Approved by: ……..

Dean

Date.....

SOFIA UNIVERSITY "ST. KLIMENT OHRIDSKI"

Faculty: .....Chemistry and Pharmacy…….....

Subject area: *(code and name)*

C	H	L	3	8	2	4	1	3

.....**Pharmacy**.....

M.Sc. Program: *(code and name)*

C	H	L	3	8	2	4	1	3

.....**Pharmacy**.....

S Y L L A B U S

Course:

C	0	9	7

Physics and Biophysics

(code and name)

Lecturer: Assoc. Prof. Vassil Vulchev, Assoc. Prof. Detelin Stefanov

Teaching assistant: **Assist. Prof. G. Goev**

Academic work	Type	Acad. hours
In-class work	Lectures	45
	Seminars	0
	Practical classes (teaching assistance)	45
Total curricular activity		**90**
Extracurricular activity	Preparation for practical exercises	20
	Independent literature research	15
	Student teaching	50
Total out-of-class work		**85**
TOTAL ACADEMIC WORK		**175**
ECTS credits in-class work		3.6
ECTS credits out-of-class work		3.4
TOTAL ECTS CREDITS		**7**

№	Grade components [1]	% of the score
1.	Practical exercises	30%
2.	Final exam	70%

Outline of the course:

The Physics and Biophysics course is basic for "Pharmacy" specialty. It is required for mastering profile and special disciplines. The main goal of this course is providing basic knowledge and skills to students in physics and biophysics, which they can apply in their studies of chemical and other pharmaceutical disciplines, as well as in their professional career as pharmacists.

The Physics and Biophysics graduate course is divided into two parts – Physics and Biophysics. Its themes are aimed at providing qualitative description of physical and biophysical theories, explaining known facts and predicting new effects. The course makes use of mathematical knowledge acquired in high school. The first part of the course – Physics - introduces basic physical concepts and laws of mechanics, electricity and magnetism, and oscillations and waves. The part on Biophysics includes sections such as biomechanics, heat and thermodynamics, wave processes in biology, bioelectromagnetism, radiation biophysics and molecular and cell biophysics. The two parts complement each other. The program's themes contain useful applications.

Laboratory exercises, accompanying the course, help students understand the physical and biophysical phenomena and teach them how to use measurement devices and apply physical and biophysical research methods. Laboratory exercises follow and complement the contents of the lectures, helping students to better adopt them.

Preliminary requirements:

- Physics (high school course, obligatory schooling)
- Algebra and trigonometry (high school course, obligatory schooling)
- Elementary mathematical analysis (Higher mathematics – university course)
- Biology (university course)

Key competences acquired:

After successful completion of the course students:

- describe motion of a particle with kinematic values path, displacement, velocity and acceleration;
- formulate and apply the three principles of the dynamics;
- formulate and apply laws for conservation of energy and momentum;
- know and can apply basic laws of hydrostatics and hydrodynamics;
- analyze basic phenomena in electrical and magnetic fields;

[1] Depending on the course specificity and on the requirements of the teacher, other types of activities can be added or the unnecessary ones can be removed.

- characterize oscillations and wave propagation;
- know and apply basic optical laws;
- know many pharmaceutical applications of the studied phenomena, mentioned above;
- are familiar with mechanical characteristics of various materials from biological origin at different level of organization – tissues, organs and organisms;
- are familiar with features of the formation and propagation of nerve pulses;
- analyze a from biophysical point of view characteristics and behavior of sensory system such as audition and vision;
- get introductory knowledge on various imaging systems based on many contemporary diagnostic techniques;
- are familiar with the structure and dynamical properties of biomolecules, cells and tissues;
- know and characterize damages induced by ionizing radiation and the evaluation of the risk by it and the application of the ionizing radiation in contemporary radiotherapy;

Lessons plan

№	Topic:	Acad. hours
	Lectures	
	Part I. Physics (20 h)	
I	**Mechanics**	
1	Kinematics of particle. Motion along a straight line and motion in two and three dimensions.	2
2	Principles of the dynamics.	1
3	Circular motion. Centripetal and centrifugal forces.	1
4	Lows of conservation of energy and momentum.	1
5	Fluid mechanics. Hydrostatics. Motion of ideal fluid. Motion of real fluid.	2
II	**Electricity and magnetism**	
6	Electrostatic interaction.	1
7	Conductors and dielectrics in electric field.	1
8	Electrical current.	1
9	Magnetic field.	1
10	Electromagnetic induction.	1
11	Magnetic properties of the matter.	1
III	**Oscillations and waves**	
12	Mechanical oscillations.	1
13	Mechanical waves.	1
14	Sound.	1
15	Alternating current.	1
16	Electromagnetic waves.	1
17	Dispersion and polarization of light.	1
18	Light absorption and scattering.	1

