



Course: Medical Physics and Biophysics

Course Coordinator: Associate Professor Gordana Žauhar, PhD

Department: Department of Medical Physics and Biophysics

Study program: Integrated Undergraduate and Graduate University Study of Medicine in English language

Study year: first

Academic year: 2020/2021

SYLLABUS

Course description (a brief description of the course, general instructions, where and in what form the lessons are organized, necessary equipment, instructions for attendance and preparation for classes, student obligations, 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

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 topics and descriptions):

L1 Introduction. SI Units.

L2 Optics in Medicine. Laws of Refraction and Reflection: Image Formation by Plane and Spherical Surfaces of Refraction.

L3 The Human Eye – the Optical Model.

L4 Errors of optical systems

L5 Image Formation by Lens and Microscope: Resolution of the Microscope and the Eye.

L6 Types of Optical Microscopes. Electron microscopes.

- L7 Fundamental Forces. Statics of the Body. Review of Forces, Torques and Equilibrium.**
- L8 Mechanics of the Human Body. Implementation of Newton's Laws: Levers in the Body, Passive Walking and High Jump.**
- L9 Mechanical Properties of Tissues. Elasticity and Strength of Materials. Viscoelastic Properties of Body Tissues – Mechanical Models.**
- L10 Fluids. Hydrostatics. Surface Tension and Its Implications. Law of Laplace.**
- L11 Hydrodynamics. Bernoulli's Equation, Viscosity and Poiseuille's Law. Turbulent Flow.**
- L12 Rheological Properties of Blood. Physics of the Circulatory System. Consequences of Clogged Arteries.**
- L13 Ideal and Real Gases. Gas Laws. Physics of Breathing.**
- L14 Basic Principles of Thermodynamics: I and II Law.**
- L15 Thermodynamics of a Biological system. Transfer of Heat.**
- L16 Transfer of Particles and Ions through Membranes. Action Potential.**
- L17 Physical Basis of Electro- and Magneto- Diagnostics (EKG, EEG, EMG).**
- L18 Dielectric Properties of Tissues. Tissues in Electric Field. Therapeutic Applications of Electric Fields.**
- L19 Matter in the External Magnetic Field: A Biological System in the Electric Circuit, Magneto therapy**
- L20 Oscillations and Waves**
- L21 Sound Waves: The Physics of Hearing. Intensity of Sound Waves.**
- L22 Connection between Physical and Physiological Parameters of Sound.**
- L23 Structure of Atom and Molecule: Molecular Bonds and Energy States.**
- L24 Electromagnetic Waves.**
- L25 Medical Use of X Rays.**
- L26 Structure of the Atomic Nucleus. Nuclear Decay. Decay Rate and Half-life.**
- L27 Radioactivity. Alfa, Beta and Gamma Decay.**
- L28 Interaction of Photons with Matter. Detection and Dosimetry of Ionizing Radiation.**
- L29 Application of Ultrasound in Medicine.**
- L30 Final Lecture and Preparation for Final Exam**

The list of seminars with descriptions:

- S1 Calculating Measurement Errors and Estimating Measurement Accuracy**
- S2 Optics**
- S3 Vectors and Operations with Vectors. Graphical Representation of Measurement Results and**

interpretation of Graphs. Differential Calculus.

S4 Levers in the Human Body

S5 Hydromechanics

S6 Physics of Breathing

S7 Diffusion and Osmosis. Transport of Energy and Matter through Cell Membranes.

S8 Sound. Hearing and the Ear.

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 Audiometry

P3 Surface Tension and Viscosity

P4 Calorimetry

P5 Thermal Environmental Conditions

P6 Index of Refraction. Spectroscopy

P7 Spherical Mirrors and Lenses

P8 Electric Circuits

P9 Measurement of Resistance. The Wheatstone Bridge Method.

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 14 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 50 credits during the course and a maximum of 50 credits on the final exam). Students are allowed to take the final exam if they acquire a minimum of 25 credits during the trimester.
 Students who did not gain 50% on each midterm exam may retake their midterm exams.
 On the final exam, which is worth 50 credits, a student must obtain at least 50% on the written part of exam.

