MINISTRY OF PUBLIC HEALTH OF UKRAINE
BUKOVINIAN STATE MEDICAL UNIVERSITY

" **Agreed** "
Vice-rector of scientific and pedagogical work of BSMU
Assoc. prof. _____ I.V.Gerush

"____"____2015

STUDENT'S REFERENCE BOOK

for study of subject **"Medical and biological physics"**

The student's reference book for study of course **"Medical and biological physics"** is provided by "Programme on medical and biological physics" for higher medical education establishments of Ukraine with III-IV accreditation level (Ministry of Public Health of Ukraine, 2005)

Affirmed and considered on department sitting of biological physics and medical informatics department ("___"_____2015 year. Minutes No___)

Head of Biological Physics and
Medical Informatics Department _____ prof. M.V.Shaplavsky

Approved at sitting of methodical committee of medico-biological disciplines physical-chemical and physiological specialization of Bukovinian State Medical University
"_____" _ _____2015 year. Minutes № _____

Head of Methodical Committee _____ prof. S.S.Tkachuk.

Composed by Assoc. prof. Fediv V.I.

Chernivtsi, 2015

1. Desccription of course
Medical and biological physics

<table>
<tr><td>Name of indicators</td><td>Areas of knowledge, specialty, education level, tuition</td><td>Description of the course</td></tr>
<tr><td>Quantity of credits – 5</td><td>Area of knowledge
1201 Medicine
(code and name)</td><td>Regular</td></tr>
<tr><td>Modules – 2</td><td rowspan="3">Speciality (direction):
12010001 Medicine
(code and name)</td><td rowspan="2">Year of study (course)
1st</td></tr>
<tr><td>Structural Moduls – 9</td></tr>
<tr><td>Total number of hours – 150</td><td>Semester
1st or 2nd</td></tr>
<tr><td rowspan="2">Number of auditorium hours - 80</td><td rowspan="2">Educational qualification:
specialist</td><td rowspan="2">Lectures
20 hours.</td></tr>
<tr><td></td></tr>
<tr><td rowspan="2">Number of independent work hours - 70</td><td rowspan="2">Education form:
_____</td><td>Practical classes
60 hours</td></tr>
<tr><td>Seminars
_____ hours</td></tr>
<tr><td></td><td></td><td>Independent work
70 hours</td></tr>
<tr><td></td><td></td><td>Type of control:
The final module control</td></tr>
</table>

In auditoriums – 53,33%, independent work – 46,66%.

2. CURRICULUM

for study subject of **Medical and biological physics**

(name of the subject)

for students of **Medical** **faculty**

(name of the faculty)

specialty (direction) **General Medicine**

Structure of course	Quantity of hours				Year of study, semester	Kind of control
	Total, hours/credits	In auditoriums		Independent work		
		Lecture	Practical classes			
	150/5,0	20	60	70		
Module 1 5 of pithy modules	60/2,0	8	26	26	1st, I	Total test.
Module 2 4 of pithy modules	90/2,0	12	34	44	1st, I and II	Total test.

3. Aims and tasks

Core abilities developed in this course:

This course should help you:

• use written and oral communication skills effectively, employing methods appropriate to message and context.

• think clearly and critically, fusing experience, knowledge and reasoning into considered judgment.

• identify, interpret, and solve problems, effectively implementing and evaluating proposed strategies.

• organizational, problem solving, and critical thinking skills

• an ability to work both independently and in groups

• an ability to transfer knowledge to new contexts

• practice comprehending and interpreting abstract materials from text

• an appreciation of the importance of persistence, attitude and energy

Assessment criteria

Assessment will be criterion based as required by University policy. The student's understanding of the course will be shown by their being able to:

• define, explain and interrelate the key concepts involved in the course.

• recognise the regime of applicability of the theory presented

• use the basic theory to describe quantitatively the behaviour of important laser systems

• apply the theory to new problems and obtain correct analytical and numerical results in the appropriate units of measurement

• utilise the appropriate mathematical and other techniques to derive relationships for physical quantities

• interpret the results of numerical simulations qualitatively in terms of key concepts

The working program of “Medical and biological physics” course consists of 3 modules with 9 content modules inside them.