	Part II. Biophysics (25 h)	
1	Biomechanics.	3
2	Heat and thermodynamics.	3
3	Wave processes in biology.	2
4	Bioelectromagnetism.	3
5	Photobiology.	3
6	Quantum biophysics.	3
7	Radiational biophysics.	3
8	Molecular and cell biophysics.	5
	Seminars/Practical exercises	
1	Treatment of experimental data. Determination of Young's modulus by deflection of a beam.	3
2	Determining the viscosity of a fluid and a gas.	3
3	Determining the density of a solid body and a fluid.	3
4	Determining the gravitational acceleration with pendulum. Determining the velocity of sound with standing wave.	3
5	Working with electrical measurement devices.	3
6	Resonance in driven RLC circuit.	3
7	Ferromagnetic hysteresis.	3
8	Diffraction spectrum. Determining wave length with diffraction grating.	3
9	Malus's and Bruster's laws. Optical activity. Polarimeter.	3
10	Helium-neon laser. Study of the refraction of light, total internal reflection, diffraction.	3
11	Study of Geiger-Müller tube. Colloquium.	
12.	Measuring theory.	2
13.	Biomembranes – oxidative damages in erythrocyte membranes.	3
14.	Passive electric properties of tissues – bioimpedance.	2
15.	Quantum pharmacology.	2
16.	Biothermodynamics and quantum biochemistry of macroergic bonds. Colloquium.	3

Topics Covered on the Final Exam

№	Topic
	Part I. Physics
I	**Mechanics**
1	Kinematics of particle. Motion along a straight line. Path, displacement, velocity, acceleration. Curvilinear motion. Tangential and normal acceleration.
2	Principles of the dynamics. Force, mass, momentum. Types forces.
3	Circular motion. Centripetal and centrifugal forces. Sedimentation and centrifugation. Types centrifuges.
4	Work and energy, power. Laws of conservation of energy and momentum.

5	Fluid mechanics. Hydrostatics. Pascal's law. Hydrostatic pressure, Archimedes' law. Motion of ideal fluid. Equation of continuity. Bernoulli's equation. Motion of ideal fluid. Motion of real fluid. Laminar and turbulent flow. Viscosity. Stokes and Poiseuille's laws. Reynolds number. Non-Newtonian fluids. Viscometers.
II	**Electricity and magnetism**
6	Electrostatic interaction. Coulomb's law. Electric field. Electric field lines. Electric potential and voltage.
7	Conductors and dielectrics in electric field. Conductor in electrostatic field. Capacitor. Energy stored in an electric field. Electric dipole. Dielectric constant and polarization of the dielectrics.
8	Electrical current. Current density. Ohm's law. Joule-Lenz law. Electromotive force. Electrical circuits.
9	Magnetic field. Magnetic force. Motion of charged particles in magnetic field. Cyclotron. Mass-spectrometer. Magnetic force on current carrying wire. Torque on a current loop. Magnetic dipole moment. Biot-Savart law.
10	Magnetic flux. Electromagnetic induction. Faraday's law. Inductance. Energy of the magnetic field.
11	Magnetic properties of the matter. Magnetization. Magnetic susceptibility and permeability. Types of magnetics.
III	**Oscillations and waves**
12	Mechanical oscillations – harmonic oscillator. Energy of the harmonic oscillator. Damped oscillator, forced oscillator and resonance.
13	Mechanical waves – main features. Velocity of waves. Energy transport. Intensity. Standing waves. Doppler effect – applications.
14	Sound. The speed of sound gases. Sound pressure. Ultrasound – applications.
15	Alternating current. Resistance and capacitive and inductive reactance. Impedance. Power in the alternating current circuits. Conditions for AC damages.
16	Electromagnetic waves – properties. Electromagnetic waves spectrum. Reflection and refraction laws. Total internal reflection. Measuring refraction. Fiber optics.
17	Dispersion and polarization of the light. Malus' and Bruster's laws. Birefringence (Double refraction). Optical activity. Measurement of the polarization.
18	Light absorption and scattering. Beer–Lambert–Bouguer law. Colorimetry. Scattering of the light in turbid medium. Rayleigh scattering. Nephelometer. Molecular scattering.
	Part II. BIOPHYSICS
1	**I. Biomechanics** 1. Biostatics – Properties of materials (The ratio Stress/strain relationships:, bones, tissues, viscoelasticity); Mechanical equilibrium; Equations of static equilibrium; Stress analysis (Tension and compression. bending; Structural instability (The Euler theory, Compressive failure of the long bones); 2. Biofluid mechanics – Pressures in the body (pressure in the cardiovascular system, hydrostatic pressure, bladder pressure, respiratory pressures, foot pressures, eye pressure); Hydrostatic skeleton; Blood pressure control; Atherosclerosis. Doppler spectroscopy. 3. Mechanics of elastic walls – Windkessel effect; the Moens–Korteweg model;
2	**II. Heat and biothermodynamics**

