Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Institution of Higher Education
“National Research Nuclear University “MEPhI”

INSTITUTE OF ENGINEERING PHYSICS FOR BIOMEDICINE

APPROVED НТС ИФИБ

Protocol No. 3.1

dated 30.08.2024

ACADEMIC COURSE OUTLINE

РАДИОЛОГИЯ И РАДИОТЕРАПИЯ / RADIOLOGY AND RADIOTHERAPHY

Educational program track (speciality) [1] 31.05.01 General Medicine

Semester	**Labour input, credits**	**Total course academic, hours**	**Lectures, hrs.**	**Practical sessions, hrs.**	**Laboratory sessions, hrs.**	**In the form of practical studies, hrs.**	**Independent studies, hrs.**	**Independent studies monitoring, hrs.**	**Course progress, Exam/Pass-fail exam/Term**
11	3	108	20	40	0		48	0	PFE
Total	3	108	20	40	0	40	48	0	

ABSTRACT

This course provides knowledge, skills, and abilities in the field of radiology. Students are introduced to the fundamental principles of radiotherapy, the specifics of organizing radiological care for the population, study the basic methods of radiotherapy, and become familiar with modern principles of treating cancer patients.

1. ACADEMIC COURSE GOALS AND OBJECTIVES

The purpose is to develop a holistic understanding of radiation therapy as an independent scientific and practical discipline, familiarize students with the fundamental principles of radiation therapy, the specifics of organizing radiological care for the population, study the basic methods of radiotherapy, and familiarize them with modern principles of treating cancer patients.

Objectives:

- To develop a holistic understanding of radiation therapy as an independent scientific and practical discipline;
- To familiarize students with the fundamental principles of radiation therapy and the specifics of organizing radiological care for the population;
- Developing the ability to determine indications and contraindications for radiation therapy based on knowledge of the advantages and limitations of radiation treatment methods;
- Developing the ability to select a rational radiotherapy method, taking into account the characteristics of the course and severity of the disease and in accordance with clinical guidelines;
- Developing the ability to evaluate the effectiveness and safety of the prescribed treatment.

2. PLACE OF THE ACADEMIC COURSE IN THE MAIN HIGHER EDUCATION CURRICULUM

This course is a logical continuation of such disciplines as radiology, radiopharmaceuticals, oncology, and diagnostic practice.

The study of this course is preceded by the study of the following disciplines: Medical and Biological Physics, Radiobiology, Topographic Anatomy and Operative Surgery, Pathological Anatomy and Physiology, Medical Informatics, Artificial Intelligence in Medicine, Internal and Surgical Diseases (faculty and hospital courses), and other clinical disciplines.

The knowledge, skills, and abilities acquired through mastering this course are necessary for solving professional problems.

3. DEVELOPED COMPETENCIES AND INTENDED LEARNING OUTCOMES

Universal and/or general professional competencies:

Competency code and title	**Code and title of competency-based rubrics**
ОПК-7 [1] – Capable of prescribing treatment and monitoring its effectiveness and safety.	З-ОПК-7 [1] – Know: - pharmacological groups of medicinal drugs and their intended purposes; - mechanisms of action of pharmacological and non-pharmacological treatments, indications and contraindications for their use, side effects, and complications caused by their application; - methods for

	monitoring the effectiveness and safety of various treatment approaches. У-ОПК-7 [1] – Be able to: - make rational choices for pharmacological and non-pharmacological treatments based on clinical guidelines and in accordance with medical care standards; - develop a treatment plan for a disease or condition considering the diagnosis, age, disease course characteristics, and comorbidities, based on clinical guidelines and medical care standards; - prescribe medications, medical devices, and therapeutic nutrition considering the diagnosis, age, disease course characteristics, and comorbidities, based on clinical guidelines and medical care standards; - justify prescribed pharmacological and non-pharmacological treatments; - evaluate the effectiveness and safety of medications, medical devices, therapeutic nutrition, and other treatment methods. В-ОПК-7 [1] – Possess skills in: - administering medications through various routes of administration; - developing treatment plans for diseases or conditions considering diagnosis, age, disease course characteristics, and comorbidities; - assessing the effectiveness and safety of prescribed treatments.

