Univerza v Mariboru
Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Diferencialne enačbe
Course title:	Differential Equations

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Matematika, 3. stopnja		**1.**	**2.**
Mathematics, 3rd cycle		**1st**	**2nd**

Vrsta predmeta / Course type obvezni ali izbirni/compulsory or elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45					225	9

Nosilec predmeta / Lecturer: Valerij Romanovskij

Jeziki / **Languages:**	**Predavanja /** **Lectures:**	Slovenski / Slovene
	Vaje / Tutorial:	

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

Prerequisits:

Znanje osnovnih pojmov in rezultatov iz teorije NDE

Basic knowledge of fundamental notions and results of the theory of ODE's

Vsebina:

- diferencialne enačbe 2. reda
- približne rešitve linearnih diferencialnih enačb
- približne rešitve nelinearnih diferencialnih enačb
- reguarna in singularna perturbacijska teorija
- perturbacijske metode za probleme lastnih vrednosti
- aproksimacije WKB
- tokovi in invariantni podprostori
- funkcije Ljapunova
- normalne forme diferencialnih enačb in preslikav
- bifurkacije ravnovesne lege
- bifurkacije periodičnih orbit
- izohronost nihanj
- uvod v kaos

Content (Syllabus outline):

- second order ODEs
- approximate solutions of linear differential equations
- approximate solutions of nonlinear differential equations
- regular and singular perturbation theory
- perturbations methods for the eigenvalues problem
- WKB approximations
- flows and invariant subspaces
- Lyapunov functions
- normal forms of differential equations and maps
- bifurcations of singular points
- bifurcations of periodic orbits
- isochronicity of oscillations
- an introduction to chaos

Temeljni literatura in viri / Readings:

- D.K. Arowsmith, C. M. Place, Dynamical systems. Diferential equations, maps an chaotic behaviour, Chapman and Hall Mathematics Series, Chapman & Hall, London 1992.
- 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.
- S. N. Chow, J. K. Hale, Methods of bifurcation theory, Grundlehren der Mathematischen wissenschaften, 251. Springer-Verlag, New York – Berlin 1982.
- J. Guckenheimer, P. Holmes, Nonlinear oscillations, dynamical systems and bifurcations of vector fields, Applied Mathematical sciences, 42, Springer-Verlag, New York 1983.
- J. A. Murdock, Normal forms and unfoldings for local dynamical systems, Springer, New York, 2003
- V. G. Romanovski, D. S. Shafer, The Center and Cyclicity Problems A Computational Algebra Approach. Birkhäuser, Boston, 2009

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
- Razviti sposobnost samostojnega razvijanja novega znanja s področja diferencialnih enačb
- Zmožnost razvijanja kritične refleksije na področju diferencialnih enačb
- Razviti zmožnost vodenja najzahtevnejših znanstvenoraziskovalnih projektov s širšega področja diferencialnih enačb.

Objectives and competences:

- Understanding 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 smoth maps
- To develop the ability to independently develop new knowledge in the field of differential equations
- Ability to develop critical reflection in differential equations
- To develop the ability to lead the most challenging scientific research projects in the wider field of differential equations

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding:
• Razumevanje metod kvalitativne in bifurkacijske analize dinamičnih sistemov • Pridobivanje sposobnosti sistematskega študija rešitev dinamičnih sistemov in njihovih lastnosti. • Sposobnost uporabe znanja za študij matematičnih modelov različnih procesov in pojavov v fizikalni, tehnični in drugih uporabnih znanosti • Sposobnost razumevanja in analiziranja dinamičnih procesov opisanih diferencialnimi enačbami in gladkimi preslikavami	• Understanding of methods of qualitative and bifurcational analysis of dynamical systems • Gaining some systematic approaches to studying of solutions of dynamical systems and their properties • The ability to 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 analyze the dynamics of processes described by differential equations and smooth maps

Metode poučevanja in učenja:	**Learning and teaching methods:**
• predavanja; • priprava seminarja; • konzultacije; • samostojni študij.	• lectures; • seminar work; • consultations; • self-study.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
• seminarsko predavanje; • pisni izpit; • ustno izpraševanje.	**20%** **30%** **50%**	• seminar talk; • written work; • oral examination.

Reference nosilca / Lecturer's references:

1. HAN, Maoan, PETEK, Tatjana, ROMANOVSKI, Valery. Reversibility in polynomial systems of ODE's. *Applied mathematics and computation*, ISSN 0096-3003. [Print ed.], 2018, vol. 338, str. 55-71. [COBISS.SI-ID 21654550], [JCR]
kategorija: 1A1

2. ZHENGXIN, Zhou, ROMANOVSKI, Valery. The center problem and the composition condition for a family of quartic differential systems. *Electronic journal of qualitative theory of differential equations*, ISSN 1417-3875, 2018, vol. 2018, no. 15, str. 1-17, doi: 10.14232/ejqtde.2018.1.15. [COBISS.SI-ID 21365270], [JCR]
kategorija: 1A1

3. ROMANOVSKI, Valery, SHAFER, Douglas. Complete integrability and time-reversibility of some 3-dim systems. *Applied Mathematics Letters*, ISSN 0893-9659. [Print ed.], January 2016, vol. 51, str. 27-33, doi: 10.1016/j.aml.2015.07.006. [COBISS.SI-ID 21562120], [JCR]
kategorija: 1A1

4. XIA, Yong-Hui, ROMANOVSKI, Valery. Bifurcation analysis of a population dynamics in a critical state. *Bulletin of the Malaysian Mathematical Sciences Society*, ISSN 0126-6705, 2015, vol. 38, iss. 2, str. 499-527, doi: 10.1007/s40840-014-0033-9. [COBISS.SI-ID 21522952], [JCR]
kategorija: 1A2

5. LLIBRE, Jaume, ROMANOVSKI, Valery. Isochronicity and linearizability of planar polynomial Hamiltonian systems. *Journal of differential equations*, ISSN 0022-0396, 2015, vol. 259, iss. 5, str. 1649-1662, doi: 10.1016/j.jde.2015.03.009. [COBISS.SI-ID 21472264], [JCR]
kategorija: 1A1