Course descriptions – Earth Science Engineering MSc

Contents

Core part

Numerical methods and optimization

<table>
<tr><td colspan="2">Course Title: Numerical methods and optimization</td><td>ECTS: 2</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: GEMAK712MA</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 1 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): P

Grading scale:
% value — Grade
90 -100% — 5 (excellent)
80 – 89% — 4 (good)
70 - 79% — 3 (satisfactory)
60 - 69% — 2 (pass)
0 - 59% — 1 (failed)</td></tr>
<tr><td colspan="2">Position in Curriculum (which semester): 1.</td><td>Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
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.

<u>Course content</u>:
1. Extrema of functions.
2. Unconstrained and constrained optimization.
3. Convex optimization.
4. Minimization of functions with one variable (golden section, parabola method).
5. Minimization of multivariable functions (Nelder-Mead, Newton, modified Newton, quasi-Newton, minimization with line search).
6. Methods of penalty functions.
7. Multiaided and multicriteria decision problems (Pareto efficient solutions).
8. Linear programming.
9. About Soft Computing (SC) methods: fuzzy systems
10. About Soft Computing (SC) methods: genetic algorithms
11. About Soft Computing (SC) methods: neural network
12. Numerical solutions of ordinary differential equations and system of equations: Runge-Kutta,
13. Numerical solutions of ordinary differential equations and system of equations: predictor-corrector
14. Numerical solutions of ordinary differential equations and system of equations: finite differences.

<u>Teaching methodologies</u>:</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
Égertné, M. É., Kálovics, F., Mészáros, G.: Numerical Analysis I.-II. (Lecture notes), Miskolci Egyetemi Kiadó (1992), 1-175.
R. Fletcher: Practical Methods of Optimization, John Wiley &Sons, 2000.
P. E. Gill, W. Murray, M. H. Wright: Practical Optimization, Academic Press, 1981.
J. Nocedal, S. J. Wright: Numerical Optimization, Springer, 2000.</td></tr>
</table>

Galántai Aurél-Jeney András: Numerikus Módszerek; Miskolci Egyetemi Kiadó, 1997.
Galántai Aurél: Optimalizálási módszerek; Miskolci Egyetemi Kiadó, 2004.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T11
Skills: K4, K5, K6, K7, K8, K9, K10, K11
Attitudes:
Autonomy and responsibility: F1, F3, F4, F5

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 Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Körei Attila matka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Engineering physics

<table>
<tr><td colspan="2">Course Title: Engineering physics</td><td>ECTS: 4</td></tr>
<tr><td colspan="2">Type of course (C/E):</td><td>Course code: MFGFT7100011</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature

Grading scale:
% value — Grade
85 -100% — 5 (excellent)
70 – 84% — 4 (good)
60 - 69% — 3 (satisfactory)
46 - 59% — 2 (pass)
0 - 45% — 1 (failed)</td></tr>
<tr><td colspan="2">Position in Curriculum (which semester): 1.</td><td>Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
Within the framework of the Earth Science Engineering MSc program, the students gain the deepening knowledge in those fields of the continuum physics, which are necessary to understand the geological processes and geophysical methods.

<u>Course content</u>:
The principles of continuum physics. The relationship between the micro- and macroscopic descriptions, averaging in time and space. The kinematical principles of deformable continuum, deformation tensor. Volume and surface forces, stress tensor. Basic equations of continuum mechanics, continuity theories. The equation of motion of elastic continuum, integral and differential forms. Law of conservation of mass, continuity equation. Extensive and intensive quantities, the 0th law of thermodynamics. General forms of law of conservation of mass. Material equations, Curie’s law. Perfectly elastic body, linearly elastic body. Equation of motion of Hooke body. Fluid models, ideal fluids, viscous fluids. Newton body, Navier-Stokes body. Rheological models, Kelvin-Voight model, Maxwell model, Poynting-Thomson’s law for material and motion equation of standard body. Wave propagation in linearly elastic medium. Solutions of wave equation. Wave propagation in different rocks, dispersion, absorption. Disperse waves.

<u>Teaching methodologies</u>:
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
1.Dobróka M., Somogyiné M. J. 2014: An introduction to continuum mechanics and elastic wave propagation Lecture notes. University of Miskolc.
2.K. Aki and P. Richards. Quantitative seismology. vol. 1: Theory and Methods. W H Freeman & Co (1980)
3.K. Aki and P. G. Richards. Quantitative seismology. vol. 2: Theory and Methods. W H Freeman & Co (1980)
4. Hudson J.A.1980. The excitation and propagation of seismic waves. Cambridge University Press
5. Schön J. 1998. Physical properties of Rocks. In. Seismic Exploration vol. 18.</td></tr>
<tr><td colspan="3">Competencies to evolve (relevant Learning outcomes, Appendix 1):</td></tr>
</table>

Knowledge: T1, T2
Skills:
Attitudes: A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is primarily a theoretical course, giving strong background for later geophysical courses in order to understand and interpret the physical processes that are used in geophysical prospecting and exploration works.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete different exercises in continuum mechanics.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Physical geology

Course Title: Physical geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT710001**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks, Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: The main objectives of the course are deepening the students' abilities for geological interpretation, making them familiar with the reconstruction of rock-forming processes, introducing them to facial analysis and the stratigraphic methods. **<u>Course content</u>**: Fieldtrip, analysis of sedimentary formations The formation and the inner structure of the Earth Plate tectonic background of the geological processes The role of physical geology in the geological exploration. Magmatic processes, their interpretation on field Sedimentary processes, their interpretation on field Fieldtrip, studying magmatic rocks Metamorphic processes, their interpretation on field Principles of stratigraphy, stratigraphic nomenclature Stratotype, lito-, bio- and chronostratigraphy Magneto-, chemo-, seismic, sequence, and cycle stratigraphy Reconstruction of continental sedimentary environments Reconstruction of marine sedimentary environments Defining the succession of rock-forming processes and tectonic events **<u>Teaching methodologies</u>**: During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks,	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Sam J. Boggs: Principles of Sedimentology and Stratigraphy, Prentice Hall Publishing, 2011 Angela L. Coe: Field techniques. Wiley-Blackwell 2010 Gary Nichols: Sedimentology and Stratigraphy. Wiley-Blackwell, 2009	
Competencies to evolve (relevant Learning outcomes, Appendix 1):	

Knowledge: T1, T2, T3, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13
Attitudes:
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives the fundamentals to later specific geological courses. It introduces the basic concepts and skills necessary for interpreation of different geological processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by classworks as well as field works

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Hartai Éva foldshe@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineralogy and geochemistry

Course Title: Mineralogy and geochemistry	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT710005**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam. 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): **1**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: Students will get the knowledge of the principals of the distribution of chemical element in the Earth. They will also know the most important thermodynamic processes concerning solid materials, the geochemical classification of elements, the geochemical aspects of the genesis of the most important minerals and mineral assemblages. The geochemistry of isotopes, which explores the chemical evolution of the Earth will also be introduced, as well as the geochemical characteristics of water, organic matter, magmatic, sedimentary and metamorphic rocks by which we can describe the mineral-and rock-forming processes in the crust and mantle. **<u>Course content</u>**: Introduction; Hydrogen and alkaline metals Alkaline earth metals Boron, aluminium, carbon and silicon Rare earth elements, titanium and zirconium Uranium, thorium, vanadium, niobium and tantalum Chromium, molybdenium and tungsten Midterm test (1st); Manganese, iron, cobalt and nickel Copper, gold, silver and platina group elements Zinc, cadmium, mercury, gallium, indium and thallium Tin, lead, arsenic, antimony and bismuth Nitrogen, phosphorus and oxygen Sulphur, selenium, tellurium, haloids and noble gases **<u>Teaching methodologies</u>**: The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam.	
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. White, W. M. (2013): Geochemistry. Wiley-Blackwell. Nordstrom D.K., Blowes D.W., Ptacek C.J. (2015): Hydrogeochemistry and microbiology of mine drainage: An update. Applied Geochemistry, Elsevier. Albared, F. (2005): Geochemistry. An introduction. Cambridge Univ. Press.	

Sarkar D., Datta R., Hanningan R.(2007): Concepts, and applications in environmental geochemistry, Elsevier.
John W. Anthony, Richard A. Bideaux, Kenneth W. Bladh, and Monte C. Nichols, Eds. (2003): Handbook of Mineralogy. Mineralogical Society of America.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T7
Skills: K1, K2
Attitudes: A1, A2, A9
Autonomy and responsibility: F2, F5

Demonstration of coherence of course content and unit's objectives:
This is a fundamental course, discussing systematic mineralogy and geochemical background of mineral formation processes

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by mineralogy laboratory work and geochemical modeling exercises

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Móricz Ferenc**

Geodesy, spatial informatics

Course Title: Geodesy, spatial informatics	**ECTS: 4**
Type of course (C/E):	Course code: **MFGGT710002**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Students will be assessed with using the following elements. Attendance15 %Short quizzes10 %Midterm exam40 %Final exam 35 % Grading scale: % value — Grade 85 -100% — 5 (excellent) 70 – 84% — 4 (good) 55 - 69% — 3 (satisfactory) 40 - 54% — 2 (pass) 0 - 39% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The students will acquire the principles of modern geomatics, its measuring methods and the application of IT in the subject. They will be prepared to apply the modern measuring techniques, the remote data-acquiring methods and use them to solve practical problems. They will learn the application fields of geo-informatics and GIS programs. The students will be competent in the application of modern geodetic technology and geo-informatics in their field. The students enable to process their professional data and organize them into geo-information databases. **Course content**: Coordinate Systems in geodesy. Geometric shape and gravitational field of Earth. Projections and mapping. Hungarian projections and mapping. Modern measuring techniques in Geodesy: Photogrammetry, Remote Sensing, GPS, Inertial Measurements, SAR technology for promoting surveying tasks in the related special fields. Geo-objects and geo-models. Raster and vector models. Data-storing techniques. Database-modelling in geo-informatics. Thematical data and their storage problems. GIS packages. Digitalization, analytical problems, knowledge based systems in GIS environment. Practical work: self-made solutions of simple case-study problems. **Teaching methodologies**: Students will be assessed with using the following elements. Attendance15 %Short quizzes10 %Midterm exam40 %Final exam 35 %	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Quest: GeodesyTutorial; Vanicek,P.:Geodesy; Burkard,R.K.: GeodesyfortheLayman; Gábor Bartha: Geoinformation Master Course. University of Miskolc, 2014. István Havasi -Gábor Bartha: Introduction to GIS, Introduction to Geoinformatics (pp. 10.5) (Gábor Bartha), Satellite Global Positioning Systems (pp. 67) (István Havasi). angol nyelvű digitális tankönyv: http://digitalisegyetem.uni-miskolc.hu, Miskolci Egyetem. TÁMOP 4.1.2.-08/1/A-2009-0033 projekt, 2011; Short,N.: The RemoteSensingTutorial	

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T7
Skills: K2
Attitudes: A2
Autonomy and responsibility: F6

Demonstration of coherence of course content and unit's objectives:
The course contributes to skills of students which should be applied for different geological and geophysical prospecting and exploration tasks in field as well as presenting and handling spatial data.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by exercises

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Bartha Gábor iitgabor@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Computer science for engineers

Course Title: Computer science for engineers	**ECTS: 2**
Type of course (C/E):	Course code: **GEMAK713MA**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** 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): **1**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
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.

Course content:
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.

Teaching methodologies:

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 (relevant Learning outcomes, Appendix 1):
Knowledge: T2, T7
Skills:
Attitudes:
Autonomy and responsibility:

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 Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Körei Attila matka@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical exploration methods I.

Course Title: Geophysical exploration methods I.	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT7100021**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	

Type of Assessment (exam. / pr. mark. / other): **E**
Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

Grading scale:

% value	Grade
86 -100%	5 (excellent)
70 – 85%	4 (good)
60 - 69%	3 (satisfactory)
46 - 59%	2 (pass)
0 - 45%	1 (failed)

Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
Understanding the surface geophysical methods and the geophysical methods used in boreholes for the purpose that students can design and execute geophysical research and evaluate data.

