Course descriptions – Environmental Engineering MSc

Contents

Core part

Analytical chemistry

Course Title: Analytical chemistry		**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec + 2 sem**		
The degree of <u>theoretical</u> or practical nature of the course, " course's character "[13]: **60** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **oral/written exam.** **Assessment and grading:** Students will be assessed with using the following elements. Attendance 15 % Individual report 10 % Midterm exam 40 % Final exam 35 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		
The aim of the course is to familiarize students with the analytical methods used to determine the elemental and molecular composition of materials The short curriculum of the subject: Process analysis, types of correlation between analytical signal and concentration, calibration methods, how to provide analytical results, reliability of analytical results. Sampling, sample preparation for analysis: dissolution, digestion, extraction, enrichment methods. Classical methods of analysis: gravimetic and titrimetric methods (precipitation, acid-base, complexometric and redox titrations). Instrumental analytical methods: electroanalytical methods: potentiometry, conductometry, electro gravimetry, amperometry; Spectral analytical methods: nuclear-, atomic-, molecular spectroscopy methods. Methods based on emission, absorption and light scattering.		

Separation techniques: chromatography, electrophoresis, mass spectrometry. Analysis of gases after combustion of sample. Analysis of liquid samples: evaporation residue, TOC, COD, BOD, methods capable of determination of cation, anion, organic components. Analysis of solid samples. Mono- and multi-element techniques.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- D. Harwey: Modern analytical chemistry, McGraw Hill, Boston (2000)
- Rancis Rouessac, Annick Rouessac: Chemical analysis modern instrumentation methods and techniques, John Wiley and Sons, Chichester, 2007
- Elas Lundaness: Chromatography: Basic principles, sample preparation and related methods. John Wiley and Sons, Chichester, 2013

Competencies to evolve (see Appendix 1):
T1, T2, T3, K1, K6, K7, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is a course to give strong fundamentals on different analytical methods which can later be applied by the students in different applied courses for environmental analysis

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by demonstration of the analytical methods with the relevant equipment.

Responsible Instructor (*name, position, scientific degree):*
János Lakatos Dr., associate professor, PhD; mtasotak@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Soil- and water chemistry

Course Title: Soil- and water chemistry		Credits: 4
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **55** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements: Attendance: 15% Short quizzes 10% Mid-term test 40% Final exam 35% **GradingLimits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: AKKEM 6003 equivalent		
Course Description:		
Students will be familiar with the structure and physical and chemical properties of soils and water or aquatic media. The course will highlight the main intersection that exist between the phases of soils and the transformation of inorganic and organic materials in soils, the equilibriums exist in the aquatic phase. Definition and physica and chemical classification of soils. Inorganic and organic constituents of soils. Structure of soils: aggregates and pores. Composition of phases of soils. Chemical equilibrium that exists between the soil phases: sorption and ion exchange, dissolution of soils and gases, acid-base and redox interactions. Soil contaminats and soil protection. Physical and chemical properties of water. The state diagram of water. Properties of ice, liquid water and the vapour. Supercritical state of water. Behaviour of water as a solvent. Dissolution process of gases, liquids and solids in water. Behaviour of water as a chemical partner. Acid base equilibria, hydrolysis, complex formation and redox reactions. Isotopic, and chemical compositions of different waters. The main possibilities for modifying the water composition. Education method: Oral lectures with slides, five 2 h laboratory practice focused to investigate the structure and composition of the soils (Study the soil suspensions, humidity, organic content		

determination of soils, investigation of acid-base character and buffer capacity of soils, preparation and investigation of soil extracts).

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- D. L. Sparks: Environmental Soil Chemistry, Acad. Press, London (2002). Elsevier BV, ISBN: 978-0-12-656446-4
- W. Stumm: Aquatic Chemistry, An introduction emphasizing chemical equilibria in natural waters, John Wiely and Sons, New York, (2012).
- M.R. Ashaman and G. Puri: Essential Soil science, Blackwell Publ., (2002.)
- P.L Breonik, W.A Arnold: Water Chemistry, An introduction to the Chemistry of natural and Engineered aquatic system. Oxford (2011)
- Lakatos J. Geothermal Hydrochemistry (2014),
- William F. Bleam: Soil and Environmental Chemistry. Academic Press, ISBN 9780128041956, (2016)

Competencies to evolve (see Appendix 1):
Tl, T2, Kl, K6, K7, A3, Fl, F4

Demonstration of coherence of course content and unit's objectives:
The corurse gives the fundamental chemical knowledges of two mediums – water (surface watercourses and grouondwater) and soil – which are in the main focus of investigation and remediation for the environmental engineers completing their studies in this master programme. Theoretical knowledge of this course is applied by several consecutive courses, especially on the Remediation and Environmental Geotechnics specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Calculations and experiments complement the theoretical part of the course, that help the better understanding of the content.

Responsible Instructor (*name, position, scientific degree):*
János Lakatos Dr., associate professor, PhD; mtasotak@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Applied physical chemistry

Course Title: Applied physical chemistry	**AKKEM6008M**	**Credits: 3**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of <u>theoretical</u> or practical nature of the course, " course's character "[13]: **55** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** During the semester the following tasks should be completed: take part the lecture min 60%, Fulfil the laboratory practice work. One missing is allowed. Answer the minimum questions properly min. 50 %, must be correct. Writing the the test from the subject of lecture. Mark: (final test mark 2x + lab practice mark 1x)/3 **GradingLimits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
<u>Study goals:</u> Acquiring the knowledge of main topics of physical chemistry, as thermodynamics, thermodynamic equilibrium, reaction kinetics, transport phenomena and electrochemistry, which are essential for the design of environmental engineering approach. The exercise is intended to: practice the above mentioned topics through calculation examples. <u>Course content:</u> Basic concepts, characterization of the material systems. The basic laws of thermodynamics. Application the basic laws of thermodynamics regarding to gases, vapors, liquids, and solids systems. Equilibrium conditions of chemical reactions and phase transfer processes. Equilibrium of homogeneous and heterogeneous systems. Phase diagrams of two- and multi-component systems. Rate and mechanism of homogeneous and heterogeneous chemical reactions. The main factors influencing the reaction mechanism. Transport phenomena: viscosity, diffusion, thermal conductivity and electrical conductivity. Transport phenomena in heterogeneous systems, surface and interfacial phenomena Electrochemistry: electrolytes, thermodynamic properties of electrolyte systems, electrode processes, corrosion of electrolyte systems. <u>Education method:</u> Presentations using projector. Numeracy practices at blackboard (and chalk) using interactive method with the students.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		

- János Török, Lipót Fürcht, Tibor Bódi; PVT properties of reservoir fluids; University of Miskolc, 2012.
- Peter Atkins; Julio de Paula; Physical Chemistry; W. H. Freeman and Company; 2006.
- Prof. Ing. Anatol Malijevsk´y, CSc., et al.; Physical Chemistry in Brief; Institute of Chemical Technology, Prague Faculty of Chemical Engineering; 2005.
- Howard Devoe; Thermodynamics and Chemistry; Pearson Education; 2012.

Competencies to evolve (see Appendix 1):

T1 T2, T3, K1, K6, K7, A3, F1, F4.

Demonstration of coherence of course content and unit's objectives:

The course discusses the fundamental parts of physical chemistry which are essential to understand the processes which take place in the near-surface environment. The course serves the fundamentals for applied courses such as environmental risk assessment, remediation but contributes also to understand processes used for waste management.

Demonstration of coherence between teaching methodologies and the learning outcomes:

This is a strong theoretical course, where the material is explained also through practical calculations.

Responsible Instructor (*name, position, scientific degree):*

Béla Viskolcz Dr., full professor; bela.viskolcz@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Environmental Geology

Course Title: Environmental Geology	**MFFTT710008**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec + 1 sem**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **exam.**

Assessment and grading:
Students will be assessed with using the following elements.

Attendance:	15 %
Individual report	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **1st**

Pre-requisites *(if any)*: -

Course Description:

The main objective of the course is to make the students familiar with the effects of geological medium on the state and changes of the environment, and prepare them for revealing the geological background of environmental problems as well as mitigating or minimizing these problems.

The short curriculum of the subject:
System approach in geology, changes in the four main systems of the Earth. The objects, methods and legal background of environmental geology. Environmental minerals, their characteristics and role in causing and mitigating of environmental problems. Geological hazards (volcanism, earthquakes, mass movements). The role of geological medium in the anthropogenic contamination and pollution (processes of environmental geochemistry, interactions between soil, rocks and contamination, geological conditions effecting on the spreading of contamination). Geological and geochemical concerns of the effects of mining on the environment. Geological background of the radioactive waste disposal. Geology in nature protection. Geological tasks in the environmental assessment.

Practical work: self-made solutions of simple case-study problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Keith,S. Environmental hazards, Routledge,, Abingdon, Oxon ;;NewYork:, 2008,
- Knödel, Klaus: Environmental geology: handbook of field methods and case studies, Springer, Berlin; New York, 2007,
- Montgomery, C W: Environmental Geology, McGraw-Hill, 2010,
- Patnaik, P.: Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes, Taylor and Francis, 2009,
- Keller, E A: Introduction to Environmental Geology, Prentice Hall, 2011

Competencies to evolve (see Appendix 1):

T1, K1, K10, A1, F1, F4

Demonstration of coherence of course content and unit's objectives:

The course gives an overview about interaction of different elements of a near-surface geological environment. Using case studies, the students gain practical skills also to discover the interrelationsip between these diferent elements.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Individual project tasks on environmental geology cases should be completed by the students using GIS softwares.

Responsible Instructor (*name, position, scientific degree):*

Viktor Mádai Dr., associate professor, PhD; askcesar@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Basics of environmental processing

Course Title: Basics of environmental processing	**MFEET710005**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec + 1 sem**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** **Assessment and grading** Requirements of the practical mark: Less than 20 % class missing; Presenting the laboratory measurements reports; Writing the classroom test successfully **Assessment:** Five grades scale Assessment according to a five grade scale: Missing basic knowledge – unacceptable Student demonstrates basic knowledge – acceptable Student demonstrates basic knowledge and can apply it in practice – intermediate Student demonstrates system level knowledge in contexts – good Student demonstrates outstanding system level knowledge in contexts - excellent **Assessment:** 88 – 100: excellent (5), 75 – 87: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		

Aim of the course:
Environmental processing deals with the processes, machines and technologies of cleaning and keeping clean the air, water and soil. The aim of the course is let the students learn the mainly mechanical processing theoretical and practical fundamental knowledge necessary for the design, sizing and operation of the processes, machines and technologies of environmental processing.

Course description:
Physical characterization of coarse disperse systems. Rheological properties of one- and multiphase media. Steady-state and unsteady-state particle motion in Newtonian and non-Newtonian media. Motion of particles bulks. Flow through a particles bulk. Permeability tests. Particle motion in electrostatic field. Particle motion in centrifugal field. Forming of bubbles in liquids and their motion. Forming of droplets in gases and their motion. *Phase separation of solid – liquid coarse disperse systems.* Liquid bonds in particulate materials. Solid – liquid phase separation by mechanical processes. Settling in gravitational and centrifugal fields. Filtration in gravitational and centrifugal fields and by pressure difference supplied by pumps. Solid – liquid phase separation by pressing. *Phase separation of solid – gas coarse disperse systems* in gravitational, centrifugal and electrostatic fields. Phase separation of solid – gas coarse disperse systems by the application of filtering media and the wet dust separation.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Lecture notes
- Tarján I.: A mechanikai eljárástechnika alapjai. Miskolci Egyetemi Kiadó, 1997.
- Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai praktikum. Miskolci Egyetemi Kiadó, 2017.
- Faitli J. - Tarján I.: Mérési Gyakorlatok (A mechanikai eljárástechnika alapjai II.) Jegyzet. Miskolc, 1997. ME Eljárástechnikai Tanszék
- Stieβ, M: Mechanische Verfahrenstechnik 1,2. Springer (Lehrbuch) 1995.
- Tarján G.: Mineral Processing (Vol. 1, 2). AK. Bp.1981.

