Sveučilište u Rijeci
University of Rijeka

Sveučilište u Rijeci • Fakultet dentalne medicine
University of Rijeka • Faculty of Dental Medicine
Krešimirova 40/42 • 51000 Rijeka • CROATIA
Phone : + 385 51 559 200; 559 202, 559 203

Course: Physics
Course Coordinator: Christian Pfeifer, PhD, Associate Professor
Course Collaborators: Boris Mifka, PhD, Assistant Professor; Klaudija Lončarić, mag. educ. phys. et inf.
Department: Faculty of Physics, University of Rijeka
Study program: University Integrated Undergraduate and Graduate Study of Dental Medicine (in English)
Study year: 1st
Academic year: 2026/2027

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.):

The Physics course is taught during the winter semester of the first year of University Study of Dental Medicine and consists of 15 hours of lectures, 15 hours of seminars, and 15 hours of exercises (3 ECTS).

The course is held in the lecture halls of the University of Rijeka's Faculty of Physics (Campus Trsat, Ulica Radmile Matejčić 2). Lectures and seminars are held on the first floor of the University Departments building in lecture hall O-161, while practical exercises are held in room O-162.

The course's goal is to introduce, acquire, and apply basic physical knowledge required to explain and comprehend the biological functions of the human body.

The lectures will cover the fundamentals of physics (biomechanics, fluid mechanics, gas physics, thermodynamics, oscillations and waves, optics, electricity and magnetism) that are required for understanding the important physiological functions as well as the preservation and treatment of the human organism.

In the seminars, the theoretical knowledge gained in the lectures is applied to problems such as the action of forces on a rigid body and the statics of teeth, the mechanics of motion, the physics of blood flow, respiration, hearing and vision. Students are expected to participate actively in the seminars. Midterm exams will be given at the end of the first and second halves of the seminar program.

Practical exercises are designed to teach students the fundamentals of using simple measuring instruments. In the practical exercises, students apply the theoretical knowledge gained in the lectures and learn the fundamental rules of error analysis and proper results presentation. The preparation for the exercises as well as the processing of measurement results will be graded. During the exercises, protective clothing (lab coat) is required.

All aspects of the course are obligated and must be completed in order for students to take the final exam.

Assigned reading:

I.P. Herman. Physics of the Human Body, Springer, Berlin, 2007.
G. Žauhar, M. Čargonja, M. Paulišić, D. Mance, B. Dresto-Alač, A. Lekić, M. et al. Laboratory Practicals, University of Rijeka, Rijeka, 2018.

Optional/additional reading:

Davidovits Paul. Physics in Biology and Medicine, Academic Press, Elsevier, 2008.

COURSE TEACHING PLAN:

The list of lectures (with topics and descriptions):

L1 Orientation Lecture. Physics measurements, physical quantities and measurement units.
Learning outcomes
Understand the course's objective and methodology.
Learn the rules of the course, particularly how to collect points and take the exam.
Be able to distinguish between groups of measurement units.
Understand how to convert units.

L2 Geometrical optics
Learning outcomes
Understand the difference between geometrical optics and wave optics, their limitations and applicability.
State the laws of geometrical optics.
Define and explain total internal reflection and its applications in medicine and dentistry.
Construct images of objects for mirrors and lenses.
Describe the physical model of the eye.
Explain accommodation of the eye.
List the basic eye defects and explain the use of lenses using vision correction as an example.

L3 Motion, forces, work, and energy and conservation laws.
Learning outcomes
Distinguish between various types of simple motions.
List all of Newton's laws.
Recognize different kinds of energy and forces.
Recognize the significance of conservation laws.

L4 Rigid body rotation, torque and lever
Learning outcomes
Understand equilibrium and the law of the lever.
Understand the application of the law of the lever in biomechanics with focus on the application in dental medicine.
Explain problem of levers in the human body using force diagrams and Newton's equation of motion.

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L5 Heat
Learning outcomes
State the 1st and 2nd laws of thermodynamics.
Learn about thermodynamics and thermodynamic functions as the basis of physiology.
Explain metabolic rate.
List the basic mechanisms of heat transfer and explain each of them using the example of heat exchange between the human body and the environment.
Discuss the thermo-physical properties of tissues and organs.

L6 Gas laws
Learning outcomes
Distinguish between ideal and real gases.
State the gas laws.
Describe the mechanism of respiration using the gas laws.
Explain the phase diagram.
Define equilibrium vapour pressure and partial pressure.
Discuss the solubility of gases in liquids.
Explain the problems of respiration at reduced and increased atmospheric pressure.

