

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	Bachelor
1.6 Study programme / Qualification	Environmental Engineering/ Engineer

2. Information regarding the discipline

2.1 Name of the discipline	Exposure to radon- methods of measurements and remediation						
2.2 Course coordinator	CS I, PhD, Cucos Alexandra						
2.3 Seminar coordinator	CS I, PhD, Cucos Alexandra						
2.4 Year of study	3	2.5 Semester	5	2.6. Type of evaluation	C	2.7 Type of discipline	DS

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					10
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					8
Evaluations					4
Other activities:					-
3.7 Total individual study hours	42				
3.8 Total hours per semester	98				
3.9 Number of ECTS credits	4				

4. 4. Prerequisites (if necessary)

4.1 curriculum	
4.2 competencies	• Basic knowledge of physics and chemistry • Basic knowledge of using computers (using scientific databases, carrying out scientific projects)

Conditions (if necessary)

5.1 for the course	• Video projector
5.2 for the seminar /lab activities	• Laboratory with computers; Specialised laboratory

6 . Specific competencies acquired

Professional competences	• Knowledge of the principles of action of ionizing radiation on matter • Knowledge of measurement techniques for radon and its progeny • Understanding of the principles of transport and accumulation of radon in indoor spaces • Understanding of remedial methods to reduce exposure to radon
Transversal competencies	• Concepts related to the impact of radon on human health • Critical evaluation of information related to case-control and systematic studies regarding the impact of radon exposure on the occurrence of lung cancer • Development of problem-solving skills related to choosing the most optimal prevention/mitigation methods to reduce radon exposure

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

7.1 General objective of the discipline	• Knowledge, understanding and deepening of the concepts of nuclear physics with direct reference to the impact of ionizing radiation on the human body
7.2 Specific objective of the discipline	• Understanding the mechanisms of transport and accumulation of radon in indoor spaces • Understanding the principles of operation for prevention and remediation methods in closed spaces to reduce radon exposure • Awareness of the risks associated with chronic radon exposure

8. Content

8.1 Course	Teaching methods	Remarks
Types of radiation. Mechanisms of action. Health effects	Interactive exposure, conversation	1 hour
2. Natural and artificial irradiation of the human population. Radioactive contamination of the environment. Radon – sources and its descendants. Transport mechanisms	Interactive exposure, explanation, conversation	1 hour
3. Active and passive methods of measuring radon in indoor air	Interactive exposure, explanation, conversation	2 hours
4. Risk of radon exposure in the process of increasing energy efficiency of buildings	Interactive exposure, explanation, conversation	2 hours
5. Methods of preventing and controlling of radon penetration in the new buildings	Interactive exposure, explanation, conversation	2 hours
6. Remedial methods for radon exposure reduction in existing buildings	Interactive exposure, explanation, conversation	2 hours
7. Methods for remediating indoor radon concentration – case studies	Interactive exposure, explanation, conversation	2 hours
8. Innovative methods for remediating radon concentration inside homes. Smart devices connected to IoT	Interactive exposure, explanation, conversation	2 hours

Bibliography

1. Cernea V., (2003), Elemente de radiobiologie, Ed. Medicală Universitară „Iuliu Hațieganu”, 339 pg.
2. Cinelli, G., De Cort, M. & Tollefsen, T. (Eds.) (2019) ‘European Atlas of Natural Radiation’, Publication Office of the European Union, Luxembourg.
3. Cosma C. Et al., (2009), Radonul și cancerul pulmonar. Ed. Quantum, 168 pg.
4. Cothorn R., Smith J., (1987), Environmental radon, Environmental Science Research, volume 35, Springer Science.
5. EURATOM 59 Council Directive 2013/59/Euratom of 5 December 2013 Laying down Basic Safety Standards for Protection against the Dangers Arising from Exposure to Ionising Radiation, and Repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom; 2013, <http://www.cncan.ro/assets/Legislatie/Legislatie-comunitara/DIRECTIVA-2013-59-EURATOM-ro.pdf>
6. Ghiorgă G., Corneanu G., (2002), Radiobiologie, Ed. ALMA MATER, 308 pg.
7. HG No. 526/2018 for the approval of the National Radon Action Plan, published in the Official Monitor of Romania, part I, No. 645/25.VII.2018, <http://www.cncan.ro/assets/Radon/HG526-2018.pdf>
8. Order of the President of CNCAN No. 153/ 27.07.2023, published in MO No. 729/ 08.08.2023, which completes and repeals the Order of the President of CNCAN No. 185/2019 on the approval of the Methodology for determining the concentration of radon in the air inside buildings and workplaces, <http://www.cncan.ro/assets/Radon/2023/Ordin-153-din-2023-Metodologie-radon.pdf>
9. Order of the Minister of Development, Public Works and Administration No. 2.219/2023 for the approval of the technical regulation "Guide regarding remedial methods in existing buildings to reduce the level of exposure to radon, indicative RTC 6 - 2022", published in MO No. 967/ 25.10.2023, <http://www.cncan.ro/assets/Radon/2023/Ghid-remediere-aprobat-prin-Ordinulnr.-220192023.pdf>
10. Order of the Minister of Development, Public Works and Administration No. 2.223/2023 for the approval of the technical regulation "Guide on the methods of prevention and control of radon penetration in new buildings, indicative RTC 7-2022" published in MO No. 973 / 26.10.2023, <http://www.cncan.ro/assets/Radon/2023/Ordin-nr.-22232023ghid-prevenire.pdf>
11. Murray R., (2008), Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Butterworth-Heinemann, 576 pg.
12. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (1993) ‘Sources and Effects of Ionizing Radiation’ United Nations Publication Sales No. E.94.IX.2, United Nations, New York.
13. Ursu I., (1973), Energia atomică, Ed. Științifică, 540 pg.
14. World Health Organization. In: Zeeb, Hajo, Shannoun, Ferid (Eds.), *Handbook on Indoor Radon, a Public Health Perspective*. 110, 2009.

