



MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION  
Federal state autonomous educational institution  
of higher education  
«Far Eastern Federal University»  
(FEFU)

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**SCHOOL OF BIOMEDICINE**

«AGREED»

Head of education program  
«General medicine»

  
\_\_\_\_\_  
(signature) Khotimchenko Yu.S.  
(Full name)  
«09» of July 2019

«APPROVED»

Director of the Department of Clinical  
Medicine

  
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(Full name)  
«09» of July 2019



**WORKING PROGRAM OF ACADEMIC DISCIPLINE (WPAD)**

«Medical Physics»

Educational program

Specialty 31.05.01 «General medicine»

**Form of study: full time**

year 2 semester 3  
lectures 18 hours  
practical classes 36 hours  
laboratory works 18 hours  
total amount of in-classroom work 72 hours  
independent self-work 72 hours  
control works ()  
credit 4 semester  
exam not provided

The working program is drawn up in accordance with the requirements of the Federal state educational standard of higher education (level of training), approved by the order of the Ministry of education and science of the Russian Federation from 09.02.2016 № 95.

The working program of the discipline was discussed at the meeting of the Department of fundamental and clinical medicine. Protocol No. 8, 09 of July 2019

Author: Ostanin M.V.

## **Annotation**

The discipline "Medical Physics" is intended for the direction of training on the 31.05.01 "medical business", students of the educational program "General Medicine". This course is included in the basic part of the curriculum and is implemented in the 2 course, 3 semester. The complexity of the discipline in accordance with the training curriculum is 4 credits and 144 academic hours.

The work program was compiled in accordance with the requirements of the federal state educational standard of higher education (level of training specialty), approved by order of the Ministry of Education and Science of the Russian Federation of 09.02.2016 No. 95.

Students are trained on the basis of the continuity of knowledge and skills acquired in the following disciplines: "Medical Informatics, Mathematics", "Philosophy", "History".

Content of the course "Medical Physics".

The subject of medical physics. Tasks, research methods. Methodological issues of medical physics. Introduction to the course of medical physics. The purpose, objectives and characteristics of the subject. The main sections of medical physics. Relationship with other disciplines. The history of the development of medical physics. The contribution of domestic and foreign scientists in the development of medical physics. The value of medical physics for theoretical and practical medicine. The relationship of medical physics with other sciences. Directions of development of modern medical physics.

Mechanics of rotational motion. Basic concepts. The equation of the dynamics of rotational motion. The concept of free axes of rotation, degrees of freedom. Centrifugation Biomechanical properties of skeletal muscles. Biomechanics of skeletal joints. Articulation and levers in the human musculoskeletal system. Mechanical work of man. Vestibular apparatus as an inertial orientation system. The nature of sound. Physical characteristics. Characteristics of the auditory sensation. Physical basis of sound research methods in the clinic. Biophysics of hearing. The interaction of ultrasound with biological objects. Ultrasound and its use in medicine. Ultrasound diagnostic methods. Basics of ultrasound stimulation and ultrasound therapy. Ultrasound in surgery. Ultrasound in pharmacy. Flow and fluid properties. Biophysical patterns of blood flow through the vessels.

Fluid viscosity Newton's equation. Newtonian and non-Newtonian fluids. The flow of viscous fluid through the pipes. Poiseuille formula. The movement of bodies in a viscous fluid. Stokes law. Methods for determining the viscosity of the fluid. Clinical method for determining blood viscosity. Laminar and turbulent flow. Reynolds number. Biophysical patterns of blood flow through the vessels. Biophysical features of the aorta. Biophysical features of arterioles of a big circle of blood circulation.

Biological electrodynamics. The main provisions of the electromagnetic field. Maxwell material equations. The interaction of the electromagnetic field with matter. Basic equations of Maxwell. Radiation and propagation of the electromagnetic field. Electromagnetic spectrum (scale of electromagnetic waves). Transformation of the electric field by physical media. The effect of electric fields on cells. The interaction of the electric component of the electromagnetic field with the body. Biological effect of low frequency electromagnetic field. Biological effect of high frequency electromagnetic field. Frequency-dependent biological effects of the electromagnetic field. The use of electromagnetic fields in medicine.

Ionizing radiation. Basics of Dosimetry. The physical basis of ionizing radiation. X-ray radiation. Brake X-radiation. Characteristic x-rays. Atomic x-ray spectra. Physical aspects of the interaction of x-rays with matter. The physical basis of the use of X-rays in medicine.

Radioactivity. The interaction of ionizing radiation with a substance. Biophysical basis of the effect of ionizing radiation on the body. Ionizing radiation detectors. The use of radionuclides and neutrons in medicine. Accelerators of charged particles and their use in medicine. Radiation dose and exposure dose. Dose rate. Quantitative assessment of the biological effects of ionizing radiation. Equivalent dose. Dosimetric instruments. Protection against ionizing radiation.

**The goal** is to form the students a holistic view of the theoretical foundations and basic physicochemical, mathematical and other natural science concepts, and methods for solving problems in biological systems.

**Tasks:**

- the acquisition by students of knowledge on the collection and analysis of patient complaints, his medical history, examination results, laboratory, instrumental, pathological and other studies in order to recognize the condition or establish the presence or absence of the disease;

- the acquisition by students of knowledge of medical physics, including those physical principles that underlie the functioning of cells, organs and tissues of the human body;
- the acquisition by students of knowledge of medical physics, including consideration of biophysical processes and properties related to organs, systems and tissues of the human body in health and disease;
- acquisition by students of a scientific outlook; the ability to conduct an active dialogue on the scientific issues of physical research; skills to present the results in the form of written (scientific article) and oral communications (reports).

To successfully study the discipline "Medical Physics" the following preliminary competences should be formed among the students:

- GC-1 - the ability to abstract thinking, analysis, synthesis;
- GC-2 - the ability to use basic philosophical knowledge to form a worldview;
- GC-3 - the ability to analyze the main stages and the laws of historical development of society to form civic position;
- GPC-5 - the ability and willingness to analyze the results of his own activity to prevent professional errors
- GPC-7 - the readiness to use basic physical and chemical, mathematical and other natural science concepts and methods in solving professional problems
- PC-6 - the ability of determining the patient's basic pathological conditions, symptoms, syndromes, diseases in accordance with the International Statistical Classification of Diseases and problems related to health , the 10th review.

As a result of studying this discipline, students form the following general professional competencies (elements of competencies).

Code and formulation of competence.	Stages of formation of competence	
the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	<b>Know</b>	Biophysical parameters characterizing the functional state of organs and tissues: mechanical, electrical, electromagnetic, optical; biophysical phenomena and processes underlying the vital activity of the organism, their characteristics;

<b>Code and formulation of competence.</b>	<b>Stages of formation of competence</b>	
	<b>Can</b>	Measure physical parameters and evaluate biophysical properties of biological objects with the help of mechanical, electrical and optical methods;
	<b>Master</b>	Methods of evaluation of morphofunctional, physiological and pathological processes in the human body;
the readiness to collect and to analyze patient complaints, data of its history, the results of laboratory, instrumental, postmortem and other examinations to recognize the incidence or the absence of diseases (PC – 5)	<b>Know</b>	Possibilities of instrumental, pathological-anatomical and other methods of research;
	<b>Can</b>	Interpret the results of laboratory, instrumental, pathological and anatomical and other research methods;
	<b>Master</b>	skills in working with diagnostic equipment; methods of interpreting received information;
the ability of determining the patient's basic pathological conditions , symptoms, syndromes, diseases in accordance with the International Statistical Classification of Diseases and problems related to health , the 10th review. (PC – 6)	<b>Know</b>	the main pathological conditions; radiation symptoms of diseases;
	<b>Can</b>	determine the patient's underlying pathological conditions, diseases; determine the patient's main radiation symptoms of disease;
	<b>Master</b>	algorithms of interpretation of the revealed radial symptoms.

