MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY

Department of Medical and Biological Physics and Medical Informatics
Academic year 2024-2025

SILLABUS
THE EDUCATIONAL DISCIPLINE

«MEDICAL AND BIOLOGICAL PHYSICS»

(title of the educational discipline)

Normative or selective educational discipline selective

Form of education full-time form of education
(full-time form of education; correspondence form of education; distance form of education)

Field of knowledge 22 «Health Care»
(code and title of the field of knowledge)

Specialty 221 «Dentistry»
(code and title of the specialty)

Educational and professional program (educational scientific program) «Dentistry»

Second (master's) level of higher education

Academic year: 1st

The syllabus of the educational discipline was considered at the meeting of the Department of Medical and Biological Physics and Medical Informatics

Protocol No. 1
"26" August 2024

Head of the Department

prof. O.V. Zaytseva

Approved by the Methodological Committee of KhNMU on Problems of general and natural science training

Protocol No.1
"30" August 2024

Head

prof. M.S. Myroshnychenko

SYLLABUS DEVELOPERS

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INTRODUCTION

The syllabus of the discipline «Medical and biological physics» is compiled in accordance with the educational and professional program (hereinafter – OPP) «Dentistry» and the Standard of Higher Education of Ukraine (hereinafter – Standard), the second (master's) level of higher education, field of knowledge 22 «Health care», specialty 221 "Dentistry".

Description of the discipline (abstract)
Educational component: «Medical and biological physics» is offered for study by students of higher medical education of the 1st year. The volume of the educational component (in ECTS credits with determining the distribution of hours for lectures, practical classes, SRS): **3 ECTS credits**, 90 hours, including 6 hours of lectures, 34 hours of practical classes, 50 hours of students' self-study work. Type of final control is **Credit**.

The subject of study of the educational component «Medical and biological physics» are basic biophysical concepts, laws, physical and technical principles of the functioning of modern electronic medical devices, the use of mathematical methods in biomedical research, which form the basis of subject competences from this educational component and are an integral component of the professional competence of the future specialist.

Interdisciplinary connections of the educational component «Medical and biological physics»: with educational components such as «Human anatomy», «Medical and bioorganic chemistry», «Medical biology».
Prerequisites. Studying the educational component «Medical and biological physics» involves knowledge of biology, mathematics and physics on a high school basis.
Post-requisites. The main provisions of the selective educational component «Medical and biological physics» are the basis for further study of «Biological chemistry», «Pathophysiology» and should be used in the study of professional educational components.

Link to the page of the educational component in Moodle:
http://distance.knmu.edu.ua/course/view.php?id=4973

1. PURPOSE AND OBJECTIVES OF THE DISCIPLINE

1.1 The purpose of the discipline is the formation of higher education students' system of knowledge and new competences about basic physical principles and approaches to the study of processes in living nature, physical and technical principles of the functioning of medical devices, the use of mathematical methods in biomedical research, as well as competences in the field of digital technologies; study of regularities and principles of information processes in systems of different levels of hierarchy in the field of health care; study of decision support systems in medicine information technologies of analysis, modeling, forecasting, management in the field of medical and biological research.

1.2. The main task of the educational component «Medical and biological physics» is to acquire knowledge of biophysical mechanisms and factors affecting the human body; knowledge and understanding of the principles of medical electronic equipment; safety techniques when working with

medical electronic equipment; hygienic regulation of the levels of electromagnetic fields; knowledge of medical and biological aspects of atomic and nuclear physics, dosimetry.

1.3. Competences and learning outcomes, the formation of which is facilitated by the discipline "Medical and biological physics; medical information technologies" (relationship with the normative content of training of higher education, formulated in terms of learning outcomes in the Standard of Higher Education of Ukraine).

1.3.1. Studying of the educational component ensures mastering of **competencies**:

Integral competence:
The ability to solve complex problems and problems in the field of health care in the specialty «Dentistry» in professional activity or in the process of learning, which involves conducting research and/or carrying out innovations and is characterized by uncertainty of conditions and requirements.

General competences (GC):

GC 1. Ability to abstract thinking, analysis and synthesis.
GC 2. Knowledge and understanding of the subject area and understanding of professional activity.
GC 3. Ability to apply knowledge in practical activities.
GC 4. Ability to communicate in the state language both orally and in writing.
GC 6. Skills in the use of information and communication technologies.
GC 7. Ability to search, process and analyze information from various sources.
GC 8. Ability to adapt and act in a new situation.
GC 9. Ability to identify, pose and solve problems.
GC 10. Ability to be critical and self-critical.
GC 11. Ability to work in a team.
GC 13. Ability to act socially responsibly and consciously.

