MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Lviv National Stepan Gzhytsky University of Veterinary Medicine and Biotechnology

Faculty of veterenary medicine
Department of Physics and Mathematics

APPROVED
Dekan of faculty
_____
(Signature)
"16" 06 2021

WORK PROGRAM OF EDUCATIONAL DISCIPLINE

Biophysics
(name of the discipline)

high education level second (master)
(name of educational level)
knowledge field 21 «Veterinary medicine»
(name of knowledge area)
speciality 211 «Veterinary medicine»
(name of speciality)
educational program Veterinary medicine
discipline type required
(required / not required)

Lviv – 2021

Work program of educational discipline Biophysics for students of the second (master) high education level of speciality 211 "Veterinary medicine"
for educational programm "Veterinary medicine"

Developers:

Head of Physics and Mathematics Department,
PhD degree in Optics and Laser Physics, Doctor of Science, docent _____ A. M. Kostruba

PhD degree in Optics and Laser Physics,
Senior Lecturer of Physics and Mathematics Department _____ V. I. Savaryn

The work program is considered and approved at the session of the Physics and Mathematics Department

protocol from "18" 05 2021 № 7

Head of Physics and Mathematics Department _____ A. M. Kostruba
(name of department) (signature) (name)

Agreed by educational - methodical commission of the speciality 211 "Veterinary medicine"
protocol № 6 from "21" 05 2021

Head of EMCS _____ Tybinka A. M.

Approved by educational - methodical commission decision of veterinary medicine faculty
protocol № 6 from "21" 05 2021
head of EMCF _____ Tybinka A. M
(name, signature)

Accepted by Faculty Academic Council

protocol № 3 from "16" 06 2021

1. Discipline description

Indicators name	General academic hours	
	Full-time education	External education
Number of credits / hours	3/90	-
Total hours of classroom work	48	-
including:		-
• lectures, h	16	-
• practical work, h	-	-
• laboratory work, h	32	-
• seminars, h	-	-
Total hours of independent work	42	-
Type of control	test	-

2. SUBJECT, PURPOSE AND TASKS OF THE DISCIPLINE

2.1. Subject and purpose of academic discipline

Subject of the academic discipline subject is the basic phenomena and physics laws that are necessary for the full professional activity of the veterinarian and for the study of a number of adjacent and special disciplines.

Purpose of "Biophysics" discipline for "Veterinary Medicine" students is assimilation of the physics base, physical and physical-chemical interpretation of biological processes, as well as acquirement of physical methods and devices that are widely used in the practice of veterinary medicine and scientific research.

Study of the academic discipline "Biophysics" based on such disciplines as: Bioneorganic chemistry, and Philosophy and base of logic.

Acquire knowledge from Biophysics is the base for study of the next educational disciplines: Physiology, Surgery, inside diseases of animals, and Ophtalmology.

2.2. Discipline Task (TC, SC (CC))

Study of the discipline involves the formation of necessary for students' competencies:

- ✓ **general competencies**:
  - ability to think, analyze and synthesize (GC1);
  - ability to search and process information from different sources (GC2);
  - ability to apply knowledge in practical situations (GC3);
  - ability to communicate in the state language, both oral and writing (GC5);
  - skills to information use and communication technologies (GC7);
  - ability to conduct research at the appropriate level, make reasonning decisions, evaluate and ensure the quality of work performed (GC8);
  - ability to communicate with non-professionals in their field (with experts from other fields) (GC10);
  - determination and persistence on the tasks and duties (GC11);
  - desire to save the environment (GC12).

- ✓ **professional competencies**:
  - ability to use tools, laboratory devices and other technical equipment for conducting of necessary manipulations during professional activity (PC2);
  - ability to follow rules of labor protection, aseptics and antiseptics during professional activity (PC3);
  - ability to organize, conduct and analyze results obtained during laboratory and special diagnostic research (PC7);
  - ability to organize, implement and control documents circulation during professional activity (PC20).

2.3. Program results of studying (PRE)

As a result of learning a educational discipline, student must be able to demonstrate the results of studying such as:

- know the basic parameters of the structural functions of organs and the characteristics and purpose of technical devices used to determine these parameters (PRE 2)
- know the technological processes of production and current regulations on storage, transportation and sale of livestock products, as well as beekeeping and aquaculture products (PRE 15)
-know the principles and features of using specialized software (PRE 19).