Course content:
Classification of applied geophysics methods. Gravity methods: measured quantities, basic corrections and data processing methods. Filtering gravity maps.
Evaluation of measurement data for causative bodies with simple geometries. Geological and environmental geological applications. Magnetic methods: measured quantities, basic corrections and data processing methods.
Reducing magnetic data to the pole. Evaluation of measurement data for magnetizable bodies with simple geometries. Geological and environmental geological applications. The specific resistivity of rocks, the concept of apparent resistivity. Direct current geoelectric methods. VES and multi-electrode measurement methods. Introduction of electromagnetic methods.
Induced Polarization (IP) in the time domain (TDIP) and the frequency domain (FDIP). Types of electric polarizations creating the IP signal and their geological background. Frequency domain electromagnetic methods (FDEM): MT and VLF methods, artificial source frequency sounding methods: measurement systems, zones around the transmitter, characteristics of the apparent resistivity and phase curves.
Time-domain electromagnetic methods (TDEM): transient, IP and ground radar methods. The transient EM measurement system and the zones around the transmitter. In the case of electrical and electromagnetic methods, the possibilities of controlling the depth of penetration.
The development of seismic reflected waves. The travel-time curve and its characteristic parameters. Dynamic and static corrections. The common mid-point (CMP) gather. Features of seismic (TWT) sections.
Interpretation of seismic (2D and 3D) sections. Isochronal maps. Seismic stratigraphy. Vertical and horizontal resolution. Acoustic impedance, reflection and transmission coefficients. Possibilities of detecting gas reservoirs by seismic method. The bright spot.
The development of seismic refracted waves. The travel-time curve and its characteristic parameters. Processing and evaluation of refraction data. Near-surface applications. The relationship between the petrophysical properties of rocks and parameters measured by well logging methods.
Introduction to petrophysics. Reservoir modeling. The basics of nuclear well logging methods. Determination of lithology and porosity. Presentation of main application areas.
The basics of acoustic well logging methods. Determination of sonic porosity and permeability. Presentation of main application areas.

The basics of electric well logging methods. The relation between resistivity and water saturation. Presentation of main application areas.
Possibilities for joint processing of open-hole well logging data. Crossplot techniques. Statistical and depth-by-depth inversion methods.
Principle of engineering geophysical sounding measurements. Determination of petrophysical and geotechnical properties of soils/rocks.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Telford W. M., Geldart L. P., Sheriff R. E., 1990. Applied geophysics. Second edition. Cambridge University Press.
Kearey P., Brooks M., Hill I., 2002. An Introduction to Geophysical Exploration. Third edition. Blackwell Science Ltd.
Serra O. & L., 2004. Well logging data acquisition and application, Editions Technip.
Szabó N. P., 2015. Geophysical exploration methods I. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html
Szabó N. P., 2016. Well-logging methods. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.htmlScientific papers selected from geophysical journals, e.g., First Break, Near Surface Geophysics, Geophysics, Journal of Applied Geophysics etc.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course intruduces the principal theoretical background and practical skills to plan and perform geophysical explorations for different geological environments and deposit types

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students are introduced to different geophysical prospecting and exploration methods in practice.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter gfnmail@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Data and information processing

Course Title: Data and information processing	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT7100031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	

Type of Assessment (exam. / pr. mark. / other): **P**
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature.

Grading scale:

% value	Grade
86 -100%	5 (excellent)
70 – 85%	4 (good)
60 - 69%	3 (satisfactory)
46 - 59%	2 (pass)
0 - 45%	1 (failed)

Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
Understanding the basics of inversion method-based geoinformation processing

Course content:
Introduction to the vector analysis. Multidimensional Euclidean spaces: N-dimensional dataspace, M-dimensional model parameter space. The parameters of inversion-based data and information processing. Classification of geophysical problems: direct problem, inverse problem. Explicit and implicit forms of direct problems. The linearization of the nonlinear direct problems, introduction of the Jacobi-matrix. The linear inverse problems. Solution of the overdetermined linear inverse problems: Gaussian Least Squares method (LSQ). Normal equation, stability, condition number. Definition of the generalized linear inverse problem. Solution of the underdetermined linear inverse problem by Lagrange multiplicators, generalized inverse problem. The principle of the simple solution. The principles of information theory. The theory of signals. The principles of data and information processing by means of inversion methods. Modeling, model types. Theoretical and measured characteristics. Error characteristic parameters in the data and the model space. The purport of local and global inversion methods. Spectral transformations (Fourier integral transformation, DFT, FFT, Z-transformation). Convolution, discrete convolution. Correlation functions, discrete correlation functions. Deterministic filtering. Image processing filters.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Dobróka M., 2001: The Methods of Geophysical Inversion. University textbook, University of Miskolc.
W. Menke, 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press Inc.
Mrinal Sen and Paul L. Stoffa: Seismic Exploration - Global Optimization: Methods In Geophysical Inversion. Software, Elsevier Science Ltd. 1997.
Szabó N.P., Dobróka M.: Float-encoded genetic algorithm used for the inversion processing of well-logging data Global Optimization: Theory, Developments and Applications: Mathematics Research Developments, Computational Mathematics and Analysis Series. New York: Nova Science Publishers Inc., 2013. pp. 79-104.

P.J.M. van Laarhoven, E.H.L. Aarts, 1987: Simulated Annealing: Theory and Applications. D. Reidel Publishing Company, ISBN 90-277-2513-6

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T6, T9
Skills: K2, K6, K7
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Theoretical background and application of data processing tasks are princial for completion of geophysical measurements and interpretation works. The course provides both theory and practice in this topic.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete data management and processing exercises.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Graduate research seminar

Course Title: Graduate research seminar	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT710006**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%), Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: To introduce the methods of information gathering and evaluation, formal and ethic requirements of scientific communication, rules for preparation of oral and poster presentations. During the course these general requirements are actualized to the field of earth science and engineering. Examples and excercises will use English publications and text materials. **Course content**: Editorial and formal requirements of scientific publications. Planning of the concept and structure of a scientific publication, making an outline, development of a concept map. Usage of references, reference styles. Etics of scientific writing: how to avoid plagiarism, usage of citations. Information sources provided by the Central Library: hard copy, catalogue search, electronic resources. Usage of electronic information resources: search options, simple and combined search, electronic libraries. Data visualization: graphs, figures, tables. The art of presentation: preparation for an oral contribution. The art of presentation: preparation of a poster. **Teaching methodologies**: During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%),	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: L. C. Perelman, J. Paradis, and E. Barrett: The Mayfield Handbook of Technical and Scientific Writing (McGraw-Hill, 2001). G. J. Alred, C. T. Brusaw, and W. E. Oliu: Handbook of Technical Writing, (St. Martin's, New York, 2003). Hagan P; Mort P: Report writing guideline for mining entógineers. Mining Education Australia, 2014. Chun-houh Chen, Wolfgang Härdle, Antony Unwin (eds.) Handbook of Data Visualization (Springer, 2008). MEA Report writing guide. https://www.engineering.unsw.edu.au/mining-engineering/sites/mine/files/publications/MEA_ReportWritingGuide_eBook_2018ed.pdf ISO 690-2: Information and documentation - Bibliographic references.	

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T5, T8, T12
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11
Attitudes: A2, A3, A4, A5, A6, A7, A8, A9
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students are introduced to the information sources available paper-based and electronically. They are also introduced to best practices on scientific writing, referencing and presentation techniques.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Completing a small research article and a presentation the students improve their knowledge in scientific communication. This is a learning by doing course, where one of the most important goals is to learn the proper way of scientific writing and referen

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Structural geology

Course Title: Structural geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT720020**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is ora Grading scale: % value — Grade 86 -100% — 5 (excellent) 70 – 85% — 4 (good) 60 - 69% — 3 (satisfactory) 46 - 59% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The course provides a background in the fundamentals of structural geology. It introduces the methods of interpreting structural observations and determining the 3-D distribution of the lithological units, the physical properties controlling the development of fractures, folds and other structural features. The course also introduces the students to building up, constructing and analysing spatial models. **Course content**: Theoretical backgrounds: basic terms of structural geology and tectonics. Techniques of data acquisition, recording and visualization. Stress and strain, deformation mechanisms, rheological models. Brittle and ductile features, their style and origin. Syngenetic structures and their role in further structural evolution. Plate tectonics and large scale structures. Characteristics of tectonic regimes. Practical exercises: use of tools to measure, demonstrate and analyze the structural data. Basics for constructing maps and cross sections. Lecture: Basic terms; information on the interior of the Earth. Practice: Use of geological maps; rules and geometrical basis of construction of cross sections. Lecture: Structural features of the rocks, deformation, description of movements. Practice: construction of cross sections. Lecture: Stresses, mechanics. Practice: construction of cross sections. Lecture: Rheology and failure envelopes. Practice: construction of cross sections. Lecture: Mechanisms and features of brittle deformation. Practice: construction of cross sections with drill logs Lecture: Mechanisms and features of ductile deformation Practice: construction of cross sections with drill logs. Field exercise: structural orientation measurements on folded and faulted rocks. (The exercise is organised by exchange with the contact hours of another course, in 6 hours) Practice: working with orientation data, stereograms. Practice: working with orientation data, stereograms. Practice: construction exercises. Practice: construction exercises. **Teaching methodologies**:	

Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is ora

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Twiss, R. J. & Moores, E. M: Structural Geology. Freeman & Co., New York, 1992, 532 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 1: Strain Analysis. Academic Press, London, 1983, 1-308 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 2: Folds and Fractures. Academic Press, London, 1987, 309-700 p.
Ramsay, J. G. & Lisle, R. J: The techniques of modern structural geology. Vol. 3: Applications of continuum mechanics in structural geology. Academic Press, London, 2000, 701-1062 p.
Twiss, R. J. & Moores, E. M: Tectonics. Freeman & Co., New York, 1995, 415 p.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
In the limited timeframes of the semester, the thematics includes all topics which belong to the structural geology on introductory level. It also provides a possibility to go deeper in some topics for those who have the appropriate basic knowledge alread

Demonstration of coherence between teaching methodologies and the learning outcomes:
The program is arranged with giving the theoretical and practical basics first and then going to the application of these basics by making field observations, measurements and then working with these data. The students have to be able to interpret the obs

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Németh Norbert foldnn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineral deposits

Course Title: Mineral deposits	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720021**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%). Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: The key target of the course is to introduce the geology of raw material deposits, their spatial distribution, their quantity and quality for the different commodities. **<u>Course content</u>**: During the introduction the students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history. In the next period, the students will learn the ore forming geological processes and their appearances, which creates the different deposits. Also they will learn the genetic classification of the deposits with national and international examples. It prepares the students to be able to recognize the geological features of mineralizations, alterations and tectonic preformation. It covers all the important mines and ore districts in Europe and worldwide. During the laboratory classes the students can learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and texture of the different raw material types, and how to identify and distinguish them. To the proper use of geological maps and sections in 3D, the students will do exercises to develop their capabilities. During the related field trips the students will examine real deposits in the field. **<u>Teaching methodologies</u>**: Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%).	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Robb, L., (2005): Introduction to Ore-Forming Processes: Blackwell Publishing Co., 373 p. (ISBN 0-632-06378-5). EVANS, A. M. 1993: Ore Geology and Industrial Minerals – An Introduction. Blackwell Publishing, ISBN 978-0632-02953-2 CRAIG, J. R. & Vaughan, D. J. 1994: Ore Microscopy & Ore Petrography. John Wiley and Sons Inc. ISBN 10158-0012 Dill H.G. (2010): The „chessboard" classification scheme of mineral deposits. Elsevier, 2010. Cox, D.P. Singer D.E. (1992): Mineral Deposit Models, U.S.G.S. Bulletin 1993.	
Competencies to evolve (relevant Learning outcomes, Appendix 1):	

Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history, as well as the ore forming geological processes and their appearances, genetic clas

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory classes where students analyze specimens from different deposit types. learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and te

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Leskó Máté**

Engineering geology and hydrogeology

Course Title: Engineering geology and hydrogeology	**ECTS: 4**
Type of course (C/E):	Course code: **MFKHT720020**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam Grading scale: % value — Grade 85 -100% — 5 (excellent) 75 – 84% — 4 (good) 63 - 74% — 3 (satisfactory) 50 - 62% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: It introduces students to the key concepts of engineering geology, modern hydrogeology, and field hydrogeology, soil formation, soil classification methods, laboratory and field soil tests, water-to-rock underwater stress, and groundwater flow patterns. **Course content**: Introduction to the examination of soil characteristics Determination of shear strength parameters of soils Soil consolidation Shallow and deep foundation, the basics of EC7 design The most important basics, problems and relationships of hydrogeology Hydrogeological pools, flow systems, sustainability, artificial replenishment Hydrogeochemistry, transport processes Water management issues, particularly in cross-border areas Hydrogeology of the Carpathian Basin Isotope hydrogeology, use of stable isotopes to understand groundwater Groundwater recharge and their interpretation Well hydraulics calculations Isotope hydrogeology, use of radioactive isotopes to understand groundwater **Teaching methodologies**: Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002. F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992 Dr. Juhász József: Hidrogeológia. Akadémiai kiadó, Budapest, 2002. Dr. Juhász József: Mérnökgeológia I-III. Miskolci Egyetemi Kiadó, 1999; 2002; 2003 Dr. Kleb Béla: Mérnökgeológia Budapest, 1980 David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education,	

