ZDRUŽENE ŠKOLE – JOINT SCHOOLS

Geo-Engineering - Courses and lecturer's			Remarks
MWG 1	HYDROGEOLOGY	B. Biondić, J. Fank, R. Jecl, K. Posavec, S. Semprich, L. Trauner	obvezni
MG 1	ADVANCED SOIL MECHANICS	T. Ivšić, A. Szavits-Nossan, V. Szavits-Nossan, B. Žlender	obvezni
MG 2	ADVANCED ROCK MECHANICS	S. Kieffer, M.-S. Kovačević, W. Schubert, B. Tomljenović	obvezni
OG 1	GROUND PROFILE CHARACTERIZATION	M. Garašić, J. Pusztai, S. Strelec	izborni
OG 2	NUMERICAL AND CONSTITUTIVE MODELLING	S.Škrabl, V. Szavits-Nossan	izborni
OG 3	SOIL-STRUCTURE INTERACTION	R. Marte, S. Škrabl, A. Szavits-Nossan,	izborni
OG 4	SOIL DYNAMICS AND GEOTECHNICAL EARTHQUAKE ENGINEERING	T. Ivšić, P. Kvasnička, A. Umek	izborni
OG 5	GEOTECHNICAL ENGINEERING	M. Dobrilović, G. Durn, K. Ivandić, M.S. Kovačević, B. Kovačević Zelić, B. Soldo, W. Schubert, L. Trauner	izborni

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**HYDROGEOLOGY**
COURSE STATUS:	Mandatory course (MWG 1)
LECTURER'S	**Božidar Biondić, Johann Fank, Renata Jecl, Kristijan Posavec, Stephan Semprich, Ludvik Trauner**

COURSE DESCRIPTION:

Karst

- Basic geological characteristics of Karst areas; Basic characteristics of Karst aquifers; Application of different research methods; Aquifers human impact; Experiences of different European countries in the protection of Karst aquifers; Vulnerability mapping; Criterions for the definition of protection zones; Management of coastal Karst aquifers – fresh-salt water interaction – remediation methods; Groundwater intake structures in Karst areas; Case studies in different Mediterranean countries; Water protection in national parks and other protected areas.

Granular soils

- The origin of porosity and permeability; Groundwater movement; Main equations of flow and solute transport; Sources of groundwater contamination; Contaminants in groundwater; Risk assessment; Solute plumes as a manifestation of processes; Design and quality assurance issues in solute sampling: Sampling methods; Indirect methods for detecting contamination; Methods of remediation: Containment; Pump and treat; Interceptor systems; Soil-vapour extraction; Air sparging; Intrinsic Bioremediation; Bioventing and bioslurping; Abiotic chemical destruction. Case studies in Remediation.

Unsaturated soils

- Soils (nature and origin, soil profile, texture and structure, classification, clay minerals); Oxides and hydroxides (nature and origin, size, cation exchange, specific adsorption); Natural organic matter (nature and origin, geochemical reactions, interactions between organic matter and anthropogenic chemicals); Reactions in the unsaturated zone (gas dissolution and redistribution, carbonate and silicate dissolution, sulphide oxidation, gypsum precipitation and dissolution, ion exchange and sorption, organic reactions); Anthropogenic influences (agricultural pollution, industrial pollution, solid and liquid waste, petroleum contamination, acid rain, mining); Pollutants (heavy metals - origin and interactions; pesticides, organics); Chemical analysis of water, soils and sediments (total versus partial; analytical methods); Mineralogical analyses of soils and sediments; Remediation of contaminated soils.

Soil sedimentation

- Problems of soil sedimentation; Geomechanical, chemical and microbiological laboratory tests; Hydrodynamical analysis of sediments; Monitoring techniques.

Seepage flow in jointed rock

- Modelling of seepage flow through fissured rock; Laboratory and field tests according to groundwater flow in rock; Equation for steady flow of incompressible viscous liquids; Laminar and turbulent flow in fissures; Discrete and continuous models; Seepage forces and hydrostatic uplift; Input data for the design of structures.