L7 Fluid mechanics
Learning outcomes
Understand the concept of pressure.
To distinguish between different types of pressure.
State the continuity equation and Bernoulli's principle.
Discuss how the continuity equation and Bernoulli's principle are applied to blood flow in the circulatory system.
Explain Poiseuille's law using blood flow in the circulatory system as an example.
Discuss how viscosity affects blood flow.

L8 Fundamentals of electricity and magnetism.
Learning outcomes
Acquire the basic concepts of electricity and magnetism and apply the acquired knowledge to the transport of ions across the cell membrane.
Understand the effects of electric current on the human body.
Explain the processes of diffusion and osmosis.
Understand how electrical activity affects the function of various organs.

L9 Oscillations and waves, sound.
Learning outcomes
Name the basic parameters used to characterise oscillations.
State the differences between various types of waves.
Distinguish between infrasound, audible sound, and ultrasound.
Relate sound intensity and energy transfer.
Discuss hearing damage in relation to relative sound intensity levels.

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L10 Final lecture
Learning outcomes
Systematize the material presented in the previous lectures.

The list of seminars with descriptions:

S1 Geometrical optics
Learning outcomes
Application of the laws of geometrical optics.
Acquire the ability to construct images for spherical mirrors and lenses for different object positions.
Analyse the properties of the image produced by spherical mirrors and lenses for different object positions.
Apply the conjugation equation to calculate the focal length of spherical mirrors and lenses.
Application of appropriate lenses for vision correction.

S2 Vectors, work, power, energy, conservation laws.
Learning outcomes
Use the fundamentals of vector calculus to separate forces and calculate the resultant force.
Differentiate between scalar and vector products.
Recognize and apply work, power, and energy physical quantities to various types of human body motion.
Use conservation laws to solve problems involving various types of human body motion.

S3 Torque and leverage.
Learning outcomes
Distinguish between different types of levers and recognize them in the human body.
Apply equilibrium conditions to a lever with particular reference to levers in the human body.

S4 Heat
Learning outcomes
Calculate the linear, surface, and volumetric thermal expansion of various materials.
Calculate the final temperature of a mixture.
Calculate the metabolic rate for various physical activities.

S5 Gas laws
Learning outcomes
Use gas laws to solve problems involving the physics of respiration.
Solve respiratory problems at normal, reduced, and increased external pressures.

S6 Hydromechanics
Learning outcomes
Apply the basic physical laws of hydrostatics and hydrodynamics to examples related to human blood flow.
Calculate hydraulic resistance in blood flow for various blood vessel geometries and blood vessel connection types.
Determine the Reynolds number and the cases where turbulent flow occurs.

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S7 Fundamentals of electricity and magnetism. Transport of substances.
Learning outcomes
Calculate the total resistance in different electric circuits.
Solve electrical conductivity and axon magnetic field problems.
Apply Fick's 1st law to solve diffusion problems.
Calculating the equilibrium membrane potential.
Calculating the osmolarity and osmotic pressure of the solution.

S8 Sound
Learning outcomes
Solve numerical problems involving sound intensity.
Understand how to apply the decibel scale.

The list of practicals with descriptions:

P1 Introduction. Presentation of measurement results with error analysis.
Learning outcomes
Process measurement results and perform simple error analysis.
Measurement unit conversion.
Graphical representation of measurement results.

P2 Audiometry
Learning outcomes
Define and explain sound intensity, intensity level, and loudness.
Differentiate between tone, musical sound, and noise.
Describe the connection between acoustic parameters and physiological sensations.
Learn about the physical principles behind audiometry.

P3 Calorimetry
Learning outcomes
Distinguish between the heat capacity and the specific heat capacity of a substance.
Apply Richman's rule to determine the specific heat capacity of a substance.
Define the specific heat of fusion of a substance.

P4 Assessment of thermal environmental conditions
Learning outcomes
Describe the basic types of heat transfer between the organism and the environment.
Define and determine the humidity.
Determine the velocity of air flow.
Determine the average radiant temperature.

P5 Electrical circuits
Learning outcomes
Use simple measuring instruments (voltmeter, ammeter).
Analyse different electrical circuits.

Apply basic laws and rules of electricity (e.g. Ohm's law, Kirchhoff's rules) to explain changes in resistance/voltage/current in different circuits.

P6 Refraction of light
Learning outcomes
Understand the law of refraction of light.
Apply the law of refraction to calculate the refractive index of a glass plate and prism.
Know the principle of operation of the spectroscope.
Distinguish between a line spectrum and a continuous spectrum.

P7 Spherical mirrors and lenses
Learning outcomes
Analyse the characteristics of the image formed by spherical mirrors and lenses for various object distances.
Apply the conjugation equation to calculate the focal length of spherical mirrors and lenses.
Construct images for spherical mirrors and lenses.

