI-ID 18017814]

2. MANOS, Thanos, ROBNIK, Marko. Survey on the role of accelerator modes for anomalous diffusion : the case of the standard map. *Physical review. E, Statistical, nonlinear and soft matter physics*, ISSN 1550-2376. [Online ed.], 2014, vol. 89, iss. 2, str. 022905-1 - 022905-12, graf. prikazi, doi: 10.1103/PhysRevE.89.022905. [COBISS.SI-ID 77280257]

3. ANDRESAS, Dimitris, BATISTIĆ, Benjamin, ROBNIK, Marko. Statistical properties of one-dimensional parametrically kicked Hamilton systems. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2014, vol. 89, no. 6, str. 062927-1-062927-14, graf. prikazi, doi: 10.1103/PhysRevE.89.062927. [COBISS.SI-ID 78977281]

4. BATISTIĆ, Benjamin, MANOS, Thanos, ROBNIK, Marko. The intermediate level statistics in dynamically localized chaotic eigenstates. *Europhysics letters*, ISSN 0295-5075, 2013, vol. 102, no. 5, str. 50008-1-50008-6. http://iopscience.iop.org/0295-5075/102/5/50008/pdf/0295-5075_102_5_50008.pdf, doi: 10.1209/0295-5075/102/50008. [COBISS.SI-ID 74806017]

5. BATISTIĆ, Benjamin, ROBNIK, Marko. Dynamical localization of chaotic eigenstates in the mixed-type systems: spectral statistics in a billiard system after separation of regular and chaotic eigenstates. *Journal of physics. A, Mathematical and theoretical*, ISSN 1751-8113, 2013, vol. 46, no. 31, str. 315102-1-315102-17. http://iopscience.iop.org/1751-8121/46/31/315102/pdf/1751-8121_46_31_315102.pdf, doi: 10.1088/1751-8113/46/31/315102. [COBISS.SI-ID 75147009]

6. MANOS, Thanos, ROBNIK, Marko. Dynamical localization in chaotic systems: spectral statistics and localization measure in the kicked rotator as a paradigm for time-dependent and time-independent systems. *Physical review. E, Statistical, nonlinear and soft matter physics*, ISSN 1550-2376. [Online ed.], 2013, vol. 87, iss. 6, str. 062905-1 - 062905-17, graf. prikazi. http://pre.aps.org/pdf/PRE/v87/i6/e062905, doi: 10.1103/PhysRevE.87.062905. [COBISS.SI-ID 74771713]