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

The lecture will be based - beside others - on the EU COST action 65 ''Hydrogeological aspects of groundwater protection in Karst areas'', COST action 620 ''Vulnerability" and COST action 621 ''Management of coastal Karst aquifers''. Students will acquire knowledge on contaminants in groundwater and methods of remediation, acquire skills in applying knowledge on solving specific problem; Recognize soil horizons and types, describing soil

characteristics; Identify anthropogenic influences on soil, sediments and water; Describe main reactions in the unsaturated zone; Interpret mineralogical and chemical results for soils and sediments; Development opinions, judgements and decisions for soil remediation; Acquainted with the principles of sedimentation of soil in water and seepage flow in rock.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Appelo, C.A.J.; Postma, D. (1994). Geochemistry, Groundwater and Pollution, A.A.Balkema Publishers, 400.
2. Aquifer Remediation Wells, The Class V Underground Injection Control Study (1999). EPA, Office of Groundwater and Drinking Water (4601), EPA/816-R-99-0124p, (available on web site).
3. Biondić, B.; Biondić, R.: Dukarić, F. (1988). Protection of Karst aquifers in the Dinarides in Croatia. Environmental Geology, Springer, vol. 34/4, pp 309-320.
4. Biondić, B.; Kapelj, S.; Mesić, S. (1997). Natural tracers – indicators of the Vrana lake water origin – Cres, Croatia. Intern. Symp. On water tracing, Balkema, Portorož, Slovenia.
5. Biondić, B.; Biondić, R. (2003). State of sea water intrusion of the Croatian coast. Book ‘’Coastal aquifers intrusion technology: Mediterranean countries /Lopez-Geta, de Dios Gomez, dela Orden, IGME, Spain, pp 225-238.
6. Bradl, H.B. (ed.) (2005). Heavy Metals in the Environment: Origin, Interaction and Remediation.- Interface Science and Technology – Volume 6, 269.
7. Dixon, J.B.; Weed, S.B. (1989). Minerals in Soil Environments.- Soil Science of America, 1244.
8. Domenico, P.A.; Schwartz F.W. (1998). Physical and Chemical Hydrogeology.
9. Hsai-Yang Fang: Introduction to Environmental Geotechnology.- CRC press. Boca Raton, New York, 652.
10. Malcolm E.S. (ed.) (2001). Handbook of Soil Science.- CRC press. London-New York-Washington.
11. Richardson, M. (ed.) (1995). Environmental Toxicology Assessment.- Taylor & Francis, 438.
12. Saether, O.M.; de Caritat, P. (1997). Geochemical Processes, Weathering and Groundwater Recharge in Catchments.- A.A.Balkema Publishers, 400.
13. Schüring, J.; Schulz, H.D.; Fischer, W.R.; Böttcher, J.; Duijnisveld (eds.) (2001). Redox - Fundamentals, Processes and Applications.- Springer, 251.
14. Survactant-Enhanced Aquifer Remediation (SEAR) Design Manual, NFESC Technical Report TR-2206-ENV, Naval Facilities Engineering Command, Washington DC, (available on web site).
15. Survactant-Enhanced Aquifer Remediation (SEAR) Implementation Manual, NFESC Technical Report TR-2206-ENV, Naval Facilities Engineering Command, Washington DC, (available on web site).
16. Morrison, G.L.; Fan, J. (1998). Reservoir sedimentation handbook. USA.
17. Thornton, I (ed.) (1983). Applied Environmental Geochemistry.- Academic Press, 501.
18. Tulipano, G.; Biondić, B. et al. (2005). Groundwater management of costal karst aquifers. EU COST 621 action, Luxemburg.
19. Wittke, W. (1990). Rock Mechanics – Theory and Applications with Case Histories, Springer Verlag, Berlin.
20. Zwahlen, F. et al. (2004). Vulnerability and risk mapping for the protection of carbonate (karst) aquifers. EU COST action 620, Bruxelles.

QUALITY ASSURANCE METHODS:

An anonymous questionnaire will be filled in by all of the course participants. This procedure is compulsory for all subjects and is aimed at evaluation both of the teacher's performance (quality of delivery) and of the overall content and structure of the course.

