NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

General Ecology, Radiobiology and Life Safety Department

"CONFIRMED"
Dean of Faculty of Plant Protection,
Biotechnology and Ecology
_____ Julija KOLOMIJETS
«18» May 2023, protocol № 9

"APPROVED"
at the meeting of the department of General Ecology
Radiobiology and Life Safety
Protocol № 9 dated «19» 04 2023
Head of Department
_____ Alla KLEPKO

"REVIEWED"
Program Coordinator of the educational and professional
program "Ecology and Environmental protection"
_____ (Gaychenko V.A.)

PROGRAM OF THE COURSE

"ASSESSMENT OF RADIATION RISKS FOR HUMANS AND ENVIRONMENT"

Specialty:	101 - Ecology
Educational program:	«Ecology and Environmental Protection»
Faculty:	Plant protection, biotechnology and ecology
Developers:	Volodymyr Illienko , PhD in Biology, senior lecturer of General Ecology, Radiobiology and Life Safety Department Alla Klepko , PhD in Biology, docent of General Ecology, Radiobiology and Life Safety Department

Kyiv – 2023

1. Description of the course

__ ASSESSMENT OF RADIATION RISKS FOR HUMANS AND ENVIRONMENT _____
(name)

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Master's*	
Specialization	*101 Ecology*	
Educational program	*"Ecology and Environmental Protection"*	
Characteristics of the course		
Mode	Elective	
Total number of hours	120	
Number of credits ECTS	4	
Number of meaningful modules	3	
Course project (work) (if available)	-	
Form of control	*Exam*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Year of study (course)	2	-
Semester	1	-
Lectures	*20 hours*	*- hours*
Practical and seminar lessons	*20 hours*	*- hours*
Laboratory practical	*- hours*	*- hours*
Self-dependent work	*80 hours*	*- hours*
Self-dependent work	*- hours*	*hours*
Week hours for full-time education	*4 hours*	

2. Purpose, objectives, and competencies of the course

The purpose of teaching the discipline "Assessment of radiation risks for humans and environment" is the formation of students' knowledge and skills for a comprehensive assessment of the impact on human health and the quality of the environment, objects of economic activity that use sources of ionizing radiation (NPP construction projects, operation of existing nuclear reactors, the Exclusion Zone, places of temporary localization of nuclear waste, etc.) in the scale of the chosen territory, provides skills for preliminary checking of compliance of projects with

current legislation and safety requirements, guarantee of minimization of radioactive isotopes' intake to the human body with food products, skills in control and management of actions in the event of radiation accidents in order to assess the extent of pollution and radiation risks.

The task is to provide opportunities for using the acquired knowledge and skills for the description, analysis and prediction of radiation risks during the use of ionizing radiation sources under the conditions of limited information, as well as for the implementation of the master's thesis.

After finishing of course students have to

The student should know the characteristics of various types of ionizing radiation and the features of their interaction with living matter, the unit of measurement of radioactivity and doses of ionizing radiation, the basis of statistical processing of experimental data, sources of ionizing radiation in Ukraine and in the world.

Student should be able to:

- measure the specific, volume radioactivity for α-, β-, γ-radionuclides;

- use modern software packages (ERICA, Crom) to assess radiation risks, predict the level of pollution of the territory as a result of a radiation accident;

- conduct a comprehensive radioecological assessment of the territory;

- determine the level of risk for the population and the environment from the construction of objects using sources of ionizing radiation;

- formulate logical conclusions.

Acquisition of competencies:

general competencies (GC):

1. Ability to learn and acquire modern knowledge.
2. Ability to make informed decisions.
4. Ability to generate new ideas (creativity).
5. Ability to communicate in a foreign language.
6. Ability to search, process and analyze information from various sources.

professional (special) competencies (PC):

1. The ability to manage the strategic development of the team in the process of carrying out professional activities in the field of ecology, environmental protection and balanced nature management

2. The ability to organize work related to the assessment of the ecological state, environmental protection and optimization of nature use, in conditions of incomplete information and conflicting requirements.

4. The ability to self-educate and improve skills based on innovative approaches in the field of ecology, environmental protection and balanced nature management.

5. Ability to apply interdisciplinary approaches in critical understanding of environmental issues.

6. Ability to independently develop environmental projects through creative application of existing and generation of new ideas.