## **I. STRUCTURE AND CONTENT OF THE THEORETICAL PART OF THE COURSE (18 hours)**

### **Section 1. Fundamentals of Biological Physics (8 hours)**

#### **Lecture 1. Mechanical properties of tissues (2 hours).**

Basic concepts and laws of translational and rotational motions. Methods of deformation of bodies. Mechanical properties of materials and methods of their investigation. Mechanical properties of biological tissues. Mechanical models. Basic concepts and formulas. Hooke's Law. Young's modulus.

**Lecture 2. Fundamentals of biomechanics. Mechanical vibrations and waves in biological media, their use in medicine (2 hours).**

Fluctuations. Periodic fluctuations. Harmonic oscillations. Free oscillations. Undamped and damped oscillations. Forced oscillations. Resonance. Human body vibrations and their registration. Basic concepts and formulas. Mechanical waves, wave frequency. Longitudinal and transverse waves. Wave front. Speed and wavelength. Equation of a plane wave. Energy characteristics of the wave. Some special types of waves. The effect of Doppler and its use in medicine.

**Lecture 3. Fundamentals of bioacoustics. Physical and auditory characteristics of sound. Acoustic methods of diagnosis in medicine (2 hours).**

Sound, kinds of sound. Physical characteristics of sound. Characteristics of auditory sensation. Sound measurements. Passing sound through the medium interface. Sound methods of research. Factors determining the prevention of noise. Protection from noise. Basic concepts and formulas. Sound-conducting and sound-receiving parts of the hearing aid. The role of the external ear. The role of the middle ear. The role of the inner ear. Hearing aids and prostheses.

**Lecture 4. Ultrasound and its properties. Biophysical fundamentals of ultrasound application. Infrasound. Vibration. (2 hours).**

Radiators and ultrasound receivers. Absorption of ultrasound in the substance. Acoustic currents and cavitation. Reflection of ultrasound. Sounds. Biophysical effect of ultrasound. Use of ultrasound in medicine: therapy, surgery, diagnostics. Infrasound and its sources. Impact of infrasound on humans. Use of infrasound in medicine. Basic concepts and formulas. Tables.

**Section 2. Fundamentals of Medical Physics (10 hours)**

**Lecture 5. Physical principles of electrography of organs and tissues. Biophysical fundamentals of rheography (2 hours).**

Functions of membranes. Structure and model of membranes. Physical properties of membranes. Transfer of molecules (atoms) through membranes, Fick's equation. Transfer of charged particles, electrodiffusion Nernst-Planck equation. Types of transport through membranes: passive and active. Basic concepts and formulas.

**Lecture 6. Physical processes occurring in the tissues of the body under the influence of currents and electromagnetic fields (2 hours).**

The action of direct current. The action of alternating current (LF, FH, UZCH). Threshold values. The action of high-frequency current. Effect of magnetic fields. The action of a constant electric field. The action of an alternating electric field (UHF). The effect of electromagnetic waves (SHF).

### **Lecture 7. Some questions of medical electronics (2 hours).**

The main groups of medical electronic devices and devices. Electrical safety of medical equipment. Reliability of medical equipment. Structural scheme of the removal, transmission and registration of medical and biological information. Electrodes for the removal of medical and biological information. Sensors of medical and biological information. Basic concepts and formulas.

### **Lecture 8. Lasers. Laser radiation (2 hours).**

Passing monochromatic light through a transparent medium. Creating an inverse population. Methods of pumping. The principle of the laser. Types of lasers. Features of laser radiation. Characteristics of laser radiation used in medicine. Changes in the properties of the tissue and its temperature under the action of continuous high-power laser radiation. Use of laser radiation in medicine. Basic concepts and formulas.

### **Lecture 9. X-ray radiation (2 hours).**

X-ray sources. Brake X-rays. Characteristic X-ray radiation. Mosely's Law. Interaction of X-rays with matter. Law of Weakening. Physical basis of the use of X-rays in medicine. Basic concepts and formulas.

## **II. STRUCTURE AND CONTENT OF PRACTICAL COURSE**

### **Classes (54 hours)**

#### **Section 1. Fundamentals of Biological Physics (20 hours)**

##### **Lesson 1. Mechanical properties and models of biological tissues (2 hours).**

The main provisions of the molecular-kinetic theory. Comparative characteristics of aggregate states of matter. The effect of external forces on solids. Deformation. Elastic and inelastic deformation. Types of deformations (longitudinal, shear, bending, torsion). Mechanical properties of solids. Hooke's Law. Deformation diagram of a solid. Mechanisms of deformation of solids.

## **Lesson 2. Kinematics and dynamics of oscillations (2 hours).**

The oscillatory processes and their definitions are considered. Classification of fluctuations in nature and in form. Periodic, non-periodic fluctuations. Period. Frequency. Their dimensions. Harmonic oscillations. Amplitude. Phase. The initial phase. Cyclic frequency. Classification of oscillations by the nature of the effect on the oscillatory system. Free undamped oscillations. Free damped oscillations. Forced mechanical vibrations. Resonance, resonance phenomena

## **Lesson 3. Waves (4 hours).**

Waves. Classification by nature. Propagation of waves in media. Surface waves and their types. Wave surface. Front of the wave. Wavelength. Longitudinal and transverse waves. Equation of waves: flat, spherical, flat harmonious. Graphs of the wave. Phenomena at the interface between media. Laws of reflection and refraction of waves. Resonance of waves in distributed systems. The resonance condition in closed and open systems. Examples of resonance waves. The Doppler effect.

## **Lesson 4. Acoustics (2 hours).**

Acoustics. Acoustic (sound) waves. Scale of sound waves. Characteristics of sound waves: Amplitude, frequency, intensity, spectrum. Tone. The main tone. Overtones. Noises. Characteristics of auditory sensation. Height. Timbre. Volume. The threshold of hearing and the threshold of pain. The Weber-Fechner law. Unit volume. Audiometry.

## **Lesson 5. Physical basis of ultrasound studies (2 hours).**

Physical principles of the use of sound methods in medicine: a) auscultation (stethoscope, phonendoscope, the principle of the phonendoscope); b) percussion, physical principles of percussion. Ultrasound and its application in medicine: a) diagnostics; b) treatment; c) Pharmacy; d) surgery. Infrasound, its manifestation. Vibration. Effect of infrasound on the human body.

## **Lesson 6. "Physical processes in biological membranes" (4 hours)**

Biological membranes. Functions of membranes. Modern ideas about the structure of biological membranes. Transport of substances through the membrane. Transport phenomena. Passive transport. Types of passive transport: simple and lightweight diffusion, diffusion through the pores. Diffusion of molecules and ions through the biological membrane. The Nernst-Planck equation. Active transport.



K-Na is a pump. Biopotentials. Ionic nature of biopotentials. Potential of rest. Potential for action. The origin of the action potential.

### **Lesson 7. Knowledge control Test (4 hours).**

Deformation. Elastic and inelastic deformation. Types of deformations (longitudinal, shear, bending, torsion). Mechanical properties of solids. Hooke's Law. Classification of oscillations by the nature of the effect on the oscillatory system. Longitudinal and transverse waves. Equation of waves: flat, spherical, flat harmonious. Height. Timbre. Volume. The threshold of hearing and the threshold of pain. The Nernst-Planck equation. Active transport. K-Na is a pump. Biopotentials. Ionic nature of biopotentials. Potential of rest. Potential for action.

