UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Bioelektromagnetizem
Course title:	Bioelectromagnetism

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		2	3

Vrsta predmeta / Course type izbirni/ optional

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
45	15	0	0	0	90	5

Nosilec predmeta / Lecturer: Klemen Bohinc

Jeziki / Languages:		
	Predavanja / Lectures:	Slovenski/Slovenian in/and angleški/English
	Vaje / Tutorial:	Slovenski/Slovenian in/and angleški/English

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

Predznanje iz elektromagnetnega polja

Prerequisits:

Preknowledge of Electromagnetic field

Vsebina:

1. Osnove električnega in magnetnega polja (jakost električnega polja, električni potencial, gostota magnetnega polja, vektorski potencial, multipolni razvoj, Maxwellove enačbe)
2. Bio-električni izvori in prevodniki (makromolekule kot npr. DNA, aktinske molekule, membrane, virusi, proteini), interakcije med makromolekulami
3. Električno in magnetno polje v bioloških sistemih (v celicah in organizmu), električna dvojna plast, elektrokinetski pojavi, Maxwellove enačbe v snovi
4. Elektromagnetno valovanje in sevanje v bioloških sistemih (valovna enačba, vpliv elektromagnetnega valovanja na človeško telo, elektromagnetna stimulacija tkiv)

Content (Syllabus outline):

1. Fundamentals of electric and magnetic field (electric field strength, electric potential, magnetic flux density, vector potential, multipole expansion, Maxwell equations)
2. Bioelectric sources and conductors (macromolecules, e.g. DNA, actin molecules, membranes, viruses, proteins), interactions between macromolecules
3. Electric and magnetic fields in biological systems (in cells and organisms). Electric double layer, electrokinetic phenomena, macroscopic Maxwell equations
4. Electromagnetic waves and radiation in biological systems (wave equation, influence of electromagnetic field on the human body, electromagnetic stimulation of tissue)

Temeljni literatura in viri / Readings:

1. J.D. Jackson, Classical Electrodynamics, John Wiley &Sons, Inc. 1998.
2. J. Malmivuo, R. Plonsey, Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, 1995.
3. W. Greiner, Classical Electrodynamics, Springer Verlag 1996.
4. R. Plonsey, R.C. Barr, Bioelectricity: A quantative Approach, Kluwer Academic, Plenum Pub. New York, 2000.
5. J. Schnakenberg, Elektrodynamik, Wiley-VCH, 2003.

Cilji in kompetence:

Objectives and competences:

Cilj predmeta je obravnavati elektromagnetno polje in njegovo uporabo v bioloških sistemih. Študent spozna biološke izvore električnega in magnetnega polja ter razume elektromagnetne interakcije med makroioni. Pristop temelji na matematični formulaciji konceptov v fiziki. Obravnavani primeri so izbrani iz biologije in medicine.	The main objective of the course is to study the electromagnetic field and its application in biological systems. Students get acquainted with the biological sources of electric and magnetic field and the electromagnetic interactions between the macroions. The method is based on the mathematical formulation of the concepts in physics. In particular, systems presented are selected from biology and medicine.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje elektromagnetnih procesov v bioloških sistemih. Študent zna uporabiti pridobljeno znanje na primerih bioloških sistemov. Zna aplicirati fizikalne metode na področje biologije. Prenesljive/ključne spretnosti in drugi atributi: Matematično formuliranje opisanih sistemov. Sposobnost vključitve v raziskovalno ali strokovno delo.	Knowledge and Understanding: Understanding of electromagnetic processes in biological systems. The student is able to apply the acquired knowledge on biological systems. Application of physical methods on the field of biology. Transferable/Key Skills and other attributes: Mathematical formulation of described systems. Ability to involve in research and professional work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja Seminarji	lectures seminars

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni izpit seminarska naloga	60% 40%	Oral exam Seminar

Reference nosilca / Lecturer's references:

MAY, Sylvio, BOHINC, Klemen. Attraction between like charged surfaces mediated by uniformly charged spherical colloids in a salt solution. *Croat. chem. acta*, 2011, iss. 2, vol. 84, str. 251-257, ilustr., doi: 10.5562/cca1824. [COBISS.SI-ID 4246379]

BOHINC, Klemen, SHRESTHA, Anil, MAY, Sylvio. The Poisson-Helmholtz-Boltzmann model. *The European physical journal. E, Soft matter*, 2011, vol. 34, no. 10, str. 1-10, ilustr., doi: 10.1140/epje/i2011-11108-6. [COBISS.SI-ID 4246635]

BOHINC, Klemen, REŠČIČ, Jurij, MASET, Stefano, MAY, Sylvio. Debye-Hückel theory for mixtures of rigid rodlike ions and salt. *J. chem. phys.*, 2011, vol. 134, no. 7, str. 074111-1-074111-9, doi: 10.1063/1.3552226. [COBISS.SI-ID 4134763]

POŽAR, Josip, BOHINC, Klemen, VLACHY, Vojko, KOVAČEVIĆ, Davor. Ion-specific and charge effects in counterion binding to poly(styrenesulfonate) anions. *PCCP. Phys. chem. chem. phys. (Print)*, 2011, no. 34, vol. 13, str. 15610-15618, doi: 10.1039/c1co21291e. [COBISS.SI-ID 4226155]

BOHINC, Klemen, SHRESTHA, Ahis, BRUMEN, Milan, MAY, Sylvio. Poisson-Helmholtz-Boltzmann model of the electric double layer : analysis of monovalent ionic mixtures. *Phys. rev., E Stat. nonlinear soft matter phys. (Print)*, 2012, vol. 85, no. 3, str. 031130-1-031130-12, doi: 10.1103/PhysRevE.85.031130. [COBISS.SI-ID 4353131]

BOHINC, Klemen, GRIME, John M. A., LUE, Leo. The interactions between charged colloids with rod-like counterions. *Soft matter*, 2012, vol. 8, no. 20, str. 5679-5686, doi: 10.1039/c2sm07463j. [COBISS.SI-ID 4366443]