THE MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
PENZA STATE UNIVERSITY
MEDICAL INSTITUTE

«APPROVED»
Director of Medical Institute of PSU
MD Professor
_____
Mitroshin A. N.
«06» 03 2016 г.

THE WORKING PROGRAM

Of discipline C1.1.12 «Physics, mathematics»

Specialty 31.05.01 « General Medicine»

Qualification (degree) graduate – medical doctor

Full-time

Пенза, 2016

1. The objectives of learning the discipline

The purpose of mastering of the discipline is to develop in medical students the system of knowledge about physical properties of matter and physical processes in biological objects, including the human body, as well as the development of the fundamental bases of mathematics and applied mathematical apparatus needed for studying other disciplines and to acquire professional medical qualities: forming General professional competences: possession of basic knowledge of mathematical and natural Sciences to the extent necessary for use in professional activity of the basic laws of science, the developed approaches and results of the scientific analysis and modeling, theoretical and experimental studies.

The objective of this course is the study of physics and mathematics together with other disciplines of the cycle, the formation of students ' modern scientific world view, mastering modern style of physical and scientific thinking.

2. Discipline position in the structure of the basic education program of higher professional education

Discipline C1.1.12 «Physics, mathematics» refers to basic parts (C1 GEF VO). The study of discipline based on school preparation of students on disciplines of "Physics" and "Mathematics". The main of the current status of the discipline should be used when studying disciplines of a professional cycle C1, C2.

3. the competence of the learner, formed as a result of learning the discipline

C1.1.12 "Physics, mathematics". The process of the discipline is aimed at formation of elements of the following competency in accordance with GEF VO in this specialty:

Codes competency	the Name of competency	Structural elements of competency (as a result of learning the discipline taught himself should know, be able, to own)
1	2	3
OPK-7	ready to use fundamental physical, chemical, mathematical and other scientific concepts and methods in solving professional tasks	Know: the physical basis of the functioning of medical equipment, rules and safety in physical laboratory in those areas, with the devices; Mat. methods of solving intellectual problems and their application in medicine: the basic laws of mathematical statistics; the laws of the distribution of discrete random variables; methods of correlation, regression and variance analysis;
		Be able to: use computers to study physical and biological processes using models. to use educational, scientific, popular scientific literature, network Internet for professional activities;
		To possess: basic conversion technologies of information: textual, tabular editors, technique on the Internet for professional activities; the conceptual mathematical devices.

4. The structure and content of the discipline C1.1.12 «Physics, mathematics»

4.1. The structure of the discipline

The total complexity of discipline is 2 credit units, 72 hours In 1 Semester.

№ positions	The name of the sections and the discipline	Weeks of the semester	Kinds of academic work, including independent work of students and the complexity (in hours)						Forms of current control of progress by weeks		
			Classroom work			independent work					
			Total	Lecture	Practical classes	Total	Class preparation	Credit preparation	Interview	Intermediate testing	The validation control works
1	Section 1. Mathematics Theme 1.1. The use of methods probability theory in the diagnosis of diseases.	1	4	2	2	0.5	0.5		3		
2	Theme 1.2. Ways submission to the experimental data: Statistical row, variation row of the histogram	2	2		2	0.5	0.5		4		
3.	Section 2. Elements of biomechanics.	2	2		2					5	
4	Theme 2.1 Periodic mechanical processes in a Living organism	3	4	2	2	0.5	0.5			6	
5	Theme 2.2 Mechanical properties of biological tissues	4	2		2	0.5	0.5			6	
6	2.3 Physics of biomacromolecules	5	2	2		0.5	0.5			7	
7	Section 3. Fundamentals of fluid dynamics	5	2		2					7	
8	Theme 3.1 Dynamic elm-bone	6	2		2	0.5	0.5			8	
9	Theme 3.2 Surface tension	7	2	2		1	1			8	
10	3.3 Topic Model circulation	8	1		1	1	1			9	
11	Section 4. Fundamentals of thermodynamics of life	8	1		1					10	
12	Theme 4.1 Apply the first law of	9	4	2	2	1	1			11	

