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	Technological risk assessment						
2.2 Course coordinator	Assoc. Prof. Dr. Ing. Török Zoltán						
2.3 Seminar coordinator	Assoc. Prof. Dr. Ing. Török Zoltán						
2.4 Year of study	**IV**	2.5 Semester	**VII**	2.6. Type of assessment	**E**	2.7 Discipline regime	**Compulsory.**

3. Total estimated time (hours per 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					7
Additional documentation (in libraries, on electronic platforms, field documentation)					0
Preparation for seminars/labs, homework, papers, portfolios and essays					5
Tutorship					0
Evaluations					2
Other activities:					

3.7 Total individual study hours	**14**
3.8 Total hours per semester	**70**
3.9 Number of ECTS credits	**3**

4. Prerequisites (if necessary)

4.1 Curriculum	• knowledge of the fundamental elements of environmental science and engineering: chemistry, mathematics, physics, thermodynamics, unit operations, technological hazards and risks
4.2 Competences	• Technical; use of the computer;

5. Conditions (if necessary)

5.1 For the Course	• requires digital projector and laptop
5.2 for the seminar/lab activities	• access to computers for the use of modeling and simulation programs, access to online databases, access to information necessary for the development of the project.

6. Specific competences acquired

Professional competencies	• knowledge of basic methods of technological risk analysis; • knowledge of the concepts and principles of carrying out technological risk analyses; • acquiring the knowledge of preparing a technological risk analysis;
Transversal competences	• the ability to conduct literature research in all existing formats; • knowledge of the use of computer programs; • acquiring the knowledge of preparing a scientific project; • teamwork;

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

7.1 General objective of the discipline	• studying and knowing the methods, techniques and procedures for technological risk assessment;
7.2 Specific objectives of the discipline	• the acquisition of technological risk management terminology; • knowledge of the basic content of a safety report; • knowledge of the qualitative risk analysis method: Preliminary Hazard Analysis (PHA); • knowledge of quantitative risk analysis methods: physical effects by modeling chemical industrial accidents; • knowledge of the use of the ALOHA modeling program • knowledge of how to prepare a technological risk analysis project, which is based on the use of the methods mentioned above.

8. Contents

8.1 Course	Teaching methods	Remarks
1. Introduction to Technological Risk Management . General.	lecture, interactive discussions	Terminology aspects. Films and images of technological disasters.
2. European and national regulations for the chemical industrial sector in order to prevent major accidents.	lecture, interactive discussions	Presentation of the European Seveso and national legislation
3. The framework content of a technological risk study involving hazardous substances. Risk assessment cycle.	lecture, interactive discussions	Presentation of subsequent legislation and risk study requirements.
4. Identification and analysis of technological hazards. Methods and techniques.	lecture, interactive discussions	Presentation of the most used methods and techniques.
5. Historical analyses. Databases.	lecture, interactive discussions	Presentation of disaster databases and legal requirements for reporting industrial accidents.
6. Qualitative risk analyses: Preliminary Hazard Analysis (PHA).	lecture, interactive discussions	Presentation of the method, with advantages and disadvantages. Solved examples.

7. Source terms	lecture, interactive discussions	Presentation of the factors and conditions that define the source of the accident.
8. Types of technological accidents: fires, explosions, toxic dispersions.	lecture, interactive discussions	Presentation of the types of possible accidents, sequences of events and connections between different possible situations.
9. Analysis of physical effects – release of hazardous substances; Evaporation	lecture, interactive discussions	Presentation of mathematical models for modelling and simulating hazardous substance spills and evaporation of liquids.
10. Analysis of physical effects – toxic dispersions in the atmosphere	lecture, interactive discussions	Presentation of mathematical models for modeling and simulating toxic dispersions.
11. Analysis of physical effects – fires and explosions	lecture, interactive discussions	Presentation of mathematical models for modeling and simulating fires and explosions.
12. Quantitative risk analyses: Fault trees (FT).	lecture, interactive discussions	Presentation of the method, with advantages and disadvantages. Solved examples.
13. Quantitative Risk Analyses: Event Trees (ET).	lecture, interactive discussions	Presentation of the method, with advantages and disadvantages. Solved examples.
14. Summary course. General conclusions on risk assessment and communication.	lecture, interactive discussions	Summary. Recap. Conclusions. Discussion of the examination.

Bibliography

Course Support:

- The presentations held at the course in PDF format, available at the FSIM library on CD and are sent to students upon request by email.

