



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 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 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
- 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 %) /

Weight (in %)

Načini ocenjevanja:**Assessment:**Način (pisni izpit, ustno izpraševanje, naloge, projekt):

- seminarsko predavanje;
- pisni izpit;
- ustno izpraševanje.

20%**30%****50%**Type (examination, oral, coursework, project):

- seminar talk;
- written work;
- oral examination.

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. [COBISS.SI-ID 130109955], [JCR, SNIP, WoS, Scopus]

financer: ARRS, Program, P1-0306, SI

kategorija: 1A2 (Z, A1/2); uvrstitev: SCIE, Scopus, MBP (MSN);

2. referenca: LI, Yongjun, ROMANOVSKI, Valery. Hopf bifurcations in a predator - prey model with an omnivore. Qualitative theory of dynamical systems. Dec. 2019, vol. 18, iss. 3, str. 1201-1224. ISSN 1575-5460. <https://link.springer.com/article/10.1007%2Fs12346-019-00333-9>, DOI: 10.1007/s12346-019-00333-9. [COBISS.SI-ID 47367683], [JCR, SNIP, WoS do 27. 9. 2022: št. citatov (TC): 6, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 2.00, Scopus do 15. 3. 2022: št. citatov (TC): 6, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 2.00]

kategorija: 1A1 (Z, A', A1/2); uvrstitev: SCIE, Scopus, MBP (METADEX, MSN, PUBMED)

"3. referenca: 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. 2018, vol. 2018, no. 15, str. 1-17. ISSN 1417-3875. DOI: 10.14232/ejqtde.2018.1.15. [COBISS.SI-ID 21365270], [JCR, SNIP, WoS do 16. 8. 2023: št. citatov (TC): 9, čistih citatov (CI): 9, čistih citatov na avtorja (CIAu): 4.50, Scopus do 23. 9. 2023: št. citatov (TC): 12, čistih citatov (CI): 12, čistih citatov na avtorja (CIAu): 6.00]
kategorija: 1A1 (Z, A', A1/2); uvrstitev: SCIE, Scopus, MBP (MSN, PUBMED)