Special (professional) competences (SC):
SC 1. The ability to collect medical information about the patient and analyze clinical data.
SC 2. Ability to interpret the result of laboratory and instrumental studies.
SC 12. Ability to organize and conduct a screening examination in dentistry.
SC 13. The ability to assess the impact of the environment on the state of health of the population (individual, family, population).

1.3.2. The study of the educational component ensures that education seekers acquire the following program learning outcomes (PLO):
PLO 6. Plan and implement measures for the prevention of dental diseases among the population to prevent the spread of dental diseases.
PLO 7. Analyze the epidemiological state and carry out measures of mass and individual, general and local drug and non-drug prevention of dental diseases.
PLO 8. Determine the approach, plan, type and principle of treatment of a dental disease (according to list 2) by making an informed decision according to existing algorithms and standard schemes.
PLO 9. Determine the nature of the regime of work, rest and the necessary diet in the treatment of dental diseases (according to list 2) on the basis of a preliminary or final clinical diagnosis by making a well-founded decision according to existing algorithms and standard schemes.
PLO 14. To analyse and evaluate public, social and health information using standard approaches and computer information technologies.
PLO 15. Evaluate the impact of the environment on the state of health of the population in the

conditions of a medical institution according to standard methods.
PLO 17. Adhere to a healthy lifestyle, use methods of self-regulation and self-control.
PLO 18. To be aware of and guided in their activities by civil rights, freedoms and obligations, and to raise the general educational cultural level.
PLO 20. Organize the necessary level of individual safety (own and persons of concern) in the event of typical dangerous situations in the individual field of activity.

1.3.3. The study of the discipline provides students with the following **special skills (soft skills)**:

- Ability to analyze and apply in medical practice the basic concepts, laws of biophysics and informatics.
- Ability to explain the physical basis and biophysical mechanisms and effects of the interaction of electric currents and electromagnetic fields with the human body.
- Ability to correctly explain the physical basis of operation and use of modern electronic medical devices used in medical diagnostics and therapy (in particular, in electrocardiography, rheography, impedance plethysmography, audiometry, optical and quantum mechanical devices and systems, radiometric and dosimetry devices).
- Ability to use information technologies in medical practice.

INFORMATION CONTENT OF THE EDUCATIONAL DISCIPLINE

<table>
<tr><td rowspan="2">Credits and credit hours</td><td rowspan="2">Field of knowledge, specialty, educational degree, educational professional program</td><td>Characteristics of the discipline</td></tr>
<tr><td>Full-time study</td></tr>
<tr><td>Credits: 3.0</td><td>Field of knowledge:
<u>22 “Healthcare”</u></td><td>Elective discipline</td></tr>
<tr><td rowspan="5">Total hours: 90</td><td rowspan="5">Specialty:
<u>221 “Dentistry”</u></td><td>Academic year (course):</td></tr>
<tr><td>1st</td></tr>
<tr><td>Semester</td></tr>
<tr><td>2nd</td></tr>
<tr><td rowspan="14">Hours for full-time (or evening) form of study:
classes: 40
self-study: 50</td><td rowspan="14">Educational degree:
<u>master</u>

Educational professional program:
<u>221 “Dentistry”</u></td><td>Lectures</td></tr>
<tr><td>6 hours</td></tr>
<tr><td>Practical classes</td></tr>
<tr><td>34 hours</td></tr>
<tr><td>Seminar classes</td></tr>
<tr><td>–</td></tr>
<tr><td>Laboratory classes</td></tr>
<tr><td>–</td></tr>
<tr><td>Self-study</td></tr>
<tr><td>50 hours</td></tr>
<tr><td>Individual tasks: 0 hours</td></tr>
<tr><td>Assessment form:
differentiated credit</td></tr>
</table>

2. CONTENT OF THE EDUCATIONAL COMPONENT

List of lecture topics (6 hours)

1. Fluid mechanics. Some applied issues of hemodynamics.
2. Basics of bioacoustics. Acoustic methods in medicine
3. Ionizing radiation. Dosimetry

List of topics of classes (34 hours)

