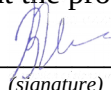


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**APPROVED**  
by the Decision of the Scientific Institute of Medicine,  
Ecology and physical education  
dated «09» of June 2019 at the protocol № 10\210  
chairman:  /V.I. Midlenko  
(signature)  
«1» of June 2019 year

### THE WORKING PROGRAM OF DISCIPLINE

Discipline:	<b>Physics , mathematics</b>
Faculty:	<b>Faculty of Physics and High Technology Engineering</b>
Department:	<b>Department of Physical Methods in Applied Researches</b>
Course (year):	<b>1</b>

Direction (specialty) **31.05.01 general medicine** (specialist degree)  
(specialty code (direction), full name)

Qualification (degree) **Doctor of Medicine**

Mode of study: **full-time**

(full-time, part-time, part-time (indicate only those that are implemented))

Date of introduction to the educational process of UISU: **«1» September 2019 year**

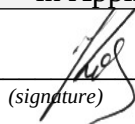
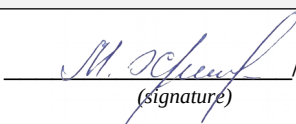
The program is updated at the meeting of the department: protocol № \_\_\_\_\_ от \_\_\_\_\_ 20\_\_ г.

The program is updated at the meeting of the department: protocol № \_\_\_\_\_ от \_\_\_\_\_ 20\_\_ г.

The program is updated at the meeting of the department: protocol № \_\_\_\_\_ от \_\_\_\_\_ 20\_\_ г.

Developer Information:

Full name	Department:	Position, academic degree
<b>Eliseeva S.V.</b>	<b>Department of Physical Methods in Applied Researches</b>	<b>Ph.D., Associate Professor</b>

AGREED BY	AGREED BY
Head of the Department of Physical Methods in Applied Research	Head of the graduating department
 (signature) /B.M. Kostishko/ (Full name)	 (signature) /M.A. Vise-Khripunova/ (Full name)
« <u>29</u> » of <u>May</u> 20 <u>19</u> year	« <u>29</u> » of <u>May</u> 20 <u>19</u> year

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**The purpose of mastering the discipline:**

formation of medical students systematic knowledge of the physical laws and processes in biological objects, understanding of the device and the operation of medical equipment, qualified use of mathematical methods to solve educational, scientific, diagnostic and medical tasks, necessary, both for training in other academic disciplines, and for the direct formation of a specialist in the field of General Medicine.

**The main objectives of the discipline are:**

- the study of basic physical concepts and laws to explain the processes taking place in biological systems;
- study the features of manifestations of the laws of physics in the body;
- obtaining ideas about the possibilities of using technical devices in medicine, their types and principles of work;
- the formation of representations on the application of physical laws to justify the use of medical equipment;
- students mastering mathematical methods and forming practical skills of statistical processing of experimental material;
- safety training for students working with medical equipment.

**2. PLACE OF DISCIPLINE IN THE STRUCTURE OF THE BASIC PROFESSIONAL EDUCATIONAL PROGRAMS**


Discipline is mandatory and applies to the base of Block B1 «Disciplines (modules)» of the basic professional educational programs (BPEP), established by the university.

Discipline is read in the first 1 st semester of the course full-time students and is based on knowledge in the subjects of physics and mathematics in the volume of the school program. In particular, in physics, one needs to know the basic laws of mechanics, electrodynamics, optics, the basic principles of molecular kinetic theory, have ideas about mechanical and electromagnetic vibrations and waves, and about the structure of an atom and atomic nucleus. Finally, students should be familiar with the currently accepted SI system of units.

In mathematics, you need: knowledge - rules of action with fractions, degrees, logarithms; trigonometric functions; concepts of derivative and primitive, indefinite and definite integral, rules of differentiation and integration, tabular derivatives and primitives; ability to build graphics; Skills in calculating the simplest derivatives and integrals.

The results of mastering the discipline will be necessary for the further learning process as part of the phased formation of competencies in the study of the following special disciplines:

- «Anatomy»
- «Latin language»
- «Philosophy»
- «Biology»
- «Chemistry»
- «Biochemistry»
- «Topographic anatomy and operative surgery»
- «Radiation diagnostics»
- «Neuroanatomy»
- «Informatics (medical)»
- «Modern medical information systems»
- «Modern biomedical technologies»

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- «Nanotechnology in medicine»
- «Microbiology, Virology»
- «Propaedeutics of internal diseases»
- «Hygiene»
- «Startup Management in Social Entrepreneurship»
- «Preparation for passing and state exam»

### 3. LIST OF PLANNED RESULTS OF TRAINING IN THE DISCIPLINE (MODULE) RELATED TO THE PLANNED RESULTS OF THE DEVELOPMENT OF THE BPEP