8.2 Seminar / laboratory	Teaching methods	Remarks
1.Determination of indoor radon concentration in buildings based on LR 115, CR 39 trace detectors. Determination of public exposure	Experiment, dialogue, computer exercise	2 hours
2.Completion of radon risk map in Romania	Dialogue, computer exercise	2 hours
3.Carrying out radon measurements in soil and determining the radon index	Experiment	4 hours
4.Calibration of active radon concentration measuring devices using the accumulation chamber (4 hours)	Experiment	4 hours
5.Case studies on identifying radon sources and recommending remediation solutions for an existing building (6 hours)	Experiment, dialogue, computer exercise	6 hours

6.Determining the effectiveness of remediation methods applied in the case studies presented in the course	Experiment, dialogue, computer exercise	6 hours
7.Determination of the diffusion coefficient through anti-radon barriers (4 hours)	Experiment	4 hours

Bibliography:

1. Cinelli, G., De Cort, M. & Tollefsen, T. (Eds.) (2019) 'European Atlas of Natural Radiation', Publication Office of the European Union, Luxembourg.
2. Cosma C. Et al., (2009), Radonul și cancerul pulmonar. Ed. Quantum, 168 pg.
3. Cothorn R., Smith J., (1987), Environmental radon, Environmental Science Research, volume 35, Springer Science.
4. Cucos (Dinu), A., et al. (2017), Residential, soil and water radon surveys in north-western part of Romania, Journal of Environmental Radioactivity, 166 (2), pp. 412-416.DOI: 10.1016/j.jenvrad.2016.10.003
5. Cucos (Dinu) Alexandra, T. Dicu, C. Cosma (2015), Indoor radon exposure in energy-efficient houses from Romania, Romanian Journal of Physics, 60 (9-10), pp. 1574–1580. https://rjp.nipne.ro/2015_60_9-10/RomJPhys.60.p1574.pdf
6. Dicu T., A. Cucos, et al. (2023), Exploring statistical and machine learning techniques to identify factors influencing indoor radon concentration, Science of The Total Environment, Vol.903/2023, <https://doi.org/10.1016/j.scitotenv.2023.167024>
7. Ghiorghe G., Corneanu G., (2002), Radiobiologie, Ed. ALMA MATER, 308 pg.
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9. Order of the Minister of Development, Public Works and Administration No. 2.223/2023 for the approval of the technical regulation "Guide on the methods of prevention and control of radon penetration in new buildings, indicative RTC 7-2022" published in MO No. 973 / 26.10.2023, <http://www.cncan.ro/assets/Radon/2023/Ordin-nr.-22232023ghid-prevenire.pdf>
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11. Ursu I., (1973), Energia atomică, Ed. Științifică, 540 pg.
12. Links:
[https://enviro.ubbcluj.ro/cercetare/laboratoare-de-cercetare/laborator-de-radon/;](https://enviro.ubbcluj.ro/cercetare/laboratoare-de-cercetare/laborator-de-radon/)
<https://radon.enviro.ubbcluj.ro/>

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

Considering the specific legislation and regulations in this field in Romania and at a global level (European/world), it is necessary to inform, popularize the subject of radon and adequately train environmental engineers and other professional categories involved in environmental health issues and reducing the risks of population illness due to natural hazards - natural ionizing radiation, radon, as well as ensuring the information and dissemination process to the community.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of the concepts presented in the course	Written exam	33%
10.5 Seminar/lab activities	Project/ essay	Evaluation during the semester	66%
10.6 Minimum performance standards			
Each student has to prove that (s)he acquired an acceptable level of knowledge and understanding of the: - Knowledge of measurement techniques for radon and its progeny - Understanding of the principles of transport and accumulation of radon in indoor spaces - Understanding of remedial methods to reduce public exposure to radon The student will prepare and sustain a project / essay according to the content of the framework. Obtaining the minimum mark of 5 is an entry condition for the Exam			

Date

Signature of course coordinator

Signature of seminar coordinator

05.12.2024




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Date of approval

Signature of the head of department

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