Faculty of Medicine

Course title: Medical Physics and Biophysics
Course coordinator: Gordana Žauhar, PhD, Associate Professor
Collaborators: Marta Žuvić, PhD, Associate Professor
Slaven Jurković, PhD, Assistant Professor
Diana Mance, PhD, Senior Assistant
Marija Čargonja, Assistant
Ana Diklić, Assistant

Study program: Integrated Undergraduate and Graduate University Study of Medicine in English
Course status: compulsory
Year: first
ECTS workload coefficient: 6.0
Workload (L+P+S). 75 (L30+P25+S20)

SYLLABUS

COURSE DESCRIPTION (Course information, basic description, general information, teaching overview, required equipment and preparation, etc.)

Medical Physics and Biophysics is an introductory course which gives students an insight into the physical principles required for a better understanding of processes in other fields, such as anatomy, biochemistry, physiology, histology, pathology, etc. The purpose of this course is to motivate students to use the analytical and quantitative approach in the research of human body functions.

COURSE STRUCTURE
Formal lectures: 30 hours
Seminars: 20 hours
Practicals: 25 hours
Total hours: 75

During practicals students will develop abilities and skills in using various measuring devices which are a part of different medical devices. Upon completing this course students will be able to collect data, critically evaluate and interpret the results, as well as correctly use the International System of Units and Measurements in medicine.

Assigned reading:

I.P. Herman. Physics of the Human Body, Springer, Berlin, 2007.

Optional / additional reading:

R. K. Hobbie, B.J. Roth. Intermediate Physics for Medicine and Biology, Springer, New York, 2007.
Davidovits Paul. Physics in Biology and Medicine, Academic Press, Elsevier, 2008.

COURSE TEACHING PLAN

The list of lectures with titles:

L1 Introduction. SI Units.

L2 Fundamental Forces. Statics of the Body. Review of Forces, Torques and Equilibrium.

L3 Mechanics of the Human Body. Implementation of Newton's Laws: Levers in the Body, Passive Walking and High Jump.

L4 Mechanical Properties of Tissues. Elasticity and Strength of Materials. Viscoelastic Properties of Body Tissues – Mechanical Models.

L5 Optics in Medicine. Laws of Refraction and Reflection: Image Formation by Plane and Spherical Surfaces of Refraction.

L6 The Human Eye – the Optical Model.

L7 Image Formation by Lens and Microscope: Resolution of the Microscope and the Eye. Types of Optical Microscopes: Electronic Transmission and Scanning Microscope.

L8 Physical Optics

L9 Fluids. Hydrostatics. Surface Tension and Its Implications. Law of Laplace.

L10 Hydrodynamics. Bernoulli's Equation, Viscosity and Poiseuille's Law. Turbulent Flow.

L11 Rheological Properties of Blood. Physics of the CirculatorySystem. Consequences of Clogged Arteries.

L12 Ideal and Real Gases. Gas Laws. Physics of Breathing.

L13 Basic Principles of Thermodynamics: I and II Law.

L14 Thermodynamics of a Biological system. Transfer of Heat.

L15 Oscillations and Waves

L16 Sound Waves: The Physics of Hearing. Intensity of Sound Waves.

L17 Connection between Physical and Physiological Parameters of Sound.

L18 Ultrasound

L19 Dielectric Properties of Tissues. Tissues in Electric Field. Therapeutic Applications of Electric Fields.

L20 Matter in the External Magnetic Field: A Biological System in the Electric Circuit, Magneto therapy.

L21 Transfer of Particles and Ions through Membranes. Action Potential.

L22 Physical Basis of Electro- and Magneto- Diagnostics (EKG, EEG, EMG).

L23 Structure of Atom and Molecule: Molecular Bonds and Energy States.

L24 Electromagnetic Waves.

L25 Medical Use of X Rays.

L26 Interaction of Photons with Matter.

L27 Structure of the Atomic Nucleus. Nuclear Decay. Decay Rate and Half-life.

L28 Radioactivity. Alfa, Beta and Gamma Decay.

L29 Application of Radioactivity in Medicine.

L30 Detection and Dosimetry of Ionizing Radiation.

The list of seminars with descriptions:

S1 Calculating Measurement Errors and Estimating Measurement Accuracy

S2 Vectors and Operations with Vectors. Graphical Representation of Measurement Results and Interpretation of Graphs. Differential Calculus.