2002. F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992 S. E. Ingebritsen, W. E. Sanford: Groundwater in Geologic Processes. Cabridge University Press, 1998. Kruseman G.P. and Ridder N.A: Analysis and Evaluation of Pumping Test Data, ILRI publication, Wageningen, Netherlamds, 1990, pp. 1-377. Neven Kresic: Quantitative Solutions in Hydrogeology and Groundwater Modeling. Lewis Publishers, 1997. Barnes, C. W. (1988): Earth, Time and Life. John Wiley and Sons, New York Brookfield, M. (2006): Principles of Stratigraphy. Blackwell Publishing, New York

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course provides the theory and practical skills to understand the hydrogeological and engineering geological background for interpretation of different geological and geotechnical processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory classes where students perform calculations and modeling exercises of hydrogeological systems and geotechnical characterization of soils.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szűcs Péter hgszucs@ui-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Analytical technics in mineralogy and petrology

Course Title: Analytical technics in mineralogy and petrology	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT720025**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The key target of the course is to introduce the different analytical methods used in mineralogy and geology for the students. There are laboratory classes with individual work about the learned methods nearby the theoretical classes. Thru these exercises the students learn what is the best available method to answer certain geological questions. **Course content**: Description of the work, formulating analytical pairs, work and lab safety teaching Physical properties (hardness, magnetic, solubility, density), density measurements X-ray diffraction lecture I. X-ray diffraction lecture II. X-ray diffraction practice DTA lecture DTA quantitative calculations Scanning electron microscopy lecture I. Scanning electron microscopy lecture II. Scanning electron microscopy practice Formula calculations **Teaching methodologies**: There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Reed SJB (2005): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press. O'Donoghue M (2006): Gems: Their sources, descriptions and identification. Elsevier. Pracejus B (2008): The ore minerals under the microscope: an optical guide. Elsevier. Goldstein J et al. (2003): Scanning Electron Microscopy and X-ray Microanalysis. Kluwer Academic/Plenum Publishers.	

King M. et al. (1993): Mineral Powder Diffraction File Search- and Databook. ICDD, USA.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Lectures cover the theoretical fundamentals for different methods of analysis of minerals, which is essential basics for geological exploration tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the introduction of different analytical methods, this is a learning by doing course where students go through the preparation, analysis and interpretation steps for various analytical techniques (XRPD, EPMA, SEM)

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological interpretation and prospecting

Course Title: Geological interpretation and prospecting	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT730026**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Participation in presentation lectures and practical classes is mandatory. Field trips and classroom exercises. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam. Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The main objective of this course is (1) to integrate all the information from the different applied survey methods to allw assessing the economic potential of mineral raw material occurrences, (2) to build capacity to use practical methods in mineral exploration, (3) to develop team working skills, (4) training of different exploration tasks in real field situations **Course content**: Introduction, objectives, team exercise information Exploration methods, quality control and quality assurance Project planning and scheduling Resource estimation terminology and basic methods Team exercise – Rudabánya and Martonyi geology Geological models in interpretation Overview of available statistical tools Spatial distribution statistics – basic practices JORC and NI43-101 reporting standards, exploration requirements Introduction to Rockworks modelling Team field exercise – Rudabanya sample Preparation, handling and storage Team exercise –data harmoniztation with geophysics and geochemnistry Presentation and discussion of team exercise project Rudabánya and Martonyi **Teaching methodologies**: Participation in presentation lectures and practical classes is mandatory. Field trips and classroom exercises. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Marjoriebanks R. 2010: Geological Methods in Minerals Exploration and Mining ISBN 978-3-540-74370-5 e-ISBN 978-3-540-74375-0 Sinclair A.J. and Blacwell G.H. 2002: Applied Mineral Inventory Estimation ISBN 0-511-03145-9 eBook Alastair J. Sinclair and Garston H. Blackwell 2004 2002	

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course goes through the key points of performance and quality assurrance of geological prospection and exploration tasks. This is a synthetizing course for the whole master programme.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete small projects about mineral resource assessment and a complex project where geological, geophysical and geochemical prospecting data should be interpreted.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Földessy János foldfj@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical interpretation and prospecting

Course Title: Geophysical interpretation and prospecting	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730025**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** During the semester the following tasks should be completed: presentation on a report covering the process from exploration planning to interpretation (60%), exam (40%) Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: In the scope of this subject students acquire knowledge about the closing phase of geological-geophysical exploration and study the linkage and hierarchy of different geophysical methods. They learn how to determine the most probable geological model by using geophysical measurement results and other geoscientific information jointly. They study the points of view of exploration and measurement planning related to the interpretation of data acquited **<u>Course content</u>**: Water exploration by geophysical methods: Some types of water aquifers. Simultaneous application of geoelectrical and IP methods. The use of frequency and time domain EM methods in water exploration. The role of GPR and surface nuclear magnetic resonance methods. The most important well logging methods and their interpretation. Case histories including water base protection. Coal, bauxite, uranium exploration: Coal formation, low-rank and high-rank coals. The physical parameters of different coal types. The use of surface geophysical methods, the adventages of underground exploration. In-seam seismic surveys, in mine geoelectrical methods. Well logging methods for coal qualification. Complex coal exploration case histories. Bauxite formation (carbonate, lateritic bauxite). The role of seismic refraction and VLF method in bauxite exploration. Well logging for quantitative interpretation and neutron activation analysis. The most important types of uranium deposits. The determination of K, U, Th content with (airborne, surface, borehole) NGS method. Rn measurement applied in U exploration. Geophysical methods in geothermal exploration: The types of heat propagation (conduction, convection), Fourier equations, Fourier-Kirchhoff equation, heat transport in porous, isotropic formation. Radioactive heat production. Heat flow maps and their interpretation.The depth dependence of heat flow and temperature for a continental and an oceanic crust. Mantle plumes and hot spots. The role of gravity, magnetic, EM methods in geothermal exploration and the application of passive and active seismic methods. Complex case histories in geothermal energy exploration. HC exploration: HC formation, the basic geological elements of a petroleum system. Different stages of HC exploration (lead, prospect, play). The role of gravity exploration (from the torsion balance invented by R. Eötvös till ROVdog seafloor gravity) measurements in the course of HC exploration including reservoir monitoring. The application of frequency domain EM methods (MT, CSAMT,CSEM, MCSEM). Simultaneous interpretation of marine controlled source electromagnetics and marine seismic reflection. Seismic reflection method for 1D, 2D and 2D situation. Corrections, migration process, VSP, time to depth transformation. The most important seismic attributes. Geological information can be gained based on seismic sequence analysis. Information can be gained from seismic data cube (time slice, horizon slice, etc.).	

Interpretation of up-to-date open hole, cased hole logging data systems, the role of production logging. Complex HC exploration case history presented by a MOL expert

Teaching methodologies:
During the semester the following tasks should be completed: presentation on a report covering the process from exploration planning to interpretation (60%), exam (40%)

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Kearey P., Brooks M., Hill I.: An Introduction to Geophysical Exploration, Blackwell Publishing, 2002
Bacon M., Simm R., Redshaw T.: 3-D Seismic Interpretation, 2003
Serra O.: Well Logging and Reservoir Evaluation, 2007
Periodicals: Geophysical Transactions, The Leading Edge, First Break, etc.
Work-help tutorials, geophysical softwares

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course goes through the key points of performance and quality assurrance of geophysica prospection and exploration tasks. This is a synthetizing course for the whole master programme.

Demonstration of coherence between teaching methodologies and the learning outcomes:
During the semester the students complete a project-based tasks based on geophysical exploration data and prepare presentations on relevant topics.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Takács Ernő**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Quality management

Course Title: Quality management	**ECTS: 2**
Type of course (C/E):	Course code: **GTVVE7002MA**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 0 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** Submitting tasks in the Moodle-system for the signature. Writing a mid-term test or a final test. Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Having finished the course students will be able to define the parameters of quality and customers satisfaction in connection with the own business. They can overlook the establishment process of the ISO 9001 standard. Business excellence evaluation show a new way of business development. Case studies and other practices draw up the main mistakes and prepare the students for being able to manage a successful quality management solution. **Course content**: Product-quality and Quality management Quality Control (QC), Quality Assurance (QA), Quality management (QM) Historical development of the toolset in the 20th century Models of Quality Management 7 old tools of quality The Japanese and the US way (video case-study) ISO 9000 standard-family ISO 9001 management concept ISO 9001 requirements ISO 9004 overview Quality audit. Performing a quality audit. Possibilities of a second-party audit In search of Excellence: video case-study Business Excellence **Teaching methodologies**: Submitting tasks in the Moodle-system for the signature. Writing a mid-term test or a final test.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Berényi L. (2013). Fundamentals of Quality Management. Saarbrücken: LAP Vivek (2005). Quality management system handbook for product development companies, Boca Raton: CRC Press. Griffith G. (2003). Quality Technician's Handbook. London: Pearson Kanji, G.K., Asher, M. (1996). 100 Methods for Total Quality Management. London: SAGE Oakland, J.S. (1992). Total quality management, Oxford: Butterworth-Heinemann. Foster, S.T. (2011). Managing Quality Integrating the Supply Chain. London: Pearson	

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills: K5,, K9, K13
Attitudes:
Autonomy and responsibility:

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 Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Berényi László szvblaci@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Legal and economic studies for mining and geology

<table>
<tr><td colspan="2">Course Title: Legal and economic studies for mining and geology</td><td>ECTS: 2</td></tr>
<tr><td colspan="2">Type of course (C/E):</td><td>Course code: MFFTT730027</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 0 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Attendance of lectures and completion of homeworks about legal cases, best practices applications related to permitting procedures or resource projects

Grading scale:
% value — Grade
80 -100% — 5 (excellent)
70 – 79% — 4 (good)
60 - 69% — 3 (satisfactory)
50 - 59% — 2 (pass)
0 - 49% — 1 (failed)</td></tr>
<tr><td colspan="2">Position in Curriculum (which semester): 3.</td><td>Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
The main objective is to provide an in-depth and practical knowledge of the supranational and national legislation and regulatory framework with regard to mining and geology

<u>Course content</u>:
Essential legal terms and definitions
Specific Community legislation of the European Union (the „acquis”)
International conventions and standards
The Hungarian national mining and geology legislation
Other Hungarian acts on the environment, energy, water, etc.
Other national quasi-legislation (orders of MBFH) and the licensing framework
The concept of sustainable development, its role for the mineral ectractive industry, marginal cost defining factors, concept of mineral rent,
The Hotelling rule and its resolution under certain conditions,
Financial analysis of mining projects, cost types, deposit parameters (flow, fund, bonity, quality),
Discounted cash flow methods in the mineral industry, mineral taxation.

<u>Teaching methodologies</u>:
Attendance of lectures and completion of homeworks about legal cases, best practices applications related to permitting procedures or resource projects</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
Wagner H. et al. 2006: Minerals planning policies and supply practices in Europe – European Commission Directorate, General Enterprise, University of Leoben
Hámor T. 2004: Sustainable mining in the European Union: The legislative aspect – Environmental Management, Vol. 33., pp. 252-261.
Pearce, D.W. & Turner R.K. Economics of natural resources and the environment (Harvester Wheatsheaf, London, 1990)
Whateley, M.K.G. & Harvey, P.K. (eds.) Mineral resource evaluation II: Methods and case stories (Geological Society Spec. Publ. No. 79., London, 1994)
J. Otto & J. Cordes. The Regulation of Mineral Enterprises: A Global Perspective on Economics, Law and Policy; (RMMLF, 2002.)</td></tr>
</table>

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T6, T7
Skills: K10, K11, K12, K15
Attitudes: A4, A5, A8
Autonomy and responsibility: F2, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course introduces the most important legal and economic concepts which are relevant to the raw materials sector, focusing on the interrelationship between the legal and economic drivers, which effect on the economic, social and legal feasibility of a

Demonstration of coherence between teaching methodologies and the learning outcomes:
This is a series of lectures, however the students receive homeworks to analyse legal cases, best practices. The aim of these homeworks to improve the critical thinking skills of the students

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Strategic Management

Course Title: Strategic Management	**ECTS: 2**
Type of course (C/E):	Course code: **GTVVE7041MA**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 0 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Class participation, Written exam 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): **4**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
To get students acquanted with the basic terms and concepts of corporate strategy, strategic analysis and planning. To introduce the participants to strategic management, its concepts and process. To discuss the methods of strategy formulation and implementation.

