Syllabus
Course Program

Radiation and Electromagnetic Safety

Specialty
E2 – Ecology

Specialization
Engineering ecology

Educational program
Engineering ecology

Level of education
Master's level

Semester
2

Institute
Institute of mechanical engineering and transport

Department
Department of Car and Tractor Industry (152)

Course type
Optional

Form of study
Full-time, part-time, distance learning

Language of instruction
English, Ukrainian

Lecturers and course developers

Voldymyr Babenko

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Ph.D., associate professor of the Department of Chemical Engineering and Industrial Ecology at NTU "KhPI".

Experience of teaching work - 17 years. Author and co-author of more than 40 scientific and methodical publications.
Delivers lectures on the following courses:"Environmental monitoring", "Topography with the basics of cartography", "Radioecology", "Methods for measuring environmental parameters", "Geoecology".
More about the lecturer on the department's website

General information

Summary

The discipline is aimed at forming in students a complex of theoretical and applied knowledge on the study of the impact of radiation and electromagnetic radiation on humans and the biosphere, biocenoses and populations of organisms. Radiation and electromagnetic safety is a branch of knowledge related to medical ecology and studies the effect of high-frequency radiation on living organisms and methods of protection against them.

Course objectives and goals

Formation of students' systemic knowledge about the impact of radiation and electromagnetic radiation on the organic and inorganic environment. To have the ability, based on the latest trends in the

development of environmental technologies, to justify methods and ways to reduce the negative impact of high-frequency radiation in order to increase environmental safety for people and the biological environment.

Format of classes

Lectures, laboratory classes, consultations, self-study. Final control in the form of an differentiated grading.

Competencies

Awareness of the latest scientific and engineering achievements in the field of technical means of protecting the biosphere from high-frequency radiation, the ability to choose materials and equipment that allow significantly reducing the impact and ensuring proper radiation and electromagnetic safety, especially during man-made accidents and in conditions of military operations.

Learning outcomes

Be able to determine the most effective technological means of protection against high-frequency radiation, know and justify ways to improve equipment and materials in order to increase environmental safety for people and the biological environment, possess the basics of engineering calculations of materials and equipment for radiation and electromagnetic protection.

Student workload

Total course duration 120 hours (4 ECTS credits): lectures – 32 hours, practical work – 16 hours, independent work – 72 hours.

Course prerequisites

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Eco-innovations in the creation of new technologies", "Equipment and fundamentals of designing environmentally safe technologies using CAD".

Features of the course, teaching and learning methods, and technologies

Lectures are conducted interactively using multimedia technologies. The traditional teaching approach and the form of lectures-visualizations are used. In practical classes, the reproductive learning method is used, which helps students develop skills and abilities in solving real problems in ecology.

Program of the course

Academic classes

Lectures

Topics of the lectures	Hours
Topic 1. Radiation safety The concept of radiation safety. History of radiation safety development. Problems and modern tasks of radiation safety. Properties of emission radiation.	4
Topic 2. Basic laws of radiation absorption. Concepts related to radiation safety. Relationship between the structure of the atomic nucleus and its radiation properties.	4
Topic 3. Sources of radiation emissions. Natural background radiation. The emergence of natural background radiation. Existing natural protection against radiation.	4
Topic 4. Characteristics of electromagnetic radiation. Measurement of electromagnetic radiation. Measurement of emission radiation. Simple and complex devices for monitoring electromagnetic and emission radiation.	4

Topic 5. Artificial sources and routes of electromagnetic and radiation emissions. Sources and pathways of high-frequency radiation of natural and man-made origin into the biosphere. Radio-ecological consequences of the Chernobyl accident. Old and new shelter facilities at the Chernobyl nuclear power plant. Artificial problems created at the Zaporizhia nuclear power plant.	4
Topic 6. Materials and equipment for protection against electromagnetic radiation. Artificial and natural substances for protection against electromagnetic radiation. Materials and equipment for absorption and reduction of high-frequency radiation. Natural ways to reduce the impact of radiation on biological structures. New artificial materials with unique properties for protection and redistribution of electromagnetic and emission radiation.	4
Topic 7. Biological effects of electromagnetic radiation. Direct and indirect effects of electromagnetic radiation. The effect of electromagnetic radiation on aqueous solutions inside living organisms. Evolutionary methods of protection against electromagnetic and emission radiation.	4
Topic 8. Consequences of the biological effects of radioactive electromagnetic and radiation radiation. Radiation and electromagnetic safety. Effects of electromagnetic and radiation exposure in small doses on inorganic and organic substances and materials. Search for new artificial materials for radiation and electromagnetic safety.	4
Total hours	**32**