### **Section 2. Fundamentals of Medical Physics (34 hours).**

#### **Lesson 8. The main characteristics of electromagnetic interaction. Electrical properties of body tissues (2 hours).**

The main characteristics of electromagnetic interaction. Classification of substances by electrical properties. a) free and bound charges; b) conduction current and polarization current; c) Examples of substances. Electrical properties of body tissues. a) the main types of charges in the cell (tissue), b) the features of the motion of charges when the cell is introduced into a constant electric field. c) types of polarization in the cell. Equivalent electrical circuit of body tissues.

#### **Lesson 9. Biological tissue under the influence of permanent and alternating current (2 hours).**

EMF. The dependence of the current on time. Dependence of the impedance of the tissue (impedance) on frequency. Dependence of the impedance of the tissue on its functional state. Rheography.

#### **Lesson 10. Effects on tissues by constant and variable currents and fields. Basics of physiotherapy (4 hours).**

Electrical irritation. Threshold electric current, its dependence on the rate of increase. Dependence of the threshold current on the duration of the pulse and frequency. Physical processes occurring in the tissues of the body under the influence of constant and alternating currents and fields. Classification of basic methods of electrotherapy. Specific amount of heat released into tissues during diathermy, UHF therapy (for electrolyte tissues, dielectrics).

#### **Lesson 11. High-frequency electrotherapy and electrosurgery methods (4 hours).**

Physical basis of high frequency therapy and electrosurgery. Effect on biological tissue of high-frequency alternating magnetic field. Effect on biological tissue by a high-frequency alternating electric field. Influence on biological tissue by electromagnetic waves. Darsonvalization, surgical diathermy.

### **Lesson 12. Knowledge control Test (4 hours).**

Electrical properties of body tissues. a) the main types of charges in the cell (tissue), b) the features of the motion of charges. EMF. The dependence of the current on time. Dependence of the impedance of the tissue (impedance). Classification of basic methods of electrotherapy. Specific amount of heat released into tissues during diathermy, UHF therapy. Physical basis of high frequency therapy and electrosurgery.

### **Lesson 13 "Radiation of atoms and molecules" (2 hours)**

Radiation and absorption of energy by atoms and molecules. Experimental study of atomic spectra. Development of views on the structure of the atom. Model of the atom of Thomson, Rutherford. The postulates of Bohr. Quantum transitions. Luminescence. Classification by excitation type. The mechanism of the appearance of luminescence. Rule Stokes. Application of luminescence in medicine. Spontaneous and stimulated emission. Inverse population. Amplification of light in an active medium. Optical quantum generators (lasers).

### **Lesson 14. Forced radiation. Lasers and their medical Application (4 hours)**

Forced radiation and its properties. Amplification of light. The main properties of laser radiation. Application of lasers in medicine. The design of the laser. Three and four-level laser pumping systems. Properties of laser radiation, its use in therapy and surgery.

### **Lesson 15 X-ray radiation (4 hours)**

The list of questions, tasks assigned to the practical occupation The nature of X-ray radiation. Properties of X-rays. X-ray tube. Brake and characteristic X-rays The mechanism of occurrence. Range. Types of interaction of X-ray radiation with matter: coherent scattering, photoelectric effect. Attenuation of X-rays. Absorption coefficient of X-ray radiation. Use of X-rays in medicine, fluoroscopy. radiography. Fluorography. CT scan.

### **Lesson 16 "Radioactivity" (2 hours)**

The nucleus, as an integral part of the atom. Dimensions of the core, composition. Isotopes, isobars. The main characteristics of the nucleus: atomic number, mass number, binding energy, mass defect, specific binding energy. Dependence of the specific binding energy on the mass number. Nuclear forces, their properties. The phenomenon of radioactivity .. Natural and artificial radioactivity. The main types of radioactive decay:  $\alpha$ ,  $\beta$  - electron,  $\beta$  - positron, electron capture, spontaneous fission. Reactions of formation in the nucleus, the equation of decay. Spectra of radiation.  $\gamma$ -radiation, as the main form of decreasing the energy of the nucleus. Spectrum of  $\gamma$ -radiation. Properties of radioactive emissions.

### **Lesson 17 "Dosimetry" (2 hours)**

Interaction of ionizing radiation with matter. Linear density of ionization. Linear braking power. Average mileage. Primary processes of interaction with matter of  $\alpha$ ,  $\beta$ ,  $\gamma$  - radiation. Dosimetry of ionizing radiation. Absorbed and exposure doses, units of their measurement. The dose rate. Quantitative assessment of the biological effect of ionizing radiation. Coefficient of quality (relative biological effectiveness). Equivalent biological dose. Protection against ionizing radiation. Biophysical basis of the action of ionizing radiation on the body.

### **Lesson 18 Knowledge Control Test (4 hours).**

Development of views on the structure of the atom. Model of the atom of Thomson, Rutherford. The postulates of Bohr. Quantum transitions. Luminescence. Forced radiation and its properties. Amplification of light. The main properties of laser radiation. Properties of X-rays. X-ray tube. Brake and characteristic X-rays The mechanism of occurrence. Range. The main characteristics of the nucleus: atomic number, mass number, binding energy, mass defect, specific binding energy. Dosimetry of ionizing radiation. Absorbed and exposure doses, units of their measurement. The dose rates. Quantitative assessment of the biological effect of ionizing radiation. Coefficient of quality

## **III. EDUCATIONAL-METHODICAL SUPPORT OF STUDENTS' INDEPENDENT WORK**

The educational and methodological support of students' independent work in the discipline "Medical Physics" is presented in Appendix 1 and includes:

- characteristics of tasks for independent work of students and methodological recommendations for their implementation;

- requirements for the presentation and presentation of the results of independent work;
- criteria for assessing the performance of independent work.

#### IV. CONTROL OF ACHIEVEMENT OF THE COURSE GOALS

№ п/п	Controlled sections / topics of disciplines	Codes and stages of competence formation	Position tools		
			Formative assessment	Midterm control / exam	
	Section 1. Fundamentals of Biological Physics	GPC -9 with the ability to assess morpho functional, physiological states and pathological processes in the human body for solving professional problems;	<b>Know</b>	Poll Test control Presentation	Question for credit 1-25
			<b>Can</b>	task	assignment
			<b>Master</b>	test	assignment
	Section 2. Fundamentals of Medical Physics	PC-5 is ready to collect and analyze patient complaints, his history, examination results, laboratory, instrumental, pathoanatomical and other studies in order to recognize the condition or establish the fact of the presence or absence of the disease	<b>Know</b>	Poll Test control Presentation	Question for credit 1-25
			<b>Can</b>	task	assignment
			<b>Master</b>	test	assignment
	Section 1. Fundamentals of Biological Physics Section 2. Fundamentals of Medical Physics	PC-6 ability to determine the patient's underlying pathological conditions,	<b>Know</b>		
			<b>Can</b>		

		symptoms, disease syndromes, nosological forms in accordance with the International Statistical Classification of Diseases and Health Problems, X revision.	<b>Master</b>		
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Typical control tasks, methodical materials, defining the knowledge assessment procedures, skills and (or) experience activities, as well as criteria and indicators needed to assess the knowledge, skills and characterizing stages of competences formation during learning the educational program are provided in Appendix 2

## **V. LIST OF TEXTBOOKS AND INFORMATIONAL-METHODOLOGICAL SUPPORT OF DISCIPLINE**

### **Basic literature**

1. The Mathematics and Biology of the Biodistribution of Radiopharmaceuticals - A Clinical Perspective / Springer International Publishing Switzerland 2016 <https://link.springer.com/book/10.1007/978-3-319-26704-3#authorsandaffiliationsbook>
2. Cardiovascular Biomechanics / Springer International Publishing Switzerland 2017 <https://link.springer.com/book/10.1007/978-3-319-46407-7#editorsandaffiliations>
3. Quantification of Biophysical Parameters in Medical Imaging / Springer International Publishing AG 2018 <https://link.springer.com/book/10.1007/978-3-319-65924-4#editorsandaffiliations>

