National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of
Biomedical Engineering

RADIATION SAFETY AND DOSIMETRY

Working program educational disciplines (Syllabus)

Details educational disciplines

Level of higher education	First (bachelor's)
Field of knowledge	16 - Chemical and Bioengineering
Specialty	163 - Biomedical engineering
Educational program	Medical Engineering
Discipline status	Normative
Form acquisition higher education	Full-time (daytime)/ mixed/ online
Year of training, semester	4 course, autumn semester
Course volume	5 ECTS credits / 150 hours (lectures 36 hours, practical 36 hours, self-study 78 hours)
Terminal control/control measures	Exam, Calculation and graphic work (CGW), Module control work (MCW)
Class schedule	https://schedule.kpi.ua
Language of instruction:	English

Information about the course lecturers/ teachers

Lectures: M.D., Ph.D., Orel V.B., e-mail: orel.valeriy@gmail.com
Practical classes: M.D., Ph.D., Orel V.B., e-mail: orel.valeriy@gmail.com

Placing course: https://classroom.google.com/c/NDIwOTYxMTIxMDc0

Program educational disciplines

1. Description educational disciplines, subject and teaching results

The main goal of the academic discipline "Radiation Safety and Dosimetry" is to develop in students the ability to solve fundamental tasks and practical problems related to medical-physical and physical-chemical properties in biology and medicine, using basic theories, physical, chemical, and mathematical methods, and computer technologies.
Teaching in the discipline "Radiation Safety and dosimetry" is carried out on the basis of a student-centered approach and strategies for interactions between teachers and students, with the purpose of assimilating students' material and developing their practical skills.

The subject of study of "Radiation Safety and Dosimetry" is the basics of radiation physics and radiobiology, dosimetric quantities and units of their measurement for assessing the danger of ionizing radiation exposure during the organization of radiation safety in medical institutions, scientific institutions, enterprises and radioactive waste disposal sites.

In accordance with educational and professional programs (EP) the first "bachelor's" equal higher education, after studying the discipline, students must acquire the following **general competencies (EP put into effect by the Order of the Rector NON/434/2024 dated June 10, 2024):**

GC-1 Ability to apply knowledge in practical situations
GC-6 Ability to search, process, and analyze information from various sources
GC-10 Skills in conducting safe activities

Special (professional) competencies (EP put into effect by the Rector's Order NON/434/2024 dated June 10, 2024):

PC-2 Ability to provide engineering and technical expertise in the planning, development, evaluation, and specification of medical equipment
PC-12 Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.

The program learning outcomes after studying the discipline "Biophysics" are (EP put into effect by the Order of the Rector of the National University of Science and Technology No. 434/2024 dated June 10, 2024):

PLO-8 Understand theoretical and practical approaches to the creation and management of medical equipment and medical technology
PLO-12 Provide recommendations for selecting equipment to facilitate diagnosis and treatment

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the relevant educational program)

The academic discipline "Radiation Safety and dosimetry" has an interdisciplinary applied character. It integrates, in accordance with its subject, knowledge from other academic disciplines: physics, biophysics, higher mathematics, human anatomy and physiology, etc. According to the structural and logical scheme of the specialist training program, the discipline "Radiation Safety and dosimetry" is closely related to other disciplines of general and professional training: "Biophysics", "Fundamentals of Clinical Engineering and radiology". Her directly precedes discipline "Foundations clinical engineering and radiology.

Practical skills acquired and theoretical knowledge acquired while studying the academic discipline "Radiation safety and dosimetry" can use in further under time mastering academic disciplines:

- with cycle professional preparation (educational and professional program "Medical engineering"): "Biomedical devices, devices and complexes".

- with selective disciplines (educational and professional program "Medical engineering"):

"Therapeutic" medical machinery", "Development and operation physiotherapy medical devices", "Treatment and diagnostic complexes on basis biophotonic converters".

3. Content educational disciplines

Main topics that will be covered during the course:

Topic 1. Physical and technical foundations ionizing radiation.