Module 1. Mathematical treatment of medical and biological information**.** Basic regularities of biomechanics and electricity and use of them in medical diagnostic and treatment.

Content module 1. Mathematical treatment of medical and biological information.

Content module 2. Basic laws of biomechanics and use of it in medical diagnostic and treatment

Content module 3. Biomembranes and transport phenomenon in cell. The elements of thermodynamics.

Content module 4. Electrical field of cells, tissue, organs and it use in medicine.

Content module 5. Electrical properties of cells, tissue, organs and methods of fixation of medical and biological information by electrical current.

Module 2. Basic regularities of electromagnetism, optical, atomic and nuclear physics.

Content module 6. Influence of physical factors on human body.

Content module 7. Fixation of medical and biological information by optical methods**.**

Content module 8. The elements of photobiology and quantum mechanics**.**

Content module 9. Nuclear physics in medicine

4. CONTENTS OF THE PROGRAM

Theme	Quantity of hours				
	In all	In lecture room		Independent student's work	Individual work
		Lectures	Practical classes		
1	2	3	4	5	6
Module 1. Mathematical treatment of medical and biological information					
1st pithy module. Basics of higher mathematics. Mathematical treatment of medical and biological information					
Theme 1. Function of many variables. Partial derivatives. Partial differentials of function of many variables. Total defferential.		-	2	2	
Theme 2. Mathematical treatment of direct and indirect measurements		-	2	2	
Theme 3. Differential equations. Methods of their integration.		-	2	2	
Theme 4. Simulation of medico-biological process by means of the differential equation		-	2	2	
Total of 1st pithy module			**8**	**8**	
2nd pithy module. Basic laws of biomechanics and use of it in medical diagnostic and treatment					
Theme 1. Subject and methodics of biophysics. Connect of it with other scince. Periodic processes and representation of them in animate nature.		2	-	1	
Theme 2. Sound and hearing. Registration of the spectral characteristic of an ear on a threshold of audibility.		-	2	1	
Theme 3. Ultrasound in medicine. Use of ultrasound in treatment and diagnostic.		-	2	1	
Theme 4. Basic laws and regularities of hemodynamics.		4	-	-	
Theme 5. Fluid mechanics. Determine of coefficient viscosity by Osvald method. Viscosity of liquid.		-	2	2	
Theme 6. Liquids surface		-	2	2	

tension. Determine of coefficient surface tension by Rebinder method					
Total of 2nd pithy module		**6**	**8**	**7**	
3 pithy module. Biomembranes and transport phenomenon in cell. The elements of thermodynamics.					
Theme 1. Types of chemical bonds that important in biology. Form of membran. Transport phenomenon in cell (passive and active transport).		1	2	3	
Theme 2. The elements of thermodynamics.		2	-	-	
Total of 3 pithy module		**3**	**2**	**3**	
4 pithy module. Electrical field of cells, tissue, organs and methods of fixation of medical and biological information.					
Theme 1. Biopotential. Resting and action potentials. Electrostatic copying of tissue and organs.		1	2	3	
Theme 2. Simulation of electrical field of heart. Registration of electrocardiogram, determine of pulse rate and magnitude of jag R. Electrocardiograph.		-	2	4	
Theme 3. Electrical determine of non electrical magnitude. Sensors.		-	2	2	
Total of 3 pithy module		**1**	**6**	**9**	
5rd pithy module. Electrical properties of cells, tissue, organs and methods of fixation of medical and biological information by electrical current.					
Theme 1. Direct electric current in medicine. Galvanization and iontophoresis Determine of electroconductivity of electrolyte and bioligical fluid as diagnostic method.		-	2	2	
Theme 2. Alternating electric current in medicine. Impedance plethysmography. Recording of rheogram. Estimate of cardial discharge. Rheography.		-	2	2	
Theme 3. Pulsed currents in medicine.		-	2	2	
Total of 5rd pithy module			**6**	**6**	
Total test			2	3	
In all, hours		**8**	**32**	**33**	