Course content:
Development of strategic management world wide.
Development of strategic management in Hungary.
Strategy safary
Strategic analysis
Strategy formulation as a rational planning process
Strategy formulation as an organizational process
Typology of strategies
Strategic alliances
Mergers and acquisitions
Strategic innovation and entrepreneurship
Implementation of strategies
Management of strategic changes

Teaching methodologies:
Class participation, Written exam

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Grant, R.: Contemporaty strategy analysis . 8th edition. Wiley, 2000.
Balaton K.: Organizational strategies and structures following the system turnout. Budapest, Akadémiai Kiadó.
McGrath, R.G.: Transient advantage. Harvard Business Review, June 2013. pp. 64-70.
Mintzberg, H.: Strategy Safary. The Free Press, New York, 1998.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T6, T7, T8
Skills: K11, K14
Attitudes: A2, A4, A5, A8

Autonomy and responsibility: F2, F4, F5, F6

Demonstration of coherence of course content and unit's objectives:
The objectives of the curriculum can be divided into two groups: providing information on the content and the process of strategic management. These two arias are covered during the lectures of the course. The required and recommended reading provide further information for the students on the topics of the curriculum.

Demonstration of coherence between teaching methodologies and the learning outcomes:
The lectures provide information on the content and process of strategic management. The seminars provide possibilities to discuss the practical implementation of strategic management. During the seminars the students solve practical tasks on how to develop and implement strategies in enterprises. After finishing thes course the students will be capable to participate in developing strategies for enterprises and institutions.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Balaton Károly balaton@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Safety techniques and labor safety

Course Title: Safety techniques and labor safety	**ECTS: 2**
Type of course (C/E):	Course code: **MFKOT740010**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 0 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Participation on the project courses and preparation of an advancement documentation based on the topic discussed. Project work in a chosen topic. Oral Exam 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): **4**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The aim of the subject for students is to learn the basics of work safety and health. Get knowledge about the skills of an EHS specialist in practice. Basic Concepts. Basis of law. Occupational health. Mental health. Safety of machinery and equipment. Chemical safety. Biological hazards. Personal protective equipment. Realization of work safety in practice. OHS Tasks at a Workplace (EHS Work Safety, Change Management). OHSAS. **Course content**: General Induction Basics of Law Building Safety/Construction safety Workplace safety-general requirements Emergency and Fire Safety Accidents and First Aid Ergonomics Biosafety Chemical safety Noise Vibration and Radiation Safety Electrical Safety, Safety of Machines Office/screen workplace, Stress OHS Management System, Risk Management and Safe Work Instructions Audits, Inspections and Monitoring **Teaching methodologies**: Participation on the project courses and preparation of an advancement documentation based on the topic discussed. Project work in a chosen topic. Oral Exam	
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 (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

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 fo

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zákányiné Mészáros Renáta zmr@afki.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geopphysical engineering specialisation

Geophysical measurements

Course Title: Geophysical measurements	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT720012**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 65 - 79% — 3 (satisfactory) 60 - 64% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Within the frame of this subject the students specialized in geophysical engineering study the application of geophysical methods in the different exploration phases, as well as the principles and aspects of planning geophysical surveys. An additional aim of the subject is to familiarize the students with the working principles and use of geophysical measurement devices. **Course content**: Lectures: General principles and main tasks of the raw-material exploration. Exploration phases. The principles of geophysical surveys. The role of geophysical methods in the exploration phases. Gravity data acquisition. Measuring devices and measured quantities of the gravity method. Gravity data processing and corrections. Magnetic data acquisition. Measuring devices and measured quantities of the magnetic method. Magnetic gradiometry. Magnetic data processing and corrections. The components and properties of geoelectrical data acquisition systems. Electrode configurations and setting up of electrode spreads. Main aspects of planning geoelectrical surveys. The components and properties of electromagnetic data acquisition systems. Survey configurations of different electromagnetic methods. Main aspects of planning electromagnetic surveys. Quality control of recorded data. The types and properties of seismic sources. The components and properties of seismic data acquisition systems. Main aspects of planning seismic surveys. Quality control of recorded seismic data. The field techniques of improving the signal-to-noise ratio. Basic steps of seismic data processing. Components and properties of data acquisition systems used for vertical seismic profiling (VSP). Basic steps of VSP data processing. Main properties and components of the techniques of borehole geophysical logging (wireline logging and measured while logging). Quality control a well logs. The constructions and properties of resistivity and induction logging tools. The constructions and properties of nuclear logging tools. The constructions and properties of sonic logging tools. Seminar Spreading systems of geophysical surveys. The steps and products of the workflow of geophysical surveys. The introduction of Scintrex CG-5 Autograv gravimeter. The introduction of GEM GSM-19 Ovehauser magnetometer. The introduction of geoelectrical data acquisition systems. The introduction of VLF measuring devices and ground penetrating radar. The introduction of a gamma spectrometer. The main functions and properties of the components of a wireline logging system. The main aspects of planning a well logging program. **Teaching methodologies**:	

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
P. Kearey, M. Brooks, I. Hill, 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
D. V. Ellis, J. M. Singer, 2007: Well logging for earth scientists. Springer, Dordrecht, The Netherlands, ISBN 978-1-4020-3738-2 (HB).
W. M. Telford, L. P. Geldart, R. E. Sheriff., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
O. Serra, L. Serra, 2004: Data Acquisition and Applications, Editions Serralog, France, ISBN: 978295156125
Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz/segedlet.html
Operating manuals: https://scintrexltd.com/wp-content/uploads/2017/02/CG-5-Manual-Ver_8.pdf; https://userpage.fu-berlin.de/geodyn/instruments/Manual_GEM_GSM-19.pdf

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K9, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The syllabus elaborated for and applied to the education of the course strives to cover all the important parts of the specialities connected to the objectives. This well-considered construction of topics enables the lecturer to emphasize the essential re

Demonstration of coherence between teaching methodologies and the learning outcomes:
The applied teaching methodologies are aimed at communicating up-to-date knowledge, developing the students' capability to apply the introduced ideas and information, improving their ability to test these ideas and evidence, to generate own ideas and evid

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Vass Péter, private professor gfvassp@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Gombár László, Dr. Turai Endre, Dr. Szabó Norbert Péter**

Engineering and environmental geophysics

Course Title: Engineering and environmental geophysics	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT720013**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Attendance at lectures is regulated by the university code of education and examination. Two writing tests (the weight of each grade item is 50 %). One assignment during the semester is the requirement of signature Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Analysis of geotechnical, engineering geological, hydrogeological and environmental applications of near-surface geophysical methods, as well as a description of specific methods and their development trends. **Course content**: Classification of near-surface applied geophysical methods. Basic principles of microgravity surveying methods, correction of measurements. Calculation of derivatives. Engineering and environmental applications. Basic principles of magnetic methods, correction of measurements. Magnetic gradiometry. Pole reduction and analytic continuation techniques. Engineering and environmental applications. DC geoelectric measurement methods. Inversion and interpretation of pseudo-resistivity profiles, maps. Engineering, environmental, archaeological and geophysical applications. Frequency-domain EM surveying methods. The induction method. Shallow applications of frequency sounding. Time-domain (transient) EM surveying methods and their shallow applications. Detection of highly conductive structures. The physical background of surface nuclear magnetic resonance sounding. Determination of the depth distribution of the water content. Near-surface application of the seismic method. Refraction method, its theory and possibilities of use. Surface-wave seismic method, dispersion analysis. Engineering and environmental applications of the seismic method. Theory of engineering geophysical sounding methods. Investigation of the relationship between the petrophysical (water, air saturation, clay content, matrix fraction) and geotechnical (dry density) characteristics and measured physical parameters. Opportunities for inversion evaluation. **Teaching methodologies**: Attendance at lectures is regulated by the university code of education and examination. Two writing tests (the weight of each grade item is 50 %). One assignment during the semester is the requirement of signature	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9 Skills: K1, K2, K3, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7	

Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** The course gives the theoretical background and skills to complete applied geophysical tasks for groundwater research, to solve environmental and geotechnical issues. **Demonstration of coherence between teaching methodologies and the learning outcomes:** Theoretical part is complemented by field practice applying near-surface geophysical methods.
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter, full professor gfnmail@gold.uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Gombár László**

Engineering Physics II.

Course Title: Engineering Physics II.	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT720011**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Attendance at lectures is regulated by the university code of education and examination and two individual assignments during the semester are the requirements of signature Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Students gain the deepening knowledge in those fields of the electrodynamics, which are the necessary to understand deeper the geological processes and geophysical methods. **Course content**: The electrodynamics as continuum theory, continuum mechanical similarities, definition of the charge density and density of dipole moment. Introduction of the electromagnetic parameters based on continuum physics. Maxwell's equations in integral and differential forms. Repeating of the deductions, exercise of the derivative operators. Special electromagnetic phenomena and their conditions, electrostatics and magnetostatics, special phenomena and their conditions, field of stationary and quasi-stationary current – exercise of the deductions. Solutions of potential equations, retarded potential. The homogeneous wave equation and its major solutions. Introduction of the electromagnetic potentials, potential equations. Scale transformation. Lorentz condition. Solutions of potential equations, retarded potential. The homogeneous wave equation and its major solutions Exercise of the deductions. Electromagnetic potentials in conductors, telegraph equations. Electromagnetic wave propagation in homogeneous, isotropic, infinite insulators. Exercise of deductions. Electromagnetic wave propagation in homogeneous, isotropic, infinite conductors. Skin-effect. Electromagnetic waves propagation on the boundary of an infinite conductor half-space. Properties of electromagnetic wave fields in infinite insulator in case of electrical dipole. Properties of electromagnetic wave fields in infinite insulator in case of magnetic dipole. Wave propagation in weakly inhomogeneous space, eikonal equation, WKB method. **Teaching methodologies**: Attendance at lectures is regulated by the university code of education and examination and two individual assignments during the semester are the requirements of signature	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: L. D. Landau, E. H. Lifshitz (1976) Course of Theoretical Physics Volume 2. The Classical Theory of Fields. Pergamon Press Dobróka M. (2017): Engineering physics 2 (.pdf) university text book M. Zhdanov (2009) Geophysical Electromagnetic Theory and Methods, Volume 43. Elsevier Science M. Dobróka (1984) Love seam-waves in an inhomogeneous 3-layered medium. Geophysical Transactions Vol. 30. No. 3. 237-251.	

M. Dobróka (1975) Small amplitude hydromagnetic waves in wave-guides, treated by generalized polytropic equations of state. Plasma Physics, Vol. 17. 1171-1172

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2
Skills:
Attitudes: A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is primarily a theoretical course, giving strong background for later geophysical courses in order to understand and interpret the physical processes that are used in geoelectric prospecting and exploration works.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete different exercises in field of electrodynamics.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály, professor emeritus dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical inversion

Course Title: Geophysical inversion	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT720014**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: In the frame of the course, students learn how can be the geological and geophysical information from the measured data obtained by recent inversion methods. **Course content**: Solution of the mixed determined inverse problem: solution of the weighted Least Squares method, Marquardt-algorithm. Relationship between the optimization of the damping factor and the condition number. Solution based on the weighted least squares method in data space. Solution based on the weighted Least Squares method in the parameter space. Solution of the inverse task by the minimizing of Lp-norm, the method of iterative re-weighting. The qualification of accuracy and reliability of parameter-estimation: covariance and correlation matrices in the parameter space: dissolving matrix, in data and parameter space, generalized inverse, sub-division by singular values. Solutions of the nonlinear inverse task by global optimization methods. The Simulated Annealing and its variations. The Genetic Algorithm methods. The joint inversion method. Applying the inversions methods in case of different geophysical datasets. The series expansion inversion method. Applying the inversions methods in case of different geophysical datasets. **Teaching methodologies**: Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Dobróka M., 2001: The Methods of Geophysical Inversion. University textbook, University of Miskolc. W. Menke, 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press Inc. Mrinal Sen and Paul L. Stoffa: Seismic Exploration - Global Optimization: Methods In Geophysical Inversion. Software, Elsevier Science Ltd. 1997. Szabó N.P., Dobróka M.: Float-encoded genetic algorithm used for the inversion processing of well-logging data Global Optimization: Theory, Developments and Applications: Mathematics Research Developments, Computational Mathematics and Analysis Series. New York: Nova Science Publishers Inc., 2013. pp. 79-104. P.J.M. van Laarhoven, E.H.L. Aarts, 1987: Simulated Annealing: Theory and Applications. D. Reidel Publishing Company, ISBN 90-277-2513-6	

Dobróka, M., Völgyesi, L. 2008. Inversion Reconstruction of Gravity Potential based on Gravity Gradients. Mathematical Geoscience, Vol. 40, pp. 299-311

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T6, T7
Skills: K2
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is primarily a theoretical course, giving the fundamentals to understand and aply inversion method for geophysical prospecting and exploration works.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete exercises using computer programs.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály, professor emeritus dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical Exploration Methods II

Course Title: Geophysical Exploration Methods II	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT720015**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
The main objective of the subject is to familiarize the students specialized in geophysical engineering with the details of different geophysical methods used in the fields of raw-material exploration and environmental investigations.