Competencies to evolve (see Appendix 1):
T1, K7, K10, A1, A2, A3, F1, F3, F4

Demonstration of coherence of course content and unit's objectives:
The course gives the fundamentals of processing techniques and technologies, which serve the basis for applied courses first of all in the Waste management specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures explaining the theory are complemented by demonstrations of the different processing equipment a by laboratory measurements that should be completed by individual or group work of the students.

Responsible Instructor (*name, position, scientific degree):*
József Faitli Dr., habilitated associate professor, PhD; ejtfaitj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Ecology and nature conservation

Course Title: Ecology and nature conservation	**MFKHT710009**	**Credits: 3**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 2 sem.**		
The degree of theoretical or <u>practical</u> nature of the course, " course's character "[13]: **75** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** **Assessment and grading:** **Signature:** Participation in lessons and field trips. **Grade:** nature protection description of a certain area (course) during the semester. Assessments (tests, exam, documentation, etc.). **Grading limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		
Scope and objective of subject: To introduce the basics of ecology as a biology discipline. To familiarize students with nature conservation such as the key of long-term well-being and peace. To present the process of knowing the nature conservation situation of an area. To make students sensitive for the challenge of nature conservation. To introduce consequences of human activities, focusing on engineering work and land use. To introduce methods of information gathering and documentation of any modification in nature which impact living and nonliving nature elements. Emphasizing the necessity of practical activity for the students and preparing them to use the basic nature protection approach in a creative way in their future professional activities. To generate positive experiences and feelings about nature, to point out the importance of personal responsibility and credibility. **Thematic description of subject:** Concept and subject of ecology. Ecological environment, biotic and abiotic ecological factors, niche, biotope, species and population, community. Environmental protection, nature conservation and sustainability. Anthropogenic impacts. History of nature conservation. Ecosystem services. Biodiversity, native and non-native (introduced, invasive) species. Why to protect nature? Natural values. Principles of nature conservation. Study cases: harmony, too much collection, lack of ecological sense, introduced species, biological invasions, pets, hated animals. Tourism: types, motor vehicles, trekking sports. Engineering: nature, technology, or both? Protecting technology from wildlife - protecting wildlife from technology. Transportation and sustainability. Green deserts, ecological architecture. Helping wildlife. Levels of nature conservation. Authorities, formal and informal nature conservation. Monitoring, research, education, popularization, friendly nature conservation. Credibility: "black" and "green" lifestyle, privacy and publicity.		

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Fülep, Teofil (2019): Nature conservation for engineers. Sketch for the Environmental Engineering MSc master course in English. - Természetvédelem mérnököknek. Vázlat az angol nyelvű környezetmérnöki MSc mesterképzéshez. - pdf manuscript-pre-first test edition, University of Miskolc - Holocén Nature Conservation Association, Miskolc, Hungary, 77. pp. – manuscript
- Mcdonald, Tein - Gann, George D. - Jonson, Justin - Dixon, Kingsley W. (2016): International standards for the practice of ecological restoration - including principles and key concepts. -Society for Ecological Restoration, Washington, D.C., United States of America, 48. pp. -http://seraustralasia.com/wheel/image/SER_International_Standards.pdf
- Povilitis, Tony (eds.) (2012): Topics in Conservation Biology. - InTech, Intechopen.com, Rijeka, Croatia, 110. pp. - http://library.umac.mo/ebooks/b28110031 .pdf
- Sodhi, Navjot S. - Ehrlich, Paul R. (eds.) (2010): Conservation Biology for All. - Oxford University Press, Oxford, England, United Kingdom, 344. pp. - http://con-bio.org/images/content_publications/ConservationBiologyforAll_reducedsize.pdf
- Richard B Primack: Essentials of Conservation Biology - sixth edition. Sinauer Associates, 2014,603 p.

Competencies to evolve (see Appendix 1):
T1, T8, T9, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is a fundamental topic in any environmental engineering programme. The course explains the complexity of the natural environment and the interrelationship between the constituents. It also discusses the possible consequences of an engineering interaction in the ecological system and the means to avoid problematic consequences.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures about the theoretical part are complemented by field trips and individual project-based assignments that the students shall complete. This method develops the autonomy of the student as well as the ability towards critical thinking.

Responsible Instructor (*name, position, scientific degree):*
Teofil Fülöp Dr., invited lecturer, PhD;

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Computer science for engineers

Course Title: Computer science for engineers	**GEMAK713M**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **80** (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **pr. mark**

Assessment and grading:
Students will be assessed with using the following elements.

Attendance:	15 %
Short quizzes	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **1st**

Pre-requisites *(if any)*: -

Course Description:

Extend the application of the computer as engineering training aids for numerical and symbolic computation.
Programming and using of MATLAB environment (desktop): opration with matrices, elements of linear algebra, plot of one, two or three dimensional functions, printing, control statements, handle graphics and user interface.

The short curriculum of the subject:
Object-oriented programming. Design of programming. Computer aided solution plan for chosen problems. Numerical kernel: numerical methods, input-output. Using of files. User interface with karakters and graphics. Writing, testing an documentation for programs. Online and printed description of programs. Help and demo in programs. Printability for the results.
Basic concepts, objects of Maple programming language: definition and using of assign, variable, set, array, function. The Maple as programming language: using of array, conditional and loop

statement. Definition and application of procedure. Main algorithm in Maple. Graphics of Maple: plot and plot3d, animation statements. Using of files, applications.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- H. Moore: MATLAB for Engineers, Prentice Hall, 2011
- P. E. Gill, W. Murray, M. H. Wright: Practical Optimization, Academic Press, 1981.
- J. Nocedal, S. J. Wright: Numerical Optimization, Springer, 2000.
- Stoyan G. (szerk.): MATLAB, Typotex, 2005.
- The MATH WORKS Inc., Release 13 Product Family Documentation Set, 2002.

Competencies to evolve:
T1, T7, T8, K1, F1, F4

Demonstration of coherence of course content and unit's objectives:
The course provides practical skills to solve technical tasks by applying numerical methods

Demonstration of coherence between teaching methodologies and the learning outcomes:
This is a learning by doing course where students shall complete calculations using numerical methods with application of MATLAB

Responsible Instructor (*name, position, scientific degree):*
Attila Körei Dr., associate professor, PhD; matka@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Numerical Methods and Optimization

Course Title: Numerical Methods and Optimization	**GEMAK712M**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** During the semester the following tasks should be completed: one test and a computerized homework **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: Study goals: Upon completing the course, students shall understand the relation between engineering and mathematics; comprehend important concept of solution methods using both analytical and numerical techniques when the problems can be formulated using differential equations, system of linear equations and system of nonlinear equations. In addition, students shall be able to apply the optimization techniques to various engineering problems. **Course content** Extrema of functions. Unconstrained and constrained optimization. Convex optimization, Minimization of functions with one variable (golden section, parabola method). Minimization of multivariable functions (Nelder-Mead, Newton, modified Newton, quasi-Newton, minimization with line search). Methods of penalty functions. Multiaided and multicriteria decision problems (Pareto effitient solutions). Linear programming. About Soft Computing (SC) methods: fuzzy systems, genetic algorithms, neural network. Numerical solutions of ordinary diffrential equations and system of equations: Runge-Kutta, predictor-corrector, finite differences.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		

- Égertné, M. É., Kálovics, F., Mészáros, G: Numerical analysis I.-II. (Egyetemi jegyzet), Miskolci Egyetemi Kiadó (1992), 1-175.
- R. Fletcher: Practical Methods of Optimization, John Wiley &Sons, 2000.
- P. E. Gill, W. Murray, M. H. Wright-.Pracrtca/ Optimization, Academic Press, 1981.
- J. Nocedal, S. J. Wright: Numerical Optimization, Springer, 2000.
- J. E. Dennis, Robert B. Schnabel: Numerical methods for unconstrained optimization and nonlinear equations, Society for Industrial and Applied Mathematics, 1987

Competencies to evolve (see Appendix 1):
T1, T7, F1, F4

Demonstration of coherence of course content and unit's objectives:
The course gives the theory beckground for calculations applying numerical methods which are essential to solve different statistical and geophysical tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
The course focuses on theory, which is supplemented by the course Computer sciences for engineers, providing the practical applications and exercises.

Responsible Instructor (*name, position, scientific degree):*
Attila Körei Dr., associate professor, PhD; matka@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Environmental and Waste Management Law

Course Title: Environmental and Waste Management Law	**AJAMU04MF1N**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **70** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** The examination includes: a, an oral presentation on a topical issue of environmental law and b, a written exam. The presence is compulsory on the course. **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
Thematic of the subject (in weekly periods): 1. A brief introduction to law I. 2. A brief introduction to law II. 3. The concept of sustainable development 4. The development, the subject and the system of environmental law 5. The sources and the methods of environmental law 6. International environmental law I 7. International environmental law II 8. The EU's environmental law I 9. The EU's environmental law II 10. Constitutional aspects of environmental law 11. Waste management law I 12. Waste management law II 13. The presentation of the course participants I 14. The presentation of the course participants II 15. The presentation of the course participants III		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		

- Bell, Stuart – McGillivray, Donald – Pedersen, Ole.: *Environmental law*, Oxford, Oxford University Press, 2013
- Krämer, Ludwig: *EU environmental law*, London, Sweet & Maxwell, 2012
- Kubasek, Nancy – Silverman, Gary: *Environmental law*, Boston [etc.], Pearson, 2014
- Raisz Anikó: A Constitution's Environment, *Est Europa*, 2012/special edition 1, pp 37-70

Competencies to evolve (see Appendix 1):
T1, T6, K3, A2, F1, F2, F4, F5, F6

Demonstration of coherence of course content and unit's objectives:
The course introduces the complex legal framework of the environmental protection, nature conservation as well as the that of the environmental industry. Knowledge obtained by this course is essential for a practicizing environmental engineer. Since the group is composed of Hungarian and also international students, the course focuses on the general framework of environmental legislation, not the specific rules applied in Hungary.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures are complemented by analysis of legal case studies which should be completed by the students individually during the semester and presented before the group. This method develops the autonomy of the student as well as the critical thinking approach.

Responsible Instructor (*name, position, scientific degree):*
Ede János Szilágyi Dr., habilitated associate professor, PhD; civdrede@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Methods of environmental assessment

Course Title: Methods of environmental assessment	**MFKHT730013**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **65** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Students will be assessed with using the following elements. Attendance: 15 % Individual report 40 % MFinal exam 55 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
Students awareness of the environmental assessment procedures, the methods can be used to make the study. **The short curriculum of the subject:** The history of environmental impact assessment. The legal regulation of the environmental impact assessment. Environmental assessment, environmental impact assessment, uniform environmental permit. The qualification of environmental test activities can be combined with the functionality and connectivity of the procedures. The phases of environmental testing, the method of the official method. The preliminary environmental study. The detailed requirements for environmental compatibility studies. Acting factors stakeholders, impact processes, the spread effects. The effect areas, control areas. The main aspects of recruitment procedures and environmental standards. In the effectiveness test methods and procedures. Impact Assessment. Monitoring. The impact assessment public of the hearing, public hearing. Analysis of practical examples. Preparation of an impact test, study management, presentation, public discussions. Practical work: self-made solutions of simple case-study problems.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		

- Charles H. Eccleston: Environmental Impact Assessment: A Guide to Best Professional Practi¬ces. CRC Press, 2011
- David P. Lawrence: Environmental Impact Assesment, Practical solutions to recurrent prob¬lems, Wiley-Interscience 2004.
- John Glasson: Methods of Environmental Impact Assessment. Routledge, 2009.
- M, Schmidt, J. Glasson, L. Emmelin,H. Helbron: Standards and Thresholds for Impact Assess¬ment Springer, 2008.
- Anji Reddy Mareddy (2017): Environmental Impact Assessment - Theory and Practice. Butter-worth-Heinemann, ISBN: 978-0-12-811139-0
- EU directives

Competencies to evolve (see Appendix 1):

T1, T2, K3, K7, K9, A5, A6, A7, F1, F2, F4, F5, F6

Demonstration of coherence of course content and unit's objectives:

The course goes through the steps of the completion of an EIA, thus gives applied knowledge and skills to manage and complete the task for an EIA. The course gives valuable knowledge and skills especially to the Remediation and Environmental Geotechnics specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:

The students shall complete individual tasks in a relevant topic. The completion of the assignment develops applied skills of the student as well as the autonomy and responsibility.