	thermodynamics.										
13	Theme 4.2 Heat transfer in isolated systems	10	1		1	1	1			12	
14	Section 5.The elements of electro-dynamics	10	1		1					13	
15	Topic 5.1 Bioelectric potentials	11	4	2	2	1	1			13	
16	Topic 5.2 the electrical Conductivity of biological tissues and fluids for AC and DC.	12	1		1				13		
17	Section 6.Optics, elements of quantum optics.	12	1		1	1	1		14		
18	Theme 6.1 The basics of optical methods of research	13	4	2	2	0.5	0.5			14	
19	Section 7. Basics of radiation medicine	13	2		2	0.5	0.5		15		
20	Topic 7.1 Radioactive decay.	14	2		2	1	1		16		
21	Theme 7.2. The fundamentals of radiation research methods	15	2	2		0.5	0.5		17		
22	Section 8.The physical basis of the measurement methods	16	2		2	0.5	0.5			17	
23	Theme 8.1. Modern NDT methods	17	3	1	2					17	
25	Preparation for the credit							9			
26	Total labor input in hours of per semester		51	17	34	21	12	9			

	Interim certification	
	form of certification	semester
	credit	1

4.2. Sections and their contents

Elements of Biomechanics

Periodic mechanical processes in vivo. Various kinds of oscillations: free (damped and continuous) forced and self-oscillation. The vibration equations. Wave equation. The energy flow and wave intensity. The Doppler effect and its use in biomedical research. Shock waves.

Acoustics. The physical characteristics of sound. Characteristics of auditory sensations and their relationship to the physical characteristics of sound. Sound measurement. Audiometry.

The sound level meter. Some questions of hearing. Physical basis of sound research methods in the clinic. Phonocardiography.

Ultrasound. Sources and receivers of ultrasound. Features of propagation of ultrasonic waves. Application of ultrasound diagnosis. Ultrasonic locating equipment.

The action of ultrasound for a substance into cells and tissues. The use of ultrasound for treatment, ultrasound therapy apparatus and the ultrasound surgery.

Infrasound, especially its spread. Biophysical basis of the effect of infrasound. Vibration their physical characteristics.

The internal friction (viscosity) fluid. Newton's equation. Newtonian and non-Newtonian fluids. Blood as a non-Newtonian fluid.

The influence of the physical properties of red blood cells in the blood viscosity. Laminar and turbulent flow. Reynolds number. Laminar flow of a viscous fluid in cylindrical tubes. Hydraulic resistance.

The pressure distribution in the flow of a real fluid in pipes of constant, variable cross-section and branched. Methods for determining the viscosity of liquids, determination of the viscosity of the blood. Basics viscometry. Viscometers.

Mechanical properties of biological tissues: bone and blood vessels. Biophysics of muscle contraction. Structure and rheological properties of muscles. Model moving yarns. The Hill equation, the work of a single reduction. Electromechanical coupling in the muscles.

Blood circulation model. Stroke volume of blood. Pulse wave propagation velocity its dependence on the parameters of the vessel. Physical basis of the clinical method of measuring blood pressure. Device for measuring blood pressure. The apparatus of forced circulation of blood. Work and power of the heart.

Physics of biological macromolecules. The structure and physical properties of biological membranes. Models membranes. Liposomes and their use in medicine.

Diffusion. Fick's equation. The diffusion equation for membranes. Permeability. Transfer of ions in the electrolyte in the presence of an electric field. Nernst-Planck equation and its expression of the membrane.

Variations passive transport of molecules and ions through the membrane. Active transport. Experience Using. Ion pumps and their types. Paired processes in ion pumps.

Basics of Thermodynamics life

The basic equation of the molecular-kinetic theory of gases. Root mean square velocity of the gas molecules. The average kinetic energy of motion of the gas molecules. Degrees of freedom. The energy distribution over degrees of freedom.

The internal energy of an ideal gas. Maxwell distribution. Barometric formula. The Boltzmann distribution. The mean free path of the gas molecules.

Application of the first law of thermodynamics to processes in an ideal gas. The amount of heat, work, and the change in internal energy. The heat capacity. Mayer equation.

Transport phenomena. A general view of the transport equations. The diffusion equations, viscosity and thermal conductivity. Transfer coefficients and their relation to the quantities characterizing the molecular structure of the substance.

