Semmelweis University, Faculty of Dentistry - undivided, one-tier training in dentistry
Name of the host institution (and any contributing institution):
Biofizikai és Sugárbiológiai Intézet

Name of subject in Hungarian: Biofizika I.
Name of subject in English: Biophysics I.
Name of subject in German: Biophysik I.

Credit value of the course: 4
Semester: 1st semester
(in which the subject is taught according to the curriculum)

Weekly hours	Lecture	Practice	Seminar
4.0	1.0	3.0	0.0

Semester hours	Lecture	Practice	Seminar
56.0	14.0	42.0	0.0

Type of course:
obligatory

Academic year:
2026/27

Language of instruction (for optional and elective subjects):
Angol

Course code:
FOKOFIZ378_1A
(in the case of a new course, to be completed by the Dean's Office, following approval)

Course coordinator name: Dr. Liliom Károly
Course coordinator location of work, telephone availability: Department of Biophysics and Radiation Biology, +36308246229
Course coordinator position: associate professor
Course coordinator Date and number of habilitation: Semmelweis University 06/2021

Objectives of the course, and its place in the curriculum of the medical training program:

The main aims of biophysics teaching are to gain knowledge and scientific reasoning skills in order to understand the functioning of human body and biological systems in general, as well as the basic methods of their quantitative investigations.

Format of the course (lectures, group work, practical lessons, etc.):

lectures and practicals

Competencies acquired through completion of course:

Students will understand the physical description of live matter's structure and function, specifically learn the physical basis of physiologic processes, gain theoretical and practical knowledge of medical analytical techniques and medical diagnostics, including modern medical imaging.

Course outcome (names and NEPTUN ID of related subjects):

Prerequisites for course registration and completion: (NEPTUN ID):

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In the case of multi-semester courses, position on the possibility of and conditions for concurrent registration:

Course-rollover is not possible. Students can register for Biophysics II only after successful completion of Biophysics I.

The number of students required to start the course (minimum, maximum), method of selecting participants:

The maximum number is: students enrolled in the first year plus those of retrying the course.

Detailed course syllabus (if the course can be divided into modules, please indicate): (Theoretical and practical instruction must be broken down into hours (weeks), numbered separately; names of instructors and lecturers must be listed, indicating guest lecturers/instructors. It cannot be attached separately! For guest lecturers, attachment of CV is required in all cases!)

Lectures:

1 Introduction to biophysics, radiations

2 Ray optics: Fermat's principle, refraction, image formation by lenses, microscope

3 Wave optics: Huygens' principle, diffraction, interference, resolution of lenses

4 Light absorption, reflection, scattering, color vision

5 Structure of matter: atoms, molecules, crystals

6 Thermal emission, emission of human body, infra diagnostics

7 Luminescence and its applications in medicine

8 LASER: principles of function, types, and medical applications

9 Biological effects of light with medical applications

10 Modern microscopy techniques

11 X-ray production, spectral characteristics, interactions with matter

12 X-ray diagnostics

13 Nuclear radiations, isotope diagnostic

14 Clinical applications of nuclear radiations

Practicals:

1 Introduction, data analysis

2 Light emission

3 Refractometry

4 Microscopy 1

5 Nuclear medicine

6 Light absorption

7 Resonance

8 Microscopy 2

9 Gamma absorption

10 Polarimetry

11 Amplifier

12 Optics of the Eye

13 Dosimetry

14 Summary, repetition

Other courses with overlapping topics (obligatory, optional, or elective courses) in interdisciplinary areas. To minimalize overlaps, topics should be coordinated. NEPTUN ID(s) of courses (to be provided):

Requirements for attendance, options for making up missed sessions, and method of absence justification:

An electronic lab report must be made during the practicals, which have to be uploaded into the bifilab system. Missed practicals can be done within the 4-weeks measuring cycles in an appropriate group with the agreement of the group teachers.

