SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline	**Dosimetric techniques in environmental studies and radioprotection training**						
2.2 Course coordinator	**Associate Professor Dr. Gabor (Timar) Alida**						
2.3 Seminar coordinator	**Associate Professor Dr. Gabor (Timar) Alida**						
2.4. Year of study	**2**	2.5 Semester	**3**	2.6. Type of evaluation	**C**	2.7 Type of discipline	SD/ Optional course

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

3.1 Hours per week	2	Of which: 3.2 course	1	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	**42**	Of which: 3.5 course	**14**	3.6 seminar/laboratory	**28**
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					3
Additional documentation (in libraries, on electronic platforms, field documentation)					6
Preparation for seminars/labs, homework, papers, portfolios and essays					9
Tutorship					3
Evaluations					4
Other activities:					-

3.7 Total individual study hours	18
3.8 Total hours per semester	67
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	Blackboard, video projector
5.2. for the seminar /lab activities	Laboratory

6. Specific competencies acquired

Professional competencies	• Participants in the course will achieve the level of knowledge necessary in order be able to understand and interpret an environmental radioactivity report. • Students will be acquainted with the most recent regulations, recommendations and trends in radioprotection. They will be trained in radiation protection and the safe use of radiation sources. • Learning to conduct incipient original research in the field of radioactivity with emphasize in environmental radioactivity measurements.
Transversal competencies	• Problem solving abilities. • Recording and interpreting experimental data abilities. Understanding the experimental error limitations of measurements. • Development of critical scientific reasoning based on a quantitative interpretation of data. • Gaining the ability to synthesise and interpret complex information based on rigorous scientific methods. • Manifesting a responsible attitude toward the scientific fields and respecting the professional and ethical principles. • Gaining the ability to critically evaluate information presented by the media.

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

7.1 General objective of the discipline	• Gaining knowledge on: environmental radioactivity of natural and artificial origin, the potential applications of background radioactivity in environmental studies, the peaceful use o radioactive sources, nuclear regulations and legislation, the effects of ionizing radiations on living beings and the risk associated with exposure to sources of radioactivity in the environment.
7.2 Specific objective of the discipline	• Knowing the sources of nuclear radiation in the environment. Understanding the basis of nuclear decay and types of radiation. • Identifying the sources of human and other biota exposure to nuclear radiation in the environment and the pathways of radionuclide's migration in the environment and ecosystems. • Training in basic dosimetry. • Developing a well-documented opinion on the advantages as well as the risks associated with nuclear energy production. • Obtaining knowledge on the radioactive contaminated sites and the potential remediation of these areas. • Gaining knowledge on various other applications of environmental radioactivity to environmental studies such as radioactive dating methods.

8. Content

8.1 Course	Teaching methods	Remarks
1. **Radioactive decay and nuclear radiations. Basic physical aspects.** -nuclear stability, nuclear decay and radiations -the law of radioactive decay - basic principles on the interaction of radiation with matter	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours

2. Natural Radioactivity. Human exposure to natural ionizing radiation. Technological processes that enhance natural radioactivity. -naturally occurring radioactive substances -induced/cosmogenic radionuclides -natural sources of external/internal irradiation -areas with high natural radioactive background -natural radioactivity in phosphate fertilizers -natural radioactivity in building materials -natural radioactivity in fossil fuels	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours
3. Power reactors and nuclear weapons. Production and reprocessing of nuclear fuels. Radioactive waste management. -physical aspects of reactor design and operation -worldwide fallout from nuclear weapons tests -uranium mining and milling -nuclear fuel cycle -low level/high level nuclear waste, nuclear waste repositories.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours
4. Dosimetry and environmental radioactivity monitoring. -basic dosimetric units - passive and active nuclear detectors -radioactive surveillance and monitoring	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours
5. Potential sources of radioactive contamination inhabited sites.Remediation of contaminated sites. -accidents at nuclear installations -accidents with highly radioactive sources -transport accidents -radiological terrorism -estimation of doses in inhabited ares and countermeasures for reduction of dose in contaminated inhabited areas. -international approaches to remediation of territorial radioactive contamination -site characterization and measurement strategies for remediation purposes -remediation of areas contaminated after radiation accidents-lessons from the past -remediation of sites contaminated by nuclear weapon tests -remediation as part of the decommissioning of nuclear facilities -remediation planning of uranium mining and milling facilities -radon remediation	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours
6. Radiation exposure and risks. -stochastic effects of radiation exposure. -epidemiological studies: life spam studies on survivors of nuclear attacks and radon epidemiological studies -nuclear legislation and regulations -the linear no threshold hypothesis -the disparity between actual and perceived risk	• Interactive exposure • Explanation • Conversation • Didactical demonstration	2 hours
7. Methods for retrospective dose assessment. -retrospective techniques with emphasize on physical methods -quartz as a retrospective dosimeter -unconventional materials fortuitous luminescence dosimeters	• Interactive exposure • Explanation • Conversation • Didactical	2 hours

	demonstration	

BIBLIOGRAPHY

1. ***Radioactivity in the Environment***, series editor M. Baxter

Volume 14 - *Remediation of Contaminated Environments*, Edited by G. Voigt, S. Fesenko, Elsevier 2009, 496 Pages, ISBN 13: 978-0-08-044862-6