Real gases. The interaction between the gas molecules. The internal energy of a real gas. The critical state of matter. The liquefaction of gases. The use of low temperatures in pharmacy and medicine.

Elements of electrodynamics

Variable electric current. Resonance in the AC circuit. Nature capacitive properties of tissues. Impedance tissues. Equivalent electrical circuit tissues.

Bioelectric potentials. The membrane potentials and ionic nature of their origin. The resting potential. The mechanism of action potential generation. Ionic currents during excitation

of the membrane. The spread of the action potential along the nerve fiber. Research objectives of the electric fields in the body.

Active-excitable media (AEM) and their properties. Features of propagation of excitation in the AEM.

Electro conductivity biological tissues and fluids for DC. Primary processes in the tissues in galvanizing and medical electrophoresis. Apparatus therapy DC.

Optical elements of quantum optics.

The polarization of the light. Natural light and polarized. The polarization of light by double refraction. The rotation of the polarization plane of the optically active media. Polarimetry. Investigation of the biological tissue in polarized light.

The optical system of the eye. Accommodation. The angle of view. Resolution. Disadvantages of the optical system of the eye and methods for their compensation with lenses.

Thermal radiation body. Thermal radiation characteristics. Black body. Gray bodies. Kirchhoff's law. Planck's formula. The Stefan-Boltzmann law. Wien's law. Radiation from the sun: the spectrum, the solar constant. Infrared and ultraviolet radiation and their application in medicine. The devices phototherapy (ultraviolet and infrared radiation). The radiation of the human body. Physical principles of thermography. Thermography, thermal imager.

Photo-biological processes, their primary stage and the action spectrum. Biophysics of visual reception. Fundamentals of photo medicine.

Radioactive decay

Types of ionizing radiation. X-ray: the characteristic and braking. Bremsstrahlung spectrum and its boundary. The main properties and characteristics of X-ray radiation. Radioactive decay as a source of corpuscular and photon-ionizing radiation.

The interaction of ionizing radiation with matter: the interaction of the photon radiation, a stream of charged particles and neutron flux (the main phenomena, their characteristics, the law easing the flow of ionizing radiation).

Biophysical basis of the effect of ionizing radiation on the body. The primary products of the radiolysis of water and their interaction with molecules, the mechanism of formation and the nature of free radicals.

The physical basis for the use of ionizing radiation in medicine. Diagnostic Applications: X-ray, X-ray (CT), X-ray tomography, tracer method, autoradiography, ionic medical radiography. Therapeutic applications: radiation therapy, radon therapy.

Dosimetry of ionizing radiation. The absorbed dose and exposure, their units. The dose rate. Contact the exposure dose and activity. Quantitative evaluation of the biological effects of ionizing radiation.

The equivalent dose. Dosimeters. Protection against Ionizing Radiation. Safety rules during work with sources of ionizing radiation.

Physical principles of measuring methods.

The electromagnetic wave. Equations of electromagnetic wave. The bulk density of the electromagnetic field. Scale of electromagnetic waves. Classification of frequency intervals, adopted in medicine.

Physical processes occurring in the body tissues under the influence of high-frequency current (darsonvalization and electrosurgery), the alternating magnetic field of high and ultra-high frequency (inductothermy), the electric field of ultrahigh frequency (UHF-therapy), ultrahigh-frequency electromagnetic waves (UHF and microwave therapy-therapy) and of extremely bands (EHF-therapy).

Air Ions, their classification and therapeutic and preventive value. Sources of air ions: balloelektrics effect and electrical discharge. Ionizers/

Basic concepts of probability theory.

The random variables types of events. The probability of events. The basic theorems of probability theory. Generation probability of dependent events. Application of the theory of probability in diagnosing diseases. Types of random variables. Numerical characteristics of discrete random variables. The laws of distribution of discrete random variables. The binomial distribution. Gauss-Laplace distribution. Continuous random variables.