Books:

- Török Zoltán, Ajtai Nicolae, Ozunu Alexandru: Computational applications for assessing the risk of major industrial accidents involving hazardous substances, Ed. EFES, Cluj-Napoca, 2011.
- Alexandru Ozunu, Călin Anghel: Technological Risk Assessment and Environmental Security, Accent Publishing House, Cluj-Napoca, 2007.
- Alexandru Ozunu, Carmen Teodosiu: Prevention of Environmental Pollution, Transilvania University Publishing House, Braşov, 2002.
- Gheorghe Maria: Quantitative Evaluation of the Risk of Chemical Processes and Modeling of the Consequences of Accidents, Printech Publishing House, Bucharest, 2007.

- Frank P. Lees: Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control, Second edition, United Kingdom, 1996.
- Van den Bosch, C. J. H., Weterings R.A.P.M: "Yellow Book": Methods for the Calculation of Physical Effects, Third edition, Committee for the Prevention of Disasters, Netherlands, 1997.
- P.A.M. Uijit de Haag, B.J.M. Ale: "Purple Book": Guidelines for Quantitative Risk Assessment, First edition, Committee for the Prevention of Disasters, The Hague, 1999.
- C. A. Ericson: *Hazard Analysis Techniques for System Safety*, Ed. Wiley-Interscience, New Jersey, 2005.
- American Institute of Chemical Engineers (AIChE): *Guidelines for Chemical Process Quantitative Risk Analysis*, Second Edition, New York, 2000.
- T. Kletz, *HAZOP & AN. Notes on the Identification and Assessment of HazardsHAZ*, Institution of Chemical Engineers, Fourth Edition, UK, 1999.
- N. Hyatt, *Guidelines for Process Hazards Analysis, Hazard Identification & Risk Analysis*, Ed. Dyadem Press, Ontario, 2003.

Articles:

1. Török, Z., Petrescu-Mag, R.-M., Mereuță, A., Maloș C.-V., Arghiuș V., Ozunu, A., Analysis of territorial compatibility for Seveso-type sites using different risk assessment methods and GIS technique, Land Use Policy, https://doi.org/10.1016/j.landusepol.2019.02.037.
2. Ozunu A., Mereuta A., Török Z., Literat. L., 2017, A national hazard analysis and mapping for Seveso establishments, Journal of Engineering Sciences and Innovation, Vol.2, Issue 3, pg. 93-102.
3. Török Z., Ozunu A., 2015, Hazardous properties of ammonium nitrate and modeling of explosions using TNT equivalency, Environmental Engineering and Management Journal, Vol.14/11, pp. 2671-2678.
4. Török Z., Kovacs A., Ozunu A., 2015, Ammonium Nitrate explosions. Case study: the Mihăilești accident (2004), Romania, Ecoterra, 12(2), pp. 56-60.
5. Crăciun I., Török Z., Ozunu A., 2015, Comparative analysis of individual risk using different Probit functions in estimating heat radiation consequences, AES BIOFLUX, 7/2, pp. 223-229.
6. Gheorghiu A.-D., Török Z., Ozunu A., Antonioni G., Cozzani V., 2014, Comparative Analysis of Technological and Natech Risk for two Petroleum Products Tanks Located in a Seismic Area, Environmental Engineering and Management Journal, Vol.13/8, pp. 1887-1892.
7. GHEORGHIU A.-D., TÖRÖK Z., OZUNU A., ANTONIONI G., COZZANI V., 2014, Natech Risk Analysis in the Context of Land Use Planning. Case Study: Petroleum Products Storage Tank Farm Next to a Residential Area., Chemical Engineering Transactions, Vol. 36, pp. 439-445.
8. Zoltán TÖRÖK, Nicolae AJTAI, Adrian T. TURCU, Alexandru OZUNU - Comparative consequence analysis of the BLEVE phenomena in the context on Land Use Planning; Case study: The Feyzin accident, Process Safety and Environmental Protection, 89 (2011) pp. 1-7.
9. TÖRÖK, Z., OZUNU, A., CORDOȘ E., Chemical risk analysis for land-use planning. I. storage and handling of flammable materials, Environmental Engineering and Management Journal, January 2011, Vol.10, No. 1, 81-88.
10. Zoltán TÖRÖK, Nicolae AJTAI, Alexandru OZUNU, Chemical Risk Area Estimation as a Tool for Efficient Emergency Planning, Studia Universitas Babeș – Bolyai, Chemia series, 2009, ISSN 1224 – 7154.
10. Zoltán TÖRÖK, Alexandru OZUNU, 2010, Chemical risk assessment for storage of hazardous materials in the context of Land Use Planning. AES BIOFLUX 2(1): 33-56
11. OZUNU, A., TÖRÖK, Z., COSARA, V., CORDOS, E., DUTRIEUX, A., (2008), Vulnerability Mitigation and Risk Assessment of Technological Disaster, NATO Science for Peace and Security Series, E: Human and Societal Dynamics, Volume 35, Risk Assessment as a Basis for the Forecast and Prevention of Catastrophes, Edited by Ion Apostol, Wilhelm G. Coldewey, David L. Barry, Dieter Reimer, ISBN 978-1-58603-844-1, Springer Publishing House Netherlands.
12. L. ȘTEFĂNESCU, TÖRÖK, Z., F. SENZACONI, A. OZUNU, 2013, Quantitative fire risk assessment procedure at pesticide storage facilities in Romania, NATO Science for Peace and Security Series: Environmental Security Assessment and Management of Obsolete Pesticides in Southeast Europe, Edited by L.Simeonov, F. Macaev and B. Simeonova, Springer Science+Business media B.V., pp. 249-256.

