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, 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
15					**165**	**6**

Nosilec predmeta / Lecturer:	**Valerij Romanovskij**

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):**
Navadne diferencialne enačbe: • diferencialne enačbe 1. reda • diferencialne enačbe 2. reda • približne rešitve linearnih diferencialnih enačb • približne rešitve nelinearnih diferencialnih enačb	Ordinary differential equations: - first order ODE - second order ODE - approximate solutions of linear differential equations - approximate solutions of nonlinear differential equations

• reguarna in singularna perturbacijska teorija • perturbacijske metode za probleme lastnih vrednosti • aproksimacije WKB • problem dveh zavojnih točk <u>Metode bifurkacijske teorije:</u> • 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 <u>Some methods of the theory of Bifurcations:</u> • 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) Kuznecov, J. A. (1998). *Elements of applied bifurcation theory* (2nd ed., Let. 112, str. XIX, 591). Springer.
2) Barreira. (2019). *Dynamical Systems by Example*. Springer International Publishing. **Celotno besedilo dostopno v SpringerLink Books**

Dodatna:

3) D.K. Arowsmith, C.M. Place, Dynamical systems. Diferential equations, maps an chaotic behaviour, Chapman and Hall Mathematics Series, Chapman & Hall, London 1992.
4) 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.
5) S. N. Chow, J. K. Hale, Methods of bifurcation theory, Grundlehren der Mathematischen wissenschaften, 251. Springer-Verlag, New York – Berlin 1982.
6) J. Guckenheimer, P. Holmes, Nonlinear oscillations, dynamical systems and bifurcations of vector fields, Applied Mathematical sciences, 42, Springer-Verlag, New York 1983.
7) 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.

Cilji in kompetence: **Objectives and competences:**

• 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	• Understanding of main approaches to the qualitative and bifurcational analysis of differential equations • Gaining knowledege 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:	**Intended learning outcomes:**
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	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:	**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:

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]

ARCET, Barbara, ROMANOVSKI, Valery. Integrability and linearizability of symmetric three-dimensional quadratic systems. Discrete and continuous dynamical systems. Series S. 2023, vol. 16, issue 3-4, str. 361-378. ISSN 1937-1632. DOI: 10.3934/dcdss.2022104. [COBISS.SI-ID 130109955],