Topic 2. Medical and physical aspects interactions ionizing radiation with substance.

Topic 3. Doses and units' measurement ionizing radiation and analysis in accordance with the recommendations of the National Bank of Ukraine-97.

Topic 4. Engineering methods and appliances dosimetry ionizing radiation.

Topic 5. Cellular and organ effects of ionizing radiation.

Topic 6. Dosed load and maximum permissible levels irradiation in medicine.

Topic 7. Regulatory and legal documents in industries radiation security according to from standards.

Topic 8. Possession physical and technical principles equipment and radiation security for radiation diagnostics and therapy.

Topic 9. Modular test Topic 10. Calculation and graphic work

4. Educational materials and resources

Basic literature:

1. Handbook of basic knowledge and health effects of radiation. Vol. 1. Radiation health management division, Environmental health department, Minister's Secretariat, Ministry of the Environment, Government of Japan, 2019. – p. 254.
2. Handbook of accidents at TEPCO's Fukushima Daiichi NPs and thereafter (initiatives by ministries and agencies). Vol. 2. Radiation health management division, Environmental health department, Minister's Secretariat, Ministry of the Environment, Government of Japan, 2019. – p. 206.
3. IAEA safety standards for protecting people and the environment: General Safety Guide No. GSG-8. International Atomic Energy Agency, Vienna, 2018. – p. 76.
4. A. Martin, S. Harbison, K. Beach, P. Cole. An introduction to radiation protection. Seventh edition. CRC Press. 2018. – p. 434.
5. Richard J. Vetter, Magdalena Stoeva. Radiation protection in medical imaging and radiation oncology. CRC Press, 2016. - p. 512.

Additional literature:

6. R. Antoni, L. Bourgois. Applied physics of external radiation exposure dosimetry and radiation protection. Springer, 2017. – p. 484.
7. Ben Greenebaum, Frank Barnes. Handbook of biological effects of electromagnetic fields. Vol 1. Fourth edition, CRC Press, 2019. – p. 651.
8. Ben Greenebaum, Frank Barnes. Handbook of biological effects of electromagnetic fields, Vol 2. Fourth edition, CRC Press, 2019. – p. 537.
9. F. Paquet, M.R. Bailey, R.W. Leggett, J. Lipsztein, J. Marsh, T.P. Fell, T. Smith, D. Nosske, K.F. Eckerman, V. Berkovski, E. Blanchardon, D. Gregoratto, J.D. Harrison. Occupational intakes of radionuclides: Part 3. ICRP publication 137. Ann. ICRP 46(3/4). SAGE, 2017. – p. 491.
10. Y. Lemoigne, A. Caner. Radiation protection in medical physics (NATO Science for peace and security series B: physics and biophysics). Springer, 2011. – p. 213.

Educational content

5. Method mastery educational disciplines (educational component)

Under time study educational material are applied next methods teaching:

Lectures are held using the explanatory and illustrative method, the problem-based presentation method, and the interactive method during lecture sessions, which is used to establish a dialogue with the audience.

Practical occupation passes with using:

1) A reproductive method, thanks to which students consolidate the studied theoretical material and learn to use it in specific tasks.

2) Partially searchable, or heuristic method, which teaches search faithful ways and problem-solving methods.

3) Interactive method, which is used during laboratory classes for involving students in problem-solving processes and the theoretical facts used for this purpose.

4) Presentation and discussion received results provides using problem-based and interactive learning methods.

5) Mathematical modeling.

Lower given calendar plan carrying out classes.