4. PEDAGOGIC POTENTIAL OF THE COURSE

Pedagogic tracks/objectives	**Pedagogic goals (code)**
Professional education	Establishing conditions for: formation of responsibility for professional choice, professional development and professional decisions (B18)
Professional education	Establishing conditions for: formation of motivation to improve the quality of medical care to the population and the desire to follow the rules and norms of interaction between the doctor, colleagues and the patient, contributing to the creation of the most favorable environment for the patient's recovery (B34)

5. ACADEMIC COURSE STRUCTURE AND CONTENT

Academic course sections, their scope, terms of study and assessment:

No.	**Academic course section name**	**Weeks**	**Lectures/ Practical (seminars)/ Laboratory sessions, hrs.**	**Compulsory current assessment (form*, week)**	**Maximum grade per section****	**Section assessment (form*, week)**	**Competency-based rubrics**
	11 Semester						
1	The First Section	1-8	10/20/0	T-6 (25)	25	T-8	3-ОПК-7,

							У-ОПК-7, В-ОПК-7
2	The Second Section	9-15	10/20/0	Т-14 (25)	25	Т-15	З-ОПК-7, У-ОПК-7, В-ОПК-7
	Totals for 11 Semester		20/40/0		50		
	Assessment events for 11 Semester				50	PFE	З-ОПК-7, У-ОПК-7, В-ОПК-7

* – abbreviated name of assessment

** – 100 maximum points per semester including a pass/fail exam and (or) an exam

Abbreviated current assessment forms and section assessment

Abbreviation	Full name
T	Testing
PFE	Pass/fail examination

SYLLABUS

Weeks	Topics / Content	Lect., hrs.	Pr./sem., hrs.	Lab., hrs.
	11 Semester	20	40	0
1-8	**The First Section**	10	20	0
1 - 2	**Fundamentals of Nuclear Physics.** Radiation Sources. Ionizing Radiation Dosimetry. Dosimeters	All		
		2	5	0
		Online		
		0	0	0
3 - 8	**Organization of work with ionizing radiation sources.** Radiation protection. Radiometric equipment. Design of a radionuclide diagnostic laboratory.	All		
		8	15	0
		Online		
		0	0	0
9-15	**The Second Section**	10	20	0
9 - 15	**Physical Principles of Radiation Therapy.** Dose Calculation. Dose Fields. Technological Fundamentals of Radiation Therapy. Contact Irradiation Methods. External Beam Radiation Therapy. Radiation Therapy of Malignant Tumors. Working in the Radiation Therapy Department. Working in the Radiology Department. Radiation Reactions and Complications in Radiation Therapy. Chronic Radiation Sickness. Prevention and Treatment. Radionuclide Thyroid Studies. Radiation Detection of Tumors. Radionuclide Studies of the Digestive and Excretory Organs.	All		
		10	20	0
		Online		
		0	0	0

Abbreviated names of online options:

Abbreviation	Full name
EC	E-course
FtM	Full-text material
FtL	Full-text lectures

VM	Video materials
AM	Audio materials
Prs	Presentations
T	Tests
ERM	E-reference materials
IS	Interactive site

PRACTICAL SESSIONS TOPICS

Weeks	**Topics / Content**
	11 Semester
1 - 2	**Fundamentals of Nuclear Physics Radiation sources.** Ionizing radiation dosimetry. Dosimeters. Atomic structure. Corpuscular and photon radiation. Radioactivity, activity units. Half-lives. Properties of ionizing radiation. Characteristics of the absorbed radiation energy in an object. Units of ionizing radiation dose. Dose rate. Maximum permissible dose (MPD). Dosimetry methods. Dosimeters. Organization of dosimetric monitoring in the radiation diagnostics and therapy department.
3 - 4	**Organization of work with ionizing radiation sources.** Radiation protection. Sealed and open sources of ionizing radiation. Principles of protection against radiation and radioactive contamination. Stationary and mobile protective devices, personal protective measures for personnel. Layout of a radiology department. Organization of dosimetric monitoring in the radiation diagnostics and radiology department. Radiodiagnostic research methods. Indications and contraindications. Radiation protection during examination and treatment of children. Indications and contraindications for employment with ionizing radiation sources.
5 - 6	**Radiometric equipment.** Layout of a radionuclide diagnostic laboratory. Radiometers (clinical radiometers, scanners, thyrographs), their design principles, and purposes. Methods for recording ionizing radiation in radionuclide diagnostics. Layout of a radionuclide laboratory and operating procedures. Support unit, diagnostic rooms. Visit to the ultrasound diagnostic room. Equipment and the principle of ultrasound imaging.
7 - 8	**Radionuclide imaging.** Radiation detection of tumors. Radionuclide thyroid imaging methods (radiometry, scanning, radiocompetitive assays). Thyroid ultrasound. Radionuclide imaging of the digestive and excretory organs. Radionuclide imaging of the hepatobiliary system (radiometry, scanning, dynamic gamma scintigraphy). Ultrasound imaging of the liver, gallbladder, and pancreas. Radionuclide imaging in urology and nephrology (renography, dynamic gamma scintigraphy). Introduction to these imaging methods in the radionuclide diagnostic laboratory and ultrasound room. Analysis of imaging data.
9	**Physical principles of radiation therapy.** Dose calculation. Dose fields. Dose distribution characteristics in the human body depending on the type of external irradiation. Dosimetric assessment of absorbed radiation energy. Interaction of ionizing radiation with matter. Comparison of topograms.
10	**Technological Fundamentals of Radiation Therapy.** Methods of contact radiation. Design of radiation therapy devices. Gamma-therapy and X-ray therapy units, betatrons, and linear accelerators. Principles and techniques of clinical topometry. Methods of contact radiation (application, intracavitary, interstitial). Indications and contraindications. Radiation sources. Combined radiation therapy.
11	**External beam radiation therapy methods.** External beam X-ray therapy units (indications for treatment and methods of irradiating tumors and non-neoplastic diseases). External beam gamma therapy units (indications and contraindications for treatment). Devices for shaping dose fields during external beam