7. Ability to assess the level of negative impact natural and anthropogenic factors of ecological danger to the environment and people.

8. Ability to apply new approaches to the analysis and prediction of complex phenomena, critical understanding of problems in professional activities.

10. Ability to prove knowledge and own conclusions to specialists and non-specialists.

11. Ability to organize work related to environmental assessment, environmental protection and optimization of nature use, in conditions of incomplete information and conflicting requirements.

Program learning outcomes (PLO):

1. Know and understand fundamental and applied aspects of environmental sciences.

2. Be able to use conceptual environmental patterns in professional activity.

3. Know at the level of the latest achievements the basic concepts of natural science, sustainable development and methodology of scientific knowledge.

4. Know the legal and ethical standards for evaluation professional activity, development and implementation of socially significant environmental projects in conditions of conflicting requirements.

5. Demonstrate the ability to organize collective activities and implement complex environmental protection projects, taking into account available resources and time restrictions

6. Know the latest methods and tools ecological research, including methods and means mathematical and geoinformation modeling.

7. To be able to communicate in a foreign language in the scientific, industrial and social spheres of activity.

8. Be able to clearly and unambiguously convey professional knowledge, own justifications and conclusions to specialists and the general public.

9. Know the principles of personnel management and resources, basic approaches to decision-making in conditions of incomplete/insufficient information and conflicting requirements.

10. Demonstrate awareness of the latest principles and methods of environmental protection.

11. Be able to use modern information resources on ecology, nature management and environmental protection.

12. Be able to evaluate landscape and biological diversity and analyze the consequences of anthropogenic impact on natural environments.

13. Be able to assess the potential impact of man-made objects and economic activity on the environment.

14. Apply new approaches to production decision-making strategies in complex, unpredictable conditions.

15. Assess environmental risks under conditions of insufficient information and conflicting requirements.

18. Be able to use modern methods of information processing and interpretation when carrying out innovation activity.

19. To be able to independently plan the implementation of an innovative task and formulate conclusions based on its results.

20. Possess the basics of ecological engineering design and ecological expert assessment of the impact on the environment.

3. PROGRAM AND STRUCTURE OF THE COURSE FOR:

– complete full-time (part-time) form of study

№	Topic	The topic content, recommended literature	Types of educational activity, hours.		
			lectures	practical training	independent work
		Module 1. Ecological and radiation risk			
1.1.	Scientific fundamentals of estimation	An ecological approach to the assessment of the state and regulation and of the quality of the environment.	2	2	10

	standardization of the effects of man-made systems on the environment	Threshold and non-threshold concept. Environmental and sanitary regulation. Toxicological regulation of chemicals. Limit-permissible concentrations. Limit-permissible environmental load. Fields of influence; fields of concentration.			
		Literature: 1-7, 9, 10			
1.2	Ecological risk and basic principles of environmental safety.	Natural and man-made catastrophic processes. The role of radiation factors in environmental risk for the population. Geochemical factors of ecological risk. Features of ecological risk and criteria for its assessment. An economic approach to security issues; cost estimation of risk; acceptable level of risk. Connection of the level of security with the economic opportunities of society. Social aspects of risk; perception of risks and society's reaction to them.	2	2	10
		Literature: 7, 9-11, 17			
1.3	The main directions and methods of reducing the environmental risk	Environmental safety policy. Reducing the effects and compensating for the damage. Environmental Risk and Public Interaction. Placement of industrial facilities and environmental protection. Development and implementation of new technologies. Ecologically safe use of biotechnology.	2	4	10
		Literature: 1, 4-8, 16, 21			
		Module 2. Theoretical and methodological bases of analysis and risk assessment			
2.1	Conceptually-methodical apparatus for analysis and risk assessment	Concepts of analysis and risk assessment. Methods of analysis and risk assessment. Models of analysis and risk assessment.	2	2	10
		Literature: 4-7, 21, 22			
2.2	Formal means of constructing risk assessment	System analysis. Expert methods and decision-making systems. Stochastic Modeling Techniques. Logic-	2	2	10

