



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Fizika v medicini
Course title: Physics in medicine

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 1. stopnja		3	6
Physics 1 st cycle			

Vrsta predmeta / Course type

izbirni / elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
30	15		15		120	6

Nosilec predmeta / Lecturer:

Aleš Fajmut

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

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

Ni pogojev za vključitev v delo.

Vsaka obveznost študenta v načinih ocenjevanja mora biti opravljena s pozitivno oceno. V celoti opravljen projekt je pogoj za pristop k teoretičnemu izpitu.

Prerequisites:

There are no prerequisites to join the course.

Each student requirement within the assessment methods must be completed with a passing grade. Completed project is a prerequisite for taking the theoretical exam.

Vsebina:

Content (Syllabus outline):

FIZIKA ČLOVEŠKEGA TELES (biomehanika, regulacija temperature in tlaka, energetika človeka, metabolizem in poraba kisika) BIOMEDICINSKE MERITVE (meritve električnih potencialov (EKG, EEG, in elektrostimulacija) spirometrija, ultrazvočno slikanje in terapija, oksigenacija krvi, sestava tkiva) ANALITIČNE METODE V BIOMEDICINI (masna in FTIR spektrometrija, fluorescenčna mikroskopija) IONIZIRAJOČE SEVANJE (vrste ionizirajočega sevanja, dozimetrija, detektorji, zaščita pred sevanjem) SLIKANJE V MEDICINI (klasični in CT načini slikanja, rentgensko, SPET in PET metoda slikanja, MRI, termografija) 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. V okviru laboratorijskih vaj študenti izvedejo več vaj na rentgenskem aparatu, slikanje in vaskularno analizo z ultrazvokom, elektrostimulacijo, detekcijo in spektrometrijo gama žarkov, EKG ter obišejo Onkološki Inštitut UKC Maribor.	PHYSICS OF THE HUMAN BODY (biomechanics, temperature and pressure regulation, energetics of human, metabolism, oxygen consumption) BIOMEDICAL MEASUREMENTS (measurements of electrical potentials (ECG, EEG, and electrostimulation), spirometry, ultrasound imaging and therapy, blood oxygenation, tissue composition) ANALYTICAL MEASUREMENTS IN BIOMEDICINE (mass spectrometry, FTIR, fluorescence microscopy) IONIZING RADIATION (types of ionizing radiation, dosimetry, detectors, protection against radiation) IMAGING IN MEDICINE (classic and CT modes of imaging, X-ray, SPET and PET imaging techniques, MRI, thermography) 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. Within the laboratory work, students perform several exercises on X-ray apparatus, imaging and vascular analysis with ultrasound, electrostimulation, detection and spectrometry of gamma rays, ECG and visit the Oncology Institute at UKC Maribor.
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Temeljni literatura in viri / Readings:

1. Magee, P., & Tooley, M. (2005). *The physics, clinical measurement and equipment of anaesthetic practice*. Oxford University Press.
2. Herman, I. P. (2007). *Physics of the Human Body*. Springer.
<http://link.springer.com/book/10.1007/978-3-540-29604-1>
3. *Physics for Medical Imaging Applications* (Let. 240). (2007). Springer.
<http://link.springer.com/book/10.1007/978-1-4020-5653-6>

Interna skripta in navodila za laboratorijske vaje, izročki prosojnic s predavanj in druga dodatna interna študijska literatura, ki je v elektronski obliki dostopna na:

<https://estudij.um.si/> v okviru predmeta Fizika v medicini.

Pojasnilo/Remark: Med temeljno študijsko literaturo sodijo samo tista poglavja iz omenjenih knjig, ki so del vsebine predmeta v okviru predavanj, seminarja in vaj. / Only those chapters from the abovementioned books that are considered within the syllabus outline of the course, including lectures, seminar and laboratory work, are regarded as core readings.