### **Additional literature**

1. Physics: Low-Energy Brachytherapy Physics / Springer, Cham 2016  
[https://link.springer.com/chapter/10.1007/978-3-319-26791-3\\_4](https://link.springer.com/chapter/10.1007/978-3-319-26791-3_4)
2. Computed Radiography: Physics and Technology / Springer, Singapore 2018  
[https://link.springer.com/chapter/10.1007/978-981-13-3244-9\\_3](https://link.springer.com/chapter/10.1007/978-981-13-3244-9_3)

### Electronic resources

1. Catalog of the Russian State Library <http://aleph.rsl.ru>
2. Scientific electronic library <http://elibrary.ru/>
3. Scientific and educational portal: <http://www.med-edu.ru/>
4. Mediobiophysics - <http://www.fbm.msu.ru/kafedri/MedBioFizika.htm>
5. Medbiophysics, medical technology and computer technologies in medicine  
<http://ysrp.sgm.ru/upld/main.shtml>

### LIST OF INFORMATION TECHNOLOGIES AND SOFTWARE

The location of the computer equipment on which the software is installed, the number of jobs	List of licensed software
Multimedia auditorium Vladivostok Russian island, Ayaks 10, building 25.1, RM. M723 Area of 80.3 m2 (Room for independent work)	Windows Seven enterprise SP3x64 Operating System Microsoft Office Professional Plus 2010 office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.); 7Zip 9.20 - free file archiver with a high degree of data compression; ABBYY FineReader 11 - a program for optical character recognition; Adobe Acrobat XI Pro 11.0.00 - software package for creating and viewing electronic publications in PDF; WinDjView 2.0.2 - a program for recognizing and viewing files with the same format DJV and DjVu.

In order to provide special conditions for the education of persons with disabilities all buildings are equipped with ramps, elevators, lifts, specialized places equipped with toilet rooms, information and navigation support signs

## **VI. METHODOICAL INSTRUCTIONS ON SUBJECT STUDYING**

During the study course "Medical physics" a variety of methods and tools are offered for the development of educational content: lectures, practical exercises, examinations, tests, independent work of students.

Lecture is the main active form of classroom teaching, clarifying of basic and most difficult theoretical sections of human anatomy, which involves intense mental activity of the student, and is particularly difficult for first-year students. Lecture should always be informative, developing, educational and organizing character. Lecture notes help to assimilate the theoretical material discipline. During the lecture, it is necessary to write the most important and desirable to own wording to better remember the material.

Lecture notes are useful when it is written by the student.

You can develop your own pattern of words cuts. The name of those sections can be isolated by colored markers or pens. In the lecture the teacher gives only a small portion of the information on topic or other topics, which are described in textbooks. Therefore, it is always necessary to use the basic textbook at work with lecture notes and additional literature that is recommended in the discipline.

In teaching of lecture course on the subject "Human anatomy" as a form of active learning are used: lecture - conversation lecture-visualization, which are based on the knowledge acquired by students in other disciplines: "Biology", "Chemistry", "Physics".

To illustrate the verbal information can be used presentations, tables, diagrams on the board. During the presentation of lecture material are placed problematic issues or issues with the discussion items.

### **Lecture - Visualization**

Lecturing is accompanied by display tables, slides, which facilitates better perception of the material. Lecture - visualization requires certain skills - verbal presentation of the material must be accompanied by and integrated with visual form. The information contained in the form of diagrams on the blackboard, tables,

slides, allows you to create the problematic issues, and contribute to the development of professional thinking of future specialists.

### **Lecture - discussion.**

Lecture - discussion, in pedagogy this form of learning is called "dialogue with the audience". It is the most common form of active learning and allows engaging students in the learning process, as there is direct contact with the teacher and audience. Such contact is achieved during the lectures, when students are asked informational and problem or when the students can ask lecturer questions themselves. Questions are offered for of all audience, and every student may offer their answer, another student can supply them. At the same time, it is possible to gradually reveal more active students and try to activate the students who do not participate in the work. This form of lectures allows students to engage in work, to increase their attention, thinking, get a collective experience, and learn how to form questions. Lecture-conversation advantage is that it allows you to attract the students' attention to the most important issues of the theme, to determine the content and temp of presentation of educational material.

### **Lecture - Press Conference**

At the beginning of classes a teacher calls the lecture topic and asks the students to put questions to him in writing on this topic. Each student should for 2-3 minutes to formulate the most interesting questions on topic of the lecture, write them on a piece of paper and pass a note to the teacher.

For 3-5 minutes a teacher sorts questions about their semantic content and begins to lecture. The material is presented in the form of a connected theme disclosing, and not as a response to every question, but in the process of the lectures appropriate responses are formulated. At the end of the lecture the teacher conducts a final assessment of the issues, identifying the knowledge and interests of students.



## **Practical classes on discipline "Human Anatomy"**

Practical classes - a collective form of consideration of educational material. The seminars, which are also one of the main types of practical classes for in-depth study of discipline going online.

At the lessons the questions related to the subject are puzzled out, then teachers and students together hold discussions, which aims at consolidating the discussion material, formation of skills, to debate, to develop independence and critical thinking, the ability of students to orient in large information flows, to develop and defend their own position on the problem issues of educational disciplines.

The active learning methods are used in practical classes: press conference, detailed discussion, debate. The detailed discussion suggests the preparation of students for each issue of the lesson plan with common for all the recommended list of obligatory and additional literature.

The reports are prepared by the students on the previously proposed theme.

The dispute in the group has a few advantages. The dispute may be caused by the teacher during the classes or planned him previously.

During the debate, students formed their inventiveness, speed of mental reactions. Press conference. Teacher instructs 3-4 students to prepare summary reports. Then one of the members of this group makes a report. After the presentation, students asked questions. Speaker and other responsible members of the expert answer the questions. Based on the questions and answers the teacher organizes a creative discussion.

## **VII. MATERIAL AND TECHNICAL EQUIPMENT OF SUBJECT**

For carrying out practical work, as well as for organizing independent work, students have access to the following laboratory equipment and specialized classrooms that meet applicable sanitary and fire regulations, as well as safety requirements for educational and research and production work:

Name of equipped premises and rooms for independent	List of basic equipment
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work	
Computer classroom School of Biomedicine. Laboratory building aud. L403, 15 seats	Screen with an electric drive 236 * 147 cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x800, 2000: 1 EW330U Mitsubishi; The subsystem of specialized fixing equipment CORSA-2007 Tuarex; Video switching subsystem: DVI DXP 44 DVI Pro Extron matrix switcher; DVI extension cable for twisted pair DVI 201 Tx / Rx Extron; Audio switching and sound reinforcement subsystem; ceiling speaker system SI 3CT LP Extron; DMP 44 Extron digital audio processor; extension for the control controller IPL T CR48; Wireless LANs for students are provided with a system based on 802.11a / b / g / n access points 2x2 MIMO (2SS). Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty
Multimedia audience	Monoblock Lenovo C360G-i34164G500UDK; Projection screen Projecta Elpro Electrol, 300x173 cm; Multimedia projector, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Mortise interface with TLS TAM 201 Stan automatic cable retractor; Document Camera Avervision CP355AF; Sennheiser EW 122 G3 UHF range microphone microphone wireless system as part of a wireless microphone and receiver; Video conferencing codec LifeSizeExpress 220- Codeconly- Non-AES; Network camera Multipix MP-HD718; Dual LCD panels 47 ", Full HD, LG M4716CCBA; Audio switching and sound reinforcement subsystem; centralized uninterrupted power supply
Reading rooms of the FEFU Scientific Library with open access to the Foundation (Building A - Level 10)	HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty Internet access speed 500 Mbit / s. Jobs for people with disabilities are equipped with braille displays and printers; equipped with: portable devices for reading flat-printed texts, scanning and reading machines with a video optimizer with the ability to adjust color spectra; magnifying electronic loops and ultrasonic markers
690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax Village, 10, aud. M 510	Accreditation and Simulation Center of the School of Biomedicine Spirometer portable (1 pc.) Electrocardiograph (1 pc.) Spirograph (1 pc.) Tonometer (2 pcs.) Set with dotted electrodes for recording EEG in the system 10-20 "MCScap-26" (1 pc.) Medical couch (2 pcs.)