	models	probabilistic methods of safety research. Markov process. Poisson process. Method of statistical simulation of Monte Carlo. *Literature: 7, 21, 22*			
2.3	Assessment of the risk related to the influence of ionizing radiation	Estimation of the dose absorbed by man due to the influence of ionizing radiation. Average doses of radiation of thyroid gland of children and adolescents of different regions of Ukraine. Radiation risk assessment. *Literature: 7, 16-19, 21, 22*	2	2	12
	Module 3. The use of information technology for the assessment and prediction of radiation risks				
3.1	Assessment of radiological consequences of accidents using the COSYMA system	General information about COSYMA (Code System from MARIA). Three basic parts: the module for submitting input data, a software package and a module for submitting the results. Quantitative and qualitative characteristics of the incident. Calculation of individual and collective doses. Primary parameters groups: meteorological conditions, dispersion, parameters of sedimentation of radioactive particles, characteristics of the source of emissions, population density, consumption of products that may be contaminated, countermeasures, dose estimation and influence on public health, calculation of economic losses. *Literature: 7, 10-14, 18, 19, 21*	2	2	6
3.2	Analysis of the distribution of emissions (discharges) of toxic and radioactive contaminants in the environment using the MEPAS system	MEPAS - "Integrated Environmental Pollution Assessment System". Integral risk assessment for human health and the environment. Creating a plausible basis for optimizing (by economic indicators) measures that reduce risk and risk. Conducting an analysis of the feasibility of practical implementation (using available resources) of the measures provided	2	-	6

		for rehabilitation of the territories. Planning of rational actions and measures for prevention and restoration of the environment and reducing the negative impact on human health. *Literature: 7, 10-14, 18, 19, 21*			
3.3	Features of the ERICA software package	Simplification for dose estimation of ionizing radiation. Concept for determining the dose for animals and humans. List of radioactive isotopes for which an assessment can be made. Assessment of doses from internal and external radiation. *Literature: 7, 10-14, 18, 19, 21*	2	2	6
3.4	Modeling, forecasting and risk assessment using the CROM software package	Methodological basis of the program. Choice of model parameters: radioactive isotopes, radiation from radionuclides in air, soil, water, internal radiation due to consumption of contaminated food, due to inhaling radioactive isotopes with air. Prediction of the level of pollution of the territory at different distances from the source of emissions. *Literature: 7, 10-14, 18, 19, 21*	2	2	-
		Total:	**20**	**20**	**80**

4.Topics of seminars

№ s/n	Topic name	Number of hours
	not provided	

5. Topics of practical classes

№ s/n	Topic name	Number of hours
1	Sequential extraction method for isolation of physicochemical forms of radionuclides	2
2	Soil sampling methods for radiometric studies	4
3	Calculation of the required number of samples in the field study of radionuclide contaminated areas	2
4	Size and charge fractionation methods	2
5	Atmosphere dispersion. Discharge to the atmosphere H>2.5 H_B (CROM tool)	2
6	Measuring the width of annual rings and the length of needles using the free ImageJ software.	4
7	Data analisis from uptake experiment with Blue mussels.	4
	Total	20

6. Topics of laboratory classes

№ s/n	Topic name	Number of hours
1	not provided	-

8. Samples of control questions, tests for assessing the level of knowledge acquisition by students.

<table>
<tr><td colspan="4">National University of Life and Environmental Sciences of Ukraine</td></tr>
<tr><td>Master 2st year study
Specialty
Radioecology</td><td>General Ecology, Radiobiology and Life Safety Department</td><td>Test № __
from the course
Assessment of radiation risks for humans and environment</td><td>Approved
Head of department

