

# KHARKIV NATIONAL MEDICAL UNIVERSITY

## SYLLABUS OF THE EDUCATIONAL COMPONENT

«MEDICAL AND BIOLOGICAL PHYSICS; MEDICAL INFORMATION TECHNOLOGIES»

(name of the educational component)

Specialty: **222 «Medicine»**

Educational and professional program: **Medicine**

Component code in the educational program: **OK 4**

Level of higher education: **second (master's)**

Form of education: full-time

Year of study: **1<sup>st</sup>**

Semester: (-s): **1<sup>st</sup> (autumn), 2<sup>nd</sup> (spring)**

Type of educational component: **compulsory**

Academic year: **2024-2025**

Scope of discipline: **4,0 ECTS (120 hours)**

Educational classes: lectures, practical classes, independent work

Final control: **Final Exam**

Prerequisites: **physics, biology, mathematics, computer science of a general secondary school**

Department/subdivision: Department of Medical and Biological Physics and Medical Informatics, pr. Sciences 4, main building, 2nd floor, right wing.

Head of the educational component: Prof. Zaitseva O.V., [ov.zaitseva@knmu.edu.ua](mailto:ov.zaitseva@knmu.edu.ua)

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The page of the educational component in the Distance Learning System of KhNMU (Moodle):

<https://distance.knmu.edu.ua/course/view.php?id=4689>

### DESCRIPTION OF THE EDUCATIONAL COMPONENT

Educational component: «Medical and biological physics; medical information technologies» 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): 4 ECTS credits, 120 hours, including 18 hours of lectures, 56 hours of practical classes, 46 hours of students' self-study work. Type of final control is differentiated credit.

**PURPOSE OF THE COURSE:** 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.

### LEARNING OUTCOMES:

- Having thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integration of knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy.
- Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient to solve professional health problems.
- Search for the necessary information in professional literature and databases of other sources, analyze, evaluate and apply this information.
- Apply modern digital technology, specialized software, statistical data analysis techniques to solve complex health problems.
- Apply modern digital, information and communication technologies, specialized software in professional activities and professional self-development.

### CONTENT OF THE EDUCATIONAL COMPONENT

# KHARKIV NATIONAL MEDICAL UNIVERSITY

## List of lecture topics (18 hours)

1. Elements of probability theory. Random variables.
2. Fluid mechanics. Some applied issues of hemodynamics.
3. Bioacoustics.
4. Physical foundations of electrography.
5. Effects of electric currents and electromagnetic fields on biological objects.
6. Geometric optics. Lenses. Optical system of the human eye.
7. X-ray radiation and its use in medicine.
8. Dosimetry of ionizing radiation. Radiation diagnosis and radiation therapy.
9. Medical information technologies.

## List of topics of classes (56 hours)

1. Elements of probability theory.
2. Random variables (part 1).
3. Random variables (part 2).
4. Elements of mathematical statistics.
5. Final control № 1.
6. Fluid mechanics. Hemodynamics. Bioreology.
7. Bioacoustics.
8. Transport of substances through cell membranes. Biopotentials (s).
9. Physical foundations of electrography. ECG.
10. Effects of electric currents and electromagnetic fields on biological objects (s).
11. Basics of medical electronics.
12. Final control № 2.
13. Lenses. Optical system of the human eye.
14. Optical microscopy.
15. Polarized light, its use in medicine.
16. Interaction of light with matter. Absorption, scattering and dispersion of light.
17. Thermal radiation. Basic concepts of quantum physics. Luminescence.
18. Lasers. Magnetic resonance spectroscopy. Electron microscope.
19. Ionizing radiation. X-ray radiation; its use in medicine.
20. Dosimetry of ionizing radiation. Radiation diagnosis and radiation therapy.
21. Final control № 3.
22. Basic concepts of medical informatics.
23. Information technologies in medical information systems. Electronic medical cards.
24. Methods and systems of decision support in medicine.
25. Medical classification systems. Basics of medical standardization.
26. Electronic Health System.
27. Final control № 4.
28. Final Exam. Differential credit.

## List of topics of self-study work (46 hours)

1. Basics of differential and integral calculus. Gradient of the scalar function. First-order differential equations with separable variables. Linear differential equations of the first order. Methods of solving differential equations. Linear differential equations of higher orders with constant coefficients. (To classes № 1, 2, 3)
2. Methods of processing measurement results, methods of non-parametric statistics. Pearson and Spearman correlation coefficient. (To class № 4)
3. 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

# KHARKIV NATIONAL MEDICAL UNIVERSITY

- 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. (To class № 6)
4. 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. (To class № 7)
  5. 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. (To class № 8)
  6. Biophysics of macromolecules. The nature of the primary, secondary, tertiary, quaternary structure of proteins. (To class № 8)
  7. 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. (To classes № 9, 10, 11)
  8. Wave optics (interference of light, diffraction of light, basic concepts, formulas, laws, use in medical and biological research) (To classes № 13,14,15,16)
  9. Elements of photometry. Objective physical characteristics of light and subjective physiological characteristics of light perception by the organ of vision. (To classes № 13,14,15,16)
  10. Photobiological processes, their types, stages. Concept of photochemical reaction cross-section. Spectrum of photobiological action. Photosensitized photobiological processes. (To Classes № 13,14,15,16)
  11. Spectroscopy. Radiation and absorption of light by atoms and molecules. Radiation and absorption spectra. Spectrophotometry. (To class № 17)
  12. Induced radiation. Lasers. Magnetic resonance. Electron microscope. Radioactive decay of atoms. Interaction of ionizing radiation with matter. (To class № 18)
  13. Biophysical foundations of radiobiological processes (To classes № 19, 20)
  14. Coding and classification in the health system. (To class № 22)
  15. Analysis and methods of processing biosignals. Visualization of medical and biological data. (To class № 26)
  16. Formal logic in solving the problems of diagnosis, treatment and prevention of diseases (Before classes № 23, 24)
  17. Expert systems in medicine. (To class № 25)

**Self-study work** is aimed at deepening and consolidating theoretical knowledge obtained during classroom training and contributing to the formation of professional competences. SRS results are subject to control and included in the final knowledge control.