MINISTRY OF EDUCATION AND SCIENCE OF RUSSIAN FEDERATION  
The Federal state autonomous educational institution  
higher education  
**"Far Eastern Federal University"**  
(FEFU)

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SCHOOL OF BIOMEDICINE

**EDUCATIONAL AND METHODOLOGICAL SUPPORT INDEPENDENT WORK  
OF STUDENTS  
on the subject " Medical physics "  
Specialty 31.05.01 General Medicine  
Full-time training**

Vladivostok  
2018

Independent work includes:

- 1) The library or homework with educational literature and lecture notes,
- 2) Preparation for practical training,
- 3) Preparation for testing and control interview.

Order of independent work of the students is determined by schedule plan of this work in the subject.

### **The schedule plan of independent work in the subject.**

<b>№ п/п</b>	<b>Date / terms of performance</b>	<b>Kind of independent work</b>	<b>Estimated time standards for performance</b>	<b>Kinds of control</b>
1	During the 1-6 weeks	Working with literature and lecture notes, preparing to the practical lesson, control lesson	12 hours	Work on practical class with computer programs, verbal response, computer testing. Text of the essay file The text and electronic version of a literature review on the essay topic
2	During the 7-12 weeks	Working with preparations, literature and lecture notes, preparing to the control lesson	12 hours	Work on practical class with macroscopic preparations, verbal response, computer testing. Text of the essay file Presentation on the essay The text and electronic version of a literature review on the essay topic
3	During the 13-18 weeks	Working with preparations, literature and lecture notes, preparing to the control lesson	12 hours	Work on practical class with macroscopic preparations, verbal response, computer testing.

## **Topics for essays and presentations**

Academic plan on Anatomy includes 36 hours of independent work, within this time 3 verbal presentations are performed on the proposed topics.

1. The role of physics and biophysics in the knowledge of the surrounding world
2. Relationship of physics and biophysics with biology, medicine and pharmacy
3. Doppler effect and its use for biomedical research
4. Auscultation, principles, instruments and apparatus
5. Percussion, principles, instruments and apparatus
6. Application of ultrasound in diagnosis
7. Use of ultrasound for treatment
8. Biophysical basis for the action of infrasound
9. Physical basis of the clinical method of measuring blood pressure
10. The device of artificial circulation
11. Research problems of electric fields in the body
12. Physical principles of rheography and its application in medicine
13. The concept of holography and its possible application in medicine
14. Polarimetry. Study of biological tissues in polarized light
15. Apparatus for phototherapy (infrared and ultraviolet radiation)
16. Physical basis of thermography
17. Application of spectrophotometry in medicine and biology
18. Fluorescent labels and probes and their application in biology and medicine
19. The use of lasers in biological research and in medicine
20. The method of labeled atoms
21. Autoradiography, ionic medical radiography
22. Medical applications: radiotherapy, radon therapy
23. Protection from ionizing radiation
24. Safety rules for working with sources of ionizing radiation

## **Methodical instructions for preparation of presentations**

For preparation of the presentation ito use: PowerPoint, MS Word, Acrobat Reader, LaTeX-ovsky beamer package. The simplest program for creating presentations - Microsoft PowerPoint. To prepare the presentation, you must process the information gathered while writing the essay.

The sequence of preparation of the presentation:

1. Clearly formulate the purpose of the presentation.
2. Determine what will be the presentation format: a live performance (then, how much will its duration) or e-mailing (what will be the presentation of context
3. Select all the content part of the presentation and build a logical chain of presentation.
4. Determine the key points in the content of the text and highlight them.
5. Determine the visualization types (images) to display them on the slides according to the logic, purpose and specificity of the material.
6. Choose design and format slides (the number of images and text, their location, color and size).
7. Check the visual perception of the presentation.

The methods of visualization are illustrations, images, charts, tables.

Illustration is representation of real-life visual series.

The images - in contrast to the illustration - metaphor. Their purpose - to cause emotion and create a relationship to it, to influence an audience. With the help of well-designed and submitted images, information can long remain in memory of the person.

Diagram - visualization of quantitative and qualitative relations. They are used to demonstrate the convincing data for spatial thinking in addition to the logical.

Table - concrete, visual and accurate data display. Its main purpose - to structure the information, which sometimes facilitates the perception of data by the audience.

## **Practical advices on preparing presentations**

- printed text + slides + handout should be prepared separately;
- slides - visual presentation of information, which must contain a minimum of text, images maximum carrying semantic load, to look clearly and simply;
- the text content of the presentation - speaking or reading, which should include the arguments, facts, reasoning, and emotions;
- recommended number of slides 17-22;
- The regulated information for the presentation of: topic, name and initials of the speaker; communication plan; summary of what has been said; list of references;

Handout - should provide the same depth and scope as the live performance: the people have more confidence in what they can carry, than disappearing images, words are forgotten and slides and handouts remains constant tangible reminder; it is important to distribute the handout at the end of the presentation; Handouts must differ from the slide, should be more informative.

## **Methodical instructions for the preparation to practical classes**

Control of results of independent work carried out during the practical classes, oral interviews, interviews, solving case studies, tests, including by testing.

1. For practical classes the student should be prepared: to repeat the lecture material, read the required section in the textbook on the subject.
2. The lesson begins with a quick frontal verbal questioning on a given topic.
3. At the lessons, students work with a collection of preparations and atlases.
4. For classes, it needs to have a notebook to write theoretical material, a textbook and an atlas.
5. The study of anatomical preparations starts with the right location.
6. After viewing the preparation, students define the basic details of its structure.
7. At the end of class the teacher gives you homework on a new topic and offers to make tests on anatomical preparations, which have been studied in class.

Presentations and students' activity are assessed by current point.

## **Methodical instructions for preparation of the report**

1. Selection of literature on a chosen topic from the the recommended basic and additional literature, which is proposed in the work program of the discipline, as well as work with the resources of the network "Internet", indicated in the work program.

2. Work with the scientific publications and textbooks is not limited to reading material, it is also necessary to analyze the collected literature and to compare the presentation of material on the theme in different literary sources, to collect material, so that it reveals the theme of the report.

3. The analyzed material should be noted. Most importantly, it should not be just a conscientious rewriting source texts from the selected literature without any commentary and analysis.

4. Having worked for literature and student report makes a plan that is the basis for the preparation of the report.

5. The report should be logically built. Students expound material integrally, coherently, consistently and make conclusions. It is desirable that the student could express his opinion on the formulated problem.

6. The duration of the report is not more than 7-10 minutes. Report told, not read on paper.

Criteria for evaluation of the abstract.

The stated understanding of the abstract as a holistic copyright text defines the criteria for its evaluation: the novelty of the text; the validity of the choice of source; the degree of disclosure of the essence of the issue; compliance with the requirements for registration.

The novelty of the text: a) the relevance of the research topic; b) novelty and independence in the formulation of the problem, the formulation of a new aspect of the well-known problem in the establishment of new connections (interdisciplinary, intra-subject, integration); c) the ability to work with research, critical literature, systematize and structure the material; d) the appearance of the



author's position, independence of assessments and judgments; d) stylistic unity of the text, the unity of genre features.