Course content:
Physical basics of seismic methods. Reflexion seismic method. Refraction seismic method. Vertical seismic profile (VSP). Geophysical inversion of magnetic data. Magnetic forward problem of arbitrary shaped source. The problem of ambiguity. 3D underdetermined problems of magnetic data. Geological applications. Physical basics of geoelectrical methods. Self-potential method. Charged-body method. Direct current resistivity methods. Induced polarization method. Physical basics of electromagnetic (EM) methods. Magnetotelluric method. Frequency-domain (FD) electromagnetic methods. Transient electromagnetic method (TEM). Very-low-frequency electromagnetic method (VLF-EM). Main features and essentials of borehole geophysics. Classification of well logging methods. Formation density logging. Photoelectric factor logging. Neutron logging methods. Well log interpretation techniques. Quick-Look Interpretation. Crossplots and overlays. Formation evaluation in shaly sands.

Teaching methodologies:

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
W. M. Telford, L. P. Geldart, R. E. Sheriff., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
UBC Geophysical Inversion Facility – Inversion manuals (GRAV3D and MAG3D). http://gif.eos.ubc.ca/documentation
P. Kearey, M. Brooks, I. Hill, 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
D. V. Ellis, J. M. Singer, 2007: Well logging for earth scientists. Springer, Dordrecht, The Netherlands, ISBN 978-1-4020-3738-2 (HB).
O. Serra, L. Serra, 2004: Data Acquisition and Applications, Editions Serralog, France, ISBN: 978295156125
Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz/segedlet.html

Competencies to evolve (relevant Learning outcomes, Appendix 1):

Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Skills: K1, K2, K3, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The syllabus elaborated for and applied to the education of the course strives to cover all the important parts of the specialities connected to the objectives. This well-considered construction of topics enables the lecturer to emphasize the essential re

Demonstration of coherence between teaching methodologies and the learning outcomes:
The applied teaching methodologies are aimed at communicating up-to-date knowledge, developing the students' capability to apply the introduced ideas and information, improving their ability to test these ideas and evidence, to generate own ideas and evid

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Vass Péter, gfvassp@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Gombár László, Dr. Turai Endre, Dr. Szabó Norbert Péter**

Geophysical data processing

Course Title: Geophysical data processing	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730026**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the seminars and solution of one personal task with presentation Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: Introduce to the spectral geophysical data processing methods for MSc academic specialization in geophysical engineering. **<u>Course content</u>**: Basis of the spectral geophysical information theory. Hierarchical connection between data, news and information. Classification of geophysical signal. Theory of deterministic and stochastic geophysical processes. Analysis and synthesis of the geophysical systems. Discreet signal theory. Spectral information content of discreet signals. Planning of digital recording systems. Spectral data processing procedures. Methods for raising of spectral information. Deterministic Real Time (RT) and Non Real Time (NRT) filtering procedures. Stochastic filtering. The general spectral analysis. Multidimensional filtering. **<u>Teaching methodologies</u>**: attendance on the seminars and solution of one personal task with presentation	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Dr. Turai Endre: Spectral data- and information processing. lecture notes, Miskolci Egyetem, 2005. P. F. Panter: Modulation, Noise, and Spectral Analysis, McGraw-Hill Book Co, 1965. Meskó A.: Digital filtering. Akadémiai Kiadó, Budapest, 1984. E. O. Brigham: The Fast Fourier Transform, Prentice-Hall Inc., 1974. M. Bath: Spectral Analysis in Geophysics, Elsevier Scientific Publishing Co., 1974. R. N. Bracewell: The Fourier Transform and its Applications, McGraw-Hill Book Company, 1978. J. V. Candy: Signal Processing, McGraw-Hill Book Company, 1986. N. Hesselmann: Digital signal processing, Műszaki Könyvkiadó, 1985.	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T6, T7, T9 Skills: K1, K2, K3, K6, K7, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:**	

Geophysical data processing is a compulsory subject in the geophysical engineering specialization of the Earth Science Engineering Master Program. The main goal of the specialization is to train engineers who, by developing geophysical methods and applyin **Demonstration of coherence between teaching methodologies and the learning outcomes:** The lectures of the course introduce in detail the methods included in the curriculum and their mathematical and IT descriptions. In practical classes, students apply each method to theoretical and field-measured data systems. Students use and develop com
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Turai Endre, gfturai@gold.uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Global environmental geophysics

Course Title: Global environmental geophysics	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT730027**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the lectures and seminars and the solution of one personal task with presentation. Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: Training global environmental geophysics to a level that graduated engineers can begin to work in the field of general geophysics and maintain communication with colleagues working as experts in the field of global environmental geophysics. **<u>Course content</u>**: Solar System. Zonal interior of the Sun, radiochemical transformation in it, differential rotation of the Sun, its atmosphere with processes acting on the Earth. Physical and geometrical parameters of the Sun, solar cycles. Activity of geophysical and astronomical observatories. The classification of the planets of the Solar System. The main physical, chemical and geometrical parameters of the planets. The gravitational and magnetic field of the planets. The main features of the magnetosphere of the Earth, characterization of ionosphere. Magnetic field's reversal. Different types of remanent magnetization. Composition of the Earth' interior based on seismic tomography, the most significant boundaries. Visiting Kövesligethy Radó Seismological Observatory. The zonal composition of the Earth, characterization of the zones, putting emphasis on mantle convection, liquid and solid core. Radiometric dating methods, their reliability. Radioactive heat production. Heat flux map of the Earth. Hot spots, mantle plums. Viscosity, temperature, elastic waves velocity and density in the function of depth. Focal depth determination. Magnitude definitions, energy released, intensity. Focal mechanism based on first motion studies using focal spheres. Connection between plate tectonics and earthquake mechanism. Applied monitoring technologies by CTBTO for detecting nuclear explosion. Student's .ppt presentations, questions, evaluation. **<u>Teaching methodologies</u>**: attendance on the lectures and seminars and the solution of one personal task with presentation.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Frank Stacey & Paul Davis: Physics of the Earth. Cambridge Univ. Press, 4. edition 2008. ISBN-10: 0521873622 William Lowrie: Fundamentals of Geophysics 2nd edition, Cambridge Univ. Press. 2007. ISBN- 13 978-0-521-85902-8 http://www.uni-miskolc.hu/~geofiz/PG_GlobenvGeophysics.pdf https://www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/	
Competencies to evolve (relevant Learning outcomes, Appendix 1):	

Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Skills: K1, K2, K3, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives detailed theoretical background to understand large-scale, global geophysical processes and their invesitgation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by individual task which the student should elaborate and present during the semester

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Pethő Gábor , private professor gfpg@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geoelectric lectureship

Course Title: Geoelectric lectureship	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the seminars and solution of one personal task with presentation. Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: System of electrical and electromagnetic geophysical methods. Physical basics of direct current (DC) geoelectric methods. Solution of the Laplace equation in layered homogeneous isotropic half space. The geological information content and calculation of the kernel function. Hankel and the Inverse Hankel transformation. Physical basics of alternating current (AC) electromagnetic methods. Derivation of telegraph and wave equations. Information content of the wave number. Wavelength, penetration depth and propagation speed of electromagnetic waves. Characterization of dielectric, lossy and good conducting media. The zones formed around the electric and magnetic dipoles and the phase surfaces of the electromagnetic fields in the various zones. Electromagnetic field calculation of the horizontal electric dipole source in inhomogeneous anisotropic media. Electromagnetic field calculation of the vertical magnetic dipole source in inhomogeneous anisotropic media. Presentation of reports. **Course content**: System of electrical and electromagnetic geophysical methods. Physical basics of direct current (DC) geoelectric methods. Solution of the Laplace equation in a layered homogeneous isotropic half space. The geological information content and calculation of the kernel function. The Hankel and the Inverse Hankel transformation. Physical basics of alternating current (AC) electromagnetic methods. Derivation of telegraph and wave equations. Information content of the wave number. Wavelength, penetration depth and propagation speed of electromagnetic waves. Characterization of dielectric, lossy and good conducting media. The zones formed around the electric and magnetic dipoles and the phase surfaces of the electromagnetic fields in the various zones. Electromagnetic field calculation of the horizontal electric dipole source in inhomogeneous anisotropic media. Electromagnetic field calculation of the vertical magnetic dipole source in inhomogeneous anisotropic media. Presentation of reports and semester closing. **Teaching methodologies**: attendance on the seminars and solution of one personal task with presentation.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:	

Kearey, P., Brooks, M., Hill I., 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
Keller, G. W., Frischknecht F. C.: Electrical Methods in Geophysical Prospecting, Pergamon Press, Oxford, 1966.
Sumner, J. S.: Principles of Induced Polarization for Geophysical Exploration, Elsevier Scientific Publishing Company, Amsterdam, 1976.
Telford W. M., Geldart L. P., Sheriff R. E., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
Wait, J. R.: Overvoltage Research and Geophysical Applications, Pergamon Press, London, 1959.
Periodicals: Geophysical Transactions, First Break, etc.
Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
Geoelectric lectureship is an elective subject in the geophysical engineering specialization of the Earth Science Engineering Master Program. The main goal of the specialization is to train engineers who, by developing geophysical methods and applying the

Demonstration of coherence between teaching methodologies and the learning outcomes:
The lectures of the course introduce in detail the methods included in the curriculum and their geological and mathematical-physical descriptions. In practice, students become familiar with and apply each method during field measurements. Each student ela

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Turai Endre, gfturai@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geostatistics

Course Title: Geostatistics	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730017**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures with projected MS-PowerPoint presentation. Demonstration of statistical methods using own developed MATLAB codes (recipes) and the MATLAB Statistical Toolbox Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The subject deals with the theoretical description and practical issues of mathematical statistical methods used in earth sciences. **Course content**: Data distributions. Datasets, histograms, pdf and cdf types. Determination of the modal value. Characterization of uncertainty. The Steiner's most frequent value method as robust statistical estimator. The Maximum Likelihood method. Confidence intervals. Skewness and kurtosis. Propagation of error. Linear and non-linear regression analysis. Robust regression methods. Earth science examples. Spatial correlation of geophysical parameters, variogram models and kriging. Introduction to multivariate statistical methods. Data matrices. Multi-dimensional scaling. Multidimensional modeling and data analysis. Hierarchical and non-hierarchical cluster analysis, the K-means clustering method. Rock typing and other earth science examples. Reduction of dimensionality. Principal component analysis, factor analysis and their applications in geosciences. Lithology determination, estimation of petrophysical parameters. Linear regression using inversion tools. The Gaussian Least Squares method. Weighted norms to be minimized. Well-logging applications. The quality check of inversion results. Statistical backgrounds. The relation between the data and model covariance matrices. Error propagation. Simulated Annealing methods. Classical and float-encoded genetic algorithm. Artificial neural networks. Earth science applications. **Teaching methodologies**: Lectures with projected MS-PowerPoint presentation. Demonstration of statistical methods using own developed MATLAB codes (recipes) and the MATLAB Statistical Toolbox	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Edward H. Isaacs, R. Mohan Srivastava, 1989. An introduction to applied geostatistics. Oxford University Press. Troyan V., Kiselev J., 2010. Statistical methods of geophysical data processing. World Scientific Publishing Co. Clark I., 1979: Practical geostatistics. Elsevier Applied Science. Steiner F., 1991: The most frequent value – Introduction to modern conception of statistics. Akadémiai Kiadó.	