✓

3. Structure of academic discipline

3.1. Distribution of academic lessons by discipline

Section Name	Number of academic hours					
	Full-time education (FTE)					
	total	including				
		l	p	lab	ind.	m. r.
1	2	3	4	5	6	7
Section 1. Mechanics. Molecular physics. Electrostatics. Direct current						
1.1. Kinematics. Dynamics. Laws of conservation. Work and Energy	8	1	–	4	–	3
1.2. Hydrodynamics and hemodynamics	8	1	–	4	–	3
1.3. Mechanical vibrations and waves. Sound, ultrasound and infrasound	4	–	–	–	–	4
1.4. Molecular physics	10	2	–	6	–	2
1.5. Thermodynamics laws and biological systems	5	2	–	–	–	3
2.1. Electrostatics. Biopotential.	4	1	–	–	–	3
2.2. Direct current	6	1	–	2	–	3
Total	**45**	**8**		**16**		**21**
Section 2. Electromagnetism. Alternating current. Optics. Atom and nucleus structure						
3.1. Electromagnetism. Electromagnetic induction	9	1	–	4	–	4
3.2. Alternative current. Electromagnetic oscillations and waves	7	1	–	2	–	4
4.1. Optics and optical methods in veterinary medicine	9	2	–	4	–	3
4.2. Atom structure and wave properties of microparticles	9	2	–	4	–	3
4.3. Atomic nucleus structure	5	1	–	–		4
4.4. Radioactivity. Dosimetry	6	1	–	2	–	3
Total	**45**	**8**		**16**		**21**
Total academic hours	**90**	**16**	**–**	**32**	**–**	**42**

3.2. Lectures

№	Title and short content of curriculum	Number of academic hours FTE
Section 1 Mechanics. Molecular physics. Electrostatics. Direct current		
1	**Topic: "Kinematics and dynamics of rotational motion".** Newton's laws. The law of momentum conservation and moment of momentum. Work. Power. Energy. Kinetic energy, moment of inertia. Dynamics of rotational motion	2
2	**Topic: " Molecular physics".** Gas laws. Equation of gas state. Kinetic theory of gases. Conclutions from kinetic theory of gases. Molecules distribution of ideal gas by velocities. Average number of collisions and average mileage of molecules	2
3	**Topic: "Fundamentals of thermodynamics and biological systems".** Internal energy and the first thermodynamics law. Gas heat capacity. Meyer's equation. Adiabatic process. Entropy and the second thermodynamics law. Thermodynamics of biological systems	2
4	**Topic: "Electrostatics. Direct current".** Coulomb's law. The Ostrogradsky-Gauss theorem. Conductors in electrostatic field. Joule-Lenz law. Kirchhoff's laws. Thermoelectric phenomena. Peltier phenomenon	2
Section 2 Electromagnetism. Alternating current. Optics. Atom and nucleus structure		
5	**Topic: "Electromagnetism".** Ampere's law. Bio-Savara-Laplace law. Lorentz force and Hall effect. Magnetic field and its influence on living organisms. The basic law of electromagnetic induction. Inductance and inductive coupling. Electromagnetic oscillations and alternating current	2
6	**Topic: " Optics and optical methods in veterinary medicine".** Wave methods and light therapy. Polarization methods in veterinary medicine	2
7	**Topic: "Atom structure and wave properties of microparticles".** Semi-quantum theory of atomic structure. Quantum numbers. Pauli principle. Quantum mechanics and wave properties of microparticles. Magnetic resonance spectroscopy. Radioautography in electron microscopy and research on cellular metabolism dynamics.	2
8	**Topic: " Atomic nucleus structure".** Characteristics of nucleus. Nuclear forces. Nuclear binding energy. Nuclear and thermonuclear reactions and its use. Magnetic resonance spectroscopy. Basic law of radioactive decay. Passing of radioactive radiation through substances	2
Total number of academic hours		**16**

3.3. Laboratory work

№	Title and short content of curriculum	Number of academic hours
		FTE
1	**Introduction. Results processing of physical measurements and its representation.** Fundamentals of safety during laboratory work. Physical measurements theory. Rules of approximate calculations. Errors calculation of direct and indirect measurements.	2
2	**Measuring instruments.** Familiarity with structure and methodology of measuring instruments for measure of linear dimensions, accuracy and finding errors of measurements.	2
3	**Determining bodies volume of correct geometric form.** Conducting measurements of linear body sizes by using calipers and micrometer. Calculation of cylinder and parallelepiped volumes.	2
4	**Control work №1.**	2
5	**Determination of milk density by lactodensimeter.** Study the principle of work and structure of lactodensimeter, skills development for determining the density of milk.	2
6	**Determination of the Young modulus by deflection deformation.** Determination of the Young modulus of bone by deflection deformation.	2
7	**Study the rotation motion of a solid using the Oberbeck pendulum.** Determination of rigid body moment of inertia relative to the stationary axis of rotation.	2
8	**Determination the period of mathematical pendulum oscillations.** Determination the period of mathematical pendulum oscillations and acceleration of free fall.	2
9	**Determination of air humidity.** Study of the aspiration and August psychrometers and rules of its use.	2
10	**Determination of liquid kinematic viscosity and critical velocity by a capillary viscometer.** Familiarity with viscometer structure, develop skills to use its for determination viscosity and critical fluid velocity.	2
11	**Control work №2.**	2
12	**Measurement of conductor resistors by using DC current bridge.** Determination of conductors resistances at different combinations.	2
13	**Determination of light wavelength and quantum radiation energy of a gas laser.** Studying the diffraction and interference phenomena. Wavelength determination and laser radiation quantum energy calculation.	2
14	**Study of radioactive β-radiation interaction with substance and determination of its quantitative characteristics.** Familiarity with radiometer structure, determination of linear absorption coefficient and half-absorbing layer.	2
15	**Control work №3.**	2
16	**Final lesson.** Summing and scoring of the credits.	2
	Total number of academic hours	**32**

