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 in dental medicine
Course Coordinator: Diana Mance, PhD, Assistant Professor
Course Collaborators: Marija Čargonja
Department: Faculty of Physics, University of Rijeka
Study program: University Integrated Undergraduate and Graduate Study of Dental Medicine (in English)
Study year: 2nd
Academic year: 2023./24.

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 in dental medicine course is taught during the winter semester of the second year of University Study of Dental Medicine and consists of 24 hours of lectures and 12 hours of exercises (2 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 are held on the first floor of the University Departments building in lecture hall O-161, while exercises are held in room O-162.

The goal of the course is for students to gain knowledge in physics with specific applications in dentistry and diagnostic imaging.

The lectures cover topics relevant to the properties of dental materials, dynamics of the human masticatory system, bite force, ultrasound, and basics of lasers, plasma physics and ionizing radiation.

In the practical exercises, students apply the theoretical knowledge gained in the lectures 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 obligatory and must be completed in order for students to take the final exam.

Assigned reading:

Dresto-Alač, B.; Bojić, D.; Cvejanović, S.; Lekić, A.; Mandić, M.; Žauhar, G: Praktikum fizikalnih mjerenja, Sveučilište u Rijeci, Medicinski fakultet, Rijeka 2010.
Irving P. Herman: Physics of the Human Body, Springer, 2016.

Optional/additional reading:

Herbert H. Frommer; Jeanine J. Stabulas-Savage: Radiology for the Dental Professional, Elsevier, 2018.

COURSE TEACHING PLAN:

The list of lectures (with topics and descriptions):

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L1 Orientation Lecture. Physics in dentistry.
Learning outcomes
Understand the course's objective and methodology.
Learn the rules of the course, particularly how to collect points and take the exam.
Give a general overview of the role of physics in dentistry.

L2 Mechanical properties of dental materials.
Learning outcomes
Explain the deformation curve of a solid.
Define Hooke's law.
Distinguish between plastic and elastic deformations.
State the basic physical principles of fracture and non-carious damage to tooth structure (abrasion, abfraction, attrition).
State mechanical properties of the mandibula.

L3 Dental biomechanics
Learning outcomes
Apply the principles of statics to explain the biomechanics of the jaw and teeth.
State the basic physical principles of bite mechanics.
State the basic physical principles of dental bridges.
Describe the basic physical principles of tooth extraction.
Describe the basic physical principles of dental forceps and various levers used for tooth extraction.

L4 Fluid mechanics in dentistry.
Learning outcomes
Describe the physical principles of barodontalgia.
Apply the principles of fluid mechanics to describe root canal irrigation.
Describe surface phenomena (phenomena at the phase boundary).
State the significance of the Navier-Stokes equations for fluid dynamics.
State the basic principles of fluid dynamics and the role of teeth in speech.

L5 Thermal properties of dental materials.
Learning outcomes
Apply the principles of thermodynamics to describe the thermal properties of dental materials.
Define the coefficient of thermal expansion.
Explain the thermal expansion of materials.
Describe the effects of sudden temperature changes on teeth.

L6 Electrical properties of dental materials.
Learning outcomes
Apply the principles of electricity to determine the electrical properties of dental materials.
Describe the electrical conductivity of the material.
Discuss the electrical resistance of healthy and carious tissue.
Define bioimpedance.
Describe the impedance method for determining root canal length.

L7 Optical properties of dental materials.
Learning outcomes
Describe the electromagnetic spectrum.
Describe light as an electromagnetic wave.
State the fundamental laws of geometrical optics.

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Distinguish between the optical properties of healthy and diseased teeth.
Explain the Beer-Lambert law.
Learn about the Kubelka-Munk reflection theory.

L8 Ultrasound and its application in dentistry.
Learning outcomes
State the wave equation.
Explain the the term oscillation and the occurrence of resonance.
Explain the reflection and transmission of waves.
Explain the Doppler effect.
Explain the physical principles on which the use of ultrasound in diagnostics is based.
Distinguish between the piezoelectric effect and the reverse piezoelectric effect.
Give examples of the use of ultrasound in dentistry.

L9 Structure of substances
Learning outcomes
Explain the terms: atom, chemical element, ion and isotope.
Distinguish and compare the properties of elementary particles (electron, proton, and neutron).
Describe Bohr's model of the atom.