Voume 15 - *Airborne Radioactive Contamination in Inhabited Areas*, Edited by K.G. Andersson, Elsevier 2009, 368 Pages, ISBN 13: 978-0-08-044989-0

Volume 16- *Environmental Radionuclides*, Edited By Klaus Froehlich, Elsevier 2009, 432 Pages, ISBN 13: 978-0-08-043873-3

2. M. Eisenbud, T. Gessel, ***Environmental Radioactivity(From Natural, Industrial and Military Sources),***4th Edition,Academic Press, 1997
3. J. Kiefer, ***Biological Radiation Effects,*** Springer-Verlag Berlin-Heidelberg, 1990.
4. H. Cember, ***Introduction to Health Physics***, 3rd Edition, McGraw-Hill, New York (2000).
5. M. L`Annunziata, ***Handbook of Radioactivity Analysis***, 2nd Edition, Academic Press, ISBN: 9780080495057, 2004.
6. G. F. Knoll, ***Radiation Detection and Measurement***, 3rd Edition, John Willey and Sons Inc, ISBN-10: 0471073385, 2000.
7. ICRP 2007, ***The 2007 Recommendations of the International Comission on Radiological Protection. Publication 103.*** Pergamon press, Oxford and New York.
8. ***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.
9. A. Timar-Gabor, ***Retrospective luminescence dosimetry, applications in archaeology, geology and environmental studies***, Presa Universitară Clujeană, 2012.
10. http://www.iaea.org/
11. http://www.icrp.org/
12. http://www.unscear.org/

8.2 Seminar / laboratory	Teaching methods	Remarks
1.Radioactive decay and nuclear radiations. Basic physical aspects. Experimental uncertainty quantification in radioactivity measurements. The statistical nature of radioactive decay.	• Explanation • Conversation • Assignment	4 hours
2. Dosimetry and environmental radioactivity monitoring. Dosimetric units. The study of the variation of absorbed dose in air with the distance from a weak radioactive source.	• Assignment • Explanation • Conversation	4 hours
3. Dosimetry and environmental radioactivity monitoring. Dosimetric units. Environmental dosimetry using passive detectors: LiF:Mg,Cu, P TL detectors. Radon monitoring using CR-39 detectors.	• Assignment • Explanation • Conversation	4 hours
4. Potential sources of radioactive contamination inhabited sites. High resolution gamma spectrometry. Qualitative interpretation of a gamma spectrum.	• Assignment • Explanation • Conversation	4 hours
5. High resolution gamma spectrometry. Quantitative measurements of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs from soil.	• Assignment • Explanation • Conversation	4 hours
6. Dosimetric properties (TL/OSL and ESR) of quartz .	• Assignment • Explanation • Conversation	4 hours
7. Accident dosimetry. Retrospective dosimetry. Study of the dosimetric (TL/OSL and ESR) properties of some unconventional materials.	• Assignment • Explanation • Conversation	4 hours

Bibliography

1. A. Timar-Gabor – Radioactivity notes - Will be handed in 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 of the discipline is consistent with the similar disciplines from other universities 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
http://www.ed.ac.uk/schools-departments/health-safety/radiation-protection/training/course-list/radiation-protection

As well, they are in line with the requirements that potential employers such as the National Radioactivity Surveillance Network or the Local Environmental or Health Agencies would have in the field.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	• A theoretical research report based on some recent research papers should be prepared and presented	Evaluation of a research report	**3 p (33%)**
	• The correctness of the accumulated knowledge.	Written exam	**3 p (33%)**
10.5 Lab activities	• Laboratory written assignments	Evaluation of the project (documentation and demonstration)	**3 p (33%)**
10.6 Minimum performance standards			
• Each student has to prove that (s)he acquired an acceptable level of knowledge and understanding, that (s)he is capable of stating these knowledge in a coherent form. Attendance to laboratory activities is mandatory as well as the presentation of the research report. Successful passing of the exam is conditioned by the final grade that has to be at least 5.			

Date | Signature of course coordinator | Signature of seminar coordinator

April, 4th 2018 | Associate Professor Dr. Alida Gabor | Associate Professor Dr.Alida Gabor

Date of approval

Signature of the head of department

Associate Professor Dr. Radu Mihaiescu