



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Izbrana poglavja iz diferencialnih enačb
Course title:	Differential equations – selected topics

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
15					165	6

Nosilec predmeta / Lecturer:

Valerij Romanovskij

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:

Navadne diferencialne enačbe:

- diferencialne enačbe 1. reda
- diferencialne enačbe 2. reda
- približne rešitve linearnih diferencialnih enačb
- približne rešitve nelinearnih diferencialnih enačb

Content (Syllabus outline):

Ordinary differential equations:

- first order ODE
- second order ODE
- approximate solutions of linear differential equations
- approximate solutions of nonlinear differential equations

- regularna in singularna perturbacijska teorija
- perturbacijske metode za probleme lastnih vrednosti
- aproksimacije WKB
- problem dveh zavojnih točk

Metode bifurkacijske teorije:

- tokovi in invariantni subprostori
- linearne in nelinearne preslikave
- normalne forme diferencialnih enačb in preslikav
- bifurkacije ravnovesne lege
- bifurkacije periodičnih orbit
- • uvod v kaos

- regular and singular perturbation theory
- perturbations methods for the eigenvalues problem
- WKB approximations
- the two turn points problem

Some methods of the theory of Bifurcations:

- flows and invariant subspaces
- linear and nonlinear maps
- normal forms of differential equations and maps
- bifurcations of singular points
- bifurcations of periodic orbits
- an introduction to chaos

Temeljni literatura in viri / Readings:

- 1) D.K. Arowsmith, C.M. Place, Dynamical systems. Differential equations, maps and chaotic behaviour, Chapman and Hall Mathematics Series, Chapman & Hall, London 1992.
- 2) C. M. Bender, S. A. Orszag, Advanced mathematical methods for scientists and engineers, International series in pure and applied mathematics, McGraw-Hill Book Co., New York 1978.
- 3) S. N. Chow, J. K. Hale, Methods of bifurcation theory, Grundlehren der Mathematischen wissenschaften, 251. Springer-Verlag, New York – Berlin 1982.
- 4) J. Guckenheimer, P. Holmes, Nonlinear oscillations, dynamical systems and bifurcations of vector fields, Applied Mathematical sciences, 42, Springer-Verlag, New York 1983.
- 5) Yu. A. Kuznetsov, Elements of Applied Bifurcation Theory, Springer, 2004.
- 6) L. Barreira, C. Valls, Dynamical Systems, Universitext, Springer, 2014.

Cilji in kompetence:

- Razumevanje osnovnih načinov kvalitativne in bifurkacijske analize diferencialnih enačb
- Poznavanje metod študija lastnosti rešitev diferencialnih enačb in gladkih preslikav
- Pridobiti si sposobnost detajlne analize določenih matematičnih modelov opisanih z navadnimi diferencialnimi enačbami ali gladkimi preslikavami

Objectives and competences:

- Understanding of main approaches to the qualitative and bifurcational analysis of differential equations
- Gaining knowledge of methods of studying the properties of solutions of differential equations and smooth maps
- Gaining skills of detail analysis of certain mathematical model described by ordinary differential equations or smooth maps

Predvideni študijski rezultati:

Znanje in razumevanje:

- Razumevanje metod kvalitativne in bifurkacijske analize dinamičnih sistemov
- Pridobivanje sposobnosti sistematskega študija rešitev dinamičnih sistemov in njihovih lastnosti

Prenesljive/ključne spretnosti in drugi atributi:

- Uporaba znanja za študij matematičnih modelov različnih procesov in pojavov v fizikalni, tehnični in drugih uporabnih znanostih
- Sposobnost razumevanja in analiziranja dinamičnih procesov opisanih z diferencialnimi enačbami in gladkimi preslikavami

Intended learning outcomes:

Knowledge and understanding:

- Understanding of methods of qualitative and bifurcational analysis of dynamical systems
- Gaining some systematical approaches to studying of solutions of dynamical systems and their properties

Transferable/Key Skills and other attributes:

- The use of knowledge for studying of mathematical models of various processes and phenomena arising in physical, technical and other applied sciences
- The ability to understand and analyse the dynamics of processes described by differential equations and smooth maps

Metode poučevanja in učenja:

Predavanja, seminar

Learning and teaching methods:

Lectures, seminar

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)

- Ustni izpit
- Pisni izpit

Delež (v %) /

Weight (in %) /

Assessment:

Type (examination, oral, coursework, project):

- Oral exam
- Written exam

Reference nosilca / Lecturer's references:

DE GAETANO, Andrea, NAGY, Ilona, KISS, Daniel, ROMANOVSKI, Valery. A simplified longitudinal model for the development of Type 2 Diabetes Mellitus. Journal of theoretical biology. June 2024, vol. 587, [article no.] 111822, 17 str., ilustr. ISSN 0022-5193. DOI: 10.1016/j.jtbi.2024.111822. [COBISS.SI-ID 195458307]

DREXLER, Dániel András, NAGY, Ilona, ROMANOVSKI, Valery. Stability analysis of the singular points and Hopf bifurcations of a tumor growth control model. Mathematical methods in the applied sciences. 15 May 2024, vol. 47, iss. 7, str. 5677-5691. ISSN 1099-1476.

<https://dk.um.si/IzpisGradiva.php?id=89788>, Digitalna knjižnica Univerze v Mariboru – DKUM, DOI: 10.1002/mma.9885. [COBISS.SI-ID 184526595]

XIA, Yong-Hui, GRAŠIČ, Mateja, HUANG, Wentao, ROMANOVSKI, Valery. Limit cycles in a model of olfactory sensory neurons. International journal of bifurcation and chaos in applied sciences and engineering, ISSN 0218-1274, 2019, vol. 29, no. 3, str. 1950038-1-1950038-9, doi: 10.1142/S021812741950038X.