


**Federal State Budgetary Educational Institution higher education "Dagestan  
State Medical University" Ministry of Health of the Russian Federation  
(FSBEI HO DSMU of the Ministry of Health of Russia)**

AGREED  
Act. Vice-Rector for Academic Affairs,  
Ph.D. R. M. Ragimov  
  
31/05/2023

**WORKING PROGRAM of the discipline  
«MEDICAL EQUIPMENT WITH BASICS OF BIOPHYSICS»**

Curriculum discipline index – ***B1. O. 03***

Direction of training (specialty): ***31.05.01 – General medicine***

Level of higher education: ***speciality***

Graduate Qualification: ***Physician***

***Faculty of General medicine***

Department: ***Biophysics, informatics and medical equipment***

***Full-time*** form of education

Course: ***1***

Semester: ***1***

Total labor intensity (in credits/hours): ***2 CU / 72 hours***

Contact: ***54*** hours

Lectures: ***18*** hours

Practical training: ***36*** hours

Independent work: ***18*** hours

Form of control: ***offset***

**Makhachkala, 2023**

The working program of the discipline “*Medical equipment with basics of biophysics*” was developed in accordance with the *Federal State Educational Standard of HE* in the field of training (specialty) **31.05.01 – General medicine** approved by the order №988 of the Ministry of Education and Science of the Russian Federation from 12.08.2020 y.

The working program of the discipline was approved at the meeting of the department on 12.05.2023 protocol № 11.

Work program agreed with:

1. Director of the Library of the DSMU \_\_\_\_\_ (V.R. Musaeva)
2. Head of the Department of UMR KCO \_\_\_\_\_ (A.M. Karimova)
3. Dean \_\_\_\_\_ (R.T. Savzikhanov)

Head of the Department \_\_\_\_\_ ( R.M. Abdulgalimov)

***Program Developers:***

1. R.M. Abdulgalimov - Head of the Department of Biophysics, doctor of pedagogical sciences, professor
2. A.M. Kurbanova - assistant professor of the Department of Biophysics, Candidate of Physical and Mathematical Sciences.

***Reviewers:***

1. E.R. Nagiyev – Head of the General and Biological Chemistry Department of DSMU, Professor.
2. G.M. Magomedov - Head of department of theory and methods of physics teaching of DSPU, Doctor of physical and mathematical Sciences, Professor.

## **I. PURPOSE AND OBJECTIVES OF MASTERING THE DISCIPLINE**

**Purpose:** to form systematic knowledge among medical students about physical properties and physical processes occurring in biological objects, including the human body, necessary both for studying other academic disciplines and for direct formation of a doctor; structure and principle of operation of modern medical and diagnostic equipment, as well as safety precautions when working with medical equipment.

**Tasks:**

1. the formation of modern natural-science ideas about the surrounding material world;
2. the development of students' methodological orientation, essential for solving the problems of modern medicine;
3. the formation of students' logical thinking, the ability to accurately formulate a problem, the ability to calculate the main and secondary, the ability to draw conclusions based on the measurement results;
4. students mastering physical methods for solving intellectual problems aimed at preserving the health of the population, taking into account the factors of adverse effects of the environment.

**II. PLANNED TRAINING OUTCOMES IN THE DISCIPLINE**  
**Competences formed in the process of studying the discipline**  
**Federal State Educational Standard 3++**

<i>Code and name of competence</i>
<b><i>General professional competencies</i></b>
<b>GPC-4</b> - Able to use medical devices provided for by the order of medical care, as well as conduct examinations of the patient in order to establish a diagnosis
<b>CAI-1 GPC-4</b> - Uses medical devices provided for by the procedure for providing medical care
<b><i>Know:</i></b> safety rules and work in physical laboratories with instruments and apparatus; the basic laws of physics, physical phenomena and patterns underlying the processes occurring in the human body; the physical foundations of the functioning of medical equipment, the design and purpose of medical equipment; physical and chemical essence of the processes occurring in a living organism at the molecular, cellular, tissue and organ levels
<b><i>Be able to:</i></b> use physical equipment; predict the direction and result of physical processes and chemical transformations of biologically important substances.
<b><i>Skill:</i></b> the skills of using measuring, computing tools, the basics of safety when working with devices.

### III. THE PLACE OF DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM

The discipline "*Medical equipment with basics of biophysics*" is studied in the first semester and belongs to the mandatory part **B1** of the curriculum for the specialty **31.05.01 - General medicine**.

The discipline "*Medical equipment with basics of biophysics*" is fundamental for the study of the following disciplines:

- normal physiology;
- biochemistry;
- microbiology and virology;
- hygiene;
- public health and healthcare;
- neurology;
- medical genetics;
- ophthalmology;
- propaedeutic of internal diseases;
- radiation diagnostics and therapy;
- forensic medicine of catastrophes.

The previous ones, on which the discipline "*Medical equipment with basics of biophysics*" is directly based, are school courses in physics and mathematics.

The development of competencies in the process of studying the discipline contributes to the formation of knowledge, skills and abilities that allow to carry out effective work on the implementation of the following type of tasks of professional activity: to know the physical foundations of the functioning of medical equipment, the design and purpose of medical equipment; physical and chemical essence of the processes occurring in a living organism at the molecular, cellular, tissue and organ levels.

### IV. THE TOTAL COMPLEXITY OF THE DISCIPLINE is 3 credit units.

<i>Type of study work</i>	<i>Total hours</i>	<i>Semester</i>
		<i>1</i>
<i>Contact work of students with the teacher</i>	54	54
<i>Classroom activities (total)</i>	54	54
<i>Including:</i>		
Lectures ( <i>L</i> )	18	18
Practical exercises ( <i>PE</i> )	36	36
<i>Independent Work of Student (IWS)</i>	18	18
Type of intermediate certification	offset	offset
<b>TOTAL labor intensity:</b> of hours	72	72
of credit units	2	2

## V. CONTENT OF THE EDUCATIONAL DISCIPLINE

### 5.1. Sections of the discipline and competencies that are formed during their study

<i>№ section</i>	<i>Name of the discipline section</i>	<i>Section content</i>	<i>Controlled code competencies</i>
1	2	3	4
1	<b><i>Fundamentals of Medical Electronics.</i></b>	Basic concepts of medical electronics. Safety and reliability of medical equipment. Features of signals processed by medical electronic equipment and related requirements for medical electronics. The principle of operation of medical electronic equipment (generators, amplifiers, sensors). Fixation and registration devices. General scheme, amplification, transmission and registration of biomedical information. Features of signals processed by medical electronic equipment and related requirements for medical electronics. General requirements for safety and reliability, the procedure for metrological support and certification of medical equipment.	<b>CAI -1 GPC- 4</b>
2	<b><i>Acoustics. Devices for measuring the mechanical characteristics of the body.</i></b>	Mechanical oscillations and waves. Fluctuations. Types of oscillations. Parameters of oscillations and waves. Mechanical waves. Sound. Types and characteristics of sound. Hearing diagnostics. Sound research method. Physical bases of sound research methods in the clinic Audiometry. Spirometry. Microprocessor spirometer. The main parameters of the spirogram. Biophysics of ultrasound. Obtaining ultrasonic oscillations. Propagation and reflection of ultrasound. Methods of ultrasonic research. Ultrasonic transducer. Components of the ultrasound diagnostic system. Types of sensors. The effect Doppler and its use in medicine. Physical bases of application of ultrasound in medicine. Generation and registration of US. US devices. Apparatus for ultrasound therapy. The structure and principle of operation of the ultrasound therapy apparatus. Diagnostic equipment, based on the principles of visualization and image analysis - US. The study of the mechanical properties of tissues on model materials for tissues (metals, polymers).	<b>CAI -1 GPC- 4</b>

3	<b><i>Devices and apparatus for diagnosing the state of the main functional systems of the body.</i></b>	Membrane potentials. Resting potential. Action potential. Diagnostic equipment for registration of biopotentials of the heart. Electrography. Electrocardiography. Physical bases of an ECG. Electric dipole. The main postulates of the Einthoven model. The device and principle of operation of the ECG apparatus. Holter ECG and BP monitoring systems. Heart monitors. Devices and methods of analysis of hemodynamics. Rheography. Physical bases of rheography. Full impedance: constant and pulsed. Rheogram. Rheograph device. Dispersion of electrical conductivity. Capacitive and ohmic resistance of biological tissues of the body.	<b>CAI -1 GPC- 4</b>
4	<b><i>Instruments and devices for non-drug therapeutic effects of various physical factors</i></b>	Physical factors are used in electrotherapy. Apparatus and devices for low-frequency electrotherapy. Apparatus for low-frequency electrotherapy. Galvanization. The structure and principle of operation of the galvanization apparatus. Physical bases of galvanization. Devices for electrical stimulation (impulse currents). The main types of impulse currents. Amplipulse therapy. The structure of Amplipulse therapy device. Electropuncture therapy. Device for electropuncture. Electric defibrillators. Types and structure of pacemakers. Types of pacemakers. Electrosleep. Apparatus for high-frequency electrotherapy (UHF, microwave). Therapeutic application of high-frequency currents and fields. The structure and principle of operation of the UHF-therapy apparatus. Physical basis of UHF-therapy. Inductothermy. Microwave therapy. High frequency currents. Darsonvalization.	<b>CAI -1 GPC- 4</b>
5	<b><i>Diagnostics What equipment is based on the principles of visualization and image analysis.</i></b>	High tech. X-ray radiation. X-ray sources. Bremsstrahlung and characteristic x-rays. X-ray apparatus. Interaction of X-ray radiation with matter. Physical basis for use of X-rays in medicine. Methods of X-ray diagnostics (fluoroscopy, radiography). X-ray tube structure. Fluorography. Tomography. X-ray computed tomography. Electronic paramagnetic resonance. EPR tomograph. Nuclear magnetic resonance (NMR). MRI tomograph. Magnetic resonance angiography. Physical bases. Radioactivity. Interaction of $\alpha$ -, $\beta$ - and $\gamma$ -radiation with matter. The mechanism of action of ionizing radiation on the human body. The use of	<b>CAI -1 GPC- 4</b>