No.	Topic	Program learning outcomes	Control	Term implementation
1	**Introduction and history subject. Radiation security in medicine.** Part 1. Key principles of radiation safety in medicine and risk management in the operation of medical equipment. Part 2. Bioengineering and technical expertise during radiation protection planning for medical equipment (assessment and specification of requirements).	PLO 8	Practical work 1	1st week
2	**Types of ionizing radiation. Interaction ionizing radiation with substance.** Part 1. Types of ionizing radiation and physical models of their interaction with matter. Part 2. Justification of technical parameters of sources and screens in the specification of medical equipment, taking into account safety requirements and biomedical ethics.	PLO 8	Practical work 2	2nd week
3	**Biological effects ionizing radiation.** Part 1. Biological effects of ionizing radiation: mechanisms of action, tissue reactions. Part 2. Risk/benefit assessment when planning diagnostic and therapeutic procedures using medical equipment.	PLO 8	Practical work 3	3rd week
4	**Physical foundations methods dosimetry ionizing radiation.** Part 1. Physical foundations of dosimetry: detectors, measurement methods and calibration. Part 2. Recommendations for choosing dosimetric equipment.	PLO 8 PLO 12	Practical work 4	4th week
5	**Units of measurement of ionizing radiation.**	PLO 8	Practical work 5	5th week

	Part 1. Units of measurement of ionizing radiation: activity, exposure, absorbed, equivalent and effective dose; calculations and data analysis. Part 2. Selection of devices and software for dose monitoring and documentation with control of safety compliance when working with medical equipment.	PLO 12		
6	**Sequence processes, which lead to radiation damage.** Part 1. Sequence of physicochemical and biological processes leading to radiation damage; dose-effect relationship. Part 2. Damage prevention measures: control of equipment parameters, organization of radiation protection and safe work.	PLO 8	Practical work 6	6th week
7	**Physics X-ray radiation.** Part 1. Physics of X-ray radiation: generation, spectrum, filtering, collimation; control of X-ray system modes. Part 2. Recommendations for the selection of X-ray equipment based on dose characteristics and radiation safety and biomedical ethics requirements.	PLO 8 PLO 12	Practical work 7	7th week
8	**Modular control work.** Part 1. Knowledge control on the physical foundations of ionizing radiation and dosimetry methods. Part 2. Solving bioengineering problems: dose assessment, selection of protective equipment, justification of safe operation of medical equipment.	PLO 8 PLO 12	Writing MCW	7th week
9	**Technical means X-ray equipment.** Part 1. Technical means of X-ray technology (generator, tube, collimator, detector): examination criteria. Part 2. Recommendations for the specification, acceptance control and safe operation of X-ray equipment in compliance with biomedical ethics.	PLO 12	Practical work 8.9	8–9th week
10	**Calculation and graphic work.** Part 1. Calculation of dose rates and radiation protection parameters for typical medical diagnostic and treatment procedures. Part 2. Preparation of technical recommendations for the selection/assessment of equipment (dosimetry, protective equipment, quality control) and preparation of safety documentation.	PLO 8 PLO 12	Design and sending abstract.	9th week
11	**Physical and technical foundations X-ray computer tomography.** Part 1. Physical and technical foundations of CT: detectors, reconstruction, dose factors; control of scanning parameters and optimization of protocols. Part 2. Recommendations for the selection of CT equipment and protocols based on image quality and radiation safety criteria (bioengineering assessment and specification).	PLO 8 PLO 12	Practical work 10	10th week
12	**Technical means and security MRI security in medicine.** Part 1. MRI technical equipment (magnet, radiofrequency coils) and safety factors when working with medical equipment (implants,	PLO 12	Practical work 11	11th week

	heating). Part 2. Engineering and technical expertise, specification and control of safe MRI operation.			
13	**Methods and equipment radial therapy.** Part 1. Radiation therapy methods and equipment, dosimetric provision and quality control. Part 2. Selection and evaluation of radiation therapy equipment with provision and control of radiation safety.	PLO 12	Practical work 12.13	12–13th week
14	**Nuclear medicine. Medical and physical foundations.** Part 1. Nuclear medicine: medical and physical foundations (radionuclides, decay, detectors); calculation of activity and dose loads. Part 2. Recommendations for the selection of equipment (SPECT / PET, gamma camera) and protective equipment; monitoring of compliance with the safety of personnel and patients.	PLO 8 PLO 12	Practical work 13	13-14th week
15	**Regulatory documents with radiation security.** Part 1. Regulatory documents on radiation safety in medicine: standards, regulations, requirements for documentation and audit. Part 2. Procedure for engineering and technical expertise and control of safety compliance when working with medical equipment.	PLO 12	Practical work 14	14th week

Platform remote teaching:

For better assimilation of the subject material during distance learning, it is used electronic mail, platform remote teaching "Sikorsky" based on systems Google Classroom and platform for carrying out online meetings Google Meet and ZOOM, which allow you to:

- simplifies placing methodical recommendations, educational materials, literature, etc.