3.4. Individual work

№ з/п	Title and short content of curriculum	Number of academic hours FTE
Section 1. Mechanics. Molecular physics. Electrostatics. Direct current		
1	Kinematics. Dynamics. Mechanical motion and its characteristics. Parameters and laws of rectilinear uniform and accelerated motion. Newton's laws. Forces of nature and their types.	1
2	Conservation laws. Work and energy. Hydrodynamics and hemodynamics. Dynamics of rotational motion. Laws of conservation of energy, momentum, momentum in dynamics. Mechanics of liquids and gases. Bernoulli's equation. Internal friction forces.	1
3	Mechanical wave oscilattions. Sound, ultrasound and infrasound. Harmonic oscillations and their characteristics. Kinematics and dynamics of harmonic oscillations. Wave processes and their characteristics. Wave energy.	1
4	Molecular physics Gas laws. Basic equation of molecular kinetic theory of gases. The internal energy of an ideal gas. Heat capacity of gas. The speed of molecules. The concept of temperature.	1
5	Thermodynamics laws and biological systems. Thermodynamic process. The first law of thermodynamics. Reversible and irreversible processes. Circular processes. The second law of thermodynamics. Carnot cycle. The concept of entropy.	1
6	Electrostatics. Biopotential. The intensity and potential of the electric field, the relationship between them. Conductors in an electric field. Capacitors. Electric field energy. Using an electric field to study materials and raw materials.	1
7	Direct current. Ohm's law for a plot and a vicious circle. Electromotive force. Thermal action of current. Operation and power of current. Branched circles. Kirchhoff's laws. Conductivity.	1
Section 2. Electromagnetism. Alternating current. Optics. Atom and nucleus structure		
8	Electromagnetism. Electromagnetic induction. Magnetic induction, magnetic field strength. Magnetic flux. The magnetic field of a current-carrying conductor. Forces acting on a current and a charged particle in a magnetic field.	1
9	Alternating current. Electromagnetic oscillations and waves. The phenomenon of electromagnetic induction. Faraday's law. Mutual induction and self-induction. Magnetic field energy. Investigation of electromagnetic characteristics of matter.	1
10	Optics and optical methods in veterinary medicine. Laws of propagation, reflection and refraction of light. Optical devices and systems. Wave optics. Interference, diffraction, dispersion, light absorption and their application.	1
11	Atom structure and wave properties of microparticles. De Broglie's formula. Heisenberg uncertainty ratio. Bohr's postulates .. Spectral series of the hydrogen atom. Major quantum numbers. Pauli principle.	1
12	Structure of atom nucleus. The composition of the nucleus. Interaction of nucleons. Strong interaction. Communication energy. Kernel models. Mass defect. Nuclear and thermonuclear reactions. Nuclear reactor.	1
13	Radioactivity. Dosimetry. Radioactive decay and its types. Activity. Laws of radioactive decay. Radiation doses. Measurement of irradiation doses and degree of RA contamination of raw materials.	1
14	Preparation for training sessions and control activities	29
	Total number of academic hours	**42**

4. Individual tasks

Students are offered the following themes of individual work to improve their success:

1. Work and horse tractive force (power of horse work).
2. Viscosity (viscosity measurement, physical basis of the clinical method for determination of blood viscosity).
3. Physical basis of hearing, sound methods of clinical research and treatment.
4. Fundamentals of Ultrasound Diagnostics.
5. Laser radiation and its application (inversion population, structure of lasers).

5. Methods of education

Study of the "Biophysics" subject is conducted using the following methods: explanatory-illustrative, research, part-search (heuristic), inductive.

Study of the Biophysics discipline involves to use the information and computer technologies (global Internet system) and electronic textbooks, visualization of physical phenomena and processes (laboratory works and lecture demonstrations), processing of laboratory research results, assessment of knowledge.

6. Methods of control

Forms of current checking:

- oral interview;
- written frontal interrogation;
- written examination by taking into account the specifics of the subject;
- express control;
- control consultation;
- checking of independent work implementation, etc.

