[Medicinski fakultet u Rijeci]

**Curriculum**
**2024/2025**

[Za kolegij]

# Radiation Protection of Population and Environment from Ionizing Radiation

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|---|---|
| Study program: | **Medical Studies in English (R)** (elective)<br>[Sveučilišni integrirani prijediplomski i diplomski studij] |
| Department: | **[Katedra za nuklearnu medicinu]** |
| Course coordinator: | **izv. prof. dr. sc. Bogović Crnčić Tatjana, dr. med.** |
| Year of study: | **3** |
| ECTS: | **1.5** |
| Incentive ECTS: | **0 (0.00%)** |
| Foreign language: | **No** |

## Course information:

OBJECTIVES OF THE COURSE: This is an elective course designed to encounter students with open ionizing radiation sources available in nuclear medicine department (radionuclides, RN). Having in mind future general practitioners, the objective is to teach students about possible danger for people and our environment arising from ionizing (predominantly gamma) radiation, emphasizing the knowledge about the methods and rules of behaviour designed for protection of professionals, patients and environment and solving contamination incidents. Hybrid imaging (SPECT/CT, PET/CT) is introduced, with consequences regarding radiation protection. Preventive measures are discussed, including a handling and storage of radioactive waste. The legislature on radiation protection is presented.

COURSE DESCRIPTION: The basic physics of ionizing radiation, radioactive decay, production of radionuclides, and specific RNs used in NM are studied. Interactions of ionization with matter, including persons and environment are discussed. A lecture is given on basic points in radiation dosimetry introducing absorbed, equivalent and effective doses, stochastic and deterministic biological effects on persons and population. Radionuclides used in nuclear medicine are demonstrated, their production (generator, cyclotrons), storage and clinical (diagnostic and therapeutic) use. Complexity of radiation exposure arising from hybrid imagining is mentioned. Methods and rules in radiation protection are being demonstrated in «hot laboratory», contamination and decontamination concept, specifically for persons, patients and environment. Legal international regulations are presented (“Basic safety standards” issued by IAEA and COUNCIL DIRECTIVE 2013/59/EURATOM), including effective dose limits for professionals and population.

BASIC COMPETENCIES: A student should acquire knowledge that will enable him/her to estimate possible risks arising from the ionizing radiation used in routine diagnostic and therapeutic procedures in nuclear medicine. This is accomplished by understanding and using terms: absorbed, equivalent and effective dose. Radiation protection measures and procedures for solving or minimizing the consequences of accidental contamination of persons and environment should be adopted, which students may implement in their future professional work.

SPECIFIC COMPETENCIES: As students are not allowed to handle radioactive sources (according to the radiation protection legislature), the education is limited to demonstration of work with RN and instructions on specific procedures (use of radiation detectors) in radiation protection.

COURSE STRUCTURE:

Lectures: 8 hours

Seminars: 13 hours

Practicals: 4 hours

Total hours: 25

## List of assigned reading:

1. Lectures, IAEA publication 2004 (Radiation, People and the Environment)

2. Fred A. Mettler Jr., and Milton J. Guiberteau. Essentials of Nuclear medicine and Molecular imaging, Seventh edition, 2019 by Elsevier, Inc. Chapters:1, 2, 4, 13.

**List of optional reading:**

OPTIONAL/ADDITIONAL READING:

1. RADIATION PROTECTION AND SAFETY IN MEDICAL USES OF IONIZING RADIATIONR. IAEA SAFETY STANDARDS SERIES No. SSG-46, Vienna 2018. (International Atomic Energy Agency, 2018. | Series: IAEA safety standards series, ISSN 1020–525X ; no. SSG-46 .UDC 614.876 | STI/ **PUB/1775**)
2. COUNCIL DIRECTIVE 2013/59/EURATOM. Official Journal of the European Union, 17.1.2014.

## Curriculum:

**[Predavanja] list (with titles and explanation):**

**Basics of nuclear physics. Radionuclides and ionizing radiation. Types of radiation. Radiation and matter. Sources of ionizing radiation**

Understand the basics of nuclear physics and the term radionuclide. Explain radioactive decay and gamma radiation.

**The interaction between the radiation and matter. Radiation attenuation. Physical basics of radiation protection.**

Describe the interaction of radiation and matter. Explain the concept of radiation attenuation and the physical basis of radiation protection.