- is carried out reverse connection from students of educational tasks and the content of the academic discipline.

- are being checked and are evaluated completed task.

- is underway accounting implementation students plan educational disciplines, adherence to the schedule for submitting educational/individual assignments and their evaluation

6. Independent work student

Types of independent work *(preparation for classroom lessons, calculations based on primary data obtained in laboratory classes, solving problems, writing an essay, performing calculation work, completing homework tests, etc.):*

No.	Types of work submitted for independent processing	Number hours of self-study work
1	Review of lecture material and study of questions assigned for independent work	20
2	Preparation for practical classes	18
3	Preparation for the modular control work	3
4	Performing calculation and graphic work	7
5	Exam preparation	30
	Total	78

Distribution of hours of independent work of students by educational content topics

No.	Titles of topics and questions to be studied independently and references to literature	Number of hours of self-study
1	Statistical premises of radiation measurements and processing of dosimetric data: estimation of standard uncertainty and confidence intervals; construction and analysis of the calibration characteristic of a dosimeter [4, 6, 10].	3
2	Metrological characteristics of ionizing radiation detectors: sensitivity, detection threshold, energy dependence [4, 6, 10].	3
3	Bioengineering calculations of radiation protection of workplaces and medical premises: contribution of scattered radiation, requirements for the selection of protective barriers [4, 5, 6, 10].	3
4	Contamination, decontamination and handling of radioactive materials and waste in healthcare facilities: classification of contamination (surface/bulk) and control methods; decontamination principles and efficiency criteria; temporary storage, labeling, accounting and transportation of radioactive waste in healthcare facilities [2, 3, 5, 10].	3
5	Biological dosimetry and quantitative criteria for radiation damage: a comparison of deterministic and stochastic effects in the context of medical exposure [1, 4, 5].	3
6	Assessment of internal exposure: routes of radionuclide entry and model concepts of biodistribution ; principles of converting activity into absorbed/equivalent/effective dose [4, 9, 10].	3
7	Terminology and classification of radiation protection values and regulated levels in medicine: “dose limit”, “control levels”; interpretation of units and derived quantities (kerma, absorbed, equivalent, effective dose); key definitions of radiation safety of the population and personnel [3, 4, 10].	2

One of the main types of semester control during the mastering of the academic discipline "Radiation safety and dosimetry" is the execution of CGW. CGW is performed in accordance with the requirements, within the period specified by the teacher.

The main goal of CGW is to solve a practical problem using theoretical material learned in lectures and independently, and practical skills obtained in practical classes. A student can write a computational and graphical work only on a topic agreed with the teacher.

Policy and CONTROL

7. Policy educational disciplines (educational component)

7.1 Incentives points

Incentives points		**Violation terms deadline***	
Criterion	*Gravimetric mark*	*Criterion*	% decrease assessments
Improve practical works	*1 mark (for each practical work)*	*Untimely execution and submission of MCW*	From -10% to -20% per task (depends on term delivery)
Passage remote courses on topics agreed with teachers	*5 points*	*Untimely execution and submission of CGW*	From -10% to -20% per task (depends on term delivery)
Design scientific works to participate in the student research paper competition	*10 points*	*Late submission of abstracts*	From -10% to -20% per task (depends on term delivery)

Writing theses, articles, participation in international, all-Ukrainian and/or other events or competitions on the topic educational disciplines	*5 points*		

* If control West was missed with respectable reasons (disease, which confirmed reference established sample) – Violation of deadlines does not apply.

However, according to position https://osvita.kpi.ua/node/37 clause 2.7, sum incentive/ penalty points cannot exceed 10% of the rating scale.