		<p>radionuclides in medicine. Biophysical bases of action of ionizing radiation. Radionuclide single photon emission computed tomography (SPECT). Positron emission tomography (PET)</p> <p>Radionuclide (radioisotope) diagnostics. Types of radioisotope diagnostics. Equipment for radionuclide diagnostics.</p> <p>Endoscopic devices (fibroendoscope, laparoscope, etc.). Study of the structure and principle of operation of endoscopes. Operating procedure. Safety engineering.</p> <p>Lasers. Optical resonator. Helium-neon laser. Red ruby laser. Features of laser radiation. Laser scalpel. Application of laser to medicine. Safety precautions when working with lasers.</p> <p>Dosimetry of ionizing radiation. Doses of radiation. Dose rate. Absorbed, exposure and equivalent doses. Dosimetric devices. Detectors of ionizing radiation. Methods of protection against ionizing radiation.</p>	
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## 5.2. Sections of the discipline and labor intensity by types of educational work

<i>N<sup>o</sup> section</i>	<i>Name of the discipline section</i>	<i>Types of educational work, hour</i>			<i>Total hours</i>
		<i>auditorium</i>		<i>extra- curricular</i>	
		<i>L</i>	<i>PS</i>	<i>IWS</i>	
1	Fundamentals of Medical electronic equipment	2	4	2	8
2	Acoustics. Devices for measuring the mechanical characteristics of the body	4	6	2	12
3	Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.	4	8	4	16
4	Devices and apparatus for non-drug therapeutic effects of various physical factors.	4	10	4	18
5	Quantum physics, ionizing radiation. Dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.	4	8	6	18
<b>TOTAL</b>		18	36	18	72



### 5.3. Thematic plan of lectures

<i>Nº</i>	<i>The discipline section</i>	<i>Topics of lectures</i>	<i>Number of hours</i>
1	<i>Fundamentals of Medical electronic equipment.</i>	<i>L.1.</i> Introduction to the discipline. medical electronic equipment. Item of medical equipment. Safety engineering. Metrology.	2
2	<i>Acoustics. Instruments for measuring mechanical body characteristics.</i>	<i>L.2.</i> Mechanical oscillations and waves. Sound. Ultrasound. Ultrasound images. Ultrasound equipment.	2
3	<i>Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.</i>	<i>L.3.</i> Biophysics of tissues and organs. Membrane electric potentials. Diagnostic equipment for registration of biopotentials.	2
4	<i>Instruments and apparatus non-drug therapeutic effects of various physical factors.</i>	<i>L.4.</i> Electric current in biological tissues. Dispersion of electrical conductivity. Rheography.	2
		<i>L.5.</i> Equipment for low-frequency therapy.	2
		<i>L.6.</i> Equipment for high-frequency therapy. UHF therapy.	2
5	<i>Quantum physics, ionizing radiation. dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.</i>	<i>L.7-8.</i> Radiation images. X-ray and gamma-diagnostic equipment. Tomographic methods in medicine. CT, MRI, PET.	4
		<i>L.9.</i> Radioactivity. Dosimetry. The use of radionuclides in medicine.	2
TOTAL			18

## 5.4. Thematic plan of practical studies

<i>Nº section</i>	<i>Section of discipline</i>	<i>Topics of practical studies /seminars</i>	<i>Forms of current control</i>	<i>Number of hours</i>
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
1	Fundamentals of Medical Electronics	<b>PS.1.</b> "General requirements for safety and reliability, the procedure for metrological support and certification of medical equipment."	T	2
2	Acoustics. Devices for measuring the mechanical characteristics of the body.	<b>PS.2.</b> "Mechanical oscillations and waves".	T, ST	2
		<b>PS.3.</b> "Sound. Sound research methods in the clinic".	T, ST	2
		<b>PS.4.</b> "Ultrasound. Ultrasound images.	I, T	4
3	Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.	<b>PS.5.</b> "Membrane electrical potentials".	T, ST, I	4
4	Instruments and apparatus non-drug therapeutic effects of various physical factors.	<b>PS.6.</b> “The device and principle of operation of the galvanization apparatus. Amplipulse Therapy.	T, ST, I	4
5	Quantum physics, ionizing radiation. Dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.	<b>PS.7.</b> “Lasers. Features of the action of laser radiation on biological tissues.	T, I	2
		<b>PS.8.</b> “X-ray radiation. X-ray and gamma-diagnostic equipment”.	T, I	4
		<b>PS.9.</b> "Tomographic methods in medicine CT scan, MRI, PET".	T, I	4
		<b>PS.10.</b> "Radioactivity. Law of radioactive decay.	T, I	2
		<b>PS.11.</b> "Instruments used in endoscopy".	T, I	4
<b>Intermediate certification</b>			<b>offset</b>	2
<b>TOTAL</b>				36

## 5.6. Educational and methodological support for independent work in the discipline

### 5.6.1. Independent work of a student in the discipline "Medical equipment with the basics of biophysics".

<i>Nº</i>	<i>Name of the discipline section</i>	<i>Types of IWS</i>	<i>Labor intensity (hour)</i>	<i>Forms of control</i>
<b>1</b>	Fundamentals of Medical Electronics	Study of educational and scientific literature; work with lecture material; preparation of abstracts.	<b>2</b>	<b>I</b>
<b>2</b>	Acoustics. Devices for measuring the mechanical characteristics of the body.	Study of educational and scientific literature; preparation for practical study; preparation for a laboratory lesson; work with lecture material; preparation of abstracts.	<b>2</b>	<b>ST, I, A</b>
<b>3</b>	Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.	Study of educational and scientific literature Work with lecture material, preparation for testing.	<b>4</b>	<b>T, ST, I, A</b>
<b>4</b>	Devices and apparatus for non-drug therapeutic effects of various physical factors.	Repetition and consolidation of the studied material (work with lecture material, educational literature); wording of questions; preparation for testing.	<b>4</b>	<b>T, I, A, PSA</b>
<b>5</b>	Quantum physics, ionizing radiation. Dosimetric devices.	Diagnostic equipment based on the principles of visualization and image analysis. Repetition and consolidation of the studied material (work with lecture material, educational literature); preparation of abstracts.	<b>6</b>	<b>I, T, A</b>
<b>Total per semester</b>			<b>18</b>	

<i>Nº</i>	<i>Name of the discipline section</i>	<i>Essay topics</i>
<b>1</b>	Fundamentals of Medical Electronics.	Medical devices for the study of the central nervous system, brain EEG ( <b>GPC- 4 CAI -1</b> )
<b>2</b>	Acoustics. Devices for measuring the mechanical characteristics of the body.	Physical basis of acoustic research methods in medicine: audiometry, percussion, auscultation, phonocardiography ( <b>GPC- 4 CAI -1</b> )

<b>3</b>	Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.	Devices and equipment for diagnosing the state of the main functional systems of the body ( <b>GPC- 4 CAI -1</b> )
<b>4</b>	Devices and equipment for non-drug therapeutic effects of various physical factors.	Electrical and magnetic properties of living tissues ( <b>GPC- 4 CAI -1</b> )
<b>5</b>	Quantum physics, ionizing radiation. dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.	1. Nuclear magnetic resonance (NMR) and its biomedical applications. 2. Physical principles of the positron emission tomograph (PET). Application of PET methods in medicine ( <b>GPC- 4 CAI -1</b> ).

### **5.6.2. Guidelines for students on mastering the discipline (attached) Appendix № 3**

## **VI. INDEPENDENT WORK OF STUDENTS IN THE DISCIPLINE "MEDICAL EQUIPMENT WITH THE BASICS OF BIOPHYSICS".**

### **6.1. The list of competencies with the appearance of their formation in the process of mastering the work programs of disciplines**

<i>№ section</i>	<i>Name of the discipline section</i>	<i>Controlled competency code</i>	<i>Forms of control</i>
<b>1</b>	Basics of medical electronic equipment	CAI - 1 GPC - 4	T, A

2	Acoustics. Devices for measuring the mechanical characteristics of the body.	CAI - 1 GPC - 4	T, A, ST, I
3	Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.	CAI - 1 GPC - 4	T, A, ST, I
4	Devices and apparatus for non-drug therapeutic effects of various physical factors.	CAI - 1 GPC - 4	T, I, A, PSA
5	Quantum physics, ionizing radiation. Dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.	CAI - 1 GPC - 4	I, T, A

**Description of indicators and criteria for assessing the competence specified in Section 2 at various stages of their formation, description of assessment scales:**  
**Criteria for evaluating the results of mastering the discipline**

<i>Assessment Metrics</i>	<i>Evaluation criteria</i>	
	<i>"not passed "</i>	<i>"passed"</i>
<b>Competency Code GPC – 4 CAI - 1</b>		
<b>know</b>	The student does not know the safety rules and work in physical laboratories with instruments and apparatus; the basic laws of physics, physical phenomena and patterns underlying the processes occurring in the human body; the physical foundations of the functioning of medical equipment, the design and purpose of medical equipment; physical and chemical essence of the processes occurring in a living organism on the molecular, cellular, tissue and organ levels	The student knows the safety rules and work in physical laboratories with instruments and apparatus; the basic laws of physics, physical phenomena and patterns underlying the processes occurring in the human body; physical bases of functioning of the medical equipment. There is a deep understanding of the material.
<b>be able to</b>	The student does not know how to use physical equipment; predict the direction and result of physical processes and chemical transformations of biologically important substances.	The student knows how to use physical equipment; predict the direction and result of physical and chemical processes and chemical transformations of biologically important substances.
<b>skill</b>	The student does not have the skills to use measuring, computing tools, the basics of safety when working with devices.	The student has the skills to use measuring, computing tools, the basics of safety when working with devices.