Cilji in kompetence:

Študent je po uspešno opravljenem izpitu zmožen:

- prenosa osnovnih fizikalnih znanj na biomedicinsko področje,
- razumeti obravnavane fizikalne koncepte delovanja raznih diagnostičnih, terapevtskih in analitičnih naprav v medicini
- razumeti obravnavane fizikalne teorije in zakone ter jih aplicirati na razlago pojavov in fizioloških procesov v človeškem telesu
- strokovnega sodelovanja, komunikacije ter prenosa znanj s področja fizike v interdisciplinarnem bolnišničnem okolju
- osnovnega rokovanja s posameznimi diagnostičnimi in merilnimi napravami, ki se uporabljajo v medicini

Objectives and competences:

After passing the exam, the student is able:

- to transfer basic physical knowledge to the biomedical field,
- to understand the discussed physical concepts of the functioning of various diagnostic, therapeutic and analytical devices in medicine
- to understand the discussed physical theories and laws and apply them to the interpretation of phenomena and physiological processes in the human body
- of professional cooperation, communication and transfer of knowledge in the field of physics in an interdisciplinary hospital environment
- basic handling of some diagnostic and measuring devices used in medicine

Predvideni študijski rezultati:

Znanje in razumevanje:

Po zaključku predmeta je študent zmožen: prepoznave širokega spektra primerov prenosa znanja fizike na področje medicine aplikacije posameznih fizikalnih vsebin, ki jih je že usvojil pri osnovnih fizikalnih predmetih (Mehanika, Termodinamika, Moderna fizika idr.) na osnovnejše primere v medicini izvesti posamezne metode merjenja, ki so uporabne v medicini, in analizirati meritve utemeljiti primernost in smiselnost uporabe posameznih diagnostičnih, terapevtskih in analizičnih metod v medicini predvideti posamezne vplive na uspešnost in kvaliteto nekaterih fizikalnih meritev v medicini

Prenosljive/ključne spretnosti in drugi atributi:

- sposobnost prenosa znanj iz teorije v prakso

Intended learning outcomes:

Knowledge and understanding:

Upon completion of the course, the student is able:

- to recognize a wide range of cases of transfer of knowledge of physics to the field of medicine
- to apply individual physical contents that he/she has already adopted in basic physical subjects (Mechanics, Thermodynamics, Modern Physics, etc.) to basic examples in medicine
- to carry out selected methods of measurements that are useful in medicine, and analyse the measurements
- to justify the appropriateness and meaningfulness of the use of particular diagnostic, therapeutic and analytical methods in medicine
- to foresee some impacts on the success and quality of certain physical measurements in medicine

Transferable/Key Skills and other attributes:

- tehnične spretnosti merjenja in dela s posameznimi napravami, ki so uporabne v medicini in biofiziki

- the ability to transfer knowledge from theory into practice
- technical skills of measuring and working with particular devices that are used in medicine and biophysics

Metode poučevanja in učenja:

Predavanja podkrepljena s simulacijami in demonstracijskimi eksperimenti
Seminar; pisne in ustne predstavitve projektnih nalog iz izbrane teme
Laboratorijske vaje.

Learning and teaching methods:

Lectures, supported by simulations and demonstration experiments
Seminar; oral and written presentations of projects from selected topics
Laboratory work

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Teoretični izpit
projekt

70

30

theoretical exam

Project

Reference nosilca / Lecturer's references:

1. DOBOVIŠEK, Andrej, BLAŽEVIČ, Tina, KRALJ, Samo, FAJMUT, Aleš. Enzyme cascade to enzyme complex phase-transition-like transformation studied by the maximum entropy production principle. Cell reports physical science. 2025, vol. 6, iss. 2, [article no.] 102400, 11 str. ISSN 2666-3864. <https://doi.org/10.1016/j.xcrp.2024.102400>, [COBISS.SI-ID 225246211]
2. DOBOVIŠEK, Andrej, VITAS, Marko, BLAŽEVIČ, Tina, MARKOVIČ, Rene, MARHL, Marko, FAJMUT, Aleš. Self-organization of enzyme-catalyzed reactions studied by the maximum entropy production principle. International journal of molecular sciences. 2023, vol. 24, iss. 10, 21 str. ISSN 1422-0067, DOI: 10.3390/ijms24108734 [COBISS.SI-ID 152729603]
3. 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]