7.2 Regulations visiting classes

Attending lectures Classes are not mandatory. Attending practical classes is desirable, as they include writing express control papers/tests, and also defending practical papers.

System evaluation oriented on receiving points by activity student, and as well as completing tasks that can develop practical skills and abilities.

7.3. Regulations implementation individual task

Main target CGW – solution practical tasks with using learned on lectures and independently theoretical material, and practical skills obtained in practical work. A student can write a CGW only on a topic agreed with the teacher.

Approximate subject computational and graphic works:

No.	Topic
1	Physical and technical principles thermoluminescent dosimetry.
2	Individual dosimetry in medical institutions.
3	Methods micro- and nanodosimetry.
4	Methods biological dosimetry.
5	Methods measurement radioactive aerosol and gases.
6	Construction clinical dosimeters.
7	Construction individual dosimeters.
8	Verification and calibration of dosimeters.
9	Metrology devices for measurement ionizing radiation.
10	Devices for locking and alarming X-ray rooms.

* Student maybe perform and another topic computational and graphic works by own desire, agreed with the teacher.

The title page of the calculation and graphic work should have the following content: name of the university; name of the faculty; name of the department; name of the specialty, name of the educational and professional programs, name educational disciplines; topic computational and graphic work; student's last name and first name, course, academic group number, year.

The title page is followed by a detailed plan (table of contents) of the calculation and graphic work, which should include an introduction, sections of the main content (the main topics studied), their subdivisions (if necessary), a conclusion, and a list of sources used. The table of contents indicates the page numbers of the beginning of each question on the right. Each section begins on a new page.

The total volume of computational and graphical work, depending on the chosen topic, can vary from 15 to 25 pages of the main text (as agreed with the teacher). The volume of computational and graphical work works is determined skilled student succinctly and simultaneously comprehensively explain and analyze the obtained data in the IBM SPSS Statistics package.

Mandatory requirement: clear reference to sources of information. All figures, facts, opinions of scientists, quotes, formulas must have link in in the form of [2, with. 54] (first figure means the number of the source in the list of references given at the end of the creative work, and the second number is the page number in this source). It is advisable to use tables, diagrams,

graphs, charts, etc.

List used sources (not Less 10 sources) is being drawn up according to with current rules. If the information is taken from the Internet, it is necessary, as for ordinary literature, to indicate the author, the title of the article, and then provide the address of the Internet site.

Calculation and graphic work are evaluated according to the following criteria: logicality of the plan; completeness and depth of disclosure of the topic; reliability of the data obtained; reflection of practical materials and results calculations; correctness formulation conclusions the results and conclusions obtained; design; justification of the student's own opinion on this issue in the form of a conclusion.

Deadline for submitting calculation and graphic work for review: 12-13th week of study.

Calculation and graphic work are not checked for plagiarism but must meet the requirements academic virtue. IN case detection academic not integrity, the work is canceled and not checked.

7.4. Policy extreme terms and rearrangements

Missed control measures (defense of practical works) must be completed in the following classes, provided that they are completed an assignment that is scheduled for the current lesson or during consultations.

Omission writing modular control works and express control are not being worked out.

Calculation and graphic work, which is served on verification with violation The execution period is evaluated with a decreasing number of weight points.

7.5. Procedure appeal results control events

Students have the opportunity to raise any issue related to the examination procedure and expect it to be addressed according to predetermined procedures.

The student has the right to appeal the results of the control measure in accordance with the approved regulations on appeals at Igor Sikorsky Kyiv Polytechnic Institute (approved by order No. NON/128/2021 from 20.05.2021 (r.) - https://osvita.kpi.ua/index.php/node/182

7.6. Remote teaching

Remote teaching is happening through Platform remote teaching "Sikorsky".

Distance learning through additional online courses on certain topics is allowed. by conditions coordination from students. IN case, if small number of students have a desire to take an online course on a certain topic, studying the material through such courses is allowed, but students must complete all the tasks provided for in the academic discipline.