1. Fluid mechanics. Hemodynamics. Bioreology.
2. Mechanical oscillations and waves. Bioacoustics.
3. Transport of substances through cell membranes. Biopotentials.
4. Physical foundations of electrography of organs and tissues.
5. Effects of electric currents and electromagnetic fields on biological objects.
6. Basics of medical electronics.
7. Geometrical optics. Lenses. Optical system of the human eye.
8. Optical microscopy. Special methods of optical microscopy.
9. Polarized light, its use in medicine.
10. Interaction of light with matter. Absorption, scattering and dispersion of light.
11. Thermal radiation; its use in medicine.
12. Basic concepts of quantum physics. Spectroscopy.
13. Induced radiation. Lasers. Magnetic resonance spectroscopy. Electron microscope.
14. Interaction of different types of ionizing radiation with matter.
15. X-ray radiation; its use in medicine.
16. Dosimetry of ionizing radiation. Radiation diagnosis and therapy.
17. Final control. CREDIT

List of topics for self-study work (50 hours)

1. Basics of materials science. Some issues and laws of biomechanics (absolutely solid; rotational motion; angular velocity; angular acceleration; moment of force; moment of inertia; moment of momentum). Human musculoskeletal system. Dynamic and static work of a person in various types of his activity. Ergometry. Hill's equation. Determination of viscosity of liquids. The method of measuring blood pressure according to Korotkov. Mechanical work and heart power. Pulse wave.
2. Differential equation of harmonic non-damping, damping, forced oscillations and their solution. Decrement and logarithmic decay decrement. Resonance. Vibrations. Self-oscillation. Relaxation fluctuations. Vector Condition. Doppler Effect. Hygienic normalization of noise, infrasound, vibration levels. System for maintaining the balance of the body in space.
3. Thermodynamic systems, their types. The first and second laws of thermodynamics. Hess's law. Concept of thermodynamic potentials: enthalpy, Gibbs free energy, Helmholtz free energy. Prigozhin theorem, Prigozhin-Glansdorf principle. The concept of synergy.
4. Magnetic field and its characteristics. Magnetic properties of substances. Biot-Savard-Laplace law. Electromagnetic induction. The effect of a magnetic field on bio-objects. Elements of magnetobiology. Single-pole amplified leads when taking an electrocardiogram. Hygienic normalization of electromagnetic field levels.
5. Wave optics (interference of light, diffraction of light, basic concepts, formulas, laws, use in medical and biological research).
6. Elements of photometry. Objective physical characteristics of light and subjective physiological characteristics of light perception by the organ of vision.
7. Photobiological processes, their types, stages. Concept of photochemical reaction cross-section. Spectrum of photobiological action. Photosensitized photobiological processes.
8. Biophysical foundations of radiobiological processes.

3. EVALUATION CRITERIA FOR THE EDUCATIONAL COMPONENT «MEDICAL AND BIOLOGICAL PHYSICS»

3.1.1 Evaluation of the success of education of education seekers is carried out on the basis of the current «Instructions for evaluating the educational activity of education seekers of KhNMU.

Control methods:

Oral and computer control of the acquisition of the topic is carried out in practical classes.

Current control is carried out in each practical session according to the specific goals of the topic. Also, all practical classes apply types of standardized control of theoretical training and control of the assimilation of practical skills: computer tests on the MOODLE remote platform, performance of practical tasks, including competence-oriented ones.

The assessment for each practical lesson from the educational component is comprehensive and includes control of the theoretical and practical training of the student of higher education; it is presented by the teacher on a traditional four-point scale and transferred to the ACS.

The final control involves the use of computer tests on the MOODLE remote platform to check the level of theoretical knowledge and the formation of practical skills in education seekers in the process of performing a practical task on a computer.

Each final control contains 25 questions:

15-19 correct answers corresponds to a score of "3",

20-23 correct answers correspond to the rating "4",

24-25 correct answers correspond to the rating "5".

Evaluation of current educational activities (CEA):

After conducting the last practical lesson and the teacher's assigns an assessment to the electronic journal, the automated control system (ACS) calculates the average score of the student for the semester, and if the student does not have an academic debt/skip of the lesson, a score is awarded. The recalculation of the average assessment for the current activity into a multi-point scale is carried out at the ACS in accordance with the «Instructions for evaluating the educational activity of students of the KhNMU», approved by the Order of the KhNMU dated August 21, 2021 №181. (Table 1).