Workshops

Topics for workshops	Hours	Weighting coefficients *a*
Topic 1. Problems and modern tasks of radiation and electromagnetic safety. Problems and modern tasks of radiation and electromagnetic safety in Ukraine.	2	0,1
Topic 2. Interaction of electromagnetic and emission radiation with substances (example). Interaction of electromagnetic and radiation with inorganic and organic substances.	2	0,1
Topic 3. Natural and artificial sources of electromagnetic and emission radiation (example). The origin of natural and artificial sources of electromagnetic and radiation radiation.	2	0,1
Topic 4. General characteristics of devices for monitoring electromagnetic and emission radiation (example). Opportunities, advantages and disadvantages of electromagnetic and radiation control devices.	2	0,2
Topic 5. Distribution of artificial and natural electromagnetic and emission radiation in the natural environment. Uneven distribution in the natural environment of electromagnetic and radiation.	2	0,1
Topic 6. Maximum and minimum doses of irradiation of organisms by natural electromagnetic and emission radiation. Automatic devices for monitoring different spectra of electromagnetic and emission radiation (example). Permissible single maximum doses of radiation of organisms with natural radiation.	2	0,1

Topic 7. Radiation and electromagnetic protection of the body from the effects of radiation. Physical, biological and chemical protection. Natural and artificial substances for radiation and electromagnetic protection of the body against irradiation. Modern materials for protection.	2	0,1
Topic 8. Preparations and materials of plant origin that have a radio-protective effect. Natural possibilities of transferring radiation irradiation. Preparations and materials of plant origin that can withstand irradiation.	2	0,2
Total hours	**16**	$\sum_{i=1}^{n} b_i = 1$

Laboratory classes

Laboratory work is not provided within the discipline.

Control works

One final test work that covers theoretical and practical issues of the course and takes place in the form of testing with the Forms resource on the Office 365 platform.

Topics for control works	Weighting coefficients *b*
Control work	1,0
Total	$\sum_{i=1}^{n} b_i = 1$

Self-study

The course involves the self-processing of theoretical material and the completion of an individual task in the form of a calculated task, which is to perform two tasks of a branched trophic pyramid of forest-steppe and lake biocenosis to clarify the possibility of existence of all its components, with subsequent monitoring. The settlement task is provided in the form of a written report, and the results are discussed in practical classes. .

Work on theoretical materials

Topics for self-study	Hours
Topic 1. The law of radioactive decay. Absorbed and exposure doses of radiation.	8
Topic 2. Radiation situation in Ukraine, radioactive contamination of ecosystems. The impact of the Chernobyl disaster on soils.	8
Topic 3. Migration of radionuclide's in aquatic ecosystems. Radio-ecological consequences of the Chernobyl accident for aquatic ecosystems.	8
Topic 4. Intake of radionuclide's into the human body. The influence of electromagnetism on the human body.	8
Topic 5. Radioecology of irrigated agriculture. Radioecology of farm animals.	8
Topic 6. Distribution of radionuclide's in the marine ecosystem.	8

Behavior of radionuclide's in marine ecosystems. Dose loads on aquatic organisms and effects of radiation exposure.	
Topic 7. Radioecology of settlements. Basic noise parameters. Regularity of deposition of radionuclide's from the atmosphere onto the surface of the territory of settlements. Radioecology of urbanized areas.	8
Topic 8. Radio-ecological monitoring. Basic provisions of radio-ecological monitoring. Regulatory framework of Ukraine on nuclear and radiation safety.	7
Total hours	**63**

Topics for individual assignments

The requirements for the performance of individual task and the terms of execution are detailed at the link in methodical instructions: https://repository.kpi.kharkov.ua/handle/KhPI-Press/88587.

Topics for individual assignments

Topic 1. Nuclear power, its negative and positive consequences for the environment.	
Topic 2. Radiation and nuclear safety of nuclear power facilities.	
Topic 3. Classification of emergency NPPs. Probable safety criteria for NPP power units.	
Topic 4. Basic regulatory requirements and provisions for accident management at NPPs.	
Topic 5. Radiation safety of storage facilities for ionizing radiation sources.	
Topic 6. Legislative and regulatory frameworks in the field of radioactive waste management.	
Topic 7. Purpose, safety principles for radioactive waste disposal.	
Topic 8. Criteria and basic requirements for ensuring safety during surface and deep disposal of radioactive waste.	
Topic 9. Requirements for ensuring safety during the design and operation of RWD.	
Total hours	**9**

Non-formal education

The elements of non-formal education recommended in the syllabus may be enrolled in a simplified procedure without additional validation of results (creation of a subject commission). The successful completion of the online course "Assessment of environmental damage from Russian aggression" is credited instead of practical work № 1. Passing the online course "Welfare of the planet: what everyone needs to know and can know" instead of practical work № 3.

