



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Diferencialne enačbe
<b>Course title:</b>	Differential equations

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Matematika, 3. stopnja		1. ali 2.	1. ali 2. ali 4.
Mathematics, 3 <sup>rd</sup> Degree		1 <sup>st</sup> or 2 <sup>nd</sup>	1 <sup>st</sup> or 2 <sup>nd</sup> or 4 <sup>th</sup>

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
60					240	10

Nosilec predmeta / Lecturer:

Jeziki / Languages:	Predavanja / Lectures:	<input type="text" value="Slovenski / Slovene"/>
	Vaje / Tutorial:	<input type="text" value="Slovenski / Slovene"/>

**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:**

**Content (Syllabus outline):**

- 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 Lyapunova
- normalne forme diferencialnih enačb in preslikav
- bifurkacije ravnovesne lege
- bifurkacije periodičnih orbit
- izohronost nihanj
- uvod v kaos

- 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.
- 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 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:

### Intended learning outcomes:

### 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

### 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. ROMANOVSKI, Valery, SHAFER, Douglas. *The center and cyclicity problems : a computational algebra approach*. Basel: Birkhäuser, 2009. XV; 330 str. ISBN 978-0-8176-4726-1. [COBISS.SI-ID [62709761](#)]
2. ROMANOVSKI, Valery, XIA, Yong-Hui, ZHANG, Xiang. Varieties of local integrability of analytic differential systems and their applications. *Journal of differential equations*, ISSN 0022-0396, 2014, vol. 257, iss. 9, str. 3079-3101, doi: [10.1016/j.jde.2014.06.007](#). [COBISS.SI-ID [20828680](#)]
3. MAHDI, Adam, ROMANOVSKI, Valery, SHAFER, Douglas. Stability and periodic oscillations in the Moon-Rand systems. *Nonlinear analysis: real world applications*, ISSN 1468-1218, 2013, vol. 14, iss. 1, str. 294-313. <http://dx.doi.org/10.1016/j.nonrwa.2012.06.005>. [COBISS.SI-ID [19482120](#)]
4. GINÉ, Jaume, KADYRSIZOVA, Zhibek, LIU, Yirong, ROMANOVSKI, Valery. Linearizability conditions for Lotka-Volterra planar complex quartic systems having homogeneous nonlinearities. *Computers & Mathematics with Applications*, ISSN 0898-1221. [Print ed.], 2011, vol. 61, no. 4, str. 1190-1201 1201 [COBISS.SI-ID [18187272](#)]
5. LEVANDOVSKYY, Viktor, ROMANOVSKI, Valery, SHAFER, Douglas. The cyclicity of a cubic system with nonradical Bautin ideal. *Journal of differential equations*, ISSN 0022-0396, 2009, vol. 246, iss. 3, str. 1274-1287. [COBISS.SI-ID [62112257](#)]