P8 Compensations

Students' obligations:

Assessment (exams, description of written / oral / practical exam, the scoring criteria):

The verification of learning outcomes is accomplished through a continuous review of knowledge via:

(a) two midterm exams that involve solving numerical problems related to the seminar material; and

(b) assessment of the practical exercises, which includes assessment of the student's preparation for the exercises, assessment of the exercise performance, and assessment of the processing and interpretation of the measurement results.

The final exam consists of a written and an oral component in which the theoretical knowledge taught in lectures is tested.

A student may miss 20% of classes only for health reasons, which is justified by a doctor's excuse. Attendance of lectures, seminars and exercises is compulsory. Compensating for practical exercises is only possible during the designated times.

If a student misses more than 20% of the classes, excused or unexcused, he/she will not be able to continue the course and will lose the possibility to take the final exam. As a result, he/she will receive 0 ECTS points and will be graded F.

Of the total 100 points, a student may earn 50 points in class and 50 points on the final exam. Students are graded using the ECTS (A-E) and a numerical system (1-5). To be eligible to take the final exam, a student must earn at least 25 points out of the maximum 50 points that can be

earned in class. Students who receive a score of 24.9 or lower (Category F) must re-enrol in the course.

The student receives evaluation points in the following ways:

	Assessment	**Grade Point Maximum**
Midterm Exams	Midterm 1 (16 questions)	16
	Midterm 2 (16 questions)	16
Practicals	Accepted practicals and reports 6 x 5 x 0.6 credits	18
FINAL EXAM	Written part (25 questions)	30
	Oral part	20
TOTAL POINTS		**100**

First midterm exam (up to 16 points)
The first midterm exam consists of 16 problems and covers the material of the first four seminars (S1 - S4). In the exam, students solve multiple-choice questions. For each question there are five possible answers, of which more than one can be correct. Only tasks with completely correct answers will be graded. One point is awarded for each correctly solved task.

Second midterm exam (up to 16 points)
The second midterm exam consists of 16 problems and covers the material of the last four seminars (S5 – S8). In the exam, students solve multiple-choice questions. For each question there are five possible answers, of which more than one can be correct. Only tasks with completely correct answers will be graded. One point is awarded for each correctly solved task.

The student has the right to take each midterm exam two times.

Practicals (up to 18 points)

All six exercises must be completed by the students. Students will process the results of the measurements on the exercises, and their work and processing will be graded from 1 to 5 at the end of each exercise. All exercises with a positive grade (≥ 2) are required to take the final exam. The total score of the exercises is calculated by adding the scores of all exercises and multiplying the result by 0.6. Based on the results of the practical exercises, a maximum of 18 points can be earned.

The final exam (up to 50 points)

The student will take the final exam at the end of the course if he or she has received at least 25 points and all practical exercises have been evaluated positively. The final exam is divided into two parts: written and oral.

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The written examination consists of 30 multiple choice questions. There are five possible answers to each question or statement, and more than one can be correct. Only tasks with completely correct answers will be graded. A written examination is considered successful if at least 15 correct answers are provided.

The oral examination is mandatory. A student may only take the oral examination if he or she has passed the written part of the final examination. The student is given three questions to answer for a total of 20 points. To pass the exam, the student must answer all three questions correctly.

The total of the points (percentages) earned in class and on the final exam constitutes the final grade. The table below depicts the grading system.

Points (%)	**Grade**	**ECTS**
90 - 100%	5	A
75 – 89.9%	4	B
60 – 74.9%	3	C
50 – 59.9%	2	D

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COURSE SCHEDULE (for the academic year 2026/2027)

Date	Lectures (time and place)	Seminars (time and place)	Practicals (time and place)	Instructor
10/11/2026 Tuesday	L1,2 (10:00-13:00) O-152 / Faculty of Physics	S1 (13:00-15:00) O-152 / Faculty of Physics	P1 (15:00-16:00) O-152 / Faculty of Physics	Christian Pfeifer Boris Mifka Klaudija Lončarić
11/11/2026 Wednesday	L3,4 (12:30-15:30) O-161 / Faculty of Physics	S2 (08:00-10:00) O-152 / Faculty of Physics	P2 (10:00-12:00) O-162 / Faculty of Physics	Boris Mifka Klaudija Lončarić Christian Pfeifer
12/11/2026 Thursday	L5 (13:00-14:00) O-152 / Faculty of Physics	S3, S4 (09:00-12:00) O-152 / Faculty of Physics		Boris Mifka Christian Pfeifer
13/11/2026 Friday			P3 (14:00-16:00) O-162 / Faculty of Physics	Klaudija Lončarić
17/11/2026 Tuesday		**FIRST MIDTERM EXAM (13:00-14:30) O-161 / Faculty of Physics**	P4 (08:00-10:00) O-162 / Faculty of Physics	Klaudija Lončarić Boris Mifka
19/11/2026	L6 (08:00-10:00)			Christian Pfeifer

