Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Modeliranje in simulacije v medicini in biologiji
Course title:	Modeling and Simulations in Medicine and Biology

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Fizika 2. st.		2	3
Physics 2nd degree			

Vrsta predmeta / Course type	izbirni/elective
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**
15	15		15		105	5

Nosilec predmeta / Lecturer:	Aleš Fajmut, Marjan Slak Rupnik

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Jih ni.	None.

Vsebina:	**Content (Syllabus outline):**
KONTROLA CELIČNEGA VOLUMNA IN ELEKTRIČNE LASTNOSTI CELIČNE MEMBRANE (modeliranje kontrole celičnega volumna, prehod ionov preko membrane, simulacija širjenja akcijskega potenciala po živčni celici) MEHANIKA MIŠIC (relacija med silo in hitrostjo, dinamika prečnih mostičkov, računalniška simulacija pripetja in odpetja prečnih mostičkov) BIOLOŠKI RITMI (razne oscilacije v bioloških sistemih) FIZIOLOŠKO BAZIRANI FARMAKOKINETIČNI MODELI (regulacija glukoze v krvi)	CONTROL OF CELL VOLUME AND ELECTRICAL PROPERTIES OF CELL MEMBRANES (modeling of cell volume control, the movement of ions across membrane, computer simulation of the nerve action potential) MUSCLE MECHANICS (the force-velocity relationship, crossbridge dynamics, computer simulation of crosbridge attachment and detachment) BIOLOGICAL RHYTHMS (various oscillations in biological systems) PHYSIOLOGICALY BASED PHARMAKOKINETIC MODELS (regulation of blood-glucose level)

ANALIZA IN REKONSTRUKCIJA SLIK V MEDICINI IN PRI MIKROSKOPSKIH TEHNIKAH V okviru seminarja študent izbere eno izmed razpisanih tem za projektno nalogo, ki ima obliko krajšega strokovnega prispevka. Študent po izdelavi in pregledu naloge pripravi predstavitev pred kolegi. *Vsebina laboratorijskih vaj:* - modeliranje izbranih bioloških procesov tudi s stališča medicine - računalniška simulacija in vizualizacija rezultatov z računalniškimi orodji	ANALYSIS AND RECONSTRUCTION OF IMAGES IN MEDICINE AND MICROSCOPY TECHNIQUES The seminar is intended for the presentations of student projects, which should have the form of a shorter professional paper. After preparing and reviewing the project, the student prepares a presentation in front of colleagues. *Laboratory work outline:* - modeling of selected biological processes also from the medical point of view - computer simulation and visualization of results with computer tools

Temeljni literatura in viri / Readings:

1. Hoppensteadt F. C., Peskin C. S. Modeling and Simulation in Medicine and the Life Sciences, Springer-Verlag, New York 2004.
2. Keener J., Sneyd J. Mathematical Physiology, Springer-Verlag, New York 1998
3. Hobbie R. K. Intermediate Physics for Medicine and Biology, John Wiley & Sons, New York 1988
4. Wood A.W. Physiology, biophysics and biomedical engineering, CRC Press, Boca Raton 2012

Cilji in kompetence:	**Objectives and competences:**
Študent je po uspešno opravljenem izpitu zmožen: - razumeti obravnavane zahtevnejše teoretične biofizikalne koncepte in metode modeliranja živih sistemov predvsem na ravni fizioloških procesov v telesu - identificiranja in obravnave izbranih kompleksnejših problemov v bio-znanostih in medicini ter pristopa k iskanju njihovih rešitev s pomočjo metod teoretičnega biofizikalnega modeliranja in računalniških simulacij - strokovnega sodelovanja, komunikacije ter prenosa znanj na področju naravoslovnih interdisciplinarnih ved in medicine	After passing the exam, the student is able: - to understand the discussed complex theoretical biophysical concepts and methods of modeling of living systems especially on the level of physiological processes within the body - to identify and treat the selected complex problems in bio-sciences and medicine, and to find strategies for their solutions with methods of theoretical biophysical modeling and computer simulations - of professional cooperation, communication and transfer of knowledge in the field of interdisciplinary natural sciences and medicine

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Po zaključku predmeta je študent zmožen: - kvalitativno in kvantitativno (s fizikalno-matematičnimi odvisnostmi) opisati obravnavane zahtevnejše teoretične biofizikalne koncepte predvsem na fiziološki ravni - aplicirati te koncepte na konkretnih primerih kompleksnejših modelov bioloških sistemov z aplikacijo v medicini in fiziologiji - rešiti z računalniškimi orodji konkretne kompleksne obstoječe modele bioloških sistemov in z njimi napovedati rezultate, ki so relevantni za medicino in fiziologijo - na podlagi rezultatov matematičnega modeliranja oblikovati in napovedovati enostavnejše hipoteze, ki so relevantne za medicino in fiziologijo Prenesljive/ključne spretnosti in drugi atributi: - sposobnost napredne uporabe računalniških orodij za modeliranje in simulacijo v medicini in fiziologiji - zavedanje o pomenu in koristnosti biofizikalnih teoretičnih pristopov k obravnavi bioloških sistemov za razvoj novih eksperimentov in metod zdravljenja	Knowledge and Understanding: Upon completion of the course, the student is able: - to qualitatively and quantitatively (with physical and mathematical dependencies) describe selected complex theoretical biophysical concepts especially at the physiological level - to apply these concepts on selected examples of complex models of biological systems with applications to medicine and physiology - to solve selected complex existing models of biological systems with help of computer tools and to predict the results that are relevant to medicine and physiology - predict simpler hypotheses that are useful to medicine and physiology on the basis of the results of mathematical modeling Transferable/Key Skills and other attributes: - the ability to use advanced computer tools for modeling and simulations in medicine and physiology - awareness of the importance and usefulness of biophysical theoretical approaches for the treatment of biological systems accounting for the development of new experiments and methods of medical treatment

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja podkrepljena s simulacijami Seminar; pisne in ustne predstavitve projektnih nalog iz izbrane teme Laboratorijske vaje (delo z računalnikom).	Lectures, supported by simulations Seminar; oral and written presentations of projects from selected topics Laboratory work (work with computer)

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni izpit iz vsebin predavanj in vaj	70	Oral exam from the topics of lectures and tutorials
Poročilo o delu na problemu	30	Case study report

Reference nosilca / Lecturer's references:

1. GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, PERC, Matjaž, RUPNIK, Marjan, MARHL, Marko. Critical and supercritical spatiotemporal calcium dynamics in beta cells. Frontiers in physiology, ISSN 1664-042X, 2017, vol. 8, str. 1-17, ilustr., doi: 10.3389/fphys.2017.01106. [COBISS.SI-ID 512760376]

2. GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, MARHL, Marko, RUPNIK, Marjan, PERC, Matjaž. The relationship between node degree and dissipation rate in networks of diffusively coupled oscillators and its significance for pancreatic beta cells. Chaos, ISSN 1054-1500, July 2015, vol. 25, iss. 7, 073115-1-073115-8, doi: 10.1063/1.4926673. [COBISS.SI-ID 512523576]

3. GOSAK, Marko, DOLENŠEK, Jurij, MARKOVIČ, Rene, RUPNIK, Marjan, MARHL, Marko, STOŽER, Andraž. Multilayer network representation of membrane potential and cytosolic calcium concentration dynamics in beta cells. Chaos, solitons and fractals. [Print ed.], 2015, vol. 80, str. 76-82, ilustr. http://www.sciencedirect.com/science/article/pii/S0960077915001794, doi: 10.1016/j.chaos.2015.06.009. [COBISS.SI-ID 512513080]

4. 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]

5. 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]