Elements of mathematical statistics, correlations

The population and the sample. Ways to present experimental data: the statistical series, ordered series, histograms. Numerical characteristics of the measurement results. The confidence level and confidence interval. Statistical tests of significance. Evaluation of random measurement errors. Elements of the theory of errors. Types of correlation, the correlation field. Parametric correlation indices. Calculation of the correlation coefficients. Evaluation of reliability. Determine the minimum sample size. The correlation between quality characteristics. The calculation of the correlation strength relationship. A generalized scheme of the correlation analysis

Regression analysis of experimental data. Variance analysis

Concept and types of regression. Finding the equation of the regression line. Evaluation of the reliability of the regression coefficients and finding the confidence area of the regression line. The general sequence of regression analysis. Evaluation of representativeness of the linear regression. The curvilinear relationship.

Single-factor analysis of variance systems for small and large groups. The dispersion analysis of non-orthogonal two-factor complexes. Analysis of variance in qualitative traits.

Conclusion

The possible use of the latest achievements in physics, biophysics and electronics solutions for medical applications. Possible applications of the methods developed in the field of biometrics and computer science to solve medical problems. Prospects for use of the acquired knowledge for the study of theoretical and medical disciplines

4.3. Practical exercises

1. Study of properties of the fluid, surface tension, viscosity, capillary phenomena. Transport phenomena: Fick's law, Fourier's law, the law of Van't Hoff. Fundamentals of hydrodynamics. Bernoulli's law. Stokes' law.
2. Study particle transport in biological systems. Determination of the coefficient is the transfer
3. Laws DC. Alternating electric current.
4. Dielectrics. The polarization of the different types of insulators. The measurement of the dielectric constant materials.
5. Fundamentals of acoustics. The law of Weber-Fechner law. Methods of acoustic diagnostics.
6. Elements of biomechanics. Centrifugation. The elastic properties of biological tissues.
7. Fundamentals of Thermodynamics. Heat transfer. The first and second laws of thermodynamics.
8. The study of the law of radioactive decay. Basics of Radiation Medicine
9. Types of events. The probability of events. The basic theorems of probability theory. The total probability of dependent events. Application of the theory of probability in the diagnosis of diseases.
10. Types of random variables. Numerical characteristics of discrete random variables. The laws of distribution of discrete random variables. The binomial distribution. Gauss-Laplace distribution
11. The population and the sample. Ways to present experimental data: statistical series, ordered series, histograms. Numerical characteristics of the measurement results. The confidence level

and confidence interval. Criteria for statistical significance. Evaluation of random measurement errors. Elements of the theory of errors.
12. Types of correlation, the correlation field. Parametric correlation indices. The computation of the correlation coefficients. Evaluation of reliability. Determination of the minimum strength of the sample. The correlation between quality characteristics. The calculation of the correlation relationship. A generalized scheme of the correlation analysis.
13. Concept and types of regression. Finding the equation of the regression line. Evaluation of the reliability of the regression coefficients and finding the confidence area of the regression line. The general sequence of regression analysis. Evaluation of representativeness of the linear regression.
14. Single-factor analysis of variance and non-orthogonal two-factor complexes of small and large groups. Dispersion analysis of qualitative features.
Form of the lessons - problem solving, traditional workshops, seminars - conferences, seminars - discussion and self-control works. The material - technical support - not required.

5. Educational technology

5.1. Lectures on discipline are carried out in traditional form and with using of multimedia computer projector with the distribution of the demonstrated slides and comments.
5.2. Form of practical training:
5.2.1. Theoretical seminar with the solution of tasks on sections of the course.
5.2.2. Practical work in experimental facilities.
5.2.3. Seminars with case studies reflecting some aspects of biomedical practices.
5.3. In the study of materials used online resource from the website of the Department of "Physics" PSU (physics.pnzgu.ru)
5.4. The educational process for people with disabilities: the choice of places for passage of practices takes into account the state of health and accessibility requirements.

