Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Numerična analiza in izbrana poglavja iz dinamičnih sistemov
Course title:	Numerical Analysis and Selected Topics from the Theory of Dynamical Systems

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Matematika, 2. stopnja		**1. ali 2.**	**2. ali 4.**
Mathematics, 2nd degree		**1. or 2.**	**2. ali 4.**

Vrsta predmeta / Course type	
Univerzitetna koda predmeta / University course code:	

Predavanja **Lectures**	**Seminar** **Seminar**	**Sem. vaje** **Tutorial**	**Lab. vaje** **Laboratory work**	**Teren. vaje** **Field work**	**Samost. delo** **Individ. work**		**ECTS**
60		**30**	**15**		**195**		**10**

Nosilec predmeta / Lecturer:	Valerij ROMANOVSKIJ

Jeziki / Languages:	**Predavanja / Lectures:**	SLOVENSKO/SLOVENE
	Vaje / Tutorial:	SLOVENSKO/SLOVENE

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

Poznavanje matematične analize.

Prerequisits:

Knowledge of mathematical analysis.

Vsebina:

1. Reševanje nelinearnih enačb. Reševanje sistemov nelinearnih enačb.
2. Diferenčni operatorji in diferenčne enačbe.
3. Sistemi linearnih enačb. Iterativne metode.
4. Problem lastnih vrednosti: Schurov in Gershgorinov izrek. Simetrični in nesimetrični problem lastnih vrednosti.

Content (Syllabus outline):

1. Nonlinear equations solving. Systems of nonlinear equations solving.
2. Difference equations and difference operators.
3. Systems of linear equations. Iterative methods.
4. Eigenvalues computation problem: Schur's

5. Polinomski sistemi: Groebnerjeva baza. Raznoterost polinomskega ideala in njene lastnosti. Razcep raznoterosti. 6. Navadne diferencialne enačbe: Picardova metoda. Metode Runge-Kutta. Večkoračne metode. Robni problem. 7. Parcialne diferencialne enačbe. 8. Lastnosti rešitev in stabilnost rešitev sistemov navadnih diferencialnih enačb. 9. Dvodimenzionalni avtonomni sistemi: Kanonične ravnovesne točke, fazne slike. 10. Limitni cikli, bifurkacije. 11. Izbrani modeli, opisani z navadnimi diferencialnimi enačbami.	and Gershgorin's theorems. Symmetric and non-symmetric eigenvalue problem. 5. Polynomial systems: Groebner basis, variety of polynomial ideal and its properties. Decomposition of varieties. 6. Ordinary differential equations: Picard method. Runge-Kutta methods. Multi-step methods. Boundary-value problems. 7. Partial differential equations. 8. Properties of solutions and stability of solutions of ordinary differential equations. 9. Two-dimensional autonomous systems: canonical equilibrium points, phase portraits. 10. Limit cycles, bifurcations. 11. Selected models described by ordinary differential equations.

Temeljni literatura in viri / Readings:

Z. Bohte, Numerično reševanje nelinearnih enačb, DMFA Slovenije, Ljubljana, 1993.
Z. Bohte, Numerično reševanje sistemov linearnih enačb, DMFA Slovenije, Ljubljana, 1994.
D. Kincaid, W. Cheney: Numerical Analysis, Brooks/Cole, Pacific Grove, 1996.
E. Zakrajšek, Uvod v numerične metode, druga izdaja, DMFA Slovenije, Ljubljana, 2000.
V. G. Romanovski and Douglas S. Shafer, The Center and Cyclicity Problems. A Computational Algebra Approach, Boston-Basel-Berlin: Birkhauser, 2009.
G. Teschl, Ordinary Differential Equations and Dynamical Systems. Providence: American Mathematical Society, 2012.
D. K. Arrowsmith and C.M. Place, Ordinary Differential Equations – A qualitative approach with applications, Chapman and Hall, 1982.
S. Lynch, Dynamical Systems with Applications using Mathematica, Birkhäuser, 2017.