The process of studying the discipline is aimed at the formation of the following competencies:

Code and name of competency	List of planned learning outcomes by discipline (module), correlated with indicators of achievement of competencies
<b>General competence-1-</b> ability to abstract thinking, analysis, synthesis.	<p><b>To know:</b> mathematical methods for solving intellectual problems and their application in medicine;</p> <p><b>To be able to:</b> carry out statistical processing of experimental data, analyze and summarize the results obtained in the process of professional activity;</p> <p><b>To own:</b> skills of modeling physical processes in biological systems.</p>
<b>General professional competence-1-</b> willingness to solve the standard tasks of professional activity using information, bibliographic resources, biomedical terminology, information and communication technologies and taking into account the basic requirements of information security.	<p><b>To know:</b> basic concepts and definitions of physical quantities, the laws of physics, physical phenomena and patterns that underlie the processes taking place in the human body.</p> <p><b>To be able to:</b> use information resources to find the necessary information when solving standard problems in the field of medicine.</p> <p><b>To own:</b> biomedical terminology, basic concepts and skills of using IT technologies for creating a database, storing and transmitting information, taking into account security requirements.</p>
<b>General professional competence-7</b> ready to use basic physical and chemical, mathematical and other natural science concepts and methods in solving	<p><b>To know:</b> the theoretical foundations of modern research methods, the principles of operation of physical devices used in medicine; biophysical mechanisms of action of physical factors on a living organism.</p> <p><b>To be able to:</b> make a plan and determine the objectives of the study; apply basic methods and techniques for measuring physical parameters, assessing the physical properties of biological objects; evaluate the accuracy of the selected measurement method, based on mathematical methods of processing the obtained data.</p>

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professional problems.	<b>To own:</b> skills of using the conceptual and functional apparatus in the field of natural sciences; skills of argumentation when choosing a method or equipment for solving professional problems.
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#### 4. TOTAL DIFFICULTY OF DISCIPLINE

##### 4.1. The volume of discipline in credit units (total) 3 CU.

##### 4.2. The volume of discipline by type of educational work (in hours)

Type of study	Number of hours (full-time course)			
	Total according to plan	Including by semester		
		1	2	3
1	2	3	4	5
Contact the work of students with the teacher in accordance with the curriculum	72	-	72	-
Auditory lessons:	54		54	-
lectures	18		18	-
seminars and practices	-	-	-	-
laboratory works, practices	54		54	-
Students' Individual Work	36		36	-
The form of current control of knowledge and control independent work: testing, control, colloquium, abstract, etc. (at least 2 types)		-	Testing, oral questioning on control questions of laboratory work, a written report on laboratory work	-
Course work	-	-	-	-
Types of intermediate certification (exam, test)			test	
<b>Total hours for discipline</b>	<b>108</b>		<b>108</b>	-

##### 4.3. The content of the discipline (module). Clock distribution on topics and types of educational work:

###### 1. Full-time form of education

Title of sections and topics	Total	Types of Training		
		Auditory lessons	including interactive classes	Students' Individual Work

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		lectures	seminars and practices	laboratory works		
1	2	3	4	5	6	7
<b>Section 1. (Mechanics)</b>						
1. The basic laws of mechanics.	6	1	-	4	-	1
2. Mechanical vibrations and waves. Acoustics.	6	1	-	3	-	1
<b>Section 2. (Elements of fluid mechanics)</b>						
3. Properties of liquids.	5	1	-	2	-	2
4. The movement of bodies in liquids and gases	5	1	-	2	-	2
<b>Section 3. (Molecular Physics. Thermodynamics)</b>						
5. The basics of molecular physics.	6	1	-	3	-	2
6. The laws of thermodynamics.	7	1	-	3	-	2
<b>Section 4. (Transfer processes in biological systems)</b>						
7. Passive and active transport of matter.	6	1	-	3		2
8. Biopotentials.	7	1	-	3	-	2
<b>Section 5. (Electromagnetic Oscillations and waves)</b>						
9. Alternating current.	5	1	-	2	-	2
10. Electromagnetic waves.	6	1	-	3	-	2
<b>Section 6. (Wave and geometric optics)</b>						
11. Interference and diffraction of light waves.	6	1	-	3	-	2
12. The laws of geometric optics.	8	1	-	4	-	2
<b>Section 7. (Thermal radiation and absorption)</b>						
13. Thermal radiation from the body	5	1	-	2	-	2
14. The laws of absorption. Colorimetry.	6	1	-	3	-	2
<b>Section 8. (Physics of Atoms and Molecules)</b>						
15. The structure of atoms and	6	1	-	3	-	2