**6.1. Evaluation tools for monitoring progress**  
EXAMPLES!

For the current control of the progress of the discipline, the following evaluation tools are used:

**INTERVIEW ON CONTROL QUESTIONS**

**Section 4. Devices and apparatus for non-drug therapeutic effects of various physical factors.**

**Lab №10.** «Equipment for high-frequency electrotherapy. The structure and principle of operation of the UHF-therapy apparatus»

1. Varieties of HF and UHF therapy. Physical factors used in RF and UHF therapy
2. Physical processes in the tissues of the body when exposed to alternating electric current, electric, magnetic, electromagnetic fields of UHF and microwave ranges.
3. Physical basis of UHF therapy.
4. The structure and principle of operation of UHF therapy devices, the functional purpose of its main blocks.
5. Design and purpose of the therapeutic circuit.

**Criteria for assessing the current control of progress (interview on control questions):**

✓ **"Excellent":**

The student has a deep knowledge of the educational material on the topic of the laboratory lesson, formulated a complete and correct answer to the questions of the topic of the lesson, in compliance with the logic of the presentation of the material, shows the assimilation of the relationship of the main concepts used in the work, was able to answer all clarifying and additional questions. The student demonstrates knowledge of theoretical and practical material on the topic of the lesson. Prepared a lab report.

✓ **"Good":**

The student showed knowledge of the educational material, mastered the basic literature, was able to answer almost completely all the additional and clarifying questions asked. The student demonstrates knowledge of theoretical and practical material on the topic of the lesson, allowing minor inaccuracies.

✓ **"Satisfactory":**

The student as a whole mastered the material of the practical lesson, answered not all clarifying and additional questions. The student finds it difficult to correctly assess the proposed task, gives an incomplete answer, requiring leading questions from the teacher.

✓ **"Unsatisfactory":**

The student has significant gaps in the knowledge of the main educational material of the practical lesson, did not fully disclose the content of the questions, could not answer clarifying and additional questions. The student gives an incorrect assessment of the situation, incorrectly chooses an algorithm of actions. An unsatisfactory grade is given to a graduate who refuses to answer questions on the topic of a practical lesson.

**TESTING**

**Section 2. Acoustics. Devices for measuring the mechanical characteristics of the body**  
**Practical lesson № 2. "Mechanical oscillations and waves"**

**Codes of controlled competencies: GPC-4 ID-1 GPC-4**

**Option 2.**

1. Doppler effect.

- a. change in the intensity of the wave perceived by the wave receiver (observer) due to the relative motion of the wave source and the observer;
- b. change in the amplitude of the wave perceived by the wave receiver (observer) due to the relative motion of the wave source and the observer;
- c. change in the frequency of the wave perceived by the wave receiver (observer) due to the relative motion of the wave source and the observer; d. change in the phase of the wave perceived by the wave receiver (observer) due to the relative motion of the wave source and the observer.

**2. Ultrasound is a mechanical (elastic) wave with a frequency ...**

- a. from  $2 \cdot 10^4$  to  $10^9$  Hz;
- b. from 20 to 20000 Hz;
- c. less than 20 Hz;
- d. more than  $10^9$  Hz.

**3. Oscillation amplitude:**

- a. number of oscillations per second;
- b. the maximum displacement of the oscillating body from the equilibrium position;
- c. time of one oscillation of the body;
- d. the value that determines the position of the oscillating point at a given moment in time and the direction of its movement.

**4. Oscillation period:**

- a. the number of complete oscillations in one second;
- b. a quantity that determines the position and direction of motion of an oscillating body;
- c. the maximum displacement of the oscillating body from the equilibrium position;
- d. time of one complete oscillation.

**5. Oscillation frequency:**

- a. number of oscillations in one period;
- b. the maximum displacement of the oscillating body from the equilibrium position;
- c. time of one complete oscillation;
- d. the number of complete oscillations in 1 s.

**6. Mechanical wave is a mechanical disturbance:**

- a. localized in space;
- b. propagating in an elastic medium and carrying energy;
- c. self-excited in space;
- d. the distribution of which is not associated with the transfer of energy.

**7. Energy characteristic of sound:**

- a. timbre;
- b. height;
- c. intensity;
- d. frequency.

**8. Determination of the threshold of hearing:**

- a. the lowest frequency of sounds at which subtle auditory sensations occur;
- b. the lowest sound intensity at which a barely perceptible auditory sensation occurs;
- c. the highest sound intensity at which auditory perception ceases sound;
- d. the highest frequency of sound at which a subtle auditory sensation occurs.

**9. Subjective characteristics of sound:**

- a. intensity;
- b. height;
- c. sound pressure;
- d. sound intensity level.

**10. Highlight the objective characteristics of the sound:**

- a. height;
- b. volume;
- c. frequency;
- d. timbre.

Criteria for assessing the current control of progress (testing):

- ✓ "Excellent": 100-90%
- ✓ "Good": 89-80%
- ✓ "Satisfactory": 79-70%
- ✓ "Unsatisfactory": <69%

**SITUATIONAL TASKS. Section 2. Physics of liquids, gases and solids. Acoustics.**  
**Laboratory lesson № 12 "Radioactivity. Dosimetry".**

**Controlled Competency Codes: GPC-4 CAI-1**

**Be able to.**

**Task № 1.**

When working in an X-ray room, personnel are exposed to excessive X-ray training. It is known that the exposure dose rate at a distance of 1 m from the X-ray source is 0.1 R/min. A person is within 6 hours a day at a distance of 10 meters from the source. What is the equivalent dose of training he receives during the working day?

1. **Question:** Find the exposure dose received by the personnel for 6 hours of work in the X-ray room, being at a distance of 1 m from the radiation source.

Answer:  $\frac{X}{t} = 0.1 \frac{R}{min}$   $X = 0.1 \frac{R}{min} \cdot 360 min = 36 R$

2. **Question:** How does the exposure dose rate at a given point depend on the distance to the radiation source?

Answer:  $\frac{x}{t} \sim \frac{1}{R^2}$

3. **Question:** What is the exposure dose received by personnel at a distance of 10 m from the source?

Answer:  $X = \frac{36}{100} = 0.36 R$

4. **Question:** How are exposure, absorbed and equivalent doses related?

Answer:  $H=k D$ ;  $D=f X$

**Skill.**

**Task 4.**

Calculation of the coefficient of linear attenuation  $\mu$ . Using the expression  $I = I_0 e^{-\mu d}$  and the values of the ratio  $I(x)/I_0$  (table) calculate the values of the coefficient of linear attenuation of X-rays in air, blood, muscle and bone tissue. Record the obtained data in a table.

**Criteria for assessing the current monitoring of progress (situational tasks):**

- ✓ "Excellent":

The answer to the question is correct. The explanation of the course of its solution is detailed, consistent, competent, with theoretical justifications (including from the lecture course), with the necessary schematic images and demonstrations on obstetric phantoms, with the correct and fluent knowledge of obstetric-gynecological terminology; answers to additional questions are correct, clear.

- ✓ "Good":

The answer to the question is correct. The explanation of the course of its solution is detailed, but not logical enough, with single errors in details, some difficulties in theoretical



justification (including from lecture material), in schematic images and demonstrations on obstetric phantoms, with single errors in the use of obstetric and gynecological terms ; answers to additional questions are correct, but not clear enough.

✓ **"Satisfactory":**

The answer to the question is correct. The explanation of the course of its solution is not complete enough, inconsistent, with errors, weak theoretical justification (including lecture material), with significant difficulties and errors in schematic images, demonstrations on obstetric phantoms, in the use of obstetric and gynecological terms; answers to additional questions are not clear enough, with errors in details.

✓ **"Unsatisfactory":**

The answer to the question was given incorrectly. The explanation of the course of its solution is given incomplete, inconsistent, with gross errors, without theoretical justification (including lecture material); answers to additional questions are incorrect (missing).

## **Abstract**

**Chapter 5. Quantum physics, ionizing radiation. Dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis. Laboratory lesson №12. "Radioactivity. Dosimetry".**

### **Controlled Competency Codes: GPC-4 CAI-1**

#### **Abstract topics:**

1. "Nuclear magnetic resonance (NMR) and its biomedical applications"
2. "Physical principles of the positron emission tomograph (PET). Application of PET methods in medicine".

#### **Criteria for evaluating current control (abstract):**

- Novelty of the abstracted text: max. – 20 points;
- The degree of disclosure of the essence of the problem: max. – 30 points;
- Validity of the choice of sources: max. – 20 points;
- Compliance with design requirements: max. – 15 points;
- Literacy: max. – 15 points.