Legislation:

- Law 59 of 2016 on the control of major accident hazards involving dangerous substances

- ORDER No. 156/2017 of 11 December 2017 for the approval of the Methodological Norms regarding the elaboration and testing of emergency plans in case of major accidents involving hazardous substances
- ORDER No. 3710/1212/99/2017 of 19 July 2017 regarding the approval of the Methodology for establishing the appropriate distances from the potential sources of risk within the sites that fall under the provisions of Law no. 59/2016 on the control of the dangers of major accidents involving hazardous substances in spatial planning and urban planning activities
- ORDER No. 1175/2019/39/2020 of 20 December 2019 regarding the approval of the Procedure for the notification of activities that present dangers of major accidents involving hazardous substances
- ORDER No. 1176/2019/40/2020 of 20 December 2019 regarding the approval of the Procedure for the notification of major accidents involving hazardous substances, including in a cross-border context
- DECISION no. 557 of 3 August 2016 on risk management
- DIRECTIVE 2012/18/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on the control of major accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC
- REGULATION (EC) NO. 1272/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 16 December 2008 on the classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, as well as amending Regulation (EC) no. 1907/2006

Access places: Central University Library, Library of the Faculty of Environmental Science and Engineering.
ISUMADECIP Electronic Library, Faculty of Environmental Science and Engineering
Web pages (Internet):
http://echa.europa.eu/regulations/clp, http://ec.europa.eu/index_ro.htm, http://reach.anpm.ro/
https://www.mmediu.ro/categorie/legislatie/116 www.enviro.ubbcluj.ro, http://www.epa.gov.us, https://minerva.jrc.ec.europa.eu/en/minerva

8.2 Seminar / **laboratory**	Teaching methods	Remarks
1. Introduction to the topic of the semester project	-lecture;	- Description of the topic. - Study objectives
2. Analysis of the area of the studied site	-lecture; - teamwork; -Brainstorming;	- description of factors such as: neighborhoods, climate, hydrology, natural hazards, vulnerabilities.
3. Identification and assessment of technological hazards Substance-related hazards - aspects about the substance(s), physicochemical and toxicological properties that determine technological hazards - aspects related to protective measures and prevention of exposure	-lecture; - interactive discussions;	- the use of safety data sheets in the process of identifying hazards related to substances used in technological processes
4. Technological accidents involving the studied substance	-lecture; - interactive discussions;	- use of the eMARS electronic database to identify possible accidents
5. Preliminary hazard analysis (PHA)	-lecture; - teamwork; -Brainstorming;	- general description of the method - solving examples in work groups - completing the project - verification of projects;
6. Analysis of the physical effects of accidents (part 1)	-lecture; - teamwork; -Brainstorming;	- general description of physical effects modeling - building the scenarios based on those obtained in the PHA