Table 1

Recalculation of the average rating for current educational activities into a 200-point scale
(for educational component ending in credit)

4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale
5	200	4.3-4,31	172	3.6-3,61	144
4.97-4,99	199	4,27-4,29	171	3.57-3,59	143
4.95-4,96	198	4.24-4,26	170	3.55-3,56	142
4.92-4,94	197	4.22-4,23	169	3.52-3,54	141
4.9-4,91	196	4.19-4,21	168	3.5-3,51	140
4.87-4,89	195	4.17-4,18	167	3.47-3,49	139
4.85-4,86	194	4.14-4,16	166	3.45-3,46	138
4.82-4,84	193	4.12-4,13	165	3.42-3,44	137
4.8-4,81	192	4.09-4,11	164	3.4-3,41	136
4.77-4,79	191	4.07-4,08	163	3.37-3,39	135
4.75-4,76	190	4.04-4,06	162	3.35-3,36	134
4.72-4,74	189	4.02-4,03	161	3.32-3,34	133
4.7-4,71	188	3.99-4,01	160	3.3-3,31	132
4.67-4,69	187	3.97-3,98	159	3.27-3,29	131

4.65-4,66	186		3.94-3,96	158		3.25-3,26	130
4.62-4,64	185		3.92-3,93	157		3.22-3,24	129
4.6-4,61	184		3.89-3,91	156		3.2-3,21	128
4.57-4,59	183		3.87-3,88	155		3.17-3,19	127
4.54-4,56	182		3.84-3,86	154		3.15-3,16	126
4.52-4,53	181		3.82-3,83	153		3.12-3,14	125
4.5-4,51	180		3.79-3,81	152		3.1-3,11	124
4.47-4,49	179		3.77-3,78	151		3.07-3,09	123
4.45-4,46	178		3.74-3,76	150		3.05-3,06	122
4.42-4,44	177		3.72-3,73	149		3.02-3,04	121
4.4-4,41	176		3.7-3,71	148		3-3,01	120
4.37-4,39	175		3.67-3,69	147		**Less than 3**	**Not enough**
4.35-4,36	174		3.65-3,66	146			
4.32-4,34	173		3.62-3,64	145			

3.1.2. Assessment from the educational component «Medical and biological physics».
The score is determined by CEA points and ranges from 120 to 200 points.

Correspondence of grades on a 200-point scale according to the ECTS scale and to a four-point scale is given in Table 2.

Table 2
Correspondence of grades according to the 200-point scale to the ECTS scale and to the four-point (national) scale:

Grade on 200-point scale	Grade on ECTS scale	Grade on 4-point scale
180–200	A	excellently
160–179	B	good
150–159	C	good
130–149	D	satisfactory
120–129	E	satisfactory
< 120	F, Fx	unsatisfactory

The student receives the mark «credited» in the scorebook if he/she scored from 120 to 200 points.

3.2. Questions for final control:
questions for final control coincide with questions for Credit

3.3. Questions for Credit:
1. Ideal and real liquids.
2. Bernoulli's equation.
3. Flow continuity equation.
4. Newton's formula for the force of viscous friction.
5. Viscometry.
6. Newtonian and non-Newtonian fluids.
7. Laminar and turbulent flow of liquids.
8. Reynolds number.
9. Poiseuille formula.
10. Hydraulic resistance of a system.

11. Real fluid flow as a shear deformation.
12. Basic rheological characteristics and the relationship between them (shear rate, shear stress).
13. Flow curves for Newtonian and non-Newtonian fluids.
14. Properties of blood as a visco-plastic fluid.
15. Hematocrit index.
16. Shvedov-Bingham equation, Caisson formula.
17. Distribution of the average linear speed of blood flow in a large circle of blood circulation.
18. Distribution of the average blood pressure during the cardiac cycle in the large circle of blood circulation.
19. Work and power of the heart.
20. Pulse wave.
21. Clinical method of measuring blood pressure (according to Korotkov).
22. Working formulas for determining the viscosity coefficient of a liquid by the Ostwald and Hess methods.
23. Oscillatory process, its main physical characteristics.
24. Classification of oscillations (undamped, damped and forced oscillations).
25. Resonance, resonance frequency.
26. Self-oscillations, self-oscillating systems.
27. Wave processes, their characteristics.
28. General form and solution of the differential equations of undamped, damped and forced oscillations.
29. Logarithmic attenuation decrement.
30. Methods of measuring the speed of blood movement in vessels and blood pressure: Doppler effect (echodopplerography), electromagnetic method (electromagnetic flowmetry).
31. The system supporting the equilibrium of the human body in space.
32. Acoustics, acoustic waves.
33. Physical (objective) characteristics of sound.
34. Physiological (subjective) characteristics of sound.
35. Weber-Fechner law.
36. Curves of equal loudness, the threshold of sound audibility and the threshold of pain sensation.
37. Sound diagnostics methods (audiometry, auscultation, percussion, phonocardiography and ultrasound diagnostics).
38. Ultrasound and its applications in medicine.
39. Infrasound and its impact on biological objects.
40. Biophysical basis of human perception of sound.
41. Hygienic regulation of noise, infrasound and vibration.
42. Thermodynamic systems: isolated, closed and open.
43. Internal energy of a system.
44. Heat exchange (heat transfer).
45. Amount of heat, units of measurement (system and non-system).
46. Hess law.
47. Reversible and irreversible processes.
48. The concept of entropy, its meaning and unit of measurement.
49. The principle of non-decreasing entropy.
50. The first, second and third laws of thermodynamics.