#### **Abstract evaluation:**

The abstract is evaluated on a 100-point scale, the points are converted into performance assessments as follows (points are taken into account in the process of the current assessment of knowledge of the program material):

- ✓ 86 – 100 points – "*excellent*";
- ✓ 70 – 75 points – "*good*";
- ✓ 51 – 69 points – "*satisfactory*";
- ✓ Less than 51 points – "*unsatisfactory*"

### **Testing by discipline sections**

#### **Section 1. Fundamentals of medical electronic equipment.**

##### **Controlled Competency Codes: GPC-4 CAI-1**

1. Instruments and devices for diagnosing the state of the main functional systems of the body include:

- a) electrocardiograph, rheograph, electroencephalograph, myograph, spiograph, ergometer, sensors;
  - b) electrocardiograph, rheograph, UHF, myograph, thermometer, ergometer, sensors;
  - c) electrocardiograph, rheograph, electroencephalograph, myograph, spiograph, ergometer, sensors;
  - d) electrocardiograph, electroencephalograph, myograph, spiograph, ergometer, thermometer.
2. The general diagnostic method based on the registration of the potential difference of electric fields caused by the electrical activity of tissues, organs is called:
- a) encephalography;      b) electrogram;      c) encephalogram;      d) electrography.
3. Electrography of brain tissues is called:
- a) encephalography;      b) electrocardiogram;      c) electroenzolography;      d) encephalogram.
4. Choose the correct answer. The general scheme for the collection, transmission and registration of medical and biological information is:
- a) Internet, collecting device, amplifier, ADC, PC, RU;
  - b) collecting device, amplifier, ADC, Internet, PC, RU;
  - c) collecting device, ADC, amplifier, PC, Internet, RU;
  - d) amplifier, collecting device, ADC, PC, Internet, RU.
5. Complete the offer. An amplifier is a device that increases ... due to the energy of an external source.
- a) electrical signal;      b) electric potential;      c) electrical surge;      d) mechanical signal.
6. ADC-converting device ...
- a) an electrical signal into a mechanical one;      b) analog signal to digital;
  - c) digital signal to analog;      d) all answers are correct.
7. Standard leads are:
- a) I - between the left hand and the right hand, II - between the left foot and the right hand, III - between the left foot and the left hand.
  - b) I - between the left hand and the right foot, II - between the left foot and the right hand, III - between the left hand and the left hand.
  - c) I - between the left hand and the right hand, II - between the left foot and the right hand, III - between the right foot and the left hand.
  - d) I - between the left hand and the left hand, II - between the right foot and the right hand, III - between the left foot and the left hand.
8. The magnitude of the pulse impedance is negligible - no more than ...
- a) 0.5-1% of the total impedance and is the object of study of rheography
  - b) 0.05-1% of the total impedance and is the object of study of rheography
  - c) 0.05-0.1% of the total impedance and is the object of study of rheography
  - d) 1.5-2% of the total impedance and is the object of study of rheography
9. Complete the definition. Rheography is a method for studying pulse fluctuations ... and tissues, based on graphic registration of changes in the total electrical resistance of tissues.
- a) vessels of various organs;      b) blood filling of vessels of various organs;
  - c) blood filling of various cells;      d) blood filling of the whole organism.
10. To obtain a rheogram, an alternating current with a frequency of 50-100 kHz, low power (no more than 10  $\mu$ A) is passed through the patient's body, created by:

a) an oscillatory circuit;      b) a special device;      c) a special generator;      d) special electrodes.

11. With an increase in blood supply, the following occurs:

- a) an increase in the amplitude of the resistance curve;
- b) an increase in the frequency of the curve;
- c) drop in the amplitude of the curve and vice versa;
- d) an increase in the amplitude of the curve and vice versa.

12. The rheograph consists of the following main elements:

- a) high frequency generator, impedance-voltage converter, detector;
- b) amplifier, calibration device, differentiating chain;
- c) amplifier, filter, calibration device, differentiating circuit, recorder;
- d) "impedance-voltage" converter, detector, ADC.

13. Block diagram of the rheograph:

- a) electrodes, filter, recording device, bridge circuit and RF generator, detector, calibration device, amplifier, differentiating device;
- b) electrodes, calibration device, bridge circuit and LF generator, amplifier, differentiating device, filter, recording device;
- c) electrodes, bridge circuit and RF generator, detector, calibration device, amplifier, differentiating device, filter, recording device;
- d) electrodes, bridge circuit and UHF generator, detector, calibration device, differentiating device, recording device.

14. Complete the offer. With the tetrapolar research technique, ... is applied, and the voltage that has arisen in them is removed using another pair of electrodes located outward in relation to the first (current).

- a) a pair of measuring electrodes;
- b) four measuring electrodes;
- c) a pair of matching electrodes;
- d) there are no correct answers.

15. Complete the answer. With the bipolar technique, 2 electrodes are applied, each of which is simultaneously:

- a) receiving and measuring;
- b) current and measuring;
- c) current and non-measuring;
- d) power and measuring.

16. Apparatus and devices for low-frequency electrotherapy:

- a) galvanotherapy, amplipulse therapy;
- b) darsonvalization, inductothermy;
- c) electrosleep therapy, electropuncture;
- d) diathermocoagulation and diathermotomy.

## **Section 2. Acoustics. Devices for measuring the mechanical characteristics of the body.**

### **Controlled competency code: GPC-4 CAI-1**

1. The main medical and biological direction of the application of ultrasound.

- a. diagnosis of diseases;
- b. strengthening of biochemical processes;
- c. destruction of pathological cells;
- d. increased electrical activity of membranes.

2. Physical basis of the method of ultrasonic location of organs for the purpose of diagnosis

- a. obtaining images of tissues by using the diffraction of ultrasonic waves as they propagate through the internal organs;
- b. obtaining an image of tissue by registering ultrasonic rays that have passed through the tissue;
- c. obtaining images of tissues by using the phenomenon of absorption of ultrasonic waves by body tissues;
- d. Obtaining images of tissues by registering the reflected ultrasonic signal from the boundaries of tissues with different acoustic impedances.

3. Ultrasonic echo-Doppler method is a method for determining the speed of moving tissues in the body (blood, valves and walls of the heart) by measuring:

- a. the intensity of the ultrasonic waves passed through the tissues;
- b. the intensity of the ultrasonic waves reflected from tissue boundaries with different acoustic impedances;
- c. the changes in the frequency of ultrasound observed when it is reflected from tissues;
- d. the absorption coefficient of ultrasound by body tissues.

4. The primary mechanism of ultrasound therapy.

- a. activation of the transport of substances across membranes
- b. mechanical and thermal
- c. destruction of abnormal cells
- d. increased electrical activity of macromolecules

5. Ultrasonic beams when they fall on the interface between media with different wave (acoustic) resistance ...

- a. completely absorbed;
- b. completely dissipate;
- c. partially reflected and partially refracted;
- d. are diffracted.

6. A phenomenon used in surgery and observed when high-intensity ultrasound is applied to solids –

- a. evaporation; b. crystallization; c. melting; d. destruction.

7. What impulses are recorded for diagnostic purposes during ultrasound location?

- a. passed through tissues with different acoustic properties;
- b. scattered at the interface between two media with different acoustic properties;
- c. reflected from the interface between two media with different acoustic parameters;
- d. interfered at the interface between two media with different acoustic parameters.

8. The biological effect of ultrasound on the body is based on ...

- a. mechanical, thermal and chemical effects of ultrasound
- b. electrical, optical action of ultrasound
- c. acoustic, magnetic action of ultrasound
- g. nuclear action of ultrasound

9. The therapeutic effect of ultrasound is one-factor or complex

- a. one-factor, namely mechanical
- b. one-factor, namely magnetic
- c. one-factor, namely chemical
- d. complex: mechanical plus physical and chemical

10. Classification of sounds:
- a. cavitation, shock waves
  - b. tones, noises, sound waves
  - c. vibration, resonant sounds
  - d. forced, fading, harmonic sounds.

**Section 3. Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.**

**Controlled Competency Codes: GPC-4 CAI-1**

1. The effect of electrical stimulation depends on:
  - a. amplitudes and frequencies.
  - b. forms of electric current
  - c. voltage
  - d. forms of electric current amplitude and frequency.
  - e. semi-cosoidal shape
2. A device that allows you to generate artificial stimulus impulses and apply them to the heart is called
  - a. pacemaker.
  - b. electrostimulator
  - c. stimulant
  - d. an electric defibrillator
3. The pacemaker consists of:
  - a. Sound generator and electrodes.
  - b. pulse generator and electrodes
  - c. pulse generator, cathode and anode
  - d. signal generator and electrodes
4. List the types of pacemakers:
  - a. External, Wearable, Internal
  - b. External, Implantable, Stationary
  - c. External, Implantable, Internal
  - d. Wearable, Stationary, Implantable
5. Electrosleep therapy apply:
  - a. triangular pulses
  - b. alternating pulses
  - c. acute impulses
  - g. rectangular pulses
6. Basic rules for ensuring safety when working with electrical equipment.
  - a. Do not touch appliances with both bare hands at the same time
  - b. do not work on wet floors
  - c. do not touch metal structures (for example, radiators) when working with electrical equipment; do not touch the metal parts of two devices at the same time
  - d. all of the above