Responsible Instructor (*name, position, scientific degree):*

Balázs Zákányi Dr., assistant professor; hgzb@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Environmental Economics

Course Title: Environmental Economics	**GTERG204MKMA**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **70** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Assignment (Mid-Semester Task): Writing an essay (15 pages, +-10%) and making a presentation (15 minutes) during the semester. The essay has to focus on a market analysis of a selected raw material (i.e. rare earth metal, precious metal, etc.). The essay has to be developed individually. The paper structure has to contain the following chapters: 1. Introduction; 2. Market data: Top 10 producer, exporter, importer, annual production data, trade, dependency rates, price volatility; 3. Sectoral analysis: description of uses in different industrial subsectors; 4. SWOT-analysis; strategies for substitution; 5. Summary; 6. Resources. Evaluation: The good problem solving of the issue (making essay and a presentation) represents 50% in the annual grade. Aspect of the evaluation: • The quality and the quantity of the references (10p). • The compliance of the chosen topic, the quality and fairly of the graphs, diagrams (10p). • The form and the quality of the presentation (10p) • Own opinions and suggestions of the presenter (20p) Getting the signature: The requirement for the signature is the participation in the lectures and practical courses and performing successfully the Mid-semester task. Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: Study goals: To show the development of environmental thinking and the reason of foundation of environmental economics as new scientific field of the economics science. To analyze the current		

status of space science. To highlight the relationship between environment and economy at macro and micro-economic context, the applied tools and methods.

Course content:
1. Introduction, theory of sustainable development, basic definitions.
2. Development of environmental thinking.
3. Main differences between the mainstream economics and the environmental economics.
4. Relationship between economic growth and environmental quality.
5. Economics of environmental pollution.
6. Environmental regulations in the European Union.
7. Environmental policy in the European Union.
8. Energy policy in the European Union.
9. Climate change.
10. Alternative indicators.
11. Energy, as economic resource. World energy use.
12. Crude oil (prices, demand and supply, OPEC).
13. Global scenarios about World's future.
14. Review of databases, useful links and sources/presentations.

Education method: Lectures (some lessons with additional short YouTube film and animations). During the semester the students have to make an essay and present it.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Daly Herman E. (1999): Uneconomic Growth: In Theory, in Fact, in History, and in Relation to Globalization. Clemens Lecture Series. Paper 10. https://digitalcommons.csbsju.edu/cgi/view-content.cgi?article=1009&context=clemens_lectures
- Akizu O., Urkidi L., Bueno G., Lago R., Barcena I., Mantxo M., Basurko I., Lopez-Guede J. M. (2017): Tracing the emerging energy transitions in the Global North and the Global South. International Journal of Hydrogen Energy, 42, pp. 18045-18063.
- Evans J., Hunt L. C. (2009): International Handbook on the Economics of Energy. Edward Elgar Publisher, Cheltenham 684 p. http://www.gbv.de/dms/zbw/583711596.pdf
- Bradshaw M. J. (2010): Global energy dilemmas: a geographical perspective. The Geographical Journal. Vol. 176. No. 4. pp.275-290.
- Arto I., Capellán-Pérez I., Lago R., Bueno G., Bermejo R. (2016): The energy requirement of a developed world. Energy for Sustainable Development, 33, pp. 1-13.

Competencies to evolve (see Appendix 1):
T6, T8, K3, K11, A4, A5, A6, A7, F2, F5, F6

Demonstration of coherence of course content and unit's objectives:

The course gives fundamental knowledge about economic rules and requirements related to environment. Knowledge obtained by this course is essential for a practicizing environmental engineer. **Demonstration of coherence between teaching methodologies and the learning outcomes:** The students shall complete individual tasks in a relevant topic during the semester and present them before the group. The completion of the assignment develops applied skills of the student as well as the autonomy, responsibility towards the environmental problems and critical thinking.
Responsible Instructor (*name, position, scientific degree):* **Tekla Sebestyénné Szép., assistant professor, PhD; regtekla@uni-miskolc.hu**
Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Quality Management

Course Title: Quality Management	**GTVVE7002MA**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **65** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** 40%: successful midterm test; 20%: presentation about a chosen quality management tool; 40%: oral exam **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
The objective of the course is to prepare students to perform professional tasks on a higher level by applying the approach of quality management, including managing or participating related projects. The student will learn about principles, concept and terminology of quality management, quality-related corporate activities, requirements of the ISO 9001 standard and the specialities of project quality management. **1.** week: Terminology of quality management (principles, 5 approaches, 9 influencing factors), history of quality management. **2.** week: Quality management standardization. ISO 9000 family. Concept of quality management by ISO 9001. **3.** week: Process approach in quality management. Kaizen. **4.** week: ISO 9001 requirement: Management system. **5.** week: ISO 9001 requirement: Product and production. **6.** week: Auditing quality management system. ISO 19011:2011 standard. **7.** week: Total Quality Management. Lean approach in quality management. **8.** week: Enhancing quality management, integrated management systems. **9.** week: Quality tools: 7 old&new tools, finding the root cause, 8D **10.** week: Quality tools: FMEA, QFD **11.** week: Business excellence. Quality Awards. Tools and methods of self-evaluation. **12.** week: Project quality management: planning. **13.** week: Project quality management: risk analysis. week: Project quality management: monitoring and performance evaluation.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		

- Defeo, J. A.: Juran's Quality Handbook: The Complete Guide to Performance Excellence. McGraw Hill Education, New York, 2017.
- Berényi L.: Fundamentals of Quality Management. LAP, Saarbriicken, 2013.
- Slack, N., Jones, A.: Operations & Process Management: Principles & Practice for Strategic Impact, Pearson, Harlow, 2018.
- Vivek, N.: Quality management system handbook for product development companies, CRC Press, Boca Raton, 2005.
- Black, J. Miller, D., Sensel, J.: The Toyota Way to Healthcare Excellence: Increase Efficiency and Improve Quality with Lean. ACHE, 2016.

Competencies to evolve (see Appendix 1):

T5, T6, T9, K3, K11, K12, K13, K14, A4, A5, A6, A7, F2, F5, F6

Demonstration of coherence of course content and unit's objectives:

The course develops the theoretical background on quality assurrance and quality management issues, which contributes to human and economic skills of the students

Demonstration of coherence between teaching methodologies and the learning outcomes:

This is primarily a theoretical course, but students complete and submit exercises as well.

Responsible Instructor (*name, position, scientific degree):*

László Berényi Dr., associate professor, PhD; berenyi.laszlo@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Occupational Health and Safety

Course Title: Occupational Health and Safety	**MFKHT740025**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 60 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Participation on the courses and preparation of an advancement documentation based on the topic discussed. Project work in a chosen topic. Oral Exam. **Assessment:** based on the advancement doc. Assesment according to a five grade scale: 1. Structure and clearness of the work. (max. 10 points) 2. Aims and goals are clear: (max. 10 points) 3. Literature study: (max. 15 points) 4. Methodology: (max. 15 points) 5. Results and discussion: (max. 25 points) 6. Rate of independent work: (max 25 points) **Grading Limits:** > 88%: excellent, 75-87%: good, 63-74%: medium, 51-62%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **4th**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: Study goals: This course covers recognition, control, and regulation of safety hazards in the workplace. Course content: Topics include accident investigation, Workers Compensation, record keeping, training, machine guarding, facilities, personal protection, and fire protection. Upon completion, students should be able to recognize safety hazards and recommend strategies for remediation and compliance. 1. Week: General Induction 2. Week: Basics of Law 3. Week: Building Safety/Construction safety 4. Week: Workplace safety-general requirements 5. Week: Emergency and Fire Safety 6. Week: Accidents and First Aid 7. Week: Ergonomics		

8. Week: Biosafety
9. Week: Chemical safety
10. Week: Noise Vibration and Radiation Safety
11. Week: Electrical Safety, Safety of Machines
12. Week: Office/screen workplace, Stress
13. Week: OHS Management System, Risk Management and Safe Work Instructions Audits, Inspections and Monitoring
14. Week: Task report (students)

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- OSHA Handbook, Sixth EditionSep 3, 2014 by Steven D. High and President
- Health and Safety at Work: An Essential Guide for Managers Paperback – 3 May 2016 by Jeremy Stranks
- Safety Professional's Reference and Study Guide, Second Edition 2nd Edition by W. David Yates
- Introduction to Health and Safety at Work, 2002. Phil Hughes, Ed Ferrett
- Introduction to Health and Safety in Construction, 2004. Ed Ferrett, Phil Hughes
- International Health and Safety at Work Revision Guide, 2012. Ed Ferrett

Competencies to evolve (see Appendix 1):
T5, T8, K3, K11, A5, A6, A7, F2, F5, F6

Demonstration of coherence of course content and unit's objectives:
This course covers recognition, control, and regulation of safety hazards in the workplace.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Topics include accident investigation, Workers Compensation, record keeping, training, machine guarding, facilities, personal protection, and fire protection. Upon completion, students should be able to recognize safety hazards and recommend strategies for remediation and compliance.

Responsible Instructor (*name, position, scientific degree):*
Renáta Mészáros Dr. Zákányiné Dr., AFKI, research fellow, PhD; zmr@afki.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Basics of waste management

Course Title: Basics of waste management	**MFEET710010**	**Credits: 3**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **60** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Attendance: 5 % Homework: 10 % Short quizzes: 10 % Midterm exam: 40 % Final exam: 35 % Total: 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: The aim of the subject for students is to learn knowledge about the waste management. History and development of waste management. Generation and types of industrial and municipal wastes. Introduction, position and aim of the subject in the course. Generation, types, composition, environmental effect of wastes. Definition and basics of sustainable development and sustainable raw material management. Determination of material characteristics (chemical and physical properties) and evaluation of the results. Material flow of production and consumption wastes. Relationship of waste management and environmental protection. Product and production integrated environmental protection. Treatment and preparation of wastes based on various utilization needs. Processes of mechanical waste preparation. General waste preparation technologies. Selective waste collection. Treatment of Municipal Solid Waste -1.: technology of waste sorting plant Calculation of waste mass flow and volume flow of various fractions. Treatment of Municipal Solid Waste - IL: treatment of residue: stabilization and technology for production of secondary fuel (RDF-Refuse-derived fuel).		

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Bernd Bilitewski: Waste management. 1997. Springer Science & Business Media
- Jacqueline Vaughn: Waste Management: A Reference Handbook. 2009
- Ramesha Chandrappa: Solid Waste Management: Principles and Practice. 2012. Springer
- A. D, Salman, M. Ghadiri, M. J. Hounslow: Handbook of Powder Technology: Particle Breakage. 2007. Elsevier
- Recently published Journal Papers, Journal of Cleaner Production, Waste manegement,

Competencies to evolve (see Appendix 1):

T1, T2, T4, A,1 A2, F1, F3, F4

Demonstration of coherence of course content and unit's objectives:

Students will know the fundamentals of waste management and the generation of wastes. Furthermore, they will be able to characterize – from process engineering and chemical point of view – and utilize the various wastes.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Lectures are complemented by demonstrations of different waste management technologies as well as laboratory works.