51. State functions of a thermodynamic system (thermodynamic potentials), their formulas: enthalpy (*H*), Gibbs free energy (*G*), Helmholtz free energy (*F*).
52. The concept of chemical potential.
53. The phenomenon of osmosis and its role in biological processes, osmotic pressure.
54. The concept of negentropy.
55. Biophysics of macromolecules: levels of structural organization of proteins, types of interactions of atomic groups that are part of macromolecules, levels of structural organization of nucleic acids (RNA and DNA).
56. Basic functions of biological membranes. Liquid-mosaic model of the structure of biological membranes
57. The main types of transport of substances through surface (plasma) membranes.
58. Diffusion of uncharged molecules, Fick equation.
59. Diffusion through membrane pores, facilitated diffusion, exchange diffusion.
60. Electrodiffusion, Nernst-Planck equation, Theorell equation.
61. Electrochemical potential.
62. Active transport of substances through membranes, types of ion pumps.
63. Sodium-potassium pump of plasma membranes, its operation.
64. Calcium pump of sarcoplasmic reticulum membranes, its operation.
65. Proton pump of mitochondria and chloroplasts, its operation.
66. Membrane potential. Resting membrane potential.
67. Nernst equilibrium potential. Diffusion potential. Donnan potential.
68. Goldman-Hodgkin-Katz equation.
69. Membrane permeability, its formula.
70. The ratio of membrane permeabilities for K^+, Na^+ and Cl^- ions at rest and in the excited state.
71. Action potential, its generation and distribution.
72. Electric field and its characteristics (tension and potential, the relationship between them).
73. Principle of superposition of fields.
74. Electric dipole.
75. Dipole moment of an electric dipole, formula.
76. Characteristics of direct current (current strength, current density, conductor resistance, specific resistance, specific electrical conductivity).
77. Ohm's law in the differential form.
78. Current dipole. Dipole moment of a current dipole, formula.
79. Multipole decomposition of the field potential formed by a system of currents.
80. The main postulates of the second model of Einthoven's theory of electrocardiography.
81. Concept of an electrocardiogram. Standard leads. Augmented leads. Chest leads.
82. Analysis of a normal electrocardiogram in the second standard lead.
83. The concept of vector cardiography.
84. Concepts of electrographic techniques: electroencephalography (EEG), electromyography (EMG), electroneurography (ENG), electroretinography (ERG), concepts of electrical activity of the skin.
85. Conductive properties of biological tissues for alternating current, their total resistance (impedance) and its components.
86. Dependence of the tissue impedance module on the frequency of alternating current.
87. Electrical equivalent of a biological tissue.
88. Dispersion coefficient, formula.