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molecules.						
16. Radioactivity. Dosimetry.	3	1	-	2	-	2
<b>Section 9. (Basic concepts of quantum mechanics)</b>						
17. Elements of quantum mechanics.	3	1	-	2	-	2
18. Lasers.	6	1		3		2
<b>Section 10. (Elements of higher mathematics)</b>						
19. The basic concepts of mathematical analysis.	3	-	-	2	-	1
20. Integration rules and methods for solving differential equations.	3	-	-	2	-	1
<b>Итого</b>	<b>108</b>	<b>18</b>	<b>-</b>	<b>54</b>	<b>-</b>	<b>36</b>

## 5. DISCIPLINE CONTENT (MODULE)

### Section 1. Mechanics

#### Theme 1. Basic laws of mechanics

Fundamental interactions in nature. The law of gravity. The force of gravity. Body weight. Inert and gravitational mass. Cosmic speeds. Friction. The nature of friction. Types of friction. Elastic and deformation forces. Hooke's law. Mechanical work. Kinetic and potential energy. The law of conservation and transformation of energy in mechanics. Moment of power. Moment of momentum. The law of conservation of angular momentum. The law of the dynamics of the rotational motion of a rigid body relative to a fixed axis. The moment of inertia of the body.

#### Theme 2. Mechanical vibrations and waves. Acoustics

Harmonic vibrations. Differential equations of harmonic oscillations. The energy of an oscillating body. Damped oscillations. Differential equations of damped oscillations. Forced vibrations. Resonance. Self-oscillations. Additions of harmonic oscillations. Mechanical waves. Wave equation. The flow of wave energy. Intensity, Umov vector. Sound. Physical characteristics of a sound wave, their relationship with the physiological characteristics of sound perception. Ultrasound. Sources and receivers of ultrasound. The use of ultrasound in pharmacy and medicine.


### Section 2. Elements of fluid mechanics

#### Theme 3. Properties of liquids

The movement of an ideal fluid. The equation of continuity. Bernoulli equation. Flow pressure. Viscous liquid. Body Wrap Lifting power. Viscous fluid flow. Internal friction. Reynolds number. Poiseuille formula. Forces acting on a body in a stream. Stokes formula. Methods for determining the viscosity of a liquid.

#### Theme 4. Transfer processes in biological systems

The basic equation of diffusion. Fick's equation. The diffusion equation for a membrane. The concept of electrochemical potential. Diffusion in ideal gases and solutions. Theorell equation.

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The transfer of ions through the membrane. The Nernst-Planck equation. Types of transport through the membrane. Energy conversion diffusion.

### **Section 3. Molecular Physics. Thermodynamics**

#### **Theme 5. Fundamentals of molecular physics**

The main provisions of the molecular kinetic theory. Molecular forces. Differences in the molecular structure of gases, liquids and solids. Phase transitions. Amorphous bodies, glassy state, liquid crystals, polymers. Perfect gas. The basic equations of the molecular-kinetic theory of an ideal gas. The internal energy of an ideal gas and an ideal crystal. Boltzmann distribution. Gas liquefaction.

#### **Theme 6. Laws of thermodynamics**

The first law of thermodynamics. The work done by an ideal gas in various processes. Change in the internal energy and heat capacity of an ideal gas in various processes, Mayer's equation. The heat capacity of an ideal crystal. The second law of thermodynamics. Thermodynamic probability and entropy. Entropy and heat transfer. Heat and mass transfer. The equation of diffusion, thermal conductivity, viscosity. Application in pharmaceutical technologies.

### **Section 4. Transfer processes in biological systems**

#### **Theme 7. Passive and active transport of matter**

The basic equation of diffusion. Fick's equation. The diffusion equation for a membrane. The concept of electrochemical potential. Diffusion in ideal gases and solutions. Theorell equation. The transfer of ions through the membrane. The Nernst-Planck equation. Types of transport through the membrane. Energy conversion diffusion.

#### **Theme 8. Biopotentials**

Bioelectric potentials. Ionic streams. The potential for rest. Action potential. The electric field of the dipole. Dipole in an external electric field. Registration of biopotentials. Einthoven Lead Theory. Cardiography.

### **Section 5. Electromagnetic Oscillations and Waves**

#### **Theme 9. Alternating current**

Alternating current. Excitation of electromagnetic waves. Inductive, capacitive and impedance in the AC circuit. Ohm's law in an alternating current circuit. Resonance in the AC circuit. AC power. Electrical conductivity of biological tissues. The effect of current on body tissues. High-frequency current physiotherapy methods.

#### **Theme 10. Electromagnetic waves**

Electromagnetic field. Electromagnetic waves. Maxwell's equations. Energy characteristics of an electromagnetic wave. Scale of electromagnetic waves. Human exposure to electromagnetic radiation. The use of electromagnetic fields in medicine. Physical foundations of mass spectrometry.