The degree of disclosure of the essence of the question: a) the plan compliance with the topic of the abstract; b) compliance with the content of the topic and plan of the abstract; c) completeness and depth of knowledge on the topic; d) the validity of the methods and methods of work with the material; e) the ability to generalize, draw conclusions, compare different points of view on one issue (problem).

The validity of the choice of sources: a) evaluation of the used literature: whether the most famous works on the topic of research are involved (including recent journal publications, recent statistics, summaries, references, etc.).

Compliance with the requirements for registration: a) how correct the references to the used literature, references are; b) assessment of literacy and presentation culture (including spelling, punctuation, stylistic culture), knowledge of terminology; c) compliance with the requirements for the volume of the abstract.

The reviewer should clearly state the remark and questions, preferably with references to the work (possible on specific pages of the work), to research and evidence that the author did not take into account.

The reviewer can also indicate: whether the student addressed the topic earlier (essays, written works, creative works, olympiad works, etc.) and whether there are any preliminary results; how the graduate conducted the work (plan, intermediate stages, consultation, revision and processing of the written or lack of a clear plan, rejection of the recommendations of the head).

The student submits an essay for review no later than a week before the defense. The reviewer is the teacher. Experience shows that it is advisable to acquaint the student with the review a few days before the defense. Opponents are appointed by the teacher from among the students. For an oral presentation, a student needs about 10–20 minutes (approximately as long as he answers with tickets for the exam).

Grade 5 is set if all the requirements for writing and defending an essay are fulfilled: the problem is indicated and its relevance is justified, a brief analysis of various points of view on the problem under consideration is made and one's own position is logically presented, conclusions are formulated, the topic is fully disclosed, the volume is met, the external requirements are met design, given the correct answers to additional questions.

Grade 4 - the basic requirements for the abstract and its protection are met, but there are shortcomings. In particular, there are inaccuracies in the presentation of the material; there is no logical sequence in the judgments; not sustained volume of the abstract; there are omissions in the design; Additional questions for the protection given incomplete answers.

Grade 3 - there are significant deviations from the requirements for referencing. In particular: the topic is covered only partially; factual errors in the content of the abstract or when answering additional questions; during the protection there is no output.

Grade 2 - the topic of the essay has not been disclosed, there is a significant misunderstanding of the problem.

Grade 1 - student's essay not submitted



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SCHOOL OF BIOMEDICINE

**FUND OF ASSESSMENT TOOLS**  
**on the subject "Medical physics"**  
**The basic educational program (specialty) 31.05.01 General Medicine**  
**Full-time training**

Vladivostok  
2018

## Fund of assessment tools passport

The passport is filled in accordance with the Regulations on the Funds of assessment tools of educational programs of higher education - undergraduate, specialist's and master's programs of Far Eastern Federal University, approved by order of the rector of 12.05.2015 №12-13-850.

Code and formulation of competence.	Stages of formation of competence	
GPC -9 with the ability to assess morpho functional, physiological states and pathological processes in the human body for solving professional problems;	<b>Know</b>	Biophysical parameters characterizing the functional state of organs and tissues: mechanical, electrical, electromagnetic, optical; biophysical phenomena and processes underlying the vital activity of the organism, their characteristics;
	<b>Can</b>	Measure physical parameters and evaluate biophysical properties of biological objects with the help of mechanical, electrical and optical methods;
	<b>Master</b>	Methods of evaluation of morphofunctional, physiological and pathological processes in the human body;
PC-5 is ready to collect and analyze patient complaints, his history, examination results, laboratory, instrumental, pathoanatomical and other studies in order to recognize the condition or establish the fact of the presence or absence of the disease;	<b>Know</b>	Possibilities of instrumental, pathological-anatomical and other methods of research;
	<b>Can</b>	Interpret the results of laboratory, instrumental, pathological and anatomical and other research methods;
	<b>Master</b>	skills in working with diagnostic equipment; methods of interpreting received information;
PC-6 ability to determine the patient's underlying pathological conditions, symptoms, disease syndromes, nosological forms in accordance with the International Statistical Classification of Diseases and Health Problems, X revision.	<b>Know</b>	the main pathological conditions; radiation symptoms of diseases;
	<b>Can</b>	determine the patient's underlying pathological conditions, diseases; determine the patient's main radiation symptoms of disease;
	<b>Master</b>	algorithms of interpretation of the revealed radial symptoms.

## CONTROL OF ACHIEVEMENT OF THE COURSE GOALS

№ п/п	Controlled sections / topics of disciplines	Codes and stages of competence formation		Position tools	
				<u>Formative assessment</u>	Midterm control / exam
	Section 1. Fundamentals of Biological Physics	GPC -9 with the ability to assess morpho functional, physiological states and pathological processes in the human body for solving professional problems;	<b>Know</b>	Poll Test control Presentation	Question for credit 1-25
			<b>Can</b>	task	assignment
			<b>Master</b>	test	assignment
	Section 2. Fundamentals of Medical Physics	PC-5 is ready to collect and analyze patient complaints, his history, examination results, laboratory, instrumental, pathoanatomical and other studies in order to recognize the condition or establish the fact of the presence or absence of the disease	<b>Know</b>	Poll Test control Presentation	Question for credit 1-25
			<b>Can</b>	task	assignment
			<b>Master</b>	test	assignment
	Section 1. Fundamentals of Biological Physics Section 2. Fundamentals of Medical Physics	PC-6 ability to determine the patient's underlying pathological conditions, symptoms, disease syndromes, nosological forms in accordance with the International Statistical Classification of Diseases and Health Problems, X revision.	<b>Know</b>	Poll Test control Presentation	Question for credit 1-25
			<b>Can</b>	task	assignment
			<b>Master</b>	test	assignment

### Scale of competence level assessment

Code and formulation of competence.	Stages of formation of competence		Criteria	Indicators	Points
GPC - 9 with the ability to assess morpho functional, physiological states and pathological processes in the human body for solving professional problems;	Knows (entry level)	Biophysical parameters characterizing the functional state of organs and tissues: mechanical, electrical, electromagnetic, optical; biophysical phenomena and processes underlying the vital activity of the organism, their	Knowledge of the fundamentals of biophysical parameters characterizing the functional state of organs and tissues; mechanical, electrical, electromagnetic, optical phenomena and processes underlying the	Formed structured systematic knowledge of the fundamentals of biophysical parameters characterizing the functional state of organs	65-71

		characteristics;	vital activity of the organism;	and tissues; mechanical, electrical, electromagnetic, optical phenomena and processes underlying the vital activity of the organism;	
	Able (advanced level)	Measure physical parameters and evaluate the biophysical properties of biological objects with the help of mechanical, electrical and optical methods;	Ability to measure physical parameters and evaluate the biophysical properties of biological objects with the help of mechanical, electrical and optical methods;	Ready and able to measure physical parameters and evaluate the biophysical properties of biological objects with the help of mechanical, electrical and optical methods;	71-84
	Master (high level)	Methods of evaluation of morphofunctional, physiological and pathological processes in the human body;	Skills of assessment of morphofunctional, physiological and pathological processes in the human body;	Applies the skills of assessment of morphofunctional, physiological and pathological processes in the human body;	85-100
PC-5 is ready to collect and analyze patient complaints, his history, examination results, laboratory, instrumental, pathoanatomical and other studies in order to recognize the condition or	Knows (entry level)	Possibilities of instrumental, pathoanatomical and other methods of research;	Knowledge of the possibilities of instrumental, pathoanatomical and other methods of research;	Formed structured systematic knowledge of the possibilities of instrumental, pathoanatomical and other research methods;	65-71
	Can	Explain the results	Ability to	Interprets the	71-84