7. Electrodes in medical measurements are used for
  - a. removal of bioelectric potentials and measurement of electrical conductivity of tissues
  - b. measurements of non-electrical parameters of body tissues
  - c. conversion of non-electrical (mechanical, thermal, optical, etc.) information into electrical
  - d. Amplification of electrical signals
8. What are electrodes?
  - a. dielectrics of various shapes
  - b. metal components in electronic equipment
  - c. specially shaped conductors
  - d. complex technical devices of special design
9. Basic requirements for electrodes.
  - a. fast on and off
  - b. have stable electrical parameters
  - c. do not irritate biological tissue
  - d. all of the above
10. Classification of sensors according to the principle of operation.
  - a. cardiovascular sensors
  - b. sensors - amplifiers of biomedical information
  - c. respiratory system sensors
  - d. generator and parametric.
11. The basis of the structure of membranes.
  - a. monolayer of phospholipid molecules
  - b. liposomes
  - c. double layer of lipid molecules
  - d. double layer of phospholipid molecules
12. The structure of membrane phospholipid molecules. Phospholipid molecules consist of functionally different parts:
  - a. polar hydrophilic "head" and non-polar hydrophobic tail
  - b. non-polar hydrophobic "head" and polar hydrophilic tail
  - c. non-polar hydrophilic "head" and non-polar hydrophobic tail
  - d. polar hydrophobic "head" and polar hydrophilic tail
13. What model of membranes is generally accepted?
  - a. single layer membrane model
  - b. sandwich model
  - c. fluid mosaic model
  - d. fluid model
14. What is flip flop diffusion?
  - a. diffusion of phospholipid molecules across the membrane
  - b. diffusion of phospholipid molecules in the plane of the membrane
  - c. facilitated diffusion with a fixed carrier
  - d. facilitated diffusion with a mobile carrier
15. What is lateral diffusion?
  - a. diffusion of phospholipid molecules across the membrane
  - b. facilitated diffusion with a mobile carrier

- c. facilitated diffusion with a fixed carrier
- d. diffusion of molecules of phospholipids and proteins in the plane of the membrane

16. Transfer phenomena.

- a. convection, doping, melting and crystallization
- b. only diffusion and viscosity
- c. electrical conductivity, thermal conductivity, diffusion, viscosity
- d. only electrical conductivity and thermal conductivity

17. Active transport of ions across membranes is the transport

- a. electrically charged particles from a region of high concentration to a region of lower concentration
- b. ions without the expenditure of internal energy
- c. charged particles (ions) under the action of an electric field
- d. particles from an area with a lower concentration to an area with a higher concentration due to the energy of ATP

18. Determination of ion pumps in biological membranes

- a. chloroplast systems
- b. systems of phospholipid molecules
- c. membrane protein systems
- d. system of cytoplasmic membranes

19. Varieties of passive transport of ions and molecules through the membrane.

- a. diffusion through pores
- b. diffusion with mobile carriers
- c. all of the above
- d. diffusion with fixed carriers

20. Passive transport of ions and molecules through the membrane.

- a. transport of molecules and ions in the direction in which their concentration falls
- b. transport of ions and molecules through membranes with the expenditure of external energy
- c. transport of ions and molecules in the direction in which their concentration increases
- d. transfer of ions and molecules without changing their concentration gradient.

#### **Section 4. Devices and devices for non-drug therapeutic effects of various physical factors**

##### **Controlled Competency Codes: GPC-4 CAI-1**

1. List the high-frequency methods of electro- and magnetotherapy.

- a. UHF therapy, galvanization, inductothermy, HF therapy
- b. inductothermy, electrophoresis, HF therapy, microwave therapy
- c. UHF therapy, inductothermy, microwave therapy, DCV therapy
- d. microwave therapy, darsanvalization, microwave therapy, amplipulse therapy

2. What is electrothermotomy?

- a. electrosurgery technique that uses high frequency currents to cut tissue
- b. direct current cutting method
- c. method of connecting tissues under the influence of direct current
- d. a method of electrosurgery that uses high-frequency currents to cauterize (weld) tissues

3. Physical foundations of inductothermy. Inductothermy method.

- a. method of treatment with an alternating magnetic field. The therapeutic effect is achieved by heating tissues during the passage of eddy currents excited by a magnetic field.
- b. change in the internal energy of the tissue under the influence of currents caused by a constant magnetic field
- c. a method of treatment based on a change in body temperature under the influence of external permanent magnetic induction
- d. a method of therapy due to a change in tissue temperature under the influence of high-frequency electric fields

4. Microwave therapy.

- a. method of therapy where microwave fields are used
- b. method of treatment with an electromagnetic field of frequency 2375 MHz. The therapeutic effect is achieved by heating the tissues with conduction and displacement currents.
- c. therapeutic method based on the release of heat under the influence of the HF range
- d. a method of treatment based on obtaining heat under the influence of UHF fields

5. Formulas for the heat released in tissues when exposed to: high-frequency currents; alternating magnetic field;

- a.  $q = RTI^2$ ,  $q = kB^2$
- b.  $q = k\epsilon\epsilon_0\omega^2 E^2 tg\delta$ ,  $q = \frac{\omega^2}{\rho}$
- c.  $q = \frac{\omega^2}{\rho} E^2$ ,  $q = k\omega^2 B^2$
- d.  $q = \rho i^2$ ,  $q = k \frac{\omega^2}{\rho} B^2$

6. The formula for the heat released in dielectric tissues when exposed to an alternating electric field.

- a.  $q = E^2/\rho$
- b.  $q = \omega E^2 \epsilon\epsilon_0 tg\delta$
- c.  $q = Ipl t/S$
- d.  $q = U^2 t/R$

Classification of frequency intervals adopted in medicine. High frequencies

- a. 0.2 – 30 MHz
- b. 20 Hz - 20 kHz
- c. over 300 MHz
- d. 30 - 300 MHz.

8. Classification of frequency intervals adopted in medicine. Ultra high frequencies

- a. over 300 MHz
- b. 0.2 - 20 MHz
- c. 30 - 300 MHz
- d. over 30 MHz.

9. Local darsonvalization

- a. therapeutic use of pulsed currents to restore the activity of organs and tissues that have lost their normal function
- b. impact with a therapeutic purpose on certain parts of the body with an electric current of high frequency and great strength.
- c. impact with a therapeutic purpose on certain parts of the body with an electric current of high frequency and low strength.
- d. method of electrotherapy, carried out by exposing the body to sinusoidal modulated currents.

10. Highlight a method based on the use of high frequency currents

- a. inductothermy;
- b. galvanization;
- c. darsonvalization
- d. electrophoresis.

11. Highlight the method of electrosurgery based on the use of high frequency currents

- a. UHF therapy,
- b. galvanization;
- c. diathermocoagulation,
- d. electrical stimulation.



12. Highlight the method of therapy with an alternating magnetic field  
a. microwave therapy   b. diathermy   c. inductothermy   d. thermocoagulation.

13. The physical process through which the therapeutic effect of the tissue is achieved during darsonvalization

- a. depolarization of tissue membranes
- b. tissue heating
- c. movement, separation and accumulation of charges on tissue membranes
- d. tissue heating by displacement currents

14. Physical foundations of UHF-therapy of conductive tissues.

- a. the therapeutic effect is achieved by heating tissues with eddy currents of conduction
- b. the therapeutic effect is achieved by heating tissues with conduction currents caused by the displacement of ions under the action of an alternating electric field
- c. the therapeutic effect is achieved by heating tissues with displacement currents caused by the polarization of molecules and their periodic reorientation as electric dipoles
- d. The therapeutic effect is achieved by heating tissues with both displacement currents and conduction currents

15. Physical basis of microwave therapy. The therapeutic effect is achieved by heating tissues with electromagnetic waves.

- a. UHF
- b. high frequency
- c. frequency 2375 MHz
- d. 460 MHz frequency

**Section 5. Quantum physics, ionizing radiation. Dosimetric devices. Diagnostic equipment based on the principles of visualization and image analysis.**

**Controlled Competency Codes: GPC-4 CAI-1**

1. Name the primary processes observed in tissues when exposed to ionizing particles:

- a. total internal reflection
- b. excitation and ionization of atoms and molecules
- c. photochemical reactions
- d. Doppler effect

2. How are the types of *X*-rays distinguished by the mechanism of formation?

- a. braking and characteristic
- b. longwave and shortwave
- c. ultraviolet and infrared
- d. microwave and ultrahigh frequency

3. What is characteristic x-ray radiation?

- a. electromagnetic radiation of free electrons;
- b. electromagnetic radiation observed during deceleration of electrons on the anticathode;
- c. thermal radiation of an anticathode heated by an electron beam;
- d. radiation observed during the transition of electrons from the upper energy levels of the anticathode atoms of an *X*-ray tube in the operating mode to their deep levels