### **Section 6. Wave and geometric optics**

#### **Theme 11. Interference and diffraction of light waves**

Light interference. Coherence. Jung's experience. Interference in thin films. Enlightenment of optics. Interferometers and their use in pharmacology.

Diffraction of waves. Huygens-Fresnel principle. Diffraction on a slit in parallel beams. Diffraction grating. Diffraction spectroscopy in pharmacology.

Polarization of light. Natural and polarized light. The law of Malus. Birefringence polarization of light. Rotation of the plane of polarization. Polarimetry in pharmacy.

#### **Theme 12. Laws of geometric optics**

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Basic concepts of geometric optics. Lenses. The formula of the lens. Magnifier. Optical microscopy. The device of the microscope. Formula to increase. Resolution. Refraction and reflection of light. Full internal reflection. Refractometry, its use in pharmacology. Fiber optics.

### **Section 7. Thermal radiation and absorption**

#### **Theme 13. Thermal radiation of bodies**

Characteristics of thermal radiation. Black body. Kirchhoff's Law. Planck formula. The laws of Stefan-Boltzmann, Wines. The radiation of the sun. Infrared and ultraviolet radiation and their use in medicine. Radiation of the human body. The use of thermography for diagnostic purposes.

#### **Theme 14. Laws of absorption. Colorimetry**

Absorption and scattering. The Bouguer-Lambert-Beer Act. Concentration colorimetry in pharmacy. Photoelectric colorimeters.

### **Section 8. Physics of Atoms and Molecules**

#### **Theme 15. The structure of atoms and molecules**

The structure of the electron shells of the atom. Quantum numbers. Theory of Bohr. Wave properties of particles. Emission and absorption spectra.

#### **Theme 16. Radioactivity. Dosimetry**

The structure of the nucleus of an atom. Nuclear Forces. The binding energy of the nucleus. Radioactivity. The law of radioactive decay. Labeled atoms, their use in pharmacy and medicine. Dosimetry of ionizing radiation. The effect of ionizing radiation on matter and the body. Methods for recording ionizing radiation. Dosimeters. Protection against ionizing radiation.

### **Section 9. Basic concepts of quantum mechanics**

#### **Theme 17. Elements of quantum mechanics**

Schrödinger equation. Quantum-mechanical model of the atom. Luminescence. Mechanisms and types of luminescence: photoluminescence, chemiluminescence, photobiological processes. Electron microscopy.

#### **Theme 18. Lasers**

Spontaneous and induced radiation. Creation of the inverse population. The principle of operation of an optical quantum generator. The property of laser radiation. The use of lasers in pharmacy.

### **Section 10. Mathematics**

#### **Theme 19. Elements of higher mathematics**

Basic concepts of mathematical analysis. Derivatives and differentials.

#### **Theme 20. Integration rules**

Calculations of indefinite and definite integrals. Methods for solving first-order differential equations with separating variables.

## **6. TOPICS OF PRACTICAL AND SEMINAR LESSONS**

This type of work is not provided by training program.


## **7. LABORATORY WORKS, PRACTICES**

### **Section 1. Mechanics**

#### **Theme 1. Accurate weighing**

Methods of accurate weighing, determination of body weight on technical and analytical scales.



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Calculation of errors of direct measurements.

### **Theme 2. Mathematical and physical pendulums**

The study of the work of the revolving pendulum and the determination of the acceleration of gravity. Assimilation of the concepts of weightlessness, overloads. The mechanics of the musculoskeletal system of a person (the basic equation of the dynamics of rotational motion).

### **Theme 3. Determination of the ear hearing by the threshold method**

Learning the basics of acoustics. Familiarization with the work of the speech and hearing apparatus of a person. Mastering the diagnostic method of the hearing aid. Determining the boundaries of the range of frequencies perceived by the ear; determination of the threshold of sound perception for different frequencies; Audiogram construction - dependence of threshold volume levels in dB on frequency.

## **Section 2. Elements of fluid mechanics**

### **Theme 4. Determination of the viscosity of liquids**

Studying the properties of liquids. Determination of the viscosity of liquids with an Ostwald viscometer and the Stokes method.

### **Theme 5. Measurement of blood pressure by Korotkov's method**

Study of the human circulatory system model. The study of the tonometer (mechanical and electronic). Mastering the method for determining the pressure of the circulatory system in humans. Bernoulli equation.

## **Section 3. Molecular Physics. Thermodynamics**

### **Theme 6. Determination of the ratio $C_p/C_v$ and sound velocity in air by acoustic resonance**

Studying the laws of an ideal gas, familiarization with the resonant method for determining the speed of sound in air using the standing wave method.

### **Theme 7. Determination of specific heat and specific heat of water vaporization, checking the heat balance equation**

The study of the method for determining the specific heat of water and the specific heat of vaporization; experimental verification of the heat balance equation.