Thursday	O-152 / Faculty of Physics	S5 (10:00-12:00) O-152 / Faculty of Physics		Boris Mifka
20/11/2026 Friday	L7 (10:00-12:00) O-152 / Faculty of Physics	S6 (12:00-14:00) O-161 / Faculty of Physics	P5 (14:00-16:00) O-162 / Faculty of Physics	Christian Pfeifer Boris Mifka Klaudija Lončarić
24/11/2026 Tuesday	L8 (08:00-10:00) O-152 / Faculty of Physics	S7 (12:00-14:00) O-152 / Faculty of Physics	P6 (10:00-12:00) O-162 / Faculty of Physics	Klaudija Lončarić Christian Pfeifer Boris Mifka
25/11/2026 Wednesday	L9,10 (12:00-14:00) O-161 / Faculty of Physics	S8 (14:00-15:00) O-161 / Faculty of Physics	P7 (10.00-12:00) O-162 / Faculty of Physics P8 (15:00 – 17:00) O-162 / Faculty of Physics	Klaudija Lončarić Christian Pfeifer Boris Mifka Klaudija Lončarić
26/11/2026 Thursday		**SECOND MIDTERM EXAM (10:00-11:30) O-161 / Faculty of Physics**		Boris Mifka

27/11/2026 Friday		MIDTERM EXAM – RETAKE(s) (10:00-11:30) O-161 / Faculty of Physics		Boris Mifka
	FINAL EXAM – written part (12:00-14:00) O-161 / Faculty of Physics **FINAL EXAM – oral part** (14:00-19:00) O-161 / Faculty of Physics			Christian Pfeifer

List of lectures, seminars and practicals:

	LECTURES (Topics)	Teaching hours	Location/Lecture room
L1	Orientation Lecture. Physics measurements, physical quantities and measurement units.	1	Faculty of Physics/O-161
L2	Geometrical optics.	2	Faculty of Physics/O-161
L3	Motion, forces, work, and energy and conservation laws.	1	Faculty of Physics/O-161
L4	Rigid body rotation, torque and lever.	2	Faculty of Physics/O-161
L5	Heat.	1	Faculty of Physics/O-161
L6	Gas laws.	2	Faculty of Physics/O-161
L7	Fluid mechanics.	2	Faculty of Physics/O-161
L8	Fundamentals of electricity and magnetism	2	Faculty of Physics/O-161
L9	Oscillations and waves, sound.	1	Faculty of Physics/O-161
L10	Final lecture	1	Faculty of Physics/O-161
	TOTAL TEACHING HOURS	**15**	

	SEMINARS (Topics)	Teaching hours	Location/Lecture room
S1	Geometrical optics.	3	Faculty of Physics/O-161
S2	Vectors, work, power, energy, conservation laws.	2	Faculty of Physics/O-161

S3	Torque and leverage.	2	Faculty of Physics/O-161
S4	Heat.	1	Faculty of Physics/O-161
S5	Gas laws.	2	Faculty of Physics/O-161
S6	Hydromechanics.	2	Faculty of Physics/O-161
S7	Fundamentals of electricity and magnetism. Transport of substances.	2	Faculty of Physics/O-161
S8	Sound.	1	Faculty of Physics/O-161
	TOTAL TEACHING HOURS	**15**	

	PRACTICALS (Topics)	**Teaching hours**	**Location/Lecture room**
P1	Introduction. Presentation of measurement results with error analysis.	1	Faculty of Physics/O-161
P2	Audiometry	2	Faculty of Physics/O-162
P3	Calorimetry	2	Faculty of Physics/O-162
P4	Assessment of thermal environmental conditions	2	Faculty of Physics/O-162
P5	Electrical circuits	2	Faculty of Physics/O-162
P6	Refraction of light	2	Faculty of Physics/O-162
P7	Spherical mirrors and lenses	2	Faculty of Physics/O-162
P8	Compensations	2	Faculty of Physics/O-162
	TOTAL TEACHING HOURS	**15**	

	FINAL EXAM DATES
1.	27.11.2026.
2.	18.12.2026.
3.	6.7.2027.
5.	14.9.2027.

	Lectures	**Seminars**	**Practicals**	**Total**
Total number	15	15	15	45
On-line				
Percentage				