Responsible Instructor (*name, position, scientific degree):*

Gábor Mucsi Dr., associate professor, PhD; ejtmucsi@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Waste disposal, landfill operation and reclamation

Course Title: Waste disposal, landfill operation and reclamation	**MFKHT720040**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 60 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** 30%: successful midterm test; 70%: oral exam **Grading Limits:** > 90%: excellent, 80-89%: good, 70-79%: medium, 60-69%: satisfactory, < 60%: unsatisfactory.		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: Study goals: Teaching up-to-date techniques and recent results of landfilling - as one possible method of waste disposal - in the field of construction, operation, closure and recultivation, and the interaction of contaminants and the environment Course content: Aspects of site selection of landfills, compatibility problems between contaminants and subsoil. Contaminant retention capacity of soils. Geotechnical aspects of landfilling. Priority list of selected sites. Design of landfills: construction of the base liner system and the leachate collection system. Aftercare of landfills. Up-to-date, high security landfills, maintenance-free landfills. Final closure and recultivation of landfills. Water balance control of landfills. In situ stabilization (aeration, methane-oxidation, water balance control) of landfills. Facilities of landfills, the monitoring system. Education method: the small group size permits an extensive dialogue between students and teacher.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Bagchi, A. (1989): Design, Construction and Monitoring of Sanitary Landfill. John Wiley and Sons, P. 285. • Christensen, Th.H.-Cossu, R.-Stegmann, R.. (1989):Sanitary Landfilling: Process, Technology and Environmental Impact, Academic Press • Oweis, I.S. - Khera, R.P. (1990): Geotechnology of Waste Management, Butterworths, p. 273.		

- Rowe, K.R.: Geotechnical and Geoenvironmental Engineering Handbook. Kluwer Academic Publishers, 2000.
- Sarsby, R.: Environmental Geotechnics, Thomas Telford, 2000.

Competencies to evolve (see Appendix 1):
T1, T2, T4, K6, A1, A2, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is a course that provides detailed applied knowledge for design, operation and closure of landfill sites. It is an important part of the Remediation and Environmental Geotechnics specialisation, however this knowledge is also utilized for the Waste management specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures goes through an interactive way between the student and the instructor. It develops the autonomy and responsibility competences of the student beside the applied knowledge and skills.

Responsible Instructor (*name, position, scientific degree):*
Tamás Madarász Dr., associate professor, PhD; hgmt@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Tamás Kántor, assistant lecturer

Engineering and Environmental Geophysics

Course Title: Engineering and Environmental Geophysics	**MFGFT720018**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.+ 2 lab.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 60 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam** Attendance at lectures is regulated by the university code of education and examination. Writing two tests and preparing one individual assignment as ppt presentation during the semester (requirement of signature). **Grading Limits:** > 86 %: excellent, 71-85 %: good, 61-70 %: medium, 46-60 %: satisfactory, < 45 %: unsatisfactory.		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*:		
Course Description:		
Acquired store of learning: Study goals: Introduction to shallow geophysical methods in solving geotechnical, engineering geological, hydrogeological and environmental problems. Overview of special geophysical methods and their developmental trends. Course content: From the group of near-surface geophysical methods, microgravity, magnetic, multi-electrode DC geoelectric, electromagnetic, ground penetrating radar, seismic refraction and surface NMR methods are presented. The principles of direct push logging technics and related applications. The interpretation of geophysical data by deterministic, statistical and inversion methods and their application to 1D, 2D and 3D models. The study of relationships between lithological/geotechnical properties of rocks and geophysical parameters. Applications to civil engineering and environmental problems such as sinkholes, cavity and void detection, seawater intrusions, contamination assessment, archeo-geophysics, forensic studies, UX0, road structures, petrophysical and geotechnical characterization of soils etc. Education method: Lectures with projected presentations, laboratory classes and field trips.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Sharma P. V., 1997. Environmental and engineering geophysics. Cambridge University Press. • Everett M. E., 2013. Near-surface applied geophysics. Cambridge University Press. • Kirsch R. (editor), 2009. Groundwater Geophysics - A Tool for Hydrogeology. Springer.		

- Butler, D. K. (ed.), 2005: Near-Surface Geophysics (in series: Investigations in Geophysics, No. 13.) SEG, Tulsa.
- Scientific papers selected from geophysical journals, e.g., First Break, Near Surface Geophysics, Geophysics, Journal of Applied Geophysics etc.
- Szabó N. P., 2014. Environmental and engineering geophysics. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html

Competencies to evolve (see Appendix 1):

T1, T2, A1, A2, F1, F4

Demonstration of coherence of course content and unit's objectives:

The course gives the fundamentals of environmental geophysics, which is a powerful analytical tool to discover and characterize environmental problems in the near-surface environment.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Theoretical part is complemented by demonstration of different applied near-surface geophysical methods and individual screening of relevant literature. This teaching methodology develops the theoretical basis as well as the critical thinking skills of the students.

Responsible Instructor (*name, position, scientific degree):*

Dr. Norbert Péter Szabó, PhD, Professor; gfnmail@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): -

Water quality protection

Course Title: Water quality protection	**MFKHT720023**	**Credits: 3**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **70** (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **exam.**
Students will be assessed with using the following elements.

Attendance:	15 %
Short quizzes	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **2nd**

Pre-requisites *(if any)*: -

Course Description:

The students will be familiar with the basic concepts, tasks and purposes of water quality protection. The students will also learn about the contamination transport processes in surface water as well as in groundwater. The students will be prepared to assess and solve different water quality and contamination problems. The students will learn about the different tasks given by the European Water Framework in order to achieve the good status of water resources.

The short curriculum of the subject:
Water as an environmental agent. General tasks and objectives of water quality protection. Water chemistry. Qualification of water samples. Transport processes in water. Vulnerability methods concerning groundwater resources. Remediation methods in case of different contaminations. Water quality models. Current quality status of national water resources. Water quality balance calculations. Natural water purification methods. Practical work: self-made solutions of simple case-study problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Liu David, Lipták Béla: Groundwater and Surface Water Pollution. Lewis Publishers, 2000, ISBN 1-56670-511-8, pp. 1-150.
- McLemore, Virginia T.; Russell, Carol C; Smith, Kathleen S: Sampling and Monitoring for the Mine Life Cycle, Society for Mining, 2014
- Merkel Broder, Planer-Friedrich Britta: Groundwater Geochemistry. Springer, 2005, ISBN 3-540-24195-7, pp.1-200.
- David M. Nielsen, Gillian L. Nielsen: The Essential Handbook of Ground-Water Sampling. CRC Press, 2006, ISBN 1-4200-4278-5, pp 1-300.
- Yuncong Li, Kati Migliaccio: Water quality concepts, sampling and analyses, CRC Press, 2010

Competencies to evolve (see Appendix 1):
T1, T3, K6, K7, K8, K9, K13, K14, A1, A2, A4, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is an applied course where the students get familiar with the most important skills and tools in the field of water quality analysis and treatment. Since water is the most sensitive medium in the near-surface environment, the course has a key importance for both specialisations.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by demonstrations and case studies.

Responsible Instructor (*name, position, scientific degree):*
Péter Szűcs Dr., full professor; hgszucs@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Tóth Márton, assistant lecturer

Waste incineration, air quality control

Course Title: Waste incineration, air quality control	**MAKETT730018**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **60** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Attendance: 15 % Individual report 10 % Midterm exam 40 % Final exam 35 % Total 100% **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
1.) Flow diagram of waste processing; basic regulations for thermal treatment and disposal. 2.) Combustion parameters of wastes: physical state (solid, liquid, gaseous), particle composition, density, moisture and ash content; chemical composition (C, H. N, S, Cl), calorific value. 3.) Calculation of combustion parameters: the chemical reactions of combustion, minimum oxigen and air requirement of fules, optimal air excess necessary for complete combustion. 4.) Gaseous wastes, normal burning velocity of fuels, flame velocity, flammability and explosion limits, operating conditions for safe combustion; methods for flame stabilization. 5.) Flame and flue gas characteristics: specific volume, chemical composition, specific heat capacity; combustion temperature (theoretical and actual), dissociation and adiabatic flame temperature (definition, calculation methods); methods for increasing/reducing combustion temperature. 6.) Technical parameters of waste incineration, auto-ignition range; grid types and grid structures, combustion chamber geometry, the construction of refractory walls (design and structure). 7.) Hazardous waste disposal (by incineration), required minimum incineration temperature, the thermal treatment of halogenated waste, present-day waste incinerators, determination of post-combustion chamber ('afterburners').		

8.) Characterization of solid combustion residues: physical-chemical properties, mineral composition, thermal behaviour, sintering and ash fusion characteristics, melting temperature. Treatment and disposal of slags and fly ash.
9.) Burners: classification, geometry, sizing, fuel injection by spray nozzles (oil burners).
10.) Air pollution control: regulatory measures and provisions for waste incineration; possible allowed emission and immission concentrations (EU target values).
11.) Gaseous pollutants: CO, radicals, sulphur oxides, NOx formation (conditions, intensity), primary reduction methods, determination of gas emission concentrations.
12.) Characterization of gaseous pollutants; options for secondary emission reduction; flue gas cleaning methods and equipment.
13.) Definition of dust (for environmental regulations), properties of particulate matter (PM), separation and collection mechanisms, design and operation of dust collection systems (separators).
Practical work: self-made solutions of simple case-study problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- C. Baukal Jr.: Industrial Combustion Pollution and Control, Oklahoma, 2004, ISBN 0-8247-4694-5
- M. Döing: Waste to Energy, Cologne, http://www.ecoprog.com, 2014
- Godfrey Boyle: Renewle Energy, Oxford, 2004, ISBN 0-19-926178-4
- Thad Godish: Air quality, CRC Press 2003
- Roger D. Griffin: Principles of air quality management, CRC/Taylor & Francis, 2007

Competencies to evolve (see Appendix 1):
T1, T2, T3, T4, K6, K7, K9, K13, K14, A1, A2, A3, A4, F1, F4

Demonstration of coherence of course content and unit's objectives:
The course gives on one hand the fundamentals of air quality protection, on the other hand the most relevant applied knowledges about air quality control during different industrial acticities which emit large quantities of air pollutants. The course provides important background especially to the Waste management specialization. On the other hand, this is an essential topic of any environmental engineering programme.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures are complemented by discussion of case studies. Students should complete individually a report on a case study during the semester, which develops their practical skills, autonomy and critical thinking.

Responsible Instructor (*name, position, scientific degree):*
Arnold András Kállay Dr., assistant professor, PhD; tuzaak@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Water and wastewater treatment

Course Title: Water and wastewater treatment	**MFEET730001A**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of theoretical or <u>practical</u> nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Students will be assessed with using the following elements. Attendance: 15 % Short quizzes 10 % Midterm exam 40 % Final exam 35 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: Water quality protection		
Course Description:		
Acquired store of learning: The students will be familiar with the basic elements and concepts of modern water and waste water purification technology and processes. The students will be able to choose the right purification technology concerning environmental protection aspects. The short curriculum of the subject: Contamination and pollution processes in water. Pollution limits in water and in groundwater. The most typical contaminants and their physical and chemical properties. Sampling, and preparations of samples. Cleaning and purification technology for municipal and industrial waste water. Technology design.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Spellmann F. R.:Handbook of water, and wastewater treatment plant operations, Lewis Publis-hers, 2003. • Woodard F.: Handbook of water, and waste water treatment technologies, Butterworth-Hei-nemann, 2001.		

- Dr. Michael R. Templeton, Prof. David Butler: Introduction to Wastewater Treatment. 2013
- Drechsel, Pay, Qadir, Manzoor, Wichelns, Dennis (Eds.): Wastewater Economic Asset in an Urbanizing World. Springer 2017.
- Fatta-Kassinos, Despo, Dionysiou, Dionysios D., Kiimmerer, Klaus (Eds.): Advanced Treatment Technologies for Urban Wastewater Reuse. ISBN 978-3-319-23885-2 (2016)

Competencies to evolve (see Appendix 1):
T1, T3, K6, K8, K10, A1, A2, A4, F1, F4

Demonstration of coherence of course content and unit's objectives:
Since water is the most sensitive medium in the near-surface environment, the course has a key importance for both specialisations, but especially for the Waste management specialisation. This course provides applied knowledge where the students get familiar with the most important technologies and practices of water and wastewater treatment.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by demonstrations of different water and wastewater treatment technologies, as well as with a field trip to a wastewater treatment plant.