establish the fact of the presence or absence of the disease;	(advanced level)	of laboratory, instrumental, pathoanatomical and other research methods;	interpret the results of laboratory, instrumental, pathoanatomical and other research methods;	results of laboratory, instrumental, pathoanatomical and other research methods;	
	Master (high level)	Skills of work on diagnostic devices; methods of interpreting the information received;	Work skills on diagnostic tools; methods of interpreting the information received;	Works on diagnostic devices; methods of interpreting the information received;	85-100
PC-6 ability to determine the patient's underlying pathological conditions, symptoms, disease syndromes, nosological forms in accordance with the International Statistical Classification of Diseases and Health Problems, X revision.	Knows (entry level)	The main pathological conditions; radiation symptoms of diseases	Knowledge of the main pathological conditions; radiation symptoms of diseases;	Formed structured systematic knowledge of pathological conditions; radiation symptoms of diseases;	65-71
	Can (advanced level)	Determine the patient's underlying pathological conditions, diseases; determine the patient's main radiation symptoms of disease	Ability to identify the patient's underlying pathological conditions, diseases; determine the patient's main radiation symptoms of the disease;	Ready and able to determine the patient's underlying pathological conditions, diseases; determine the patient's main radiation symptoms of the disease;	71-84
	Master (high level)	Algorithms for interpreting the revealed radiation symptoms	The skill of applying algorithms for interpreting the revealed radiation symptoms;	Applies algorithms of interpretation of the revealed radial symptoms	85-100

### **Methodical recommendations for the final evaluation of the subject development**

The interim attestation of students. The interim attestation of students on the subject " Medical physics " is carried out in accordance with the local regulations of the Far Eastern Federal University and is obligatory.

Passing the credit orally suggests as an interim attestation.

## Evaluation tools for intermediate certification

### Questions for the credit on the subject " Medical physics "

1. Give a definition of a solid body deformation. What is the difference between elastic deformation and plastic one? Specify main types of deformation.
2. What is a quantitative measure of deformation? What is the unit of a strain? Give a definition of a stress and indicate its units.
3. Write and analyze the Hooke's Law for tension (compression) deformation. What is the relation between stiffness and Young's modulus?
4. Plot and analyze a stress-strain diagram. Determine proportional limit, elastic limit, yield limit, proof stress and ultimate strength. What is the Poisson ratio?
5. Give a definition of a periodic motion, oscillations and basic characteristics
6. What are harmonic oscillations? Equation for displacement. Explain meaning of values in this equation.
7. Types of oscillations (free, forced, damped) – definitions, frequency and difference. What is the logarithmic decrement? What is the relation between a logarithmic decrement and a damping factor?
8. What is a wave, types and class? Basic characteristics.
9. Wave properties. Principle of superposition. Constructive, destructive interference. Standing wave.
10. Examples of simple harmonic motion. What does the period depend on?
11. Write the mechanical wave equation. Explain meaning of values in this equation. What does the wave intensity depend on?
12. Explain the Doppler Effect. How is it use for blood flow detection?
13. Sound waves. Physical and physiological characteristics of sound.
14. What are the sound waves? What determines the sound velocity?
15. What physical characteristics determine physiological characteristics of sound?



16. What is acoustic impedance? What does the reflection coefficient depend on?
17. Write the absorption law for acoustic waves in medium.
18. Describe ultrasound production and registration methods. Explain physical basics for the methods.
19. What is the essence of ultrasound diagnostics methods?
20. Why different frequencies are used for ultrasound diagnostics of different organs?
21. Ultrasound in diagnostic and therapeutic applications (methods, types, difference)
22. Applications of ultrasound in medicine.
23. Electromagnetic Waves. EM spectrum.
24. Medical application of **Radio waves. Microwaves. Infrared** waves.
25. Medical application of **Ultraviolet waves. Visible light (laser)** rays
26. Medical application of **X-rays. Gamma rays**
27. Compare the physical principles of ultrasound and X-rays diagnostics
28. Thermodynamics. Types and examples of thermodynamic systems.
29. What is the thermodynamic equilibrium? Equation of heat balance. Zeroth law of thermodynamics.
30. Ways of heat transfer: thermal conductivity, convection and radiation. First law of thermodynamics.
31. Heat, temperature, difference between them. Heat capacity, specific heat capacity.
32. Equation for Heat (amount of heat). Explain meaning of values in this equation.
33. Characterize the structure of cell membrane. What are the **functions** of the cell membrane **proteins**?
34. Describe types of the lipids and proteins motion in the cell membrane (lateral diffusion, rotational diffusion, flip-flop).
35. What types of passive transport across the cell membrane are known?

36. Which substances can move across cell membranes? Specify membrane channels properties.
37. What is a facilitated diffusion? Describe the types of facilitated diffusion.
38. What is the meaning of electrochemical potential?
39. What is the active transport? Explain ions active transport mechanism by the sodium-potassium pump.
40. What types of electric charges are known? Specify their units. Write Coulomb's Law.
41. What are the main characteristics of the electric field? Write formulas for electric field strength and potential. What is the relation between the electric field strength and potential?
42. What is the electrical dipole? Dipole moment. How to calculate electric potential at a point due to an electric dipole? Write the formula. Write formula for the potential difference between two points created by dipole.
43. Why do certain organs and tissues create electrical fields? What is the electric heart vector? What is the electrography? Types of electrography.
44. What are Einthoven's theory fundamentals? What are standard bipolar limb leads; augmented unipolar limb leads?
45. Give the approximated ECG. Give the relation between the physiological processes and main waves and intervals of ECG.
46. Direct current in electrolytes. Electrical conductivity of biological tissues. Some therapeutic methods based on the use of direct current.
47. Main characteristics of the alternating current. Describe the dependence of living tissue impedance on the current frequency.
48. What is a polarization coefficient? What does it characterize?
49. What is the electrostimulation? What is the electrical current used for electrostimulation? Describe parameters of a rectangular pulse. Specify main characteristics of an arbitrary pulse.
50. What is the defibrillation method? Specify main parameters and features the method.

## Evaluation tools for the current attestation

**Control tests** are designed for the students studying the course "Medical physics".

The tests are necessary for the control of knowledge during the current interim attestation, and for the evaluation of knowledge and thus to get credit for course.

While working with tests the student are asked to select one answer from the three - four proposed. At the same time the tests are not identical in their complexity.

Offered tests contain several variants of correct answers. The student must select all the correct answers.

The tests are designed both for individual and collective solving them. They can be used in the process both classroom lessons and independent work. The tests, required for the control of knowledge, are chosen in the process of the intermediate certification by each teacher individually.

The results of the test tasks are evaluated by a teacher on a five-mark grading scale or system of "**credit**" - "**not credit**".

Evaluation of "**excellent**" is got by student at the correct answer to more than 90% of the proposed tests.

Evaluation of "**good**" getting - at the correct answer by more than 70% of tests.