## **Section 4. Transfer processes in biological systems**

### **Theme 8. The study of the properties of biological membranes**

The Fick equation, Nernst-Planck equation. Study of transfer processes on a membrane model with a methylene blue solution. The study of passive transport.

### **Theme 9. Research of biopotentials of the heart using an electrocardiograph**

The study of biopotentials and the foundations of the Einthoven theory. Mastering the skills of taking an electrocardiogram using a portable electrocardiograph.

## **Section 5. Electromagnetic Oscillations and Waves**

### **Theme 10. The study of the thermal effect of RF therapy**

Studying the process of interaction of HF radiation with biological objects. The study of methods of HF therapy: darsonvalization, diathermy, inductothermy, UHF therapy. Measurement of the spatial distribution of the HF field.

## **Section 6. Wave and geometric optics**

### **Theme 11. The study of the microscope and its application for the study of biological objects**

The study of the optical scheme of the microscope. The course of the rays in a thin lens. The study of the optical system of the human eye. The concept of aperture, linear and angular magnification, aberration.

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### **Theme 12. Determination of the refractive index of liquids using a refractometer**

The study of the laws of geometric optics. The phenomena of total internal reflection. Mastering the method for determining the concentration of solutions using a refractometer.

### **Section 7. Thermal radiation and absorption**

#### **Theme 13. Photoelectric method for determining the concentration of solutions**

The theory of scattering and absorption of light. The study of the law of absorption of light. Mastering the method for determining the concentration of solutions using a photocolormeter.

### **Section 8. Physics of Atoms and Molecules**

#### **Theme 14. Measurement of resistivity of a thin wire**

The study of the mechanism of conductivity of metals, solutions, gases. Determination of the active resistance of a metal conductor from the measured values of current and voltage; measurement of the geometric dimensions of the conductor; resistivity calculation.

#### **Theme 15. Determination of sugar concentration using a saccharimeter**

Optical activity of molecules. Mastering the method for determining the concentration of sugars in solutions. Optical design of a saccharimeter. Birefringence, polarization, rotation of the plane of polarization by optically active media. Specific rotation.

### **Раздел 9. Основные представления о квантовой механике**

#### **Theme 16. The study of the properties of laser radiation and light diffraction**

Studying the principle of the helium-neon laser. OKG device. The concept of inverse population. The study of the law of Malus, the phenomenon of diffraction.

### **Section 10. Mathematics**

#### **Theme 19. Elements of higher mathematics**

Homogeneous linear differential equations of the first order. Basic concepts of mathematical analysis. Derivatives and differentials.

#### **Theme 20. Integration rules**


The main properties of the indefinite integral. Table of integrals. Replacing a variable in an indefinite integral. Integration by parts in an indefinite integral. Defined integral, its geometric and mechanical meaning.

## **8. SUBJECT OF COURSE, CONTROL WORKS, ABSTRACTS**

This type of work is not provided by training program.

## **9. LIST OF QUESTIONS FOR THE EXAM (CREDIT)**

1. Periodic processes. Basic concepts of periodic processes. Free oscillations. Equation of oscillations of a spring pendulum.
2. Damped oscillations. Equation of oscillations of a spring pendulum. Forced vibrations. Resonance.
3. The energy of undamped harmonic oscillations. Self-oscillations. Fluctuations in the human body. Vibrations.
4. Basic concepts of a mechanical wave. Longitudinal and transverse waves. Wave front. Speed and wavelength. The equation of a plane wave. Energy flow. Umova vector.
5. Varieties of waves: surface waves, excitation waves in active media, shock waves. Standing wave. The equation of a standing wave.