15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**ADVANCED SOIL MECHANICS**
COURSE STATUS:	Mandatory course (MG 1)
LECTURER'S	**Tomislav Ivšić, Antun Szavits-Nossan, Vlasta Szavits-Nossan, Bojan Žlender**

COURSE DESCRIPTION:

Soil behaviour
- Soil models
- Soil structure: its formation, stability and relationship to properties
- Conduction phenomena
- Volume change behaviour.
- Mechanics of granular materials (stress, strain and fabric tensors)
- Friction behaviour of granular materials
- Continuum theory and discrete element approach
- Observation and findings from experimental studies

Time dependent soil deformation
- Main aspects of soil rheology
- Elasto-visco plastic models
- Test procedures
- Consolidation and swelling processes

Mechanics of unsaturated soil
- Problems of unsaturated soils
- Saturated and unsaturated soils from the aspect of flow and stress-strain relationship
- Phase Relationships of the soil skeleton, pore water and air
- Stress state variables, constitutive equations, flow rules
- Flow of water through unsaturated soils
- Consolidation and creep in unsaturated soils
- Measurements of soil suction, permeability functions, shear strength parameters, volume change indices
- Numerical modelling of unsaturated soils

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

The program of this course is designed to enable students to gain knowledge on mechanical phenomena and their description in specific topics in soil mechanics.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Capriz, G.; Ghionna, V.N.; Giovine, P. (2002). Modelling and Mechanics of granular and porous materials. Series: Modelling and simulation in Science, Engineering and technology, Birkhäuser book, Springer.
2. Fredlund, D.G.; Rahardjo, H. (1993). Soil mechanics for unsaturated soils. John Wiley & Sons, Inc. New York.
3. Ng, C.W.W. (2007). Advanced unsaturated soil mechanics and engineering. Taylor and Francis.

QUALITY ASSURANCE METHODS:

An anonymous questionnaire will be filled in by all of the course participants. This procedure is compulsory for all subjects and is aimed at evaluation both of the teacher's performance (quality of delivery) and of the overall content and structure of the course.

15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**ADVANCED ROCK MECHANICS**
COURSE STATUS:	Mandatory course (MG 2)
LECTURER'S	**Daniel Scott Kieffer, Meho-Saša Kovačević, Wulf Schubert, Bruno Tomljenović**

COURSE DESCRIPTION:

Structural geology

- Application in engineering work. Earth surface's dynamics, landslides, erosion and earthquakes.
- Joints and fractures. Morphology; genetic classification; Tensional, compression and shear joints; joint-face ornamentation and associated microstructures; Development of antitaxial and syntaxial veins; Relationship between major types of joints and principal stress directions; Methods of mapping of joints and shear fractures
- Faults. Morphology and kinematics; determination of slip on faults; Dynamic analysis of faulting; Transition of faults into shear zones with progressive deformation
- Folds. Kinematical analysis of folding; orientation and distribution of joints and faults associated with folds.
- Structural projection techniques
- Tunnel trace map

Rock mechanical testing

- Standard specification and recommendation for rock mechanical tests
- In-situ tests for rock mechanics
- Stress strain measurements
- Determination of shear strength of discontinuities.
- Rock mass classification
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Stress-strain relationship of jointed rock

- Theory and analysis of primary and secondary stresses in a rock mass
- Significance of rock strength and stress
- Modelling of stress strain behaviour for numerical calculations

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

The aim of this course is to get the students acquainted with the principles of structural geology, rock mechanical stress strain behaviour and its testing procedures.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Davis, G.H.; Reynolds, S.J. (1966). Structural Geology of rocks and regions. John Wiley & Sons, New York.
2. Hudson, J.A. (1993). Comprehensive Rock Engineering, Vol. 3: Rock Testing and site characterization. Pergamon Press.
3. Lama, R.D.; Vutukuri, V.S. (1974). Handbook on mechanical properties of rock. Volume I-IV, Trans Tech Publications, Clausthal, Germany.
4. Ramsay, J.G.; Huber, M.I. (1987). The techniques of modern structural geology. Academic Press, Inc, London.