	gamma therapy. Static and mobile gamma therapy. Combining external beam radiation methods with other treatment modalities. Planning and implementation of tumor radiation therapy.
12	**Radiation therapy for malignant tumors.** Work in the radiology department of the regional department. Familiarization with the preparation of patient records for the radiology department. Review of the radiology department's layout, visits to radiation therapy rooms (external beam close-focus X-ray therapy, external beam gamma therapy). Familiarization with patient records. Analysis of radiation techniques for patients with malignant tumors. Observation of radiation therapy sessions. Demonstration of patient positioning for irradiation. Clinical assessment of patients undergoing external beam gamma therapy. Patient management, writing educational case records (determination of radiation technology, radiation therapy plan, preparation of topograms).
13	**Radiation reactions and complications during radiation therapy.** Prevention and treatment. General radiation reactions to ionizing radiation during radiation therapy, their manifestations, prevention, and treatment methods. Local radiation reactions to the skin, mucous membranes, and organs. Local radiation injuries: early and late. Prevention and treatment of radiation complications.
14 - 15	**Chronic radiation sickness.** Causes. Clinical features. Diagnosis. Treatment. Prevention. Indications and contraindications for employment with ionizing radiation sources.

6. EDUCATIONAL TECHNOLOGIES

The course is using methods based on modern advances in science and information technology in education. These methods are aimed at improving the quality of specialist training by developing students' creativity and independence. For this purpose, both traditional teaching methods (lectures, clinical practical classes) and interactive seminars and clinical case studies are used:

- training-based practical classes (clinical case studies, cases, role-playing in the form of clinical case studies or patient supervision);
- interactive clinical case studies with patient demonstrations;
- engaging students in preclinical and clinical research, preparing presentation materials, reports, essays, or papers.

7. ASSESSMENT TOOLKIT

The assessment toolkit ensures verification of the intended learning outcomes achievement (competency-based rubrics) using current, midterm and interim assessment of the course.

The link between developed competencies and their assessment is presented in the following table:

Competency	**Achievement rubrics**	**Assessment activity (Syl 1)**
ОПК-7	З-ОПК-7	PFE, T-8, T-15, T-6, T-14
	У-ОПК-7	PFE, T-8, T-15, T-6, T-14
	В-ОПК-7	PFE, T-8, T-15, T-6, T-14

Educational achievement rubrics scales

The scale of each assessment activity varies from 0 to the maximum established point, inclusive. The final assessment of the course is performed on a 100-point scale and represents the sum of the points earned by the student in the section assessments, framework of current and interim assessment.

Sections and interim assessments are considered passed when the student achieves a minimum score equal to 60% of the maximum. The final grade is assigned only upon passing all sections and the interim assessment.

The final grade is assigned in accordance with the following scale:

<table>
<tr><th>Total score</th><th>Rating on a 4-point scale</th><th>Pass/fail examination</th><th>ECTS assessment</th></tr>
<tr><td>90-100</td><td>5 – «excellent»</td><td rowspan="7">«pass»</td><td>A</td></tr>
<tr><td>85-89</td><td rowspan="3">4 – «good»</td><td>B</td></tr>
<tr><td>75-84</td><td>C</td></tr>
<tr><td>70-74</td><td rowspan="2">D</td></tr>
<tr><td>65-69</td><td rowspan="2">3 – «satisfactory»</td></tr>
<tr><td>60-64</td><td>E</td></tr>
<tr><td>below 60</td><td>2 – «fail»</td><td>«fail»</td><td>F</td></tr>
</table>

An “excellent” grade indicates a deep and solid mastery of the program material by a student who presents their answers consistently, clearly, and logically, is able to closely link theory with practice, and uses materials from monographic literature in their answers.