Assessment methods during semester (number, topics, and dates of midterms and reports, method of inclusion in the course grade, opportunities for make-up and improvement of marks):
(number, topics, and dates of midterms and reports, method of inclusion in the course grade, opportunities for make-up and improvement of marks)

We hold two mid-term reports during the semester: in the week following the 1st and 2nd practical cycles, each student may complete the report in the group corresponding to their Neptun registration. The assessment covers the theoretical background and practical material (illustration, evaluation) of the exercises in the given cycle in the form of a Moodle test (single-choice, multiple-choice, diagram, calculation). We make the test questions (along with their point values) available on the course's Moodle page, where students can practice solving the problems and thus learn the correct answers. For calculation problems, the numbers are randomly generated, so the exact value of the final result may vary, but the correct method of solving the problem is known. The mid-term report is considered successful if the average score reaches 50%. The report can be made up, or the result can be improved during the final week (within one's own group, during the practice session), by redoing the report in a format similar to the original reports, which includes the content of both reports. To pass, this paper must achieve a score of 50%. If necessary (if the score did not reach 50%), further improvement is possible in a similar format and with similar content during a session scheduled in the first week of the exam period.
If the average of the reports written for Reports 1 and 2 reaches 80%, the student is exempt from the written exam part.

Students who do not need to take a makeup or retake exam are eligible to take a competitive exam during the final week, through which they can earn a recommended grade of 5. This competitive exam includes both closed-ended questions similar to those on midterm exams (though slightly more difficult) and open-ended questions as well.

Number and type of individual assignments to be completed, submission deadlines:

There are no individual assignments. During the lab sessions, students must prepare an electronic lab report and upload it to the designated website.

Requirements for the successful completion of the course:

A maximum of three absences from the exercises (an unapproved lab report also counts as an absence), as well as the successful completion of the mid-term reports.

Type of assessment:
end term examination

Exam requirements (list of topics, topics of the test exam, and the optional project topics accepted as an exam)

Oral exam topic list:

1. Radiation: definition, types, descriptive physical parameters of radiation, examples of radiation.

2. Law of attenuation of radiation: differential and integral forms, applications in medical and laboratory practice.

3. Basic principles of optics I: geometric optics, Fermat's principle, refraction of light, Snell's law. Applications: prism, optical fiber.

4. Basic principles of optics II : reflection, spectral reflectance. Rayleigh, Mie, Raman scattering.

5. Optics of the human eye: image formation and its disorders, accomodation, reduced eye model, visual acuity, resolution of the eye.

6. Image formation by optical devices and their medical application: lenses, microscope, resolution, Abbe’s principle.

7. Light as electromagnetic wave: parameters of waves, electromagnetic spectrum.

8. Wave nature of light: Huygens' principle, diffraction, superposition principle, interference, optical grating for decomposition of white light.

9. Particle nature of light: photoelectric effect, the photon concept, example for the application of photoelectric effect.

10. Mechanism of light absorption, absorption spectra, Beer-Lambert law and its applications. Parts of a spectrophotometer.

11. Origin and characteristics of thermal radiation. Kirchhoff's law, spectrum of blackbody radiation, Wien's displacement law.

12. Principles of thermography: Stefan-Boltzmann law, Wien's displacement law, thermal radiation of human body, applications.

13. Luminescence: Mechanisms of luminescence, Kasha's rule, emission spectra, Stokes shift, lifetimes and quantum yield.

14. Definition of luminescence. Light sources based on luminescence, medical applications.

15. Concept of light amplification: Optical pumping and population inversion, induced emission, optical resonator.

16. Properties of LASER light, LASER types, medical applications of LASER light.

17. Light absorption in human tissues: skin, eye. Biological effects of light, photodynamic therapy.

18. Generation of X-ray: X-ray tube, Duane-Hunt law, spectrum of Bremsstrahlung and characteristic radiation, efficiency of X-ray tube.

19. Absorption of X-ray: Linear and mass attenuation coefficients, absorption mechanisms, effective atomic number.

20. X-ray diagnostics 1: principles of X-ray imaging, factors influencing image quality, application of contrast materials, DSA.