_____</td></tr>
<tr><td colspan="4">Questions</td></tr>
<tr><td colspan="4">1. Ways of radionuclide uptake to the organism of animals and humans.</td></tr>
<tr><td colspan="4">2. Comparative penetrating ability of various types of ionizing radiation.</td></tr>
<tr><td colspan="4">Tests</td></tr>
<tr><td>1.</td><td colspan="3">The probability that a person or their offspring will have a harmful effect as a result of exposure is:
a) Radiation risk; b) Oxygen effect; c) Radiobiological paradox; d) Probability theory</td></tr>
<tr><td>2.</td><td colspan="3">1 Sievert is equal to ... ber</td></tr>
<tr><td>3.</td><td colspan="3">The bulk of the radionuclides came to the human body in April-May 1986 through …
a) The skin; b) Lenses; c) Gastrointestinal tract; d) Wound surface</td></tr>
<tr><td>4.</td><td colspan="3">Exposure dose in the SI system is measured in units
a) Bq; b) Sv; c) C/kg; d) R</td></tr>
<tr><td>5.</td><td colspan="3">An equivalent dose in the SI system is measured in units …</td></tr>
<tr><td>6.</td><td colspan="3">The half-life of ^{137}Cs is ... years
a) 20; b) 30; c) 40; d) 50</td></tr>
<tr><td>7.</td><td colspan="3">Incorporated radionuclides are such that ...
a) Got on the skin; b) Got in gastrointestinal tract; c) Included in the tissues and organs;
d) Get to the ecosystem</td></tr>
<tr><td>8.</td><td colspan="3">The positively charged heavy nuclear particles forming the basis of atomic nuclei are called …</td></tr>
<tr><td>9.</td><td colspan="3">What statements are correct for β-particles:
a) Have ‘- ‘ charge; b) Consists of 2 protons and 2 neutrons; c) Is a nuclei of helium; d) Is the most harmful for organism</td></tr>
<tr><td>10.</td><td colspan="3">High-energy radiation, under the influence of which electrically neutral atoms turn into positively and negatively charged ions, is called ...</td></tr>
</table>

9. Teaching methods

The main form of knowledge control is to conduct modular tests and tests. Based on the results of modular tests, the main score is derived, which is translated into rating points. To them are added points for oral knowledge in each content module.

10. Forms of assessment

According to the "Regulations on examinations and assessments at the National University of Bioresources and Nature Management of Ukraine", approved by the academic council of the National University of Bioresources and Nature Management of Ukraine on April 26, 2023, protocol No. 10, the types of knowledge control of higher education students are current control, intermediate and final attestation.

Current control of the discipline is carried out during practicals, and aims to check the level of preparedness of higher education applicants to perform a specific job.

Intermediate attestation is conducted after studying the program material and should determine the level of knowledge of higher education students in the program material obtained during all types of classes and independent work.

Form of intermediate certification - testing,

The assimilation of the program material by the student of higher education is considered successful, if its rating is at least 60 points on a 100-point scale.

Semester certification is conducted in the form of a semester exam.

Applicants of higher education are required to take exams and tests in accordance with the requirements of the working curriculum within the time limits provided by the schedule of the educational process. The content of the exam is determined by the working curriculum of the discipline.

11. Distribution of points received by students

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023)

Student rating, points	**National grade based on exam results**	
	Exams	**Credits**

90-100	**Excellent**	**Passed**
74-89	**Good**	
60-73	**Satisfactory**	
0-59	**Unsatisfactory**	**Not passed**

In order to determine the rating of a student (listener) in the discipline $\mathbf{R_{dis}}$ (up to 100 points), the rating from the exam $\mathbf{R_{ex}}$(up to 30 points) is added to the rating of a student's academic work $\mathbf{R_{aw}}$ (up to 70 points): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$.

12. Educational and methodological support.

1. Chernobyl: 30 Years of Radioactive Contamination Legacy. Report. Lead writer and coordination of report: Prof. Valerii Kashparov, Kyiv, 2016, 59 p.
2. He, Z. L. L., Yang, X. E. & Stoffella, P. J. Trace elements in agroecosystems and impacts on the environment. Journal of Trace Elements in Medicine and Biology, 19 (2-3), 2005, p. 125-140.

13. RECOMMENDED LITERATURE

3. Choppin G. R., Liljenzin J.-O., Rydberg J. Radiochemistry and nuclear chemistry. 4th ed., Academic Press, 2013, 858 p.
4. Climate change and nuclear power. International Atomic Energy Agency, VIENNA, 2005, 112 p.
5. Natural and induced radioactivity in food. International Atomic Energy Agency, VIENNA, 2002, 136 p.
6. Gleyzes, C., Tellier, S. & Astruc, M. Fractionation studies of trace elements in contaminated soils and sediments: a review of sequential extraction procedures. Trac-Trends in Analytical Chemistry, 21 (6-7), 2002, p. 451-467.
7. International Atomic Energy Agency Safety Standards Series No. RS-G-1.8, Environmental and Source Monitoring for Purposes of Radiation Protection for