L10 Laser and its application in dentistry.
Learning outcomes
Describe the physical principles of lasers.
Describe the different types of lasers.
Explain the interaction of laser light and tissue.
Describe the various applications of lasers in dentistry.
Discuss the safety aspects of using lasers.

L11 Plasma and its application in dentistry.
Learning outcomes
Become familiar with the application of modern technologies in dentistry.
Define physical plasma.
Distinguish between high temperature and low temperature plasma.
Distinguish between different ways to create low temperature atmospheric plasma.
Describe various examples of the use of low-temperature atmospheric plasma in biomedicine and dentistry.

L12 Ionizing radiation.
Learning outcomes
Become familiar with the application of modern technologies in dentistry.
State and describe the mechanisms of interaction of ionizing radiation with matter.
Describe the origin and properties of X-rays.
Explain the origin of the discrete and continuous spectrum of X-rays.
State the diagnostic and therapeutic uses of X-rays.
Explain the law of radioactive decay.
Define the unit of activity for a radioactive source.
Define the half-life.
Describe and explain the basic types of radioactive decay.
Give examples of the use of radioactive isotopes in diagnostics.

L13 Principles of dosimetry and protection from ionizing radiation.

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Learning outcomes
Define dosimetric quantities.
State basic methods of radiation protection.
Apply knowledge of the principles of dosimetry to protection from ionizing radiation.

L14 Imaging techniques in dentistry.
Learning outcomes
Name and describe the diagnostic and therapeutic uses of ionizing radiation.
Be able to choose the appropriate diagnostic method.

L15 Final lecture.
Learning outcomes
Systematize the material presented in the previous lectures.

The list of practicals with descriptions:

P1 Levers in dentistry
Learning outcomes
Apply the conditions of lever law to examples from dentistry.

P2 Capacitive and Ohm's resistances. Impedance. Electrical conductivity.
Learning outcomes
Measure capacitive and ohmic resistances.
Determine the impedance value.
Define the electrical conductivity of the electrolyte and use the experiment to determine what it depends on.

P3 Mechanical waves
Learning outcomes
Learn about different types of mechanical waves.
Analyze sound waves using a cathode ray oscilloscope.
Analyze the phenomenon of interference.
Determine the natural frequency of vibration of a musical fork based on Melde's experiments.
Calculate the wavelength and the speed of propagation of sound with a Quincke whistle.

P4 Ionizing radiation
Learning outcomes
Differentiate between basic types of ionizing radiation.
Define the basic units used in ionizing radiation dosimetry.
Define radiation range in a material and half absorption thickness.
Determine the range of beta radiation in aluminum.

P5 Lasers
Learning outcomes
Familiarize yourself with how the laser works.
Understand and be able to explain the phenomena of bending at cracks and threads.

P6 Compensations

Students' obligations:

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

Student grading is conducted according to the current University of Rijeka Studies and studying regulation.

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

(a) one midterm exam that involve solving numerical problems related to the lecture an practical materials; 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 tests theoretical knowledge taught in lectures.

A student may miss 30% of classes only for health reasons, which is justified by a doctor's excuse. Attendance of lectures and exercises is compulsory. Compensating for practical exercises is only possible during the designated times.

If a student misses more than 30% 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 30 points in class and 70 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 15 points (5 points in the practical exercises and 10 points in midterm exam) out of the maximum 30 points that can be earned in class. Students who receive a score of 14.9 or lower (Category F) must re-enrol in the course.

The student receives evaluation points in the following ways:

	Assessment	**Grade Point Maximum**
Midterm Exam	Midterm exam (10 questions x 2 credits)	20
Practicals	Accepted practicals and reports 4 x 5 x 0.5 credits	10
FINAL EXAM	Exam (30 questions)	70
TOTAL POINTS		**100**

Midterm exam (up to 20 points)
The midterm exam consists of 10 problems and covers topics of application of lever law to examples from dentistry, properties of dental materials, ionizing radiation and dosimetry. 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. Two points are awarded for each correctly solved task. A successfully passed exam is one in which at least 10 points (5 correct answers) have been achieved.

Students who earn less than 10 points (5 correct answers) on the midterm exam have the opportunity to

retake the exam, and if they score well enough on the retake, they may take the final exam.

Practicals (up to 10 points)

All four practical exercises must be completed by the students. Students write an entrance exam. Only students who pass the entrance exam can participate in the exercises. 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 ($\geq$ 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 0.5. Based on the results of the practical exercises, a maximum of 10 points can be earned.

