SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University of Cluj-Napoca**
1.2 Faculty	**Environmental Science and Engineering**
1.3 Department	**Environmental Analysis and Assessment**
1.4 Field of study	**Environmental Engineering**
1.5 Study cycle	**Bachelor**
1.6 Study programme / Qualification	**Environmental Engineering**

2. Information regarding the discipline

2.1 Name of the discipline		**Environmental Radioactivity**					
2.2 Course coordinator		**Prof. Dr. Gabor (Timar) Alida**					
2.3 Seminar coordinator		**Prof. Dr. Gabor (Timar) Alida**					
2.4. Year of study	**3**	2.5 Semester	**1 (5)**	2.6. Type of evaluation	**E**	2.7 Type of discipline	Mandatory/DD

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					**20**
Additional documentation (in libraries, on electronic platforms, field documentation)					**10**
Preparation for seminars/labs, homework, papers, portfolios and essays					**5**
Tutorship					**5**
Evaluations					**2**
Other activities:					-

3.7 Total individual study hours	42
3.8 Total hours per semester	98
3.9 Number of ECTS credits	**4**

4. Prerequisites (if necessary)

4.1. curriculum	----------	
4.2. competencies	----------	

5. Conditions (if necessary)

5.1. for the course	Lecture room
5.2. for the seminar /lab activities	Laboratory

6. Specific competencies acquired

Professional competencies	- Developing the necessary skills to interpret and write an environmental report that presents measurements of ambient radioactivity. - Familiarization with the current radiation protection norms. - Familiarization with the basic information related to nuclear energy, the need to use this energy source and the associated risks. - Skills to be able to approach orientation research in specialized literature. - Development of the specialized language characteristic of the exact disciplines. - Practical skills of measuring radioactivity and appropriate presentation of experimental data. - Development of experimental skills in order to carry out research works.
Transversal competencies	- Acquiring an environmentally responsible component. - Acquiring notions related to the applications and implications of radioactivity/nuclear radiation in studies of physics, chemistry, geology, geophysics, geochemistry, biophysics, archaeology, taxonomy, paleontology, epidemiology, nuclear medicine. - Developing the ability to use the acquired knowledge in practical applications and the ability to solve specific problems. - Development of a critical reasoning, based on the performance and interpretation of quantitative analyses. - Capacity for analysis and synthesis, based on rigorous methods, appropriate in complex decision-making situations related to environmental issues. - The ability to responsibly and critically evaluate media information

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Acquiring knowledge related to the main aspects of the presence of ambient radioactivity and the potential applications of the existence of the radioactive decay phenomenon in the study of the environment and in energy production. Acquiring the basics in terms of radioactive pollution and associated risk assessment.
7.2 Specific objective of the discipline	- Knowledge of the main components of the natural and artificial radioactivity of the environment. Acquiring knowledge related to the applications of nuclear radiation and the phenomenon of radioactive disintegration. - Acquiring notions related to the main aspects of the interaction between ionizing radiation and living organisms and the transport of radionuclides in ecosystems. - Acquisition of basic notions related to pollution with radioactive elements and dosimetry with major importance and relevance in the assessment of risks on the quality of the environment and population health. Familiarization with the current radiation protection norms. - Awareness of the potential of using the phenomena of nuclear fission and fusion as sources of clean energy (in terms of the greenhouse effect) but also of the risks associated with the waste produced in the nuclear fuel cycle. - Learning some basic methods and techniques for radioactivity detection and measurement.

8. Content

8.1 Course	Teaching methods	Remarks
1. The structure of the atom and the nucleus. Binding energy.	Participatory lecture, dialogue, exposition, demonstration	2 hours

2. Discovery of radioactivity and its applications.	Participatory lecture, dialogue, exposition, demonstration, watching a documentary and debate	2 hours
3. Nuclear radiations and their properties.	Participatory lecture, dialogue, exposition, demonstration	2 hours
4. The law of radioactive decay. The activity. Half-life. Genetically linked radionuclides. Secular equilibrium Applications.	Participatory lecture, dialogue, exposition, demonstration	2 hours
5. Interaction of radiation with matter. The path of alpha and beta radiation in the substance. The interaction of gamma radiation with matter: the photoelectric effect, the Compton effect and the formation of pairs.	Participatory lecture, dialogue, exposition, demonstration	2 hours
6. Introduction to dosimetry. Basic dosimetric units. The effects of ionizing radiation on living organisms. Exposure to high doses - hereditary effects. Exposure to low doses - stochastic and hereditary effects. Epidemiological studies.	Participatory lecture, dialogue, exposition, demonstration	2 hours
7. Natural radioactivity. The main components of natural radioactivity.	Participatory lecture, dialogue, exposition, demonstration	2 hours
8. Dating methods based on the radioactive decay phenomenon: C-14 method, K-Ar method.	Participatory lecture, dialogue, exposition, demonstration	2 hours
9. Dating methods based on the effects of natural radiation on crystals. Optically stimulated luminescence.	Participatory lecture, dialogue, exposition, demonstration	2 hours
10. Artificial radioactivity. Production of radioisotopes. Applications in medicine, industry, agriculture and research.	Participatory lecture, dialogue, exposition, demonstration	2 hours
11. Nuclear fission and fusion. Fission with thermal neutrons. Energy Activation. Chain reactions. The nuclear reactor. Thermonuclear fusion reactions.	Participatory lecture, dialogue, exposition, demonstration	2 hours
12. Nuclear energy. Types of nuclear reactors. The nuclear fuel cycle. Radioactive waste.	Participatory lecture, dialogue, exposition, demonstration	2 hours
13. Detection and measurement of nuclear radiation. Ionization chamber, Geiger-Muller counter. Scintillation detectors. Solid state detectors	Participatory lecture, dialogue, exposition, demonstration	2 hours
14. General notions of nuclear legislation. The ALARA principle, national and international legislation.	Participatory lecture, dialogue, exposition, demonstration	2 hours