protecting people and the environment, Safety Guide, IAEA, VIENNA, 2005, p.119.
8. Radiation biology: a handbook for teachers and students. International Atomic Energy Agency, VIENNA, 2010, 150 p.
9. He, Z. L. L., Yang, X. E. & Stoffella, P. J. Trace elements in agroecosystems and impacts on the environment. Journal of Trace Elements in Medicine and Biology, 19 (2-3), 2005, p. 125-140.
10. Lind, O.C., Salbu, B., Janssens, K., Proost, K., García-León, M., García-Tenorio, R. Characterization of U/Pu particles originating from the nuclear weapon accidents at Palomares, Spain, 1966 and Thule, Greenland, 1968. Science of the Total Environment, 376, 2007, p. 294–305.
11. Salbu, B. Fractionation of radionuclide species in the environment. Journal of Environmental Radioactivity, 100 (4), 2009, p. 283-289.
12. Tessier, A., Campbell, P. G. C. & Bisson, M. Sequential extraction procedure for the speciation of particulate trace-metals. Analytical Chemistry, 51 (7), 1979, p. 844-851.
13. Гудков І.М. Радіобіологія: підручник. – Херсон : Олді-Плюс, 2016. – 504 с.
14. Гудков І.М., Гайченко В.А., Кашпаров В.О. Сільськогосподарська радіоекологія: підручник. – К.: Ліра-К, 2017. – 268 с.
15. Моисеев А.А., Иванов В.И. Справочник по дозиметрии и радиационной гигиене. - М.: Энергоатомиздат, 1990. - 252с.
16. НРБУ-97/2000
17. Пристер Б.С., Лощилов Н.А., Немец О.Ф., В.А. Поярков. Основы сельскохозяйственной радиологии. - К.: -Урожай, 1991.- 472с.
18. Хомутінін Ю.В., Кашпаров В.О., Жебровська К.І. Оптимізація відбору і вимірювань проб при радіоекологічному моніторингу, Монографія. – К.: Український науково–дослідний інститут сільськогосподарської радіології, 2002, 160 с.
19. Природний, техногенний та екологічний ризики: аналіз, оцінка, управління: монографія / Г.В. Лисиченко, Ю.Л. Забулонов, Г.А. Хміль ; НАН Україна, Ін-т геохімії навколишнього середовища. LinkКиїв : Наук. думка, 2008., 544 с.
20. Паренюк О.Ю., Іллєнко В.В., Гудков І.М. Мікрофлора забруднених радіонуклідами ґрунтів. – К.: Вид-во НУБіП України, 2018. – 198 с.
21. Бондар О.І., Фещенко В.П., Гудков І.М., Гуреля В.В. Радіоекологічний термінологічний словник (україно-англійсько-російський). – Житомир: ПП Експертний центр Укреколбіокон, 2018. – 254 с.
22. Якість ґрунту. Методи відбору проб ґрунту для радіаційного контролю, СОУ 74.14-37-425:2006.
23. Якість ґрунту. Визначення щільності забруднення території сільськогосподарських угідь радіонуклідами техногенного походження, СОУ 74.14-37-424:2006
24. Якість продукції рослинництва. Методи відбору проб для радіаційного контролю, СОУ 01.1-37-426:2006.

25. Якість продукції тваринництва. методи відбору проб для радіаційного контролю, СОУ 01.2-37-427:2006.
26. Якість продукції тваринництва. Проведення прижиттєвого контролю тварин на територіях, забруднених радіонуклідами, СОУ 01.2-37-428:2006.

INFORMATION RESOURCES:

1. https://www.iaea.org/publications
2. https://web.archive.org/web/20110515164252/http://www-pub.iaea.org/MTCD/publications/PDF/INES-2009_web.pdf
3. https://www.who.int/news/item/05-09-2005-chernobyl-the-true-scale-of-the-accident
4. https://www.iaea.org/newscenter/news/fukushima-nuclear-accident-update-log-15
5. http://www.unscear.org/docs/reports/2008/11-80076_Report_2008_Annex_C.pdf
6. https://www.wright.edu/sites/www.wright.edu/files/page/attachments/radiation-safety-biological-effects-of-ionizing-radiation.pdf
7. https://doi.org/10.1016/j.jenvrad.2008.12.013
8. https://doi.org/10.1007/978-3-319-22171-7