4. Select the formula for the dependence of the  $X$ -ray flux on the voltage, current in the  $X$ -ray tube, and the charge of the nuclei of the anticathode atoms.  
 a.  $h\nu = h\nu' + mv^2/2 + A$       b.  $\Phi = kIU^2Z$       c.  $h\nu = A + mv^2/2$       d.  $\Phi = \Phi_0 e^{-\mu d}$
5. Select the formula for the energy of  $X$ -ray quanta subjected to incoherent scattering:  
 a.  $h\nu = h\nu' + mv^2/2 + A$ ;      b.  $\Phi = kIU^2Z$       c.  $h\nu = A + mv^2/2$       d.  $\Phi = \Phi_0 e^{-\mu d}$
6. Select the formula for the attenuation coefficient of  $X$ -rays as it passes through tissues and substances:  
 a.  $\mu \approx \lambda^3 Z^3$       b.  $\Phi = kIU^2Z$       c.  $h\nu = A + mv^2/2$       d.  $\Phi = \Phi_0 e^{-\mu d}$
7. Describe the physical basis of  $X$ -ray diagnostics:  
 a.  $X$ -ray diffraction, observed during its interaction with tissues, makes it possible to see in the shadow projection an image of the internal organs of a person;  
 b. selective absorption of  $X$ -rays by atoms of biological tissues;  
 c. the difference between tissues in the absorption of  $X$ -ray radiation allows you to see the image of the internal organs of a person in a shadow projection;  
 d. obtaining a picture of the thermal radiation of various tissues, observed when they are exposed to  $X$ -rays
8. List the parameters by which the quantitative assessment of the interaction of ionizing particles with tissues (substances) is carried out:  
 a. linear ionization density      b. linear stopping power      c. average line mileage      d. all of the above
9. What is average line mileage?  
 a. the average value of the distance between the beginning and the end of the run of an ionizing particle in a given substance;  
 b. the average distance traveled by an ionizing particle in a substance during 1 s;  
 c. the average distance at which the energy of an ionizing particle in a substance remains unchanged;  
 d. the average distance at which the energy of an ionizing particle in a substance decreases by a factor of  $e$
10. Highlight the formula for the basic law of radioactive decay ( $N$  is the number of radioactive nuclei at a given time  $t$ ,  $N_0$  - initial number of cores,  $\lambda$  - decay constant):  
 a.  $N = -\lambda t$       b.  $N = N_0 e^{-\lambda t}$       c.  $N = N_0 e^{\lambda x}$       d.  $N = 10N_0 e^{-\lambda t}$
11. Approximately to what depth do beta particles penetrate into body tissues?  
 a. pass through the human body      b. up to several cm.  
 c. up to 0.1 mm      d. up to several meters
12. What material should be used to protect the body from the action of beta radiation?  
 a. a layer of wood, plexiglass, glass, light metal 1-2 cm thick  
 b. a thin layer of any substance (clothes, paper, cellophane, etc.)  
 c. a thick layer of water, earth, concrete, heavy metals, lead several cm thick,  
 d. all of the above
13. At what age does ionizing radiation pose the greatest danger to humans?  
 a. child's body  
 b. body of an adult  
 c. body in old age  
 d. body after effective treatment
14. What is radiography?

- a. method of transillumination of internal organs for diagnostic purposes
- b. a method of obtaining an image of internal organs on photographic film by exposing it to  $X$ -rays that have passed through the organs
- c. method of using  $X$ -rays for medical purposes
- d. method of layer-by-layer  $X$ -ray imaging of organs

15. What radiations used in medicine are ionizing?

- a. ultraviolet radiation and the entire range of visible radiation
- b. ultrahigh frequency, ultrahigh frequency electromagnetic radiation
- c. ultrasonic and microwave electromagnetic radiation
- d.  $X$ -ray and  $\gamma$  radiation

16. Select sources of ionizing radiation:

- a. incandescent lamps, gas discharge lamps
- b. strongly heated solids, electrical discharges, gases placed in strong magnetic fields
- c.  $X$ -ray tube, nuclei of radioactive atoms, charged particle accelerators
- d.  $UHF$ -device, microwave,  $EHF$ -devices

17. What phenomenon results in bremsstrahlung?

- a. as a result of deceleration of electrons by the electric field of the nuclei, the electron shell of the anti-cathode atoms
- b. in the form of spontaneous emission of anticathode atoms during their interaction with high-energy electrons
- c. when electrons are slowed down by an external field applied to the anticathode of an  $x$ -ray tube
- d. in the form of thermal radiation of the anti-cathode heated by a stream of accelerated electrons

18. Select the formula for the frequency of short-wave  $X$ -ray photons:

- a.  $\nu = E/h$
- b.  $\nu = c/\lambda$
- c.  $\nu = eU/h$
- d.  $\nu = P/m\lambda$

19. List the primary processes of interaction of  $X$ -rays with body tissues.

- a. photochemical reactions, tissue heating;
- b. coherent, incoherent scattering and photoelectric effect;
- c. formation of free radicals
- d. tissue destruction

20. Select the formula for the photoelectric effect caused by  $X$ -ray photons:

- a.  $h\nu = h\nu' + mv^2/2 + A$
- b.  $\Phi = kIU^2Z$
- c.  $h\nu = A + mv^2/2$
- d.  $\Phi = \Phi_0 e^{\mu d}$

## SITUATIONAL TASKS BY SECTIONS OF THE DISCIPLINE

### Section 2. Acoustics. Devices for measuring the mechanical characteristics of the body

#### Controlled Competency Codes: GPC-4 CAI-1 GPC-4

#### Typical tasks for evaluating the results of the formation of competence at the level of "To be able"

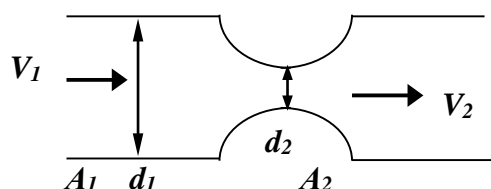
**Task 1.** US, the frequency of which  $\nu = 3$  MHz, falls on the artery at an angle  $\alpha = 60^\circ$  to the axis of the artery. Determine the speed of erythrocytes in the carotid artery, if the value of the Doppler frequency shift during the reflection of ultrasound from erythrocytes  $\Delta\nu = 1.7$  kHz. Velocity of ultrasound in blood  $c = 1500$  m/s.

**Task 2.** Determine the reflection coefficient of ultrasound at the interface between the skull and the brain. Density of brain tissue  $\rho_1 = 1.05 \cdot 10^3 \text{ kg/m}^3$ , and density of skull bone tissue  $\rho_2 = 1.7 \cdot 10^3 \text{ kg/m}^3$ . Velocity of ultrasound in these tissues  $U_1 = 1.52 \text{ km/s}$ ,  $U_2 = 3.6 \text{ km/s}$ , respectively.

**Task 3.** Ultrasound falls on the tissue-tumor interface and is reflected from it. Determine the speed of passage of an ultrasound wave through the tissue, if the depth of the tumor-tissue boundary is 3 cm, the time of ultrasound cooling from the emitter to the tumor and in the opposite direction is 2 s.

**Typical tasks for evaluating the results of the formation of competence at the level of "To master"** (to solve complicated problems based on the acquired knowledge, skills and abilities, with their application in atypical situations, is formed in the process of practical activity):

**Task 1.** In the case of partial blockage of the artery, they say that there is a thrombosis (formation of arterial plaques). Through the carotid artery, the average diameter of which is  $d_1 = 1 \text{ cm}$  (Fig), blood circulates at an average speed  $V_1 = 20 \text{ cm/s}$ . For simplicity, assume that the artery is located horizontally, the density of blood is equal to the density of water ( $10^3 \text{ kg/m}^3$ ), and the pressure inside the unoccluded portion of the artery is  $P_1 = 120 \text{ mm Hg}$ . Calculate the blood pressure  $P_2$  in the area of arterial plaques if their radius  $R_2 = 0.5 \text{ cm}$ . How will arterial disease develop?



**Task 2.** Determine the maximum amount of blood that can pass through the aorta in 1 second, if the speed of blood flow in the aorta is 0.5 m/s, the diameter of the aorta is  $d = 2 \text{ cm}$ .

**Section 3. Electric current in biological tissues. Devices and apparatus for diagnosing the state of the main functional systems of the body.**

**Controlled Competency Codes: GPC-4 CAI-1**

**Typical tasks for evaluating the results of the formation of competence at the level of "To be able"**

**Task 1.** The table shows the values of intracellular and extracellular concentrations of ions  $K^+$ ,  $Na^+$ ,  $Cl^-$  in millimoles per 1 liter of  $H_2O$  for the squid axon.

<i>Ions</i>	<i>Inside the cell</i>	<i>Outside the cell</i>
$K^+$	340	10,4
$Na^+$	49	463
$Cl^-$	114	592

Calculate separately the values of the Nernst potential in the squid axon for potassium, sodium and chloride ions, as well as the value of the stationary Goldman-Hodgkin-Katz potential

for the squid axon cell. Cell temperature  $T=293$  K, universal gas parameter  $R=8.31$  J/mol·K, Faraday number  $F=9.6 \cdot 10^4$  C/mol, ion permeability ratio  $P_K:P_{Na}:P_{Cl} = 1:0,04:0,45$ .

**Task 2.** Extracellular and intracellular concentrations of the main ions in the giant nerve cell of the mollusk Aplysia are given in the table in mmol/l.

<i>Ions</i>	<i>Inside the cell</i>	<i>Outside the cell</i>
K <sup>+</sup>	280	12
Na <sup>+</sup>	61	480
Cl <sup>-</sup>	51	490

The permeability of ions in a resting mollusc cell is in relation to  $P_K:P_{Na}:P_{Cl} = 1:0,12: 1,44$ . Determine the resting potential of the cell using the Goldman-Hodgkin-Katz equation

**Typical tasks for evaluating the results of the formation of competence at the level of "Own"** (to solve complicated problems based on the acquired knowledge, skills and, with their application in atypical situations, is formed in the process of practical activity):

#### **Solving complicated situational problems:**

**Task 1.** Calculate the resting potential of the giant nerve cell of the mollusk Aplysia as a function of the extracellular potassium concentration at  $[K_0] = 0.1, 1, 10$  and  $100$  mmol/L. Draw a graph.

**Task 2.** Using the Goldman-Hodgkin-Katz equation, calculate the magnitude of the peak value of the action potential for the giant squid axon. The ratio between the permeability for potassium, sodium and chlorine ions:  $R_K:P_{Na}:P_{Cl}=1:10:0.45$ . The values of intracellular and extracellular concentrations of  $K^+, Na^+, Cl^-$  ions are given in the table for the task №1.

### **6.4. Intermediate certification based on the results of mastering the discipline**

#### **6.4.1. The form of intermediate attestation - test. Semester 1**

**6.4.2. The procedure for conducting intermediate certification.** The test is conducted orally in the form of an interview on tickets.