89. The main mechanism of action of direct electric current on biological tissues, EMF of tissue polarization.
90. Galvanization, electrophoresis, medical electrophoresis.
91. Pulsed electric current, its characteristics.
92. The main mechanism of action of pulsed electric current on biological tissues.
93. Du Bois-Reymond law.
94. Electrodiagnosis in medicine.
95. Hoorweg-Weiss-Lapicque equation, concept of rheobase and chronaxie.
96. Therapeutic methods based on the use of pulsed current (cardiostimulation, electrosleep, electrogymnastics of muscles, defibrillation).
97. Alternating electric current, its characteristics.
98. Mechanisms of action of alternating current on biological tissues depending on its frequency.
99. Nernst's law at different frequencies of alternating current.
100. Rheography (impedance plethysmography).
101. Diathermy (electrosurgery), its varieties (diathermotomy and diathermocoagulation).
102. Local darsonvalization.
103. The main mechanism of action of alternating electromagnetic fields on biological tissues.
104. Inductothermy, UHF therapy, microwave therapy.
105. Effect of a constant electric field on biological tissues.
106. Effect of electromagnetic radiation of the radio frequency range on biological tissues.
107. Hygienic regulation of electromagnetic field levels.
108. Magnetic field and its characteristics.
109. Magnetic field induction.
110. Ampere's force.
111. Magnetic moment.
112. Lorentz force.
113. Magnetic permeability, magnetic properties of substances.
114. Magnetic field strength.
115. Biot-Savart-Laplace law.
116. Phenomenon of electromagnetic induction.
117. Magnetic flux.
118. Law of electromagnetic induction.
119. The phenomenon of self-induction.
120. Magnetobiology and biomagnetism.
121. Magnetocardiography.
122. Monitoring and diagnostic equipment, its purpose and composition.
123. Electrotherapeutic equipment, its purpose and composition.
124. Cybernetic electronic devices.
125. Concepts of "case breakdown" and "leakage current".
126. Methods of eliminating the danger of electric shock in the event of a breakdown to the device case.
127. Classification of electronic devices by the amount of permissible leakage current.
128. Reliability of an electronic device; the probability of failure-free operation of an electronic device.
129. Intensity of failures; the curve of the time dependence of the intensity of failures.

130. The relationship between the probability of failure-free operation and the intensity of failures for the period of normal operation.
131. Classification of medical electronic devices according to the reliability criteria.
132. Electrodes and basic requirements for them.
133. Classification of sensors: energy and biocontrolled.
134. Types of biocontrolled sensors: generating and parametric.
135. Classification of sensors based on the physical phenomena underlying their operation.
136. Conversion function and sensitivity of a sensor.
137. Main disadvantages and general requirements for sensors, hysteresis.
138. Purpose of amplifiers and their types.
139. Basic characteristics of amplifiers: formulas of gain coefficients for amplifiers of alternating and direct currents.
140. Amplitude and frequency characteristics of alternating current amplifiers.
141. Pass band of an alternating current amplifier and determination of its limits.
142. Purpose and types of generators, their applications in medicine.
143. Devices for displaying and registering medical and biological information, their types.
144. Laws of reflection and refraction of light.
145. Absolute and relative indices of refraction of light.
146. Phenomenon of limiting refraction of light, the limiting angle of refraction.
147. Phenomenon of total internal reflection, the limiting angle of total internal reflection.
148. Light guides, endoscopes and laparoscopes, their use in medicine.
149. Lenses and their characteristics.
150. Construction of object images in converging and diverging lenses.
151. Formula of a thin lens and linear magnification of an object in a lens.
152. Types of lens aberrations (spherical aberration, chromatic aberration, astigmatism, distortion).
153. Principles of refractometry.
154. Optical microscope, the path of rays in it.
155. Angular magnification of an optical system.
156. Magnification of an optical microscope.
157. Resolution of a microscope.
158. The limit of resolution of a microscope (with normal and oblique incidence of rays on an object).
159. Ways of reducing the resolution limit of an optical microscope.
160. Ultraviolet microscope.
161. Special methods of microscopy: microprojection and microphotography; dark field method; phase contrast method; polarization and fluorescence microscopy.
162. Optical system of the human eye: light-conducting and light-perceiving components.
163. Optical power of the human eye.
164. Process of accommodation, distance of best vision.
165. Construction of an image of an object in the optical system of the human eye.
166. Defects of the light-conducting and light-perceiving systems of the human eye, their correction.
167. Photoreceptors, their types.
168. The process of darkness adaptation, its mechanisms.
169. Angle of vision, the smallest angle of vision, the limit of resolution of the human eye.
170. Resolution of the eye.