Module 2. Basic regularities of electromagnetism, optical, atomic and nuclear physics.					
6 pithy module. Influence of physical factors on human body.					
Theme 1. Basic regularities of electromagnetism. Electromagnetic waves. Interaction EMW with medium. Biological effects of electromagnetic waves..		2	-	-	
Theme 2. Magnetic field in medicine..		-	2	4	
Theme 3. Shortwave therapy. Surgical diathermy.		-	2	5	
Total of 6 pithy module		**2**	**4**	**9**	
7 pithy module. Fixation of medical and biological information by optics methods					
Theme1.Absorption of light. Estimation of concentration.		-	2	2	
Theme 2. Polarization of light, polarimetry.		-	2	2	
Theme3. Optical microscopy.		-	2	1	
Total of 7 pithy module		**-**	**6**	**5**	
8 pithy module. The elements of photobiology and quantum mechanics					
Theme 1. Eye (defects, acuity, diagnostic, byophysics of visual photodetection.)		-	2	2	
Theme 2. Thermal radiation of bioobjects		-	2	1	
Theme 3. Luminiscence.		-	2	2	
Theme 4. Laser.		-	2	2	
Theme 5. The elements of photobiology. Ultraviolet, visible and IR light and its therapeutic application		2	2	1	
Theme 6. Nuclear magnetic resonance. Magneto-resonance tomography.		2	-	1	
Theme 7. Electron microscopy.		-	2	-	
Theme 8. Nanomedicine		2	-	-	
Total of 8 pithy module		**6**	**12**	**12**	
9 pithy module. Nuclear physics and medicine					
Theme 1. X-ray		-	2	2	
Theme 2. Radioactivity.		-	1	2	
Theme 3. Biophysics of ionizing radiation. Radiation dosimetry. Radionucleotides in medicine.		2	1	2	
Total of 9 pithy module		**2**	**4**	**6**	
Individual work				**2**	
Total test			**2**	**3**	
In all, hours		**12**	**28**	**37**	

5. PLAN OF LECTURE'S SUBJECTS

№	Theme	Quantity of hours
1	Periodic processes and representation of them in animate nature.	2
2	Basic laws and regularities of hemodynamics	4
3	The elements of thermodynamics.	2
4	Biological membranes: structure, properties, functions. Transport phenomenon in cell. Biopotential.	2
5	Interaction of electromagnetic radiation with matter and its biological effects.	2
6	The elements of photobiology	2
7	Nuclear magnetic resonance. Magneto-resonance tomography.	2
8	Biophysics of ionizing radiation.	2
9	Nanomedicine	2
	In all, hours	**20**

6. PLAN OF SUBJECTS OF PRACTICAL CLASSES

№ з/п	Theme	Quantity of hours
1	Derivative of function and composite function. Derivatives of different (higher) orders. Differentials of function of one independent variable. Function of many variables. Partial derivatives. Partial differentials of function of many variables. Total differential.	2
2	Mathematical treatment of direct and indirect measurements.	2
3	Differential equations. Methods of their integration.	2
4	Simulation of medico-biological process by means of the differential equation.	2
5	Sound and hearing. Registration of the spectral characteristic of an ear on a threshold of audibility.	2
6	Ultrasound in medicine. Use of ultrasound in treatment and diagnostic.	2
7	Fluid mechanics. Determine of coefficient viscosity by Osvald method. Viscosity of liquid.	2
8	Liquids surface tension. Determine of coefficient surface tension by Rebinder method	2
9	Sensors. Electrical determine of non electrical magnitude.	2
10	Transport phenomenon in cell. Passive transport. Active transport.	2
11	Cell potential. Calculation of magnitude potential of cell in quiescent state and act state.	2
12	Electrical field of the heart. Simulation of electrical field of heart. Methods of investigation of the heart activity. Registration of electrocardiogram, determine of pulse rate and magnitude of jag R. Electrocardiograph.	2
13	Direct electric current in medicine. Galvanization and iontophoresis Determine of electroconductivity of electrolyte and bioligical fluid as diagnostic method.	2
14	Alternating electric current in medicine. Impedance plethysmography. Recording of rheogram. Estimate of cardial discharge. Rheography.	2
15	Pulsed currents in medicine.	2
16	Total test of module 1.	2

17	Magnetic field in medicine.	2
18	Shortwave and microwave therapy. Surgical diathermy and violet rays therapy	2
19	Optical microscopy.	2
20	Biophysics of vision.	2
21	Light absorption and medical diagnostics	2
22	Polarized light in medicine	2
23	Ultraviolet, visible and IR light and its therapeutic application	2
24	Thermal radiation of bioobjects	2
25	Luminescence in medicine	2
26	Lasers in medicine	2
27	X-rays in medicine	2
28	Quantum mechanics and electron microscopy	2
29	Radioactivity. Nuclear medicine. Dosimetry	2
30	Total test of module 2	2
	In all, hours	**60**

7. PLAN OF SUBJECTS OF INDEPENDENT STUDENT'S WORK

№ з/п	**Theme**	**Quantity of hours**
1.	Find derivative of simple and composite function, differential of function.	2
2.	Find total differential of function of many variables	
3.	Solve differential equation	4
4.	Simulation of medicobiological process by differential equations	
5.	Mathematical treatment of direct and indirect measurements.	2
6.	Audiometry	2
7.	Ultrasound in medicine	2
8.	Viscosity in medicine	2
9.	Surface tension in medicine	2
10.	Transport phenomenon in living cells. Passive transport.	2
11.	Transport phenomenon in living cells. Active transport.	1
12.	The practical considerations of thermocouples	2
13.	Calculation of magnitude potential of cell in quiescent state and act state.	3
14.	Iontophoresis	2
15.	The physical basis of electrocardiography	2
16.	Electrocardiogram.	2
17.	Impedance plethysmography	2
18.	Pulsed current.	2
19.	Training of total test 1	3
20.	Magnetic field and medicine	2
21.	Shortwave and microwave therapy	3
22.	Surgical diathermy and violet rays therapy	2
23.	Use of optical microscope in medicine.	1
24.	Physiotherapy	2
25.	Light absorption and medical diagnostics	2
26.	Polarized light and medicine	2
27.	Ultraviolet light and its therapeutic application Visible light and	1

	itstherapeutic application	
28.	Biophysics of vision (optical system, receptor system)	2
29.	Thermal radiation of bioobjects	1
30.	Luminescence in medicine	2
31.	Laser in medicine	2
32.	Оволодіти знаннями про характеристики методів електронних мікроскопій.	3
33.	X-ray in medicine	2
34.	Radioactivity. Nuclear medicine	2
35.	Dosimetry	2
36.	Training of total test 2	3
37.	Individual work	2
38.	**In all, hours**	**70**

8. LIST OF TASKS FOR TOTAL TEST

1st module

1. Simple harmonic motion
2. Undamped simple harmonic oscillations
3. Damped simple harmonic oscillations
4. Wave function for a sinusoidal wave
5. Energy in wave motion
6. Kinds of sound
7. Sound (objective and subjective characteristics)..
8. The decibel scale
9. Veber-Fechner law
10. Audiometry
11. Physical characteristics of ultrasound
12. Ultrasonic transducers
13. Effects of Ultrasound
14. Diagnostic applications of ultrasound
15. Therapeutic applications of ultrasound
16. Coefficient of viscosity
17. Newton fluid
18. Nonnewton fluid
19. Poiseuille's equation.
20. Viscometer.
21. Reynolds number
22. Factors influencing blood viscosity
23. Resistance to Blood Flow
24. Sphygmomanometry
25. Coefficient of surface tension
26. Capillary action
27. Use surface tension in medicine.
28. Measurement of surface tension.
29. Temperature measurement in medicine
30. Thermocouple
31. Goal of calibration
32. Diffusion.
33. Fik’s law
34. Stockes-Einstein equation

