Basic information about the course			
Title	Physics		
Code	71294	Abbreviation	111OFIZK
Total ECTS points	6	Status	Obligatory
Exam	Yes	Calculated in grade average	Yes
Language of teaching	Croatian	e-learning	
Department	Physics and Biophysics		
Course leader	Assistant Professor Sanja Dolanski Babić, PhD		

Course load			
	1		Total
Lectures	20		20
Seminars	20		20
Laboratory practicals	20		20
ECTS			6

Course description

The goal of physics course for student of dental medicine is to learn how to use basic physical principles and laws to describe biological processes and structure of biological systems at the molecular level. In studying metabolic processes and the interaction of the body with the environment simple physical models are used. Those models are based on knowledge of energy and matter transfer inside biological systems and action of external energy sources on biological systems. The main teaching task is to familiarize students with the knowledge of selected parts of physics connected with biological systems and, with examples in seminar classes, bring them closer to ways of thinking necessary to apply that knowledge in dentistry. In addition, students should be able to explain the physical basis of diagnostic and therapeutic methods in dentistry practice necessary for understanding them. Laboratory exercise have task to qualify students to do measurements, explain and present results of experiments. They also have a goal to qualify students for handling simple measuring devices and improve their understanding of basic physical laws. All lectures, seminars and labs are obligatory. A student can be absent from class up to 20 % of the overall course load but have to make up for seminars and lab work. Missed seminars have to be submitted in the form of essay to the course coordinator before the exam. Missed labs have to be made up during the make-up lab hours provided by the Department. During the make-up lab, only one missed exercise can be completed. The completion and proper documentation of each lab exercise and seminar and approval thereof by the course instructor are conditions for the course completion and obtaining the signature in the Index. A student has to get the signature prior taking the exam.

Criteria for taking the course exam

What is graded

Written exam	Yes	Oral exam	Yes	Practical exam	Yes
Seminar		Minor preliminary exam	Yes	Major preliminary exam	Yes

Rules of grading and additional information

The exam has three parts: written, practical and oral.
Throughout the course, students are offered two partial tests (quizzes) consisting of **18** questions each. Student must have **10** (55 %) correct answers to pass the quiz.
If a student has not collected **20** points throughout the course, then he has to take a written exam prior to oral exam. Written exam has **36** questions and to pass it the student must have **22** (61 %) correct answers. To take an oral exam a student has to pass the written part.
Immediately after finishing all lab exercises, students are offered to take preliminary practical exam. If a student fails in this exam, he or she is obliged to take practical part of the exam at regular exam terms. Once the written and practical parts of the exam are passed they remain valid for all exam terms in that academic year. To get a grade of the course a student has to pass all three parts of the exam.

Weekly teaching plan

1. component

Lecture topics:

No.	Topic	Date	Time	Lecturer
1.	The structure of matter: force and energy, vector and scalar fields, fundamental forces in nature; basic mathematical functions, periodic functions, Fourier theorem	16.04.2018.	10:00 -11:30	S. Dolanski Babić, PhD
2.	The structure of atom energy states of atoms, electron quantum numbers, Paulli exclusion principle	17.04.2018.	10:45 -11:30	S. Dolanski Babić, PhD
3.	Structure of molecule; molecular bonds; energy states; spectroscopy	18.04.2018.	12:30 -14:00	S. Dolanski Babić, PhD
4.	Oscillations: free, damped and forced - resonance	19.04.2018.	9:00 -9:45	S. Dolanski Babić, PhD
5.	Structure of solids: crystals and polycrystals; imperfections and defects in crystal lattice: point and line defects; metal alloys, polymers	20.04.2018.	8:30 -9:15	O. Gamulin, PhD
6.	Elastic force; linear elastic deformation; viscoelastic properties of matter; mechanical elements and models; mechanical properties of polymers; deformation in polymers	20.04.2018.	9:30 -11:00	O. Gamulin, PhD
7.	Model of real fluid, Newton and Poiseuille law; rheological properties of fluid	23.04.2018.	13:00 -13:45	S. Dolanski Babić, PhD
8.	Heat transfer: conduction, convection, evaporation and radiation	24.04.2018.	11:00 -11:45	O. Gamulin, PhD
9.	Polarization mechanisms of matter in electric field	30.04.2018.	11:00 -11:45	S. Dolanski Babić, PhD
10.	Contact voltage; thermocouple, galvanic cell, galvanic corrosion and mouth galvanic phenomena	30.04.2018.	12:00 -12:45	S. Dolanski Babić, PhD
11.	Matter in external magnetic field: paramagnetism, diamagnetism and ferromagnetism	02.05.2018.	9:00 -9:45	S. Dolanski Babić, PhD