**Concept of ionizing radiation. Concept of dosimetry, units of measurement; D, H, E doses. Three protection groups. (Basic safety standards, BSS) Permissible limits of effective doses.**

Explain the concept of ionizing radiation and dosimetry. Understand D, H, E doses. Get to know "Basic safety standards", BSS. Understand the concept of the permissible limit of effective doses.

**Biological effects of radiation on living organisms (stochastic and non-stochastic).**

Describe the biological effects of radiation on living organisms. Explain the terms stochastic and non-stochastic effects.

**Protection of the environment and family members after radioiodine therapy.**

Describe the consequences of exposure to ionizing radiation and measures for protection of patients from excessive radiation.

**Diagnostic and therapeutic application of radionuclides - 99mTc and I-131.**

Understand the role of radionuclides-99mTc and I-131 in the diagnosis and treatment of thyroid diseases. Describe measures to protect people and the environment after radioiodine therapy.

**Hybrid imaging diagnostics (SPECT/CT, PET/CT)**

Explain and understand the concept of hybrid imaging diagnostics. Understand the role.

**Radiation protection in Hybrid imaging**

Describe the main principles of protection against ionizing radiation.

**[Seminari] list (with titles and explanation):**

**Radioactivity and Radiation. The types of radioactive decay.**

Explain the concept of ionizing radiation. Briefly describe the types of radioactive decay and explain the meaning of the half-life. Explain the interaction between ionizing radiation and tissue and basic units and quantities.

**General Principles Of Radiation Protection**

Explain general Principles Of Radiation Protection

**Biologic Effects Of Ionizing Radiation. Clinical Syndromes. Internal Contamination. Radiation Exposed Injuries**

Explain Biologic Effects Of Ionizing Radiation. Describe clinical syndromes.

**Radiation Protection In PET Studies**

Briefly explain radiation protection measures in PET scans, i.e. in positron emission tomography.

**Radiation Exposure To Family Members Of Patients With Thyrotoxicosis Treated With Iodine-131**

Explain shortly radiation Exposure To Family Members Of Patients Treated With Iodine-131

**Protection of patients' families, restrictions.**

Explain shortly the measures for protection of family members.

**Electron And Photon Interactions With Matter**

Explain Interactions of ionizing radiation with matter

**Personnel radiation protection**

Briefly explain and describe ionizing radiation protection measures for personnel.

**Detection of radioactivity (counters, dosimeters, gamma camera)**

Describe and name the most commonly used radioactivity detectors

**Radioactive waste**

Explain the term radioactive waste and the principle of working with it.

**Extract from document Euroatom 59/2013**

Explain the extract from document Euroatom 59/2013.

**Therapeutic use of radioiodine (I-131) - benign diseases**

Explain the role of therapy of benign thyroid diseases with radioiodine.

**Radiation accidents**

Describe one or two radiation accidents.

**[Vježbe] list (with titles and explanation):**

**“Hot laboratory”. Storage of radioactive sources. Mo- Tc- generator. Detectors of ionizing radiation. Instrumentation in Nuclear medicine. Patients’ ward for application of radioiodine therapy.**

Get to know the work in the "hot laboratory". Understand the working principle of the Mo-Tc generator. Name radiation detectors.

**Implementation of radiation protection measures (TDS).**

List and understand protection measures when working with radionuclides.

**Contamination and decontamination. Radioactive waste. Protection measures when working with radioactive patients.**

Explain the term contamination, describe the decontamination procedure. Understand protective measures when working with radioactive patients.

**Shielding, personal protection (exposed workers). Personal dosimetry.**

Explain the term personal dosimetry.

**Student obligations:**

STUDENTS' OBLIGATIONS**:**

The attendance at lectures, seminars and practicals is mandatory. If necessary, a student can be absent from 30% of the classes of the overall course workload, but has to make up for the practicals and seminars he/she failed to attend. Students' obligation is active participation in all practicals and seminars.

During the classes, students are required to prepare one seminar presentation (Power Point Presentation, max 7 slides) on the given seminar topic (S 1, 2, 3, 4, 5, 6) and present it during seminars. After the class, the seminar presentation should be submitted as Power Point document in electronic form. Students are required to actively participate in discussion during seminars. Seminars will be evaluated. Successful completion of seminar is mandatory for taking final oral exam. If student does not satisfy, he/she will have the opportunity to repeat the presentation of the seminar paper.