6. Training and methodological support independent work of students.

Current control is performed upon delivery of homework; individual observed students; the writing test; the control works. Interim certification of the results of discipline development takes the form of over-the couple in the 1st semester

6.1. Plan of independent work of students

No. weeks.	Theme	Type of independent work	Assigned task	Recommended reading	The number of hours
1	Theme 1.1. The application of methods of probability theory in the diagnosis of diseases	Preparation for classroom work	Solving problems on the topic	1,2,3,4	0.5
2	Theme 1.2. Ways of representation of experimental data: statistical series, statistics, histogram	Preparation for classroom work	Solving problems on the topic	1,2,3,4	0.5
3	Topic 2.1 Periodic mechanical processes in a living organism	Preparation for classroom	Solving problems on the topic	1, 2, 3, 4	0.5

		work			
4	Topic 2.2 Mechanical properties of biological tissues	Preparation for classroom work	The abstract to the practical work "Experimental determination of osmotic pressure"	1, 2, 3, 4	0.5
5	Topic 2.3 Physics of biomacromolecules.	Preparation for classroom work	Solving problems on the topic	1, 2, 3, 4	0.5
6	Theme 3.1 Dynamic viscosity	Preparation for classroom work	The abstract to the practical work "Experimental determination of surface tension".	1, 2, 3, 4	0.5
7	Theme 3.2 Surface tension	Preparation for classroom work	The abstract to the practical work "Experimental determination of liquid viscosity"	1, 2, 3,4	1
8	Topic 3.3 the Model of blood circulation	Preparation for classroom work	Solving problems on the topic	1, 2, 3,4	1
9	Topic 4.1 the first law of thermodynamics	Preparation for classroom work	Solving problems on the topic	1, 2, 3,4	1
10	Theme 4.2 Heat transfer in insulated systems	Preparation for classroom work	The abstract to the practical work "Experimental determination of the thermal conductivity of the material"	1, 2, 3,4	1
11	Topic 5.1 Bioelectric potentials	Preparation for classroom work	Solving problems on the topic	1, 2, 3,4	1
12	Topic 5.2 the electrical Conductivity of biological tissues and fluids for AC and DC.	Preparation for classroom work	The abstract to the practical work "Study of the physical principles of operation of the electrocardiograph in an experimental model of the current dipole"	1, 2, 3,4	1
13	Theme 6.1 the basics of optical methods of research	Preparation for classroom	The abstract to the practical work "Experimental determination of the	1, 2, 3,4	0.5

		work	refractive index of a substance using a Refractometer"		
14	Topic 7.1 Radioactive decay.	Preparation for classroom work	The abstract to the practical work "Experimental determination of the level of background radiation in the laboratory"	1, 2, 3,4	0.5
15	Topic 7.2. Fundamentals of radiological methods of research	Preparation for classroom work	Solving problems on the topic	1, 2, 3,4	1
16	Topic 8.1. Modern NDT methods	Preparation for classroom work	The abstract to the practical work "Experimental measurement of the temperature of the heated body, using an optical pyrometer"	1, 2, 3,4	0.5
17	Topic 8.2 Lasers and MRI in medical research	Preparation for classroom work	The abstract to the practical work "Experimental determination of rotational dispersion of the sugar solution"	1,2, 3,4	0.5

6.2. Control the development of competences

№	Type of control	Controlled topics (Sections)	Competence, the components of which are controlled
1.	Intermediate testing	Sections 1,2,3,4 5,6,7,8	OPK-7
2.	The interview topics	Sections 1,2,3,4,5,6,7,8	OPK-7

6.3. Control questions for final practice.

Topic 1. Mathematics

Event. Types of events. Probability. The probability of dependent events. A theorem on addition of probabilities. The theorem of multiplication of probabilities. The Bayes 'Theorem. A modified Bayes 'formula.

Topic 2. Elements of biomechanics.

Deformation. Hooke's Law. Mechanical stress. Elongation. Co-factor Poisson. The shear modulus. Work tension-compression. Acoustic wave, its characteristics: sound intensity, sound intensity at the hearing threshold, specific acoustic impedance, acoustic pressure, sound intensity level. The Law Of Rayleigh. Law of the absorption of sound in the substance.

Simple diffusion. Passive transport in membranes. Active transport. Internal friction (viscosity) of liquid. Surface tension. The Law of Bernoulli. The Pascal's Law. The Law of Laplace. The Stokes Law. Transport phenomena: Fick's law, Fourier's law, the law of Van't-Gough.