#### **1.4.3. Sample questions to prepare for the test.**

1. Classification of medical equipment.
2. Medical equipment. Medical device. Medical equipment.
3. The order of maintenance and control of measuring instruments for medical purposes (SIMS).
4. General safety requirements when working with medical equipment.
5. Classes of electrical safety of medical equipment. Rules of technical and functional safety in the operation of certain types of medical equipment.
6. Devices and instrumental methods for diagnosing the state of the main functional systems of the human body.
7. Main technical groups and types of functional diagnostic equipment.
8. Instrumental methods and diagnostic equipment for the study of the electrical activity of the heart. Recording, monitoring and remote ECG equipment. Computer ECG systems. Features of design and work.

9. Equipment and methods for studying the mechanical activity of the heart and analyzing hemodynamics. Equipment for phonocardiography and rheography.
10. Devices and apparatus for diagnosing the state of the main functional systems of the body: devices and methods for analyzing the functional state of the human cardiovascular system. Method-electrocardiography.
11. Sound methods in the clinic.
12. Ultrasound. Ultrasound parameters.
13. Physical processes in tissues when exposed to ultrasound. Medical applications of ultrasound.
14. Physical basis of methods of ultrasonic location and Doppler echo studies.
15. Types of fluid flow. Reynolds number.
16. Rheography. Physical bases of rheography.
17. Electric currents. Varieties and parameters of currents. Threshold of perceptible and non-releasing current.
18. Low-frequency methods of electrotherapy. Physical processes in tissues under the influence of low-frequency currents.
19. Varieties of high-frequency therapy methods. Factors of high-frequency therapy. Physical processes in tissues under the influence of high-frequency factors.
20. Galvanization and electrophoresis. Physical processes in tissues during galvanization
21. Galvanization apparatus. The principle of operation and device.
22. UHF - therapy. Physical processes in conductive and dielectric tissues when exposed to an electric field in the UHF range.
23. Classification of optical methods and diagnostic studies based on the phenomena of the interaction of light with bodies.
24. Absorption of light by transparent solutions. Law of absorption of light (Bouguer-Ber's law). Transmission coefficient, optical density of solutions. Photoelectrocolorimetry.
25. Lasers. The device and principle of operation of a gas (or ruby) laser.

#### **6.4.4 Exam Ticket Examples.**

FSBEI HE DSMU of the Ministry of Health of Russia

Department of Biophysics, Informatics and Medical Equipment

Specialty (direction) General Medicine

Discipline "Medical equipment with the basics of biophysics"

QUESTIONS FOR OFFSET

TICKET № 1

Approved at a meeting of the department, minutes from « 31 » 08 2023 . № 1

1. Sound. Objective and subjective characteristics of sound. Sound methods in the clinic.
2. Types of ionizing radiation. Primary processes of interaction of ionizing radiation with body tissues.
3. The principle of operation of the ultrasound therapy apparatus.

Head of Department:  
Abdulgalimov R.M. doctor of pedagogical  
sciences, assistant professor

\_\_\_\_\_/\_\_\_\_\_  
*signature*

Compilers:  
Abdulgalimov R.M., doctor of  
pedagogical sciences, assistant professor,  
Head of department of Biophysics

\_\_\_\_\_/\_\_\_\_\_  
*signature*

Kurbanova A.M., Candidate of  
Physical and Mathematical Sciences,  
assistant professor Of Department of Biophysics

\_\_\_\_\_/\_\_\_\_\_  
*signature*

« \_\_\_\_ » \_\_\_\_\_ 20\_\_\_\_

## VII. EDUCATIONAL-METHODOLOGICAL AND INFORMATION SUPPORT OF THE EDUCATIONAL DISCIPLINE

### 7.1. Main literature

#### Printed publications

<i>№</i>	<i>Name of publication</i>	<i>Number of copies in library</i>
1		

#### Electronic editions

1	Remizov, A.N. Medical and biological physics: textbook / A.N. Remizov. - 4th ed., corr. and reworked. - Moscow: GEOTAR-Media, 2018. - 656 p.: ill. - 656 p. - ISBN 978-5-9704-4623-2. - Text: electronic // URL: <a href="http://www.studmedlib.ru/book/ISBN9785970446232.html">http://www.studmedlib.ru/book/ISBN9785970446232.html</a>
2	Antonov, V. F. Physics and biophysics. Guide to practical exercises: textbook / Antonov V. F., Chernysh A. M., Kozlova E. K., Korzhuev A. V. - Moscow: GEOTAR-Media, 2013. - 336 p. - ISBN 978-5- 9704-2677-7. - Text: electronic // URL: <a href="http://www.studmedlib.ru/book/ISBN9785970426777.html">http://www.studmedlib.ru/book/ISBN9785970426777.html</a>
3	

## 7.2. Additional literature

### Printed sources

<i>№</i>	<i>Name of publication</i>	<i>Number of copies in the library</i>
1	Practical course on physics and mathematics. Kurbanova A.M., Truzhenikova S.E. ИПЦ ДГМУ, Махачкала, 2017.	70
2		

### Electronic editions

<i>№</i>	<i>Name of publication</i>
1	Медицинская и биологическая физика = Medical and biological physics: курс лекций / Л. В. Кухаренко, М. В. Гольцев. – Минск: БГМУ, 2018. ISBN 978-985-21-0186-8. Text: electronic // URL : <a href="http://rep.bsmu.by/bitstream/handle/BSMU/25737/978-985-21-0186-8.Image.Marked.pdf?sequence=1&amp;isAllowed=y">http://rep.bsmu.by/bitstream/handle/BSMU/25737/978-985-21-0186-8.Image.Marked.pdf?sequence=1&amp;isAllowed=y</a>
2	Medical and biological physics. Textbook. = Медицинская и биологическая физика. Учебник. / A.N. Remizov. Moscow: GEOTAR Media”, 2021. Text : electronic // URL : <a href="https://static.my-shop.ru/product/pdf/424/4232298.pdf">https://static.my-shop.ru/product/pdf/424/4232298.pdf</a>
3	

## 7.3. Resources of the information and telecommunications network "Internet"

<i>№</i>	<i>Resource name</i>	<i>Website address</i>
1	PubMed MEDLINE	<a href="http://www.pubmed.com">http://www.pubmed.com</a>
2	Google scholar	<a href="http://scholar.google.com">http://scholar.google.com</a>
3	Scirus	<a href="http://www.scirus.com/srapp">http://www.scirus.com/srapp</a>
4	Medical News	<a href="mailto:info@univadis.ru">info@univadis.ru</a>
5	Health issues. About WHO	<a href="http://www.who.int/en/">http://www.who.int/en/</a>
6	Ministry of Education and Science of the Russian Federation	<a href="http://минобрнауки.рф">http://минобрнауки.рф</a>



7	Ministry of Health of the Russian Federation	<a href="http://www.rosminzdrav.ru">http://www.rosminzdrav.ru</a>
8	Ministry of Health of the Republic of Dagestan	<a href="http://minzdravrd.ru">http://minzdravrd.ru</a>
9	Scientific Electronic Library CyberLeninka	<a href="http://cyberleninka.ru">http://cyberleninka.ru</a>
10	Electronic scientific library	<a href="https://elibrary.ru/defaultx.asp">https://elibrary.ru/defaultx.asp</a>
11	Federal Electronic Medical Library (FEMB)	<a href="http://feml.scsml.rssi.ru">http://feml.scsml.rssi.ru</a>
12	Univadis®: an international information and educational portal that helps doctors around the world stay at the forefront of their specialties.	<a href="http://www.medlinks.ru/">http://www.medlinks.ru/</a>
13	Medical search engine	<a href="http://www.medinfo.ru/">http://www.medinfo.ru/</a>
14	Faculty of Fundamental Medicine, Lomonosov Moscow State University M. V. Lomonosov (publications).	<a href="http://www.fbm.msu.ru/sci/publications/">http://www.fbm.msu.ru/sci/publications/</a>
15	Reference book of medicines.	<a href="http://www.rlnet.ru/">http://www.rlnet.ru/</a>
16	RFBR electronic library.	<a href="http://www.rfbr.ru/">http://www.rfbr.ru/</a>
17	State Central Scientific Medical Library	<a href="http://www.scsml.ru//">http://www.scsml.ru//</a>
18	Недуг.py (medical information service)	<a href="http://www.nedug.ru/">http://www.nedug.ru/</a>
19	Libraries on the Internet.	<a href="http://guide.aonb.ru/libraries1.htm">http://guide.aonb.ru/libraries1.htm</a>
20	Science and education on the Internet.	<a href="http://guide.aonb.ru/nauka.htm">http://guide.aonb.ru/nauka.htm</a>
21	Electronic library of textbooks.	<a href="http://studentam.net">http://studentam.net</a>
22	Library.	<a href="http://www.MedBook.net.ru">www.MedBook.net.ru</a>
23	Electronic medical books.	<a href="http://www.med.book.net.ru/21shtm">http://www.med.book.net.ru/21shtm</a>
24	Portal textbooks - free RF.	<a href="http://учебникибесплатно.рф/http://sci-book.com/">http://учебникибесплатно.рф/http://sci-book.com/</a>

## 7.4. Information Technology

When studying the discipline, a common package of documents and Internet materials is used, which provide ample opportunities for improving university training in physics and mathematics in order to master the skills of educational activities. The standard features of most programs are the implementation of the didactic principle of visibility in teaching, their use enables students to apply various methods to solve an educational problem. Work with educational literature is

considered as a type of educational work in the discipline "Physics, Mathematics" and is performed within the hours allotted for its study (in the IWS section). Each student is provided with access to the library funds of the university and the department. Guidelines for students have been developed for each section of the academic discipline.