QUALITY ASSURANCE METHODS:

An anonymous questionnaire will be filled in by all of the course participants. This procedure is compulsory for all subjects and is aimed at evaluation both of the teacher's performance (quality of delivery) and of the overall content and structure of the course.

15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**GROUND PROFILE CHARACTERIZATION**
COURSE STATUS:	Optional course (OG 1)
LECTURER'S	**Mladen Garašić, Jozsef Pusztai, Stjepan Strelec**

COURSE DESCRIPTION:

Subsurface exploration

- Investigation strategies and design of investigation programs with respect to the progress in the course of a project (feasibility study, preliminary design, detailed design, construction planning)
- Types and selection of appropriate methods of site investigation and testing, depending of geological conditions and objectives
- Soil and rock exploration; safety guidelines for geotechnical borings
- Geophysical methods
- Field measurements of permeability
- Soil properties from Cone penetration, pressuremeter and deflectometer tests

Rock mass characterization

- Assessment and documentation of rock and rock mass properties in the field, evaluation of important parameters

Karst hydrogeology

- Karst terrain genesis
- Role of water in the Karst terrains
- Groundwater exploration and protection in the Karst
- Storage and dynamics of ground water in Karst areas
- Karst hydrological objects
- Application of Karst hydrogeology

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

Advanced understanding of subsurface exploration, rock mass characterization and Karst hydrogeology.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Ford, D.; Williams, P. (1989). Karst geomorphology and hydrology. Chapman & Hall.
2. Goodman, R.E. (1993). Engineering geology. John Wiley, New York.
3. Lunne, T.; Robertson, P.K.; Powell, J.J.M. (1992). Cone penetration testing. Blackie Academic &Professional.
4. Mayne,P.W.; Christopher, B.R.; DeJong, J. (2001). Manual on subsurface investigation, geotechnical site characterization.
5. Priest, S.D. (1993). Discontinuity analysis for rock engineering. Chapman & Hall Publishers.

QUALITY ASSURANCE METHODS:

An anonymous questionnaire will be filled in by all of the course participants. This procedure is compulsory for all subjects and is aimed at evaluation both of the teacher's performance (quality of delivery) and of the overall content and structure of the course.

15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**NUMERICAL AND CONSTITUTIVE MODELLING**
COURSE STATUS:	Optional course (OG 2)
LECTURER'S	**Stanislav Škrabl, Vlasta Szavits-Nossan**

COURSE DESCRIPTION:

Continuum approach

- Overview of numerical methods in geotechnics
- Introduction to theory of plasticity. Elastic-plastic behaviour, mathematical description with respect to numerical methods.
- Constitutive models for soil and rock. Discussion of various models and their application, interpretation of results, shortcomings of simple constitutive models, influence of material properties on results of the finite element analysis.
- Input data: finite element mesh, boundary conditions, soil and rock strata, soil and rock parameters, initial stress state, pore pressure condition, construction phases
- Simulation of standard tests
- Simulation of construction sequences
- Back analysis and case histories
- Introduction to the application and limitation of elastic plastic constitutive models for practical problems
- Emphasis is given on the critical assessment of numerical results

Discrete approach

- Definition and history of discrete elements models
- Phenomena and modelling of particle breakage
- PFC and UDEC software and its application

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

Students acquire a basic and advanced understanding of the concepts of soil modelling with special emphasis to geotechnics. They will be able to understand features of simple and advanced constitutive soil models.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Muir Wood, D. (2004). Geotechnical Modelling. Spon Press, Taylor & Francis Group, London.
2. Potts, D.M., Zdravković, L. (1999). Finite element analysis in geotechnical engineering, Theory. Thomas Telford, London.
3. Potts, D.M.; Zdravković, L. (2001). Finite element analysis in geotechnical engineering, Application. Thomas Telford, London.
4. Sharma; Saxena; Woods (1999). Distinct element modelling in geomechanics. Balkema.

