UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Matematični modeli v biologiji
Course title:	Mathematical models in biology

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

Vrsta predmeta / Course type	izbirni
Univerzitetna koda predmeta / University course code:	M2724

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. 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):**

Osnovni principi matematičnega modeliranja, motivacijski zgledi iz biologije. Diskretni modeli populacijske dinamike. Stabilnost v linearnih in nelinearnih sistemih, Lesliejev matrični model, modeli za eno populacijo, diskretni modeli za več populacij (modeli zajedavstva in sodelovanja, tekmovalni modeli, epidemiološki modeli). Verjetnostni modeli v biologiji. Uporaba verjetnosti v ekologiji (Mendelova dednost, izumiranje linij), Osnovni genetski modeli (Hardy-Weinbergov in Fisher-Haldane-Wrightov zakon), evolucijski modeli. Zvezni modeli v biologiji. Uporaba dinamičnih sistemov v populacijski dinamiki, stabilnost v linearnih in nelinearnih sistemih (teorija Ljapunova), različni modeli rasti, osnove Poincare-Bendixsonove teorije, modeli tipa plen-plenilec (Lotka-Volterra), modeli simbioze in tekmovanja ter posplošitve, konkretni ekološki in epidemiološki modeli (biološka pestrost, sistemi SIR ipd.), molekularna kinetika (Menten-Michaelis) in osnovni nevrološki modeli (Hodgkin-Huxley, Fitzhugh-Nagumo).	Fundamental principles of mathematical modeling, biological motivation. Discrete models of population dynamics. Stability in linear and nonlinear systems, Leslie matricial model, models for a single population, discrete models for interacting populations (models of parasitism and mutualism, competition, and epidemiological models). Stochastic models in biology. Application of probability theory in ecology (Mendelian heritage, lineage extinction), Fundamental genetic models (Hardy-Weinberg and Fisher-Haldane-Wright law), evolutionary models. Continuous models in biology. Application of dynamical systems in population dynamics, stability in linear and nonlinear systems (Lyapunov theory), various growth models, fundamentals of Poincare-Bendixson theory, predator-prey models (Lotka-Volterra), models of symbiosis, of competition, and their generalizations, concrete ecological and epidemiological models (biodiversity, systems of type SIR), molecular kinetics (Menten-Michaelis) and basic neurological models (Hodgkin-Huxley, Fitzhugh-Nagumo).

Temeljni literatura in viri / Readings:

L.J.S. Allen, An Introduction to Mathematical Biology, Prentice Hall, New York 2007.

J.D. Murray: Mathematical Biology, Springer, 1993.

L. Edelstein-Keshet: Mathematical Models in Biology, McGraw-Hill, 2005.

N.F. Britton: Essential Mathematical Biology, Springer 2003.

J. Hofbauer, K. Sigmund: Evolutionary Game Dynamics, Cambridge University Press, 1998.

A.W.F. Edwards: Foundation of Mathematical Genetics, Cambridge University Press, 2000.

Cilji in kompetence:

Objectives and competences:

Glavni cilj je uporaba doslej osvojenega matematičnega znanja v opisovanju bioloških procesov. Študent bo po tečaju pripravljen na interdisciplinarno delo in sodelovanje z raziskovalci v drugih vedah.	The main goal is the application of already obtained mathematical knowledge to the description of biological processes. The student will be prepared to the interdisciplinary work and to the collaboration with experts from other disciplines.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje principov matematičnega modeliranja v naravoslovju. Poznavanje osnovnih bioloških modelov. Uporaba: Formulacija in reševanje preprostih problemov v biologiji (modeliranje, napovedovanje pojavov). Refleksija: Preko številnih zgledov študent spoznava uporabnost matematike v naravoslovju. Prenosljive spretnosti – niso vezane le na en predmet: Zmožnost opisa bioloških (in drugih) procesov v matematičnem jeziku, splošna razgledanost po uporabni matematiki. Razvijanje spretnosti uporabe domače in tuje literature ter različnih računalniških programov.	Knowledge and understanding: To achieve understanding of principles of mathematical modeling in science. To be acquainted with basic biological models. Application: Formulating and solving simple problems in biology (modeling, forecasting o!!f phenomena). Reflection: Through various examples one begins to appreciate the applicability of mathematics in science. Transferable skills: One can learn how to describe biological (and other) processes using mathematical language and achieve a general feeling for mathematical applications. The goal is also to develop the skills for using existent literature and various computer programs.

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): predstavitev domače naloge izpit iz vaj (2 kolokvija ali pisni izpit) ustni izpit Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL) Ocenjevanje delovnega znanja na kolokvijih, pri domačih nalogah, na pisnem delu izpita, ocenjevanje teoretičnega razumevanja na ustnem izpitu. Predvidena sta 2 kolokvija (namesto pisnega izpita), individualna domača naloga, pisni izpit, ustni izpit.	20% 40% 40%	Type (examination, oral, coursework, project): Presentation of home exercises 2 midterm exams instead of written exam, written exam oral exam Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL) Estimating working knowledge on two midterm tests, home exercises and possible on the written test as well as estimating theoretical knowledge on the final oral exam.

Reference nosilca / Lecturer's references:

Jasna Prezelj:

– 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]

– FORSTNERIČ, Franc, IVARSSON, Björn, KUTZSCHEBAUCH, Frank, PREZELJ-PERMAN, Jasna. An interpolation theorem for proper holomorphic embeddings. Mathematische Annalen, ISSN 0025-5831, 2007, bd. 338, hft. 3, str. 545-554 [COBISS.SI-ID 14335065]

– PREZELJ-PERMAN, Jasna. A relative Oka-Grauert principle for holomorphic submersions over 1-convex spaces. Transactions of the American Mathematical Society, ISSN 0002-9947, 2010, vol.

362, no. 8, str. 4213-4228 [COBISS.SI-ID 15641433]