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6. Doppler effect and its use in medicine.
7. Acoustics. Sound, types of sound. Physical characteristics of sound. Characteristics of auditory sensation. Sound measurements.
8. Physics of hearing. Sound-conducting and sound-receiving parts of the hearing aid. Determination of localization of a sound source in horizontal and vertical planes.
9. Physical characteristics of sound. Characteristics of auditory sensation. Weber-Fechner Law. Audiometry Sound research methods in medicine.
10. Ultrasound. Sources and receivers of ultrasound. Features of the propagation of ultrasonic waves. The use of ultrasound in the diagnosis. The effect of ultrasound on the substance, cells and tissues of the body.
11. Infrasound, features of its distribution. Biophysical basis of the action of infrasound. Vibrations.
12. Properties of liquids. Internal friction (viscosity) of a fluid. Newton's equation. Blood as a non-Newtonian fluid.
13. The condition of continuity of the jet. Laminar turbulent flow. Reynolds number.
14. Bernoulli equation.
15. Viscous fluid flow in cylindrical tubes. Poiseuille formula. Pressure distribution during the flow of real fluid through pipes of constant, variable cross-sections.
16. Mechanical properties of biological tissues: bones and blood vessels, muscle tissue.
17. Blood circulation model. Shock volume of blood. Dependence of the propagation velocity and pressure on the parameters of the vessel in the circulatory system. Korotkov method.
18. Characteristics of the heart. Work and power of the heart.
19. Diffusion in gases and liquids. Fick's diffusion equation.
20. The diffusion equation for a membrane. Determination of electrochemical potential.
21. Diffusion in electrolytes. Transport equation for electrochemical potential (Theorell equation).
22. The transfer of ions in an electrolyte in the presence of an electric field. The Nernst-Planck equation.
23. Modes of transport: passive and active. Energy conversion diffusion.
24. Basic concepts of thermodynamics. The first law of thermodynamics. The heat capacity of the substance.
25. Application of the first law of thermodynamics to isoprocesses and biological systems.
26. The Entropy. The second law of thermodynamics. The third law of thermodynamics.
27. Heat exchange. Types of heat transfer: equations of heat conduction, convection, radiation. The energy balance of the body. Heat treatment. Methods of obtaining low temperatures.
28. Bioelectric potentials. Ionic streams. The potential for rest. Goldman-Hodgkin-Katz equation. Action potential.
29. Electric dipole. The electric field of the dipole. Dipole in an external electric field (in homogeneous and inhomogeneous).
30. Electrocardiography. Einthoven Theory.
31. Electrical conductivity of biological tissues and liquids for direct current. Measurement methods. Primary processes in tissues during galvanization and therapeutic electrophoresis.
32. The magnetic properties of the substance. Classification of magnets: para-, di-, ferromagnets. The concept of magnetobiology and biomagnetism. Magnetic field therapy.

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33. Alternating current. Excitation of electromagnetic waves. Capacitive, inductive and impedance in an alternating current circuit. Phase relations of current and voltage.
34. Ohm's law for an alternating current circuit. Resonance in the AC circuit. Electric pulse and pulse current. Pulse electrotherapy.
35. Electromagnetic wave. Maxwell's equations, their solution.
36. Energy characteristics of an electromagnetic wave. Scale of electromagnetic waves. Classification of frequency intervals, adopted in medicine. Human exposure to electromagnetic radiation.
37. The nature of light. Basic concepts of light waves. Huygens-Fresnel principle.
38. Wave interference. The condition for the appearance of maxima and minima in the interference pattern. Methods of observing the phenomenon of interference (Jung's experiment).
39. Light interference. Enlightenment of optics. Interferometers and their use in medicine.
40. Diffraction of light on a slit in parallel rays. Diffraction grating. Diffraction spectrum.
41. Diffraction of electromagnetic waves in spatial structures. Wulf-Bragg Formula Fundamentals of X-ray diffraction analysis.
42. The light is natural and polarized. The degree to which light passes through the polarizer. The law of Malus.
43. Methods of obtaining polarized light. Prism Nicolas.
44. Rotation of the plane of polarization. Polarimetry. The study of biological tissues in polarized light.
45. The concept of the beam. Laws of reflection and refraction. Refractometry
46. The phenomenon of total internal reflection. Fiber optics, its use in medical devices. Endoscope.
47. Lenses. Beam path in collecting and scattering lenses. Lens Formulas The optical power of the lens.
48. The structure of the eye. The optical system of the eye. Accommodation. Binocular vision. Myopia and farsightedness.
49. Microscopy. The optical system of the microscope. Magnification, resolution, microscope.
50. Thermal radiation. Black body. Kirchhoff's Law. The Law of Wine. Stefan-Boltzmann Law. The radiation of the sun. The basics of thermography.
51. Light absorption. Booger's Law. Concentration colorimetry. Phototherapy.
52. Wave properties of particles. Wave de Broglie. Electron diffraction. Uncertainty relation. Discreteness of energy states.
53. Luminescence. Mechanisms and types of luminescence. Stokes rule. The use of luminescence in biology and medicine.
54. Lasers Creation of the inverse population. The principle of the laser. Properties of laser radiation. The use of lasers in biological research and in medicine.
55. The structure of the nucleus of an atom. Nuclear Forces. The binding energy of the nucleus.
56. Radioactivity. The law of radioactive decay. The main types of radioactive decay.
57. Biophysical basis of the action of ionizing radiation on the body. Dosimetry.
58. X-ray radiation. Sources of radiation. Braking and characteristic radiation. The use of x-rays in medicine.
59. The main properties of the indefinite integral. Table of integrals.
60. Replacing a variable in an indefinite integral.
61. Integration by parts in an indefinite integral.
62. A definite integral, its geometric and mechanical meaning.

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63. Homogeneous linear differential equations of the first order.