The teaching methods using information technology, used both in lectures and in practical classes in physics and mathematics, include:

- computer testing;
- demonstration of multimedia materials;
- a list of encyclopedic sites.
- operating system MICROSOFT Windows 10 Pro
- Application packages Microsoft Office Professional Plus 2013 (as part of Microsoft Word 2013, Microsoft Excel 2013, Microsoft Power Point 2013).
- Microsoft Office Standard 2016 (as part of Microsoft Word 2016, Microsoft Excel 2016, Microsoft Power Point 2016).
- Antivirus software
- Kaspersky Security 10 Windows.

### ***List of information reference systems:***

1. **Electronic Information and Educational Environment (EIOS) of DSMU.** URL: <https://eos-dgmu.ru>
2. **Student advisor:** electronic library system. URL: <http://www.studentlibrary.ru>
3. **Physician's consultant:** electronic library system. URL: <http://www.rosmedlib.ru>
4. **Federal Electronic Medical Library (FEMB).** URL: <http://feml.scsml.rssi.ru/>
5. **Scientific electronic library eLibrary.** URL: <https://elibrary.ru/defaultx.asp/>
6. **Medical reference and information system.** URL: <http://www.medinfo.ru/>

7. **Scientific electronic library KiberLeninka.** URL: <http://cyberleninka.ru/>
8. **RFBR electronic library.** URL: <http://www.rfbr.ru/>
9. **All-Russian educational Internet program for doctors.** URL: <http://www.internist.ru/>

## VIII. LOGISTICS

<i>№</i>	<i>Appointment of premises with an indication of the area</i>	<i>Equipment identification</i>
<b>1</b>	For practical classes - audience: No. 1 - 42.25 m <sup>2</sup> (Imam Shamil Avenue, 44, 3rd floor. Practice, Lectures)	Study tables and chairs
<b>2</b>	№2 – 42.25 m <sup>2</sup> (Imam Shamil Avenue, 44, 3rd floor. Practice, Lectures)	Study tables and chairs
<b>3</b>	№6 – 39 m <sup>2</sup> ((Imam Shamil Avenue, 44, 3rd floor. Practice, Lectures)	Study tables and chairs
<b>4</b>	Assistant – 19,5 m <sup>2</sup> Address: Imam Shamil Avenue, 44	For practical and laboratory classes - a set of demonstration tables and posters; oscilloscope; laser; sound generator; ultrasonic generator; polarimeter; optical microscope; UHF therapy device; photoelectric colorimeter; refractometer; dosimeter; installation for determining the hardness of dental materials; computer classes with the installed program for testing KTS, TV with Internet access.
<b>5</b>	For lectures - halls: №1 – 270 m <sup>2</sup> (Imam Shamil Avenue, 44, 1 <sup>st</sup> floor) №2 – 270 m <sup>2</sup> ((Imam Shamil Avenue, 44, 1 <sup>st</sup> floor) №6 – 270 m <sup>2</sup> ((Imam Shamil Avenue, 44, 1 <sup>st</sup> floor)	For lectures: set of electronic presentations/slides. Samsung laptop; EpsonEB-X02 projector; CanonMF231;
<b>6</b>	Scientific library of DSMU. Reading room of the library (for self-study). st. Aziza Aliyeva 1. Biobuilding, 1st floor.	Library reading room (electronic reading room). Tables, chairs, computers for working with electronic resources, educational scientific periodicals.

## **IX. METHODOLOGICAL SUPPORT OF THE DISCIPLINE (attached)**

### **FEATURES OF THE ORGANIZATION OF TRAINING ON THE DISCIPLINE FOR DISABLED PEOPLE AND PERSONS WITH LIMITED POSSIBILITIES HEALTH**

#### **10.1. Education of disabled people and persons with disabilities**

If necessary, it is carried out by the department on the basis of an adapted work program using special teaching methods and didactic materials, compiled taking into account the characteristics of the psychophysical development, individual capabilities and health status of such students (student).

#### **10.2. In order to master the curriculum of the discipline for people with disabilities and people with disabilities, the department provides:**

- 1) for the disabled and persons with visual impairments:
  - placement in accessible places for students who are blind or visually impaired, and in an adapted form of reference information about the schedule of training sessions;
  - the presence of an assistant providing the student with the necessary assistance;
  - release of alternative formats for methodological materials (large print or audio files);
- 2) for the disabled and people with hearing disabilities:
  - appropriate sound means of reproduction of information;
- 3) for disabled people and persons with disabilities who have disorders of the musculoskeletal system:
  - the possibility of unimpeded access of students to classrooms, toilets and other premises of the department. In case of impossibility of unhindered access to the department, organize the educational process in a specially equipped center for individual and collective use of special technical training aids for the disabled and persons with disabilities (A.Aliyev street 1, biological building, 1st floor).

**10.3. The education of students with disabilities** can be organized both jointly with other students and in separate groups.

#### **10.4. The list of educational and methodological support for independent work of students in the discipline.**

Educational and methodological materials for independent work of students from among the disabled and persons with disabilities are provided in forms adapted to the limitations of their health and perception of information:

Categories of students	Forms
Hearing impaired	- in printed form; - in the form of an electronic document;
Visually impaired	- in printed form in enlarged type; - in the form of an electronic document; - in the form of an audio file;
With a violation of the musculoskeletal system	- in printed form; - in the form of an electronic document;

This list can be specified depending on the contingent of students.

**10.5. Fund of assessment tools for conducting intermediate certification of students in the discipline.**

**10.5.1. List of funds for evaluation funds correlated with the planned results of the development of the educational program.**

**10.5.2.**

For students with disabilities

Categories of students	Types of evaluation tools	Forms of control and evaluation of learning outcomes
Hearing impaired	test	predominantly written review
Visually impaired	interview	predominantly oral examination (individually)
With a violation of the musculoskeletal system	solving remote tests, control questions	organization of control in EIOS DSMU, written examination

Students with disabilities and persons with disabilities are given more time to prepare answers for the test, they are allowed to prepare for the test using distance learning technologies.

**10.5.3. Methodological materials that define the procedures for assessing knowledge, skills and (or) experience of activity, characterizing the stages of the formation of competencies.**

When carrying out the procedure for evaluating the learning outcomes of people with disabilities and persons with disabilities, the use of technical means necessary for them in connection with their individual characteristics is envisaged.

The procedure for evaluating the learning outcomes of people with disabilities and people with disabilities in the discipline provides for the provision of information in forms adapted to the limitations of their health and information perception:

For persons with visual impairments:

- in printed form in enlarged type;
- in the form of an electronic document;
- in the form of an audio file.

For people with hearing impairments:

- in printed form;
- in the form of an electronic document.

For people with musculoskeletal disorders:

- in printed form; - in the form of an electronic document;
- in the form of an audio file.

This list can be specified depending on the contingent of students.

When carrying out the procedure for evaluating the learning outcomes of people with disabilities and persons with disabilities in a discipline (module), the following additional requirements are met, depending on the individual characteristics of students : instruction on the procedure for conducting the assessment procedure is provided in an accessible form (orally, in writing, orally using the services of a sign language interpreter);

1. an accessible form for providing assignments of assessment tools (in printed form, in printed form in an enlarged font, in the form of an electronic document, assignments are read out by an assistant, assignments are provided using sign language translation);
2. an accessible form of providing answers to tasks (in writing on paper, a set of answers on a computer, using the services of an assistant, orally).

If necessary, for students with disabilities and the disabled, the procedure for evaluating learning outcomes in a discipline (module) can be carried out in several stages.

The procedure for evaluating the learning outcomes of people with disabilities and persons with disabilities is allowed using distance learning technologies.

#### **10.6. The list of basic and additional educational literature necessary for mastering the discipline.**

For mastering the discipline, disabled people and persons with disabilities are provided with basic and additional educational literature in the form of an electronic document in the library fund and / or in electronic library systems. Also, special textbooks and teaching aids, other educational literature and special technical training aids for collective and individual use, as well as the services of sign language and sign language interpreters are provided free of charge.

#### **10.7. Guidelines for students on mastering the discipline**

Individual work is of great importance in mastering the discipline by disabled people and persons with disabilities. Individual work means two forms of interaction with a teacher: individual educational work (consultations), i.e. additional explanation of the educational material and in-depth study of the material with those students who are interested in this, and individual educational work. Individual consultations on the subject are an important factor contributing to the individualization of education and the establishment of educational contact between the teacher and the student with a disability or a student with disabilities.

#### **10.8. Description of the material and technical base necessary for the implementation of the educational process in the discipline**

Mastering the discipline by disabled people and persons with disabilities is carried out using general and special-purpose training tools:

- lecture audience - multimedia equipment, mobile radio class (for students with hearing impairments); power supplies for individual technical means;
- classroom for practical classes (seminars), multimedia equipment, mobile radio class (for students with hearing impairments);
- classroom for independent work - standard workstations with personal computers; workplace with a personal computer, screen reader, screen magnifier and braille display for visually impaired students.

In each classroom where people with disabilities and people with disabilities study, an appropriate number of places for students should be provided, taking into account their health limitations.

## **XI. CHANGES LIST**

Changes to the work program are made on the basis of orders and instructions of the rector, as well as on the basis of decisions on improving the educational and methodological support of the discipline, approved at the appropriate level (decision of the Academic Council), the Central Committee for Comprehensive Education and are registered in the list of changes.

### **List of changes to the work program**

<b>List of additions and changes made to the work program disciplines</b>	<b>WP updated at the meeting of the department</b>		
	<b>Date</b>	<b>Number of minutes of the meeting of the department</b>	<b>Signature of the head of the department</b>
The following changes are made to the work program 1. ....; 2.....			