171. Visual acuity.
172. The nature of light.
173. Light wave and its characteristics.
174. Phenomenon of light interference.
175. Phenomenon of light diffraction.
176. Phenomenon of polarization of light.
177. Natural light, partially polarized light, plane polarized light.
178. Polarizer and analyzer.
179. Malus law.
180. Polarization of light upon its reflection and refraction at the boundary of two transparent dielectrics.
181. Brewster's law.
182. Polarization of light during double refraction.
183. The path of rays in a Nicol prism.
184. Phenomenon of dichroism.
185. Polarimetry method and its use in medicine.
186. Polarizing microscope.
187. Absorption of light by matter.
188. Bouguer's law.
189. Natural monochromatic light absorption index.
190. Absorption of light by solutions.
191. Bouguer-Lambert-Beer law.
192. Natural molar absorption coefficient and molar absorption coefficient.
193. Transmission coefficient and optical density of a solution.
194. Absorption spectra of substances.
195. Photoelectric colorimetric determination of concentration of solutions.
196. Objective (physical) characteristics of light (energy photometric quantities): radiation flux, spectral density of radiation flux, relative spectral light efficiency (visibility function) and visibility curve.
197. Subjective (physiological) characteristics of light perception (light quantities): light intensity, luminous flux, illumination, luminosity, brightness.
198. Physical and visual photometers.
199. Photobiological processes, their classifications.
200. General stages of photobiological processes.
201. Photochemical reactions: photoionization, photoreduction, photooxidation, photodissociation, photoisomerization, photodimerization.
202. Spectrum of photobiological action.
203. Photosensitized photobiological processes.
204. Photosensitizers of the first and second types.
205. Biophysics of visual reception.
206. Thermal radiation of bodies.
207. Energy radiance and spectral density of energy radiance.
208. Spectrum of thermal radiation of the body.
209. Black and gray bodies.
210. Kirchhoff's law.
211. Stefan-Boltzmann law.

212. Wien's law of displacement.
213. Optical pyrometry.
214. Human thermal radiation.
215. Diagnostic techniques: thermoscopy, thermometry, thermography.
216. Wave properties of microparticles.
217. Wave function.
218. De Broglie wavelength.
219. Schrödinger's equation.
220. Quantum-mechanical model of the hydrogen atom.
221. Quantum numbers.
222. Pauli principle.
223. Heisenberg uncertainty relation.
224. Selection rules.
225. Luminescence and its types.
226. The mechanism of photoluminescence, its types (fluorescence and phosphorescence).
227. Stokes' law and deviations from it (anti-Stokes luminescence).
228. Luminescence spectra.
229. Luminescent analysis and its use in medical and biological research.
230. Absorption and emission spectra of substances.
231. The use of emission and absorption spectroscopy in the UV and visible parts of the spectrum.
232. Absorption spectroscopy in the IR and microwave parts of the spectrum.
233. Induced radiation.
234. The principle of operation of a helium-neon laser.
235. Biological effect of laser radiation.
236. Types of lasers. Application of lasers in medicine.
237. The phenomenon of electron paramagnetic resonance (EPR).
238. Information carried by EPR spectra.
239. Spin marks and spin probes.
240. The phenomenon of nuclear magnetic resonance (NMR).
241. NMR-introscopy (magnetic resonance imaging, MRI)
242. Electron microscope, the resolution limit of the electron microscope.
243. Ionizing radiation, the main types of ionizing radiation.
244. X-ray radiation, its nature.
245. Bremsstrahlung and characteristic X-ray radiation.
246. Mechanism of occurrence of bremsstrahlung X-ray radiation.
247. The minimum wavelength in the spectrum of bremsstrahlung X-ray radiation.
248. Mechanism of occurrence of characteristic X-ray radiation.
249. Spectrum of characteristic X-ray radiation.
250. Moseley's law.
251. X-ray tube.
252. X-ray radiation flux generated by an X-ray tube.
253. Attenuation of the flux of monochromatic X-ray radiation by matter, Bouguer's law for X-rays.
254. Mechanisms of X-ray interaction with matter: coherent scattering, incoherent scattering (Compton effect), photoeffect.
255. Total attenuation coefficient of X-ray radiation, its components.

