Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Metode biofizikalnega modeliranja**
Course title:	**Methods of biophysical modelling**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		**1. ali 2.**	**1., 2. ali 4.**
PHYSICS, 3rd cycle		**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
10	**5**				**165**	**6**

Nosilec predmeta / Lecturer:	**Aleš Fajmut**

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian
	Vaje / Tutorial:	slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Vsaka obveznost študenta v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Opravljen projekt je pogoj za pristop k ustnemu izpitu.	Each student requirement within the assessment methods must be completed with a passing grade. Completed project is a prerequisite for taking the oral exam.

Vsebina:	**Content (Syllabus outline):**
- modeliranje encimske kinetike in mrež biokemijskih reakcij	- modelling of enzyme kinetics and networks of biochemical reactions
- kontrolna analiza	- control analysis
- modeliranje prenosa signalov v celici	- modelling of signal transduction in the cell
- optimizacijske metode in določanje parametrov	- optimization methods and parameter estimation

- modeliranje fizioloških sistemov (srce, krvni obtok, izmenjava plinov, krčenje mišic, regulacija volumna celice…) - farmakokinetični modeli	- modelling of physiological systems (heart, blood flow, gas exchange, muscle contraction, cell volume regulation…) - pharmacokinetic models

Temeljni literatura in viri / Readings:

1. Hoppensteadt, F. C., & Peskin, C. S. (2002). *Modeling and simulation in medicine and the life sciences*. Springer. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/3328340
2. Keener, J., & Sneyd, J. (1998). *Mathematical physiology*. Springer. https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/1182804
3. *Computational methods for estimating the kinetic parameters of biological systems: Let. [2385]* (str. XI, 379). (2022). Humana Press. https://doi.org/10.1007/978-1-0716-1767-0
4. FAJMUT, Aleš. Molecular mechanisms and targets of cyclic guanosine monophosphate (cGMP) in vascular smooth muscles. V: SAKUMA, Kunihiro (ur.). Muscle cell and tissue : novel molecular targets and current advances. London: IntechOpen, cop. 2021. Str. 1-31. ISBN 978-1-83968-651-1, ISBN 978-1-83968-650-4, ISBN 978-1-83968-652-8. https://www.intechopen.com/chapters/76823, DOI: 10.5772/intechopen.97708. [COBISS.SI-ID 79467011]

Dodatna:

1. Klipp, E., Herwig, R., Kowald, A., Wierling, C., & Lehrach, H. (2005). *Systems biology in practice*. Wiley-VCH.
2. Sauro, H. M. (2011). *Enzyme kinetics for systems biology*. Ambrosius Publishing.
3. Izbrani znanstveni članki / Selected scientific papers

Cilji in kompetence:	**Objectives and competences:**
Študent je po uspešno opravljenem izpitu zmožen: - obravnavati in uporabljati najzahtevnejše teoretične biofizikalne koncepte in metode modeliranja živih sistemov od ravni medmolekularnih interakcij do ravni delovanja celice, tkiva in organizma - identificiranja in obravnave najkompleksnejših problemov v bio-znanostih ter pristopa k iskanju njihovih rešitev s pomočjo metod teoretičnega biofizikalnega modeliranja - znanstvenoraziskovalnega sodelovanja, komunikacije ter prenosa znanj na področju raziskav v naravoslovnih interdisciplinarnih vedah	After passing the exam, the student is able: - to tackle and apply the most demanding theoretical biophysical concepts and methods of modeling the living systems from the level of intermolecular interactions to the level of cell, tissue and organism - to identify and treat the most complex problems in bio-sciences and to select the right strategies for their solutions using theoretical methods of biophysical modeling - of cooperation in scientific research as well as of communication and transfer of knowledge within interdisciplinary research in natural sciences

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku predmeta je študent zmožen: - kvalitativno in kvantitativno (s fizikalno-matematičnimi odvisnostmi) opisati najzahtevnejše teoretične biofizikalne koncepte - aplicirati te koncepte na konkretnih primerih najkompleksnejših modelov bioloških sistemov - samostojno nadgraditi in/ali izgraditi kompleksne modele bioloških sistemov in jih analitično ali z računalniškimi orodji rešiti ter z njimi napovedati nove izvirne rezultate - na podlagi rezultatov matematičnega modeliranja oblikovati in oblikovati nove hipoteze Prenesljive/ključne spretnosti in drugi atributi: - sposobnost poglobljenega reševanja kompleksnih interdisciplinarnih problemov v bioloških vedah z matematično-fizikalnimi orodji in računalniško podprtimi numeričnimi metodami - sposobnost apliciranja univerzalnosti v fiziki in celostnega pristopa k reševanju kompleksnih biofizikalnih problemov - sposobnost raziskovalnega dela v interdisciplinarnem okolju	Knowledge and understanding: Upon completion of the course, the student is able: - to describe qualitatively and quantitatively (with physical and mathematical dependencies) the most demanding theoretical biophysical concepts - to apply these concepts to concrete examples of the most complex models of biological systems - to upgrade and/or to build *de novo* complex models of biological systems and to solve them analytically or with computer tools and to predict new original results with them - to formulate new hypotheses based on the results of mathematical modeling Transferable/Key Skills and other attributes: - the ability to solve complex interdisciplinary problems in biological sciences with mathematical and physical tools as well as computer-aided numerical methods - the ability to apply universality in physics and an integrated approach to solving complex biophysical problems - the ability of research work in an interdisciplinary environment

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in študij primerov	Lectures and case study

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni izpit	50	Oral exam
Projekt	50	Project

Reference nosilca / Lecturer's references:

1. DOBOVIŠEK, Andrej, MARKOVIČ, Rene, BRUMEN, Milan, FAJMUT, Aleš. The maximum entropy production and maximum Shannon information entropy in enzyme kinetics. Physica. A, Statistical mechanics and its applications, ISSN 0378-4371. [Print ed.], 2018, vol. 496, str. 220-232, doi: 10.1016/j.physa.2017.12.111. [COBISS.SI-ID 23601416],

2. DOBOVIŠEK, Andrej, VITAS, Marko, BRUMEN, Milan, FAJMUT, Aleš. Energy conservation and maximal entropy production in enzyme reactions. Biosystems, ISSN 0303-2647. [Print ed.], 2017, vol. 158, str. 47-56, doi: 10.1016/j.biosystems.2017.06.001. [COBISS.SI-ID 23218696]

3. FAJMUT, Aleš, EMERŠIČ, Tadej, DOBOVIŠEK, Andrej, ANTIĆ, Nataša, SCHÄFER, Dirk, BRUMEN, Milan. Dynamic model of eicosanoid production with special reference to non-steroidal anti-inflammatory drug-triggered hypersensitivity. IET systems biology, ISSN 1751-8849. [Print ed.], 2015, vol. 9, iss. 5, str. 204-215, doi: 10.1049/iet-syb.2014.0037. [COBISS.SI-ID 21404168]

4. GOSAK, Marko, MARKOVIČ, Rene, FAJMUT, Aleš, MARHL, Marko, HAWLINA, Marko, ANDJELIĆ, Sofija. The analysis of intracellular and intercellular calcium signaling in human anterior lens capsule epithelial cells with regard to different types and stages of the cataract. PloS one, ISSN 1932-6203, 2015, vol. 10, iss. 12. http://dx.doi.org/10.1371/journal.pone.0143781, doi: 10.1371/journal.pone.0143781. [COBISS.SI-ID 2645676]