7. Criteria for evaluating student outcomes

Current control results are evaluated on a four-point scale ("2", "3", "4", "5").

Table 1 – **Criteria of current evaluation**

Answer, performance, control work, task implementation	Criteria for evaluation
5	Student fully possesses educational material, freely, independently and reasonably sets it out, deeply and comprehensively disclose the content using the obligatory and additional literature. Correctly solves 90% of the tasks.
4	Sufficiently possesses the educational material, substantiates sets it out, basically reveals the content of the tasks, using the obligatory literature. But while student sets out, some questions does not have enough depth and arguments, some inessential inaccuracies and minor mistakes are allowed.

	Correctly solved most of the tasks.
3	In general, student know the educational material, sets out his main content, but without a deep comprehensive analysis, justification and argumentation, while admitting some significant inaccuracies and errors. Correctly solved half of the tasks.
2	Not fully possesses educational material. Fragmentarily, superficially, does not adequately reveal the content of theoretical questions and practical problems, while admitting significant inaccuracies, correctly resolved the minority of the tasks set.

Monitoring of student learning is a necessary element of the educational process. Control provides an objective assessment of educational activities quality. The gist of control is to identify and measure the competencies of the students, the interrelated work of teacher and student.

Assessment of students' training results is carried out by conducting current and final control (test).

Assessment of the training results is carried out in points, the maximum number for each final control is 100. Each score corresponds to the national and ECTS scales (table 1).

Maximal number of points during semester is 100:

$$100\ (CC) = 100,$$

where:

100 (CC) − maximum points of current control that can be earned by a student during semester.

Table2 – **Evaluation scale of students success**

100-point scale	National scale		ECTS scale
	Exam, differentiated credit	Test	
90-100	Excellent	Passed	A
82-89	Good		B
74-81			C
64-73	Satisfactorily		D
60-63			E
35-59	Not satisfactory (not credited) with the possibility of re-passing		FX
0-34	Not satisfactory (not credited) with compulsory repeated study of discipline		F

At the end of the semester, the average arithmetic mean value (AMV) is calculated for all the points received by student, followed by transferring it to the score by the formula:

$$CC = \frac{100 \cdot AMV}{5} = 20 \cdot AMV$$

Current control mark can be changed at the expense of the encouragement points:

- ❖ for students who do not have absence classes during the semester (plus 2 points);
- ❖ for participating in university student olympiads, scientific conferences (plus 2 points), at interuniversity level (plus 5 points);
- ❖ for other types of teaching and research work points are added according to the decision of the department.

8. Educational and methodical support

1. Savaryn V., Kostruba A., Krupych O. Biophysics. Physical methods of substances and biological objects studying. Textbook. Lviv: S.Z. Gzytskyj, 2020. 320 p.
2. Savaryn V., Kostruba A. Laboratory workshop on physics and biophysics. Textbook. Lviv: «New World – 2000», 2019. 145p.
3. Textbooks, study guides and methodological instructions for individual tasks.List of recommended topics for individual tasks. Author Savaryn V.

9. Recommended literature

Basic

1. Savaryn V., Kostruba A., Krupych O. Biophysics. Physical methods of substances and biological objects studying. Textbook. Lviv: S.Z. Gzytskyj, 2020. 320 p.
2. Savaryn V., Kostruba A. Laboratory workshop on physics and biophysics. Textbook. Lviv: «New World – 2000», 2019. 145p.
3. Textbooks, study guides and methodological instructions for individual tasks.List of recommended topics for individual tasks. Author Savaryn V.
4. B. Kappen, Introduction to biophysics. Textbook. Netherlands: 2008. 97p.
5. K. Schulten and I. Kosztin, Lectures in Theoretical Biophysics. Textbook. USA: 2000. 206p.
6. E. Kukurová, Basics of Medical Physics and Biophysics. Textbook. Asklepios: 2013. 231p.
7. W. Bialek, Biophysics: Searching for Principles. Textbook. New-York: 2011. 310p.
8. A. B. Rubin, Fundamentals of Biophysics. Textbook. Scrivener Publishing LLC: 20014. 215p.
9. Yu. Posudin, Laboratory practicum. Textbook. Kyiv: 2012. 104p.
10. Yu. Posudin, Physics with fundamentals of biophysics. Textbook. Kyiv: 2004. 195p.

Additional

1. P. Narayanan, Essentials Of Biophysics. Textbook. New Age International: 2000. 528p.
2. P. F. Dillon, Biophysics. Textbook. United States of America by Cambridge University Press, New York: 2012. 298p.

10. Information resources

1. Biophysics lectures http://www.sfu.ca/~boal/4xx.html

2. Virtual learning environment
   https://onlinelibrary.wiley.com/doi/book/10.1002/9781118842768
3. Web-site of department https://physics.dp.ua/?page_id=2773