S3 Optics

S4 Levers in the Human Body

S5 Hydromechanics

S6 Physics of Breathing

S7 Sound. Hearing and the Ear.

S8 Diffusion and Osmosis. Transport of Energy and Matter through Cell Membranes.

S9 Medical Use of X-Rays

S10 Application of Radioactive Isotopes in Nuclear Medicine

The list of practicals with descriptions:

Location: Department of Physics, Radmile Matejčić 2 Street, 1st floor, O-162

P0 Introduction to Practicals. General Laboratory Safety Procedures and Rules.

P1 Mechanical Waves

P2 Surface Tension and Viscosity

P3 Calorimetry

P4 Thermal Environmental Conditions

P5 Index of Refraction. Spectroscopy.

P6 Spherical Mirrors and Lenses

P7 Electric Circuits

P8 Measurement of Resistance. The Wheatstone Bridge Method.

P9 Audiometry

P10 Ionizing radiation

P11 Compensation

P12 Compensation

Students' obligations:

The attendance at lectures, seminars and practicals is mandatory. If necessary, a student can be absent from 30% of the classes of the overall course workload, but has to make up for the practicals he/she failed to attend. Students' obligations are course attendance and active participation in all practicals and seminars.
Throughout the course, students have two midterm exams (tests) consisting of 16 questions each. Test 1 covers the topics presented in seminars 1-5. Test 2 covers the topics presented in seminars 6-10.
The completion and proper documentation of each practical as well as the consent of the course instructor are required for course completion.

Evaluation of students' work:
Students can obtain a total of 100 credits (a maximum of 70 credits during the course and a maximum of 30 credits on the final exam). Students are allowed to take the final exam if they acquire a minimum of 40 credits during the trimester.
Students who did not gain 40% on each midterm exam may retake their midterm exams, but henceforth they can only gain **the minimum number of credits required to pass** the midterm exam.
On the final exam, which is worth 30 credits, a student must obtain at least 50% on the written part of exam.
The student who gains between 30 – 39,99 credits during the semester may take the final exam, in which case the only grade he can be awarded, upon completing the final exam, is E.

EXAM (Exam taking, detailed exam description oral/written/practical part, point distribution, grading criteria):

Assessment of students' progress during classes and on the final exam is shown in Table 1.
Table 1.

	Assessment	**Grade Point Maximum**
Midterm Exams	Midterm 1 (16 questions)	16
	Midterm 2 (16 questions)	16
	total	**32**
Practicals	Accepted practicals and reports 10 x 5 x 0.7 credits	35
	total	**35**
Active participation	Active participation during seminars	**3**
TOTAL		**70**
FINAL EXAM	Written part (29 questions)	15
	Oral part	15
	total	**30**
TOTAL		**100**

Partial exams:
Two midterm exams are scheduled during the trimester.
1. Midterm exam. 16 questions
2. Midterm exam. 16 questions

Practicals:
Throughout 10 practicals a student can obtain a maximum of 35 credits.
Each completed and accepted practical is assessed.

Active participation during seminars:
During the trimester student participation and dedication will be monitored. A maximum of 3 points is awarded through active participation.

Final exam:
Students have to pass the written exam (in form of a test consisting of 29 questions, each containing 5 statements) before approaching the oral exam. In order to pass the written part of the exam students have to score at least 50% (15/29 correct answers).

Assessment of the written part of the final exam:

Number of correct answers	Credits
15	1
16	2
17	3
18	4
19	5
20	6
21	7
22	8
23	9
24	10
25	11
26	12
27	13
28	14
29	15

Assessment of the oral part of the final exam:

Grade on oral exam	Credits
sufficient	9
good	11
very good	13
excellent	15

The ECTS grading system is defined by the following criteria:

A (5) – 80-100 credits
B (4) – 70-79,99 credits
C (3) – 60-69,99 credits
D (2) – 50-59,99 credits

E (2) – 40-49,99 credits

Possibility of teaching in another language:

Croatian

Other important information regarding the course:

Retaking the course:

A student who acquires less than 30 credits during the course has failed the course and is graded with **F** and must retake the course **MEDICAL PHYSICS AND BIOPHYSICS.**

COURSE SCHEDULE (for academic year 2017/2018)