35. Einstein relation
36. Nernst-Plank equation
37. Kinds of diffusion.
38. Osmosis.
39. Active trasport
40. Basic mechanism of active transport
41. Types of active transport
42. Diagnostic characteristics of carrier-mediated processes
43. Biological membranes (structure, properties)
44. Cell potential
45. Nernst equation
46. Action potential (the sequence of events, properties)
47. Goldman equation
48. Donan Equilibrium
49. Bioelectricity of the heart
50. The heart's electrical conduction system
51. Endhoven's theory
52. Formation of the ECG Signal
53. Electrocardiogram
54. ECG Leads
55. Additional ECG procedures
56. Impedance plethysmography: basic principles
57. Measurement methods of impedance plethysmography.
58. Type of stimulation.
59. Excitability curve of nerve fibers
60. Electrotherapy

2nd module

1. Factors contributing to efficient stimulation
2. External defibrillator
3. Electromagnetic waves (properties, production)
4. The spectrum of electromagnetic waves
5. Relationships of photons and waves
6. Interaction of electromagnetic radiation with matter (atomic, macroscopic)
7. Light as an electromagnetic wave
8. Reflection and refraction of light, total internal reflection
9. Thin-lens equation
10. Ray diagrams for thin lenses
11. Lens aberrations
12. The compound microscope
13. Rayleigh's criterion
14. The electron microscope
15. Polarization of light
16. Methods for achieving polarization of light
17. Malus' law
18. Optical activity
19. Polarimetry
20. The polarizing microscope
21. The Bouger-Beer-Lambert law
22. Estimation of concentration of the solution
23. Thermal radiation
24. Graybody

25. Wien's displacement law
26. Stefan–Boltzmann law
27. Infrared radiation
28. Thermography
29. Basic components of laser
30. Characteristics of laser light
31. Kinds of lasers
32. Medical applications of laser
33. Defects of the eye
34. Power of a lens
35. Rods and cones
36. The blind spot and the yellow spot
37. Wavelength response
38. Reduced eye
39. Visual acuity
40. Clinical method for stating visual acuity
41. The ophthalmoscope and retinoscope
42. Kinds of X-ray (produce, properties)
43. X-ray interaction with matter
44. Use X-ray in medicine
45. Radioactivity
46. Types of radioactive rays
47. The decay constant and half-life
48. The decay processes
49. Natural radioactivity
50. Nuclear reaction
51. Practical uses of radioactivity
52. Radiation damage in matter
53. Absorbed dose, equivalent dose
54. Radioisotopes in medicine
55. Kinds of hazards in clinical environments
56. Physiological effects of electricity.
57. Nanomedicine.

9. List of practical tasks for total test

1st module

1. Record of audiograms.
2. Measurement of viscosity coefficients.
3. Measurement of surface tension coefficients.
4. Measurement of temperature by thermocouple
5. Using electrophoretic device.
6. Calculation of magnitude potential of cell in quiescent state and act state.
7. Record of electrocardiograms. Determination pulse and biopotential value.
8. Record of reogram.
9. Determination of parameters pulsed current.

2nd module

1. Using optical microscope: measurement of objects size.
2. Measurement of concentration of solution using polarimeter.
3. Measurement of concentration of solution using calorimeter.
4. Measurement of erythrocyte diameter using laser.
5. Exploitation of UV and IR sources of radiation.
6. Observation of photoluminescence.
7. Exploitation of devices from shortwave therapy and surgical diathermy.

10. BASIC PRINCIPLES OF STUDENTS' RATING WHILE USING CREDIT MODULE SYSTEM IN EDUCATIONAL PROCESS

ECTS system of educational process includes:

- the study of subjects structured as *modules which are documented, logically completed parts of the educational program implemented by using the appropriate form of educational process* and end with the final module control;

- use the ECTS credits as units of student's workload required for assimilation of the course;

Credit appointed to qualifications or educational programs in general, and their training (education) components (such as modules, courses, course work, work placements and laboratory work).

