



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Izbrana poglavja iz diferencialnih enačb
Course title: Differential equations – selected topics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali 2.	1., 2. ali 4.
PHYSICS		1. or 2.	1., 2. or 4.

Vrsta predmeta / Course type

Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
15					165	6

Nosilec predmeta / Lecturer:

Valerij Romanovskij

Jeziki /

Languages:

Predavanja /

Lectures:

Vaje / Tutorial:

slovenski/Slovenian in/and angleški s slovenskim
prevodom/English with translation in Slovenian

/

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

Ni posebnih zahtev.

Prerequisites:

No special prerequisites.

Vsebina:

Navadne diferencialne enačbe:

- diferencialne enačbe 1. reda
- diferencialne enačbe 2. reda
- približne rešitve linearnih diferencialnih enačb
- približne rešitve nelinearnih diferencialnih enačb

Content (Syllabus outline):

Ordinary differential equations:

- first order ODE
- second order ODE
- approximate solutions of linear differential equations
- approximate solutions of nonlinear differential equations

- reguarna in singularna perturbacijska teorija
- perturbacijske metode za probleme lastnih vrednosti
- aproksimacije WKB
- problem dveh zavojnih točk

Metode bifurkacijske teorije:

- tokovi in invariantni subprostori
- linearne in nelinearne preslikave
- normalne forme diferencialnih enačb in preslikav
- bifurkacije ravnovesne lege
- bifurkacije periodičnih orbit
- • uvod v kaos

- regular and singular perturbation theory
- perturbations methods for the eigenvalues problem
- WKB approximations
- the two turn points problem

Some methods of the theory of Bifurcations:

- flows and invariant subspaces
- linear and nonlinear maps
- normal forms of differential equations and maps
- bifurcations of singular points
- bifurcations of periodic orbits
- an introduction to chaos

Temeljni literatura in viri / Readings:

- 1) D.K. Arowsmith, C.M. Place, Dynamical systems. Differential equations, maps an chaotic behaviour, Chapman and Hall Mathematics Series, Chapman & Hall, London 1992.
- 2) 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.
- 3) S. N. Chow, J. K. Hale, Methods of bifurcation theory, Grundlehren der Mathematischen wissenschaften, 251. Springer-Verlag, New York – Berlin 1982.
- 4) J. Guckenheimer, P. Holmes, Nonlinear oscillations, dynamical systems and bifurcations of vector fields, Applied Mathematical sciences, 42, Springer-Verlag, New York 1983.
- 5) Yu. A. Kuznetsov, Elements of Applied Bifurcation Theory, Springer, 2004.
- 6) L. Barreira, C. Valls, Dynamical Systems, Universitext, Springer, 2014.

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

Objectives and competences:

- Understanding of 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

Predvideni študijski rezultati:

Znanje in razumevanje:

- Razumevanje metod kvalitativne in bifurkacijske analize dinamičnih sistemov
- Pridobivanje sposobnosti sistematskega študija rešitev dinamičnih sistemov in njihovih lastnosti

Prenesljive/ključne spretnosti in drugi atributi:

- Uporaba znanja za študij matematičnih modelov različnih procesov in pojavov v fizikalni, tehnični in drugih uporabnih znanostih
- Sposobnost razumevanja in analiziranja dinamičnih procesov opisanih z diferencialnimi enačbami in gladkimi preslikavami

Intended learning outcomes:

Knowledge and understanding:

- Understanding of methods of qualitative and bifurcational analysis of dynamical systems
- Gaining some systematical approaches to studying of solutions of dynamical systems and their properties

Transferable/Key Skills and other attributes:

- The 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 analyse the dynamics of processes described by differential equations and smooth maps

Metode poučevanja in učenja:

Predavanja, seminar

Learning and teaching methods:

Lectures, seminar

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)

- Ustni izpit
- Pisni izpit

Delež (v %) /

Weight (in %)

Assessment:

Type (examination, oral, coursework, project):

- Oral exam
- Written exam

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](https://doi.org/10.1016/j.cam.2017.02.003). [COBISS.SI-ID [23085576](https://www.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](https://doi.org/10.1016/j.jmaa.2017.01.058). [COBISS.SI-ID [22987784](https://www.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](https://doi.org/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](https://doi.org/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](https://doi.org/10.1016/j.jde.2016.01.009). [COBISS.SI-ID [22043144](#)]
6. FERČEC, Brigita, GINÉ, Jaume, ROMANOVSKI, Valery, EDNERAL, Victor F. Integrability of complex planar systems with homogeneous nonlinearities. *Journal of mathematical analysis and applications*, ISSN 1096-0813. [Online ed.], feb. 2016, vol. 434, issue 1, str. 894-914, doi: [10.1016/j.jmaa.2015.09.037](https://doi.org/10.1016/j.jmaa.2015.09.037). [COBISS.SI-ID [84566529](#)]