Topic 3. Fundamentals of thermodynamics of life

Biological system as an open thermodynamic system. Work in thermodynamic process. Internal energy. Entropy. 1 and 2 laws of thermodynamics. The production of entropy. The heat production. Thermodynamic flow

Theme 4. Elements of electrodynamics

Bioelectric potentials, their formation in the body. Dielectric properties of body tissues. Capacitive properties of tissues. Resistive properties of the tissues. Ohms law for DC. The alternating current resistance(the impedance of the tissue). Ohm's law for alternating current.

Topic 5. Optics, elements of quantum optics

The interference of light. Interference in thin films. The diffraction of light. Defrag operating range. The polarization of light. Analysis Of Polarized Light. The absorption of light. The scattering of light. The Law Of Rayleigh. The laws of geometrical optics. Total internal reflection. Photoelectric effect. The Laws of Stoletov. The Einstein Equation.

Topic 6. Fundamentals of radiological methods of research.

Electromagnetic radiation. The action of electromagnetic radiation of different origin on biological objects. Radioactive decay. The rule of displacement. The law of radioactive decay. Activity. The irradiation dose. Types of radioactive radiation. The ionizing action of radiation.

Topic 7. Physical basis of measurement methods

The thermal radiation. Characteristics of thermal radiation. The Kirchhoff's Law. The Stefan-Boltzmann Law. The Law Of Wine. The radiation of the human body. Physical processes occurring in tissues under the influence of high-frequency current

6.4. Questions for the credit

1. The types of events. The probability of events. The main theorem of probability theory.
2. Total probability of dependent events. The application of methods of probability theory in the diagnosis of diseases.
3. Types of random variables. Numerical characteristics of discrete random variables. The laws of distribution of discrete random variables.
4. Binomial distribution. The Distribution Of Laplace-Gauss. In the continuous case values.
5. General population and sampling. Ways of representation of experimental data: statistical series, order statistics, and histograms.
6. Numerical characteristics of the measurement results. Trust the measuring interval.
7. Statistical tests of significance. Evaluation of random errors of measurement. Elements of the theory of errors.
8. Types of correlation field. Parametric correlations, correlation coefficients. The confidence score.
9. Concept and types of regression. Find the equation of the regression line.
10. Analysis of variance one-factor complexes small and large groups. Dispersion-session analysis, two factor non-orthogonal complexes. Analysis of variance qualitative characteristics.
11. Mechanical wave. The wave equation. Doppler effect and its application to medical and biological research.
12. The physical characteristics of sound. Sound measurements. The reflection of sound at the boundary of two media. The Law Of Weber-Fechner.
13. Ultrasound. The sources and receivers of ultrasound. Peculiarities of propagation of ultrasonic waves. The use of ultrasound in diagnosis.
14. The effect of ultrasound on the substance on the cells and tissues of the body. The use of ultrasound for treatment, ultrasound therapy and ultrasound surgery.
15. Infrasound, especially his distribution. Biophysical basis of the his action. Vibrations, their physical characteristics.
16. The state of aggregation of a substance in a living organism. Biological crystals.
17. Polymers and their mechanical properties. Hooke's Law. The change in energy when the deformation information of the sample.