Responsible Instructor (*name, position, scientific degree):*
Sándor Nagy Dr., associate professor, PhD; sandor.nagy@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Valéria Üveges Dr. Mádainé, assistant lecturer

Remediation and environmental geotechnics specialization

Hydrogeology

Course Title: Hydrogeology	**MFKHT710017**	**Credits: 5**
Type of course: compulsory/elective (delete that is not relevant)		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of <u>theoretical</u> or practical nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Attendance: 15 % Short quizzes 10 % Midterm exam 40 % Final exam 35 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*: -		
Course Description:		
Acquired store of learning: The students will be familiar with the basic concepts of modern hydrogeology as well as field hydrogeology. The students will learn about the relationships of rocks and groundwater, and about the phenomena of groundwater flow through the pores and fractures. The students will be able to handle and solve basic problems in hydrogeology and contamination transport. The main relationships of well hydraulics concerning steady-state and transient problems are also discussed. The students will be able to calculate the discharge value, the depression curve and the velocity distribution of an operating well or a group of wells. The students will be able to carry out field pumping tests, and they will be able to interpret the obtained results effectively. The short curriculum of the subject: The main properties and quality aspects of groundwater. Classification of groundwater resources. Storage and hydraulic properties. Darcy-law, flow and seepage equations. Temperature properties		

under the surface. Shallow and deep groundwater. Karst water, river bank filtered water resources. Relationship between groundwater and surface water. Springs. Flow systems under the surface. Groundwater as a geologic agent. Determination of hydraulic conductivity. Transport processes in groundwater. Basics of well hydraulics. Calculation of well discharge, determination of depression curve and velocity distribution around wells. Group of wells. Pumping tests and their interpretation. Complex interpretation of groundwater data.

Practical work: self-made solutions of simple case study problems. Students take measurements at the Hydrogeological Measurement Station in the University where water levels, yields, and wells are interacted. By using a field multimeter, the main parameters of the groundwater are determined (e.g. pH, conductivity, dissolved oxygen concentration, etc.).

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Péter Szűcs: Hydrogeology. Course materail for Geothermal engineers. University of Miskolc, 2011.
- David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002.
- Dassargues, Alain: Hydrogeology: goundwater science and engineering, Taylor & Francies, ISBN 9780429894411, (2019)
- Yiqun Tang, Jie Zhou, Ping Yang, Jingjing Yan, Nianqing Zhou (auth.): Groundwater Engineering. Springer Singapore, ISBN 978-981-10-0669-2, (2017)
- Bernward Hölting, Wilhelm G. Coldewey: Hydrogeology. Springer, ISBN 978-3662563738, (2018)

Competencies to evolve (see Appendix 1):

T1, T2, T4, K1, K2, K4, K6, K7, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:

The course gives the theoretical background and also practical skills for understanding and modeling the status and dynamic changes of groundwater resouces. This is a principal course to assess and solve issues related to remediation of the subsurface environment as well as to complete risk assessment tasks. The course is a fundamental one for the Remediation and Environmental Geotechnics specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Theoretical part is complemented by laboratory exercises and calculations as well as demonstration and measurements of pumping tests. Thus, the course develops both theoretical knowledge and practical skills of the students.

Responsible Instructor (*name, position, scientific degree):*

Péter Szűcs Dr., full professor; hgszucs@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Balázs Zákányi Dr., lecturer, PhD

Groundwater flow and contaminant transport modeling

Course Title: Groundwater flow and contaminant transport modeling **(Project practice)**	**MFKHT7200061**	**Credits: 5**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **60** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Attendance: 15 % Homework 10 % Midterm exam 40 % Final exam 35 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: Hydrogeology		
Course Description:		
Acquired store of learning: The students will be familiar with the theoretical and practical aspects of the numerical methods widely used in the modern hydrogeology. The students will be able to use a worldwide known numerical environment. Using this environment the students will possess an ability to solve simple problems in the field of hydrodynamics and contaminant transport, and will learn that basic knowledge based on which getting more experiences they will be later able to solve also more complex simulation problems. The short curriculum of the subject: Tasks and aims of GW flow and contaminant transport modeling. Theory of GW flow modeling: the flow equation and its numerical solutions. The phenomena of contaminant transport in porous medium, the different forms of the transport equation. Analytic and numerical solutions. Particle tracking algorithms. Data-system of GW flow and contaminant transport models. The reliability of data, the aspects of data evaluation and control, type of dataset errors. Calibration of models. GW flow and contaminant transport modeling using the Processing MODFLOW environment. Solution		

of demo problems and investigation of case studies. Practical work: self-made models of simple real problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Chiang, W-H. – Kinzelbach, W.(2001): 3D-Groundwater Modeling with PMWIN, A Simulation System for Modeling Groundwater Flow and Pollution, Springer-Verlag Berlin, Heidelberg, New York, ISBN 3-540-67744-5, SPIN 10774334
- Kinzelbach, W. (1986): Groundwater Modelling (An Introduction with Sample Programs in BASIC), Elsevier, p.331.
- Kovács B.: Hidrodinamikai és transzportmodellezés Processing MODFLOW környezetben I., 2004, Miskolci Egyetem – Szegedi Tudományegyetem – GÁMA-GEO, p. 160., ISBN 963 661 637 X
- Kovács – Szanyi: Hidrodinamikai és transzportmodellezés II., 2005, Miskolci Egyetem – Szegedi Tudományegyetem – GÁMA-GEO, p. 213., ISBN 963 661 638 8
- Neven Kresic (1997): Quantitative Solutions in Hydrogeology and Groundwater Modeling. Lewis Publishers

Competencies to evolve (see Appendix 1):
T1, T2, T7, K1, K2, K4, K7, K9, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is one of the applied courses of key importance on the Remediation and Environmental Geotechnics specialisation which provides knowledge and practical tools to understand and model the flow and transport of contamination in the subsurface environment.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by individual modelling exercise which students should complete by means of modelling software applied widely for environmental assessments.

Responsible Instructor (*name, position, scientific degree):*
Balázs Kovács Dr., honorary associate professor, PhD; hgmv@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Viktória Mikita, assistant lecturer, PhD

Geotechnical engineering

Course Title: Geotechnical engineering	**MFKHT720025**	**Credits: 4**
Type of course: compulsory/elective (delete that is not relevant)		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **55** (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **exam.**
Students will be assessed with using the following elements.

Attendance:	15 %
Individual report	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **2nd**

Pre-requisites *(if any)*: -

Course Description:

The students will be familiar with the basic concepts of geotechnical engineering, with the principles of designing and with the construction methods of different buildings and objects.

The short curriculum of the subject:

Review of foundation studies. Legal and authorization background. EUROCODE 7. Concrete as building material. Engineering design, stresses and loads. Design of concrete and reinforced concrete structures. Design of retaining walls. Jet-grouting. Building of slurry wall. Digging/excavations. Building of water-supply and channeling networks. Underground structures. Utility ducts. Hydraulic engineering structures: river walls, dams, controlling objects.
Practical work: self-made solutions of simple case-study problems

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- C. Venkataramaiah: Geotechnical engineering, New Age International, 2010
- Geotechnikai tervezés elvei és gyakorlata az EUROCODE 7 alkalmazásával
- R. F. Craig: Craig's Soil Mechanics, Spon Press, ISBN 0-415-32702-4,2004, pp
- I. Vanícek, M. Vanícek: Earth Structures. Springer, ISBN: 978-1-4020-3963-8, 2008.

- Muni Budhu: Soil mechanics and foundations. John Wiley & Sons, ISBN 978-0-470-55684-9, 2011

Competencies to evolve (see Appendix 1):
T1, K2, K6, K7, K8, A1, A2, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is a course providing theoretical background and applied skills to students in the field of civil engineering tasks which are necessary to complete in the near-surface environment during remediation tasks. This is an important fundamental course in the Remediation and Environmental Geotechnics specialisation.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Lectures are complemented by calculation exercises and by the individual completion of simple case study problems.

Responsible Instructor (*name, position, scientific degree):*
Tamás Madarász Dr., associate professor, PhD; hgmt@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Tamás Kántor, assistant lecturer

Contaminated site remediation

Course Title: Contaminated site remediation **(Project practice)**	**MFKHT720030**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Students will be assessed with using the following elements. Attendance:15 %; Short quizzes10 %; Midterm exam 40 %; Final exam 35 %; Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
The course aims to enable registered students to identify soil and groundwater contamination issues, to train them in contaminated site investigation, remediation design and implementation. The students shall be able to understand the main elements of contaminated land management tools e.g. problem formulation, risk based target value setting and risk assesment, site investigation, hydrodynamic and contaminant transport modeling, remediation action, and monitoring. **The short curriculum of the subject:** • Setting the stage, context of contaminated site remediation • Historical overview of site remediation • The process of site remediation • Site Investigation on contaminated land • Type and behaviour of contaminants in the subsurface environment • Behaviour of contaminants in groundwater • Chemistry of site investigation; Threshold value systems and their role in remediation • Quantitative risk assessment and site specific, risk based remediation; Remediation methods and aspects of their selection; Remediation without excavation; Remediation with soil excavation • Hydrauliy protective measures; Isolation from the environment; Monitoring activities • Legal framework		

Risk Assessment and its role in remediation Case studies

Practical work: self-made solutions of simple case-study problems

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- CLARINET and NICOLE (2001): The Sustainable Management and Remediation of Contami-nated Land, Special Edition of Land Contamination and Reclamation, Editors: Bardos, P. and Lewis, A., Richmond, UK
- David L. Russell - Remediation Manual for Contaminated Sites Hardcover 2nd edition, 2011
- Alok Bhandari, Contaminants of Emerging Environmental Concern, ASCE Publications, 2009
- National Research Council Natl Research Council Commission on Intrinsic Remediation Nati-onal Research: Natural Attenuation for Ground Water Remediation, National Academic Press, 2000
- Martin N. Sara, Lome G. Everett: Evaluation and Remediation of Low Permeability and Dual Porosity Environments, Astm Intl, 2002

Competencies to evolve (see Appendix 1):

T1, T2, T3, T4, K2, K4, K5, K6, K7, K8, K10, A1, A2, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:

This is one of the applied courses of key importance on the Remediation and Environmental Geotechnics specialisation which provides knowledge and practical tools to complete remediation tasks and projects in the subsurface and near-surface environment.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Theoretical part is complemented by completion of individual reports on case studies of remediation tasks.

Responsible Instructor (*name, position, scientific degree):*

Tamás Madarász Dr., associate professor, PhD; hgmt@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): István Székely, research assistant

Environmental Geotechnics

Course Title: Environmental Geotechnics	**MFKHT730030**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of <u>theoretical</u> or practical nature of the course, " course's character "[13]: **55** (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **exam.**

Students will be assessed with using the following elements.

Attendance:	15 %
Short quizzes	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **3rd**

Pre-requisites *(if any)*: -

Course Description:

Acquired store of learning:

The students will be familiar with the basic concepts of environmental geotechnics.

The short curriculum of the subject:

Physiochemistry of soils for geoenvironmental engineering. Changing of soil parameters caused by contaminants. Determination of contaminant retention capacity of soils. Barrier systems, geological and geosynthetic barrier systems, horizontal and vertical barriers. Geotechnical aspects of landfilling. Stability and deformation of waste dumps, liner systems. Geotechnical tasks of recultivation. Investigation of contaminated sites. Geotechnical problems of remediation. Waste as constructions material. Soil improvement.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Sarsby, R.: Environmental Geotechnics. Thomas Telford, 2000.
- Davis, M.L.- Cornwell, D.A.: Introduction to Environmental Engineering. WCB McGraw-Hill, Boston, 1998.
- Bell, F.B.: Environmental Geology. Blackwell Science Ltd, Oxford, 1998.

- Rowe, K.R.: Geotechnical and Geoenvironmental Engineering Handbook. Kluwer Academic Publishers, 2000.