Cilji in kompetence:	**Objectives and competences:**
Poglobiti znanje iz zahtevnejših konceptov in rezultatov s področja numerične analize in simbolnega računanja. Spoznati nekatere metode teorije dinamičnih sistemov.	To deepen the knowledge of more demanding concepts and results from numerical analysis and symbolic computation. To learn some methods from the theory of dynamical systems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • Poglobiti znanje iz zahtevnejših numeričnih metod, teorije dinamičnih sistemov in njihovih uporabnih vrednosti. • Prepoznati praktične probleme in	Knowledge and Understanding: • To deepen the knowledge of more demanding numerical methods, the theory of dynamical systems and their applications. • To recognize practical problems and

njihovo modeliranje z orodji numerične matematike in teorije dinamičnih sistemov. Prenesljive/ključne spretnosti in drugi atributi: • Prenos znanja numeričnih metod in dinamičnih sistemov na druga področja (računalništvo, statistika, optimizacija, matematično modeliranje, ...)	their modeling with numerical mathematics and dynamical systems tools. Transferable/Key Skills and other attributes: • Knowledge transfer of numerical methods and the theory of dynamical systems into other fields (computer science, statistics, optimization, mathematical modeling, …)

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predavanja • Seminarske vaje • Izdelava seminarske naloge	• Lectures • Tutorial • Seminar (project) work

Načini ocenjevanja:		**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) • Opravljena seminarska naloga • Pisni izpit – problemi • Pisni izpit – teorija Pisni izpit – problemi se lahko nadomesti z dvema delnima testoma (sprotni obveznosti). Pisni izpit – teorja se lahko nadomesti z dvema delnima testoma (sprotni obveznosti). Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.	Delež (v %) / Weight (in %) 10% 50% 40%	Type (examination, oral, coursework, project): • Completed seminar (project) work • Written exam – problems • Written exam – theory Written exam – problems can be replaced by two parital tests (mid-term testing). Written exam – theory can be replaced by two parital tests (mid-term testing). Each of the mentioned commitments must be assessed with a passing grade.

Reference nosilca / Lecturer's references:

1. LLIBRE, Jaume, ROMANOVSKI, Valery. Isochronicity and linearizability of planar polynomial Hamiltonian systems. Journal of differential equations, ISSN 0022-0396, 2015, vol. 259, iss. 5, str. 1649-1662, doi: 10.1016/j.jde.2015.03.009. [COBISS.SI-ID 21472264]
2. BOULIER, F., HAN, M., LEMAIRE, F., ROMANOVSKI,V. Qualitative investigation of a gene model using computer algebra algorithms. *Programming and computer software*, ISSN 0361-7688, 2015, vol. 41, no. 2, str. 105-111, doi: 10.1134/S0361768815020048. [COBISS.SI-ID 21355784]
3. ANTONOV, Valery, DOLIĆANIN, Diana, ROMANOVSKI, Valery, TÓTH, János. Invariant

planes and periodic oscillations in the May-Leonard asymmetric model. MATCH Communications in Mathematical and in Computer Chemistry, ISSN 0340-6253, 2016, vol. 76, no. 2, str. 455-474. [COBISS.SI-ID 23032840],

4. Bi-center problem for some classes of Z2-equivariant systems. Journal of Computational and Applied Mathematics, ISSN 0377-0427, 2017, vol. 320, str. 61-75, doi: 10.1016/j.cam.2017.02.003. [COBISS.SI-ID 23085576]

5. ROMANOVSKI, Valery, HAN, Maoan, HUANG, Wentao. Bifurcation of critical periods of a quintic system. Electronic journal of differential equations, ISSN 1072-6691, 2018, vol. 2018, no. 66, str. 1-11. https://ejde.math.txstate.edu/Volumes/2018/66/romanovski.pdf. [COBISS.SI-ID 21271574]