18. Mechanical properties of biological tissues, models for describing viscoelastic properties of the tissues.
19. Internal friction (viscosity) of liquid. Newton's law.
20. Laminar and turbulent flow fluid characteristics.
21. Laminar flow of a viscous fluid in cylindrical tubes. The Formula Poiseuille Flow.
22. The hydraulic resistance. The pressure distribution in the flow of a real Jew-dice through pipes of constant, tapered and branched.
23. Methods for determining the viscosity of liquids determination of the viscosity of blood.
24. Mechanical properties of biological tissues: bone and blood vessels.
25. Biophysics of muscle contraction. Structure and rheological properties of the muscles.
26. The model of sliding filaments. The equation of hill, the work of a single reduction.
27. Capillary phenomena and their role in the Biophysics of a living organism.
28. Hydrophobic and hydrophilic surfaces.
29. Wetting and non-wetting fluids and their behavior in the capillaries.
30. The model circulation. Stroke volume blood.
31. Pulse wave and its dependence of the propagation velocity on the parameters of the vessel.
32. Physics of biomacromolecules: primary, secondary, tertiary shape of the protein and their special features.
33. Structure and physical properties of biological membranes.
34. The model membranes. Liposomes and their application in medicine.
35. Diffusion in the liquid. The Fick's Equation. Examples of diffusion in living organisms.
36. The diffusion equation for membranes. The coefficient of permeability.
37. The ionic transport in the electrolyte in the presence of an electric field.
38. The equation of Nernst-Planck and his expression for the membrane.
39. Varieties of passive transport of molecules and ions across membranes.
40. Active transport, its features.
41. Ion pumps and their types. Related processes in ionic pumps.
42. The phenomenon of osmosis. Law of Van't-Goff. The role of osmosis in biological systems.
43. Bioelectric potentials. Membrane potentials and their ionic nature.
44. The rest potential. The mechanism of generation of action potential.
45. The propagation of the action potential along the nerve fiber.
46. Electric dipole. Electric field of dipole
47. Dipole in an electric field. Dipole electric generator (current dipole).
48. Equivalent electric generator organs and tissues. Dipole equivalent electric generator of the heart.
49. The electrical conductivity of biological tissues and fluids for DC.
50. Primary processes in tissues during galvanization and medicinal electrophoresis.
51. Electrical (electromagnetic) oscillations. Differential equations SVO-free electrical oscillations (continues and damped).
52. AC. Resonance in an AC circuit.
53. The nature of capacitive properties of body tissues. The impedance of body tissues.
54. The equivalent electrical circuit of the tissues of the body.
55. Physical basis of rheography and its application in medicine. The rheograph.
56. Electromagnetic wave. Equations of electromagnetic waves.
57. The volumetric energy density of the electromagnetic field. The scale of electromagnetic waves.
58. Physical processes occurring in tissues under the influence of high-frequency current (darsonvalization and electrosurgery).
59. Physical processes occurring in the tissues of the body under the impact of the change of high magnetic fields and ultrahigh frequency (inductothermy).
60. Physical processes occurring in tissues under the influence of the electric field of ultrahigh frequency (UHF-therapy).

61. Physical processes occurring in tissues under the influence of electro-magnetic waves in microwave (microwave therapy and DCV therapy).
62. Physical processes occurring in tissues under the influence of extremely-high frequency bands (EHF-therapy).
63. The interference of light. Coherence.
64. Interferometers and their applications. The interference microscope.
65. Diffraction. Diffraction by a slit into parallel rays.
66. Diffraction grating. Diffraction spectrum.
67. Diffraction of electromagnetic waves on the spatial structures is the basis of x-ray diffraction analysis.
68. The polarization of light. Light natural and polarized.
69. Polarization of light double refraction. The rotation of the plane of polarization of optically active media.
70. Polarimetry. The study of biological tissues in polarized light.
71. Thermal radiation of bodies. The Characteristics of thermal radiation.
72. Black body. Grey body. The Kirchhoff's Law.
73. Planck's Formula. The Stefan-Boltzmann's Law. The Law of Wine.
74. The radiation of the human body. Physical's basis of thermography. Thermograph and camera of thermography.
75. Wave properties of particles.
76. Basic representations of quantum mechanics. The radiation and absorption of energy by atoms and molecules.
77. Stimulated emission. Optical quantum generators (lasers).
78. Basic properties of laser radiation. The use of lasers in biological the EC investigations and in medicine
79. Types of ionizing radiation. X-ray radiation.
80. The basic properties and characteristics of x-ray radiation.
81. Radioactive decay as a source of corpuscular and photon-ionizing radiation.
82. The interaction of ionizing radiation with matter on the example of photon radiation-radiation (the main phenomena, their characteristics, the law of attenuation of the flux of ionizing radiation).
83. The interaction of ionizing radiation with matter example of a flow of charged ions of particles (the main phenomena, their characteristics, the law of weakening of the flow of ionization of radiation).
84. The interaction of ionizing radiation with matter on the example of the flow of neutrons-a new (basic phenomena, their characteristics, the law of attenuation of the flux of ionizing radiation).
85. Biophysical basis of the action of ionizing radiation on the body.
86. The primary products of water radiolysis and their interaction with molecules, the mechanism of formation and the nature of free radicals.
87. The physical basis for the use of ionizing radiation in medicine.
88. Diagnostic applications: x-ray examination (fluoroscopy), x-ray tomography, the method of tagged atoms, autoradiography, ion medical radiography.
89. Medical application: radiotherapy, radon therapy.
90. Dosimetry of ionizing radiation. Absorbed and exposure dose, units of their measurement.
91. Dose rate. The relationship between the exposure dose and activity.
92. Quantitative assessment of biological effects of ionizing radiation.
93. Equivalent dose. Dosimetric devices.
94. The thermal conductivity as a phenomenon of migration. Coefficient of thermal conductivity.
95. Thermodynamic processes. Reversible and irreversible processes and their differences.
96. The internal energy of a thermodynamic system, the amount of heat and the relationship of these concepts.