Competencies to evolve (see Appendix 1):
T1, T3, T4, K2, K6, K7, K8, A1, A2, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
This is an applied course that introduces the most important geotechnical issues and tasks that appear during the design and operation of a landfill site. This is is an important applied course in the Remediation and Environmental Geotechnics specialisation.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by demonstrations and calculations.

Responsible Instructor (*name, position, scientific degree):*
Andrea Tóth Kolencsikné Dr., assistant professor, PhD; hgandi@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Zsombor Fekete, PhD student

Chemical technologies in environmental protection

Course Title: Chemical technologies in environmental protection	**MFEET730016**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** During the semester the following tasks should be completed: laboratory work and report, written test. **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*:		
Course Description:		
Acquired store of learning: Study goals: To introduce the chemical techniques on environmental pollution treatment, waste recycling and treatment, as well as on pollution control. Course content: Theory of mass transfer, laws, relationships, diffusion equations. Principles and fundamentals of design of chemical techniques and reactors. Solid-liquid extraction as a technique for the treatment of solid wastes, methods and equipment. Treatment of contaminated fluids: adsorption, precipitation (cementation), ion exchange, liquid-liquid separation. Thermal techniques like rectification, thermal oxidation, pyrolisys and gasification. Education method: Lectures, seminars and lab practice.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Prof. Dr J. Clifford Jones (2013): Thermal Processing of Waste ISBN: 978-87-7681-590-5 • Robert Noyes (1994): Unit Operations in Environmental Engineering. • Jay H. Lehr (2004): Wiley's Remediation Technologies Handbook. John Wiley & Sons, ISBN: 978-04-7145-599-8 • Basic research of the strategic raw materials in Hungary (ed.: János Földessy 2014)ISSN: 2064-3195 ISBN: 978-615-80073-5-1 • PAUL T. WILLIAMS. (2005): Waste Treatmentand Disposal. ISBN 0-470-84912-6		
Competencies to evolve (see Appendix 1): T1, T3, T4, K2, K5, K10, F1, F4		

Demonstration of coherence of course content and unit's objectives:
The course gives the fundamentals of chemcial processes applied for waste management therefore it is one of the background courses for the Waste management specialisation. It develops the knowledge and skills obtained from the Analytical chemistry course.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory practical work of the students.

Responsible Instructor (*name, position, scientific degree):*
Ljudmilla Bokányi Dr., associate professor, PhD; ejtblj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Valéria Üveges Dr. Mádainé, assistan lecturer

Environmental Risk Assessment and Remediation

Course Title: Environmental Risk Assessment and Remediation **(Project practice)**	**MFKHT730026**	**Credits: 3**
Type of course: compulsory/elective		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 70 (kredit%)		

Type of Assessment (exam. / pr. mark. / other): **exam.**

Students will be assessed with using the following elements.

Attendance:	15 %
Short quizzes	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Position in Curriculum (which semester): **3rd**

Pre-requisites *(if any)*: -

Course Description:

Acquired store of learning:

The students will be familiarized with the basic concept and framework of Environmental and Human Health Risk assessment and its relationship to contaminated land remediation. The students shall be competent in reading and understanding risk assessment documentation and evaluating its correctness. They will be able to work together with other field specialists in a risk assessor team. They will get a brief introduction to remediation practices and their design and the European practice of remediation planning and monitoring.

The short curriculum of the subject:

History of Risk Assessment, principles and background of RA methodology, Overview of risk related terminology and definitions, Elements of HHRA methodology, Problem formulation, Exposure assessment, Toxicity assessment, Risk Characterization, Risk assessment and its role in site remediation, Risk interpretation, EU legislation and practice of RA methods, Hungarian legal background, various applications of RA methods, risk based target value and its determination, Case studies.

Practical work: self-made solutions of simple case-study problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- CARACAS (1998): Risk Assessment for Contaminated Sites in Europe, Volume 1: Scientific Basis; LQM Press, Nottingham,
- Vegter, J.J. (2001): A Risk-Based Land Management Approach; Land Contamination and Reclamation, Vol. 9, No. 1, Richmond, UK
- CLARINET and NICOLE (2001): The Sustainable Management and Remediation of Contaminated Land, Special Edition of Land Contamination and Reclamation, Editors: Bardos, P. and Lewis, A., Richmond, UK.
- Paolo Ricci: Environmental and Health Risk Assessment and Management: Principles and Practices. Springer, (2010)
- Katalin Gruiz, Tamas Meggyes, Eva Fenyvesi: Engineering Tools for Environmental Risk Management: 3. Site Assessment and Monitoring Tools. CRC Press (2014)

Competencies to evolve (see Appendix 1):

T1, T3, K2, K4, K5, K10, F1, F4

Demonstration of coherence of course content and unit's objectives:

This is one of the applied courses of key importance on the Remediation and Environmental Geotechnics spacialisation which provides knowledge and practical tools to understand concept of environmental risk assessment and to complete risk assessment tasks for the shallow subsurface environment.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Theoretical part is complemented by individual report preparation by students on different case studies. It develops the practical skills of the students as well as their responsibility and critical thinking.

Responsible Instructor (*name, position, scientific degree):*

Tamás Madarász Dr., associate professor, PhD; hgmt@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Environmental geochemistry

Course Title: Environmental geochemistry	**MFFAT 730009**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 0 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Students will be assessed with using the following elements. Attendance: 15 % Individual report 10% Mid-term test 40% Final exam 35 % Total 100% **Grading:** > 90%: excellent (5); 80 – 89%: good (4); 70 – 79%: satisfactory (3); 60 – 69%: pass (2); < 60%: failed (1).		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
The students will be guide into the distribution of the elements and compounds of the different zones of the Earth, with special focus on the upper zone of the Lithosphere. Near this, the analysis and characterization of the artificially created deposits - such as solid and liquid mining wastes and tailings, the tailings of the coal mines, etc. - is shown. The different types are characterized and visualized by the view of environmental load and potential heavy metal mobilization or other harmful effects. The Eh-pH diagram of the most important heavy metals are shown with the geochemical modelling software of HSC Chemistry 7.0. The importance of concentration and effects (both negative and positive) of the different elements and groups of elements in the biosphere, in surface of groundwater are shown. Near this, the possible enrichment of these elements are also described. The behaviour of the elements and their most important types of alterations on surface condition are presented. The short curriculum of the subject: Basic of geochemistry of the Lithosphere. Element groups. Behaviour of hydrogen, alkali and alkaline earth metals. The dominant role of carbon, aluminium and silicon in rock forming. Heavy		

metals as main source toxicity. Appearance and roles of rare earth elements and trace element. Roles and importance of nitrogen, oxygen and halogenides. Classification and analysis of the possible contingencies on the different types of waste and tailing deposits (mining waste and tailings, dumps od coal mining, etc.). The visualization of the Eh-pH diagrams of the most common heavy metals, using HSC Chemistry modelling programme. The appearance and toxicity of the different elements in the flora, fauna and human body. Effects of the different elements in surface and ground water. Alteration of the different minerals, rocks, and compounds on surface condition.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Dill H.G. (2010): The „chessboard" classification schene of mineral deposits. Elsevier, 2010.
- Albared, F. (2005): Geochemistry. An introduction. Cambridge Univ. Press.
- D. Sarkar, R. Datta, R. Hanningan: Concepts, and applications in environmental geochemistry, Elsevier 2007.
- John W. Anthony, Richard A. Bideaux, Kenneth W. Bladh, and Monte C. Nichols, Eds. (2003): Handbook of Mineralogy. Mineralogical Society of America.
- Brownlow, A. H. (1996): Geochemistry. Prentice Hall, New Jersey.

Competencies to evolve (see Appendix 1):
Tl, T3, T4, K2, K5, K10, Fl, F4

Demonstration of coherence of course content and unit's objectives:
The course provides the most important aspects of the interaction of rocks and different kind of mineral accummulations (e.g. mining waste) with other constituents of the environment, especially with water. The course gives findamental knowledge and practical skills of geochemical modelling for students of the Remediation and Environmental Geotechnics specialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by geochemical modelling of water-mineral interactions, using widely applied modelling softwares.

Responsible Instructor (*name, position, scientific degree):*
Sándor Szakáll Dr., full professor, DSc; askszs@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Geographic Information Systems

Course Title: Geographic Information Systems	**MFKFT730012**	**Credits: 3**
Type of course: compulsory/elective		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or <u>practical</u> nature of the course, " course's character "[13]: **60** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Students will be assessed with using the following elements. Attendance: 50 % Final exam 50 % Total 100% **Grading:** > 85%: excellent (5); 75 – 84%: good (4); 63 – 74%: satisfactory (3); 50 – 62%: pass (2); < 50%: failed (1).		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		

The aim of the course is to teach the basic knowledge of geographic information system and to give an overview on the most commonly used GIS softwares and application possibilities. The main goal of the course is to teach the use of ESRI ArcGIS. The course covers the tution of both vector and raster based GIS analysis, the geographic data collection, data processing and modeling tools

1. GIS basics, vector and raster format, digital mapping.
2. Vector based data format, setup of GIS databases.
3. Setup and characteristics of geometric data model.
4. Setup and characteristics of semantic data model.
5. Setup and characteristics of metadata.
6. The use of ESRI ArcMAP, data formats.
7. Tools and methods of digitization.
8. Setup of point databases.
9. Setup of polyline databases.
10. Setup of polygon databases.
11. Possibilities of visualization, theamatic mapping.
12. Data analysis, basics of spatial analsyiy.
13. Digital mapping
14. Creation of a pilot project.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Alias Abdul-Rahman, Morakot Pilouk: Spatial data modeling of 3D GIS, Springer, 2007
- ESRI. 2001. Getting started with ArcGIS. USA
- ESRI. 1994. PC Arc/TNFO user guides. USA
- Markus Neteler, Helena Mitasova: Open Source GIS: A GRASS GIS Approach, Kluwer Academic Publishers, 2004
- Shashi Shekhar, Hui Xiong, Xun Zhou (eds.) (2017): Encyclopedia of GIS. Springer, ISBN: 978-3-319-17885-1

Competencies to evolve (see Appendix 1):

T1, T4, T7, K1, K2, K3, K7, A1, A2, A3, A7, F1, F3, F4

Demonstration of coherence of course content and unit's objectives:

This is a practical course providing useful skills to students to apply widely used GIS softwares for map-based exercises and tasks that appear during the environmental engineering work.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Students should complete practical exercises using widely applied GIS software. It develops individual problem solving competences and practical skills.

Responsible Instructor (*name, position, scientific degree):*

János Vágó Dr., associate professor, PhD ecovago@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Waste management specialization

Handling and processing of Biodegradable Wastes

Course Title: Handling and processing of Biodegradable Wastes	**MFEET710006**	**Credits: 3**
Type of course: compulsory/elective		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** During the semester the following tasks should be completed: laboratory work and report, written test. **GradingLimits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **1st**		
Pre-requisites *(if any)*:		
Course Description:		
Study goals: To introduce the sustainable biological treatment systems for the conversion of biowastes into marketable materials or energy, or safe disposal. Course content: Quality and quantity biowastes according to the EU List. Microbiological and thermodynamic fundamentals of aerobic and anaerobic biodegradation. Description and classification of microorganisms. Growth law, limiting factors and inhibitors. Adaptation and gene engineering. Enzyme-catalytic reactions. Bioreactors. Biomass cultivating, up-stream and down-stream processes and operations. Composting processing systems, composting technology and equipment, quality assurance and control. Environmental impact of composting. Production of biogas: technological solutions, reactors, quality assurance and control, application of biogas. Technological design and dimensioning. Environmental impact of biogas production. Economics of the technologies. Innovative biotreatment of biowastes for the sake of "green chemistry". Sustainability and environmental aspects. Education method: Lectures and seminars.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Heribert Insam, Nuntavun Riddech, Susanne Klammer Microbiology of Composting. Springer Science & Business Media, 2002. • Paul T. Williams Waste Treatment and Disposal John Wiley & Sons, 2013		

- Ram Chandra: Advances in biodégradation and bioremediation of industrial waste, CRC Press, 2015
- Dr. W. Bidlingmaier, Dr. M. Kranert, Dr. R. Widmann, Dr. F. Scholwin: Biological waste treatment technologies. ORBIT Science, 2017
- Pranas Baltrénas, Edita Baltrénaité: Small bioreactors for management of biodegradable waste, Springer International Publishing, 2018

Competencies to evolve (see Appendix 1):
T1, T4, K1, K2, K4, K11, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
The course provides practical and theoretical knowledge on treatment of different kind of wastes (e.g. communal waste) that can be treated by biological methods. This is an important applied course on the Waste management specialisation.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical knowledge is supplemented by case studies and seminar practices.