	- activities by using the computer;	- Presentation of the ALOHA modeling and simulation software
7. Analysis of the physical effects of accidents (part 2)	-lecture; - teamwork; -Brainstorming; - activities by using the computer;	- general description of physical effects modeling - building the scenarios based on those obtained in the PHA - simulation of accident scenarios with the ALOHA software - verification of projects;
8. Analysis of the physical effects of accidents (part 3)	-lecture; - teamwork; -Brainstorming; - activities by using the computer;	- general description of physical effects modeling - building the scenarios based on those obtained in the PHA - simulation of accident scenarios with the ALOHA software - verification of projects;
9. Quantitative analyses: Analysis of equipment failure frequencies (part 1)	-lecture; - teamwork; -Brainstorming;	- general description of the method - solving examples in work groups
10. Quantitative analyses: Analysis of equipment failure frequencies (part 2)	-lecture; - teamwork; -Brainstorming;	- general description of the method - solving the problem in the project - verification of projects;
11. Analysis of the frequencies of accidental scenarios (part 1)	-lecture; - teamwork; -Brainstorming;	- general description of the method - solving examples in work groups
12. Analysis of the frequencies of accidental scenarios (part 2)	-lecture; - teamwork; -Brainstorming;	- general description of the method - solving the problem in the project - verification of projects;
13. Estimation of technological risk – risk matrix. Calculation and presentation of risk. Final conclusions.	-lecture; -Brainstorming; - activities by using the computer;	- presentation of the results obtained from the analyzes performed; - verification of projects;
14. Presentation of the projects		- presentation of projects;

Bibliography

Books:

- Török Zoltán, Ajtai Nicolae, Ozunu Alexandru: Computational applications for assessing the risk of major industrial accidents involving hazardous substances, Ed. EFES, Cluj-Napoca, 2011.
- Frank P. Lees: Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control, Second edition, United Kingdom, 1996.
- Van den Bosch, C. J. H., Weterings R.A.P.M: "Yellow Book": Methods for the Calculation of Physical Effects, Third edition, Committee for the Prevention of Disasters, Netherlands, 1997.
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- Kovacs, A., Bican-Brișan N., Maloș, C., Török, Z., Botezan, C., Ozunu, A., 2018, NaTech risk assessment at a gas expoitation well in Romania, Journal of Environmental Protection and Ecology, vol. 19(2), pp. 656-666.

- Ozunu A., Mereuta A., Török Z., Literat. L., 2017, A national hazard analysis and mapping for Seveso establishments, Journal of Engineering Sciences and Innovation, Vol.2, Issue 3, pg. 93-102.
- Radovici A – T., Roman E., Török Z., Ozunu A., 2016, A risk assessment study for local critical infrastructures used in hazmat transportation, Studia Universitatis Babes-Bolyai Chemia, vol.3, pp. 379-389.
- Török Z., Ozunu A., 2015, Hazardous properties of ammonium nitrate and modeling of explosions using TNT equivalency, Environmental Engineering and Management Journal, Vol.14/11, pp. 2671-2678.
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- KOVACS Larisa - Alexandra, Brisan Nicoleta-Sanda, Malos Cristian-Valeriu, Torok Zoltan, Ozunu Alexandru, 2015, Prerequisites of a NaTech event at a production gas well in Romania, Ecoterra, 36-43.
- Zoltán TÖRÖK, Nicolae AJTAI, Adrian T. TURCU, Alexandru OZUNU - Comparative consequence analysis of the BLEVE phenomena in the context on Land Use Planning; Case study: The Feyzin accident, Process Safety and Environmental Protection, 89 (2011) pp. 1-7.
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https://www.mmediu.ro/categorie/legislatie/116 www.enviro.ubbcluj.ro, http://www.epa.gov.us,
https://minerva.jrc.ec.europa.eu/en/minerva

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 knowledge acquired during the course can be used in the following areas: environmental protection; in process industries: chemical, petro-chemical, pharmaceutical, food, etc.; the academic field;
- Graduates can prepare a technological risk study and work in the field of technological risk analysis and assessment.
- Potential employers: environmental agencies, county inspectorates for emergency situations, economic operators with a chemical industrial profile, environmental consulting firms, academic research environment.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Seminar/lab activities	*Each student is evaluated individually according to the following criteria:* • the activity during the seminars/lab; • the correctness of the answers given to the questions • accuracy in presentation;	Team project presentation (oral) Project delivery (in electronic format)	50 %

	General criteria for evaluating the team project: • the correctness of the project; • compliance with the framework content; • scientific interpretation of the results; • the general and aesthetic appearance of the project.		
10.5 Course	• correctness of solving theoretical and practical problems during the exam	Final exam (written – 2 hours)	50%
Minimum performance standard: • grade 5 from the project and grade 5 from the written exam • Attendance at least 80% at seminar/laboratory classes.			

Date Signature of the course coordinator Signature of the seminar coordinator

05.12.2024.....

Date of approval Signature of the head of department

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