256. Mass coefficient of X-ray attenuation.
257. Protection against X-ray radiation.
258. X-ray diagnostics (digital X-ray, X-ray computed tomography) and X-ray therapy.
259. Radioactivity.
260. Types of radioactive decay: α-decay, β^--decay, β^+-decay, e-capture
261. Law of radioactive decay.
262. Half-life of a substance.
263. Activity of a substance, units of measurement.
264. Interaction of various types of ionizing radiation with matter.
265. Interaction mechanisms of gamma-radiation with matter: incoherent scattering (Compton effect), photoeffect (internal and nuclear), formation of electron-positron pairs.
266. Attenuation of monochromatic flux of gamma-radiation by matter, Bouguer's law.
267. Characteristics of the interaction of corpuscular ionizing radiation with matter: linear ionization density, linear energy transfer, average free path of a particle.
268. Penetrating ability of ionizing radiation.
269. Negative nature of the impact of ionizing radiation on biological objects.
270. Methods of protection against ionizing radiation.
271. Radiation doses (absorbed dose, exposure dose, equivalent dose), measurement units.
272. Radiation dose rate, exposure dose rate, equivalent dose rate, units of measurement.
273. Hygienic regulation of radiation loads.
274. Effective equivalent dose.
275. Internal irradiation of a human organism.
276. Detectors and dosimeters of ionizing radiation.
277. Radionuclide diagnostics: dynamic and static methods.
278. Single-photon emission computed tomography (SPECT).
279. Positron emission tomography (PET).
280. Radiation therapy and its methods.
281. Modern devices for radiosurgical treatment using ionizing radiation.
282. Autoradiography.
283. Direct and indirect effect of ionizing radiation on DNA and other biomacromolecules.
284. Oxygen effect. Oxygen enhancement ratio.
285. Types of radiation damage to the DNA of cells.
286. Reproductive and interphase death of irradiated cells.
287. Survival of irradiated cells, survival curve, its analysis.

4. POLICIES OF THE EDUCATIONAL COMPONENT

Course work recommendations: take an active part in all forms of work in classes, devote as much as an hour every day to independent work and preparation for the class, ask questions during classes, attend consultations, submit tasks on time and perform all forms of control.

Attendance. Attendance at lectures and practical classes is compulsory. The form of clothing during offline classes is a white medical gown. If the student is more than 5 minutes late, he may not be admitted to the class. Missed classes are practiced in accordance with the Regulation on the procedure for students of KhNMU to practice educational classes (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://knmu.edu.ua/wp-content/uploads/2021/05/pol_por-vidprac-zaniat.pdf)

Academic integrity. KhNMU stands on positions of zero tolerance for manifestations of academic dishonesty. Any violations of the principles of academic integrity entail responsibility in accordance with the procedure established by KhNMU (https://knmu.edu.ua/wp-content/uploads/2021/05/polog_ad-1.pdf).

Use of electronic gadgets and artificial intelligence tools is allowed only with the teacher's permission.

Policy on persons with special educational needs. Applicants with special educational needs should contact the teacher to develop an individual educational trajectory.

Teacher's response time: 24 hours**.**

Technical requirements for work on the course:

- access to a computer, laptop, tablet or smartphone
- corporate Google account with own photo
- skills with Google Workspace (Google Meet, Docs, Sheets, Slides, Forms) and Moodle

Technical support: Electronic register (ev.shevtsov@knmu.edu.ua), Google (tehotdelknmu@gmail.com), Moodle (al.korol@knmu.edu.ua)

RECOMMENDED SOURCES

Basic

1. Medical and biological physics: textbook for students studying the subject in English: In 2 parts/ V. G. Knigavko, O. V. Zaytseva, M. A. Bondarenko. Kharkiv: KhNMU, 2019. 556 p.
2. Glossary of terms on medical and biological physics / V. G. Knigavko, O. V. Zaitseva, M. A. Bondarenko, L. V. Batyuk. Kharkiv: KhNMU, 2018. 100 p.
3. Medical and Biological Physics: lectures, 2018. Knigavko V., Zaytseva O., Bondarenko M. http://repo.knmu.edu.ua/handle/123456789/21258

Auxiliary

1. Encyclopedia of Medical Physics: Two Volume Set (2nd Edition). Slavik Tabakov , Franco Milano, Magdalena S. Stoeva, Tennille D. Presley. IOP Publishing, 2021. 101 p.
2. Introduction to Medical Physics / Ed. by S. Keevil, R. Padovani, S. Tabakov, T. Greener, C. Lewis. CRC Press, 2022. 500 p.
3. S. A. Kane, B. A. Gelman. Introduction to Physics in Modern Medicine. CRC Press, 2020. 450 p.
4. Stoumpos AI, Kitsios F, Talias MA. Digital Transformation in Healthcare: Technology Acceptance and Its Applications. Int J Environ Res Public Health. 2023 Feb 15; 20(4):3407. doi: 10.3390/ijerph20043407. PMID: 36834105; PMCID: PMC9963556. p.
5. Boone JM, Benedict SH, Labby ZE, Armato SG. Medical Physics ends print. // Med Phys. 2023 Oct;50(10):5933-5934. doi: 10.1002/mp.16766.