Evaluation of "**satisfactory**" - at the correct answer to 50% of the offered tests

### TEST TASKS ON SUBJECT " Medical physics "

Theme "Biophysical fundamentals of application of thermal radiation in medicine"

1. An absolutely black body is a body whose for all  $\lambda$  and T

1)  $E(\lambda, T) = 1$

2)  $E(\lambda, T) < 1$  and does not depend on  $\lambda$

3)  $A(\lambda, T) = 1$

4)  $A(\lambda, T) < 1$  and does not depend on  $\lambda$

5)  $A(\lambda, T) < 1$  and depends on  $\lambda$

Answer: 3)

2. According to the Wien law describing the emission of a black hole,  $\lambda_m \propto 1/T$ , where  $\lambda_m$  is

1) the maximum wavelength in the spectrum

2) the minimum wavelength in the spectrum

3) the wavelength at which the maximum radiation energy

4) the wavelength at which the minimum radiation energy

5) mean wavelength in the spectrum

Answer: 3)

3. The total emissivity of the ACT when its temperature changes from 800 K to 200 K decreases in

1) 2 times 2) 4 times 3) 16 times 4) 256 times 5) 400 times

Answer: 4)

4. The total emissivity of ACT with an increase in its temperature by a factor of 3

1) decreases 3 times

2) increases 3 times

3) decreases 81 times

4) increases 81 times

5) does not change

Answer: 4)

5. In what state of aggregation must matter be that the spectrum of its radiation be ruled

1) atomic gas 2) molecular gas 3) liquid 4) solid body

Answer: 1)

Theme "Biophysical fundamentals of the application of X-ray radiation in medicine"

1. Set the matches

1) The electrons that fly from the cathode to the anode cause the appearance of

2) The electrons of the outer shells of atoms pass to the inner shells. This causes the appearance of

3) The electrons of the inner shells of atoms pass to the outer shells. This causes the appearance of

A) Bremsstrahlung X-ray radiation

B) characteristic X-ray radiation

Answers: 1A 2B

2. With increasing voltage between cathode and anode:

1)  $\lambda_{\min}$  decreases

2) the penetrating power of the radiation increases

3) decreases the rigidity of X-ray radiation

4) the X-ray flux increases

5) the flux of X-ray radiation decreases

Answers: 1), 2), 4)

3. Set the matches

1) fluoroscopy A) image on film

2) radiography B) image on the luminescent screen 3) tomography

Answers: 1B 2A 3A

4. As the cathode current intensity increases, the penetrating power

1) decreases 2) increases 3) does not change

Answer: 3)

5.  $h\nu \geq E$  and. These are the conditions of occurrence

1) coherent scattering 2) photoelectric effect 3) Compton effect

Answer: 2)

Theme "Biophysical fundamentals of the application of X-ray radiation in medicine"

1. Set the matches

- 1) The electrons that fly from the cathode to the anode cause the appearance of
  - 2) The electrons of the outer shells of atoms pass to the inner shells. This causes the appearance of
  - 3) The electrons of the inner shells of atoms pass to the outer shells. This causes the appearance of
- A) Bremsstrahlung X-ray radiation  
B) characteristic X-ray radiation

Answers: 1A 2B

2. With increasing voltage between cathode and anode:

- 1)  $\lambda_{\min}$  decreases
- 2) the penetrating power of the radiation increases
- 3) decreases the rigidity of X-ray radiation
- 4) the X-ray flux increases
- 5) the flux of X-ray radiation decreases

Answers: 1), 2), 4)

3. Set the matches

- 1) fluoroscopy A) image on film
- 2) radiography B) image on the luminescent screen 3) tomography

Answers: 1B 2A 3A

4. As the cathode current intensity increases, the penetrating power

- 1) decreases 2) increases 3) does not change

Answer: 3)

5.  $h\nu \geq E$  and. These are the conditions of occurrence

- 1) coherent scattering 2) photoelectric effect 3) Compton effect

Answer: 2)

Theme "Biophysical fundamentals of the use of radioactive radiation in medicine"

1. As a result of the collision of the core of boron  $^{11}_5\text{B}$  and the  $\alpha$  particle, a neutron and a nucleus are formed

- 1)  $^{10}_5\text{B}$  2)  $^{15}_7\text{N}$  3)  $^{14}_7\text{N}$  4)  $^{12}_6\text{C}$

Answer: 3)

2. The chemical element has the symbol  $^{16}\text{O}$ . The charge number is equal to the  
Response from the keyboard manually - 8

3. What fraction of the initial radioactive nuclei  $N_0$  decay during two periods?

Answer from the keyboard manually - 0,75

4. Which particle causes the next nuclear reaction

$^{199}\text{F} + ? \rightarrow ^{168}\text{O} + ^4\text{He}$

1) electron 2) neutron 3) positron 4) proton

Answer: 4)

5. According to the graphs, compare the half-lives

1)  $T_1 < T_2$  1000

2)  $T_1 > T_2$  750

3)  $T_1 = T_2$  500

Theme "Biophysical fundamentals of ionizing radiation on the body"

1. Ionizing radiation is by nature an electromagnetic wave

1) ultraviolet 2) X-ray 3) gamma radiation

4)  $\alpha$  - radiation 5)  $\beta$  - radiation

Answers: 1), 2), 3)

2. A physical quantity equal to the number of pairs of ions formed by ionizing radiation per unit of path length in a substance is called

1) the linear ionization density

2) linear braking power

3) the average linear run

Answer: 1)

3. The total charge of ions of the same sign, formed upon ionization of 1 kg of dry air under normal conditions, is called the dose

1) absorbed 2) exposure 3) equivalent

Answer: 2)

4. Unit of measurement of absorbed dose

1) J / kg 2) Sv 3) P 4) Gy 5) rad

Answers: 1), 4), 5)

5. The radiation energy absorbed by a unit mass of matter over the entire radiation time is called the dose

1) absorbed 2) exposure 3) equivalent

Answer: 1)

Theme "Mechanical properties and models of biological tissues"

1. The ratio of the kinetic and potential energies of atoms or molecules of a solid

1)  $E_{кин} < E_{пот}$  2)  $E_{кин} > E_{пот}$  3)  $E_{кин} = E_{пот}$

Answer: 1)

2. The location of the molecules of the amorphous body is observed

1) short-range order 2) long-range order 3) disorder

Answer: 1)

3. Modulus of elasticity of copper  $120 \cdot 10^9$  Pa. Under the action of force, a mechanical stress  $240 \cdot 10^6$  appears in it. The relative deformation of the wire is equal to the response from the keyboard manually - 0.002

Theme "Hemodynamics"

1. Establish a correspondence between the quantities included in Ohm's law and the Hagen-Poiseuille law

- 1) the voltage A) the space velocity
- 2) current strength B) hydraulic resistance
- 3) resistance B) pressure difference

Answers: 1B 2A 3B

2) In the electrical model of the cardiovascular system (SSS), the capacitor models

- 1) blood flow in one direction
- 2) the ability of elastic vessels to store blood



- 3) energy expenditure for blood flow through inelastic vessels
- 4) the ability of the heart to support the movement of blood

Answer: 2)

3) Establish a correspondence between the elements of the electrical model and the elements of the cardiovascular system

- 1) source of periodic EMF A) inelastic vessels
- 2) diode B) elastic vessels
- 3) condenser B) valve
- 4) resistor D) left ventricle

Answers: 1Г 2Б 3Б 4А

4) Compare the amplitude ( $A$ ) of the pulse wave at two points of the aorta at a distance  $x_1$  and  $x_2$  from the heart, if  $x_2 > x_1$

- 1)  $A_1 > A_2$
- 2)  $A_1 < A_2$
- 3)  $A_1 = A_2$

Answer: 1)

Theme "Physical processes in biological membranes"

1. Types of passive transport

- 1) simple diffusion
- 2) Potassium-sodium pump
- 3) hydrogen pump
- 4) diffusion through the pores
- 5) light diffusion

2. Set the correspondence Responses: 1), 4), 5)

- 1) mass transfer A) electrical conductivity
- 2) charge transfer B) viscosity
- 3) momentum transfer B) thermal conductivity
- 4) energy transfer

Answers: 1Г 2А 3Б 4Б

3. Set the correspondence D) diffusion

- 1) mass transfer A) velocity gradient
- 2) charge transfer B) temperature gradient
- 3) momentum transfer B) concentration gradient
- 4) energy transfer

Answers: 1B 2G 3A 4B D) the gradient of the potential

4. Membrane potentials form ions

- 1) Potassium 2) Chlorine 3) Calcium 4) Sodium

Answers: 1), 2), 4)

5.  $\text{grad}A = 0$ . This state of the system is called

- 1) stationary 2) equilibrium 3) nonequilibrium

Answer: 2)