Date	Lectures (time and location)	Seminars (time and location)	Practicals (time and location)	Instructor
1/3/2018	L1 (10.15-11.00) L2 (11.15-12.00) P 9 Med. Faculty			Gordana Žauhar, PhD, Associate Professor Marta Žuvić, PhD, Associate Professor
8/3/2018	L3-4 (10.00-12.00) O-029	S1 (12.00-14.00)		Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Senior Assistant
15/3/2018	L5-6 (10.00-12.00) O-029	S2 (12.00-14.00) O-029	P0 gA (9.00-10.00) O-162 P0 gB (14.00-15.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Senior Assistant Marija Čargonja, Assistant
22/3/2018	L7-8 (10.00-12.00) O-029	S3 (12.00-14.00) O-029	P1 gA (8.00-10.00) O-162 P1 gB (14.00-16.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Senior Assistant Marija Čargonja, Assistant
29/3/2018	L9-10 (10.00-12.00) O-029	S4 (12.00-14.00) O-029	P2 gA (8.00-10.00) O-162 P2 gB (14.00-16.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Senior Assistant Marija Čargonja, Assistant

5/4/2018	L11-12 (10.00-12.00) O-029	S5 (12.00-14.00) O-029	P3 gA (8.00-10.00) O-162 P3gB (14.00-16.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Marta Žuvić, PhD, Associate Professor Marija Čargonja, Assistant
12/4/2018	L13-14 (10.00-12.00) O-029		P4 gA (8.00-10.00) O-162 P4 gB (14.00-16.00) O-162	Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Marija Čargonja, Assistant
19/4/2018	L15-16 (10.00-12.00) O-029		P5 gA (8.00-10.00) O-162 P5 gB (14.00-16.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Marija Čargonja, Assistant
26/4/2018	L17-18 (10.00-12.00) O-029	S6 (12.00-14.00) O-029	P6 gA (8.00-10.00) O-162 P6 gB (14.00-16.00) O-162	Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Marta Žuvić, PhD, Associate Professor Marija Čargonja, Assistant
3/5/2018	L19-20 (10.00-12.00) O-029	S7 (12.00-14.00) O-029	P7 gA (8.00-10.00) O-162 P7 gB (14.00-16.00) O-162	Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Gordana Žauhar, PhD, Associate Professor Marija Čargonja, Assistant

10/5/2018	L21-22 (10.00-12.00) O-029	S8 (12.00-14.00) O-029	P8 gA (8.00-10.00) O-162 P8 gB (14.00-16.00) O-162	Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Marta Žuvić, PhD, Associate Professor Marija Čargonja, Assistant
17/5/2018	L23 (10.15-11.00) L24 (11.15-12.00) O-029	S9 (12.00-14.00) O-029	P9 gA (8.00-10.00) O-162 P9 gB (14.00-16.00) O-162	Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Gordana Žauhar, PhD, Associate Professor Slaven Jurković, PhD, Assistant Professor Marija Čargonja, Assistant
24/5/2018	L25-27 (10.00-13.00) O-029	S10 (13.00-15.00) O-029	P10 gA (8.00-10.00) O-162 P10 gB (15.00-17.00) O-162	Ana Diklić, Assistant Slaven Jurković, PhD, Assistant Professor Slaven Jurković, PhD, Assistant Professor Marija Čargonja, Assistant
7/6/2018	L28-30 (10.00-13.00) O-029		P11,12 gA (8.00-10.00) O-162 P11,12 gB (13.00-17.00) O-162	Ana Diklić, Assistant Slaven Jurković, PhD, Assistant Professor Marija Čargonja, Assistant

List of lectures, seminars, and practicals:

	LECTURES (Topic)	Teaching Hours	Location
L 1	Introduction. SI Units.	1	Faculty of Medicine Lecture room 9
L 2	Fundamental Forces. Statics of the Body. Review of Forces, Torques and Equilibrium.	1	Faculty of Medicine Lecture room 9
L 3	Mechanics of the Human Body. Implementation of Newton's Laws: Levers in the Body, Passive Walking and High Jump.	1	Department of Physics, O-029
L 4	Mechanical Properties of Tissues. Elasticity and Strength of Materials. Viscoelastic Properties of Body Tissues – Mechanical Models.	1	Department of Physics, O-029
L 5	Optics in Medicine. Laws of Refraction and Reflection: Image Formation by Plane and Spherical Surfaces of Refraction.	1	Department of Physics, O-029
L 6	The Human Eye – the Optical Model.	1	Department of Physics, O-029
L 7	Image Formation by Lens and Microscope: Resolution of the Microscope and the Eye. Types of Optical Microscopes: Electronic Transmission and Scanning Microscope.	1	Department of Physics, O-029
L 8	Physical Optics	1	Department of Physics, O-029
L 9	Fluids. Hydrostatics. Surface Tension and Its Implications. Law of Laplace.	1	Department of Physics, O-029
L 10	Hydrodynamics. Bernoulli's Equation, Viscosity and Poiseuille's Law. Turbulent Flow.	1	Department of Physics, O-029
L 11	Rheological Properties of Blood. Physics of the Circulatory System. Consequences of Clogged Arteries.	1	Department of Physics, O-029
L 12	Ideal and Real Gases. Gas Laws. Physics of Breathing.	1	Department of Physics, O-029
L 13	Basic Principles of Thermodynamics: I and II Law.	1	Department of Physics, O-029
L 14	Thermodynamics of a Biological system. Transfer of Heat.	1	Department of Physics, O-029
L 15	Oscillations and Waves	1	Department of Physics, O-029
L 16	Sound Waves: The Physics of Hearing. Intensity of Sound Waves.	1	Department of Physics, O-029
L 17	Connection between Physical and Physiological Parameters of Sound.	1	Department of Physics, O-029
L 18	Ultrasound	1	Department of Physics, O-029
L 19	Dielectric Properties of Tissues. Tissues in Electric Field. Therapeutic Applications of Electric Fields.	1	Department of Physics, O-029
L 20	Matter in the External Magnetic Field: A Biological System in the Electric Circuit, Magneto therapy.	1	Department of Physics, O-029
L 21	Transfer of Particles and Ions through Membranes. Action Potential.	1	Department of Physics, O-029
L 22	Physical Basis of Electro- and Magneto- Diagnostics (EKG, EEG, EMG).	1	Department of Physics, O-029

L 23	Structure of Atom and Molecule: Molecular Bonds and Energy States.	1	Department of Physics, O-029
L 24	Electromagnetic Waves	1	Department of Physics, O-029
L 25	Medical Use of X Rays.	1	Department of Physics, O-029
L 26	Interaction of Photons with Matter.	1	Department of Physics, O-029
L 27	Structure of the Atomic Nucleus. Nuclear Decay. Decay Rate and Half-life.	1	Department of Physics, O-029
L 28	Radioactivity. Alfa, Beta and Gamma Decay.	1	Department of Physics, O-029
L 29	Application of Radioactivity in Medicine.	1	Department of Physics, O-029
L 30	Detection and Dosimetry of Ionizing Radiation.	1	Department of Physics, O-029
	TOTAL TEACHING HOURS	30	

	SEMINARS (topic)	Teaching Hours	Location
S1	Calculating Measurement Errors and Estimating Measurement Accuracy	2	Department of Physics, O-029
S2	Vectors and Operations with Vectors. Graphical Representation of Measurement Results and Interpretation of Graphs. Differential Calculus.	2	Department of Physics, O-029
S3	Optics	2	O-029
S4	Levers in the Human Body	2	O-029
S5	Hydromechanics	2	O-029
S6	Physics of Breathing	2	O-029
S7	Sound. Hearing and the Ear.	2	O-029
S8	Diffusion and Osmosis. Transport of Energy and Matter through Cell Membranes.	2	O-029
S9	Medical Use of X-Rays	2	O-029
S10	Application of Radioactive Isotopes in Nuclear Medicine	2	O-029
	TOTAL TEACHING HOURS	20	

	PRACTICALS (content)	Teaching Hours	Location
P0	Introduction to Practicals. General Laboratory Safety Procedures and Rules.	1	Department of Physics, O-162
P1	Mechanical Waves	2	O-162
P2	Surface Tension and Viscosity	2	O-162
P3	Calorimetry	2	O-162
P4	Thermal Environmental Conditions	2	O-162
P5	Index of Refraction. Spectroscopy.	2	O-162
P6	Spherical Mirrors and Lenses	2	O-162
P7	Electric Circuits	2	O-162
P8	Measurement of Resistance. The Wheatstone Bridge Method.	2	O-162
P9	Audiometry	2	O-162
P10	Ionizing radiation	2	O-162

P11	**Compensation**	2	**O-162**
P12	**Compensation**	2	**O-162**
	TOTAL TEACHING HOURS	**25**	

	Final Exam Dates
1.	**15/6/2018**
2.	**29/6/2018**
3.	**13/7/2018**
4.	**3/9/2018**
5.	**17/9/2018**