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 Degree		1st	2nd

Vrsta predmeta / Course type obvezni ali izbirni/obligatory 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:	Slovenski / Slovene

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. ROMANOVSKI, Valery, FERNANDES, Wilker, OLIVEIRA, Regilene. Bi-center problem for some classes of [Z] [sub] 2-equivariant systems. *Journal of Computational and Applied Mathematics*, ISSN 0377-0427. [Print ed.], 2017, vol. 320, str. 61-75, doi: 10.1016/j.cam.2017.02.003. [COBISS.SI-ID 23085576]

2. FERNANDES, Wilker, ROMANOVSKI, Valery, SULTANOVA, Marzhan, TANG, Yilei. Isochronicity and linearizability of a planar cubic system. *Journal of mathematical analysis and applications*, ISSN 0022-247X. [Print ed.], 2017, vol. 450, iss. 1, str. 795-813, doi: 10.1016/j.jmaa.2017.01.058. [COBISS.SI-ID 22987784]

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]

4. SHENG, Lijuan, HAN, Maoan, ROMANOVSKI, Valery. On the number of limit cycles by perturbing a piecewise smooth Liénard model. *International journal of bifurcation and chaos in applied sciences and engineering*, ISSN 0218-1274, 2016, vol. 26, no. 10, str. 1650168-1-1650168-16, doi: 10.1142/S0218127416501686. [COBISS.SI-ID 23084040]

5. DU, Zengji, ROMANOVSKI, Valery, ZHANG, Xiang. Varieties and analytic normalizations of partially integrable systems. *Journal of differential equations*, ISSN 0022-0396, 2016, vol. 260, iss. 9, str. 6855-6871, doi: 10.1016/j.jde.2016.01.009. [COBISS.SI-ID 22043144]