**Consultations:** Consultations are held online according to the department's schedule with prior registration at the teacher's corporate mail.

**Teaching methods:** oral survey (individual and frontal); computer survey; test control; creative tasks; individual tasks; presentations; project method; self-control; speech on a given topic; poster report and others.

## ASSESSMENT

### Current learning activities (CLA).

The assessment of the success of students of education is carried out in accordance with the Instructions for the assessment of the educational activity of students of higher education at KhNMU ([https://knmu.edu.ua/doc\\_block\\_type/instrukcziyi-navchalnogo-proczesu/](https://knmu.edu.ua/doc_block_type/instrukcziyi-navchalnogo-proczesu/)). The grade for a class or module is from 2 to 5 points. Submission of tasks late for disrespectful reasons entails a decrease in the score according to the percentage of time delay from the time of completion of the task. Tasks are checked within 24 hours. Scores are submitted to the electronic journal. Unsatisfactory grades are

# KHARKIV NATIONAL MEDICAL UNIVERSITY

worked out in accordance with the Regulation on the procedure for students of KhNMU to study classes ([chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://knmu.edu.ua/wp-content/uploads/2021/05/pol\\_por-vidprac-zaniat.pdf](https://knmu.edu.ua/wp-content/uploads/2021/05/pol_por-vidprac-zaniat.pdf)).

At the end of the study of the discipline, the grade for the current learning activity (CLA) is calculated; it is equal to the average score (arithmetic average) for all classes during two semesters. This average score is converted into a multi-point score (from 70 to 120 points).

## **Individual tasks (IT)**

The individual tasks of the student are not a mandatory element, but if desired, the student of education can complete it. IT are evaluated in the amount of up to 10 points. IT are added to the sum of points scored for current learning activities (CLA).

## **Graded credit (GC)**

Graded credit is given in the form of Final exam on the Moodle platform and involves an answer to 25 test questions. Valuing criteria for Final exam:

16-19 correct answers - mark "3" – 50 points,

20-24 correct answers - mark "4" – 65 points,

25 correct answers - mark "5" – 80 points.

A condition for admission to the differentiated credit is that the student receives 70 points for the CEA.

The condition for admission to the credit is the absence of academic debt.

## **Discipline assessment (DA)**

DA is equal to the sum of points for current educational activity (CEA), points for individual tasks (IT) and points for differential credit (DC), i.e.  $DA = CEA + IT + DC$ .

The maximum score for the discipline is 200 points, the minimum is 120 points.

Evaluation of applicants is carried out in accordance with the «Instructions for evaluating the educational activities of higher education applicants at the Kharkiv National Medical University», approved by the order of the KhNMU dated August 21, 2021 № 181.

**The appeal** of the results of the final control is carried out in accordance with the procedure established by the KhNMU ([https://knmu.edu.ua/wp-content/uploads/2021/05/polog\\_apel\\_kontrol.pdf](https://knmu.edu.ua/wp-content/uploads/2021/05/polog_apel_kontrol.pdf)).

## **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://efaidnbmnnnibpcajpcgclefindmkaj/https://knmu.edu.ua/wp-content/uploads/2021/05/pol\\_por-vidprac-zaniat.pdf](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](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

# KHARKIV NATIONAL MEDICAL UNIVERSITY

- 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>
4. Medical informatics: tutorial for foreign English-speaking students of medical universities / V. G. Knigavko, O. V. Zaytseva, M. A. Bondarenko, L. V. Batyuk, A. S. Rukin. Kharkiv: KhNMU, 2019. 68 p.

### Auxiliary

1. Handbook of Biomedical Informatics. 2021. Электронный ресурс: [https://en.wikipedia.org/wiki/Book:Handbook\\_of\\_Biomedical\\_Informatics](https://en.wikipedia.org/wiki/Book:Handbook_of_Biomedical_Informatics)
2. Encyclopedia of Medical Physics: Two Volume Set (2nd Edition). Slavik Tabakov , Franco Milano, Magdalena S. Stoeva, Tennille D. Presley. IOP Publishing, 2021. 101 p.
3. Introduction to Medical Physics / Ed. by S. Keevil, R. Padovani, S. Tabakov, T. Greener, C. Lewis. CRC Press, 2022. 500 p.
4. S. A. Kane, B. A. Gelman. Introduction to Physics in Modern Medicine. CRC Press, 2020. 450 p.
5. 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.
6. Information Technology for Healthcare Managers, 9th ed. / G. L. Glandon, D. J. Slovensky, D. H. Smaltz. AUPHA/HAP Book, 2020. 539 p.
7. Bollmann S, Küstner T, Tao Q, Zöllner FG. Artificial intelligence in medical physics. // Med Phys. 2024. May; 34(2):177-178. doi: 10.1016/j.zemedi.2024.03.002.
8. Yaghy A. Medicine's digital revolution. // Can Med Educ J. 2024 May 1;15(2):113-114. doi: 10.36834/cmej.79045.
9. 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.

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