Responsible Instructor (*name, position, scientific degree):*
Ljudmilla Bokányi Dr., associate professor, PhD; ejtblj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Mechanical and Biological Treatment of Municipal Solid Waste

Course Title: Mechanical and Biological Treatment of Municipal Solid Waste	**MFEET720015**	**Credits: 4**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 70 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** During the semester the following tasks should be completed: laboratory work and report. **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
Study goals: To introduce the necessity of treatment of the residual fraction of municipal solid waste (MSW) to recover valuable materials (metals) and energy (refuse derived fuel (RDF) and biogas) for the creating of circular economy. Course content: Circular economy and separative waste collection concepts. Sorting plants: technology and machinery (crushers, sieves, sorting belts, magnetic and eddy current separators, robotics, sensoring techniques for plastics, baling). Sorting plants panning: policy tools, market pool, value drivers/cost drivers. Environmental and social impact assessement. Factors related to the health, safety and environment. Quality and quantity of MSW and its residual fraction. Biostabilisation of degradable organics. Recovery of ferrous and non-ferrous metals. Refuse Derived Fuel (RDF) separation and further operations. Recovery and separation of plastics to achieve higher value added RDF. Evaluation of technologies meeting different processing targets. Machinery and economics, their design. Environmental impacts. Advanced technologies to achieve the highest energy recovery rate. Organisation of the advanced MSW treatment system: legislation, economy, motivation and education. Education method: Lectures and seminars		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Chang H. Oh: Hazardous and radioactive waste treatment technologies handbook, CRC Press, 2001 • Heribert Jusam, Nuntavun Riddech, Susanne Klammer Microbiology of Composting. Springer Science & Business Media, 2002.		

- Gary C Young: Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons. Wiley, 2010
- Paul T. Williams Waste Treatment and Disposal John Wiley & Sons, 2013
- McKinnon D, Fazakerley J, Hultermans R (2017): Waste sorting plants. Extracting value from waste. ISWA

Competencies to evolve (see Appendix 1):

T1, T4, K1, K2, K4, K11, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:

This is an applied course that introduces the details of communal waste processing by mechanical and biological methods. Thus, this is one of the applied courses of key importance on the Waste management spacialisation.

Demonstration of coherence between teaching methodologies and the learning outcomes:

Theoretical knowledge is supplemented by case studies, laboratory works and seminar practices.

Responsible Instructor (*name, position, scientific degree):*

Ljudmilla Bokányi Dr., associate professor, PhD; ejtblj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Tamás Magyar, PhD; Ákos Móricz Pintér, research assistant

Recycling of Metallic and Rubber Wastes

Course Title: Recycling of Metallic and Rubber Wastes **(Project practice)**	**MFEET730018**	**Credits: 3**
Type of course: compulsory/elective		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 70 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** **Signature:** **Participation in lessons and laboratory excercises.** During the semester the following tasks should be completed: short presentation of exercise (introduction of given problem), exam. **Grading Limits:** > 80%: excellent, 70-79%: good, 60-69%: medium, 50-59%: satisfactory, < 50%: unsatisfactory.		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
Scope and objective of subject: Understand the importance of metallic and rubber waste management for recovery of structural materials. Get acquainted with metallic and rubber waste material flows, compositions, and the possible recycling technologies. **Thematic description of subject:** Technologies of processing and utilization of metal and rubber containing wastes. Main groups of introduced wastes: electronic wastes, end of life vehicle wastes, slugs. Mechanical, chemical and thermal processes of preparation. Knowledge of quality related to products.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• V. Goodship: Waste Electrical and Electronic Equipment (WEEE) handbook. Woodhead Publishing Limited, 2012. • M. E. Schlesinger: Aluminium Recycling. CRC Press • R. E. Hester: Electronic Waste Management, RSC Publishing, 2009. • J. Földessy: Criticel Monography Series 10: Research of Strategic Raw Materials in Hungary. Miskolc, 2014.		
Competencies to evolve (see Appendix 1):		

T1, T4, K1, K2, K4, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
Recycling courses are of key importance on the Waste management specialization, introducing the lice cycles and recycling technologies of different kind of material streams, focusing primarily on their reprocessing options.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the lectures, students should complete a report on one type of waste streams and its recycling options and present this report for the group. This teaching method develops also the ability to work individually and the critical thinking of the student.

Responsible Instructor (*name, position, scientific degree):*
Sándor Nagy Dr., associate professor, PhD; sandor.nagy@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Treatment and processing of construction industrial- and glass wastes

Course Title: Treatment and processing of construction industrial- and glass wastes	**MFEET720017**	**Credits: 3**
Type of course: compulsory/elective		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **50** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Students will be assessed with using the following elements. Attendance: 5 % Homework: 10 % Short quizzes: 10 % Midterm exam: 40 % Final exam: 35 % Total: 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*:		
Course Description:		
Acquired store of learning: The aim of the subject for students is to learn knowledge about the treatment and processing of construction industrial- and glass wastes. Construction industry wastes' *types, their generation. Their fundamental process engineering and chemical properties, international experience of their utilization in the road construction. Process engineering technologies.* General u*tilization possibilities.* *Main types, properties, generation of glass wastes. Types, composition and properties of glass, with special regards to the process engineering, mechanical and chemical characteristics.* Utilization. Preparation technologies. *Recovery of valuable components. Mechanical and thermal processes. Quality control methods.*		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Jorge de Brito, Nabajyoti Saikia: **Recycled Aggregate in Concrete: Use of Industrial, Construction and Demolition Waste (Green Energy and Technology)** Springer 2013.		

- Csőke B.: Építési Hulladékok előkészítése és hasznosítása. Környezetvédelmi Füzetek. OMIKK (ISBN 963 593 414 9, ISSN 0866-6091), 1999./19
- Gabor Mucsi, Barnabas Csőke, Mark Kertész, Laszlo Hoffmann: Physical Characteristics and Technology of Glass Foam from Waste Cathode Ray Tube Glass. JOURNAL OF MATERIALS 2013: pp. 1-11. (2013)
- Gábor Mucsi, Barnabás Csőke: Power plant fly ash as a valuable raw material. Journal of Geosciences and Engineering Published by The Faculty of Earth Science and Engineering Miskolc University, Vol. 1.
- Joseph Davidovits: Geopolymer Chemistry and Applications. Institut Geopolymer, 2008. (Second edition) ISBN: 9782951482012

Competencies to evolve (see Appendix 1):
T1, T4, K1, K2, K4, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
Recycling courses are of key importance on the Waste management specialization, introducing the lice cycles and recycling technologies of different kind of material streams, focusing primarily on their reprocessing options.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the lectures, students should complete a report on one type of waste streams and its recycling options and present this report for the group. This teaching method develops also the ability to work individually and the critical thinking of the student.

Responsible Instructor (*name, position, scientific degree):*
Gábor Mucsi Dr., associate professor, PhD; ejtmucsi@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Recycling of Plastic and Paper Wates

Course Title: Recycling of Plastic and Paper Wates **(Project practice)**	**MFEET730018**	**Credits: 3**
Type of course: compulsory/elective (delete that is not relevant)		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: **65** (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Participation on the project courses and preparation of an advancement documentation based on the topic discussed. **Assessment:** based on the advancement doc.. Assesment according to a five grade scale: 1. Structure and clearness of the work. (max. 10 points) 2. Aims and goals are clear: (max. 10 points) 3. Literature study: (max. 15 points) 4. Methodology: (max. 15 points) 5. Results and discussion: (max. 25 points) 6. Rate of independent work: (max 25 points) **Assessment:** 88 – 100: excellent (5), 75 – 87: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*:		
Course Description:		
Acquired store of learning: The aim of the subject for students is to learn knowledge about paper and plastics as material, their properties and their production methods and technologies, and their utilisation as secondary raw material. Also, to learn paper and plastic appearance in different waste streams, and their recycling goth technologies and unit operation level. Paper and plastic production. Properties of plastics, their production and utilisation. Waste streams and major apparence of paper and plastic in these waste streams, quality and quantity. Properties of paper and plastics focusing the properties relevant to their recycling and separation. Technical solution of paper recycling. technical solution of plastic recycling, equipment and unit operation in paper and plastic recycling, energetic and as secondary raw material utilisation of plastics and paper.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• EU BREF - Production of Pulp, Paper and Board		

- EU BREF - Production of Polymers
- Ernst Worrell And Markus A. Reuter Handbook Of Recycling State-Of-The-Art For Practitioners, Analysts, And Scientists ISBN: 978-0-12-396459-5
- Brent Strong Plastics materials and processing, 2006 ISBN 0-13-114558-4
- Donald E. Hudgin (Manas Chanda, Salil K. Roy ed) PLastic Technology Handbook 2006, ISBN 978-0-8493-7039-7

Competencies to evolve (see Appendix 1):
T1, T4, K1, K2, K4, A1, A3, F1, F4

Demonstration of coherence of course content and unit's objectives:
Recycling courses are of key importance on the Waste management specialization, introducing the lice cycles and recycling technologies of different kind of material streams, focusing primarily on their reprocessing options.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the lectures, students should complete a project-based report on one type of waste streams and its recycling options and present this report for the group. This teaching method develops also the ability to work in groups and the critical thinking of the student.

Responsible Instructor (*name, position, scientific degree):*
Imre Gombkötő Dr., associate professor, PhD; ejtimreg@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Sampling and qualification of waste

Course Title: Sampling and qualification of waste	**MFEET70016**	**Credits: 2**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec. + 1 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 60 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **pr. mark** Requirements of the practical mark: - Less than 20 % class missing - Presenting the laboratory measurements reports - Writing the classroom test successfully **Assessment:** Five grades scale Assessment according to a five grade scale: Missing basic knowledge – unacceptable Student demonstrates basic knowledge – acceptable Student demonstrates basic knowledge and can apply it in practice – intermediate Student demonstrates system level knowledge in contexts – good Student demonstrates outstanding system level knowledge in contexts - excellent **Assessment:** 88 – 100: excellent (5), 75 – 87: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1)..		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		
Let the students know the engineering, mathematical statistics, physical – chemical - biological analytical and legal authorization knowledge by with they will be able to sample and qualify of wastes in waste management. Summary of applied engineering knowledge of mathematical statistics and its theoretical and practical application for wastes. The identification, classification and notation systems of wastes according to their origin and tax and customs clearance system. Types of waste landfills and limit values for the acceptable wastes. Waste characterization: basic characterization – examination of identity – examination of conformity – on-site inspection. Physical, chemical and biological analytical methods of waste characterization.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Standards • Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai • praktikum. Miskolci Egyetemi Kiadó. 2017.		

- MSZ 21420-28:2005. Hulladékok jellemzése. 28. rész: Települési szilárd hulladékok vizsgálata. Mintavétel. MSZ 21420-29:2005. Hulladékok jellemzése. 29. rész: települési szilárd hulladékok vizsgálata. A minta előkészítése, az anyagi összetétel meghatározása anyagfajták szerinti szétválogatással.
- Csőke B. - Bokányi L. - Bőhm J. – Buócz Z. - Faitli J. - Kiss T.: Szilárd települési hulladékok előkészítése és hasznosítása. Miskolci Egyetem Mérnöktovábbképző Központ. (215. p.) 1999.