A “good” grade corresponds to a student’s solid knowledge of the material, who presents their answers competently and to the point, without any significant inaccuracies.

A “satisfactory” grade corresponds to the basic level of mastery of the material by the student, in which the main material has been mastered, but its details have not been assimilated, the answers contain inaccuracies, insufficiently correct wording and logical inconsistencies.

A grade “pass” corresponds to at least a basic level of mastery of the program material, in which the student possesses the necessary knowledge, skills, and abilities, and is able to apply theoretical principles to solve typical practical problems.

A grade “fail” is given to a student who lacks a significant understanding of the curriculum material, makes significant errors in their answers, or fails all required assignments. These students are generally unable to continue their studies without additional classes.

8. ACADEMIC COURSE EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT

CORE READING:

1. ЭИ D53 Diagnostic radiology : учебник, Akiev R.M., Alekseev K.N., Trufanov G.E., Москва: ГЭОТАР-Медиа, 2021

2. ЭИ Т 80 Лучевая терапия (радиотерапия) : учебник, Труфанов Г.Е., Москва: ГЭОТАР-Медиа, 2018

3. ЭИ О-75 Основы лучевой диагностики : учебное пособие, Лежнев Д.А., Москва: ГЭОТАР-Медиа, 2019

FURTHER READING:

1. ЭИ М 80 Основы менеджмента медицинской визуализации : учебное пособие, Морозов С.П., Москва: ГЭОТАР-Медиа, 2020

2. ЭИ А86 Радиационная гигиена. Руководство к практическим занятиям : учебное пособие, Коренков И.П., Архангельский В.И., Москва: ГЭОТАР-Медиа, 2020

3. ЭИ С 76 Стандарты лучевой терапии : монография, , Москва: ГЭОТАР-Медиа, 2020

SOFTWARE:

No special softwares is required

LMS AND ONLINE RESOURCES

https://online.mephi.ru/

http://library.mephi.ru/

9. LOGISTICAL SUPPORT

1. Персональный компьютер: Процессор CPU Intel Core i7-8700 (3.2GHz/12MB/6 cores) Материнская плата Gig (Клиническая база)

2. Мышь, клавиатура (Клиническая база)

3. Проектор SMART P109 (Клиническая база)

4. Кушетка медицинская (Клиническая база)

5. Монитор (Клиническая база)

6. Иное оснащение, предусмотренное порядками оказания медицинской помощи по соответствующему профилю (Клиническая база)

10. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR STUDENTS

Recommendations for preparing for seminars.

The plan for practical classes, their topics, recommended readings, and the purpose and objectives of the course are communicated by the instructor during introductory classes or in the curriculum for the given course. Practical classes help students gain a deeper understanding of the course material and acquire skills in creative work with scientific literature.

Before you begin studying the topic, you need to familiarize yourself with the main questions of the practical lesson plan and the list of recommended literature.

When preparing for a practical lesson, you should first review lecture notes, textbook sections, and teaching aids to gain a general understanding of the topic's place and significance in the course being studied. Then, consult additional literature and take notes on the recommended sources.

In the process of studying the recommended material, it is necessary to understand the structure of the topic being studied, identify the main points, follow their logic and thereby delve into the essence of the problem being studied.

It is necessary to keep records of the material being studied in the form of notes, which, along with visual memory, also includes motor memory and allows for the accumulation of an individual fund of auxiliary materials for the rapid repetition of what has been read, for the mobilization of accumulated knowledge.

Basic note-taking forms: outline (simple and detailed), excerpts, and abstracts. During preparation, it is important to compare sources, consider the material being studied, develop an action plan, and carefully consider your oral presentation.

Recommendations for preparing for the test.

Test – 10-15-20-25 points. Each question – 1 (2) point.

TOPICS: Specified in each specific section

Answer requirements: A clear, detailed answer (2 points/question) or a choice of the correct answer to the test question (1 point/question).

Recommendations for preparing for a test/exam

Response requirements and evaluation criteria:

An "excellent" grade of 45-50 points on a test/exam is awarded for: a correct, complete, and logically constructed answer; the ability to use specialized terminology; the ability to illustrate theoretical principles with practical material.

