UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Dinamični sistemi
Course title:	Dynamical systems

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Magistrski študijski program Finančna matematika	ni smeri	1 ali 2	prvi ali drugi
Master's study programme Financial Mathematics	none	1 or 2	first or second

Vrsta predmeta / Course type	izbirni
Univerzitetna koda predmeta / University course code:	M2115

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30	**15**	**30**			**105**	**6**

Nosilec predmeta / Lecturer:	prof. Franc Forstnerič, prof. Jasna Prezelj

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovene, angleški/English
	Vaje / Tutorial:	slovenski/Slovene, angleški/English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vsebina:	**Content (Syllabus outline):**
Kvalitativna analiza sistemov nelinearnih diferencialnih enačb. Osnovni izreki o eksistenci in enoličnosti rešitev za sisteme (ponovitev in dopolnitev).	Qualitative analysis of systems of nonlinear differential equations. Basic existence and uniquenes theorems for systems (repetition and completion)

Fazni portret avtonomnega sistema. Klasifikacija kritičnih točk, izrek Hartmana in Grobmana o linearizaciji, teorija stabilnosti, metoda Ljapunova. Periodična gibanja in cikli v ravnini. Poincaré-Bendixsonova teorija (topološke osnove, izpeljava in uporaba), izrek Kolmogorova, Hopfova bifurkacija in nastanek ciklov, uvod v kaotično gibanje. Osnove diskretne dinamike. Diferenčne enačbe. Logistična enačba. Klasifikacija fiksnih točk. Podvajanje period in kaos. Heteroklinične orbite in Smalova podkev. Polinomska iteracija v kompleksnem. Juliajeva in Fatoujeva množica. Mandelbrotova množica. Uporaba v fiziki, medicini, biologiji, ekonomiji, elektrotehniki.	Phase portraits of autonomous systems. Classification of critical points, Hartman-Grobman linearization theorem, stability theory, Lyapunov method. Periodic motions and cycles in the real plane. Poincaré-Bendixson theory (topological back-ground, proof and examples), Kolmogorov theorem, Hopf bifurcation and emerging of cycles, introduction to chaotic motion. Basic discrete dynamics. Difference equations. The logistic equation. Classification of fixed points. Period doubling and chaos. Heteroclinic orbits ans Smale horseshoe. Polynomial iteration in the complex plane. Julia, Fatou and Mandelbrot sets. Examples from physics, medicine, biology, economy, electrical engineering.

Temeljni literatura in viri / Readings:

Gerald Teschl, Ordinary Differential Equations, Graduate Studies in Mathematics, Volume 140, Amer. Math. Soc., Providence, 2012.

Boris Hasselblatt, Anatole Katok, A first course in dynamics : with a panorama of recent development, Cambridge University Press, 2003.

L. Perko: Differential equations and dynamical systems, 3rd edition, Springer, New York, 2001.

C. Robinson: Dynamical Systems, Stability, Symbolic Dynamics and Chaos, CRC Press 1999.

D.K. Arrowsmith, C.M. Place: Dynamical Systems: Differential Equations, Maps and Chaotic Behaviour, Chapman & Hall, 1992.

D.W. Jordan, P. Smith: Nonlinear Ordinary Differential Equations, Clarendon Press, Oxford 1977.

Cilji in kompetence:	**Objectives and competences:**
Študent se seznani z osnovnimi metodami, ki se uporabljajo pri obravnavi dinamičnih sistemov. Pri tem uporabi znanje iz linearne algebre, diferencialnih enačb in topologije. Spozna različne zglede modeliranja pojavov v medicini, ekonomiji, biologiji in fiziki.	Students learn basic methods used in the theory of dynamical systems. Linear algebra, differential equations and topology are applied. Various examples of modeling from medicine, economy, biology and physics are presented.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Razumevanje pojmov, kot so: dinamični sitem, stabilnost, periodično gibanje, bifurkacija in kaos. Uporaba: Formuliranje, modeliranje in reševanje raznih problemov iz medicine, biologije, fizike in ekonomije. Refleksija: Razumevanje teorije na podlagi primerov in uporabe. Številni zgledi pomagajo spoznati vlogo matematike v naravoslovju in tehniki. Prenosljive spretnosti – niso vezane le na en predmet: Identifikacija, formulacija in reševanje problemov iz drugih strok v matematičnem jeziku. Spretnost uporabe domače in tuje literature.	Knowledge and understanding: Understanding concepts such as dynamical system, stability, periodic motion, bifurcation, chaos. Application: Formulation, modeling an solving various problems in medicine, biology, physics and economy. Reflection: Understanding of the theory from the applications. Examples show the role of mathematics in other sciences. Transferable skills: Understanding of the theory from the applications. Examples given explain the role of mathematics in natural sciences and engineering.

Metode poučevanja in učenja:	Learning and teaching methods:
predavanja, vaje, domače naloge, konzultacije	Lectures, exercises, homeworks, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Način (pisni izpit, ustno izpraševanje, naloge, projekt): izpit iz vaj (2 kolokvija ali pisni izpit)	33% 34%	Type (examination, oral, coursework, project): 2 midterm exams instead of written

ustni izpit domače naloge Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 33%	exam, written exam oral exam homeworks Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Franc Forstnerič:

– FORSTNERIČ, Franc. Actions of (R,+) and (C,+) on complex manifolds. Mathematische Zeitschrift, ISSN 0025-5874, 1996, let. 223, št. 1, str. 123-153 [COBISS.SI-ID 6928729]

– FORSTNERIČ, Franc. Interpolation by holomorphic automorphisms and embeddings in C [sup] n. The Journal of geometric analysis, ISSN 1050-6926, 1999, let. 9, št. 1, str. 93-117 [COBISS.SI-ID 9452377]

– FORSTNERIČ, Franc. Holomorphic families of long c [sup] 2's. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2012, vol. 140, no. 7, str. 2383-2389 [COBISS.SI-ID 16435289]

Jasna Prezelj:

– FORSTNERIČ, Franc, PREZELJ-PERMAN, Jasna. Oka's principle for holomorphic submersions with sprays. Mathematische Annalen, ISSN 0025-5831, 2002, band 322, heft 4, str. 633-666 [COBISS.SI-ID 11554649]

– PREZELJ-PERMAN, Jasna. Interpolation of embeddings of Stein manifolds on discrete sets. Mathematische Annalen, ISSN 0025-5831, 2003, band 326, heft 2, str. 275-296 [COBISS.SI-ID 12518489]

– PREZELJ-PERMAN, Jasna. Weakly regular embeddings of Stein spaces with isolated singularities. Pacific journal of mathematics, ISSN 0030-8730, 2005, vol. 220, no. 1, str. 141-152 [COBISS.SI-ID 13910873]