The final exam (up to 70 points)

The student will take the final exam at the end of the course if he or she has received at least 15 points and all practical exercises have been evaluated positively.

The 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.

Students receive points for correct answers according to the conversion table:

Number of correctly answered questions	Points
15	35
16	36
17	37
18	38
19	40
20	42
21	45
22	48
23	51
24	54
25	57
26	60
27	64
28	66
29	68
30	70

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

COURSE SCHEDULE (for the academic year 2023/2024)

Date	Lectures (time and place)	Seminars (time and place)	Practicals (time and place)	Instructor
02/10/2023	L1,2 (12:00-15:00) O-161 / Faculty of Physics			Diana Mance
03/10/2023	L3 (10:00-12:00) O-161 / Faculty of Physics		P1-2 (12:00-14:00) O-161 / Faculty of Physics	Diana Mance Marija Čargonja
04/10/2023	L4-6 (10:00-14:00) O-161 / Faculty of Physics			Diana Mance
05/10/2023	L7-9 (10:00-14:00) O-161 / Faculty of Physics			Diana Mance
06/10/2023	L10,11 (10:00-14:00) O-161 / Faculty of Physics			Diana Mance
09/10/2023	L12,13 (12:00-16:00) O-161 / Faculty of Physics			Diana Mance
10/10/2023	L13-15 (10:00-13:00) O-161 / Faculty of Physics		P3-4 (8:00-10:00) O-162 / Faculty of Physics	Marija Čargonja Diana Mance
11/10/2023			P5-6 (16:00-18:00) O-162 / Faculty of Physics	Marija Čargonja
12/10/2023			P7-8 (10:00-12:00) O-162 / Faculty of Physics	Marija Čargonja
13/10/2023			P9-10 (8:00-10:00) O-162 / Faculty of Physics	Marija Čargonja
16/10/2023		MIDTERM EXAM – (10:00-12:00)		Diana Mance

		O-161 / Faculty of Physics		
17/10/2023		MIDTERM EXAM – (10:00-11:00) (retake) O-161 / Faculty of Physics	P9-10 (8:00-10:00) O-162 / Faculty of Physics	Marija Čargonja Diana Mance
18/10/2023		FINAL EXAM – (10:00-12:00) O-161 / Faculty of Physics		Diana Mance

List of lectures, seminars and practicals:

	LECTURES (Topics)	Teaching hours	Location/Lecture room
L1	Orientation Lecture. Physics in dentistry.	1	Faculty of Physics/O-161
L2	Mechanical properties of dental materials: deformation of solids.	2	Faculty of Physics/O-161
L3	Dental biomechanics.	2	Faculty of Physics/O-161
L4	Fluid mechanics in dentistry.	2	Faculty of Physics/O-161
L5	Thermal properties of dental materials.	1	Faculty of Physics/O-161
L6	Electrical properties of dental materials.	1	Faculty of Physics/O-161
L7	Optical properties of dental materials.	1	Faculty of Physics/O-161
L8	Ultrasound and its application in dentistry.	2	Faculty of Physics/O-161
L9	Structure of substances	1	Faculty of Physics/O-161
L10	Laser and its application in dentistry.	2	Faculty of Physics/O-161
L11	Plasma and its application in dentistry.	2	Faculty of Physics/O-161
L12	Ionizing radiation.	3	Faculty of Physics/O-161
L13	Principles of dosimetry and protection from ionizing radiation.	2	Faculty of Physics/O-161
L14	Imaging techniques in dentistry.	1	Faculty of Physics/O-161
L15	Final lecture.	1	Faculty of Physics/O-161
	TOTAL TEACHING HOURS	**24**	

	PRACTICALS (Topics)	Teaching hours	Location/Lecture room
P1	Levers in dentistry.	2	Faculty of Physics/O-161
P2	Capacitive and Ohm's resistances. Impedance. Electrical	2	Faculty of Physics/O-162

	conductivity.		
P3	Mechanical waves.	2	Faculty of Physics/O-162
P4	Ionizing radiation.	2	Faculty of Physics/O-162
P5	Lasers.	2	Faculty of Physics/O-162
P6	Compensations	2	Faculty of Physics/O-162
	TOTAL TEACHING HOURS	**15**	

	FINAL EXAM DATES
1.	18.10.2023.
2.	08.11.2023.
3.	22.11.2023.
4.	15.12.2023.
5.	19.01.2024.

	Lectures	**Seminars**	**Practicals**	**Total**
Total number	24		12	36
On-line				
Percentage				