A "good" grade of 35–44 points on the exam is awarded for: a correct, complete, and logically constructed answer with minor errors or inaccuracies; the ability to use specialized terminology, but incomplete conclusions or generalizations are made.

A “satisfactory” grade of 30–34 points on the exam is given for: a schematic, incomplete answer; inability to use special terms or ignorance of them; with one serious error;

An "unsatisfactory" grade of <30 points on the exam is given for: answering all questions on the ticket with serious errors; inability to use specialized terminology; inability to give examples of the practical use of scientific knowledge.

Admission to the exam in a discipline is granted based on a score of over 30 points.

A student can earn between 30 and 50 points per semester.

The minimum score for an exam answer is 30, the maximum is 50.

11. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR TEACHERS

Practical classes monitor students' understanding of lecture material, supervise patients, and assess their practical skills. Visual aids, surgical instruments, simulators, and device simulations, as well as demonstrations of interventional cardiology procedures in real-life settings, are used to demonstrate and practical skills. To assess clinical reasoning skills, students are offered situational problems, clinical cases, test assignments, case studies, and attendance at medical conferences, consultations, and scientific symposia. Active and interactive learning methods are widely used in the

educational process (work in small groups, fostering creative thinking, using computer-based learning programs, and conducting conferences). The instructor supervises students' independent work, including preparing papers and research projects, working with patients in collaboration with the instructor, interpreting additional research data, and completing medical documentation. Working with academic literature is considered a form of academic work and is completed within the time allotted for its study. Each student has access to the institute's and department's electronic library collections.

Students' training helps them develop skills in interacting with patients, taking ethical and deontological principles into account. Independent work helps develop skills in working with patients, working with literature, analytical thinking, documentation skills, accuracy, and discipline. Students' initial knowledge level is determined by testing, and ongoing assessment of their mastery of the subject is determined by oral questioning during classes, clinical case studies, solving typical situational problems, and answering test questions. At the end of the course, students undergo a midterm and final assessment using a test, practical skills assessment, and solving situational problems.

Grading and criteria for tests, extended tests, homework, and the final test:

1) Test questions are graded according to the following scheme:

1 point for every 1 correct answer. Student did not start work – (-1) point

2) - Tests with detailed answers are graded according to the following system: complete answer – 2 points, incomplete answer – 1 point, no answer – 0 points, student did not start work – (-2) points.

3) - Homework must be completed by all students to be admitted to the final assessment. Late submissions will result in a deduction of (-1) point from the final score.

4) - Presentation report grading criteria. Recalculation from a 100-point to a 10 (5)-point system.

5) - Essay grading criteria. Maximum 10 points. Possibly upgraded to a 5-point system.

10 points are awarded if all abstract writing requirements are met: the problem is identified and its relevance justified, a brief analysis of the issue is provided and a logical position is presented, conclusions are formulated, the article is fully analyzed, the length is maintained, and formatting requirements are met.

9 points are awarded if the following abstract writing requirements are met: the problem is identified and its relevance justified, a brief analysis of the issue is provided and a logical position is presented, conclusions are formulated, the article is fully analyzed, but the length is not maintained and formatting requirements are not met.

8 points – the basic requirements for the abstract are met, but some shortcomings are present. Specifically, there are inaccuracies in the presentation of the material; there is a lack of logical consistency in the judgments; the abstract is not within the specified length; and there are omissions in the formatting.

7 points – the basic requirements for the abstract are met, but the following shortcomings are present: there are inaccuracies in the presentation of the material; there is a lack of logical consistency in the judgments; no conclusions are formulated; the abstract is not within the specified length; and there are omissions in the formatting.

6 points – there are significant deviations from the abstracting requirements; the topic is only partially covered; there are factual errors in the content of the abstract; conclusions and a personal perspective on the problem are missing.

5 points – there are significant deviations from the abstract requirements: the topic is only partially covered; there are factual errors in the presentation of the materials and methods; conclusions and a personal perspective on the problem are missing; the format is not maintained.

4 points – there are significant deviations from the abstract requirements: the relevance of the topic is not addressed; factual errors in the presentation of materials and methods are present; conclusions and personal perspective on the problem are missing; the format is not followed.

3 points – there is no analysis of the relevance of the research topic, approaches, and methods used, while the abstract formally complies with the length requirements.

2 points – the abstract topic is not addressed, revealing a significant misunderstanding of the problem. However, the abstract length and formal requirements are met.

1 point – the abstract topic is not addressed, revealing a significant misunderstanding of the problem.

0 points – the student did not submit an abstract.

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