97. The first law of thermodynamics and its application to the processes occurring in a biological system.
98. Entropy, the second law of thermodynamics.
99. The conversion of the energy in a living organism. Thermodynamic potentials.
100. Hess's law and its application in biology.
101. Possible thermodynamic state of biological systems, their differences.
102. Open thermodynamic systems and their properties.
103. The total change in entropy in biological systems.
104. The equation of Prigogine, its biological sense.
105. The criterion of stability in biological systems.
106. The ratio of Onsager and its application in biology.

7. Educational-methodical and information support of the discipline

Recommended reading

a). Main:

1. A course of lectures on discipline "Physics, mathematics" for students majoring in dentistry. Online resource from the website of the Department of "Physics" PSU [Electronic resource] / Rychkova M.V. Penza, 2015 (physics.pnzgu.ru)
2. Physics and Biophysics: a short course [Electronic resource] / Antonov V.F., Korguev A.V. - M. ГЭОТАР-Медиа, 2011. - http://www.studmedlib.ru/book/ISBN9785970420430.html

b). Additional

3. Workshop on physics and mathematics for students of medical faculty. Online resource from the website of the Department of "Physics" PSU [Electronic resource] / Rychkova M.V. Penza, 2015 (physics.pnzgu.ru)

c). Software and Internet resources:

4. Online library "window.edu.ru/library/resources"
5. Online library www.studmedlib.ru

8. Logistics experiments:

Classroom	Area, m^2	Major training and laboratory facility
8-501	**54**	1. Experimental setup for determining the surface tension. 2. Experimental setup for determining the viscosity of the liquid. 3. Experimental setup for determining the osmotic pressure. 4. The study of the physical basics of electrocardiography in an experimental model of a current dipole 5. Experimental setup for determining the dielectric permeability of the material. 6. Experimental setup for determining of different characteristics of the current source. 7. Experimental setup for determining the refractive index of the substance.
8-505	**54**	1. Experimental setup for determining of experimental measurement of the dimensions of small objects with diffraction of the lattice 2. Experimental setup for determining the concentration of the solution using the Refractometer 3. Experimental setup for determining the sensitivity of the photocell 4. Experimental setup for determining the radiation background level in the laboratory 5. Experimental measurement experimental setup for determining of the

		temperature of the heated body, using an optical pyrometer.

The study program for the discipline "Physics, mathematics" is drawn in accordance with the federal state educational standard of higher education and academic plan for the course 31.05.01 "General Medicine".

The program developers:

Associate professor, Ph.D. _____ M.V. Rychkova

The present study program is protected by copyright and cannot be reproduced in any form without written consent of the department-developers of the program.

The program was discussed and agreed at the department meeting

Records № 7 on 04 March 2016

Head of the Department of Physics _____ M.B. Semenov

The program is agreed with the Dean of Medical Faculty of PSU

Dean of the Medical Faculty _____ I.Ya. Moiseeva

The program was approved by methodological commission of the Medical Institute

Records № 7 on 05.03.2016.

Chair of the methodological commission _____ O.V. Kalmin

Detainer-approval of the program for consecutive academic years and record of alterations

Academic year	Sub-departments' decision (Report№, date, signatur of sub-department's head)	Introduced alterations	Page numbers		
			changed	new	annulled
2016–2017	Rep№8, 20.04.2017	There is a change in the front page of the WCP in connection with the order from 10.04.2017	1	1	
2017–2018	Rep.№1, 03.09.2017	There is added an item on working with disabled people	6	6	