Bibliography:

1. A. Timar-Gabor, Environmental Radioactivity, course notes.
2. M. Eisenbud, T. Gessel, *Environmental Radioactivit http://www.cncan.ro/y (From Natural, Industrial and Military Sources)*, 4th Edition, Academic Press, 1997.
3. M. L`Annunziata, *Handbook of Radioactivity Analysis*, 2nd Edition, Academic Press, ISBN: 9780080495057, 2004.
4. G. F. Knoll, *Radiation Detection and Measurement*, 3rd Edition, John Willey and Sons Inc, ISBN-10: 0471073385, 2000.
5. ICRP 2007, The 2007 Recommendations of the International Comission on Radiological Protection. Publication 103. Pergamon press, Oxford and New York.
6. UNSCEAR 2000, Sources and effects of Ionising Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation. Report to the general assembly with annexes.
7. IAEA, 1994, Handbook of parameter values for the prediction of radionuclide transfer in temperate environments. Technical report series 364, Viena.
8. http://www.iaea.org/
9. http://www.icrp.org/

10. http://www.unscear.org/ 11. http://www.cncan.ro/ 12. http://www.cnu.ro/		
8.2 Seminar / laboratory	Teaching methods	Remarks
1. The structure of the atom and the nucleus. Specific measurement units.	Exercises. Aplications.	2 hours
2. Types of radioactive decay. The chart of nuclides.	Exercises. Aplications.	2 hours
3. Law of radioactive decay. The activity.	Exercises. Aplications.	2 hours
4. Law of radioactive decay. The activity.	Exercises. Aplications.	2 hours
5. Radiation interaction with matter. Applications.	Exercises. Aplications.	2 hours
6. Nuclear dating methods. Applications.	Exercises. Aplications.	2 hours
7. Experimental data processing and error calculation in radioactivity measurements.	Practical activity.	2 hours
8. The study of statistical fluctuations in radioactive decay.	Practical activity.	2 hours
9. High-resolution gamma spectrometry with a high-purity Ge detector - qualitative analysis.	Practical activity.	2 hours
10. High-resolution gamma spectrometry with a high-purity Ge detector - quantitative analysis.	Practical activity.	2 hours
11. Nuclear radiation dosimetry with active detectors. The study of the dependence of the dose on the distance to a radioactive source of low activity.	Practical activity.	2 hours
12. Themoluminescence dosimetry.	Practical activity.	2 hours
13. Optically stimulated luminescence dating.	Practical activity.	4 hours
Bibliography: A. Timar-Gabor- handnotes given to each participant.		

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

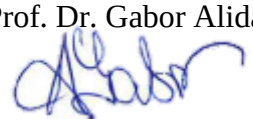
The content structure of the discipline designed following recent monographs in the field and after consulting the programs and notes available from recognized institutions in the field, which have similar programs, such as:
http://www.gla.ac.uk/services/radiationprotection/radiationprotectioncourse/coursenotes/
http://healthphysics.georgetown.edu/HP%20courses.html
http://berkeley.edu/
http://www-pub.iaea.org/MTCD/publications/PDF/TCS-18_web.pdf
http://www.epa.gov/rpdweb00/topics.html
The knowledge and practical skills gained from this course constitute a solid basis for a possible integration of future graduates as environmental specialists within the 37 stations of the National Environmental Radioactivity Monitoring Network (RNSRM) within the National Environmental Protection Agencies.
The content of the subject represents a solid theoretical basis for some specialized subjects that graduates can deepen within the framework of their master's studies (the Sustainable Development and Environmental Management section and the Environmental Quality, Health and Safety)

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Understand the concepts presented in the course	Written exam	33%
10.5 Seminar/lab activities	Solving exercises	Written exam	33%

	Participation and implication in practical activities	Colloquium	33%
10.6 Minimum performance standards:			
Active participation in practical activities and obtaining a minimum grade of 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
04.12.2024.	Prof. Dr. Gabor Alida	Prof. Dr. Gabor Alida



Date of approval

Signature of the head of department

Profesor Dr. Rosu Cristina