### 10. Students' Individual Work


The content, requirements, conditions and procedure for organizing students' individual work, taking into account the form of training, are determined in accordance with the "Regulation on the organization of students' independent work", approved by the Academic Council of UISU (protocol №8/268 from 26.03.2019 year.).

Mode of study: **full-time**

<b>Title of sections and themes</b>	<b>Type of individual work</b> ( <i>study of educational material, problem solving, abstract, report, test, preparation for passing the test, exam, etc.</i> )	<b>Volume in hours</b>	<b>Form of control</b> ( <i>verification of problem solving, abstract, etc.</i> )
1. The basic laws of mechanics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	1	testing, oral survey credit
2. Mechanical oscillations and waves. Acoustics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	1	testing, oral survey credit
3. Properties of liquids.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
4. The movement of bodies in liquids and gases	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical</li> </ul>	2	testing, oral survey credit

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	<p>classes;</p> <ul style="list-style-type: none"> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>		
5. The basics of molecular physics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
6. The laws of thermodynamics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
7. Passive and active transport of matter.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
8. Biopotentials.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
9. Alternating current.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
10. Electromagnetic	<ul style="list-style-type: none"> <li>• Development of educational material</li> </ul>	2	testing,


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waves.	using the resources of educational and methodological and information support of the discipline; <ul style="list-style-type: none"> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>		oral survey credit
11. Interference and diffraction of light waves.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
12. The laws of geometric optics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
13. Thermal radiation from the body	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
14. The laws of absorption. Colorimetry.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
15. The structure of atoms and molecules.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the</li> </ul>	2	testing, oral survey credit

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	<p>results of laboratory and practical classes;</p> <ul style="list-style-type: none"> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>		
16. Radioactivity. Dosimetry	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
17. Elements of quantum mechanics.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
18. Lasers.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	2	testing, oral survey credit
19. The basic concepts of mathematical analysis.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	1	testing, oral survey credit
20. Integration rules and methods for solving differential equations.	<ul style="list-style-type: none"> <li>• Development of educational material using the resources of educational and methodological and information support of the discipline;</li> <li>• Preparation of materials based on the results of laboratory and practical classes;</li> <li>• Preparation for testing;</li> <li>• Preparing for credit</li> </ul>	1	testing, oral survey credit



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## 11. EDUCATIONAL AND METHODOLOGICAL AND INFORMATION SUPPORT OF DISCIPLINE

### a) References

#### main:

1. Ремизов А.Н., Медицинская и биологическая физика: учебник / А.Н. Ремизов. - 4-е изд., испр. и перераб. - М. : ГЭОТАР-Медиа, 2016. - 656 с. - ISBN 978-5-9704-3577-9 - Текст: электронный // ЭБС "Консультант студента": [сайт]. - URL : <http://www.studentlibrary.ru/book/ISBN9785970435779.html>
2. Подколзина, В. А. Медицинская физика : учебное пособие / В. А. Подколзина. — 2-е изд. — Саратов : Научная книга, 2017. — 159 с. — ISBN 978-5-9758-1803-4. — Текст: электронный // Электронно-библиотечная система IPR BOOKS : [сайт]. — URL: <http://www.iprbookshop.ru/81025.html>
3. Антонов В.Ф., Физика и биофизика. Практикум: учебное пособие / Антонов В.Ф., Черныш А.М., Козлова Е.К., Коржуев А.В. - М. : ГЭОТАР-Медиа, 2012. - 336 с. - ISBN 978-5-9704-2146-8 - Текст : электронный // ЭБС "Консультант студента" : [сайт]. - URL : <http://www.studentlibrary.ru/book/ISBN9785970421468.html>

#### additional literature:

1. Антонов В.Ф., Физика и биофизика. Руководство к практическим занятиям : учебное пособие / Антонов В.Ф., Черныш А.М., Козлова Е.К., Коржуев А.В. - М. : ГЭОТАР-Медиа, 2013. - 336 с. - ISBN 978-5-9704-2677-7 - Текст : электронный // ЭБС "Консультант студента" : [сайт]. - URL : <http://www.studentlibrary.ru/book/ISBN9785970426777.html>
2. Ремизов А.Н., Медицинская и биологическая физика. Сборник задач / А. Н. Ремизов, А. Г. Максина - М. : ГЭОТАР-Медиа, 2014. - 188 с. - Текст : электронный // ЭБС "Консультант студента" : [сайт]. - URL : <http://www.studentlibrary.ru/book/ISBN97859704295561.html>
3. Васильев, А. А. Медицинская и биологическая физика. Лабораторный практикум : учебное пособие для вузов / А. А. Васильев. — 2-е изд., испр. и доп. — Москва : Издательство Юрайт, 2019. — 313 с. — (Специалист). — ISBN 978-5-534-05174-2. — Текст: электронный // ЭБС Юрайт [сайт]. — URL: <https://www.biblio-online.ru/bcode/438065>
4. Васильев, А. А. Медицинская и биологическая физика. Тестовые задания : учебное пособие для вузов / А. А. Васильев. — 2-е изд., испр. и доп. — Москва : Издательство Юрайт, 2019. — 189 с. — (Университеты России). — ISBN 978-5-534-05703-4. — Текст : электронный // ЭБС Юрайт [сайт]. — URL: <https://www.biblio-online.ru/bcode/438067>
5. Лекции по медицинской физике: учебное пособие для вузов / Ю. Н. Зубков. Ульяновск: УлГУ, 2011. – 285 с. Медицинская физика. Лабораторный практикум [Электронный ресурс] : учебное пособие / Зубков Юрий Николаевич, Т. М. Семенцова; УлГУ, ИФФВТ, Каф. физ. методов в прикл. исслед. - Электрон. текстовые дан. (1 файл :