Credit includes all types of student's work as provided in the approved individual plan: class work, independent, preparation for state certification, preparation of integrated licensing examination "Step 1" and "Step 2", practically oriented state exam, practical, performance coursework etc. One ECTS credit is 30 (36) hours.

- assessment credits to students from the components of the education plan (education subjects, practice, research and qualification works) on the grounds of positive marks at final module controls. Establishing credit to students are in full accordance with the credit established educational component, and only after their full implementation;

- - absence examinations in education process carried out with control of student's education for each module of the course;

- - the use of multiple scales of assessment, including assessment rating scale ECTS which are convertible into one another according to certain rules.

Module evaluation

Assessment for the module is calculated based on the sum of ratings of current educational activities (in points) and evaluation of the final module control (PMC) (in points), which is proposed in the assessment of theoretical knowledge and practical skills according to the lists specified discipline program.

The maximum number of points that a student can get while studying each module is 200, including:

for current educational activity – 120 points;

by the results of the final module control – 80 points.

Thus, the share of results of the assessment of current educational activities and final module control are respectively 60% and 40%.

Evaluation of current educational activities

In evaluating each topic form module the student obtain the mark on a 4-point (traditional) scale and 200-point scale using accepted and approved evaluation criteria for the discipline. This takes into account all types of work, provided by methodological developments for studying the subject. The student must obtain an *assessment of each topic*. Estimates exhibited by traditional scale are converted into points depending on the number of topics in the module.

Current educational activities of students rated on a 4-point scale which is converted into points as follows:

Mark on the 4-point scale	Points	
	Module 1	Module 2
5	8	9
4	6	7
3	5	6

2	0	0

Independent work of students, which is provided in the subject line along with the class work, is estimated at topics in the corresponding control session. Assimilation of topics considered only for private independent study, supervised at the final module control.

By the current progress in the third and fourth modules are also added scores for student individual work performance (for full-time students). Individual work has to be done in electronic and paper form and has to be submitted for module control examination. Full mapping tasks and protection of work enables to students to get the maximum possible score released for individual work.

The final score for current activities is recognized as an arithmetic sum of scores for each lesson and for individual work.

Evaluation of module and subject at all

The final module control is carried out after the study of all module topics on the last lesson of the control module.

Students attended all lessons provided by the curriculum of subject and received positive marks for them ("5", "4", "3"), and during the study module took scores of no less than minimum are allowed to have final module control examination.

Students who for any reason had missed lessons (lectures and practical) are allowed to work academic debt to a fixed period. Lectures are processed through oral questioning on the topic of missed classes and enrolled if the student answers the question posed lecturer.

The form of the final control is standardized and includes control of theoretical and practical lessons. The number of points that a student receives for each task performed correctly reflected in the module control tasks. The practical part of the tasks enables students to gain a maximum of 50 points, and answers to theoretical questions – 30 points.

The maximum number of points that a student can get at the final module control is 80.

The final module control is passed if the student scored at least 50 points.

Assessment for the module is defined as the sum of the final score for the current educational activities and points for the final module control and displayed on 200-point scale.

Evaluation subjects exposed only to students who have completed all modules in the discipline.

The number of points scored by a student in the discipline defined as the average number of points from all modules of discipline (sum of scores for all modules divided by the number of modules in discipline).

By decision of the Academic Committee to the number of points that a student get in discipline, may be added incentive points (maximum 12 points) for a prize in international competitions and the second stage nationwide student competition.

Assessment for the module is included by examiner to "Results of current and final module control" (Form No H-5.03-2), to "Individual curriculum for student", to "Journal of visits and student achievement".

Evaluation of the discipline is included by examiner to "Information of student achievement" (Form No H-5.03-1), to "Journal of visits and student achievement", to "Individual curriculum for student" and to "Creditbook".

