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:

Znanje osnovnih pojmov in rezultatov iz teorije NDE

Prerequisits:

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.
- F. Dumortier, J. Llibre, J.C. Artes, Qualitative Theory of Planar Differential Systems, Springer Verlag, Barlin, 2006.
- 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. ARCET, Barbara, ROMANOVSKI, Valery. On some reversible cubic systems. *Mathematics*. 2021, vol. 9, no. 12, str. 1-20. ISSN 2227-7390. DOI: 10.3390/math9121446. [COBISS.SI-ID 68094211], [JCR
kategorija: 1A1

2. LI, Yongjun, ROMANOVSKI, Valery. Integrability and limit cycles of a symmetric 3-dim quadratic system. *Journal of applied analysis and computation*. 2021, vol. 11, no. 5, str. 2230-2244. ISSN 2156-907X. DOI: 10.11948/20200162. [COBISS.SI-ID 95934467], [JCR]
kategorija: 1A2

3. LI, Yongjun, ROMANOVSKI, Valery. Isochronous solutions of a 3-dim symmetric quadratic system. *Applied mathematics and computation*. [Print ed.]. 15 Sept. 2021, vol. 405, 12 str. ISSN 0096-3003. DOI: 10.1016/j.amc.2021.126250. [COBISS.SI-ID 95936003], [JCR]
kategorija: 1A1

4. ARCET, Barbara, ROMANOVSKI, Valery. Integrability and linearizability of symmetric three-dimensional quadratic systems. *Discrete and continuous dynamical systems. Series S*. April 2022, 18 str. ISSN 1937-1632. DOI: 10.3934/dcdss.2022104. [COBISS.SI-ID 130109955], [JCR]
kategorija: 1A2

5. ARCET, Barbara, GINÉ, Jaume, ROMANOVSKI, Valery. Linearizability of planar polynomial Hamiltonian systems. *Nonlinear analysis: real world applications*. Feb. 2022, vol. 63, 19 str. ISSN 1468-1218. DOI: 10.1016/j.nonrwa.2021.103422. [COBISS.SI-ID 110154755], [JCR]
kategorija: 1A1