Szabó N. P., 2017. Geostatistics. Electronic course material. http://www.uni-miskolc.hu/~geofiz/education.html

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T3, T4, T5, T6
Skills: K1, K2
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course is of key importance for the correct statistical evaluation of different datasets, derived from geophysical and geological exploration methods.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by solving different statistical exercises which may appear in geophysical data processing, reserve estimation, processing and interpretation of geochemical datasets. Modules providing solutions to different issues are wir

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter, full professor gfnmail@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Introduction to the English Geophysical Literature

Course Title: Introduction to the English Geophysical Literature	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT730041**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Attendance at lectures is regulated by the university code of education and examination. One assignment (making an individual paper) during the semester is the requirement of signature Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Under the optional subject, MSc students of geosciences will be acquainted with the terminology of geophysics in English and will be instructed to find out in the literature. **Course content**: Classification of applied geophysics methods. An overview of geophysical research methods based on international literature (Kearey et al., 2002). Presentation of the most prestigious domestic and international English impact factor journals. Professional journals (Q1-Q4 and D1 ranked geophysical journals). Studying an applied geophysical encyclopedia in English and practicing professional terminology (Sheriff, 2002). Analysis of an original paper selected from the journal Acta Geodaetica et Geophysica. Analysis of an original paper selected from the journal Geophysics. Analysis of an original paper selected from the journal Mathematical Geosciences. An analysis of English-language articles freely chosen by students. An analysis of English-language articles freely chosen by students. Description of the tasks related to the written assignment. Choosing a topic to create a stand-alone article. Self-conducted task: abstract writing. Checking, analyzing, and repairing the abstract. Rules for preparing an oral conference presentation. Rules for preparing a poster presentation. Presentation of the students' professional results (BSc thesis, TDK thesis etc.) in the form of a conference presentation. Simulated conference. Exercises on answering to professional questions. **Teaching methodologies**: Attendance at lectures is regulated by the university code of education and examination. One assignment (making an individual paper) during the semester is the requirement of signature	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Lowrie W., 2007: Fundamentals of Geophysics. Second Edition. Cambridge University Press. Telford W. M., Geldart L. P., Sheriff R. E., 1990: Applied geophysics. Second edition. Cambridge University Press. Kearey P., Brooks M., Hill I., 2002: An Introduction to Geophysical Exploration. Third edition. Blackwell Science Ltd. Ellis D. V., Singer J. M., 2007: Well logging for earth scientists. 2nd edition. Springer. Sheriff R. E., 2002: Encyclopedic Dictionary of Applied Geophysics. Fourth edition. Society of Exploration Geophysicists.	

Selected publications in professional journals: Acta Geodaetica et Geophysica, Geophysics, Petrophysics, Journal of Applied Geophysics, Acta Geophysica, Hydrogeology Journal, Mathematical Geosciences etc.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T3, T4, T5, T9
Skills: K1, K2, K3, K5, K6, K7, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is a course developing important soft skills of students, giving a scope of the current content geophysical literature and skills of scientific writing

Demonstration of coherence between teaching methodologies and the learning outcomes:
This is a learning by doing course, where one of the most important goals is to learn the proper way of scientific writing and referencing.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter, full professor gfnmail@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Seismic college

Course Title: Seismic college	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730029**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the seminars and solution of one personal task with presentation. Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Summarization of seismic data acquisition, data processing and interpretation methods. Applications and uses of seismic methods for raw material exploration. New seismic technologies and methods **Course content**: Actual, up-to-date topics connected to new results and development tendencies in the field of seismic data acquisition, data processing and interpretation. Year to year selected special topics are offered to the students in the fields of raw materials' (especially hydrocarbon) exploration, as well as of seismic technology development. This subject is also useful for the students to obtain deep insight in the topics of selected thesis work **Teaching methodologies**: attendance on the seminars and solution of one personal task with presentation.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Sheriff, R. E., Geldart L. P., 1995: Exploration seismology. Cambridge University Press. Helbig K., Treitel S. (edit.), 1987: Seismic exploration (Handbook of Geophysical Exploration). Volumes 2-20, Geophysical Press. Articles presented in periodicals like: Magyar Geofizika, Geophysical Transactions, Geophysics, Geophysical Prospecting. Other seismic software available at the Geophysical Faculty.	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9 Skills: K1, K2, K3, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** The course gives knowledge and skills to plan and complete seismic exploration campaings and to process and interpret the seismic data. The course is essential for specialists orienteering to hydrocarbon exploration	

Demonstration of coherence between teaching methodologies and the learning outcomes: Practical exercises are solved by softwares widely used for seismic data processing and interpretation.
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Gombár László laszlo.gombar@geoseis.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Well-logging college

Course Title: Well-logging college	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730030**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Attendance at lectures is regulated by the university code of education and examination. One writing test with satisfactory results, one individual assignment and one powerpoint presentation are the requirement of signature Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: In the course of the subject, the Geophysical Engineering (MSc) students will be learning about special well logging measurement, data processing and interpretation methods. The subject also serves to deepen the topic of the thesis work chosen by the student and to prepare for the final exam. **<u>Course content</u>**: Well-logging measurements sensitive to lithology. Integral and spectral natural gamma-ray intensity logging. Spontaneous potential logging. Gamma-gamma logging based on photoelectric effect. Determination of shale volume in sediments. Well-logging measurements sensitive to porosity. Density (gamma-gamma) logging. Neutron-neutron logging. Sonic logging. Determination of Stoneley permeability. Determination of porosity using single well logs. Determination of porosity and lithology with the simultaneous use of well logs (i.e. crossplot techniques). Nuclear magnetic resonance logging. Determination of NMR porosity, pore-size distribution, and permeability. The Free Fluid Index. Determination of water saturation using modified Archie's equations. The total shale model. The Dual Water model. Estimation of the invasion parameters by means of the inversion of resistivity data. Borehole image logging. Resistivity, acoustic image and optical measurement techniques. Borehole radar measurements. The possibilities of radar tomography. Interpretation of well logs acquired from hydrocarbon wells. Evaluation of shaly-sand reservoirs. Evaluation of unconventional reservoirs. Hydrogeophysical well-logging methods. Evaluation of petrophysical parameters of groundwater formations. The principles and applications of engineering geophysical sounding measurements. The inversion and statistical evaluation of EGS data. Interpretation of well logs acquired from mineral exploration wells. Evaluation of coals, bauxites and ores. Theoretical probe response functions. Analysis of parameter sensitivity functions. Solution of the forward problem. Simultaneous processing of well logs using local inverse modeling. Estimation of petrophysical parameters of hydrocarbon reservoirs. Introduction to GLOBAL and OPTIMA systems. Quality check of the estimated model. Interval inversion of well logs. Estimation of rock boundary coordinates and zone parameters. Multivariate statistical processing of well logs. Rock typing, estimation of petrophysical parameters using cluster analysis and factor analysis. Replacement of well logs for unmeasured intervals. Schlumberger Techlog as an interpretation (software) system used in the current oilfield practice. **<u>Teaching methodologies</u>**:	

Attendance at lectures is regulated by the university code of education and examination. One writing test with satisfactory results, one individual assignment and one powerpoint presentation are the requirement of signature

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Asquith G., Krygowski D., 2004: Basic well log analysis. American Association of Petroleum Geologists (+ case studies with datasets).
Schlumberger, 1989: Log interpretation principles/applications.
Serra O., 1984. Fundamentals of well-log interpretation. Elsevier.
Ellis D. V., Singer J. M., 2007. Well logging for earth scientists, 2nd edition. Springer.
Rider M. H., 2002. The geological interpretation of well logs, 2nd Edition, Rider-French Consulting Ltd.
Szabó N. P., 2013. Well logging methods. Electric course material. http://www.uni-miskolc.hu/~geofiz/education.html.
User manuals on WellCAD, Techlog, Express, MATLAB etc. softwares.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Skills: K1, K2, K3, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives knowledge and skills to plan and complete well logging measurements and interpret the acquired data. The course is essential for specialists orienteering to hydrocarbon exploration

Demonstration of coherence between teaching methodologies and the learning outcomes:
Practical exercises are solved by softwares widely used for well logging and interpretation.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter, full professor gfnmail@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Vass Péter**

Engineering programming

Course Title: Engineering programming	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT73011A**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Conditions for obtaining the signature: the presence in at least 70 % of the lessons and passing two classroom tests. The determination of the practical mark is based on the evaluation of problem solving in the lessons and the results of two classroom tes Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The main objective of the subject is to familiarize the students with the elements of programming necessary to solve engineering and scientific problems. The course tries to transmit the knowledge by means of which the algorithms of simpler problems can be constructed and the algorithms can be implemented in the form of computer programs. **Course content**: Introduction. Some basic concepts and definitions: computer program, software, algorithms, constants, variables, attributes of the variables. Elements of the algorithms: read, write, assignment, conditional branch, loop. The ways of expressing algorithms: natural languages, pseudocodes, flowchart. Designing and expressing algorithms. Introduction to the use of a free flowchart editor. Doing exercises. General characteristics of high-level programming languages. Semantics, syntax, compiler and interpreter. The fundamental steps of program development. A short history of C programming language and its general characteristics. Introduction to the use of a free C and C++ program development environment. Writing the source codes of simpler algorithms in C language. Compiling and testing the implemented C programs. Lexical elements of C programming language. identifiers, keywords, constants, comments, operators (precedence and associativity), punctuators. Structure of C programs. Data types in C programming language. Defining the variables in C programs. The use of constants. Control structures: conditional branches (if, if – else, if – else if – else, switch –case), loops (the pre-test loop 'while', the post-test loop 'do –while', the for-loop. Special control statements: break, continue, return. The first classroom test on the topics of algorithms and writing simpler C programs. Pointers and their application. Dynamic memory allocation in C programs by means of a pointer. Arrays and their application. Strings and character arrays. Multi-dimensional arrays. Standard library functions. User-defined functions. Definition, declaration and function call. Text file input and output in C language. Defining a file pointer. Opening a text file. Writing, reading and closing a text file. Introduction to the application of higher level programming languages. The programming environments of Matlab and GNU Octave. Data types and formats. The execution of some important commands. Creating and running scripts in Matlab and GNU Octave. The second classroom test on the topics of C programming.	

Teaching methodologies:
Conditions for obtaining the signature: the presence in at least 70 % of the lessons and passing two classroom tests.
The determination of the practical mark is based on the evaluation of problem solving in the lessons and the results of two classroom tes

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Brian W. Kernigham – Dennis M. Ritchie: C Programming Language, 2nd Edition, Prentice-Hall Inc., ISBN-10: 0131103628
John W. Eaton, David Bateman, Søren Hauberg, Rik Wehbring: GNU Octave, A high-level interactive language for numerical computations, Edition 4 for Octave version 4.0.3
Clovis L. Tondo, Scott E. Gimpel, 1989: The C Answer Book, Second Edition, Prentice-Hall International, Inc., ISBN: 7-302-02728-5
MATLAB numerical computing, Tutorials Point (I) Pvt. Ltd., 2014: www.tutorialspoint.com

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
The syllabus elaborated for and applied to the education of the course strives to cover all the important parts of the specialities connected to the objectives. This well-considered construction of topics enables the lecturer to emphasize the essential re

Demonstration of coherence between teaching methodologies and the learning outcomes:
The applied teaching methodologies are aimed at communicating up-to-date knowledge, developing the students' capability to apply the introduced ideas and information, improving their ability to test these ideas and evidence, to generate own ideas and evid

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Vass Péter, associate professor gfvassp@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological engineering specialisation

Historical geology

Course Title: Historical geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720028**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Completion of inter-semester test with at least satisfactory result (see below). It can be repeated once. Practical requirements: obligatory participation in the field-trips, ppt-presentation for one of them Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The aim of the subject is to give knowledge (1) on the role of time in the geological processes, (2) on the different methods of age-determination, (3) on the structural evolution of the Earth and (4) on the history of life in the Earth with special emphasis on the utility of all these in prospecting raw materials) and how to reconstruct paleoenvironments in geology as basic information for raw material exploration **Course content**: Principles of stratigraphy. Basic principles of stratigraphy, litho-, bio- and chronostratigraphy. Different methods of stratigraphical correlation and their significance in raw material prospecting. Age-determining methods: biostratigraphy, radiometry, magnetostratigraphy, chemostratigraphy, event stratigraphy, sequence stratigraphy. Reconstruction of different palaeoenvironments and their application in raw materail prospecting. Different magmatic, metamorphic and sedimentary facies types. The geological time scale, the structural, climatological and biological evolution of the Earth during the Precambrian, the Paleozoic, the Mesozoic and the Cenozoic. The evolution of Homoidea. **Teaching methodologies**: Completion of inter-semester test with at least satisfactory result (see below). It can be repeated once. Practical requirements: obligatory participation in the field-trips, ppt-presentation for one of them	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Levin, H.L. (2006) – The Earth Through Time, 8th Ed., 616 p., Wiley Barnes, C.W. (1988): Earth, Time and Life. John Wiley and Sons, New York Brookfield, M. (2006): Principles of Stratigraphy. Blackwell Publishing, New York	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T7, T8, T9 Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13	

Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is a fundamental course to understand the principles of stratigraphy, its applicability to solve complex geological problems and tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
The lectures of the course introduce in detail the methods included in the curriculum, while practical skills are developed by field trips and case studies.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Less György, full professor foldlgy@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Hydrocarbon geology

Course Title: Hydrocarbon geology	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT720029**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 0 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Introduce students the basic concepts of hydrocarbone geology; the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production; the steps needed to solve the basic hydrocarbone geological tasks. **Course content**: The genesis of oil and gas deposits/fields: geodynamic background, fundamentals of organic geochemistry, primary and secondary migration. Basin analyses and thereafter: phases and methods of prospecting and exploration. After a discovery: put your field on stream (from the end of exploratipon to the commencement of the production. Core description, lithofacies modelling, depth matching, seismic validation. Hydrocarbon Geology in the field development. Stratigraphic and tectono-sedimentological modelling. Lithology, pore-structure, contacts: key issues in calculating resources, reserves. Saturation anomalies and their interpretation. Static (geological) modelling: pressure surveys, production, daily rates as a validation of the static model Geological fundaments of the dynamic model: a deterministic and a probabilistic approach. Integrated G&G studies: OOIP/GIIP/PIIP, resources reserves Oil and Gas Provinces of the Globe: resources/reserves and the future supply. **Teaching methodologies**:	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Bérczi I.: Petroleum Geology, (Jegyzet, 1988, Montanuniversität Leoben) Bérczi I.: Development Geology (Jegyzet, 2003, HOT Engineering&Shell Iran Offshore) University of Texas: Petroleum Geology & Reservoirs, www.utexas.edu/ce/petex/aids/pubs/petroleum-geology Mike Sherherd (2009): Oil Field Production Geology. AAPG Memoir 91. 1-360. Bjorlykke K. (2010): Petroleum Geoscience: From Sedimentary Environments to Rock Physics. Springer. Hyne N. J. (2001): Nontechnical Guide to Petroleum Geology, Exploration, drilling, and Production. 1-598. PennWell Corporation. Slatt R.M. (2009): Stratigraphic Reservopir Characterization for petroleum Geologists, Geophysicists and Engineers. 1-478. Elsevier.	

Wayne M. Ahr (2008) Geology of Carbonate Reservoirs. 277. Wiley Publication
Lucia (1999, 2007): Carbonte Reservoir Characterization. 226. Springer

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives an overview of the fundamentals and also about the state of the art of the topic. The position and interrelation of the course with other disciplines is given, followed by the presentation of theoretical basis and then solution of real ca

Demonstration of coherence between teaching methodologies and the learning outcomes:
The course gives an overview of the fundamentals and also about the state of the art of the topic. The position and interrelation of the course with other disciplines is given, followed by the presentation of theoretical basis and then solution of real ca

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Velledits Felicitász Margit, foldfeli@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological mapping

Course Title: Geological mapping	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720029**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i Grading scale: % value — Grade 90 -100% — 5 (excellent) 75 – 89% — 4 (good) 60 - 74% — 3 (satisfactory) 45 - 59% — 2 (pass) 0 - 44% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The subject gives knowledge on the figuration of geological phenomena on topographic maps, on preparing geological maps, cross-sections, their legend and on assembling explanatory report **Course content**: The aim of preparing geological maps. The geological map and its additional parts (geological cross-sections, stratigraphical columns and legend). Geological phenomena figured in the geological maps: lithostratigraphical units, structural chacteristics. Different types of geological boundaries and their recognition on the field. Orientation on the field with topographical map and with GPS. Documentation of field observations in the field booklet and on the topographical map. Preparation of geological cross-sections. Preparation of covered and uncovered (without Quaternary deposits) geological maps with stratigraphical column and legend. Assembly of explanatory reports **Teaching methodologies**: Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Tearprock, D.J. & Bischke, R.E. (2002): Applied Subsurface Geological Mapping with Structural Methods 2nd Edition, 846 p., Prentice Hall Hamilton, D.E. & Jones, T.A.: Computer modeling of geological surfaces and volumes. – AAPG Computer applications in geology. No.1., 589 p. Tulsa, Oklahoma McClay, K. (1995): The mapping of Geological Structures. Geolog. Soc. of London Handbook. John Wiley Sons, Chichester, New York, Brisbane, Toronto, Singapore. SURFER 8.0 Tutorial and User's Guide. - Golden Software. P512 . Denver	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T7, T8, T9 Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7	

Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** Theoretical part and laboratory exercisis givesan overview to the students about methodology and tools of geological mapping works. **Demonstration of coherence between teaching methodologies and the learning outcomes:** After giving the theoretical basis of mapping methodology, this is a learning by doing course, where the students should compete geological mapping work in the Bükk mountains
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Less György, full professor foldlgy@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Sedimentology

Course Title: Sedimentology	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT720030**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** two written exam: Midterm exam, and Final exam. In both exam must be reached 50% Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2.**	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
To acquaint students with the most important sediments like sand, silt, clay, carbontes, evaporites, cherts etc. and the processes that result in their formation. To get to know the main types of sedimentary rocks: 1.The siliciclastic sedimentary rocks. 2. Organic sedimentary rocks: carbonates, coal, oil shale. 3. Evaporites (halite, gypsum). 4. Chemical sedimentary (chert, jaspilite). At the end of the course they have to be able to interpret the ancient environmental conditions in sediment source areas and depositional sites, based on constituents, textures, structures, and fossil content of the deposits. They have to differentiate between continental, littoral, and marine deposits of the geologic record

Course content:
1. The place of sedimentology in earth sciences. The main stages in the development of sedimentology.
2. The main groups of sedimentary rocks: (siliciclastic) rocks, biogenic rocks, rocks formed by chemical precipitation, organic sediments, volcanic rocks.
3. Major aspects of rock description (composition, rock, sedimentary structures, fossils) Processes of sedimentation (stagnation, transport, settling / precipitation, diagenesis) The main laws: Steno's laws, aktualismus, Walter's law.
4. Carbonate rocks. Introduction: What are carbonate rocks? Carbonate minerals. Factors affecting carbonate formation.
5. Main sedimentation environments: Wilson's facies belts, their main rock and microfacial types. The main constituents of carbonate rocks. Changes in carbonate-producing groups of organisms during the history of the earth.
6. Classification of carbonate rocks. Pore types. Diagenesis: marine, fresh water, deep burial.
7. Carbonate platform types. Carbonate reservoirs. Comparison of carbonate and silicicastic rocks.
8. Main characteristic of silicicalstic rocks: sorting, sfericity, roundness. Cementation of siliciclastic rocks.
9. Origine, transport, sedimentotation and diagenesis of siliciclastic rocks. Classification of siliciclastic rocks.
10. Sedimentary environments of siliciclastic rocks. Alluvial fans, eolitic and fluviatile facies (sediments of meandering and braided rivers).
11. Coastal sediments, siliciclastic self seas.
12. Delta (river, wave, tidal dominated, Gilbert, coarse-grained and fan-delta). Deep sea fans.
13. Evaporites, manganese ores. Precipitation: radiolarit, chert, diatomite.
14. Fossil energy sources. Coal: lignite, brown coal, anthracite, graphite. Uranium sedimentology. Hydrocarbons: petroleum, natural gas, oil shale, tar sands

Teaching methodologies:

two written exam: Midterm exam, and Final exam. In both exam must be reached 50%

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Harold G. Reading 1996, 2006: Sedimentary Environments: Processes, Facies and Stratigraphy, Wiley, London, p.704
Asquith & Gibson: Basic well log analysis for geologists, AAPG, Methods in exploration series
Serra, 1985: Sedimentary environments from wireline logs. Schlumberger p.211
Gerhard Einsele 2000: Sedimentary Basins: Evolution, Facies, and Sediment Budget, p. 792
Mike R. Leeder, 2011: Sedimentology and Sedimentary Basins: From Turbulence to Tectonics. John Wiley & Sons, p. 784
P. A. Allen, J.R., 1990: Allen Basin Analysis: Principles and Applications. Wiley, p.451
Andrew D. Miall, 1990: Principles of sedimentary basin analysis. Springer-Verlag, - 668 p.
Emiliano Mutti, 1992:Turbidite sandstones. Agip, Istituto di geologia, Università di Parma

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives an overview of the fundamentals and also about the state of the art of the topic. The position and interrelation of the course with other disciplines is given, followed by the presentation of theoretical basis and then solution of real ca

Demonstration of coherence between teaching methodologies and the learning outcomes:
The course gives an overview of the fundamentals and also about the state of the art of the topic. The position and interrelation of the course with other disciplines is given, followed by the presentation of theoretical basis and then solution of real ca

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Velledits Felicitász Margit, foldfeli@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geochemical prospecting methods

Course Title: Geochemical prospecting methods	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT720031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** completion of three exercises during the semester and participation in a 2-3 days field trip and completion of a sampling plan based on the field trip Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: Introduction into a basic area of mineral exploration methods, including the theorethical background of geochemical sampling, the detailed discussion of different sampling and analytical methods, as well as the methods of data processing and interpretation. Completion of a geochemical exploration project, including field sampling, sample preparation, data processing and interpretation is an important part of the course. **Course content**: Geochemical distribution of chemical elements in different rock types, Periodic table for geochemists Concept of the geochemical background. Geochemical delineation of a mineralization, a mineral deposit. Primary dispersion, methods of its exploration. Geochemical aspects of weathering. Geochemistry of the surface environment. Sorption processes Secondary dispersion and methods of its exploration. Sampling methods, sampling standards. Soil surveys, vegetation and water surveys. Stream sediment sampling methods, heavy minerals geochemistry. Major analytical methods. Data processing and statistical methods. **Teaching methodologies**: completion of three exercises during the semester and participation in a 2-3 days field trip and completion of a sampling plan based on the field trip	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Reedman J.H.: Techniques in mineral exploration (Appl. Sci. Publ. London, 1979) Kuzvart M. & Böhmer M.: Prospecting and exploration of mineral deposits (Elsevier, 1986) Wite W.M. (2007): Geochemistry. Online textbook, (John Hopkins University, 2007) Hawkes H.E.: Principles of geochemical prospecting. (US DOE, Geological survey bulletin 1000-F)	

Geboj N.J.; Engle E.A. (2011): Quality Assurance and Quality Control of Geochemical Data: A Primer for the Research Scientist (USGS Open-File Report 2011–1187)
Sarkar D., Datta R., Hannigan R.: Concepts and applications in environmental geochemistry. (Elsevier, 2007)

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course content introduces the fundamental parameters of the near-surface geochemical system as well as practical skills to plan, organize, perform a geochemical prospecting campaign and interpret the resulting dataset.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Students shall understand the interrelationship between different elements of the near-surface geochemical system. Practical skills are developed by a project-like exercise to compile a geochemical prospecting sampling plan of an ore field.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc, associate professor askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Non-metallic industrial minerals

Course Title: Non-metallic industrial minerals	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT730030**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, fieldtrips, methods for data validation and documentation. Short written test. Individual data research + presentation (60-40%) in an assay. Oral examination Grading scale: % value — Grade 90 -100% — 5 (excellent) 76 – 89% — 4 (good) 60 - 75% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: The course will allow students to gather knowledge on the non-metallic mineral resources, geological characteristics of the deposits, type and mode of the accumulations, spatial distribution and quality-quantity data of the mineral types, technological requirements, exploration, exploitation and beneficiation techniques **<u>Course content</u>**: The introductory part is a short review on the geological settings and related petrological-geochemical knowledge, related non-metallic resources, industrial mineral groups. The first part dissects the grouping on genetical and industrial-application point of view mineral resources. During the semester detailed knowledge is offered on 1) native element, 2) sulphide, 3) halogenide, 4) oxide/hydroxide, 5) carbonate/nitrate, 6) borate, 7) sulphate, 8) phosphate and 9) silicate types of industrial minerals. Students get familiar with their mineralogy, deposits and formation, extraction and uses based on detailed international data. We also study the rock type industrial minerals, their generating and applications. In the case of silicates emphasis is put on clay minerals, feldspars and zeolites. Separate lecture+laboratory visit discusses the exploitation and beneficiation techniques. During the laboratory exercises and field trips students learn to recognize industrial minerals, to give mineralogical characterization, exploration and quality remarks, their natural types of occurrence. **<u>Teaching methodologies</u>**: Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, fieldtrips, methods for data validation and documentation. Short written test. Individual data research + presentation (60-40%) in an assay. Oral examination	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: EVANS A.M. (1993) Ore Geology and Industrial Minerals: an Introduction. Blackwell Publishing, 379 p ISBN 978-0-632-02953-2 Ciulo P. A. (1996) Industrial minerals and their uses. Noyes Publication, New Jersey, 607 p https://minerals.usgs.gov/minerals/pubs/myb.html https://www.ima-europe.eu/	
Competencies to evolve (relevant Learning outcomes, Appendix 1):	

Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students get familiar with their mineralogy, deposits and formation, extraction and uses based on detailed international data. We also study the rock type industrial minerals, their generating and applications. In the case of silicates emphasis is put on

Demonstration of coherence between teaching methodologies and the learning outcomes:
Field trips and individual exercises enhance the skills of the student and to understand the genetic conditions of formation of non-metallic depostis. During the laboratory exercises and field trips students learn to recognize industrial minerals, to give

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Kristály Ferenc, professor emeritus askkf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Applied environmental geology

Course Title: Applied environmental geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT730032**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures and seminars; Practical work: self-made solutions of simple case-study problems. Grading scale: % value — Grade 90 -100% — 5 (excellent) 70 – 89% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: 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. **Course content**: 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. **Teaching methodologies**: Lectures and seminars; Practical work: self-made solutions of simple case-study problems.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Edgar, Spencer;Reichard, J S;Reichard, J: Environmental Geology, McGraw-Hill, 2009, Keller, E A: Introduction to Environmental Geology, Prentice Hall, 2011, Erickson, J.: Environmental Geology: Facing the Challenges of Our Changing Earth (Living Earth) Amazon com,2002 Foley,Duncan: Investigations in environmental geology, Prentice Hall, Upper Saddle River N.J, 2009, Holland, H D.: Treatise on geochemistry, Elsevier, New York NY, 2003 Keith,S..: Environmental hazards, Routledge,, Abingdon, Oxon ;;New York :, 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,	

Bell F. G.: Geological Hazards: their assessment, avoidance and mitigation. E & FN Spon, London, 1999
Lundgren L. W.: Environmental Geology. Prentice-Hall Inernational, London, 1999.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

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 Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Viktor, associate professor askcesar@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Sedimentology of carbonate reservoirs

Course Title: Sedimentology of carbonate reservoirs	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT730015**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures with powerpoint presentation, field practice consisting of two parts: 1. visiting carbonate outcrops, representing a wide range of carbonate facies, 2. practical workshop in the MOL redepository core house in Szolnok. Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
<u>Objectives of the course</u>: To understand the carbonate reservoirs: the geometry and the petrophysical characteristics of carbonate reservoirs. To understand the main control factors influencing the formation of carbonate reservoirs: (1) sedimentology, (2) diagenesis (3) burial history. **<u>Course content</u>**: Introduction to carbonate rocks and reservoirs. Carbonate vs. siliciclastic sediments, and reservoirs. Mineralogy of carbonate rocks. Controls on carbonate production and accumulation. Fundamental rock properties: texture, fabric, composition, sedimentary structures. Classification of carbonate rocks. Porosity and permeability in carbonate rocks. Petrophysical properties of carbonate reservoirs: saturation, wettability, capillarity. Capillary pressure and reservoir performance. Capillary pressure, pores and pore throats. Carbonate depositional environments (beach-dune, tidal-flat, lagoon, shallow subtidal (neritic), slope-break, slope environment, basinal environments) and reservoirs. Depositional porosity. Paleotopography and depositional facies. Diagenetic carbonate reservoirs. Diagenesis and diagenetic processes. Diagenetic environments and facies. Diagenetic porosity. Diagnosing and mapping diagenetic reservoirs. Fractured reservoirs. Carbonate sequence stratigraphy and cyclicity. Relationship of primary depositional facies, sequence stratigraphic framework and diagenetic history to pore architecture and reservoir quality. Sequence sratigraphy in exploration and development. **<u>Teaching methodologies</u>**: Lectures with powerpoint presentation, field practice consisting of two parts: 1. visiting carbonate outcrops, representing a wide range of carbonate facies, 2. practical workshop in the MOL redepository core house in Szolnok.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Ahr Wayne M. (2008): Geology of Carbonate Reservoirs. Wiley Publication. 1-273. Lucia F. Jerry (1999): Carbonate Reservoir Characterization. Springer. 1-226. Scholle P. A., Bebout D.G., Moore C.H. ed. (1983): Carbonate Depositional Environments. AAPG Memoir 33. 1-704. Tucker M. (2003): Sedimentary Rocks in the Filed. Wiley.1-234. Stow D.A.V. (2010): Sedimentary Rocks in the Filed. Manson Publishing. 1-320.	

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
The course gives an overview of the fundamentals and also about the state of the art of the topic. The position and interrelation of the course with other disciplines is given, followed by the presentation of theoretical basis and then solution of real ca

Demonstration of coherence between teaching methodologies and the learning outcomes:
The ability to apply the acqured knowledge is highly important. Case stuies are presented to the students in the end of each unit, which should be solved by the students as homeworks. Personal experinces, both positive and negative ones are presented to t

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Velledits Felicitász Margit, associate professor foldfeli@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

X-ray diffraction applications for Petroleum Geology

Course Title: X-ray diffraction applications for Petroleum Geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT730042**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, data evaluation, interpretation of results, methods for data validation and documentation. Grading scale: % value — Grade 90 -100% — 5 (excellent) 76 – 89% — 4 (good) 60 - 75% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: This course will give the basic knowledge of XRD techniques used in petroleum geology research to support the planning and interpretations of petrology and petrography results. Meet and learn all the areas of X-ray diffraction which are routinely used and necessary in good quality petroleum geology research. The areas from sampling and specimen preparation to data evaluation and interpretation will be covered **Course content**: 1. Introduction to X-ray diffraction: crystallography review, X-rays and diffraction techniques, powder diffraction 2. Sample and specimen preparation for good diffraction practice, systematic aberrations, errors in obtained data, standards and calibration 3. Relations of crystal structures and XRD results, structure refinement 4. Interpretation of obtained data, mineral identification, proper use of databases, reference materials, integration of mineralogy knowledge into X-ray data evaluation 5. Quantitative evaluation, methods and practices, possibilities and limitations, software solutions 6. Mineral identification and quantification with solid solution species, use of mixtures from reference materials 7. Clay minerals, crystallography and mineralogy, properties, importance in petroleum geology, their investigation by XRD 8. Preparation of clay mineral samples and specimens, limitations, diagnostic chemical treatments 9. Diagnostic clay mineral investigation, detailed identification, data interpretation and integration into XRD mineralogy 10. Quantitative techniques for clay mixtures 11. Other analytical methods for XRD data validation, integration of chemical and petrology results 12. Preparing and selecting essential data for petrology report, documentation solutions 13. Testing the ability to apply XRD knowledge in petrology research planning. **Teaching methodologies**: Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, data evaluation, interpretation of results, methods for data validation and documentation.	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Bish D.L. & Post J.E. (eds.) (1981) Modern Powder Diffraction./Reviews in Mineralogy, 20/. Mineralogical Society of America, Washington, D.C. Woolfson, M.M. (1997) An Introduction to X-ray Crystallography. 2nd ed. Cambridge University Press, Cambridge. Pecharsky, V.K. & Zavalij, P.Y. (2003) Fundamentals of Powder Diffraction and Structural Characterization of Materials. Kluwer, Dordrecht.	

Jenkins, R. & Snyder, R. (eds.) (2002) Introduction to X-ray Powder Diffractometry. Wiley, New York.
Cullity, B.D. (1956) Elements of X-ray Diffraction. Addison-Wesley, Reading, Massachusetts.
Guinier, A. (1952) X-ray Crystallographic Technology. Hilger and Watts, London.
Dinnebier, R.E. & Billinge, S.J.L. (eds.) (2008) Powder Diffraction: Theory and Practice. Royal Society of Chemistry, Cambridge.
Klug H. P. & Alexander L. E. (1974) X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials. John Wiley & Sons, Inc., New York

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
The course gives an overview of the theoretical and practical fundamentals and also about the state of the art of the X-ray diffraction techniques.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Students acquire the skills of X-ray pattern analysis and interpretation with learning by doing method

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Kristály Ferenc, senior research fellow askkf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

List of competences

a) Knowledge

T1 - Understands the processes described by the general and specific theories required for the practicising of the fields of earth science engineering (geologist-engineering, geophysical-engineering, geoinformatics-engineering), understands the internal connections between geological processes, and knows the planning and interpretation procedures based on the processes.
T2 - Has a solid technical and scientific knowledge required for the high-level progress in earth sciences engineering disciplines, among others in numerical methods, technical physics and their contexts.
T3 - Based on his/her knowledge, understands the structure of the raw material extraction sector, the technologies used for the extraction and preparation of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.
T4 - Has a thorough knowledge and understanding of the best practices applied to earth science engineering tasks and the long-term development directions that can be expected in this field in the medium term.
T5 - Knows the problem-solving (research-planning and management) techniques of best available practices in earth sciences.
T6 - At the application level, knows the GIS methods of computer design and analysis and the geoinformatics systems.
T7 - Knows in detail the geological and geophysical methods suitable for exploring natural resources.
T8 - Has a well-established knowledge of the methods of exploring mineral deposits.
T9 - Has detailed knowledge and sound application practice on the methods of knowledge acquisition and data collection in the technical earth sciences, and on their instrumental measurement and IT data processing procedures.
T10 - Has a well-established knowledge of the legal, economic, administrative, safety, work and fire protection, information technology and environmental protection fields related to the fields of earth science engineering.

b) Skills

K1- Able to apply general and specific basic and applied scientific theories within the technical earth sciences, able to systematize them, to solve independent engineering tasks (mainly complex geological prospecting, final report summarizing exploration results, geological-geophysical parts of environmental impact assessments).
K2 - Able to convey knowledge authentically by preparing presentations and written documents in Hungarian or in a foreign language.
K3 - Able to perform complex planning, construction, inspection and official licensing tasks (geological-geophysical exploration plans of natural resources, acquisition of environmental geology) with the innovative application of theories and terminology describing technical earth science knowledge.
K4 - Able to review legal and economic knowledge and activities related to technical earth science tasks, to optimize connections.
K5 - Able to actively cooperate with, organize, manage, and supervise larger and more complex activities based on or incorporating technical earth science tasks (especially mining, environmental technology investments, operations).
K6 - Uses modern information acquisition and data collection methods.
K7 - Able to solve technical problems requiring innovative skills in theory and practice (especially field, surface, underground data collection, measurements, and their processing and interpretation requiring innovative skills).
K8 - Able to process raw material exploration and production data and organize it into geoinformatics databases (systems).
K9 - Able to prospect and explore geological structures, to plan these research phases.
K10 - Able to take quantitative and qualitative assessment of mineral resources, to evaluate their economics, to compile concession tenders and to give opinions on this type of report.
K11- Able to contribute to the solution of geological-geophysical tasks arising during the extraction of mineral raw materials (planning, investment, operation, closure) and to analyze the solution possibilities.
K12 - Able to review the structure of the raw materials extraction sector, the technologies used for the extraction and processing of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.

K13 - Able to organize cooperation with related disciplines and manage the (working) group within the framework of larger and more complex activities based on or incorporating technical earth science tasks.

c) Competence in terms of attitude

A1 - Open and receptive to the knowledge and acceptance of professional and technological methodological developments in the fields of technical earth sciences, to the acquisition of their management, and to the participation in their development.
A2 - Actively applies innovative skills and knowledge in solving professional problems in the fields of earth science engineering.
A3 - Commits and convincingly demonstrates to knowing and adhering to the professional and ethical values.
A4 - Professionalism and professional solidarity have deepened.
A5 - Respects and follows the ethical principles and written rules of work and professional culture in activities, and is able to follow them even when managing small workgroups.
A6 - In the course of professional work, observes and adheres to the requirements of safety, health, environmental protection and quality assurance and control (SHE and QA / QC).
A7 - Has a sufficient motivation to carry out activities in often changing working, geographical and cultural circumstances.

(d) Competence in terms of autonomy and responsibility

F1 - With the in-depth knowledge of the received strategic guidelines and external environmental requirements, is able to plan the work independently, and is also suitable to lead workgroups.
F2 - Takes responsibility and is accountable for the work processes carried out under his / her control, for the employees working in them.
F3 - Makes decisions carefully, in consultation with representatives of other disciplines (primarily legal, economic, and environmental), independently, takes responsibility for decisions.
F4 - In addition to constructive teamwork, is an autonomous specialist capable of making professional decisions in the field of operation entrusted to him/her.
F5 - Committed to the practice of sustainable natural resource management, occupational health and safety