Recommended training courses, internships

1. Online course «The online course "Assessment of environmental damage from Russian aggression".»
https://prometheus.org.ua/prometheus-free/environmental-damage-assessment/
2. The online course "Welfare of the planet: what everyone can know and can know."
https://prometheus.org.ua/prometheus-free/planet-wellbeing-knowledge/

Literature, training materials, and information resources

Main literature

1. J. S. BALLARD. Radiation Safety : Educational Textbook. 2020. – 85 p.
https://openoregon.pressbooks.pub/radsafety130/

2. Radiation Safety Manual : Environmental Health and Safety, Stanford University, Stanford Californi, 2018. – 119 p.
https://ehs.stanford.edu/wp-content/uploads/Radiation-Safety-Manual.pdf
3. RADIATION SAFETY MANUAL. Environmental Health and Safety Department University of Washington. 2023. – 133 p.
https://www.ehs.washington.edu/system/files/resources/RSManualBinder.pdf
4. RADIATION SAFETY MANUAL. For Columbia University New York-Presbyterian Hospital New York State Psychiatric Institute Barnard College, – June 2023. – 53 p.
https://research.columbia.edu/sites/default/files/content/EHS/Manuals/RadiationSafetyManual.pdf
5. Radiation Safety Fundamentals Workbook. University of California, Santa Cruz. Environmental Health & Safety. Fourth Edition January 2000. – 72 p.
https://ehs.ucsc.edu/programs/research-safety/radiation/documents/rsfw58.pdf
6. Radiation Safety. Management and Programs. Book .2017.
https://link.springer.com/book/10.1007/978-3-319-42671-6
7. Radiation Safety in Nuclear Medicine. A Practical, Concise Guide. Book. Latest edition. 2023.
https://link.springer.com/book/10.1007/978-3-031-24609-8?fromPaywallRec=true
8. Radiation Safety Guide for Nuclear Medicine Professionals. Textbook. 2022.
https://link.springer.com/book/10.1007/978-981-19-4518-2?fromPaywallRec=true

Additional materials

1. Methodical instructions for independent work and implementation of an individual task in the discipline "Radiation and electromagnetic safety" [Electronic resource] : for students of all levels of higher education and forms of study / comp.: V. M. Babenko, T. S. Tikhomirova, A. O. Sakun ; National Technical University "Kharkiv Polytechnic Institute". – Electronic text data. – Kharkiv : NTU "KhPI", 2025. – 41 p. – URI: https://repository.kpi.kharkov.ua/handle/KhPI-Press/88586
2. Methodical instructions for independent work and implementation of an individual task in the discipline "Radiation and electromagnetic safety" [Electronic resource] : for students of all levels of higher education and forms of study / comp.: V. M. Babenko, T. S. Tikhomirova, A. O. Sakun ; National Technical University "Kharkiv Polytechnic Institute". – Electronic text data. – Kharkiv : NTU "KhPI", 2025. – 41 p. – URI: https://repository.kpi.kharkov.ua/handle/KhPI-Press/88586

Information resources

1. «World Healt Organization»
Radiation: Electromagnetic fields.
https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields
2. FAQ.
EMF Radiation Protection: Strategies for Protection and Safety.
https://raybloc.com/emf-radiation-protection-strategies/

Grading system

The final grade for the educational component is determined by the lecturerand is based on topics, types of activities, etc., in accordance with the syllabus. It is an integrated assessment of the results of all types of student learning activities. The final grade should reflect all the grades for the different parts of the educational process, taking into account their weighting coefficients k:

Continuous assessment (during workshops, seminars, laboratory classes) k_1	Control works (if any), k_2	Individual assignment (if any), k_3	Final assessment (for courses with exams), k_4
0,4	0,3	0,2	0,1

The sum of the coefficients must be equal to one: $k_1 + k_2 + k_3 + k_4 = 1$. The weighting coefficients for the final assessment are decided by the course developer..
The final gradeis calculated using the following formula:

$$G = C \cdot k_1 + K \cdot k_2 + \mathrm{I} \cdot k_3 + E \cdot k_4$$

where: C – weighted average score for the continuous assessment
I–individual assignment grade
K–weighted average score for the continuous assessment
E – final assessment (exam) grade

$$C = \frac{C_1 \cdot a_1 + C_2 \cdot a_2 + \ldots + C_n \cdot a_n}{\sum_{i=1}^{n} a_i}$$

де: a_i - weighting coefficient for each workshop (seminar) or laboratory class.

$$K = \frac{K_1 \cdot b_1 + K_2 \cdot b_2 + \ldots + K_m \cdot b_m}{\sum_{i=1}^{m} b_i}$$

де: b_i - weighting coefficient for each control work.

The assessments for each component (C, K, I, etc.) are based on a 100-point scale in line with the provisions of the "Criteria and System for Assessing Knowledge and Skills, and Rating of Higher Education Students" of the National Technical University "Kharkiv Polytechnic Institute."

The final grade is finalized as the calculated value of G, rounded up to the nearest integer.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

Students must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

30.08.2025 **Head of the department**
Oleksii SHESTOPALOV

30.08.2025 **Guarantor of the educational program**
Eugenia MANOILO