	1. Biothermodynamics – biochemical thermodynamics. Extended thermodynamics by de Donder. Information and second law of thermodynamics. Non-equilibrium thermodynamics and life. Nonlinear thermodynamics of biosystems. 2. Heat and life – energy requirements of people – energy from food; heat regulation; cold tolerance, soil heat.
3	**III. Wave processes in biology** 1. Hearing and the Ear. 2. Bioacoustics. 3. Ultrasonic imaging
4	**IV. Bioelectromagnetism** 1. Non-ionizing electromagnetic radiation – tissue as leaky dielectric. Relaxation processes (Debye model; Cole–Cole model). Low-frequency effect at 0.1Hz – 100 kHz High-frequency effects above 100 kHz). 2. Electrobiology – Action Potential. Electricity in Plants. Electricity in the Bone. Physiology and electricity. Electrocardiograph and electroencephalograph. Cell electrophoresis. Electroporation. 3. Bioelectrochemistry – electron transfer in biosystems 4. Biomagnetism – Biomagnetic responses. Magnetocardiogram Magnetic sensors.
5	**V. Photobiology** 1. Vision. 2. Microscopy; Confocal microscopy. 3. Fiber Optics - endoscope. 4. Photography. Holography. Images and imaging techniques. 5. Photosynthesis. 6. Photodynamic therapy. 7. Ultraviolet radiation.
6	**VI. Quantum biophysics** 1. Electron Microscope. 2. X-rays. 3. X-ray Computerized Tomography. 4. Lasers 5. From quantum biophysics to quantum pharmacology – quantum topological molecular similarities (QTMS); Quantitative structure–activity relationship (QSAR).
7	**VII. Raduational biophysics** 1. Ionizing radiation – absorption, scattering and attenuation. 2. Biological effects and radioprotection. Maximum permissible doses. 3. Measuring ionizing radiation – Ionization chambers; G-M counters; Scintillation counters; Film dosimeters; Thermoluminescent dosimetry. 4. Isotopes – atom structure, isotopes (radioactive and stable isotopes, man-made background radiation); radionuclide imaging; using of stable isotopes in biochemistry. 5. Radiaton therapy. 6. Nuclear magnetic resonance. 7. Mössbauer spectroscopy

8	**VIII. Molecular and cell biophysics** 1. Molecular structure. Structural diagrams; 2. Molecular interaction – intra- and intermolecular interaction 3. Water biophysics – physical properties, biological role of water; pH; 4. The Hydrophobic Interaction – hydrophobic forces; amphiphilic molecules. 6. Macromolecules – proteins, nucleic acids; 7. Biomolecular complexes, organelles 8. Biomembranes – structures; artificial membranes; membrane transport. 9. Biophysics of the cell; Self-organization in cell structures and evolution of the cell.

Bibliography

Main sources:

1. P. Davidovits, Physics in biology and medicine, 3rd Ed. Academic Press. 352 pp, 2008

Additional sources:

1. J. Jewett, R. Serway, Physics for Scientists and Engineers with Modern Physics, 8th edition, International edition, 2010.
2.Kenneth R. Koehler, College Physics for Students of Biology and Chemistry, http://www.biophysics.uwa.edu.au/e_book/text.html

Date:

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