Competencies to evolve (see Appendix 1):
T1, T2, T4, K1, K2, K4, K7, K8, K10, A1, A2, A3, A4, A5, A6, A7, F1, F4

Demonstration of coherence of course content and unit's objectives:
This course gives the theoretical background of proper sampling of bulk materials and material streams as well as introduces the most widely used characterization and sampling procedures for these. The course has a key importance to acquire knowledge and skills for proper planning and performance of sampling of wastes and waste atreams, therefore it is a core course for the waste management specialisation, however the overall sampling principles are relevant to the other specialisation as well.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by seminars, planning exercises and seminar discussions.

Responsible Instructor (*name, position, scientific degree):*
József Faitli Dr., habilitated associate professor, PhD; ejtfaitj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Tamás Magyar, PhD

Design fundaments of waste preparation technological processes

Course Title: Design fundaments of waste preparation technological processes	**MFEET720018**	**Credits: 5**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Requirements of the practical mark: • Less than 20 % class missing • Presenting the laboratory measurements reports • Writing the classroom test successfully **Assessment of the exam:** Five grades scale Assessment according to a five grade scale: Missing basic knowledge – unacceptable Student demonstrates basic knowledge – acceptable Student demonstrates basic knowledge and can apply it in practice – intermediate Student demonstrates system level knowledge in contexts – good Student demonstrates outstanding system level knowledge in contexts - excellent **Assessment:** 88 – 100: excellent (5), 75 – 87: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).		
Position in Curriculum (which semester): **2nd**		
Pre-requisites *(if any)*: -		
Course Description:		

Let the students know the theoretical and practical fundaments of the design of waste preparation unit operations and technological processes of waste management.

Fundamental terms and application fields of unit operations and process engineering. Production and consumption wastes. Characterization of coarse disperse systems. Characterization of waste materials in unit operations point of view. The unit operations and processes of changing of the disperse- and mixed state of multi-phase dispersed materials. The acting forces during the change of the state of the processed dispersed materials. The characterization and evaluation of comminution and agglomeration technological processes. Features of the change of the particle size and volume, rate of comminution and the breakage work. The material and energy transfer balances of material component separation technological processes. The unit operation features of the separation processes, evaluation of productivity (component content, yield and recovery, efficiency). Production of secondary raw materials and secondary fuels from municipal solid wastes (MSW). The comparison of different MSW processing technologies in respect of the material and energy balances.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Lecture notes
- Drzymala J.: Mineral processing, foundations of theory and practice of metallurgy. Wroclaw University of Technology Publisher, 2007.
- Faitli J. – Mucsi G. – Gombkötő I. – Nagy S. – Antal G.: Mechanikai eljárástechnikai praktikum. Miskolci Egyetemi Kiadó. 2017.

Competencies to evolve (see Appendix 1):
T1, T2, T4, K1, K2, K4, K7, K8, K10, A1, A2, A3, A4, A5, A6, A7, F1, F3, F4

Demonstration of coherence of course content and unit's objectives:
The course provides the applied knowledge to design waste treatment plants with integration of different processes and technologies. The course has a key importance for the Waste management specialisation.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory exercises. Students should submit reports on measurements and processes completed at laboratory classes.

Responsible Instructor (*name, position, scientific degree):*
József Faitli Dr., PhD, habilitated associate professor; ejtfaitj@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): Roland Romenda, PhD student

Waste Processing Machines and their operationon

Course Title: Waste Processing Machines and their operationon	**MFEET730020**	**Credits: 5**
Type of course: compulsory		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 sem.**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 50 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **exam.** Requirements of the signature: • Less than 20 % class missing • Presenting the laboratory measurements reports • Writing the classroom test successfully **Examination: Written and oral exam** Five grades scale Assessment according to a five grade scale: Missing basic knowledge – unacceptable Student demonstrates basic knowledge – acceptable Student demonstrates basic knowledge and can apply it in practice – intermediate Student demonstrates system level knowledge in contexts – good Student demonstrates outstanding system level knowledge in contexts – excellent **Assessment:** 85 – 100: excellent (5), 75 – 84: good (4), 63 – 74: intermediate (3), 51 – 62: acceptable (2), ≤50: unacceptable (1).		
Position in Curriculum (which semester): **3rd**		
Pre-requisites *(if any)*: -		
Course Description:		
The aim of the subject for students is to learn knowledge about the design, operation and selection of machinery and equipment used in waste processing (shredding equipment, classification equipment, separators, biological thermal and chemical processing equipment (eg reactors). Shredding equipment (hammer schredder, cutting mill, rotary cutter shredder) design, operation and selection. Classification equipment (flat and drum screen) design, operation and selection. Separator (magnetic, eddy current, electrostatic, air-flow separators) design, operation and selection. Biological thermal and chemical processing equipment (eg reactors) design, operation and selection.		
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:		
• Lecture presentation slides and notes • Ernst Worrell And Markus A. Reuter Handbook Of Recycling State-Of- The-Art For Practitioners, Analysts, And Scientists ISBN: 978-0- 12-396459- 5		

- Tarján G.: Mineral Processing (Vol. 1, 2). AK. Bp.1981.

Competencies to evolve (see Appendix 1):
T1, T2, T4, K1, K2, K4, K7, K8, K10, A1, A2, A3, A4, A5, A6, A7, F1, F3, F4

Demonstration of coherence of course content and unit's objectives:
The course provides the applied knowledge and skills to design waste treatment plants and select the appropriate equipment park and technologies. The course has a key importance for the Waste management specialisation.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory exercises. Students should submit reports on measurements and processes completed at laboratory classes.

Responsible Instructor (*name, position, scientific degree):*
Ádám Rácz Dr., assistant professor, PhD; ejtracz@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Sustainable development and environmental policy

Course Title: Sustainable development and environmental policy	**MFKHT740054**	**Credits: 3**
Type of course: optional		
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **1 lec + 2 sem**		
The degree of theoretical or practical nature of the course, " course's character "[13]: 60 (kredit%)		
Type of Assessment (exam. / pr. mark. / other): **oral/written exam.** **Assessment and grading:** Students will be assessed with using the following elements. Attendance 15 % Individual report 10 % Midterm exam 40 % Final exam 35 % Total 100% Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)		
Position in Curriculum (which semester): **4th**		
Pre-requisites *(if any)*: -		
Course Description:		
Introducing the concept of sustainable development, its feasibility and its difficulties. Introduce international and national programs, aspirations, and agreements with the students to the study of sustainable development. The short curriculum of the subject: 1. The concept of sustainable development, the view of sustainable development, the symptoms of sustainability and the causes of unsustainability that relate to the scientific and technical foundations attached to the profession of environmental engineering. 2. The United Nations and the EU's Sustainable Development Policy Sectors and Sustainable Development 4. Social Policy 5. Environmental policy and sustainability, environmental problems in the built environment 6. Energy and Sustainability		

7. Sustainable production and consumption
8. Sustainable lifestyle
9. Environmentally friendly technologies in construction
10. Environmental consciousness around our house, with special emphasis on renewable energies, for conscious energy use
11. Study tour: Gömörszőlős, a sustainable village
Practical work: self-made solutions of simple case-study problems.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Gyulai Iván (2012): A fenntartható fejlődés. Kiadja: az Ökológiai Intézet A Fenntartható Fejlődésért Alapítvány. Miskolc.
- Ökológiai Intézet A Fenntartható Fejlődésért Alapítvány (2011): Környezettudatosság a házunk táján. Miskolc.
- Ökológiai Intézet A Fenntartható Fejlődésért Alapítvány (2011): Környezetbarát technológiák az építkezésben és praktikus megoldások a ház körül. Miskolc
- Report of the World Commission on Environment and Development, Our Common Future (1987). United Nations.
- Jason Potts, Jessica van der Meer, Jaclyn Daitchman (2010): The State of Sustainability Initiatives Review 2010. Sustainability and transparency. London

Competencies to evolve (see Appendix 1):
T3, T5, K5, A1, A6, F1, F6

Demonstration of coherence of course content and unit's objectives:
This is a course which gives the background and attitude to the students to understand the main policy drivers of the sustainable development concept.
Demonstration of coherence between teaching methodologies and the learning outcomes:
Students should prepare presentations about case studies and different concept elements of the SD. The course will deepen the attitude and responsibility of the student towards the SDGs.

Responsible Instructor (*name, position, scientific degree):*
Enikő Darabos Dr, assistant professor, PhD; hgde@uni-miskolc.hu

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

List of competences

a) Knowledge

T1 - Knows and applies scientific and technical theory and practice related to the profession of environmental engineering.

T2 - Has a comprehensive knowledge of measurement technology and measurement theory related to the field of environmental engineering.

T3 - Knows and applies environmental and remediation procedures (operations, equipment, devices), environmental remediation methods.

T4 - Knows the operation of environmental protection facilities (especially water and wastewater treatment plants, hazardous and communal landfills, waste incinerators), their structures and the possibilities of their development.

T5 - Knows and applies the rules of environmental impact assessment and preparation of environmental technical documentation.

T6 - Knows the organizational and motivational tools and methods related to management, as well as the legislation necessary for practicing the profession.

T7 - Knows and applies the methodology and tools of environmental informatics and modeling in a complex way.

T8 - Knows the basics, boundaries, and requirements of the fields of work, as well as fire protection, safety technology, information technology, law, economics and management related to environmental engineering.

T9 - Knows the promotion and opinion-forming methods related to environmental engineering.

b) Skills

K1 - Can apply the acquired general and specific mathematical, natural and social science principles, rules, connections and procedures in solving problems arising in the field of environmental protection.

K2 - Able to conduct publications and negotiations in his/her field in his/her mother tongue and at least one foreign language.

K3 - Able to perform environmental management tasks.

K4 - Able to complete tasks arising in international or cross-border projects and to present his/her research results and developed design documentation before social and professional forums.

K5 -During work, examines the possibility of setting research, development and innovation goals and strives to achieve them.

K6 - Able to plan in a complex way, implement and maintain engineering interventions in the fields of soil, subsurface, water, air, noise and vibration protection, wildlife protection, remediation and waste reduction, treatment, and processing.

K7 - Able to plan and conduct environmental sampling works, comprehensive laboratory testing and analysis, to apply monitoring systems, evaluate and document test results.

K8 - Able to apply complex environmental remediation methods, to prepare for remediation and to coordinate remediation.

K9 - Able to plan, conduct and design environmental impact assessments and conduct impact assessments.

K10 - Able to apply integrated knowledge of environmental equipment, processes, technologies, and related electronics and informatics.

K11 - Able to model, operate and control environmental technology systems and processes.

K12 - Able to design, implement and operate environment-focused management systems.

K13 - Able to perform energy efficiency analyzes, surveys, audits, identify measures and support their implementation.

K14 - Able to plan and support the execution of complex (environmental-economic-social) works.

c) Competence in terms of attitude

A1 - Open and receptive to the knowledge and acceptance of professional, technological development and innovation in the field of environmental protection, and its authentic mediation.

A2 - Assumes the professional and moral values related to the field of environmental protection.

A3 - Seeks to plan and carry out tasks independently or in a working group at a professional level.

A4 - Strives to carry out the required work in a complex approach based on a systems-based and process-oriented way of thinking.

A5 - Strives to improve the knowledge of both him/herself and subordinated employees through continuous training.

A6 - Committed to high-quality work and strives to communicate this approach to subordinated employees.

A7 - Shares experiences with co-workers, thus helping their development.

d) Competence in terms of autonomy and responsibility

T1 - Can solve environmental engineering tasks independently, takes decisions carefully, in consultation with the representatives of other (mainly legal, economic, energy) fields, independently, takes responsibility for the decisions.

T2 - In making decisions, takes into account the basic requirements of occupational health and safety, technical, economic and legal regulations, and engineering ethics.

T3 - Takes the initiative in solving environmental problems, identifies the shortcomings of the applied technologies, the risks of the processes and initiates the measures to reduce them.

T4 - Shares the acquired knowledge and experience with formal, non-formal and informal information transfer with practitioners in their field.

T5 - Evaluates the work of subordinated employees, promotes their professional development by sharing critical remarks, educates employees and subordinates on responsible and moral professional practice.

T6 - Monitors legislative, technical, technological and administrative changes in the field of profession.