12.	Optics of an eye; image formation by magnifying glass and optical microscope; Rayleigh theory of resolution; metallographic microscope, electron microscope	03.05.2018.	11:00 -12:30	O. Gamulin, PhD
13.	Basic principles of lasers, laser applications in dentistry	04.05.2018.	9:00 -9:45	O. Gamulin, PhD
14.	Interactions of electromagnetic waves with tissue	04.05.2018.	10:00 -10:45	S. Dolanski Babić, PhD
15.	X-ray tube; X-ray spectrum; effects of anode voltage and heating current; interaction of X-radiation with tissue; contrast; half thickness of absorber; CT method	04.05.2018.	11:00 -12:30	S. Dolanski Babić, PhD

Seminar topics:

No.	Topic	Date	Time	Lecturer
1.	Basic mechanics: Newton laws, torque, conditions of translational and rotational equilibrium; lever, levers in the body, application in dentistry	17.04.2018.	9:00 -10:30	S. Dolanski Babić, PhD
2.	Sound waves; physical and physiological parameters of sound, Doppler effect, ultrasound generator	19.04.2018.	10:15 -11:45	S. Dolanski Babić, PhD
3.	Basics of hydrostatic: pressure in fluids, buoyancy, surface properties of fluid; adhesion in dentistry; model of ideal liquid	23.04.2018.	11:00 -12:30	O. Gamulin, PhD
4.	Basic concepts of thermodynamics, I and II laws; mechanical and thermal interactions; Gibbs energy and chemical potential	24.04.2018.	9:00 -10:30	O. Gamulin, PhD
5.	Transport of particles: free diffusion in fluids; 1st Fick law; osmosis; transport of ions through a semi-permeable and a permeable membrane; diffusion in solid body	25.04.2018.	9:00 -10:30	O. Gamulin, PhD
6.	Sources and properties of electric and magnetic fields; Gauss's law	30.04.2018.	9:00 -10:30	S. Dolanski Babić, PhD
7.	Electric and magnetic fields in human body – application in diagnostics	02.05.2018.	10:00 -11:30	O. Gamulin, PhD
8.	Basics of geometrical optics; thick lenses – image formation using principal planes; thin lenses - image formation; lens equation; chromatic and spherical aberrations; basics of wave optics: single-slit diffraction, diffraction gratings	03.05.2018.	9:00 -10:30	O. Gamulin, PhD
9.	Radioactive decays; radiation protection; dosimetry	07.05.2018.	12:00 -13:30	S. Dolanski Babić, PhD
10.	NMR: Magnetic properties of nuclei, the interaction of magnetic moment with	08.05.2018.	9:00 -10:30	O. Gamulin, PhD

	constant external magnetic field; resonance; magnetization and chemical shift			

Laboratory exercise:

No.	Topics	Page
A	Introduction; Analysis of experimental data	1-4
1	Viscosity of fluid (exercise 1) Deformation of rigid body (exercise 1)	53-56 49-52
2	Microscope (exercises 1,2)	39-43
3	Electric circuits (exercises 1-4)	5-11
4	Measurements of gamma source energies by Geiger-Muller counter Electric conductivity of electrolytes (exercise 1)	Additional paper 19-22
5	Analysis of optical emission spectra of gasses	Additional paper
6	Lenses (exercises 1,3)	29-37

Course leader and associates

Ozren Gamulin, PhD, Assistant Professor, Department Head
Sanja Dolanski Babić, PhD, Assistant Professor, Course coordinator
Marko Škrabić, Assistant
Nikola Šegedin, Assistant

Literature

Required literature:

1. The digital version of the course textbook, power point presentations of all lectures and seminars are placed on the web site: https://www.sfzg.unizg.hr/predmet/173111.
2. Physics Laboratory Manual, Ed. M. Balarin, J. Brnjas-Kraljević, O. Gamulin, Medicinska naklada, Zagreb

Recommended literature:

1. J. Newman: Physics of the Life Sciences, Springer, New York 2008
2. I.P. Herman: Physics of the Human Body, Springer, Berlin 2007
3. P. Davidovits: Physics in Biology and Medicine, Harcourt Academic Press, San Diego, 2001.