**Exam (exam taking, description of the written/oral/practical part of the exam, point distribution, grading criteria):**

EVALUATION OF STUDENTS' WORK:

Students can obtain a total of 100 credits, half form seminar work, and half on oral exam.

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| Seminar work | Max.50 |
| Final (Oral) exam | Max. 50 |
| Total score | Max. 100 |

On the final exam, which is worth 50 credits, a student must obtain at least 10 credits (sufficient grade).

Assessment of the seminar work and final (oral) exam:

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| Sufficient | 10-20 |
| Good | 21-30 |
| Very good | 31-40 |
| Excellent | 41-50 |

The ECTS grading system is defined by the following criteria:

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| A (5) | 90 - 100 credits |
| B (4) | 75 – 89.9 credits |
| C (3) | 60 – 74.9 credits |
| D (2) | 50 – 59.9 credits |

**Other notes (related to the course) important for students:**

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## COURSE HOURS 2024/2025

Radiation Protection of Population and Environment from Ionizing Radiation

| **[Predavanja]**<br>(Place and time or group) | **[Vježbe]**<br>(Place and time or group) | **[Seminari]**<br>(Place and time or group) |
|---|---|---|
| **06.12.2024** | | |
| Basics of nuclear physics. Radionuclides and ionizing radiation. Types of radiation. Radiation and matter. Sources of ionizing radiation:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ○ RPPE<br><br>The interaction between the radiation and matter. Radiation attenuation. Physical basics of radiation protection.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ○ RPPE | | |
| izv. prof. dr. sc. Bogović Crnčić Tatjana, dr. med. [158] | | |
| **11.12.2024** | | |
| Concept of ionizing radiation. Concept of dosimetry, units of measurement; D, H, E doses. Three protection groups. (Basic safety standards, BSS) Permissible limits of effective doses.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ○ RPPE<br><br>Biological effects of radiation on living organisms (stochastic and non-stochastic).:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ○ RPPE<br><br>Hybrid imaging diagnostics (SPECT/CT, PET/CT):<br>• [Zavod za nuklearnu medicinu] (16:00 - 17:30) [452]<br>  ○ RPPE<br><br>Radiation protection in Hybrid imaging:<br>• [Zavod za nuklearnu medicinu] (16:00 - 17:30) [452]<br>  ○ RPPE | | |
| izv. prof. dr. sc. Bogović Crnčić Tatjana, dr. med. [158] · doc. dr. sc. Ilić Tomaš Maja, dr. med. [452] | | |
| **13.12.2024** | | |

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| Protection of the environment and family members after radioiodine therapy.:<br>• [ONLINE] (10:00 - 11:30) [158]<br>  ◦ RPPE<br><br>Diagnostic and therapeutic application of radionuclides - 99mTc and I-131.:<br>• [ONLINE] (10:00 - 11:30) [158]<br>  ◦ RPPE | | |
| izv. prof. dr. sc. Bogović Crnčić Tatjana, dr. med. [158] | | |
| **17.01.2025** | | |
| | “Hot laboratory”. Storage of radioactive sources. Mo- Tc- generator. Detectors of ionizing radiation. Instrumentation in Nuclear medicine. Patients’ ward for application of radioiodine therapy.:<br>• [Zavod za nuklearnu medicinu] (08:00 - 09:30) [1360]<br>  ◦ RP practicals 1<br><br>Implementation of radiation protection measures (TDS).:<br>• [Zavod za nuklearnu medicinu] (08:00 - 09:30) [1360]<br>  ◦ RP practicals 1<br><br>Contamination and decontamination. Radioactive waste. Protection measures when working with radioactive patients.:<br>• [Zavod za nuklearnu medicinu] (08:00 - 09:30) [1360]<br>  ◦ RP practicals 1<br><br>Shielding, personal protection (exposed workers). Personal dosimetry.:<br>• [Zavod za nuklearnu medicinu] (08:00 - 09:30) [1360]<br>  ◦ RP practicals 1 | |
| naslovni asistent Iskra Igor, dr. med. [1360] | | |
| **22.01.2025** | | |