List courses offered teacher after detection desire students (since the bank of available courses is updated almost every month).

The student provides a document confirming completion of the distance learning course (in case of completing the full course) or provides completed laboratory assignments from the distance learning course and by conditions passage oral interviews with teacher by passed topics can receive grades for the control measures provided for the topics studied.

7.7. Teaching foreign in the language

Teaching in English in the language is carried out only for foreign students.
By desire students, allowed study material by with help English-language online courses on topics that correspond to the topics of specific classes.

7.8. University policy

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code

Norms ethical behavior

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More information: https://kpi.ua/code

8. Types control and rating system evaluation results teaching (ERT)

No	Control	%	Mark	Number	Total
1.	Express survey / note-taking abstract	30	6	5	30
2.	Modular control work	15	15	1	15
3.	Calculation and graphic work	15	15	1	15
4.	Exam	40	40	1	40
	Total				100

In order to receive the highest rating, the student must: complete and submit the CGW in a timely manner; complete the MCW in a timely manner.
A student may appeal a teacher's grade by submitting a complaint to the teacher no later than the day after the student is informed of the grade. The complaint will be considered according to the procedures established by the university.

Admission requirements for semester control: answering five express surveys or taking notes on essays, completing MCW and CGW.

Table compliance rated points assessments by university scale

Number points	Score
100- 95	Excellent
94- 85	Very good
84- 75	Good
74- 65	Satisfactory
64- 60	Enough
Less 60	Unsatisfactory
Not completed conditions admission	No admitted

9. Additional information with disciplines (educational component)

A list of questions for preparing for the module test, as well as for preparing for the exam, is provided in Appendix 1.
Distance learning through additional online courses on a specific topic is permitted subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material through such courses is permitted, but students must complete all tasks provided for in the academic discipline.
List courses offered by the teacher after detection students' wishes (because the bank of available courses is updated almost every month).
The student provides a document confirming completion of the distance learning course (in the case of completing the full course) or provides completed practical tasks from the distance learning course and, subject to passing an oral interview with the teacher on the topics covered, may receive grades for the control measures provided for the topics studied (express control / test tasks, practical work).
Inclusive teaching included.

Addition 1 to syllabus discipline "Radiation safety and dosimetry"

List of questions for preparation for the module test, as well as for exam preparation

1. Basic properties ionizing radiation, doses and units their measurement.
2. Difference between excitation from ionization effects?
3. To bring percentage distribution doses irradiation human.
4. Dates definition corpuscular and electromagnetic radiation.
5. Analyze difference between Compton and photovoltaic effects.
6. To bring definition effect annihilation.
7. Analyze types ionizing radiation.
8. Justify effects interactions ionizing radiation with substance.
9. Analyze features interactions neutron radiation with substance.
10. To bring principles works dosimeters for registration ionizing radiation.
11. Natural sources of electromagnetic fields and ionizing radiation.
12. Artificial sources electromagnetic fields and ionizing radiation.
13. Parameters ionizing radiation.
14. What imagines by yourself braking X-ray radiation. Main properties.
15. Formation and interaction alpha particles with substance.
16. Formation and interaction beta particles with substance.
17. Formation and interaction gamma radiation with substance.
18. To bring description and characteristics sources radiation ionizing radiation.
19. Write criteria absorbed doses and their values: low, high and average.
20. Definition and units' measurement equivalent doses ionizing radiation.
21. Analyze sequence processes, which are leading to radiation damage.
22. To bring dependence of the average human lifespan from quantities absorbed dose.
23. Analyze effect actions radiation on water.
24. Analyze effect actions radiation on nucleic acids.
25. Analyze effect actions radiation on proteins.
26. Analyze effect actions radiation on lipids.
27. Dates definition relative biological efficiency irradiation.
28. Analyze principles biological actions ionizing irradiation.
29. Explain likely nature radiobiological effects.
30. IN Why consists of radioprotective effect and mechanism its actions?
31. Dates explanation primary and secondary processes in forming radiation damage to cells and organisms.
32. Dates definition relative biological efficiency irradiation.
33. Analyze principal theories targets.
34. IN Why consists of rule (law) Bergonié and Tribondeau?
35. Give definition law radiobiology HR Withers 4R.
36. Biological dosimetry.
37. Name the principles of treatment with radiation damage.
38. What is the difference between stochastic and deterministic effects?
39. Dates definition - lethal doses 50/30.
40. Name the principles of treatment with radiation damage.
41. Difference is sensitivity to radiation of different organs organism.
42. To bring physical and technical principles X-ray diagnostic systems.
43. Which exist criteria qualities aperture X-ray radiation?
44. Principle registration X-ray image.
45. Analyze quality medical X-ray image.
46. To bring concept digital image.
47. Principle works systems "screen- film".
48. To present the physical and technical principles of image acquisition in X-ray computed tomography.
49. Analyze requirements to radiation security in X-ray diagnostics.
50. To bring physical foundations nuclear magnetic resonance (MRI).
51. Security at MRI diagnostics.
52. Analyze methods obtaining radionuclides.
53. Describe the physical and technical principles gamma cameras.