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4,71 МБ). - Ульяновск : УлГУ, 2017. – Режим доступа:

<http://lib.ulsu.ru/MegaPro/Download/MObject/1459/Zubkov2018.pdf>

### educational-methodical:

1. Eliseeva S. V.  
Guidelines for independent work on discipline «Physics, mathematics» for students in the direction 31.05.01 «General medicine» mode of study: full-time / S. V. Eliseeva; Ulyanovsk state university. - Ulyanovsk : UISU, 2019. - Загл. с экрана; Неопубликованный ресурс; На англ. яз. - Электрон. текстовые дан. (1 файл : 627 КБ). - Текст : электронный.  
<http://lib.ulsu.ru/MegaPro/Download/MObject/6077>

Согласовано:

 /  /   
Должность сотрудника научной библиотеки      ФИО      подпись      дата

### b) Software:

- Windows operating system;
- Office software suite Microsoft Office.

### c) Databases, reference and search engines:

1. Electronic catalog of UISU library.
2. GARANT system: electronic periodical reference [Electronic resource]. - Electr. Dan. (7162 Mb: 473,378 documents). - [B.I., 199 -].
3. ConsultantPlus: reference and search system [Electronic resource]. - Electr. Dan. (733,861 documents) - [B.I., 199 -].
4. [www.scopus.com](http://www.scopus.com) - multidisciplinary abstract-bibliographic database with the ability to track scientific citation of publications
5. [www.iprbookshop.ru](http://www.iprbookshop.ru) - an electronic library in all major areas of knowledge that fully complies with the requirements of the legislation of the Russian Federation in the field of education
6. <http://www.sciencemag.org/collections/subject> - a multidisciplinary journal of the natural science profile, containing scientific articles, reviews of the latest developments in the natural and applied sciences, covering and commenting on the news of the scientific world
7. <http://link.springer.com/> - An international publishing company specializing in the publication of academic journals and books in the natural sciences (theoretical science, medicine, economics, engineering, architecture, construction and transportation).
8. **Collections Clinical Collection и SMART Imagebase**

The company "IPR Media" provided UISU with access to the collections of electronic books EBSCO (literature in foreign languages):

- **Clinical Collection**
- **SMART Imagebase**

Collections hosted on the platform **EBSCOhost**.

**Clinical Collection** Designed specifically for medical universities, clinics, medical libraries. This collection contains about 4,000 professionally selected books of high professional level in medicine, nursing, health and general practical issues. The collection is constantly updated - new editions replace previously published ones.



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## OPPORTUNITIES

If necessary, students from among persons with disabilities (at the request of the student) may be offered one of the following options for perceiving information, taking into account their individual psychophysical characteristics:

- for persons with visual impairments: in print in large print; in the form of an electronic document; in the form of an audio file (translation of training materials into audio format); in printed form in Braille; individual consultations with the involvement of a tiflos sign language interpreter; individual tasks and consultations;

- for persons with hearing impairment: in print; in the form of an electronic document; video materials with subtitles; individual consultations involving an interpreter; individual tasks and consultations;

- for persons with disorders of the musculoskeletal system: in printed form; in the form of an electronic document; in the form of an audio file; individual tasks and consultations.

**Developer**

  
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(signature)

**lecturer**

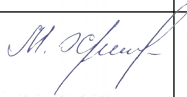
(position)

**S.V. Eliseeva**

(name)

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### CHANGE SHEET

№ п/п	Change content or link to the attached text of the change	Full name of the head of the department implementing the discipline / graduating department	Подпись	date
1.	Carry out an update of the THE WORKING PROGRAM OF DISCIPLINE with a change in clauses 4.1 and clause 13 regarding the use of partially / exclusively distance educational technologies in the educational process	M.A. Vise-Khripunova		25.06.2019