



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, 3 rd 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:

Vaje / Tutorial:

slovenski/Slovenian in/and angleški s slovenskim
prevodom/English with translation in Slovenian

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

Ni posebnih zahtev.

Prerequisites:

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
- Lagrangians
- 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 fractal dimension
- Dynamical properties of chaotic systems
- Chaotic sets, which are not strange attractors
- Quasiperiodicity
- Chaos in Hamiltonian systems
- Chaotic transitions
- Multifractals
- Quantum chaos

Temeljni literatura in viri / Readings:

- 1) I. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press, 1982.
- 2) E. Ott, Chaos in Dynamical Systems, Cambridge University Press, 1993.
- 3) A.J. Lichtenberg and M.A. Leiberman, Regular and Stochastic Motion, Springer, 1983.

Cilji in kompetence:

- Razumeti osnove nelinearne dinamike
- Pridobiti osnovne izkušnje pri uporabi metod nelinearne dinamike
- Rešiti nekaj osnovnih problemov s področja nelinearne dinamike v okviru seminarske naloge

Objectives and competences:

- Understanding the fundamentals of nonlinear dynamics
- Gaining the basic experience in applying the methods of nonlinear dynamics
- Solving some fundamental problems in the field of nonlinear dynamics as a seminar report

Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanje in razumevanje:</p> <ul style="list-style-type: none"> • Znanje osnov nelinearne dinamike • Poglobljeno razumevanje principov nelinearne dinamike <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> • Sposobnost uporabe metod nelinearne dinamike • Uporaba metod na drugih aplikativnih področjih • Samostojno razvijanje fizikalnega znanja 	<p>Knowledge and understanding:</p> <ul style="list-style-type: none"> • Knowledge of the fundamentals of nonlinear dynamics • Understanding the principles of nonlinear dynamics <p>Transferable/Key Skills and other attributes:</p> <ul style="list-style-type: none"> • Capability of applying the methods of nonlinear dynamics • Application of methods in other applied fields • Development of new knowledge
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Metode poučevanja in učenja:

Predavanja, seminar

Learning and teaching methods:

Lectures, seminar

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt)</p> <ul style="list-style-type: none"> • Ustni izpit • Pisni izpit 	<p>50%</p> <p>50%</p>	<p>Type (examination, oral, coursework, project):</p> <ul style="list-style-type: none"> • Oral exam • Written exam

Reference nosilca / Lecturer's references:

- 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](https://doi.org/10.1088/1751-8113/47/35/355103). [COBISS.SI-ID [18017814](#)]
- 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](https://doi.org/10.1103/PhysRevE.89.022905). [COBISS.SI-ID [77280257](#)]
- 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](https://doi.org/10.1103/PhysRevE.89.062927). [COBISS.SI-ID [78977281](#)]
- 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](https://doi.org/10.1209/0295-5075/102/50008). [COBISS.SI-ID [74806017](#)]
- 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: [10.1088/1751-8121/46/31/315102](https://doi.org/10.1088/1751-8121/46/31/315102). [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](https://doi.org/10.1103/PhysRevE.87.062905).

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