QUALITY ASSURANCE METHODS:

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15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**SOIL-STRUCTURE INTERACTION**
COURSE STATUS:	Optional course (OG 3)
LECTURER'S	**Roman Marte, Stanislav Škrabl, Antun Szavits-Nossan**

COURSE DESCRIPTION:

Geotechnical structures

- Classification of damages (sources of damages, categories, …)
- Role and importance of soil-structure interaction
- Shallow foundations (e.g. stiffness of buildings, settlements, deformation of utilities, …)
- Pile foundations (e.g. pile raft foundation, bearing capacity, Osterberg technique, vibrations from pile driving, stability of borehole using slurry, …)
- Laterally loaded piles
- Lateral loading and deflection of existing retaining structures
- Modelling of anchors and struts for retaining structures of excavations
- Base heave due to groundwater flow of excavations
- Staged construction of excavation
- Surface settlements and horizontal strain due to tunnelling
- Loading and deformation of tunnels due to surface structures
- Staged construction in tunnelling
- Environmental impact from tunnel construction (e.g. vibrations from blasting, vibration from trains, …)
- Dam foundations (e.g. settlements, influence of seepage forces, erosion, …)
- Case histories

Geotechnical monitoring

- Basics of the methods used for geo-measurements
- Design of measurement programmes
- Measurements of displacements and deformations, stress and strain, temperature and water content
- Analysis techniques
- Application and case histories, geotechnical measurements and geodetic monitoring of dams, tunnels, foundations and slopes
- Practical using geotechnical sensors
- Analysis of data
- Practical analysis of monitoring measurements

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

Advanced understanding of principles of compatability of contact stresses and deformations between soil-rock media and related structure elements.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Bull, J.W. (1994). Soil-structure interactions: numerical analysis and modelling. E & F N, London.
2. Dunnicliff, J. (1993). Geotechnical Instrumentation for Monitoring Field Performance. Wiley-Interscience.
3. Kastner, R.; Kjekstad, O.; Standing, J. (2003). Avoiding damage caused by soil-structure interaction: lessons learnt from case histories. Thomas Telford, London.
4. Ng, C.W.W.; Simons, N.; Menzies, B. (2004). A short course in soil-structure engineering of deep foundations, excavations and tunnels. Thomas Telford, London.
5. Wood, D.M. (2004). Geotechnical Modelling. Spon Press, London.

QUALITY ASSURANCE METHODS:

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15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**SOIL DYNAMICS AND GEOTECHNICAL EARTHQUAKE ENGINEERING**
COURSE STATUS:	Optional course (OG 4)
LECTURER'S	**Tomislav Ivšić, Predrag Kvasnička, Andrej Umek**

COURSE DESCRIPTION:

Wave propagation in soil and rock
- Vibration fundamentals
- Instruments for measurement of oscillations
- Waves in elastic media: longitudinal and transversal waves in rock, reflection, waves in infinite media, surface waves, attenuation, dispersion
- Equations of motion in the time domain. Transformation to the modal amplitudes
- Fourier and Laplace transformations, methods of discrete transformations
- Three dimensional wave equation, dynamic stiffness matrix

Cyclic behaviour of soil and rock
- Properties of cyclic loaded soils. Hysteresis, stiffness, damping, strength, cyclic volume strains, and pore water pressures, laboratory tests, field tests.

Dynamic soil-structure interaction

Geotechnical earthquake engineering
- Evaluation of site response using wave propagation techniques
- Evaluation of liquefaction potential
- Seismic analysis of retaining and earth structures
- Case studies from previous earthquakes

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

Advanced understanding of soil and rock dynamical behaviour as well as modelling in geotechnical earthquake engineering.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Achenbach, J.D. (1980). Wave propagation in elastic solids. North-Holland, Amsterdam.
2. Das, B.M. (1993). Principles of Soil Dynamics. Brooks/Cole, Pacific Growe, CA.
3. Ishihara, K. (1996). Soil behaviour in earthquake geotechnics. Clarendon Press, Oxford.
4. Kramer, S.L. (1996). Geotechnical Earthquake Engineering. Prentice Hall, NJ.
5. Prakash, S. (1981). Soil Dynamics. McGraw-Hill, NJ.
6. Wolf, J.P. (1988). Soil-structure-interaction analysis in time domain. Prentice-Hall, Inc., Englewood Cliffs, NJ.