Required knowledge

- Analytical and quantitative approach to the study of human body functions
- Know how to show and explain the biological processes at the molecular level
- Describe the mechanical phenomena in oral cavity by applying force diagram
- Describe the mechanical properties of tissue and polymer
- Describe the electrical aspects of the oral cavity
- Describe the physical basis of diagnostic methods

Required skills

- Implementation and conversion of measuring Units (SI)

- Graphical presentation of measurement results
- Assessment of result accuracy - calculation of simple errors
- Reading graphs
- Handling simple measuring instruments and results reading

Exam questions

I group

1. Analytical and graphical presentation of the basic mathematical functions: linear, inverse proportionality and exponential
2. Periodic functions: harmonic and non-harmonic functions; Fourier theorem
3. Structure of atom; meaning of quantum numbers; emission and absorption of energy; Paulli's exclusion principle; Heisenberg's uncertainty relation
4. Bonding of atoms into molecules - types of molecular bonds; Van der Waals interactions and hydrogen bond
5. Energy of molecule; vibrational and rotational energies; spectroscopy
6. Basics of mechanics: fundamental forces, force field (vector and scalar presentation), addition of forces – force diagram; energy; Newton's laws of motion
7. Torque and couple of forces; lever - conditions for translational and rotational equilibrium; types of levers in the body; lower jaw as a lever; dental bridge
8. Structure of solids: crystals and polycrystals, metal alloys, polymers
9. Imperfections and defects in crystal lattice: point and line defects
10. Elastic properties – elastic force as a function of intermolecular distance; linear elastic deformations of tissues
11. The occurrence of plastic deformation - the role of dislocation; phenomena in elastic and plastic deformations (malleability, hardening, recovery, fatigue); hardness - methods of determination; thermal expansion and thermal stresses of body
12. Viscoelastic properties of matter; mechanical elements and models
13. Mechanical properties of polymers; deformation in polymers; mechanical model of amorphous polymer
14. Harmonic oscillations: free, damped and forced - resonance; non-harmonic oscillations
15. Nature of the sound wave; wave equation; acoustic pressure; sound intensity and intensity level; acoustic impedance
16. Reflection and refraction of sound waves; absorption of sound; Doppler effect; sound generator
17. Relations between physiological and physical parameters of tone; equal loudness curves; Weber-Fechner law

II group

18. Pressure inside liquid and buoyancy; surface tension and phenomena based on surface tension; adhesion in dentistry
19. Flow - model of ideal liquid, model of real liquid: Newton's law and Poiseuille's law; hydraulic resistance
20. Reological properties of Newtonian and non- Newtonian fluids and polymers
21. Basic principles of thermodynamics; 1st and 2nd law of thermodynamics; reversible and irreversible interactions; mechanical and heat interactions; work, heat, enthalpy, entropy
22. Heat transfer: conduction, convection, evaporation and radiation
23. Spontaneous processes; Gibbs free energy and chemical potential; free diffusion of particles; 1st Fick's law

24. Diffusion of particles through a permeable membrane; membrane permeability; diffusion in solid body
25. Diffusion of particles through a semi permeable membrane – osmosis; osmotic pressure
26. Transport of ions through a semi permeable membrane - Nernst model and equation; transport of ions through a permeable membrane, Goldman- Hodgkin-Katz equation
27. Electric field of point charge, dipole and capacitor; potential energy, potential
28. Sources and properties of the electromagnetic wave – Maxwell theory; Gauss's law
29. Polarization of dielectric in an uniform and steady electric field; relative permittivity, mechanisms of polarization and relaxation times
30. Contact voltage; thermo couple, galvanic cell, galvanic corrosion and galvanic phenomena the mouth;
31. Magnetic field of wire and solenoid; force acting on charge and conductor in external magnetic field, electromagnetic induction
32. Matter in the homogenous and steady magnetic field: diamagnetism, paramagnetism, ferromagnetism
33. Generation of action potential and mechanisms of signal transfer through the nervous system; basic methods of electro diagnostics and magneto diagnostics

III group

34. Basic principles of geometrical optics: plane surface of refraction; total internal reflection; prism
35. Spherical surface of refraction - the image formation and equation; thick lenses – image formation using principal planes; thin lenses - image formation; lens equation
36. Image formation by magnifying glass and compound optical microscope; angular magnification
37. Basic principles of wave optics: single-slit diffraction, diffraction gratings; Rayleigh theory of microscope resolution
38. Metallographic microscope; electron microscope
39. Model of eye as thick lens; spherical and chromatic aberrations; astigmatism; imperfections of human vision: near-sightedness, far-sightedness, presbyopia; resolution of the eye
40. Laser – basic principles; properties of laser beam and interaction with biological tissue
41. Interaction of electromagnetic radiation with biological tissue: ionizing and nonionizing radiation; photoelectric and Compton effect
42. X-ray tube; X-ray spectrum; effects of anode voltage and heating current
43. Interaction of X-radiation with tissue; contrast; penumbra, X-ray film
44. Half thickness of absorber; basics of CT method
45. Radioactive decays; radiation protection; dosimetry
46. Magnetic properties of nuclei, the interaction of magnetic moment with steady external magnetic field; absorption energies of varying magnetic fields – emergence of resonance
47. Parameters of NMR: magnetization and chemical shift; magnetic resonance imaging