



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, 3 rd cycle		1 st	2 nd

Vrsta predmeta / Course type

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:

Jeziki / Languages:

Predavanja / Lectures:

Vaje / Tutorial:

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

Znanje osnovnih pojmov in rezultatov iz teorije NDE

Prerequisites:

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 podprostor
- 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: differential equations, maps and chaotic behaviour, Chapman & Hall/CRC, Boca Raton, 1998
- C. Robinson, Dynamical systems: stability, symbolic dynamics, and chaos (2nd ed.), CRC Press, Boca Raton, 1999.

Dodatna literatura / Additional Readings:

- 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

Objectives and competences:

- Understanding 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

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

- 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:

Znanje in razumevanje:

- 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

Intended learning outcomes:

Knowledge and understanding:

- 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:

- predavanja;
- priprava seminarja;
- konzultacije;
- samostojni študij.

Learning and teaching methods:

- lectures;
- seminar work;
- consultations;
- self-study.

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Seminarska naloga	50 %	Seminar paper
Teoretični izpit	50 %	Theoretical exam

Reference nosilca / Lecturer's references:

1. 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](https://doi.org/10.3934/dcdss.2022104). [COBISS.SI-ID [130109955](https://www.cobiss.si/id/130109955)], [[JCR](#), [SNIP](#), [WoS](#), [Scopus](#)]

kategorija: 1A2

2. MASTEV, Ivan, ROMANOVSKI, Valery, TIAN, Yun. Rational involutions and an application to planar systems of ODE. *Mathematics*. 2024, vol. 12, no. 3, [article no.] 486, 16 str. ISSN 2227-

7390. <https://dk.um.si/lzpisGradiva.php?id=89790>, DOI: [10.3390/math12030486](https://doi.org/10.3390/math12030486). [COBISS.SI-ID [184531971](https://cobiss.si/184531971)], [JCR, SNIP, WoS, Scopus]

kategorija: 1A1

3. 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/lzpisGradiva.php?id=89788>, Digitalna knjižnica Univerze v Mariboru – DKUM, DOI: [10.1002/mma.9885](https://doi.org/10.1002/mma.9885). [COBISS.SI-ID [184526595](https://cobiss.si/184526595)], [JCR]

kategorija: 1A1

4. GINÉ, Jaume, ROMANOVSKI, Valery, TORREGROSA, Joan. Time-reversibility and integrability of $p : -q$ resonant vector fields. *AIMS mathematics*. 2024, vol. 9, iss. 1, str. 73-88. ISSN 2473-6988.

DOI: [10.3934/math.2024005](https://doi.org/10.3934/math.2024005). [COBISS.SI-ID [184528899](https://cobiss.si/184528899)], [JCR]

kategorija: 1A1

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](https://doi.org/10.1016/j.nonrwa.2021.103422). [COBISS.SI-ID [110154755](https://cobiss.si/110154755)], [JCR]

kategorija: 1A1