Assessment (exams, description of written / oral / practical exam, the scoring 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 (14 questions)	14
	Midterm 2 (14 questions)	14
	total	28
Practicals	Accepted practicals and reports 10 x 5 x 0.4 credits	20
	total	48
Active participation	Active participation during seminars	2
TOTAL		50
FINAL EXAM	Written part (25 questions)	25
	Oral part	25
	total	50
TOTAL		100

Partial exams:

Two midterm exams are scheduled during the trimester.

1. Midterm exam. 14 questions
2. Midterm exam. 14 questions

Practicals:

Throughout 10 practicals a student can obtain a maximum of 20 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 2 points is awarded through active participation.

Final exam:

Students have to pass the written exam (in form of a test consisting of 25 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% (13/25 correct answers).

Assessment of the written part of the final exam:

Number of correct answers	Credits
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25

Assessment of the oral part of the final exam:

Grade on oral exam	Credits
sufficient	10-13
good	14-17
very good	18-21
excellent	22-25

The ECTS grading system is defined by the following criteria:

- A (5) – 90-100 credits
- B (4) – 75-89,9 credits
- C (3) – 60-74,9 credits
- D (2) – 50-59,9 credits

Other important information regarding to the course:

Retaking the course:

A student who acquires less than 25 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 2020/2021)

Date	Lectures (time and place)	Seminars (time and place)	Practicals (time and place)	Instructor
03/3/2021	L1 (10:15-11:00) L2 (11:15-12:00) O-029			Gordana Žauhar, PhD, Associate Professor
10/3/2021	L3-4 (10:15-11:45) O-029			Gordana Žauhar, PhD, Associate Professor
12/3/2021		S1 gA (09.00-11.00) LH9 S1 gB (11.00-13.00) LH9		Diana Mance, PhD, Assistant Professor Diana Mance, PhD, Assistant Professor
17/3/2021	L5-6 (10:15-11.45) O-029		P0 gA, B (9.00-10.00) O-162 P0 gC, D (12.00-13.00) O-162 P0 gE (13.00-14.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
19/3/2021		S2 gA (09.00-11.00) LH9 S2 gB (11.00-13.00) LH9		Diana Mance, PhD, Assistant Professor Diana Mance, PhD, Assistant Professor
24/3/2021	L7-8 (10:15-11.45) O-029		P1 gA, B (8.00-10.00) O-162 P1 gC, D (12.00-14.00) O-162 P1 gE (14.00-16.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
26/3/2021		S3 gA (09.00-11.00)		Diana Mance, PhD, Assistant Professor

		LH9 S3 gB (11.00-13.00) LH9		Diana Mance, PhD, Assistant Professor
31/3/2021	L9-10 (10:15-11:45) O-029		P2 gA, B (8.00-10.00) O-162 P2 gC, D (12.00-14.00) O-162 P2 gE (14.00-16.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
02/4/2021		S4 gA (09.00-11.00) LH9 S4 gB (11.00-13.00) LH9		Diana Mance, PhD, Assistant Professor Diana Mance, PhD, Assistant Professor
07/4/2021	L11-12 (10:15- 11:45) O-029		P3 gA, B (8.00-10.00) O-162 P3 gC, D (12.00-14.00) O-162 P3 gE (14.00-16.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
09/4/2021		S5 gA (09.00-11.00) LH9 S5 gB (11.00-13.00) LH9		Marta Žuvić, PhD, Associate Professor Marta Žuvić, PhD, Associate Professor
14/4/2021	L13-14 (10:15-11:45) O-029		P4 gA, B (8.00-10.00) O-162 P4 gC, D (12.00-14.00)	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant

			O-162 P4 gE (14.00-16.00) O-162	Ana Diklić, Assistant
16/4/2021		1 st MIDTERM EXAM (9:00-11:00) LH9 & LH3		
21/4/2021	L15-16 (10:15-11:45) O-029		P5 gA, B (8.00-10.00) O-162 P5 gC, D (12.00-14.00) O-162 P5 gE (14.00-16.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
28/4/2021	L17-18 (10:15-11:45) O-029		P6 gA, B (8.00-10.00) O-162 P6 gC, D (12.00-14.00) O-162 P6 gE (14.00-16.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant
30/4/2021		S6 gA (09.00-11.00) LH9 S6 gB (11.00-13.00) LH9		Gordana Žauhar, PhD, Associate Professor Gordana Žauhar, PhD, Associate Professor
05/5/2021	L19 (10:15-11:00) L20 (11:15-12:00) O-029		P7 gA, B (8:00-10:00) O-162 P7 gC, D (12:00-14:00) O-162 P7 gE (14:00-16:00)	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Marta Žuvić, PhD, Associate Professor Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant Ana Diklić, Assistant

			O-162	
07/5/2020		S7 gA (09:00-11:00) LH9		Marta Žuvić, PhD, Associate Professor
		S7 gB (11:00-13:00) LH9		Marta Žuvić, PhD, Associate Professor
12/5/2021	L21-22 (10:15-11:45) O-029		P8 gA, B (8.00-10.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant
			P8 gC, D (12.00-14.00) O-162	Gordana Žauhar, PhD, Associate Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant
			P8 gE (14.00-16.00) O-162	Ana Diklić, Assistant
14/5/2021		S8 gA (09:00-11:00) LH9		Gordana Žauhar, PhD, Associate Professor
		S8 gB (11:00-13:00) LH9		Gordana Žauhar, PhD, Associate Professor
19/5/2021	L23-24 (10-12:00) O-029		P9 gA, B (8.00-10.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant
			P9 gC, D (12.00-14.00) O-162	Slaven Jurković, PhD, Assistant Professor Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant
			P9 gE (14.00-16.00) O-162	Ana Diklić, Assistant
21/5/2021		S9 gA (09.00-11.00) LH9		Slaven Jurković, PhD, Assistant Professor
		S9 gB (11.00-13.00) LH9		Slaven Jurković, PhD, Assistant Professor
26/5/2021	L25-26 (10:15-11:45)		P10 gA, B (8.00-10.00) O-162	Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant

	O-029		<p>P10 gC, D (12.00-14.00) O-162</p> <p>P10 gE (14.00-16.00) O-162</p>	<p>Slaven Jurković, PhD, Assistant Professor</p> <p>Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant</p> <p>Ana Diklić, Assistant</p>
28/5/2021		<p>S10 gA (09.00-11.00) LH9</p> <p>S10 gB (11.00-13.00) LH9</p>		<p>Slaven Jurković, PhD, Assistant Professor</p> <p>Slaven Jurković, PhD, Assistant Professor</p>
02/6/2021	L27-28 (10:15-11.45) O-029		<p>P11 gA, B (8.00-10.00) O-162</p> <p>P11 gC, D (12.00-14.00) O-162</p> <p>P11 gE (14.00-16.00) O-162</p>	<p>Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant</p> <p>Slaven Jurković, PhD, Assistant Professor</p> <p>Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant</p> <p>Ana Diklić, Assistant</p>
04/6/2021		2 nd MIDTERM EXAM (9 – 11:00) LH9 & LH3		
09/6/2021	L29-30 (10-12:00) O-029		<p>P12 gA, B (8.00-10.00) O-162</p> <p>P12 gC, D (12.00-14.00) O-162</p> <p>P12 gC (14.00-16.00) O-162</p>	<p>Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant</p> <p>Gordana Žauhar, PhD, Associate Professor</p> <p>Diana Mance, PhD, Assistant Professor Ana Diklić, Assistant</p> <p>Ana Diklić, Assistant</p>

List of lectures and seminars:

	LECTURES (Topics)	Teaching hours	Location/Lecture room
L1	Introduction. SI Units.	1	Department of Physics/ O-029
L2	Optics in Medicine. Laws of Refraction and Reflection: Image Formation by Plane and Spherical Surfaces of Refraction.	1	LH O-029
L3	The Human Eye – the Optical Model.	1	LH 0-029
L4	Errors of optical systems	1	LH O-029
L5	Image Formation by Lens and Microscope	1	LH 0-029
L6	Types of Optical Microscopes. Electron microscopes	1	LH O-029
L7	Fundamental Forces. Statics of the Body. Review of Forces, Torques and Equilibrium.	1	LH 0-029
L8	Mechanics of the Human Body. Implementation of Newton's Laws: Levers in the Body, Passive Walking and High Jump.	1	LH O-029
L9	Mechanical Properties of Tissues. Elasticity and Strength of Materials. Viscoelastic Properties of Body Tissues – Mechanical Models.	1	LH 0-029
L10	Fluids. Hydrostatics. Surface Tension and Its Implications. Law of Laplace.	1	LH O-029
L11	Hydrodynamics. Bernoulli's Equation, Viscosity and Poiseuille's Law. Turbulent Flow.	1	LH 0-029
L12	Rheological Properties of Blood. Physics of the Circulatory System. Consequences of Clogged Arteries.	1	LH O-029
L13	Ideal and Real Gases. Gas Laws. Physics of Breathing.	1	LH 0-029
L14	Basic Principles of Thermodynamics: I and II Law.	1	LH O-029
L15	Thermodynamics of a Biological system. Transfer of Heat.	1	LH 0-029
L16	Transfer of Particles and Ions through Membranes. Action Potential.	1	LH O-029
L17	Physical Basis of Electro- and Magneto- Diagnostics (EKG, EEG, EMG).	1	LH 0-029
L18	Dielectric Properties of Tissues. Tissues in Electric Field. Therapeutic Applications of Electric Fields.	1	LH O-029
L19	Matter in the External Magnetic Field: A Biological System in the Electric Circuit, Magneto therapy	1	LH 0-029
L20	Oscillations and Waves	1	LH O-029
L21	Sound Waves: The Physics of Hearing. Intensity of Sound Waves.	1	LH 0-029
L22	Connection between Physical and Physiological Parameters of Sound.	1	LH O-029
L23	Structure of Atom and Molecule: Molecular Bonds and Energy States.	1	LH 0-029
L24	Electromagnetic Waves.	1	LH O-029
L25	Medical Use of X Rays.	1	LH 0-029
L26	Structure of the Atomic Nucleus. Nuclear Decay. Decay Rate and Half-life.	1	LH O-029
L27	Radioactivity. Alfa, Beta and Gamma Decay.	1	LH 0-029
L28	Interaction of Photons with Matter. Detection and Dosimetry of Ionizing Radiation.	1	LH O-029
L29	Application of Ultrasound in Medicine.	1	LH 0-029
L30	Final Lecture and Preparation for Final Exam.	1	LH O-029
	TOTAL TEACHING HOURS	30	

	SEMINARS (Topics)	Teaching hours	Location/Lecture room
S1	Calculating Measurement Errors and Estimating Measurement Accuracy	2	Faculty of Medicine/ LH9
S2	Optics	2	Faculty of Medicine/ LH9
S3	Vectors and Operations with Vectors. Graphical Representation of Measurement Results and Interpretation of Graphs. Differential Calculus.	2	Faculty of Medicine/ LH9
S4	Levers in the Human Body	2	Faculty of Medicine/ LH9
S5	Hydromechanics	2	Faculty of Medicine/ LH9
S6	Physics of Breathing	2	Faculty of Medicine/ LH9
S7	Diffusion and Osmosis. Transport of Energy and Matter through Cell Membranes.	2	Faculty of Medicine/ LH8
S8	Sound. Hearing and the Ear.	2	Faculty of Medicine/ LH8
S9	Medical Use of X-Rays	2	Faculty of Medicine/ LH8
S10	Application of Radioactive Isotopes in Nuclear Medicine	2	Faculty of Medicine/ LH8
	TOTAL TEACHING HOURS	20	

	FINAL EXAM DATES
1.	14/06/2021
2.	28/06/2021
3.	12/07/2021
4.	03/09/2021
5.	17/09/2021