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|---|---|---|
| | “Hot laboratory”. Storage of radioactive sources. Mo- Tc- generator. Detectors of ionizing radiation. Instrumentation in Nuclear medicine. Patients’ ward for application of radioiodine therapy.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [455]<br>  ◦ RP practicals 2<br><br>Implementation of radiation protection measures (TDS).:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [455]<br>  ◦ RP practicals 2<br><br>Contamination and decontamination. Radioactive waste. Protection measures when working with radioactive patients.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [455]<br>  ◦ RP practicals 2<br><br>Shielding, personal protection (exposed workers). Personal dosimetry.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [455]<br>  ◦ RP practicals 2 | Biologic Effects Of Ionizing Radiation. Clinical Syndromes. Internal Contamination. Radiation Exposed Injuries:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ◦ RPS2<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1<br><br>Radiation Exposure To Family Members Of Patients With Thyrotoxicosis Treated With Iodine-131:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ◦ RPS2<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1<br><br>Protection of patients' families, restrictions.:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ◦ RPS2<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1<br><br>Personnel radiation protection:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ◦ RPS2<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1<br><br>Radiation accidents:<br>• [Zavod za nuklearnu medicinu] (14:30 - 16:00) [158]<br>  ◦ RPS2<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1<br><br>General Principles Of Radiation Protection:<br>• [Zavod za nuklearnu medicinu] (16:15 - 18:30) [158]<br>  ◦ RPS1 |
| izv. prof. dr. sc. Bogović Crnčić Tatjana, dr. med. [158] · asistent Fischer Leo, dr. med. [455] | | |

**List of lectures, seminars and practicals:**

| [PREDAVANJA] (TOPIC) | Number of hours | Location |
|---|---|---|
| Basics of nuclear physics. Radionuclides and ionizing radiation. Types of radiation. Radiation and matter. Sources of ionizing radiation | 1 | [Zavod za nuklearnu medicinu] |
| The interaction between the radiation and matter. Radiation attenuation. Physical basics of radiation protection. | 1 | [Zavod za nuklearnu medicinu] |
| Concept of ionizing radiation. Concept of dosimetry, units of measurement; D, H, E doses. Three protection groups. (Basic safety standards, BSS) Permissible limits of effective doses. | 1 | [Zavod za nuklearnu medicinu] |
| Biological effects of radiation on living organisms (stochastic and non-stochastic). | 1 | [Zavod za nuklearnu medicinu] |
| Protection of the environment and family members after radioiodine therapy. | 1 | [ONLINE] |
| Diagnostic and therapeutic application of radionuclides - 99mTc and I-131. | 1 | [ONLINE] |
| Hybrid imaging diagnostics (SPECT/CT, PET/CT) | 1 | [Zavod za nuklearnu medicinu] |
| Radiation protection in Hybrid imaging | 1 | [Zavod za nuklearnu medicinu] |

| [VJEŽBE] (TOPIC) | Number of hours | Location |
|---|---|---|
| “Hot laboratory”. Storage of radioactive sources. Mo- Tc- generator. Detectors of ionizing radiation. Instrumentation in Nuclear medicine. Patients’ ward for application of radioiodine therapy. | 1 | [Zavod za nuklearnu medicinu] |
| Implementation of radiation protection measures (TDS). | 1 | [Zavod za nuklearnu medicinu] |
| Contamination and decontamination. Radioactive waste. Protection measures when working with radioactive patients. | 1 | [Zavod za nuklearnu medicinu] |
| Shielding, personal protection (exposed workers). Personal dosimetry. | 1 | [Zavod za nuklearnu medicinu] |

| [SEMINARI] (TOPIC) | Number of hours | Location |
|---|---|---|
| Radioactivity and Radiation. The types of radioactive decay. | 1 | |
| General Principles Of Radiation Protection | 1 | [Zavod za nuklearnu medicinu] |
| Biologic Effects Of Ionizing Radiation. Clinical Syndromes. Internal Contamination. Radiation Exposed Injuries | 1 | [Zavod za nuklearnu medicinu] |
| Radiation Protection In PET Studies | 1 | |
| Radiation Exposure To Family Members Of Patients With Thyrotoxicosis Treated With Iodine-131 | 1 | [Zavod za nuklearnu medicinu] |
| Protection of patients' families, restrictions. | 1 | [Zavod za nuklearnu medicinu] |
| Electron And Photon Interactions With Matter | 1 | |
| Personnel radiation protection | 1 | [Zavod za nuklearnu medicinu] |
| Detection of radioactivity (counters, dosimeters, gamma camera) | 1 | |
| Radioactive waste | 1 | |
| Extract from document Euroatom 59/2013 | 1 | |
| Therapeutic use of radioiodine (I-131) - benign diseases | 1 | |
| Radiation accidents | 1 | [Zavod za nuklearnu medicinu] |

**EXAM DATES (final exam):**