Distribution points that are awarded to students

, quantity of hours /quanti	Number of pithy modules	r of practical	Conversion to the traditional marks		Minimal numbe
			Traditional marks	r .in di vi d u	

			"5"	**"4"**	**"3"**	**"2"**		
1st module 60/2,0	5 (№№ 1-5)	15	8	6	5	0	0	75
2nd module 90/3,0	4 (№№ 6-9)	13	9	7	6	0	0	78

The minimum score for admission to the FMC:
Module 1: 5 points x 15 = 75 points;
Module 2: 6 points x 13 = 78 points;

The maximum number of points for the module:
Module 1: 15 x 8 points = 120 points;
Module 2: 13 x 9 points = 117 points + 3 points for individual work.

Points of discipline for student who have successfully completed the program in this discipline, are converted into a traditional 4-point scale in absolute criteria as listed in the table.

According to the University scale	According to the traditional marks
180-200	«5»
150-179	«4»
149-Minimal number of points	«3»
< Minimal number of points	«2»

Students who are enrolled in one faculty, cours, specialty, according to the number of points gained in the discipline, are ranked on a scale of ECTS as follows:

ECTS	Statistical index
«A»	Top 10 % of students
«B»	Next 25 % of students
«C»	Next 30 % of students
«D»	Next 25 % of students
«E»	Latest 10 % of students

Ranking by assigning ratings of «A», «B», «C», «D», «E» is held by deans for students of appropriate course and faculty studying for one specialty and successfully completed the study subject.

Students who have been assessed «FX» and «F» («2») are not entered into the list of students that are ranked, even after retaking the module. *These students after retaking automatically receive «E».*

Estimates of discipline «FX», «F» («2») are exposed to students who have not passed at least one module in the discipline after completion of the study.

Evaluation of «FX» is assigned to students who score a minimum number of points for current educational activity, but who are not enrolled in the final module control. This category of students has the right retake the final module control by approved schedule (but no later than the beginning of the next semester). Repeating the final module control permitted a maximum of two times.

Evaluation of «F» is assigned to students who have attended all classes of the module, but did not receive the minimum number of points for current educational activity and not allowed to final testing. This category of students has the right to re-study module.

With the permission of the rector student can increase the mark of the discipline by retaking the final module control (not more than three times during the entire period of study).

Evaluation of ECTS in the traditional four-point scale is not converted because the ECTS scale and four-point scale are independent.

11. References

11.1. Basic:

1. V.I. Fediv, O.I.Olar Medical and biological physics (Vol.1: Mathematical processing of medical and biological data).– Chernivtsi: BSMU, 2010. – 147 p.
2. V.I. Fediv, O.I.Olar Medical and biological physics (Vol.2: Biomechanical and electrical principles in medicine).– Chernivtsi: BSMU, 2011. – 266 p.
3. V.I. Fediv, O.I.Olar Medical and biological physics (Vol.3: Electromagnetism and optics in medicine).– Chernivtsi: BSMU, 2013. – 194 p.
4. V.I. Fediv, O.I.Olar Medical and biological physics (Vol.4: Quantum mechanics and elements of nuclear physics in medicine).– Chernivtsi:BSMU, 2014. – 191 p.

11.2. Supplementary:

1. Raymond A.Serway, Jerry S. Faughn Colloge physics, Fifth Edition.-Saunders College Publishing.- 1999.-1029 p.
2. Marzeniuk V.P., Diduch V.D., Vakulenko D.V. et al. Biophysics and medical informatics.-Ternopil: Ukrmedkniha, 2004.-480p.
3. Hugh D. Young, Roger A. Freedman University physics with modern physics, 11th edition.-Pearson education.-2004.-1714p.
4.Frank J. Blatt Modern Physics .-McGRAW-HILL, INC.-1992.- 517 p.

11.3 Internet resources

1. Materials for MOODLE of BSMU.
2. http://amphu.org/
3. http://uamedphys.blogspot.com/
4. http://iopscience.iop.org/0031-9155/
5. www.mednavigator.net
6. http://medicalphysicsweb.org/
7. http://iomp.org/
8. http://aapm.org/default.asp
9. http://scitation.aip.org/content/aapm/journal/medphys
10. http://efomp.org/