QUALITY ASSURANCE METHODS:

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15.02.2011, Sem

Joint Doctoral Programme "Geo-Engineering and Water Management"	
POSTGRADUATE STUDY:	Joint Doctoral Programme Geo-Engineering and Water Management
COURSE TITLE:	**GEOTECHNICAL ENGINEERING**
COURSE STATUS:	Optional course (OG 5)
LECTURER'S	**Mario Dobrilović, Goran Durn, Krešo Ivandić, Meho-Saša Kovačević, Biljana Kovačević-Zelić, Božo Soldo, Wulf Schubert, Ludvik Trauner**

COURSE DESCRIPTION:

Soil and rock improvement

- Principles of soil and rock improvement
- Improvement methods: soil replacement, drainage, compaction, grouting, jet grouting, chemical procedures, freezing, heating, vegetation
- Quality control: laboratory and field research, measuring and observational methods

Landslides, slope instabilities

- Consequences of mass movements respectively landslides
- Causes and triggering mechanisms
- Detection and assessment of potential instabilities
- Slope stability analysis: limit equilibrium and numerical methods
- Methods for stabilization of slopes
- Geosynthetic systems according to slopes and embankment construction
- Soil compaction
- Drainage and filtering rules

Tunnelling

- Advanced Tunnelling Methods
- Design and construction process
- Methods for stability analysis of underground structures
- Rock excavation methods
- Importance of studying explosives properties
- Design of underground blasting
- Computer calculations for rock blasting
- Rock Tunnel Boring Machines; types and their application; performance
- Watertightness requirement and waterproofing systems
- Construction organisation, observation, safety management
- Claims and disputes

Environmental geotechnics

Applied mineralogy:

- Mineral aggregates
- Mineralogy and key environmental systems.
- Mineral and groundwater interaction
- Weathering processes
- Mineral dust and health

Geotechnics of landfills:

- Mechanical, chemical and biological properties of waste
- Geotechnical site selection criteria for waste deposits
- Chemical and biological degradation processes
- Detailed geotechnical analysis
- Lining systems
- Collection and treatment of leachate and gas
- Landfill closure and aftercare
- Case histories

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES (*max. 500 characters – describe main goal of the subject in terms of knowledge and skills that a student would acquire by taking the course*):

Advanced understanding of principles and overview of problems and problem-solving strategies in selected topics of geotechnical engineering.

RECOMMENDED LITERATURE (*with detailed data on publisher and year of publication*):

1. Giani, P.G. (1992). Rock slope stability analysis. A.A. Balkema, Rotterdam 3. Hoek,E.; Bray, J.W. (1977). Rock slope engineering. The Institution of Mining and Metallurgy, London.
2. Hudson, J.A. (1993). Comprehensive Rock Engineering, Pergamon Press.
3. Mitchell, J.M.; Jardine, F.M. (2002). A guide to ground treatment. CIRIA publication C573, London.
4. Moseley, M.P. (1993). Ground Improvement. CRC Press, Boca Raton, USA.
5. Persson, A.; Holmberg, R.; Lee, J. (1993). Rock blasting and explosives engineering. CRC Press, USA.
6. Qian, X.; Koerner, R.M.; Gray, D. (2002). Geotechnical aspects of landfill design and construction. Prentice Hall, New Jersey 2. Rowe, R.K.; Quigley, R.M.; Brachman, R. Booker, J.R. (2004). Barrier Systems for Waste Disposal Facilities. 2nd. Edition, Taylor & Francis.
7. Vaughan, D.J.; Wogelius, R.A. (eds.) (2000). Environmental mineralogy. Eötvös University Press, Budapest.
8. Wittke, W. (1990). Rock Mechanics – Theory and Applications with Case Histories, Springer Verlag, Berlin.

QUALITY ASSURANCE METHODS:

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15.02.2011, Sem