54. Radiation security in nuclear medicine.
55. Physical and technical principles radial therapy.
56. Radiation security in beam therapy.
57. Reveal content "Norm" radiation security Ukraine» (NRBU -97).
58. To bring main regulated quantities NRBU- 97.
59. To bring quantities and units, what are used according to with NRBU- 97.
60. To bring list main standards IAEA with radiation security.
61. To bring regulatory levels maximum dose load irradiation.
62. To bring foundations radiation protection patients in X-ray diagnostics.
63. To bring foundations radiation protection patients in nuclear medicine.
64. To bring foundations radiation protection patients in beam therapy.
65. Which lessons passed with previous accidents at medical irradiated?
66. Analyze the requirements for radiation control in rooms and departments for radiation diagnostics and therapy.
67. Analyze requirements with radiation personnel protection.
68. To bring description and picture device for locking and alarms premises, where ionizing radiation is used.
69. To bring methods definition radiation loads on patients.
70. Definition and units' measurement collective doses irradiation.
71. Analyze ways reduction doses, received patients.
72. To bring requirements to radiation protection patients.
73. What size minimal registered doses ionizing radiation and What dosimetry method is used for this?
74. Basic task State inspections nuclear regulation Ukraine.
75. To bring examples liquidation accidents at medical irradiation.
76. Analyze requirements to offices radial therapy.
77. Analyze requirements to offices radial diagnostics.
78. As affects non-ionizing radiation on organism human. What limit safe doses of non-ionizing radiation from mobile phones?

Appendix 2 to syllabus with disciplines "Radiation Safety and Dosimetry"

Program learning outcomes (extended form)

As a result of studying the academic discipline "Radiation Safety and Dosimetry", students will be able to:

Learning outcomes		Relevance of learning outcomes to competencies in the educational and professional program	
		General competencies (**soft skills**)	Special competences (**professional**)
PLO 8	Understand theoretical and practical approaches to the creation and management of medical equipment and medical technology.	*Ability to apply knowledge in practical situations.*	*Ability to provide engineering expertise in the planning, development, evaluation, and specification of medical equipment.*
PLO 12	Provide recommendations on the selection of equipment to ensure diagnosis and treatment	*Ability to search, process and analyze information from various sources. Skills for carrying out safe activities.*	*Ability to ensure and monitor compliance with safety and biomedical ethics when working with medical equipment.*

Description logistical and informational software disciplines

The main one's methods there are conversation, independent work and work in groups, visual methods learning, practical exercises. To activate cognitive activity, problem-based learning methods, trap tasks, discussions, game and interactive methods, project methods, etc. are used. Individual, pair and group forms of learning, as well as game forms of conducting classes are relevant.

Working program educational disciplines (syllabus):
Compiled Orel V.B.;
Approved by department BME (protocol No. 16 from 21/06/2024)
Approved by methodical by commission faculty BME (protocol No. 9 from 26/06/2024)