21. X-ray diagnostics 2: Summation image, concept of CT, CT generations, Hounsfield units, windowing, X-ray image amplifier.

22. Nuclear radiation: Composition and stability of nuclei, nuclear force, mass defect, radioactive decay, activity.

23. Mechanisms of decay of nuclear radiations, their energy spectra and penetration depths.

24. Isotope diagnostics I: Selection of radioisotopes, radiopharmacons, isotope accumulation curve, effective and biological half-life, static and dynamic investigations.

25. Isotope diagnostics II: gamma camera, SPECT, PET.

26. Modern microscopy techniques: fluorescent microscopy, confocal laser scanning microscopy; two-photon excitation.

27. Concept of electron microscopy, resolution, TEM, SEM.

28. Structure of matter: Development of atomic models, Bohr’s model of hydrogen atom, energy levels of atoms, molecules, and solid-state materials. Fluid crystals and colloids.

The written part of the exam consists of questions similar to those on midterm exams, but covers the material from all the exercises in both semesters.

Clear, specific minimum requirements for assessment. (The list of mandatory concepts, parameters, diagrams, calculations, and practical skills required to obtain a passing grade, as well as the criteria for the completion and evaluation of project assignments accepted as an exam.) A link published on the department’s website referring to the minimum requirements of the course.

The list of m,andatory concepts:

Definition, types, and intensity of radiation. Light as an electromagnetic wave. The electromagnetic spectrum.
Differential and integral forms of the law of radiation attenuation. Mechanisms of light absorption, absorption spectrum, Lambert-Beer law.

Fermat's principle, law of refraction, total internal reflection. Light reflection, light scattering
Magnification and resolving power of a microscope, Abbe's principle.
Huygens' principle, diffraction, principle of superposition, interference, optical grating, spectral resolution of white light.
Image formation in the human eye. Accommodation, visual acuity, resolving power.
Photon. Photoelectric effect.
Thermal radiation. Infrared diagnostics.
Luminescence: fluorescence and phosphorescence, Kasha's rule, Stokes shift.
Production and properties of laser light, medical applications.
X-ray tube, spectra of bremsstrahlung and characteristic radiation.
Linear and mass attenuation coefficients, photoelectric effect, Compton scattering. Summation image, contrast agents. Principles of CT, Hounsfield units, windowing.
Structure of the atomic nucleus, characteristics of radioactive decay, activity. Characterization of nuclear radiation.
Isotope diagnostics: radiopharmaceuticals, half-life, gamma camera, SPECT, PET.
Development of atomic models, Bohr's atomic model. Energy levels of atoms, molecules, and solids.

Method and type of grading (Share of theoretical and practical examinations in the overall evaluation. Inclusion of the results in the end-of-term assessment. Possibilities of and conditions for offered grades.): (Share of theoretical and practical examinations in the overall evaluation, Inclusion of the results in the end-of-term assessment, Possibilities of and conditions for offered grades)

A written test covering the entire semester's material, similar to midterm exams, followed by the selection of two topics from the list of oral exam topics.

The rounded weighted average of the oral and written sections, weighted at 60% and 40% respectively.

If the average of the first and second midterm exams reaches 80%, the written part will be graded as a 5 (excellent).

Students who have successfully passed the competitive examin are awarded a grade of 5 (excellent).

Artificial intelligence systems used in the teaching of the subject and the manner of their application

We do not use artificial intelligence systems in the teaching of this course. Students may not use artificial intelligence systems during midterm assessments and during the exam, but they may use them critically to prepare for these assessments. Incorrect answers generated by artificial intelligence systems will not be accepted.

Printed resources:

Type	Mandatory
Author	Damjanovich, Fidy, Szöllősi (eds)

Title	Medical Biophysics
Publisher	Medicina
Year of publication	2009

Type	Mandatory
Author	Kellermayer M (ed)
Title	Madical biophysics practices
Publisher	Semmelweis Publishers
Year of publication	2018

Signature of habilitated instructor (course coordinator) announcing the course:

Signature of the director of the host institution:

Date of submission:
