UNIVERSITY UNDERGRADUATE STUDIES

University Undergraduate study – GEOLOGY

Year 1						
Semester 1			**Winter semester**		**Summer semester**	
Lecturers	**ISVU code**	**Obligatory Courses**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
Z. Franušić	36211	Mathematics I	2+1+0	4		
Ž. Soldin	36206	Chemistry I	2+0+2	5		
D. Tibljaš	36199	General mineralogy	3+3+0	7		
B. Cvetko Tešović	36200	Physical geology	3+3+0	7		
J. Sremac V. Ćosović	36201	General palaeontology	3+3+0	7		
K. Fučkar Reichel J. Vulić	38079	Physical training and health education 1*	0+2+0			
Semester 2			**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
D. Ilišević	36212	Mathematics II			2+1+0	4
Ž. Soldin	36207	Chemistry II			2+0+2	5
A. Tonejc	36208	Physics			3+2+0	6
V. Bermanec	36213	System of mineralogy			3+3+0	7
B. Primc Habdija	36209	Fundamentals of biology			2+1+0	3
	36210	Field course in geology I (60 hours/year)				5
K. Fučkar Reichel J. Vulić	38080	Physical training and health education 2*			0+2+0	
SUMMARY:			**25**	**30**	**21**	**30**

L = lectures, **P** = practices (laboratory), **S** = seminars.
* Obligatory courses in accordance to the Statute of the University of Zagreb

Year 2						
Semester 3			**Summer semester**		**Summer semester**	
Lecturers	**ISVU code**	**Obligatory Courses**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
D. Bucković	41025	Historical geology I	3+2+0	6		
N. Tomašić	41026	Mineral optics	2+4+0	5		
J. Sremac Z. Bajraktarević	41027	Systematic palaeontology	3+3+0	7		
S. Markušić	41028	Geophysics	2+1+0	5		
G. Medunić D. Tibljaš	41029	Principles of elemental and phase analysis	2+2+0	5		
	41030	Seminar I	0+2+0	2		
K. Fučkar Reichel J. Vulić	40849	Physical training and health education 3*	0+2+0			
Semester 4			**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
D. Bucković	41031	Historical geology II			2+2+0	4
D. Balen	41032	Igneous and metamorphic petrology			3+3+0	7
M. Kovačić	41033	Sedimentary petrology			3+3+0	7
Z. Bajraktarević	41035	Micropalaeontology I			1+2+0	3
	41036	Seminar II			0+1+0	2
	41037	Field course in geology II (90 hours/year)				7
K. Fučkar Reichel J. Vulić	40850	Physical training and health education 4*			0+2+0	
SUMMARY:			**26**	**30**	**20**	**30**

L = lectures, **P** = practices (laboratory), **S** = seminars.
* Obligatory courses in accordance to the Statute of the University of Zagreb

Year 3						
Semester 5			**Summer semester**		**Summer semester**	
Lecturers	**ISVU code**	**Obligatory Courses**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
V. Tomić	63318	Geological mapping I	1+6+0	6		
B. Tomljenović	63320	Structure geology and tectonics	2+2+0	5		
M. Lapaine	63321	Software in geology	2+2+0	5		
G. Medunić	41041	Geochemistry	2+1+0	4		
A. Bačani	41042	Hydrogeology	2+1+0	4		
see table		Elective course		4		
	63322	Field course in geology IIIA (30 hours/year)		2		
Semester 6			**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
J. Halamić	63319	Geological mapping II			1+2+0	3
L. Palinkaš	41043	Geology of mineral deposits			3+1+0	5
S. Mihalić	41044	Engineering geology			2+1+0	4
E. Mrinjek	41045	Sedimentary basins			3+2+0	5
		Elective course				4
	41046	Seminar III			0+2+0	2
	63323	Field course in geology IIIB (105 hours/ year)				7
SUMMARY:			**21#**	**30**	**17#**	**30**

L = lectures, **P** = practices (laboratory), **S** = seminars.
Without elective courses

Elective						
V. Ćosović	63324	Methods in palaeontology	1+2+0	4		
G. Kniewald, V. Bermanec	63325	Gemmology	2+1+0	4		
I. Gušić	63326	History of geology	2+0+0	4		
M. Juračić	63327	Marine geology	2+2+0	4		
D. Balen	63328	Rock microstructure			0+3+0	4
A. Horvat	63329	Quaternary geology			2+0+0	4
N. Tomašić	63330	Universal stage methods			1+2+0	4

UNIVERSITY GRADUATE STUDIES

University Graduate Study – GEOLOGY, ENVIRONMENTAL GEOLOGY

To be filled up to 120 ECTS from the list of elective courses in the years 1 and 2

Year 1						
Semester 1			**Winter semester**		**Summer semester**	
Lecturers	**ISVU code**	**Obligatory Courses**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
E. Mrinjek	44003	Regional geology and global tectonics	4+0+0	5		
L. Palinkaš	44008	Quantitative and isotope geochemistry	3+2+0	7		
see table		Compulsory elective course		6		
see table		Elective course		5		
see table		Elective course		5		
	44011	Seminar IV	0+2+0	2		
Semester 2			**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
G. Medunić	44013	Geostatistics			2+1+0	4
see table		Compulsory elective course				6
see table		Elective course				5
see table		Elective course				5
see table		Elective course				5
	44018	Field course in geology IV (75 hours per year)				5
SUMMARY:			**11#**	**30**	**3#**	**30**

L = lectures, **P** = practices (laboratory), **S** = seminars.
Without elective courses

Year 2						
Semester 3			**Winter semester**		**Summer semester**	
Lecturers	**ISVU code**	**Obligatory**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
T. Marjanac	44021	Elements of scientific work	2+1+0	5		
see table		Elective course		5		
see table		Elective course		5		
	44028	Seminar V	0+3+0	3		
	44031	Field project	0+7+0	12		
Semester 4			**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
see table		Elective course				5
	44034	Seminar (thesis related)				5
	44037	Thesis				20
SUMMARY:			**13#**	**30**		**30**

L = lectures, **P** = practices (laboratory), **S** = seminars.
Without elective courses

Notice: At least six courses have to be chosen from the list of elective courses for the study branch attended. The elective courses should be selected following the suggestions of the study adviser.

Obligatory elective (Year 1)

Semester 1						
			Winter semester		Summer semester	
Lecturer	**ISVU code**	**Obligatory elective course**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
GEOLOGY AND PALEONTOLOGY						
T. Marjanac	44085	Karst geology	2+1+0	6		
MINERALOGY AND PETROLOGY						
D. Balen	44086	Petrogenesis	2+1+0	6		
ENVIRONMENTAL GEOLOGY						
	44088	Geohazards	2+1+0	6		

Semester 2						
			Winter semester		Summer semester	
Lecturer	**ISVU code**	**Obligatory elective course**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
GEOLOGY AND PALEONTOLOGY						
V. Ćosović	44089	Paleoecology			2+1+0	6
MINERALOGY AND PETROLOGY						
D. Tibljaš F. M. Brückler	44090	Crystallography			1+2+0	6
ENVIRONMENTAL GEOLOGY						
M. Juračić	44087	Environmental geology			2+1+0	6

Elective (Year 1and 2)

Semester 1 or 3						
			Winter semester		Summer semester	
Lecturer	**ISVU code**	**Course**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
GEOLOGY AND PALEONTOLOGY						
V. Ćosović	44101	Methods in paleontology	1+2+0	5		
I. Gušić	44099	History of geology	2+0+0	5		
I. Gušić	44091	Paleontological aspects of evolution	2+1+0	5		
M. Juračić	44100	Marine geology	2+2+0	5		
T. Marjanac	44092	Stratigraphical classification and correlation	2+1+0	5		
A. Moro	44093	Selected topics in invertebrata paleontology	2+1+0	5		
E. Prelogović	44124	Structural geomorphology	2+1+0	5		
B. Saftić	44094	Geology of fossil fuels	2+1+0	5		
*Recommended in Year 2						
MINERALOGY AND PETROLOGY						

G. Kniewald V. Bermanec	44098	Gemmology	2+1+0	5		
D. Tibljaš G. Medunić	44125	Phase and elemental analysis	1+2+0	5		
ENVIRONMENTAL GEOLOGY						
V. Bermanec G. Kniewald	44102	Environmental mineralogy	2+1+0	5		
G. Kniewald V. Bermanec	44103	Instrumental methods in envrionmental analysis	2+1+0	5		
G. Medunić	44104	Environmental geochemistry	2+1+0	5		
G. Medunić	44105	Environmental law	2+1+0	5		
Semester 2 and 4						
Lecturer	**ISVU code**	**Course**	**L+P+S**	**ECTS**	**L+P+S**	**ECTS**
GEOLOGY AND PALEONTOLOGY						
Z. Bajraktarević	44108	Selected topics in vertebrata paleontology			2+1+0	5
V. Ćosović A. Alajbeg	44106	Geology and geochemistry of crude oil			2+1+0	5
V. Ćosović	44107	Micropaleontology II			1+2+0	5
T. Marjanac	44169	Quaternary geology			3+0+0	5
J. Sremac	44109	Paleobotany			2+1+0	5
		Field project			5-12+0	5-12
	44123	Applied geophysics			2+1+0	5
MINERALOGY AND PETROLOGY						
D. Balen	41052	Rock microstructure			0+3+0	5
D. Balen	44110	Microtectonics			1+2+0	5
V. Bermanec	44111	Silicate mineralogy			2+1+0	5
V. Bermanec	44112	Non-silicate mineralogy			2+1+0	5
L. Palinkaš	44113	Interpretation of geochcemical dana			2+1+0	5
N. Tomašić	41054	Universal stage methods			1+2+0	5
G. Medunić	44114	Geochemistry of sedimentary rocks			2+1+0	5
	44126	Field techniques «MP»			0+3+0	5
ENVIRONMENTAL GEOLOGY						
S. Kapelj	44117	Hydrogeochemistry and groundwater protection			2+1+0	5
L. Palinkaš	44115	Geological aspects of waste disposals			2+1+0	5
L. Palinkaš	44116	Geochemical methods of environmental investigation			2+1+0	5
D. Tibljaš	44119	Clay mineralogy			1+2+0	5
M. Ahel	44120	Organic geochemistry of pollutants			2+1+0	5
M. Bogunović	44121	Basics of pedology			2+1+0	5
I. Jüttner J. Nuić	44118	Introduction to geotechnology			2+1+0	5
M. Romić	44122	Biogeochemistry			2+1+0	5

It is also recommended to attend a few courses of other studies held at the Faculty of Science as well as on the University of Zagreb. These courses should be selected after the advice of the study adviser.

5001	GENERAL MINERALOGY	3+3+0	0+0+0

COURSE CONTENT: Mineral definition, three-dimensional periodicity, crystal lattice, unit cell, crystal systems. Morphology, symmetry elements without translation, crystal form, habit, zone. Law of constancy of interfacial angles, spherical projection, stereographic projection, Wulff net. Theory of rational indices for crystal faces, notations for planes and lines, point groups (Herman-Mauguin symbols, names), general form. Cubic crystals forms. Forms in other systems, tetragonal and hexagonal system. Holohedral classes of orthorhombic, monoclinic and triclinic systems, problems with symmetry determinations. Crystal structure definition, atomic coordinates, symmetry elements with translation. Bravais lattices, space groups. Chemical bonds-crystal structure dependence, coordination number, coordination polyhedron, isomorphism, polymorphism. Solid solutions, exsolution, crystal defects. Appearance of minerals (crystals, aggregates), density, cleavage, parting, fracture, hardness, colour, streak, luster. X-ray diffraction, Bragg law, Laue equations, principles of unit cell dimensions determination. Division of minerals on optical properties (optically isotropic and anisotropic materials), birefringence, optical indicatrix. Division of optically anisotropic materials (uniaxial - biaxial, optically positive and negative), relief, colour, interference colours, extinction, observations in convergent light.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams consisting of theoretical part and crystal models projections, homework assignments
EXAMINATION METHODS: written exam based on crystal polihedra symmetry determination, oral exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Klein, C. (2002): Mineral Science. John Wiley & Sons, New York, 641 str.
2. Nesse, W. D. (2000): Introduction to Mineralogy. Oxford University Press, Oxford, 442 str.
3. Hibbard, M. J. (2002): Mineralogy, a geologist's point of view. McGraw-Hill, New York, 562 str.

5002	PHYSICAL GEOLOGY	3+3+0	0+0+0

COURSE CONTENT: Relation of Geology with other natural sciences. Space, origin of the Earth, planets, asteroids, comets, meteors. Shape and constitution of the Earth. Minerals and rocks key elements of the lithosphere. Plate tectonics: boundaries, causes. Magmatism and volcanism: magmatic bodies, types of volcanic rocks, volcano types, types of volcanic eruptions and their products, calderas, post-volcanic activity. Seismics: causes of earthquakes, wave types, principles of seismograph operation, seismogram, tsunami, seiches, intensity and energy of earthquakes, MCS-scale, Richter's magnitude, earthquake effects, role of substratum on earthquake effects, post-earthquake processes, applied seismic research in geology. Tectonics: bed, bedding plane properties, bed strike and dip, geological compass, concordance and discordance, folds (components, types, systems), faults (components, types, systems), overthrusts and overthrusting mechanism. Surface processes: weathering (chemical, mechanical), origin of soils, slope processes (creep, slumping, debris flow, turbidity currents, rock-falls), transport and erosion, Hjulström's diagram, sedimentation, sedimentary structures, diagenesis. Water: hydrologic cycle, rock porosity and permeability, types of water, water table, aquifer and barrier, threats and protection of ground water, water in islands, types of springs. Rivers: drainage systems, drainage basin and divide, stream characteristics, stream graded profile, base level, river types, rivers and geological structures, flood plains, alluvial terraces, deltas (Gilbert-deltas, ordinary deltas), delta progradation, estuary (origin, types), alluvial fans and fan deltas. Lakes: types, hydrology, sediments, response to base-level change, ecological threats. Karst: genesis, geomorphology (surficial and underground features), hydrogeology of karst, origin of caves, cave morphology and tectonics, response to base-level change, ecological threats, evolution of karst. Snow, avalanches, geological role of avalanches. Ice: origin of glacier ice, ice properties, types of ice cover on the Earth, glaciers (composition, movement), glacial geomorphology, glacial sediments (moraines, proglacial lake deposits) and sedimentary bodies (eskers, drumlins, glaciofluvial and glaciomarine deltas), fiords, sandar. Deserts: distribution, origin/causes, types, desert geomorphology, evolution of desert landscape, sediments and sedimentary bodies (dunes, types of dunes), draa, ergs, desert hydrogeology, oasis, wadi, desertification in Mesopotany, water and Middle East conflicts. Seas and Oceans: volume of seas on the Earth, chemistry of sea-water, tides, sea currents, waves, wave erosion, ravinement, classification of seas, coastal types and coastal geomorphology, effects of hurricanes and storms on coastal processes, carbonate platforms, deep-sea physiography, processes and sediments in various bathymetric zones, sea-level change (relative, eustatic), types of depositional basins. Earth physics: isostasy, glacioisostasy, heat (radiation, heat flux), magnetism (cause, van Allen's radiation belts, paleomagnetism). Geological time: dating in geology (relative, radiometric), stratigraphical systems (geochronological, chronostratigraphical, lithostratigraphical). Evolution of life on the Earth: fossilisation, types of fossils, faunal turnovers in Earth history. Environments and facies.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: all exercises successfully completed, all colloquiums passed.
EXAMINATION METHODS: written and oral examination
REQUIRED LITERATURE:
1. Murck B.W., Skinner B.J. & Porter S.C. (1996): Environmental Geology, John Wiley & Sons, New York.
2. Plummer, Ch.C. & McGeary, D. (1991): Physical Geology, 5th. Ed., WC Brown Publishers.
3. Plummer, Ch.C., McGeary, D. & Carlson, D. (2001): Physical Geology, 8th Ed., Mc Graw Hill, Boston.
4. Tarbuk, E.J. & Lutgens, F.K. (1988): Earth Science. 5th. Ed., Merrill Publ. Company, Columbus.

5003	**GENERAL PALEONTOLOGY**	**3+3+0**	**0+0+0**

COURSE CONTENT: Getting familiar with essential terms, principles and applications of palaeontology. Short review of the main fossil groups
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: regular presence at exercises, short tests during the semester, successfully presented essay
EXAMINATION METHODS: written exam (test), oral exam
REQIRED LITERATURE:
1. Doyle,P.: Understanding Fossils. Wiley, Chichester, 1996
2. Raup,D.M. & Stanley, S.M.: Principles of Palaeontology. Freeman, San Francisco, 1978.
3. Sremac,J.: Opća paleontologija. Skripta, PMF, Zagreb, 1999.

5004	**SYSTEM OF MINERALOGY**	**0+0+0**	**3+3+0**

COURSE CONTENT: Historical principles of mineral classification. Crystal-chemical classification of minerals. Classification of minerals. Elements. Sulphides. Oxides. Halogenides. Carbonates. Nitrates, iodates and borates. Sulphates. Phosphates. Molibdates, tungstenates and orgnanic minerals. Nesosilicates. Sorosilicates and cyclosilicates. Inosilicates. Phyllosilicates. Tectosilicates.
PREREQUISITES FOR THE COURSE: General mineralogy
TERMS FOR RECEIVING THE SIGNATURE: attendance at classes (90%), all short tests passed
EXAMINATION METHODS: written and oral
REQUIRED LITERATURE:
1. Bermanec, V. (1999): Sistematska mineralogija – mineralogija nesilikata. Targa, Zagreb. 264 str.
2. Slovenec, D., Bermanec, V. (2003); Sistematska mineralogija – mineralogija silikata. Denona, Zagreb. 359 str.

5005	**HISTORICAL GEOLOGY I**	**3+2+0**	**0+0+0**

COURSE CONTENT: Founders of Historical Geology. Geological time scale. Radiometric dating of rocks. Origin of atmosphere, seas, oceanic and continental crust. Composition of Earth's cratons and shields. Beginning of life. Life in the Proterozoic. Proterozoic shields and Proterozoic ice ages. Life in the Cambrian and Ordovician. Paleogeography of the Cambrian and Ordovician. Life in the Silurian and Devonian. Paleogeography of the Silurian and Devonian. Life in the Carboniferous and Permian. Paleogeography of the Carboniferous and Permian. Paleozoic successions in the Dinarides.
PREREQUISITES FOR THE COURSE: Physical geology, General paleontology
METHODS TO EVALUATE STUDENT PERFORMANCE: 5 written tests during the course.
EXAMINATION METHODS: written and oral
REQUIRED LITERATURE:
1. Prothero, D. R. & Dott, R. H.: Evolution of the Earth. McGraw-Hill Science/Engineering/Math, 2001;
2. Levin, L.H.: The Earth Through Time. John Wiley & Sons, 2003;
3. Cooper, J.D., Miler, R.H. & Patterson, J.: A Trip Through Time: Principals of Geology. Merrill Publishing Co., 1990;
4. Wicander, R., Monroe, J.S.: Geology - Evolution of the Earth and Life Through Time. West Publishing Co., 1989;
5. Stanley, S.M.: Earth and Life Through Time. W. H. Freeman and Co., 1989;
6. Herak, M.: Geologija. Školska knjiga, Zagreb, 1990.

5006	**MINERAL OPTICS**	**2+4+0**	**0+0+0**

COURSE CONTENT: Nature of light, reflection and refraction of light, index of refraction, optically isotropic and anisotropic crystals, birefringence, optical indicatrix, polarisation of light, polarisation microscope, thin sections. Orthoscopic examinations without analyser: index of refraction, relief, Becke line, pseudoabsorption, colour, pleochroism. Orthoscopic examinations with analyser: extinction (parallel, symmetrical, inclined), interference colours, determination of vibration direction of polariser, accessory plates, determination of vibration directions for slow and fast wave, sign of elongation. Conoscopic examinations: interference figures for uniaxial and biaxial crystals, optic sign, determination of optic angle, optic axes angle dispersion. Optical properties of isotropic minerals: spinel, garnet, leucite. Optical properties of uniaxial anisotropic minerals: quartz, calcite, turmaline. Optical properties of biaxial anisotropic minerals: olivine and serpentine. Optical properties of biaxial anisotropic minerals: ortho- and clinopiroxene. Optical properties of biaxial anisotropic minerals: amphibole (tremolite-actinolite series, hornblende, glaucophane). Optical properties of biaxial anisotropic minerals: mica (muscovite and biotite). Optical properties of biaxial anisotropic minerals: alkali feldspar (sanidine, orthoclase, microcline). Optical properties of biaxial anisotropic minerals: plagioclase. Optical properties of biaxial anisotropic minerals: chlorite, epidote. Optical properties of biaxial anisotropic minerals: gypsum and anhydrite. Optical properties of opaque minerals.
PREREQUISITES FOR THE COURSE: General mIneralogy, System of mineralogy
TERMS FOR RECEIVING THE SIGNATURE: regular attendance at lectures and exercises, completion of all exercises, preliminary exams
EXAMINATION METHODS: written and oral

REQUIRED LITERATURE:
1. Barić, Lj. & Tajder, M (1967): Mikrofiziografija petrogenih minerala, Školska knjiga, Zagreb, p. 235
2. Međimorec, S. (1998): Kristalna optika, interna skripta, PMF, Zagreb
3. Pichler, H. & Schmitt-Riegraf, C. (1987): Gesteinsbildende Minerale im Duennschliff, Ferdinand Enke Verlag, Stuttgart, p. 230

5007	**SYSTEMATIC PALAEONTOLOGY**	**3+3+0**	**0+0+0**

COURSE CONTENT: Introduction to body structure of the most important fossil invertebrate and vertebrate taxa, also considering their evolution, biostratigraphy and palaeogeography.
PREREQUISITES FOR THE COURSE: Physical geology, General paleontology
TERMS FOR RECEIVING THE SIGNATURE: regular attending of lectures and exercises, and succesful realization of colloquia and tasks
EXAMINATION METHODS: After the active and methodically performed colloquia and tasks at the exercises: - written exam, with recognizing fossil samples and individual taska; afterwards oral exam or examination test.
REQUIRED LITERATURE:
1. Boardman, R.S. et al.: Fossil Invertebrates. Blackwell Sci.Publ., Palo Alto, 1987.
2. Sremac, J.: Opća paleontologija. Skripta. PMF, Zagreb, 1999.
3. Benton, M.J.: Vertebrate Paleontology, Chapman & Hall, London, l998.
4. Carroll, R. L.: Vertebrate paleontology and evolution. W.H. Freeman & Co., New York, 1998,
5. Chernicoff, S., Fox, H. A. & Tanner, L. H.: Earth: Geologic principles and history.29 + 570. Houghton Mifflin Comp. Boston, New York, 2002.

5008	**MICROPALAEONTOLOGY I**	**0+0+0**	**1+2+0**

COURSE CONTENT: A short historical review. The tasks of micropaleontology. Samplings, methods of preparation. The ways of fossilisation, optical methods and ways of observation of the microfossils; Morphology, organization, ways of life and the taxonomy (foraminifera; ostracodes; calpionellids, conodonts; calcareous algae; calcareous nannoplankton; radiolaria; marine diatoms; silicoflagellates; dinoflagellates; spores and pollen) and the evolution of the most important groups of microfossils in the geological time and space. The importance of the microfossils in biostratigraphy, paleoecology and oil exploration.
PREREQUISITES FOR THE COURSE: Physical geology, General paleontology
TERMS FOR RECEIVING THE SIGNATURE: ordinary attendance of the lectures, practice as well as dealing with preliminary exams, tasks/seminars
EXAMINATION METHODS: After active and properly accomplished preliminary exams at the practice ; tasks/seminars – an exam in writing with obligatory recognition of the microfossils in preparation (in slides) and a final oral exam.
REQUIRED LITERATURE:
1. Haq, B. U. & Boersma, A.: Introduction to Marine Micropaleontology, Elsevier, New York, 1998.
2. Bignot, G.: Elements of Micropalaeontology, Graham & Trotman Lim., London 1985.
3. Riding, R. : Calcareous Algae and Stromatolites. Springer Verlag, Berlin, 1991.

5009	**PRINCIPLES OF ELEMENTAL AND PHASE ANALYSIS**	**2+2+0**	**0+0+0**

COURSE CONTENT: Introduction, division and definition of quantitative chemical analysis, numerical parameters of quantitative analysis, phases of quantitative analysis. Fundamentals of sampling, basic statistical parameters. Sample preparation, Methods of sample dissolution and destruction. Wet chemistry methods: gravimetric and titrimetric methods. electromagnetic spectrum, spectrometric methods, absorption and emission methods, other methods. Electroanalytical methods, fundamentals of redox reactions. Fundamentals of X-ray diffraction, X-ray spectrum, X-ray - matter interaction. X-ray powder method, theory, instrumentation, qualitative phase analysis, Powder Diffraction File, principles of quantitative analysis. X-ray fluorescence analysis. Fundamentals of electron microscopy. Thermal analysis.
PREREQUISITES FOR THE COURSE: General mineralogy, Chemistry I, Chemistry II
TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Jones, M.P. (1997): Methoden der Mineralogie. Ferdinand Enke Verlag, Stuttgart, 260.
2. Skoog, D.A. & Leary, J.J. (1992): Principles of instrumental analysis. Saunders College Publishing, Fort Worth, 700 str.
3. Skoog, D.A., West, D.M. & Holler, F.J. (1999): Osnove analitičke kemije. Školska knjiga, Zagreb, 951 str.
4. Whiston, C. (1987): X-ray metods, John Wiley & Sons, New York, 426 str.

5010	**HISTORICAL GEOLOGY II**	**0+0+0**	**2+2+0**

COURSE CONTENT: Living world and paleogeography of the Triassic. Continental and epicontinental Triassic successions. Tethyan Triassic successions. Dinaridic Triassic successions. Living world and paleogeography of the Jurassic. Epicontinental Jurassic successions. Tethian Jurassic successions. Dinaridic Jurassic successions. Living world

and paleogeography of the Cretaceous. Epicontinental and Tethyan Cretaceous successions. Dinaridic Cretaceous successions. Living world of the Tertiary. Paleogeography and climate of the Tertiary. European and Dinaridic Paleogene successions. Tethian and Paratethian Neogene successions, Quaternary: ice ages.
PREREQUISITES FOR THE COURSE: Physical geology, General paleontology
TERMS FOR RECEIVING THE SIGNATURE: 5 written tests during the course
EXAMINATION METHODS: written and oral exam
REQUIRED LITERATURE:
1. Prothero, D.R. & Dott, R.H.: Evolution of the Earth. McGraw-Hill, 2001;
2. Levin, L.H.: The Earth Through Time. John Wiley & Sons, 2003;
3. Cooper, J.D., Miler, R.H. & Patterson, J.: A Trip Through Time: Principals of Geology. Merrill Publishing Co., 1990;
4. Wicander, R., Monroe, J.S.: Geology - Evolution of the Earth and Life Through Time. West Publishing Co., 1989;
5. Stanley, S.M.: Earth and Life Through Time. W. H. Freeman and Co., 1989;
6. Herak, M.: Geologija. Školska knjiga, Zagreb, 1990.

5011	**IGNEOUS AND METAMORPHIC PETROLOGY**	**0+0+0**	**3+3+0**

COURSE CONTENT: Rock forming minerals, structure, texture, mode of occurrence. Intrusive, vein and extrusive rocks. Pyroclastic rocks. Earth mineral and chemical composition, magma, macro-, micro- and trace-elements, mineral mode and norms, variation diagrams, magmatic series. Classification of igneous rocks. Volcanoes. Magma origin and evolution. Magma emplacement and relative age. Magma crystallization and differentiation, crystallization and melting in binary and ternary systems. Influence of different geological factors on crystallization process. Partial melting. Igneous rocks associations, plate tectonic in magmatic cycle. Mantle, meteorites, petrology of terrestrial planets and satellites. Magmatism on the active and passive continental margins. Igneous rocks of divergent plate margins, rift, oceanic crust, upper mantle. Volcanism inside oceanic plates, hot-spots, layered mafic intrusions, continental alkalic magmatism, anorthosites. Igneous rocks of convergent margins, island arc, continental magmatic arc, ophiolite suite. Plate (continental-continental) collision, granite. Metamorphism, limits, factors, grade. Type and classification of metamorphism. Prograde and retrograde metamorphism. Protoliths and chemical composition of metamorphic rocks. Rock forming minerals, textures and structures of metamorphic rocks. Classifications - scheme and recommendations. Influence of pressure, temperature and fluids on the mineral assemblage. Metamorphic isograds, facies and facies series. Metamorphic belts. Thermal, cataclastic, regional, sea floor, burial, impact, polyphase metamorphism. Geotectonic settings of metamorphism. Application of equlibrium concepts to metamorphic rocks, geotermobarometry basics, age of metamorphism, P-T-t reaction paths.
PREREQUISITES FOR THE COURSE: General mineralogy, Physical geology, System of mineralogy
TERMS FOR RECEIVING THE SIGNATURE: short written exams after each lecture block
EXAMINATION METHODS: average of written exams, oral
REQUIRED LITERATURE:
1. Best, M.G. (2003): Igneous and metamorphic petrology.- Blackwell Publishing, 729 pp.
2. Blatt, H. & Tracy, R.J. (1996): Petrology. Igneous, Sedimentary and Metamorphic.- W.H. Freeman and co., 529 pp.

5012	**SEDIMENTARY PETROLOGY**	**0+0+0**	**3+3+0**

COURSE CONTENT: Sedimentary cycle. Standard methods of study of sediments in the field and in the laboratory. Chemical and physical weathering. Breakdown products, newly formed minerals, dissolved material. Soil-forming factors (climate, relief, substrate, vegetation). Paleosols. Erosion, transport and deposition. Properties of fluids. Transport by fluids. Bedload transport (gravel, sand). Bedforms and their stability. Suspension transport and deposition. Sediment gravity flows. Rheological properties of flows and dominant particle-support mehanisms. Depositional features diagnostic for particular type of gravity flows. Primary depositional structures and their formation. Erosional structures. Post-depositional sedimentary structures. Biogenic structures. Paleocurrent analysis. Clastic sediments: A) Sandstones, conglomerates and breccias. Sediment texture and textural maturity. Interpretation of textural parameters. Terrigenous detrital components (Q, F, Lt, heavy minerals, others). Matrix problem. Compositional maturity. The main sandstone and conglomerate types and principles of classification. Petrofacies. Principal provenance terranes in the context of plate tectonics. Diagenetic processes and environments. Compositional modification. Modification of primary porosity and permeability and their influence on quality of rocks as hydrocarbon or water reserviers. Sandstone and conglomerate bodies. Depositional environments; B) Fine-grained siliciclastic deposits-mudstones: textures, structures and mineral constituents. Organic rich black shales. Diagenetic processes in mudstones. Main types of mudrocks. Depositional environments. Marls; C) Volcanoclastic deposits. Processes and products. Diagenesis. Carbonate deposits. Mineralogy. Limestones: skeletal and non-skeletal grains, lime mud-micrite and their origin. Microbial processes and products. Limestone texture. Main types of limestones - principles of classification. Depositional and early diagenetic structures. Depositional environments: shallow marine including reefs, deep-water, non-marine. Carbonate diagenesis. Diagenetic environments. Marine, meteoric, burial diagenesis. Neomorphism. Dolomitization, dedolomitization, silicification. Evaporites. Mineralogy (gypsum, anhydrite, halite). Depositional environments. Resedimentation. Diagenesis: recrystalisation, dissolution, replacement. Evaporite sequences. Chert petrology. Cherts of biogenic origin. Cherts of anorganic origin. Phosphorites: Mineralogy. Phosphorous as essential element of live cells. Early diagenetic origin of marine phosphorites. Depositional environments. Resedimentation. Bone breccias. Guano. Sedimentary iron and manganese deposits. Environmental factors controlling their precipitation. Organic deposits. Coal: petrology, the rank stages of coal, formation and occurrence of coal. Oil shales. Formation of kerogen. The principal phases of hydrocarbons

generation. Mineralogy, occurrence, genesis and geological meaning of bauxites and laterites. How knowledge about sediments is used in human activity: excavation, tunnelling, different buildings, environments protection, mining etc.
PREREQUISITES FOR THE COURSE: General paleontology, System of mineralogy, Mineral optics
TERMS FOR RECEIVING THE SIGNATURE: Activities in preparation, discussion, reading and field work, as well as the quality of the reports.
EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:

1. Tucker, E.M. (2001): Sedimentary Petrology. An Introduction to the Origin of Sedimentary Rocks. Blackwell Science, 3. izd., IX+262 str., Oxford.
2. Tucker, E.M. (2003): Sedimentary rocks in the Field. Wiley, 3. izd., 244 str., Chichester
3. Collinson, J.D. & Thompson, D.B. (1993): Sedimentary Structures. 2. izdanje. Chapman & Hall. 207 str. London.
4. Adams, A.E., MacKenzie,W.S. & Guilford, C. (1987): Atlas of sedimentary rocks under the microscope. Longham Scientific & Techical, VII+104, London.
5. Tišljar, J. (1994): Sedimentne stijene. Školska Knjiga, IX+422, Zagreb

5013	**GEOLOGICAL MAPPING I**	**1+6+0**	**0+0+0**

COURSE CONTENT: Introduction and history of geological mapping. Types of geological maps. Relations between rocks: structures,textures and tectonical movements, thickness of divided geological units. Recognotion of geological structures on the geological maps and on the field. Graphical presentation geological structures (profiles, diagrams). Preparations for geological mapping (fotogeology, remote sensing). Field work. Cabinet work (analysis of the rocks, geological colums and profiles, explanatory notes). Special maps.
PREREQUISITES FOR THE COURSE: all geological courses from semester 1 to 4
TERMS FOR RECEIVING THE SIGNATURE: successful passing exsercise and obligatory programs
EXAMINATION METHODS: oral and written examination
REQUIRED LITERATURE:

1. Bahun, S.: Geološko kartiranje. Školska knjiga, Zagreb,1993.
2. Barnes, J.W. & Lisle, R.J: Basic Geological Mapping (fourth edition). John Wiley & Sons, Ltd, England, 2004.

5014	**STRUCTURE GEOLOGY AND TECTONICS**	**2+2+0**	**0+0+0**

COURSE CONTENT: Definitions and goals of structural geology and tectonics, the role of structural geology and tectonics in a modern multi disciplinary exploration in geosciences. Concept of detailed structural analysis: descriptive, kinematic and dynamic analysis - basic idea and principles. Exercises: The principle of stereographic projection of lines and planes. Homogeneous and non-homogeneous deformation. Coaxial and noncoaxial strain - pure shear and simple shear. Concept of incremental and finite strain ellipse and strain ellipsoid. Stress ellipsoid, resolving normal and shear stresses on Mohr stress diagrams. Stress – strain relationships: rock behaviour, role of temperature, strain rate and time for brittle and ductile deformation. Exercises: Characteristics and use of different kinds of stereonets: polar, Schmidt (equal area) and Wulff net. Plotting the orientation of lines and planes. Joints and fractures – morphology, genetic classification. Tensional, compressional and shear joints – joint-face ornamentation and associated microstructures. Development of antitaxial and syntaxial veins. Exercises: The use of stereographic projection in structural geology: Measuring the angle between lines and planes (e.g. between fault striations, mineral lineations, fault planes, etc.). Relationship between major types of joints and principal stress directions. Methods for mapping of joints and shear fractures. Joints and fractures in folded and faulted rocks and regions. Exercises: The use of stereographic projection in structural geology: Orientation of the intersection of two planes (e.g. conjugate fault planes, etc.), calculation of true and apparent dips of lines and planes – the use of method in construction of structural cross-sections. Faults – basic definitions, why and where they form. Fault rocks. Types of faults, morphology and kinemtics. Determination of slip on faults. Exercises: Stereographic projection and rotation about a horizontal and inclined axes (e.g. rotation of fold limbs, fault blocks, restoration of tilted beds, etc.). Dynamic analysis of faulting. Transition of faults into shear zones with progressive deformation – transition from cataclastic into mylonitic rocks. Types of shear zones, why and where they form. Exercises: Hour-exam #1: Principle and use of stereographic projection. Shear zones: sense of shear determination – offset and deflection of markers, shear sense indicators. Exercises: Structural analysis of mylonitic rocks presented on photographs of oriented thin sections. Stereographic projection of joints and faults – determination of stress directions. Hour-exam #2: Joints, faults and shear zones. Exercises: Stereographic projection as a statistical tool – density contouring on stereograms. Preparation and reading of density contour diagrams. Folds – descriptive analysis of folds: geometric parts of folded surface, layers and multilayers, fold size, attitude, cylindricity, symmetry and style. Exercises: Stereographic projection in analysis of folds – preparation of "β" and "π" diagrams, estimation of fold cylindricity. Fold classifications. Order of folds. Superposed folding. Exercises: Structural analysis of superposed folding on photographs. Construction of "π" diagram and estimation of fold cylindricity – real example of field data, 1. part. Kinematic analysis of folding: fundamental mechanisms of folding (flexural folding, passive folding and kink folding). Orientation and distribution of joints and faults associated with folds. Exercises: Construction of "π" diagram and estimation of fold cylindricity – real example of field data, 1. part. Foliations and lineations in tectonites. Morphological classification of foliations. Mechanisms of foliation development. Foliations (cleavages) and folds. Transposition of foliation. Exercises: Structural analysis of different types of foliations on photographs of oriented thin sections. Classification of lineations. Fold mullions, boudinage and boudins – morphology, types of and mechanism of formation. Exercises: Structural analysis of boudinage on photographs. Introduction to tectonics: structural assemblages in regions characterized by extensional, compressional and wrench (strike-slip) tectonics – basic terminology, examples and analogue models. Exercises: Interpretation of

seismic reflection profiles in regions characterized by extensional, compressional and wrench (strike-slip) tectonics. Hour-exam #3: Folds, foliations, lineations and introduction to tectonics.

PREREQUISITES FOR THE COURSE: Physical geology
TERMS FOR RECEIVING THE SIGNATURE: Completion of written answers and graphical solutions of exercises
EXAMINATION METHODS: 3 hour-exams in written form (60% of final grade), completion of written answers and graphical solutions of exercises (20 % of final grade), final exam in oral form (20% of final grade). In case of absence from more then 1 hour-exams final exam is in both written and oral form.
REQUIRED LITERATURE:
1. Davis, G.H. & Reynolds, S.J. (1996) Structural Geology of Rocks and Regions. 2-nd ed., John Wiley & Sons, New York, 776 s.
2. Lisle, R.J. & Leyshon, P.R. (2004) Stereographic Projection Techniques for Geologists and Civil Engineers. 2nd ed., Cambridge Univ. Press, 112 s.

5015	**SOFTWARE IN GEOLOGY**	**2+2+0**	**0+0+0**

COURSE CONTENT: Introduction. Software for various calculations in geological research. Introduction to GIS. Presentation of data in GIS. Planing of GIS projects. Models and data formats. Organization of spatial database. Coordination systems. Preparation and input of data. Analysis. Data presentation. Modeling.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: attendace to lectures and exercises, colloquia
EXAMINATION METHODS: written exam
REQUIRED LITERATURE:
1. Zeiler, M. (1999): Modeling our world. ESRI Press, 216 pp.
2. Grupa autora (2001) GIS and science. ESRI Press, 480 pp.
3. Grupa autora (2004): Getting started with ArcGIS. ESRI Press, 265 pp.

5016	**GEOCHEMISTRY**	**2+1+0**	**0+0+0**

COURSE CONTENT: Definition, divisions, history and position of the geochemistry in natural sciences. Fundamentals of geochemical systems, geochemical variables, termodynamics and kinetics. Chemical elements, atomic quantum model, origin of elements. Fundamentals of cosmology, origin, age and composition of the Universe. Genesis, structure and composition of planets and other bodies of the Solar system. Origin of elements, theory of nucleosyntesis. The Earth megasystem, definition of geosphere, theory of Earth structure. Structure and composition of the Earth crust. Average element composition of the Earth crust. Structure and composition of the Earth mantle. Structure and composition of the Earth core. Composition of the Earth as entity. Geochemical system of the atmosphere, structure and composition of the atmosphere. The origin of variable constituents of the atmosphere, origin and evolution of the atmosphere, losses and additions to the atmoshere. Geochemical system of the hydrosphere, Hydrologic cycle. The compotion of the atmosphere. Geochemical system of oceans; Conservative and nonconservative elements in oceans. Geochemical system of the biosphere. The composition of biosphere. Main processes in the biosphere.
PREREQUISITES FOR THE COURSE: Chemistry I, Chemistry II
TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Prohić, E. (1998): Geokemija, Targa, 554 str.

5017	**HYDROGEOLOGY**	**2+1+0**	**0+0+0**

COURSE CONTENT: What is hydrogeology. Historical development of hydrogeology. The relationship between hydrogeology and other fields of geology. Water on the Earth and global balance of the water. Hydrologic cycle. Precipitation. Runoff. Evapotranspiration. Infiltration and recharge. Base flow. Hydrologic equation. Origin of ground water. Porosity. Permeability. Classification of aquifers. Darcy's experimental law and field extensions. The boundary of Darcy's law validity. Hydraulic head and Hydraulic gradient. Hydraulic conductivity and Transmissivity. Storage properties of aquifer. Specific yield of aquifer. Main equations of flow. Boundary conditions. Pumping test method. The Theis confined aquifer method. Cooper-Jacob modification. The Hantush-Jacob leaky aquifer method. Water table aquifers. Neuman method. Specific capacity of the pumped well. Drawdown in the pumping well. Efficiency of well. Principle of superposition. Bounded aquifers. Hydrogeology of karst. Groundwater as a resources.
PREREQUISITES FOR THE COURSE: Physical geology, Mathematics I, Mathematics II, Physics
TERMS FOR RECEIVING THE SIGNATURE: rješeni zadaci u formi domaćih zadaća i položeni kolokviji
EXAMINATION METHODS: ispit se polaže pismeno (rješavanje zadataka) i usmeno (teorija), s time da položeni kolokviji tijekom semestra nose 30% konačne ocjene, pismeni 30% i usmeni 40%
REQUIRED LITERATURE :
1. P.A.Domenico & F.W.Schwartz: Physical and chemical hydrogeology. J. Willey, 1997.

5018	**SEDIMENTARY BASINS**	**0+0+0**	**3+2+0**

COURSE CONTENT: Environment and facies. Depositional systems and basins. From particle to stratigraphy. The necessity of making careful, comprehensive observations and interpreting relevant processes. The following depositional systems are discussed emphasizing relevant processes, environments, facies, evolution and architecture, intrinsic and extrinsic factors. Fluvial systems. Alluvial fans. Linear clastic shorelines. River mouths. Fan deltas. Progradation, aggradation, retrogradation, regression, transgression, continuity and discontinuity, flooding surfaces, parasequences. Role of intrinsic and extrinsic factors. Accomodation space. Relative versus global sea-level changes. Lithostratigraphic and allostratigraphic units compared to time units. Clastic shelfs. Clastic and carbonate systems compared. Coastal and shallow-marine carbonate systems. Organic reefs. Deep-water systems. Lakes. Deserts. Glacial systems. Volcanic systems. Cycles of different origins and orders. Dating. Biostratigraphy. The origin of stratigraphic time-scale. Sequence stratigraphy. Stratigraphic correlation. The character and evolution of sedimentary basins and their fills related to rifting, continental margins, subduction, and continental collision. The role of diagonal movement. Intracratonic basins.
PREREQUISITES FOR THE COURSE: Physical geology, Sedimentary petrology, Field course in geology II
TERMS FOR RECEIVING THE SIGNATURE: Active participation in the solving of exercises and discussions. Regular completion of all assigned work including exercises, essays and small classroom projects. Active participation during fieldwork and regular completion of fieldwork related projects.
EXAMINATION METHODS: Oral; an important part of the grade is based on in-class activity and activity during fieldwork
REQUIRED LITERATURE:
1. Nichols, G.: Sedimentology and Stratigraphy. Blackwell Science, Oxford, 1999.
2. Walker, R. G. & James, N. P. (ur.): Facies Models: Response to Sea Level Change. Geological Association of Canada, St Johns, Newfoundland, 1992.

5019	**GEOLOGY OF MINERAL DEPOSITS**	**0+0+0**	**3+1+0**

COURSE CONTENT: Earth structure, origin of magma, elements of global tectonics. Geology of Dinarides. Deposits related to liquid magma processes, crystallisation differentiates, liquid segregates. Chromite, Ni-Co sulphides (platinum), carbonatite, komatiite, diamond, nefelinite, titanomagnetite, apatite, late-magmatic (Kiruna type), 5. Postmagmatic, pegmatites. Pneumatolites, (skarns, greisens). Massive sulphides (Cypruss type). Hydrothermal deposits (kata-, meso-epi), Cu-porphyries, (cementation zone). High-sulphidation, Low-sulphidation, (Bor, Majdanpek, Trepča). With loose connection to magmatism (Ljubija siderite deposit), SEDEX (Fe-Vareš, Hg-Idrija, Mn-Čevljanovići), Kuroko, Mississippi valley Pb-Zn (Mežica, Bleiberg, Olovo). Sedimentary deposit, Sabkha related, (Cu-schists, Ba-Lokve), resistates (Au, Pt, diamonds, cassiterite). Precipitates (U-Žirovski Vrh, Colorado plateau type), hidrolysates (bauxites, laterites, Ni-laterites). Metamorphogenic and metamorphose deposits (Au-mesothermal). Metallogeny and plate tectonics (Wilson Alpine cycle) in general, in Dinarides.
PREREQUISITES FOR THE COURSE: General mineralogy, System of mineralogy, Petrology of igneous and metamorphic rocks, Geochemistry
TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance
EXAMINATION METHODS: after fulfilling of course obligation the overall mark is formed by final exam, written, and oral
REQUIRED LITERATURE:
1. Evans, A.M.: Ore geology and industrial minerals, Blackwell, London, 1990, 389.
2. Sawkins, F.J.: Metal deposits in relation to plate tectonics. Springer Verlag, 1990, 460

5020	**ENGINEERING GEOLOGY**	**0+0+0**	**2+1+0**

COURSE CONTENT: Introduction to engineering geology; engineering geological investigation fundamentals. The Role of an Engineering Geologist. Elements of an Investigation. Types of Investigation. Engineering soil. Describing Soil for Engineering Purposes. The Engineering Properties of Soils. Uses of Soil Science Classification. Engineering properties of rocks. Intact Rock. Rock Masses. Engineering Classification of Rocks. Clastic sedimentay rocks. Geological Description. Engineering Properties of Sandstones and Conglomerates. Engineering Problems with Shales and Mudstones. Engineering Properties of Sites in Sandstone and Shale. Soluble rocks: limstone, dolomite and evaporites. Geological Description. Solution Processes and Their Effects. Engineering Properties of Limestone and Evaporites. Plutonic igneous rocks. Geological Description. Weathering of Plutonic Rocks. Engineering Properties of Plutonic Rocks. Volcanic rocks. Geological Description. Weathering of Volcanic Rocks. Engineering Problems with Volcanic Rocks. Metamorphic rocks. Geological Description. Weathering in Metamorphic Rocks. Engineering Problems in Metamorphic Rocks. Residual soils. Geological Description. Engineering Properties. Colluvium and talus. Geological features. Engineering Problems in Debris. Coarse grained soils. Geological Description. Engineering Features. Engineering Problems in Sands and Gravels. Clays. Geological Description. Engineering Problems in Clays. Loess. Geological Description. Engineering Properties of Loess. Soils of cold climate. Engineering Properties of Till, Fluvial-Glacial Deposits, Quick Clays and Permafrost. Engineering Problems in Soils of Cold Climate. Subsurface water. Basic Hydrogeological Parameters. Engineering Significance. Control of Subsurface Water. Geodynamic phenomena. Risk and Geologic Forecasting of Hazard. Earthquake-Induced Processes. Volcanic Processes. Landslides. Subsidence. Expansive Soils. Shoreline Processes. Instrumentation. Instrument Components. Instrument Types and Applications. Planning an Instrumentation Program. Engineering geological exploration. Engineering Geological Maps. Remote Sensing. Subsurface Exploration. Construciton uses of rocks. Aggregates. Riprap and other large rock materials. Graphic slope stability analysis. Geomechanical rock classification. Borehole log design. Interpretation of engineering geological units.
PREREQUISITES FOR THE COURSE: None

TERMS FOR RECEIVING THE SIGNATURE: completed exercises and positive grade of minimum 2 hour exams
EXAMINATION METHODS: exercises (40% of final grade); and 3 hour exams (60% of final grade) during the semester. In case of pre-excused absence student is obliged to take the final exam which will be scheduled after the course
REQUIRED LITERATURE:
1. Johnson, R.B. & J.V. DeGraff (1988): Principles of engineering geology.- John Wiley and So., New York, 497 p.
2. Goodman, R.E. (1993): Engineering geology. Rock in engineering construction.- John Wiley and So., New York, 412 p.

5029	**REGIONAL GEOLOGY AND GLOBAL TECTONICS**	**4+0+0**	**0+0+0**

COURSE CONTENT: Introduction, Earth structure, theories about "Earth life", methods, oceanic crust, continental crust, deformation and isostasy, "Earth machine", divergent boundary, convergent boundary, transform boundary, tectonic plate theory and regional structures, sedimentary basins and tectonic plate.
PREREQUISITES FOR THE COURSE: Physical geology, General mineralogy, System of mineralogy, Historicl geology I, Structure geology and tectonics, Sedimentary basins
TERMS FOR RECEIVING THE SIGNATURE: colloquies
EXAMINATION METHODS: written exam
REQUIRED LITERATURE:
1. Kearey, P. & Vine, F.J. (1990): Global Tectonics, (*ISBN 0-632-02424-0* Blackwell Science Ltd, Blackwell Publishing http://www.blackwellpublishing.com
2. Herak, M. (1988): Gelogija, Školska knjiga, Zagreb

5030	**QUANTITATIVE AND ISOTOPE GEOCHEMISTRY**	**3+2+0**	**0+0+0**

COURSE CONTENT: Chemical equilibrium. Acids and basis, buffers, (carbonate equilibrium, sea water as buffer, ion activity). Carbonate sediments (hydrolysis, carst phenomena, carbonate deposition, tuffa). Kinetics (chemical weathering, catalysis, complexation). Structural chemistry (bond types, isomorphism, polymorphism). Colloids, (organic, silica, Fe-Mn hydroxides, stability). Clay minerals and soil. Thermodynamic equilibria (phase rule, thermodynamic lows and functions). Eh-pH diagrams. Organic matter in sediments (diagenesis, epigenesis, maturation, genesis of oil and gas). Magma (Nernst coef. of distribution, REE, ionic potential, phase diagrams). Stabile isotopes, C,O,S,H, geothermometry. Radiogenic isotopes Rb/Sr, K/Ar, Ar/Ar, U-Th-Pb, Sm-Nd, ^{14C}, geochronology. Historical geochemistry.
PREREQUISITES FOR THE COURSE: General mineralogy, System of mineralogy, Petrology of igneous and metamorphic rocks
TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance
EXAMINATION METHODS: after fulfilling of the course obligation the overall mark is formed by the final exam, written and oral
REQUIRED LITERATURE:
1. Richardson, S.M. & McSween, Jr., H.Y.: Geochemistry, pathways and processes. Prentice Hall, 1989., str. 488.
2. Prohić, E.: Geokemija, Targa, 1998., str. 554.

5031	**GEOSTATISTICS**	**0+0+0**	**2+1+0**

COURSE CONTENT: Basic concepts in statistics: relevance of geostatistics, measuring scales. Definition of a set of data: population, sample, sampling frame, problems with geochemical data (censored values, outliers). Theory of probability: basic concepts (probability laws, Bayes's theorem, conditional probability).Measures of central tendency: arithmetic mean, mode, median, quantiles. Measures of variability: range of variation, interquartile, mean deviation, variance, standard deviation, coefficient of variation. Testing normal populations: central limits theorem, Shapiro-Wilk W test. Correlation analysis: Pearson's coefficient of correlation, simple and multiple linear correlation, partial correlation, rank correlation coefficients. Regression analysis: simple and multiple regression, scatter diagram, least-squares method, regression diagnostics. Sampling design: a concept and size of a sample, a hierarchical sampling design based on an unbalanced sampling scheme. Analysis of variance: F-test, post-hoc tests (Scheffe, HSD for unequal N). R-mode factor analysis: vector space model, problem of the number of possible factors, interpretation of factor loadings' joint behaviour towards variables. Cluster analysis: R-mode (classification of variables) and Q-mode (classification of samples) based on hierarchical clustering, construction of dendrogram. Formulating conclusions in statistics: accepting or rejecting of null-hypothesis, level of significance. Parametric and nonparametric statistics: Wald-Wolfowitz, Kolmogorov-Smirnov and Mann-Whitney U tests.
PREREQUISITES FOR THE COURSE: Mathematics I and II, Physical geology, Geochemistry
TERMS FOR RECEIVING THE SIGNATURE: absence from exercises must be less than 20% of the total time-table, and homework results should be presented in written/electronic form
EXAMINATION METHODS: a short written exam followed by an oral exam
REQUIRED LITERATURE:
1. Petz, B. (2004) : Osnovne statističke metode za nematematičare. Naklada Slap, Jastrebarsko, 384 str.
2. Šošić, I. i Serdar, V. (1995) : Uvod u statistiku. Školska knjiga, Zagreb, 363 str.

5032	ELEMENTS OF SCIENTIFIC WORK	2+1+0	0+0+0

COURSE CONTENT: Knowledge and scientific research. Information. Motives. Creativity and freedom. Scientific publications. Organization of a scientific paper. Primary and other publications. Bibliographic reference. How to find scientific information. The character of the observation. Recording observations. Role of experience and school. The necessity of being informed of the most recent publications. Critical reading. Why publish? Producing a manuscript for a scientific paper. Review process. Revision. Oral presentation. Poster presentation. Induction and deduction. Problem, hypothesis, theory. Paradigm and normal science. Falsification. Anarchistic theory. Historical, social and personal factors. Specific aspects of scientific approach in geosciences. Conditions for scientific work. Evaluation in science. Competence, elite, democracy. Industry and science. Ph. D. Thesis. Scientific project. Scientific policy.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: activity during discussions, regular completion of exercises and essays
EXAMINATION METHODS: oral, an important part of the grade is based on in-class activity
REQUIRED LITERATURE:
1. Schumm, S. A.: To interpret the Earth. Ten ways to be wrong. Cambridge University Press, Cambridge, 1991.
2. Silobrčić, V.: Kako sastaviti, objaviti i ocijeniti znanstveno dijelo. 4. izd. Medicinska naklada, Zagreb, 1998.

5033	KARST GEOLOGY	2+1+0	0+0+0

COURSE CONTENT: History of karst research. Different approaches to the karst studies (speleologic, descriptive, genetic). Tectogenetic karst classification (orogenic, epiorogenic). Water in karst (geochemical and hydrologic aspect). Karst areas in the world. Dinaric karst (lithostratigraphi, tectonics, kastification timeframe), Morphologic evolution of karst.
PREREQUISITES FOR THE COURSE: Physical geology, Chemistry I and II
TERMS FOR RECEIVING THE SIGNATURE: Lectures and practical exercises
EXAMINATION METHODS: preliminary exams during practical exercises, midtermwritten exam, final oral exam
REQUIRED LITERATURE:
1. Bahun, S. Juračić, M. (2002): Geologija krša. Interna skripta. PMF
2. Ford, D., Williams, P. (1992): Karst geomorphology and hydrology. Chapmann & Hall, London

5034	PALEOECOLOGY	0+0+0	2+1+0

COURSE CONTENT: History of Biosphere: Marine and Terrestrial environments, Life modes and trophic strategies, Global changes in atmosphere, hydrosphere and lithosphere, Geophysiology. Environmental control on biotic distribution: the structure of biosphere, Limiting factors on the distribution of organisms (light, nutrients, oxygen, temperature, salinity, substrate composition). Taphonomy: preservation potential (the fidelity of fossils assemblages), destruction (chemical, biological and physical) on sediment surface and below the sediment surface, Fossil lagersttaten, the taphonomy of plants and vertebrates. Adaptive morphology: terminology, growth strategies, investigative methods (paradigm approach, experimental palaeoautoecology, computer simulation), Adaptation, Morphology and environments (Pre - Vendian, Vendian, Tommotian, Cambrian, Paleozoic and modern biotas). Trace fossils: Preservation and taxonomy of ichnofossils, Marine and marginal marine trace fossils, Bioerosion, Terrestrial ichnofacies, Evolution of trace fossils. Fossils as environmental indicators: Clastic shelves, Carbonate environments, Oxygen deficient environments, Environment with high and low salinity, Firmness of substrate. Populations and communities: Types and dynamics of populations, Variations in populations, Spatial distribution, Opportunist and equilibrium species, Community structure, Numerical analysis of community, Community organization, Species diversity through time. Paleobiogeography: Modern biogeography, Definitions of paleobiogeography, Controls on biogeography (Dispersal vs. Vicariance biogeography), faunal province through time, Paleoclimatology, Biogeography and evolution and extinction. Evolutionary paleoecology of the marine biosphere: Diversification event in Earth history (the origin of life, the earliest prokaryote, appearance of eukaryote and metazoan, the Ediacara fauna, Cambrian fauna and three great evolutionary faunas), Extinction (pattern, causes and recoveries). Fossil terrestrial ecosystems: initial adaptation s and earliest fossil record of animals and plants, terrestrial ecosystem through time.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: succesfully resolve project tasks, active participation on exercises
EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:
1. Brenchley, P.J. & Harper, D.A.T., 1998, Palaeoecology, Ecosystems, Environments and evolution, Champan & Hall, London
2. Prothero, D.R., 1998, Bringing fossils to life, An Introduction to Paleobiology, McGraw-Hill

5035	PETROGENESIS	2+1+0	0+0+0

COURSE CONTENT: Importance of phase and chemical composition and microstructures in the genesis of igneous and metamorphic rocks. Importance of trace elements and isotopes in the genesis of igneous and metamorphic rocks. Role of accessory minerals in the genesis of igneous and metamorphic rocks. Petrochemical and geochemical calculations -

reasons, applicability, constraints, limits. Norms - approach and use in the igneous and metamorphic petrology. Specific software in the igneous and metamorphic petrology. Construction and interpretation of various petrologic, phase, variation and discrimination diagrams. Petrochemical calculations in the metamorphic petrology. AFM, ACF i A´KF diagrams. Metamorphism and deformation. Growth and importance of pretectonic, intertectonic, sintectonic and post-tectonic porphyroblasts. Microtectonics. Geometry and crystallography vs. optical elements. Necessity of 3rd dimension in thin section. Geothermobarometry basics. Age of igneous and metamorphic rocks - principles, basics and methods. P-T-t-D-X reaction paths, ideas, basics. Igneous and metamorphic rocks in the area (Pannonian Basin, Tisia, Alps, Carpathians, Dinarides). Volcanism in the area, potential hazard. The "granite problem" - ideas, evolution, state of the art.
PREREQUISITES FOR THE COURSE: Petrology of igneous and metamorphic rocks
TERMS FOR RECEIVING THE SIGNATURE: seminar
EXAMINATION METHODS: short written exams after each lecture block, seminar, oral
REQUIRED LITERATURE:
1. Hibbard, M. J. (1995): Petrography to Petrogenesis. Prentice Hall, New Jersey, 587 pp.
2. Bucher, K. & Frey, M (2002): Petrogenesis of Metamorphic rocks. Springer Verlag, 341 pp.

5036	**CRYSTALLOGRAPHY**	**0+0+0**	**1+2+0**

COURSE CONTENT: Derivation of point groups and possible crystal forms. Crystallometry (two-circle reflection goniometer), gnomonic, stereographic and parallel-perspective projections. Spherical trigonometry. Bravais lattices and space groups – principles of derivation. Reciprocal lattice, explanation of X-ray diffraction. Principles of matrix algebra
PREREQUISITES FOR THE COURSE: General mineralogy
TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Borchardt-Ott, W. (1995): Crystallography, Springer Verlag, Berlin, 307.
2. Rousseau, J.-J. (1998): Basic crystallography, John Wiley & Sons, New York, 414 str.
3. Klein, C. (2002): Mineral Science, John Wiley & Sons, New York, 641 str.
4. Nesse, W.D. (2000): Introduction to mineralogy, Oxford University Press, Oxford

5037	**ENVIRONMENTAL GEOLOGY**	**2+1+0**	**0+0+0**

COURSE CONTENT: The role of geology in environmental protection. Basic concepts: environment, environmental protection, contamination-pollution. Interdicilinarity in environmental protection. Geological Hazards. Hydrological cycle, groundwater and its quality. Waste disposal and landfills. Erosion, floods, suspended matter and its sedimentation. Marine pollution and eutrophication (Adriatic Sea). Geomaterials and protection of geological heritage. The role of geology in physical planning. Environmental protection strategies and sustainable development.
PREREQUISITES FOR THE COURSE: Physical geology, Chemistry I and II
TERMS FOR RECEIVING THE SIGNATURE: lectures and practical exercises
EXAMINATION METHODS: preliminary exams during practical exercises, midterm written exam, final oral exam
REQUIRED LITERATURE:
1. Juračić, M.: Geologija zaštite okoliša (http://geol.gfz.hr/Juracic/predavanja/index.html)
2. Bell (1998): Environmental geology, principles and practice, Blackwell Science, pp. 594.
3. Chamley, H. (2003): Geosciences, environment and man. Developments in Earth & Environmental Sciences 1, Elsevier, pp. 527.

5038	**GEOHAZARDS**	**2+1+0**	**0+0+0**

COURSE CONTENT: Hazard and risk. Natural and technological hazards. Hazard parameters. Vulnerability. Prevention, defense, mitigation, recovery, management. Recurrence. Importance of secondary hazards including socio-economic ones. Human factor. The role of scientists. The aspects mentioned above are discussed for each individual hazard type listed below. Volcanism. Processes, products, and consequences. Secondary hazards: mass movements, lahars, torrents, floods, fires, hydrographic changes. Earthquakes. Processes. Role of geology of the area. Recognition of active faults. Secondary effects: liquefaction, groundwater, mass movement, floods, fires, tsunamis. Mapping types. Mass movements. Fall, creep, sliding, sediment gravity flows, and combinations. Recognizing activity of mass movements. Morphological changes. Mapping mass movements. Snow and ice hazards. Subsidence. Running water. River types and evolution. River parameters. Erosion and accumulation. Sediment movement. Morphological changes. Floods and alluviation. Wind. Deflation. Transport and accumulation of sand and dust. Sources of sediment. Coastal hazards. Waves, currents and tides. Cliffs and beaches. Erosion and accumulation. Effects of storms. River mouths. Morphological changes. The influence of global changes. Environmental impact assessment. Field project on active slides.
PREREQUISITES FOR THE COURSE: Physical geology
TERMS FOR RECEIVING THE SIGNATURE: active participation in the solving of exercises, discussions and fieldwork; Regular completion of all assigned work, including exercises, quizzes, essays, small classroom projects, and field project
EXAMINATION METHODS: oral; an important part of the grade is based on in-class activity
REQUIRED LITERATURE:
1. Smith, K.: Environmental Hazards: Assessing Risk and Reducing Disaster 3. izd. Routledge, London, 2001.
2. Bell, F.G.: Geological Hazards. Spon Press, 1999.

5039	**SELECTED TOPICS OF VERTEBRATES PALEONTOLOGY**	**0+0+0**	**2+1+0**

COURSE CONTENT: The fossil foundings and fossilization of selected groups of the vertebrates (according to the interest of students). Comparative anatomy and selection of the most topic literature from the relevant world and domestic journals.
PREREQUISITES FOR THE COURSE: General paleontology, Systematical paleontology
TERMS FOR RECEIVING THE SIGNATURE: ordinary attendance of the lectures and practise aswell as ordinary participating in discussions of the given assignments and essays
EXAMINATION METHODS: in writting and oral examination of the knowledge acuired
REQUIRED LITERATURE:
1. Carrol, F.L.: Vertebrate paleontology and evolution. W.H. Freeman & Co., New York, 1998.

5040	**GEOLOGY AND GEOCHEMISTRY OF CRUDE OIL**	**0+0+0**	**2+1+0**

COURSE CONTENT: Basic considerations about crude oil and gas (geophysical methods, environments in which crue oil and gas appear, porosity, traps). Exercises: determination of structural characteristics if seismic profiles, calculation of porosity). Biosrtratigraphy and sequence stratigraphy in exploration of crude oil and gas – Exercises: how to use polen, nanoalgae, and forams in reconstruction of environments in which crude oil and gas could be formed. Models of sequence stratigraphy for carbonate platforms - Exercies: Analysis of edimentary space from geophysical profiles.
PREREQUISITES FOR THE COURSE: Physical geology, Historical geology I and II, Chemistry I i II
TERMS FOR RECEIVING THE SIGNATURE: succesfully resolved all tasks, active participation on exercises
EXAMINATION METHODS: writing exam
REQUIRED LITERATURE:
1. Emery, D. & Myers, K.J. (ur), 1996, Sequence Stratigraphy. Blackwell Science, 297 str., Oxford.
2. Miall, A.D., 1997, The geology of stratigraphic sequences. Spriinger Verlag, 433 str., Berlin.

5041	**MICROPALEONTOLOGY II**	**0+0+0**	**1+2+0**

COURSE CONTENT: Foraminifers (Lifestyle aspects of foraminifers, techniques of sampling that are pertinent to consolidate and unconsolidated sediments; laboratory processing of samples, systemtics). Environmental applications of deep sea benthic foraminifers. Benthic foraminifers as indicators of environmental change: marginal – marine – shelf - upperslope environments. Intertidal forminifers as environmental indicators. Environmental applications of marine and freshwater ostracods. Paleoceanographic applications of planktonic foraminifers and radiolarians. Environmental applications of diatoms, calcareous nannoplankton, dinoflagellate and pollen. Application of ecologically based statistics to micropaleontology.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: succesfully resolved all tasks ans seminar work, active participation on exercises
EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:
1. Haq, B.U. & Boersma, A., 1998, Introduction to Marine Micropaleontology. Elsevier
2. Brasier, M.D., 1985, Microfossils. George Allen & Unwin
3. Haslett, S.K. (ed), 2002. Quaternary Environmental Micropaleontology, Arnold/Oxford Univ. Press publ.

5042	**METHODS IN PALEONTOLOGY**	**1+2+0**	**0+0+0**

COURSE CONTENT: Systematic Paleontology (Exercise: An example of the Formal description of selected species). Systematics II (Exrecise: Indentify selected species, an example of benthic foraminifera). Phenetic vs. Cladistic Classifications (Exrecise: How to make cladograms and phenetic three). Biostratigraphy and biostratigraphic smpling, Reolution, Precision and Accurancy (Exercises: Correlations of geologicl logs based on index fossils and the global biotratigraphic standard, and qunatitative biotratigraphy). Biostatitics and Diversity Indexes (Exercises: Multivar analysis: indexes, clusters). Functional Morphology (Exrecises: Testing Raup's Functional Hypothesis, and anlysis of structural elements of larger foraminiferal tests). Paleoecological interpretation (Exrecise: from selected sample rich in foraminifers interpret ecologic conditions). Research Project on selected sample.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: succesfully resolve all tasks
EXAMINATION METHODS: evaluation of every task together with evaluation of oral exam
REQUIRED LITERATURE:
1. Prothero, D., 1998, Bringing Fossils to Life. An introduction to paleobiology. WCB/Mc Graw – Hill.
2. Internet izvori:
   http://gpc.edu/~pgore/geology/_lab/micro_exercises.php
   http://palaeo-electronica.org/2001_1/past/issue1_01.htm

5043	HISTORY OF GEOLOGY	2+0+0	0+0+0

COURSE CONTENT: The course should demonstrate the chronological development of ideas in geology, their mutual controversies and opposition, resistance of old ideas and their gradual submission to the newer ones. Pre-scientific epoch (antiquity, Middle ages). Neptunists – vulcanists – plutonists. Catastrophists – uniformitarianists. Ice ages (glaciations). Age of the Earth. Geosynclinal theory – plate tectonics (including fixists and mobilists in the Alpine tectonics). Constraints of the uniformitarian approach and its role in other natural sciences. History of geology in Croatia and neighbouring countries.
PREREQUISITES FOR THE COURSE: Physical geology, General paleontology, Systematical paleontology, Historical geology, Petrology of igneous and magmatic rocks, Sedimentary petrology
TERMS FOR RECEIVING THE SIGNATURE: regular attendance of lectures
EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:
1. Hallam, A.: Great geological controversies, Oxford University Press, 1983.
2. Hallam, A.: Revolutions in Earth History. Oxford University Press, 1982.

5044	PALEONTOLOGICAL ASPECTS OF EVOLUTION	2+0+1	0+0+0

COURSE CONTENT: History of the evolutionary thought. Cosmic evolution (origin of elements, etc.). Chemical evolution. Origin of life (current hypotheses). Biological evolution (including Red Queen hypothesis, etc.). Origin of eukariotes. Evolution of Metazoa. Speciation (allopatric speciation, island species, etc.). Phyletic gradualism. Punctualism. «Single-step» vs. cumulative selection. Internal selection (constraints, etc). Notion and examples of emergence. Creationsts' «objections» to evolution (eye, transitional forms, etc.). Cultural evolution.
PREREQUISITES FOR THE COURSE: General paleontology, Systematical paleontology, Historical geology I and II
TERMS FOR RECEIVING THE SIGNATURE: regular attendance of lectures and seminars; regular homework doing, presentation and explication of seminar works; passing of all preliminary exams
EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:
1. Skelton, P. (ed.): Evolution – a biological and paleontological approach. Addison-Wesley Publishing Company, 1993.
2. Erben, H.K.: Evolution. Ferdinand Enke Verlag, Stuttgart, 1990.
3. Kalafatić, M.: Osnove biološka evolucije. Sveučilište u Zagrebu, 1998.

5045	MARINE GEOLOGY	2+1+1	0+0+0

COURSE CONTENT: History of marine research. Morphology and genesis of oceans. Sources and composition of marine sediments. Lithogenous, hydrogenous and biogenous sediments. Physical oceanography relevant for genesis and sea sediment disposition (wave, current, tide). Sea water and hydrogenous sediments. Coast, sea level processes and effects of sea level change. Climates and sediments. Estuarine and anti-estuarine water exchange currents and their influence to the sea bottom. Organisms and sea bottom. Residence time. Sedimentation rates. Paleocanography. Deep-sea sediments. Mediterranean and Adriatic Sea. Marine geological cartography. Sea-bottom sampling and data acquisition.
PREREQUISITES FOR THE COURSE: Physics, Chemistry I and II, Physical geology, General mineralogy
TERMS FOR RECEIVING THE SIGNATURE: lectures and practical exercises
EXAMINATION METHODS: preliminary exams during practical exercises, midterm written exam, final oral exam
REQUIRED LITERATURE:
1. Juračić, M.: Geologija mora (http://geol.gfz.hr/Juracic/predavanja/index.html)
2. Selbold E. & Berger W.H.: The Sea Floor. An introduction to Marine geology. Springer Verlag, Berlin, 1996.

5046	STRATIGRAPHIC CLASSIFICATION AND CORRELATION	2+1+0	0+0+0

COURSE CONTENT: Lithostratigraphy: research methods, units, relation between lithostratigraphic units, conformity and disconformity, vertical and lateral succession of sediments, Walther's law, transgression and regression, depositional sequences, sequence boundaries, depositional systems, correlation (key-horizons, datum). Seismostratigraphy: research methods, types and geometry of seismic reflections, types of stratal contacts, seismofacies. Magnetostratigraphy: research methods, units, correlation in magnetostratigraphy. Biostratigraphy: principle of zonation, distribution of organisms, biocorrelation. Chronostratigraphy: research methods, correlation. Graphic correlation.
PREREQUISITES FOR THE COURSE: Physical geology, Geophysics
TERMS FOR RECEIVING THE SIGNATURE: solving correlation problems
EXAMINATION METHODS: written
REQUIRED LITERATURE:
1. Bally A.W. (1989): Atlas of Seismic Stratigraphy. A.A.P.G. Studies in Geology 27.
2. Boggs S. Jr. (1987): Principles of Sedimentology and Stratigraphy, Merill.

3. Cant D.J. (1992): Subsurface Facies Analysis. U: Walker, R.G. & James, N.P: Facies models. Response to sea-level change. Geological association of Canada. St. John's, (ISBN 0-919216-49-8)
4. Wilgus C.K., Hastings B.S:, Ross C.A., Posamentier H., Wagoner J.V. & Kendall Ch.G.St.C. (1988): Sea-level changes:
5. An integrated approach. S.E.P.M. Sp. Publ. 42

5047	**QUATERNARY GEOLOGY**	**0+0+0**	**3+0+0**

COURSE CONTENT: Quaternary stratigraphy. Research methods (field methods: study of outcrops, excavations), laboratory methods. Dating methods (radiometric, paleo(thermo) luminescence, paleomagnetism). Quaternary paleogeography, environments (glacial, proglacial, periglacial, non-glacial: fluvial, lacustrine, marsh, Aeolian, cave) and facies. Glaciation models, causes of glaciations, glaciated areas (continental, marine). Deglaciation models, glacioisostatic rebound, eustacy. Quaternary flora and fauna (continental, marine, cave).
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE:
EXAMINATION METHODS: oral
REQUIRED LITERATURE:
1. Easterbrook, D.J. (1988): Dating Quaternary Sediments. Geol. Soc. Am. Spec. Publ. 227.
2. Ehlers, J. & Gibbard, P.L. (2004): Quaternary glaciations – extent and chronology. Development in Quaternary science v. 1 – 5. Elsevier BV (ISSN 1571 0866, ISBN 0 444 51462 7)
3. Lowe J.J. & Walker M.J. (1997): Reconstructing Quaternary Environments. 2nd ed. Longman, Harlow
4. Menzies J. (2002): Modern & Past Glacial Environments. 2nd. ed. Butterworth Heinemann, Oxford
5. Nilsson, T. (1983): The Pleistocene. Geology and Life in the Quaternary Ice Age. Ferdinand Enke Verl. Stuttgart
6. Stepen, J. & Peter, G. (1991): Quaternary Sediments. John Wiley & Sons, London.
7. Walker, R.G. & James, N.P. (1992): Facies models. Response to sea-level change. Geological association of Canada. St. John's , 1-409, (ISBN 0-919216-49-8)

5048	**SELECTED CHAPTERS FORM INVERTEBRATE PALEONTOLOGY**	**2+1+0**	**0+0+0**

COURSE CONTENT: Invertebrates (taxonomy, with accent on rudists, similarities and differences within differet groups, determination fo species), way of living (environments which invertebrates inhabit), relations between different invertebrate fossils within the same environment (different subtidal environments of rudists, environments of benthic forams, relaton between rudists and benthic forams), role of invertebrates for determination of environment and vertical-lateral exchange of facies (invertebrates and paleobathimetry, change of fossil community through time and space, invertebrates as environment indicators) relation sediment-fossil remain (lateral exchange of different limestone types with respect to macro or microfossils), work on individual task.
PREREQUISITES FOR THE COURSE: General paleontology, Systematical paleontology, Micropaleontology I
TERMS FOR RECEIVING THE SIGNATURE: continous work, presence on exercises
EXAMINATION METHODS: writing and oral exame, notes from exercises
REQUIRED LITERATURE:
1. Prothero, D. (1998): Bringing fossils to life. An Introduction to paleobiology, WCB/Mc Graw-Hill.
2. Skelton, P.W. (2002):The Cretaceous World. The Open University, Cambridge University Press, 360 pp.

5049	**STRUCTURAL GEOMORPHOLOGY**	**2+1+0**	**0+0+0**

COURSE CONTENT: Introduction to of geomorphology and application in geology. Research methods. Types of relief and geological interpretation. Genesis and evolution of relief. Morphometry. Types of maps, data interpretation of active structures and faults. Recent tectonic movements. Morphostructural map.
PREREQUISITES FOR THE COURSE: Structure geology and tectonics, Geological mapping
TERMS FOR RECEIVING THE SIGNATURE: obligatory composition (development) of one type of morphometric map within the program
EXAMINATION METHODS: program completition, interpretation of geological structure and relief relationship
REQUIRED LITERATURE:
1. Embleton, C. (1985): Geomorphology of Europe. MeMillan Press, London
2. Derruan, M. (1958): Précis de Géomorphologie. Masson et Co., Paris
3. Bognar, A. (1990): Geomorfologija Baranje. Sav. geograf. društava Hrv., Zagreb.
4. Skripta iz grologije i geomorfologije. RGN fakultet.

5050	**GEOLOGY OF FOSSIL FUELS**	**2+1+0**	**0+0+0**

COURSE CONTENT: Coal as an energy source, and as a raw-material in metallurgy and chemical industry. Reserves and yearly production worldwide and in Croatia. Organic and inorganic constituents of plant tissue - carbonisation, biochemical and geochemical processes. Classification of coal according to its practical value and carbonisation level. Coal-bearing formations – depositional environments, theories of autochthonous and allochthonous formation of coal

beds. Types of hydrocarbons. Formation, migration and accumulation of oil and gas – source rocks and reservoir rocks. Water, oil and gas inside the hydrocarbon reservoir. Geological operations in petroleum geological exploration. Oil and gas reservoirs in Croatia and worldwide.
PREREQUISITES FOR THE COURSE: Physical geology, Historical geology I and II
TERMS FOR RECEIVING THE SIGNATURE: projects 1 and 2 are obligatory, their average grade accounts for 50% of the total grade for the course
EXAMINATION METHODS: final oral examination is obligatory – results make 50% of the total grade for the course
REQUIRERD LITERATURE:
1. Thomas, L. (2002): Coal Geology. John Wiley & Sons Ltd., Chichester, England, 384 str.
2. Whateley, M.K.G. & Spears, D.A., eds. (1995): European Coal Geology. Geological Soc. of London Spec. Publ. No. 82, 331 str.
3. Doveton, J.H. (1986): Log Analysis of Subsurface Geology. A Wiley-Interscience Publication, New York, 273 str.
4. Hobson, G.D. (1977): Developments in Petroleum Geology. Applied Science Publishers Ltd., London, 335 str.

5051	**PALEOBOTANY**	**0+0+0**	**2+1+0**

COURSE CONTENT: Getting familiar with essential terms in palaeobotany, main fossil groups and general trends in evolution of plants
PREREQUISITES FOR THE COURSE: General paleontology
TERMS FOR RECEIVING THE SIGNATURE: regular presence at exercises, successfuly done personal tasks, successfuly presented essay
EXAMINATION METHODS: written exam
REQUIRED LITERATURA:
1. Stewart, W.N.: Palaeobotany and the Evolution of Plants. Cambridge Univ. Press, Cambridge, 1990.
2. Sremac,J.: Paleobotanika. Skripta. Prirodoslovno-matematički fakultet, Zagreb, 1997

5052	**FIELD PROJECT**	**0+0+0**	**5-12**

COURSE CONTENT: Studenti stječu vlastito iskustvo u samostalnom opažanju geoloških pojava, posebice u raspoznavanju tipova stijena i kartografskih jedinica, dijagnosticiranju geološke građe terena i datiranju geoloških događaja. Stječu vještinu u bilježenju i prikazivanju geoloških odnosa pomoću geološke karte, profila i stupova. Uz to, studenti nauče prikazivati terenske geološke podatke na odgovarajućim grafovima, dijagramima i pomoću jednostavnih statističkih metoda. Uočavaju geološke probleme predjela i mogućnosti interpretacija na osnovi raspoloživih podataka. Studenti trebaju steći sposobnost konciznog i sadržajnog pismenog izražavanja i planiranja izvještaja, kao i organizacijske sposobnosti rada na određeni rok, planiranja i obavljanja istraživanja, logistike i sigurnosti.
PREREQUISITES FOR THE COURSE: BSc. in Geology
EXAMINATION METHODS: Student brani prethodno predani izvještaj i odgovara na pitanja povjerenstva od najmanje tri člana, od toga 2 profesora Geološkoga odsjeka i jednog vanjskog člana. Ocjenjuje se konciznost i sadržajnost izvještaja, proučenost odgovarajuće literature, kvaliteta grafičkih priloga, iskustvo i znanje stečeno o geološkoj problematici i specifičnim pojavama istraženog predjela, kao i organizacijske sposobnosti rada na određeni rok, planiranja i obavljanja istraživanja, logistike i sigurnosti.
REQUIRED LITERATURE:
1. Barnes, J. W.: Basic geological mapping, 4. izd. Wiley, Chichester, 2004.
2. Fry, N.: The field description of metamorphic rocks. Wiley, Chichester, 1993.
3. Goldring, R.: Fossils in the field: information, potential and analysis. Longman Scientific, Harlow, 1991.
4. McClay, K.: The mapping of geological structures. Wiley, Chichester, 1987.
5. Thorpe, R. S. & Brown, G. C.: The field description of igneous rocks. Wiley, Chichester, 1985.
6. Tucker, M. E.: Sedimentary rocks in the field, 3. izd. Wiley, Chichester, 2003.

5053	**ROCK MICROSTRUCTURE**	**0+0+0**	**0+3+0**

COURSE CONTENT: Polarizing microscope. Rock forming minerals in igneous, sedimentary and metamorphic rocks. Mineral, structure and texture identification, mineral relations and reactions. Rock classifications, IUGS classification system and recommendations. Acid plutonic, volcanic and vein rocks. Intermediate plutonic and volcanic rocks. Basic plutonic, volcanic and vein rocks. Ultramafic magmatic rocks. Pyroclastic rocks and volcanic glass. Diagenesis vs. metamorphism. Sedimentary protoliths. Very low grade metamorphism (VLGM). Low grade metamorphism (LG). Medium grade metamorphism (MG). High grade metamorphism (HG). Anatexis. Ultrametamorphism. Metamorphic rocks without preferred orientations (granofels, hornfels, marble, quartzite). Equilibrium mineral assemblages, mineral reactions, graphical presentation, approx. determination of metamorphic conditions. Specific textures and microstructures in sedimentary rocks.
PREREQUISITES FOR THE COURSE: Mineral optics, Petrology of igneous and metamorphic rocks, Sedimentary petrology
TERMS FOR RECEIVING THE SIGNATURE: evaluation of individual reports and thin sections description
EXAMINATION METHODS: average grade of all individual reports, oral exam
REQUIRED LITERATURE:
1. Vernon, R.H. (2004): A practical guide to Rock Microstructure.- Cambridge University Press, 594 p.

5054	MICROTECTONICS	0+0+0	1+2+0

COURSE CONTENT: Link between deformation and metamorphism - microscopic scale. Basic approach and methods. Petrographic microscope, U-stage, electron microscope. Computer based image analysis. Sampling, sample orientation, oriented thin section preparation. Geometry and crystallography vs. optical elements. Necessity of 3rd dimension in thin section. Deformation of rock forming minerals, effects in thin sections. Monomineral and polyphase systems. Foliation, lineation, preferred orientation. Mechanism of foliation development, influence and importance of geological factors, practical use of foliation in the event reconstruction. Mineral preferred orientation and shear sense determination. Shear zones, mylonite, mylonitization and metamorphism. Mylonite shear sense indicators. Porphyroblasts and reaction rims. Pretectonic, intertectonic, sintectonic and post-tectonic porphyroblast growth. Inclusions, symplectites. D-t diagrams. Sampling in metamorphic rocks of Medvednica Mt. Oriented cutting and thin sections preparation. Determination of problem, possible approach, problem solving using oriented thin sections. Seminar.
PREREQUISITES FOR THE COURSE: Mineral optics, Petrology of igneous and metamorphic rocks, Rock microstructure
TERMS FOR RECEIVING THE SIGNATURE: field work, preparation of oriented thin sections, seminar
EXAMINATION METHODS: microscopic work on the oriented thin sections prepared by student
REQUIRED LITERATURE:
1. Passchier, C.W. & Trouw, R.A.J. (1996): Microtectonics. Springer Verlag, 289 pp.

5055	SILICATE MINERALOGY	0+0+0	2+1+0

COURSE CONTENT: Crystal-chemical properties of silicates. Olivine group. Garnet group. Group of alumosilicates. Calcium silicates. Epidote group. Beryl group. Turmaline group. Inoslicates – pyroxenes. Inosilicates – amphiboles. Phylosilicates – micas. Phylosilicates – chlorites. Phylosilicates – group of kalinite-serpentine. Felsdspar and scapolite groups. Zeolite group.
PREREQUISITES FOR THE COURSE: System of mineralogy
TERMS FOR RECEIVING THE SIGNATURE: attendance at lectures and exercises, colloquiums and seminars
EXAMINATION METHODS: written and oral exam
REQUIRED LITERATURE:
1. Slovenec, D., Bermanec, V. (2003): Sistematska mineralogija – mineralogija silikata. Denona, Zagreb, 359 str.

5056	NON-SILICATE MINERALOGY	0+0+0	2+1+0

COURSE CONTENT: Gold and platinum group. Groups of sphalerite, galena and pyrite. Sulfidesalts groups. Spinel group. Oxides of iron and aluminium. Oxides of manganese.Borates, Groups of calcite and dolomite. Aragonite group. Groups of barite and gypsum. Secondary sulphates. REE phosphates. Apatite group. Pegmatitic phosphatime. Organic minerals.
PREREQUISITES FOR THE COURSE: : **System of mineralogy**
TERMS FOR RECEIVING THE SIGNATURE: attendance at lectures and exercises, colloquiums and seminars
EXAMINATION METHODS: written and oral exam
REQUIRED LITERATURE:
1. Bermanec, V. (1999): Sistematska mineralogija – mineralogija neilikata. Targa, Zagreb, 264 str.

5057	GEMMOLOGY	2+1+0	0+0+0

COURSE CONTENT: Fundamental concepts in gemmology. Geology of gemstone deposits. Crystal optics in gemmology. Optical effects on gemstones. Colour theory – causes of gemstone colour. Gemmological instruments. Methods of gemstone testing. Common gemstones. Rare gemstones. Organic gemstones. Diamond – grading and imitations. Synthetic gemstones. Imitiations, composites and gemstone treatments. Cutting of gemstones and types of cuts. Presentation of student projects.
PREREQUISITES FOR THE COURSE: System of mineralogy, Mineral optics
TERMS FOR RECEIVING THE SIGNATURE: regular attendance of course and completion of a written project paper
EXAMINATION METHODS: Written and oral final exam. The final grade will include marks given for the student's project paper.
REQUIRED LITERATURE:
1. Read, P. Gemmology. 2nd edition. Butterworth – Heineman, London, 1999.

5058	INTERPRETATION OF GEOCHEMICAL DATA	0+0+0	2+1+0

COURSE CONTENT: Geochemical data, geological processes and their geochemical significance, analytical techniques in data acquisition, sources of errors. Data analysis, correlation, regression, discriminant analysis.Variation diagrams, rock classification. Usage of trace elements, geochemical control of element distributions, REE, spider-diagrams, PGE, Transitional elements-diagrams, bivariant diagrams, modeling of data (vector diagram, partial melting, crystal

fractionation, AFC processes). Geotectonic discrimination, discrimination in the group of basalts, andesites, and granites. Radiogenic isotopes in geochronology, isochrone methods, errochrones, geochrones, T-CHUR, blocking temperature, crystallization temperature, metamorphic age, mineral age. Radiogenic isotopes in petrogenesis, recognition of isotope reservoir, epsilon notation, isotope correlation diagrams, mantle-crust dynamics, plumbotectonics, geodynamics. Stabel isotopes in genesis of igneous and metamorphic rocks, O,C,S-isotopes. Sedimentary rocks, geodynamic setting, provenance od detrital component, REE, Sr-isotope stratigraphy.

PREREQUISITES FOR THE COURSE: General mineralogy, System of mineralogy, Petrology of igneous and metamorphic rocks, Geochemistry

TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance

EXAMINATION METHODS: after fulfilling of the course obligation the overall mark is formed by the final exam, written and oral

REQUIRED LITERATURE:

1. Rollinson, H.: Using geochemical dana: evaluation, presentation, interpretation. Longman, 1995, str. 348.
2. Ragland, P.C.: Basic analytical petrology. Oxford university press. 1989, str. 370.
Winkler, H.G.F.: Petrogenesis of Metamorphic Rocks. Springer-Verlag, 1979, str. 348.

5059	**PHASE AND ELEMENTAL ANALYSIS**	**1+2+0**	**0+0+0**

COURSE CONTENT: Qualitative and quantitative parameters of the analytical method choice. Sampling plan design and selection of the best posible methods. Preselection of the analytical samples, methods of sample dissolution and destruction. Stoihiometric calculations in the wet chemistry methods. Absorption and emission spectrometric methods, instrumental optical components. Mass spectrometry methods, Moessbauer spectroscopy, nuclear activation analytical methods. Mineral separation methods. X-ray powder diffraction (factors influencing diffracted beam intensity, unit cell dimensions calculation from powder patterns, powder pattern fitting techniques). X-ray fluorescence analysis (matrix problem and methods for solving it, sample preparation). Electron microscopy (SEM, EBSD, chemical analyisis, electron diffraction).

PREREQUISITES FOR THE COURSE: Principles of elemental and phase analysis

TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance

EXAMINATION METHODS: after fulfilling of the course obligation the overall mark is formed by the final exam, written and oral

REQUIRED LITERATURE:

1. Jones, M.P. (1997): Methoden der Mineralogie. Ferdinand Enke Verlag, Stuttgart, 260 str.
2. Skoog, D.A. & Leary, J.J. (1992): Principles of instrumental analysis. Saunders College Publishing, Fort Worth, 700 str.
3. Skoog, D.A., West, D.M. & Holler, F.J. (1999): Osnove analitičke kemije. Školska knjiga, Zagreb, 951 str.
4. Whiston, C. (1987): X-ray metods, John Wiley & Sons, New York, 426 str.

5060	**UNIVERSAL STAGE METHODS**	**0+0+0**	**1+2+0**

COURSE CONTENT: Multi-axis microscope (universal stage). Adjustments of universal stage and thin sections. Determination of the vibration directions of optical inicatrix. Measurement of cleavage and twin composition planes. Plotting the results. Measurement and solution of twins. Determination of plagioclase chemical composition. Refractive index corrections. Determination of plagioclase using universal stage. Determination of pyroxene using universal stage. Determination of amphibole using universal stage. Determination of topaz using universal stage.

PREREQUISITES FOR THE COURSE: General mineralogy, System of mineralogy, Mineral optics

TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams

EXAMINATION METHODS: written and oral exam

REQUIRED LITERATURE:

1. Međimorec, S. (1998): Kristalna optika, interna skripta, Prirodoslovno-matematički fakultet, Zagreb
2. Sarančina, G. M. & Koževnikov, V. N. (1985): Fedrovski metoda (Opredelenie mineralov, mikrostrukturnjii analiz), Nedra, Leningrad, p.

5061	**GEOCHEMISTRY OF SEDIMENTARY ROCKS**	**0+0+0**	**2+1+0**

COURSE CONTENT: Aquatic solutions: water/ice structure, water's solvent power, quantifying the composition of solutions. Aquatic chemistry: chemical equilibrium, the solubility product, ionic strength, activity coefficient, Debye-Hückel equation. Chemical composition of continental waters: chemistry of elements with reference to Ca, Mg and Na, ionic potential, weathering patterns. Basic chemistry of estuaries; chemical and lithological composition of sedimentary rocks regarding Goldich's weathering series; compositional variability of sandstones, shales and carbonate rocks. Chemical weathering: hydrolysis, equilibrium solubilities in the system SiO_2-H_2O, activities of different forms of dissociated silica, behaviour of alluminium and iron during the weathering of silicates, gibbsite solubility. Calcium carbonate solubility: the solubility products of calcite and aragonite, carbonate compensation depth, equilibrium solubilities in the system CO_2-H_2O, Bjerrum's diagram, solubility of the carbonate minerals in a complex system (river, lake, sea), buffering system, *mischungkorrosion*, biomineralization. Weathering agents: carbon diokside, erosion of an average limestone terrain, contribution of plant roots and microbiological degradation of organic matter to the weathering processes. Organic acids:

their role in solution processes, significance of chelates for the metal mobility, colloids, floculation. Oxidation-reduction processes: Nernst equation, reduction potential, iron and manganese behaviour regarding electrochemistry, basic concepts of thermodynamics and electrochemistry, different approach of chemists and geochemists in expressing half reactions. Eh-pH diagrams: stability limits of water, stability fields of iron oxides; Eh-pH systems containing carbon diokside: stability of siderite regarding hematite, magnetite and dissolved iron. Diagenesis: definition of processes, kinetic factors, diffusion, Fick's laws, advection, Peclet's number, Darcy's law, kinetics of chemical reactions on the molecular level, general equation of diagenesis. Cementation: growth of oxidized surface layer, distribution of manganese in pelagic sediments, fossilization and growth of concretions. Fate of organic matter during diagenesis: geopolimers, reactions of 'darkening', vitrinite reflection, time temperature index, Van Krevelen's diagram, sulfate reduction, fermentation. Distribution of sedimentary rocks in time and space: assessment of the quantity of sedimentary rocks, distribution of evaporites, Mg/Ca ratio in carbonate rocks, 'dolomite problem', sea-level curve in response to the calcite/dolomite ratio.
PREREQUISITES FOR THE COURSE: Chemistry I and II, Sedimentary petrology, Geochemistry
TERMS FOR RECEIVING THE SIGNATURE: absence from exercises must be less than 20% of the total time-table, and homework results should be presented in written form
EXAMINATION METHODS: oral esam
REQUIRED LITERATURE:
1. Prohić, E. (1998): Geokemija. Targa, Zagreb, 554 str.
2. Krauskopf, B. K. (1979): Introduction to geochemistry. McGraw-Hill Book Company, New York, 617 str.

5062	**ENVIRONMENTAL MINERALOGY**	**2+1+0**	**0+0+0**

COURSE CONTENT: The nature and scope of environmental mineralogy; Research methods in environmental mineralogy; Minerals and soil developments; Mineralogy of marine sediments; The influence of microbes on minerals; Aerosols in the atmosphere; Mineralogy of mine wastes; Suitability of minerals for environmental remediation purposes; Mineralogy in nuclear waste management; Mineralogy and cultural heritage; Mineralogy and human health; Presentation of student's project papers
PREREQUISITES FOR THE COURSE: Mineralogy, Quantitative and isotope geology
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of classes, active participation in colloquia and seminaries.
EXAMINATION METHODS: Term papers and written and oral final exam
REQUIRED LITERATURE:
1. Vaughan, D.J. and Wogelius, R.A. (2000): Environmental Mineralogy. EMU Notes in Mineralogy, Eötvös University Press, Budapest, 434 p.
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5063	**INSTRUMENTAL METHODS IN ENVIRONMENTAL ANALYSIS**	**2+1+0**	**0+0+0**

COURSE CONTENT: 1. The role and importance of environmental chemical analysis 2. Sampling procedures and classical methods of environmental analysis 3. Spectrophotometric methods 4. Electrochemicl methods of analysis 5. Mass spectrometry 6. Methods for solid sample analysis 7. Gas chromatography 8. Analysis of water samples 9. Analysis of gaseous samples 10. Direct spectrophotometric analysis of gaseous air pollutants 11. Analysis of sulfur dioxide 12. Analysis of carbon monoxide 13. Analysis of nitrogen oxides 14. Analysis of hydrocarbons 15. Analysis of particulate matter.
PREREQUISITES FOR THE COURSE: Chemistry I and II, preferably Analytical Chemistry I and II, Fundamentals of element and phase analysis, all courses from semesters 3 and 4.
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of classes, active participation in colloquia and seminaries Successful completion of assigned coursework and tasks
EXAMINATION METHODS: Term papers and written and oral final exam
REQUIRED LITERATURE:
1. Manahan, S.E. (1994): Environmental Chemistry, 6th edition, Lewis Publishers, Boca Raton

5064	**HYDROGEOCHEMISTRY AND GROUNDWATER PROTECTION**	**0+0+0**	**2+1+0**

COURSE CONTENT: 1-3. Basic principles of hydrogeochemistry: formation of natural water composition, precipitation, surface and groundwater; physical and chemical properties, isotope composition; thermodynamic equilibrium in water solutions; 4. Natural radioactive and stable isotopes in soils, surface and ground waters – isotopes of carbon, hydrogen, oxygen, sulphur, nitrogen (^{14}C, ^{3}H, ^{18}O, D, ^{13}C, ^{34}S, ^{15}N), origin, geochemistry, application in water and soil studies; 5. Water-soil-rock interaction: reactions in unsaturated and saturated zone of aquifer (dissolution of gases, silicates and carbonates, oxidation of sulphides, cationic and anionic exchange, organic reactions); influence of salinization of different origin; geochemical types of water); 6. Fundamentals of geochemical modeling of processes in natural waters -speciation models, mass balance models, reaction-path models; 7. Groundwater protection – natural and anthropogenic sources of groundwater contamination, types of contamination sources, types of contaminations and its behavior in the underground. Aspects of alluvial and karst aquifer protection – different approach; 8. Geochemical aspects of groundwater protections, simulation of contaminant behavior by geochemical modeling; 9. Basic principles of contaminant transport modeling,

analytical and numerical models and its application; 10-11. Groundwater protection and management: monitoring of water quantity and quality, vulnerability mapping (intrinsic and specific), mapping and classification of hazards, risk assessment, GIS application in groundwater protection; 12. Overview of legislative on environmental protection, waste disposal and emission of contaminants in the environment, protection of quantity and quality of groundwaters; 13.-14. Criterions of groundwater protection – case study analysis, determination of sanitary protection zones, study of influence on environment for different purposes.

PREREQUISITES FOR THE COURSE: Chemistry, Geochemistry, Hydrogeology**.**

TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures; homework doing, presentation and explication of seminar works; passing of all preliminary exams.

EXAMINATION METHODS: Written (problem solving) + oral examination depends on teacher evaluation or on student require.

REQUIRED LITERATURE:

1. Appelo, C.A.J. & D. Postma (1994): Geochemistry, groundwater and pollution. Balkema, Rotterdam.
2. Levačić, E. (1997): Osnove geokemije voda. Sveučilište u Zagrebu, Geotehnički fakultet Varaždin, 232 str.
3. Vrba J. & Zaporozec, A. (ed)(1994): Guidebook on Mapping GroundwaterVulnerability. Vol. 16/1994, IAH, Verlag Hinz Heise, Hannover.
4. Zwahlen, F. (ed.)(2004): Vulnerability and risk mapping for the protection of carbonate (karst) aquifers.Final report – COST Action 620. European Commision - Office for Official Publications of the European Communities, Luxembourg.

5065	**GEOLOGICAL ASPECTS OF WASTE DISPOSALS**	**0+0+0**	**2+1+0**

COURSE CONTENT: Definition of the waste, kind of wastes (solid, liquid, gaseous, hazardous, radioactive, communal, etc.). Waste producer (industry, energetic plants, mining, communal infrastructure, agriculture). System of waste disposals (unsorted, sorted), incineration, communal landfills, nuclear waste disposals (low, medium, high activity wastes). Incineration plant, , emission of pollutents and toxicants, dioxin, energy production, incineration products (ashes, smoke filtrates). Communal solid waste disposals:, technical characteristics, geomembranes, leachate chemistry, biogas, balling, composting, geological characteristics of an ideal waste disposal, monitoring, transport of waste, remediation and conservation, case studies. Industrial and hazardous waste disposal, sources, (industry, medicine, oil industry, metallurgy, pharmaceuticals), waste disposal preparation (air filtration, extraction, chemical oxidation, membrane processes, adsorption on active carbon, liquefaction), biological treatment, stabilization and thermal methods. Radioactive waste disposals (industry, medicine, scientific activity, nuclear energy production, nuclear weapons, nature of radioactivity, ionizing radiation, measuring of radioactivity (dose and sievert), biological effects, natural sources of radioactivity, radon problem, artificial sources of radioactivity, level of exposure to radioactivity. Solid waste disposal sites, selection of site, geological criteria, protection of underground water, leachates collection, geomechanical stability, remediation of soil, monitoring, GIS, case studies. Radiotoxicity, legislation, nuclear waste disposal, site selection, surface and underground disposals, low-medium and high activity wastes, deep geological waste disposals, case studies (Croatia, NPS "Krško", possible accidents).

PREREQUISITES FOR THE COURSE: Mineralogy, Petrology

TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance

EXAMINATION METHODS: after fulfilling of course obligation the overall mark is formed by final exam, written, and oral

REQUIRED LITERATURE:

1. LaGrega, D.M., Buckingham, P.I., Evans, C. J.: Hazardous Wast Managment, McGraw-Hill, 1994, str. 1145
2. Murarka, I.P.: Solid waste disposal na reuse, Vol. I., Vol. II., CRC Press, 1987., str. 347.
3. Simončić, V.: Svjetska iskustva u zbrinjavanju otpada, ZGO, «Ognjen Prica», 1991., str. 472.

5066	**GEOCHEMICAL METHODS OF ENVIRONMENTAL INVESTIGATION**	**0+0+0**	**2+1+0**

COURSE CONTENT: Geochemical environment, dispersion, mobility, reactivity .Principles of trace metal analyses (sampling, digestion, separation, analytical techniques: AAS, ICP-MS, XRF, GC, LC, polarography, etc., reliability, precision, accuracy). Ore deposits and rocks as sources of natural pollution. Soil origin, chemical weathering of rocks and ores, soil classification, 5. Composition of natural waters, Eh-pH measuring techniques, complexes, solubility of minerals, cation-anions exchange processes on clays and organics (colloids). Geochemical investigation of soil. Anomalies in natural waters. Anomalies in stream sediments, lake and sea sediments. Geochemical exploration of drainage systems. Vegetation, volatiles (particles in atmosphere). Statistical treatment of data. Mapping and interpretation. Geochemical exploration of mineral deposits. Geochemical search for anthropogenic polluter, case studies.

PREREQUISITES FOR THE COURSE:

METHODS TO EVALUATE STUDENT PERFORMANCE: attending classes, preliminary exams, homework assignments

EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments

REQUIRED LITERATURE:

1. Rose, A.W., Hawkes, H.E., Webb, J.S.: Geochemistry in mineral exploration, Academic press, 2nd ed. 1979., str. 657.
2. Dean, J.R.: Methods for environmental trace analysis, Wiley, 2003., str. 253.

5067	**ENVIRONMENTAL GEOCHEMISTRY**	**2+1+0**	**0+0+0**

COURSE CONTENT: Glossary, introductory remarks, definition and basic concept of environmental geochemistry. Environment in crisis; analysis of dynamic environmental system, equilibrium, geochemical system, feedback mechanism. Biogeochemical system of carbon. Greenhouse efect, greenhouse gases, efects, causes, consequences. Biogeochemical cycles of ozone and halogenides. Ozon layer depletion, ozone hole , causes, consequences. Biogeochemical cycles of sulphur and nitrogen. Acid rains, pH of rainwater, causes and consequences of acid rains. Chemical time bomb, definition, explantionof cincept, prediction of CTB, examples. Trace elemets and health, concept of geomedicine. examples. Problems of trace element analysis in environemtal sciences.
PREREQUISITES FOR THE COURSE: Geochemistry
TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Prohić, E.. (1998): Geokemija, Targa, 554 str.
2. Berner, E.K. & Berner, R.A.. (1996): Global environment : Water, Air, and Geochemical Cycles, Prentice Hall, INC, USA

5068	**ENVIRONMENTAL LAW**	**2+1+0**	**0+0+0**

COURSE CONTENT: Definition of environment, introductory and basic questions of the environmental law, philosophy of the environment. Environmental law as a concept and its position in the legal system. Sources of the environmental law in the Croatian legal system. Environmental policy and strategy. Protection of the special parts (national parks natural parks, etc) in the Croatian legal system. Implementation and surveillance of the environmental protection. Concept and definition of the sustainable development. Permanent sustainable development and ecological modernization. International legal concept of the environmental protection and preservation of the environment. Development of international environmental law. The most important international legal acts dealing with environmental protection. Environmental law in the European community. Environment from the legal tax standpoint. Instruments of implementation and control of the environmental protection.
PREREQUISITES FOR THE COURSE:
METHODS TO EVALUATE STUDENT PERFORMANCE: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: written exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Lončarić-Horvat, O., Cvitanović, L., Gliha, I., Josipović, T., Medvedović, D., Omejec, J., & Seršić, M. (2003) : Pravo okoliša, Organizator, 348 str. Zagreb
2. Carter, N. (2004) : Strategije zaštite okoliša, Barbat, 383 str, Zagreb

5069	**CLAY MINERALOGY**	**0+0+0**	**1+2+0**

COURSE CONTENT: Definition of clays and clay minerals, division of clay minerals, properties of clays. Structures, chemistry and occurrences of different clay minerals groups (kaolinite, serpentinite, micas, vermiculite, smectite, chlorite, interstratified clays). Methods of sample preparation: rock disaggregation, chemical treatment, fraction separation, sample preparation. Methods for clay minerals analysis: X-ray powder diffraction method (qualitative and quantitative analysis). Methods for clay minerals analysis: thermal methods, infra-red spectroscopy, electron microscopy. Clay minerals genesis, clay minerals transformations during digenesis and low-grade metamorphosis, Kübler and Árkai indices. Usage of clays.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures and laboratory work.
EXAMINATION METHODS: Written and oral exam
RECOMENDED LITERATURE:
1. Moore, D.M. & Reynolds, R.C. (1997): X-ray diffraction and the identification and analysis of clay minerals, Oxford University Press, Oxford, 378 pp.
2. Brindley, G.W. & Brown, G. (1980): Crystal structures of clay minerals and their X-ray identification. Mineralogical Society, London, 495 pp.

5070	**ORGANIC GEOCHEMISTRY OF POLLUTANTS**	**0+0+0**	**2+1+0**

COURSE CONTENT: Introduction to environmental organic chemistry – definition and relationship to other disciplines of science. Basic structures and nomenclature in organic chemistry; anthropogenic vs. natural compounds; definition, classification and major types of pollutants. A brief introduction to analytical chemistry of organic pollutants. Thermodynamics and molecular interactions. Main geochemical processes, which determine behavior and distribution of organic pollutants in the environment and their relationship in real systems. Transport and transfer of pollutants – diffusion and advection. Distribution of organic pollutants between aquatic systems and atmosphere. Distribution of organic pollutants in aquatic systems – solubility and partition coefficients. Distribution of organic pollutants in aquatic organisms – bioaccumulation and biomagnification. Exchange of pollutants between solid-phase and water – sorption and geoaccumulation. Chemical transformations of pollutants. Photochemical transformation of pollutants. Biological transformations of pollutants. Modeling in organic geochemistry of pollutants. Geochemical processes and environmental risk assessment.
PREREQUISITES FOR THE COURSE: Chemistry I and II
TERMS FOR RECEIVING THE SIGNATURE: lattendace to ectures, seminars, homework

EXAMINATION METHODS: oral exam
REQUIRED LITERATURE:
1. Schwarzenbach, R.P.; Gschwend; P.M.; Imboden, D.M. (2003): Environmental organic chemistry, John Wiley & Sons, Inc., New Jersey, USA, 1313 pp.

5071	**BASICS OF PEDOLOGY**	**0+0+0**	**2+1+0**

COURSE CONTENT: Soil and land. Role of soil. Soil genesis: factors and processes. Soil morphology. Pedophysical properties (texture, structure, consistency, porosity, density, water and water regime, soil air, soil warmth). Pedochemical properties (sorption, organic matter and humus, adsorption complex, soil reaction, quality of liquid phase, biological properties of soil). Soil systematics (pedosphere in terrestrial and semi-terrestrial conditions). Evaluation of soil in plant production, for engineering purposes, for spatial and landscape planning, in ecology.
PREREQUISITES FOR THE COURSE: General geology, Geomorphology
TERMS FOR RECEIVING THE SIGNATURE: lecture attendance, field and laboratory exercises, seminars
EXAMINATION METHODS: colloquies, seminars, written and oral exam
REQUIRED LITERATURE:
1. Škorić A. (1986): Postanak, razvoj i sistematika tla. Knjiga, Fakultet poljoprivrednih znanosti, Zagreb
2. Škorić A. (1991): Sastav i svojstva tla. Knjiga, Fakultet poljoprivrednih znanosti, Zagreb
3. Škorić A. (1985): Priručnik za pedološka istraživanja. Fakultet poljoprivrednih znanosti, Zagreb

5072	**INTRODUCTION TO GEOTECHNOLOGY**	**0+0+0**	**2+1+0**

COURSE CONTENT: The importance of geotechnology in terms of mining, geological and oil engineering. Peculiarities of mining: non-recoverbility of reserves, spatial prerequisites of mineral resources, safety of mining works and protection of environment. Mineral resources (hydrocarbons, solid mineral resources). Reserves of mineral resources in Croatia and in the world, their production, supply and consumption. Research, exploitation and refinement of mineral raw material. Basic procedures in mineral resources research: geological, geophysical and geochemical investigations, drilling and mining investigation works. Physical and chemical properties of oil and gas, origin of oil, basic petrophyisical properties of rocks, oil and gas traps, depth structures of hydrocarbon accumulation. Exploitation of mineral resources: hydrocarbons, surface and subsurface exploitation of solid mineral raw material. Basics of technological processes: opening and development of mineral deposits, production, collection and transport of hydrocarbons, excavation of mineral raw materials. Basic properties of mineral refinement: grinding and separation of solid raw mineral materials, other refinement processes and oil refinement. Other activities in geotechnology: route construction, dam construction, tunnel construction, ground water exploitation.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: attendance to classes
EXAMINATION METHODS: colloquiums, seminars, written and oral exam
REQUIRED LITERATURE:
1. Jüttner, I.: Uvod u naftno rudarstvo, (gotov, pripremljen udžbenik, siječanj 2005.)
   Tehnička enciklopedija (1984.), knjiga 9, JLZ " Miroslav Krleža ", Zagreb.
2. Nuić, J., Živković, S., Galić, I.: Uvod u rudarstvo, Interna skripta, Rudarsko-geološko-naftni fakultet u Zagrebu, 2003.

5073	**BIOGEOCHEMISTRY**	**0+0+0**	**2+1+0**

COURSE CONTENT: Principles of eco-system sustainability and distortion of its stability. Functioning of eco-system (circulation of matter and energy, interaction and relationship among organisms in the system). Agroecosystems (changes in natural systems, biodiversity in agroecosystem): organisms, interaction among organisms, interactions among organisms, soil and plants; types of successions in natural and agroecosystems. Soil and environment: soil in agroecosystems (way of usage, growing measures and other anthropogenic influences); concept of soil quality; importance of natural cultivated soil chemistry in environmental protection. Degradation and contamination of soils, and consequences to other media in environment. Biogeochemical cycle of nutrients in natural and disturbed terrestrial eco-systems: cycle of nitrogen, phosphorous, sulphur and other macro- and micro-nutrients. Ecology of rhizosphere and interactions among soil, micro-organisms and plants in nutrient up-take from soil solution. Sources and origins of potentially toxic metals in soil: natural geochemical concentrations, anthropogenic emission: immobilization and dispersion of metals in soil and other environmental media (aquatic systems, organisms, atmosphere and geochemical barriers, metal mobility). Potentially toxic metals in the soil-plant system (bioavailability, bioaccumulation and biomagnifications). Bioremediation. Laboratory methods in environmental samples analysis: soil and plant sampling, sample preparation for analysis; digestion and extraction techniques of soil and plant materials, selection of methods for analysis of different soil types, sampling of soil solution and its analysis (field and laboratory methods).
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: attendance to lectures and laboratory exercises, field and laboratory exercises, seminars, colloquia
EXAMINATION METHODS: colloquia, seminars, written and oral exam
REQUIRED LITERATURE:
1. Gliessman, S.R. 2000. Agroecology. Ecological processes in Sustainable Agriculture. Ed. Engels E., CRC Press LLC, Boca Raton, USA. (odabrana poglavlja)

2. Gliessman, S.R. 2000. Field and Laboratory Invesrtigations in Agroecology. Ed. Engels E., CRC Press LLC, Boca Raton, USA. (odabrana poglavlja)
3. McBride, M.B. 1994. Environmental Chemistry of Soil. Oxford University Press, New York, USA.
4. Siegel, R.S. 2002. Environmental Geochemistry of Potentially Toxic Metals. Springer-Verlag, Berlin.

5092	**FIELD COURSE IN GEOLOGY I**	**60 hrs/year**

COURSE CONTENT: Study of rock types and minerals in field. Learning on stratigraphic successions and geological composition of the visited area. Measuring the attitude of beds and faults, reconstruction of folds after acquired data. Study of slope processes and their consequences. Application of basic geological tools. Orientation in the field and by the map. Keeping individual field logs, and collecting samples. After the completed field course students prepare individual written reports with own observations, measurements and geological maps.
PREREQUISITES FOR THE COURSE: Physical geology
TERMS FOR RECEIVING THE SIGNATURE: preparation of the written report
EXAMINATION METHODS: written exan
REQUIRED LITERATURE:
1. Bahun S. (1993): Geološko kartiranje. Školska knjiga, Zagreb.

5093	**SEMINAR I**	**0+0+2**	**0+0+0**
5094	**SEMINAR II**	**0+0+0**	**0+0+1**
5095	**SEMINAR III**	**0+0+0**	**0+0+2**
5096	**SEMINAR IV**	**0+0+2**	**0+0+0**

A student reports on a scientific paper selected from an eminent scientific journal. The student is expected to write an essay accordingly, and to make a short presentation for other students and the lecturer.

5098	**FIELD TECHNIQUES «MP»**	**0+0+0**	**0+3+0**

COURSE CONTENT: Individual (but also tutored) field work. Field work is focused on igneous and metamorphic complexes in the Croatia (Medvednica, Moslavačka Gora, Slavonian Mts., Inner Dinarides) or in favorable circumstances to Alps and Carpathians. Field technique course ended with producing of geological map and column. Written report includes field and laboratory data.
PREREQUISITES FOR THE COURSE: dependant on the selected supervisor
TERMS FOR RECEIVING THE SIGNATURE: accomplishment of field and laboratory tasks
EXAMINATION METHODS: final report and its oral presentation
REQUIRED LITERATURE:
Dependant on the selected supervisor

5121	**APPLIED GEOPHYSICS**	**0+0+0**	**2+1+0**

COURSE CONTENT: Seismic exploration – Generation and propagation of seismic waves. Time-distance graph for a layered medium. Instruments and equipment: seismic sources, detectors (geophones), seismographs. Refraction seismic exploration: data acquisition and processing, interpretation methods, complications in refraction interpretation (the blind and hidden layers), applications. Reflection seismic exploration: data acquisition, data processing (the static, the NMO and the residual corrections, the velocity analysis), seismic velocity measuring, interpretation of seismic reflection sections, migration, applications. Well logging.
PREREQUISITES FOR THE COURSE: Physics, Geophysics
TERMS FOR RECEIVING THE SIGNATURE: exercises, preliminary exams
EXAMINATION METHODS: written and oral exam
REQUIRED LITERATURE:
1. Griffits, D. H. & King, R. F.: Applied geophysics for geologists and engeneers. Pergamon, Oxford, 1981
2. Parasnis, D.S.: Principles of Applied Geophysics. Chapman and Hall, New York, 1986
3. Šumanovac, F.: Geofizička istraživanja, geoelektrične i seizmičke metode. Rudarsko-geološko-naftni fakultet, Zagreb, 1999.

5127	**GEOLOGICAL MAPPING II**	**0+0+0**	**1+2+0**

COURSE CONTENT: Types of geological maps. Principles of the production of geological maps, especially formation maps. Electronic field log – data preparation. Manipulation of filed and other data in GIS. The structure of GEOLIS.

PREREQUISITES FOR THE COURSE: all geological courses from semester 1 to 4, Geological mapping I
TERMS FOR RECEIVING THE SIGNATURE: attended course exercises and finished obligatory programs
EXAMINATION METHODS: oral and written examination
REQUIRED LITERATURE:
1. Bahun, S.: Geološko kartiranje. Školska knjiga, Zagreb,1993.
2. Barnes, J.W. & Lisle, R.J (2004): Basic Geological Mapping (fourth edition). John Wiley & Sons, Ltd, England.
3. Salvador, A. (ed.) (1994): International Stratigraphic Guide-A guide to stratigraphic classification, terminology and procedure.- 2nd ed., IUGS & GSA.

5301	**GENERAL GEOLOGY (Environmental sciences)**	**2+2+0**	**0+0+0**

COURSE CONTENT: Introduction to physical geology , Space, formation of the Earth, planets, asteriods, comets, meteors, ; Shape and composition of the Earth; Minerals and rocks of the litosphere; Primary strucutral elements of litosphere for igneous, metamorphic and sedimentary rocks ; Secundary structural elements of the litosphere (tectonics), beds, strike and dip of the bed, stratigrapic gap (hiatus), disconformity, angular unconformity, folds (geometry and types), faults (geometry and types), thrust faults ; Egzodynamics : weathering (denudation), sun as geological factor, insolation,climate ; Water : th hidrologic cycle, porosity and permability, ground water , water table,springs and wells ; Rivers : drainage and water divide (watershed), water erosion, transportation, deposition (meanders, flood plains, terraces), delta, estuary, lakes, marshes ; Oceans and seas : tide, wave erosion, bathimetry of sea floor, transgression and regression; Glaciation: Glaciers formation, types of glaciations, glaciers movement, moraines and glacial sedimentation ; Deserts : distribution of deserts on Earth, characteristics of deserts, wind action and deposition (loess and dunes); Earthquakes: causes of earthquakes, seismic waves, locating and measuring earthquakes (MCS and Richter scale), earthquakes and plate tectonics, seismograph and seismogram, tsunamis ; Plate tectonics : continental drift, sea-floor spreading, plate boundaries, magmatism, mantle plumes and hot spots, mountiain belts, geosyncline concept ; Geologic time : determing geologic time (relative and absolute), principles of stratigraphy, faunal chrisis and geological time ; Geologic resources and environmental geology : geology and economical resources, origin of ore depisits, crude oil, enironmental effects of mining, pollution of ground water.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: Regular attending classes and excercises, all exercises and colloquies solved
EXAMINATION METHODS: Written exam
REQUIRED LITERATURE:
1. Herak, M. (1987): Geologija, Školska knjiga, Zagreb.
2. Plummer, Ch.C., McGeary, D. & Carlson, D. (2001): Physical Geology, 8th Ed., Mc Graw Hill, Boston

5302	**MINERALOGY (Environmental sciences)**	**0+0+0**	**3+1+0**

COURSE CONTENT: Structural crystallography - mineral definition, three-dimensional periodicity, crystal lattice, unit cell, crystal systems, symmetry elements, morphology - crystal form, zone, law of constancy of interfacial angles, spherical projection, stereographic projection, theory of rational indices for crystal faces, notations for planes and lines, point groups. Crystal structure definition, atomic coordinates, Bravais lattices, space groups, chemical bonds-crystal structure dependence, isomorphism, polymorphism, solid solutions. Appearance of minerals, crystals, aggregates, density, cleavage, parting, fracture, hardness, colour, streak, lustre. Overview of methods most frequently used for mineral investigation – optical microscopy, electron microscopy, X-ray diffraction methods, methods of chemical analysis. Crystallochemical principles of mineral classification, review of important mineral species (their properties, genetic and paragenetic characteristics, their environmental influence).
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: to fulfil obligations (attending classes, preliminary exams, homework assignments)
EXAMINATION METHODS: Written exam (not written by students who have passed the prelim), oral exam, final grade includes also results of prelim and homework assignments
REQUIRED LITERATURE:
1. Klein, C. (2002): Mineral Science. John Wiley & Sons, New York, 641 pp.
2. Nesse, W.D. (2000): Introduction to Mineralogy. Oxford University Press, Oxford, pp.
3. Bermanec, V. (1999): Sistematska mineralogija – mineralogija nesilikata. Targa, Zagreb. 264 pp.
4. Slovenec, D., Bermanec, V. (2003); Sistematska mineralogija – mineralogija silikata. Denona, Zagreb**. 359 pp.**

5303	**PETROLOGY (Environmental sciences)**	**3+1+0**	**0+0+0**

COURSE CONTENT: Rock forming minerals, structure, texture, mode of occurrence. Intrusive, vein and extrusive rocks. Pyroclastic rocks. Earth mineral and chemical composition, magma, variation diagrams, magmatic series. Classification of igneous rocks. Volcanoes. Magma origin and evolution. Magma emplacement and relative age. Magma crystallization, differentiation, crystallization and melting in binary and ternary systems. Influence of different geological factors on crystallization process. Partial melting. Igneous rocks associations, plate tectonic in magmatic cycle. Mantle. Magmatism on the active and passive continental margins. Igneous rocks of divergent plate margins, rift, oceanic crust, upper mantle. Volcanism inside oceanic plates, hot-spots. Igneous rocks of convergent margins, island arc, continental magmatic arc,

ophiolite suite. Plate (continental-continental) collision, granite. Metamorphism, limits, factors, grade. Type and classification of metamorphism. Prograde and retrograde metamorphism. Protoliths and chemical composition of metamorphic rocks. Rock forming minerals, textures and structures of metamorphic rocks. Classifications - scheme and recommendations. Influence of pressure, temperature and fluids on the mineral assemblage. Metamorphic isograds, facies and facies series. Metamorphic belts. Thermal, cataclastic, regional, sea floor, burial, impact, polyphase metamorphism. Geotectonic settings of metamorphism.
Application of equlibrium concepts to metamorphic rocks, geotermobarometry basics, age of metamorphism. Earth surface processes - physical and chemical weathering. Soil-forming factors. Erosion of soil. Paleosols. Transport and deposition. Bedload and suspension transport. Transport by sediment gravity flows. Sedimentary structures. Clastic sediments: textures, structures and composition of sandstones, conglomerates, breccias and mudstones. Diagenetic processes and environments. Sandstone and conglomerate bodies. Depositional environments. Carbonate deposits: textures, structures and components of limestones. Microbial processes and products. Depositional environments. Diagenetic processes (neomorphism, dolomitization, dedolomitization, silicification). Evaporites, chert, phosphorites, iron and manganese deposits, bauxites: mineralogy, origin, diagenesis. Organic deposits. Coal, rank stages of coal, formation and occurrence of coal. Oil shales. Formation of kerogen. The principal phases of hydrocarbons generation. How knowledge about sediments is used in human activity: excavation, tunnelling, different buildings, environments protection, mining etc.
PREREQUISITES FOR THE COURSE: General geology (passed), Mineralogy (attended)
TERMS FOR RECEIVING THE SIGNATURE: activities in preparation, discussion, reading
EXAMINATION METHODS: written and oral
REQUIRED LITERATURE:
1. Best, M.G. (2003): Igneous and metamorphic petrology.- Blackwell Publishing, 729 pp.
2. Blatt, H. & Tracy, R.J. (1996): Petrology. Igneous, Sedimentary and Metamorphic.- W.H. Freeman and co., 529 pp.
3. Tucker, E.M. (2001): Sedimentary Petrology. An Introduction to the Origin of Sedimentary Rocks. Blackwell Science, 3. izd., IX+262 p., Oxford.
4. Collinson, J.D. & Thompson, D.B. (1993): Sedimentary Structures. Chapman & Hall. 207p. London.
5. Adams, A.E., MacKenzie,W.S. & Guilford, C. (1987): Atlas of sedimentary rocks under the microscope. Longham Scientific & Techical, VII+104, London.

5304	**ATMOSPHERIC POLLUTION AND GLOBAL WARMING (Environmental sciences)**	**2+0+0**	**0+0+0**

COURSE CONTENT: *Physical aspects of atmosphere pollution* – Structure and composition of the clean atmosphere. Sources of atmospheric pollutants (natural, □ydrosphere□c). Types of sources (continuous and accidental; point, line and area sources). Processes affecting airborne pollutants (dry and wet deposition, chemical transformations, advection, turbulent and molecular diffusion) and their dependence on the spatial-temporal scale and atmospheric stability. Models of transport and diffusion of atmospheric pollutants. *Geochemical aspects of atmosphere pollution* – air pollution: aerosols, examples of primar and secondary pollution, effects of pollution on human health, atmospheric cycles of □ydrosp and nitrogen, sulphate aerosols, nitrogen cycle in the context of its fixation and denitrication, acid rains, pH of natural rain, acid rain caused by pollution, problem with drinking water and high chimneys, stratospheric and tropospheric ozone (basic natural and anthropogenic mechanisms of formation and destruction), CO_2 and other greenhouse gases, global cycle of energy and □ydrosphere, atmospheric carbon cycle, greenhouse effect – global warming, controlling emissions of greenhouse gases, metal pollution of atmosphere, abundance of metals in atmosphere, anthropogenic sources of metals in the environment, fate of metals in the environment (specifically in atmosphere), global changes of atmospheric environment: case studies in the context of industrial, mining and natural processes.
PREREQUISITES FOR THE COURSE: None.
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures, homeworks and written essay.
EXAMINATION METHODS: Midterm exam and final oral exam.
REQUIRED LITERATURE:
1. Penzar, B. i suradnici (1996): Meteorologija za korisnike, Školska knjiga, Zagreb, 274 str., (poglavlje 3).
2. http://jadran.gfz.hr/
3. Prohić, E. (1998): Geokemija. Targa, Zagreb, 554 str.
4. Baird, C. & Cann, M. (2005): Environmental Chemistry, W.H. Freeman and Company, NY, 652 str.
5. State-of-the art scientific papers.

5305	**ENVIRONMENTAL LAW (Environmental sciences)**	**2+0+0**	**0+0+0**

COURSE CONTENT: Definition of the environment, introductory and basic terms related to the environmental law, philosophy of environment. Concept of environmental law and its place in the law system. Sources of environmental law in the law system of Republic of Croatia. Politics and strategies of nature conservation/protection. Protection of some specific parts in the croatian law system. Implementation and monitoring in environmental protection. Concept and definition of sustainable development. Permanent sustainable development and ecological modernization. International law aspects of protection and conservation of environment. Development of international environmental law. The most important international agreements on environmental protection. Environmental law in European union. Environment from the view of tax and law standpoint. Instruments of application and monitoring of environmental protection.
PREREQUISITES FOR THE COURSE: None.
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures and written essay.

EXAMINATION METHODS: Oral exam.
REQUIRED LITERATURE:
1. Lončarić-Horvat, O., Cvitanović, L., Gliha, I., Josipović, T., Medvedović, D., Omejec, J. & Seršić, M. (2003): Pravo okoliša, Organizator, 348 str, Zagreb.
2. Carter, N. (2004): Strategije zaštite okoliša, Barbat, 383 str, Zagreb.

5306	**APPLIED GEOLOGY (Environmental sciences)**	**0+0+0**	**2+1+0**

COURSE CONTENT: Geology in everyday life. Geological maps for special purposes (Special geological maps) – contents and use. Hydrogeology (basics). Application of geology in water resources management and water-power supply. Hydrogeological maps. Geology and water supply. Geology and civil engineering construction (Engineering geology – basics). Engineering geological maps. Application of geology in environmental protection – geological maps in environmental protection. Geology and mining. Mineral supplies maps. Petroleum geology (basics). Geology and exploration - exploitation of petroleum and gas. Geological hazards (basics). Military geology, historical perspectives and nowadays use.
PREREQUISITES FOR THE COURSE: General geology, Geomorphology, Petrology
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures and seminars; regular homework doing, presentation and explication of seminar works; passing of all preliminary exams.
EXAMINATION METHODS: Oral examination
REQUIRED LITERATURE:
1. Bačani, A., 2006: Hidrogeologija, Sveučilište u Zagrebu, Rudarsko-geološko naftni fakultet, Zagreb.
2. Mayer, D., 1993: Kvaliteta i zaštita podzemnih voda. Hrvatsko društvo za zaštitu voda i mora, Zagreb
3. Bell, F.G., 1993: Engineering Geology, Blackwell Sci. Publi., Oxford.
4. Montgomery, C.W., 1995: Environmental Geology. WCB Publisher, Dubuque, IA, USA, 4th ed..
5. Bell, F.G., 2003: Geohazards. Their assessment, avoidance and mitigation. Spon Press, London.
6. Tissot, B.P. & Welte, D.H., 1984: Petroleum Formation and Occurrence: A new Approch to Oil and Gas Exploration, 2.izd., Springer-Verlag, New York.

5307	**BASICS OF HISTORICAL GEOLOGY (Environmental sciences)**	**2+2+0**	**0+0+0**

COURSE CONTENT: Methods of Historical Geology. Origin of Atmosphere, Sea, Oceanic and Continental Crust. Cratons and Shields. Origin of Life. The Fossil Record of the Proterozoic. The Proterozoic Ice Ages. The Fossil Record of the Cambrian and Ordovician. Paleogeography of the Cambrian and Ordovician. The Fossil Record of the Silurian and Devonian. Paleogeography of the Silurian and Devonian. The Fossil Record of the Carboniferous and Permian. Paleogeography of the Carboniferous and Permian. Carboniferous and Permian of Dinarides. The Fossil Record and Paleogeography of the Triassic. The Triassic of Dinarides. The Fossil Record and Paleogeography of the Jurassic. The Jurassic of Dinarides. The Fossil Record and Paleogeography of the Cretaceous. The Cretaceous of Dinarides. The Fossil Record of Paleogene and Neogene. Paleogeography and climate of Paleogene and Neogene The Paleogene of Dinarides. The Neogene of Paratethys.
PREREQUISITES FOR THE COURSE: None.
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures.
EXAMINATION METHODS: Written exams.
REQUIRED LITERATURE:
1. Bucković, D: 2006: E-Books: Historijska Geologija 1 i 2. Udžbenici Sveučilišta u Zagrebu - Manualia universitatis studiorum Zagrabiensis. http://gfz.hr/~buckovic/

5308	**GEOLOGY OF MINERAL DEPOSITS (Environmental sciences)**	**3+1+0**	**0+0+0**

COURSE CONTENT: Earth structure, origin of magma, elements of global tectonics. Geology of Dinarides. Deposits related to liquid magma processes, crystallisation differentiates, liquid segregates. Chromite, Ni-Co sulphides (platinum), carbonatite, komatiite, diamond, nefelinite, titanomagnetite, apatite, late-magmatic (Kiruna type). Postmagmatic, pegmatites. Pneumatolites, (skarns, greisens). Massive sulphides (Cypruss type). Hydrothermal deposits (kata-, meso-epi), Cu-porphyries, (cementation zone). High-sulphidation, Low-sulphidation, (Bor, Majdanpek, Trepča). With loose connection to magmatism (Ljubija siderite deposit), SEDEX (Fe-Vareš, Hg-Idrija, Mn-Čevljanovići), Kuroko, Mississippi valley Pb-Zn (Mežica, Bleiberg, Olovo). Sedimentary deposit, Sabkha related, (Cu-schists, Ba-Lokve), resistates (Au, Pt, diamonds, cassiterite). Precipitates (U-Žirovski Vrh, Colorado plateau type), hidrolysates (bauxites, laterites, Ni-laterites). Metamorphogenic and metamorphose deposits (Au-mesothermal). Metallogeny and plate tectonics (Wilson Alpine cycle) in general, in Dinarides.
PREREQUISITES FOR THE COURSE: Mineralogy, Petrology
TERMS FOR RECEIVING THE SIGNATURE: colloquies, seminars, mid-term exam are prerequisite for recognition of attendance
EXAMINATION METHODS: after fulfilling of course obligation the overall mark is formed by final exam, written, and oral
REQUIRED LITERATURE:
1. Evans, A.M.: Ore geology and industrial minerals, Blackwell Sci.Publ., London, 1990, str. 389.

2. Sawkins, F.J.: Metal deposits in relation to plate tectonics. Springer Verlag, 1990, 460.

5309	**INSTUMENTAL METHODS IN ENVIRONMENTAL ANALYSIS (Environmental sciences)**	**2+0+0**	**0+0+0**

see 5063

5310	**GEOLOGICAL ASPECTS OF WASTE DISPOSALS (Environmental sciences)**	**2+1+0**	**0+0+0**

see 5065

5311	**ENVIRONMENTAL MINERALOGY (Environmental sciences)**	**2+0+0**	**0+0+0**

see 5062

5312	**ENVIRONMENTAL GEOCHEMISTRY (Environmental sciences)**	**2+1+0**	**0+0+0**

see 5067

5313	**ENVIRONMENTAL GEOLOGY (Environmental sciences)**	**0+0+0**	**2+1+0**

COURSE CONTENT: The role of geology in environmental protection. Basic concepts: environment, environmental protection, contamination/pollution. Interdisciplinarity in environmental protection. Geological Hazards. Hydrological cycle, groundwater and its quality. Waste disposal and landfills. Erosion, floods, suspended matter and its sedimentation. Marine pollution and eutrophication (Adriatic Sea). Geomaterials and protection of geological heritage. The role of geology in physical planning. Environmental protection strategies and sustainable development.
PREREQUISITES FOR THE COURSE: Chemistry, Geology
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures and exercises
EXAMINATION METHODS: Colloquia, written mid-term and final oral exam
REQUIRED LITERATURE:
1. Juračić, M.: Geologija zaštite okoliša (http://geol.gfz.hr/Juracic/predavanja/index.html)
2. Chamley, H. (2003): Geosciences, environment and man. Developments in Earth & Environmental Sciences 1, Elsevier, pp. 527.
3. Keller E.A (2008): Introduction to Environmental Geology (fourth edition). Pearson Prentice Hall, pp.661.

5314	**HYDROGEOCHEMISTRY AND GROUNDWATER PROTECTION (Environmental sciences)**	**2+1+0**	**0+0+0**

see 5064

5315	**ORGANIC GEOCHEMISTRY OF POLLUTANTS (Environmental sciences)**	**0+0+0**	**2+1+0**

see 5070

5316	**BASICS OF PEDOLOGY (Environmental sciences)**	**0+0+0**	**2+1+0**

see 5071

5317	**GENERAL PALEONTOLOGY (Environmental sciences)**	**0+0+0**	**2+1+0**

COURSE CONTENT: Introduction to paleontology, fossils, fissilization, Methods of work in paleontology, taphonomy, preservation processes, Elements of fossil ; Paleontological systematics and evolution, Micropaleontology ; Algae and

terrestrial palnts, Sponges, Cnidarians, Bivalves, Gastropods, Cephalopods ; Bryozoans, Brachiopods, Crinoids, Echinoids, Trilobites ; Vertebrates ; Paleoecology ; Biostratigraphy ans geological time ; fossils and paleoenviroments ; The history of Earth

PREREQUISITES FOR THE COURSE: None

TERMS FOR RECEIVING THE SIGNATURE: Regular attending classes and excercises, all exercises and colloquies soluved

EXAMINATION METHODS: Written exam

REQUIRED LITERATURE:

1. Sremac, J. (1999): Opća Paleontologija, skripta, PMF.
2. Prothero. D. R. (2004): Bringing Fossils to life, McGrawHill

5318	**GEOCHEMICAL PROCESSES IN SEDIMENTARY ROCKS (Environmental sciences)**	**0+0+0**	**2+1+0**

COURSE CONTENT: Aquatic systems, global cycle of water, sedimentary rocks - composition and origin, major components of sediments, chemical weathering of rocks, weathering agents, limestones - solubility, buffering in carbonate solutions, siliciclastic sediments - solution, clay minerals as heavy metal carriers in aquatic systems, soil formation and its importance for surface environment, river water, Eh/pH conditions in natural environments, total dissolved solids, organic matter in rivers and sediments, iron and manganese in surface environment, oxidation – reduction reactions, sediments/soils as metal repositories, metalo-organic complexes, selective extraction analysis, early diagenesis, diagenetic mobilization of trace metals, geochemical mapping of surface environment, sampling media, metal contamination of sediments and soils (case studies in the context of industrial and ore mining processes).

PREREQUISITES FOR THE COURSE: None.

TERMS FOR RECEIVING THE SIGNATURE: Regular participation in the course.

EXAMINATION METHODS: Tests and oral examination.

REQUIRED LITERATURE:

1. Brownlow, A. H. (1979): Geochemistry. Prentice-Hall, Inc., Englewood Cliffs, New York, 498 p.
2. Tucker, M. E. (2001): Sedimentary petrology: an introduction to the origin of sedimentary rocks. Blackwell Science, Oxford, 262 p.

5320	**OPTICAL INVESTIGATION OF MINERALS AND ROCKS (Environmental sciences)**	**0+0+0**	**2+3+0**

COURSE CONTENT: Reflection and refraction of light, index of refraction, optical isotropic and anisotropic materials, birefringence, optical inicatrix, polarisation of light, polarising (petrographic) microscope, thin sections. Mineral observation in plane-polarised light: relief, Becke line, colour, pleochroism, pseudoabsorption. Mineral observation with crossed polars: extinction (parallel, symmetrical, inclined), interference colours. Determination of vibration directons, accessory plates ; mineral observations with conoscopic illumination. Garnets, opaque minerals. Quartz and calcite. Olivines, pyroxenes and amphiboles. Phyllosilicates (micas and chlorites). Feldspars. Igneous rocks : mafic and ultramafic. Igneous rocks : neutral and acid. Metamorphic rocks of very low-grade and low-grade metamorphism. Metamorphic rocks of medium-grade and high grade metamorphism. Pyroclastic rocks. Clastic sedimentary rocks. Organic and chemical sedimentary rocks.

PREREQUISITES FOR THE COURSE: Mineralogy, Petrology

TERMS FOR RECEIVING THE SIGNATURE: attendance to lectures and exercises, passing preliminary exams, practical exercises

EXAMINATION METHODS: determination of minerals and rock types in thin sections

REQUIRED LITERATURE: :

1. Barić, Lj. & Tajder, M (1967): Mikrofiziografija petrogenih minerala, Školska knjiga, Zagreb, p. 235
2. Pichler, H. & Schmitt-Riegraf, C. (1987): Gesteinsbildende Minerale im Duennschliff, Ferdinand Enke Verlag, Stuttgart, p. 230
3. Vernon, R. H. (2004): A practical quide to rock microstructure, Cambridge University Press, Cambridge, p. 594
4. MacKenzie, W. E., Adams, A. E. (1994): A color atlas of rocks and minerals in thin section, John Wiley and Sons, New York, p.192

5321	**CLAY MINERALOGY (Environmental sciences)**	**0+0+0**	**1+2+0**

see 5069

5322	**GEOLOGICAL MAPS (Environmental sciences)**	**1+1+0**	**0+0+0**

COURSE CONTENT: Introduction and history of geological mapping. Types of geological maps. Relations between rocks: structures,textures and tectonical movements, thickness of divided geological units. Recognotion of geological

structures on the geological maps and on the field. Graphical presentation geological structures (profiles, diagrams). Preparations for geological mapping (fotogeology, remote sensing). Field work. Cabinet work (analysis of the rocks, geological colums and profiles, explanatory notes). Special maps
PREREQUISITES FOR THE COURSE: All geological courses from first and second year of study
TERMS FOR RECEIVING THE SIGNATURE: Successful passing exsercise and obligatory programs
EXAMINATION METHODS: Oral and written examination
REQUIRED LITERATURE:
1. Bahun, S. : Geološko kartiranje. Školska knjiga, Zagreb,1993.
2. Barnes, J.W. & Lisle, R.J: Basic Geological Mapping (fourth edition). John Wiley & Sons, Ltd, England, 2004

5323	**MICROFOSSILS, ENVIRONMENTS AND TIME (Environmental sciences)**	**2+1+0**	**0+0+0**

COURSE CONTENT: Lectures will introduce the various microfossil groups and detail their utility as important indicators of past environments by examining the ecology of living microplankton taxa and extrapolating this to the fossil record (palaeoecology, palaeoceanography). The applicability of different microfossil groups in providing both relative timescales (through zonal schemes) and biostratigraphic correlation will be detailed, as will the role of certain microfossils in understanding evolutionary processes (particularly in groups such as land plants). Microplankton as agents of global environmental change will also be investigated, especially with regard to fluxes of $CaCO_3$ and C and hence to CO_2 in the atmosphere. The microfossil groups which will be studied in the above context are those which form mineralised skeletons (calcareous, siliceous, phosphatic) and the organic-walled microfossils (known as palynomorphs). To give a general introduction to the various groups of microfossils, detailing their morphology, taxonomy, biology, and ecology. The aims: to show how certain microfossil groups can be used in an applied manner for the solution of geological problems (such as biostratigraphy, palaeoecology, palaeoceanographic interpretation, proxies for climatic change, etc.); to o detail some of the industrial applications of microfossils, particularly those related to hydrocarbon exploration; to provide a basic introduction to microfossil extraction/preparation methods; to demonstrate the utility of various microfossil groups in hydrocarbon exploration (source rock analyses, thermal maturity studies, etc.), to undertake an investigative exercise based on a hydrocarbon exploration borehole core.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: Attendance at practical classes is expected
EXAMINATION METHODS: Theory Examination (40%): written exercise (40%), practical examination (20%).
REQUIRED LITERATURE:
1. Haslett, S (ur), 2002, Quaternary Environmental Micropaleontology, Arnold, London, 340 str.
2. Murray, J., 2007, Ecology and Applications of Benthic Foraminifera. Cambridge Press, 438 str.

5324	**ORE DEPOSITS, ENVIRONMENTAL IMPACT (Environmental sciences)**	**0+0+0**	**2+1+0**

COURSE CONTENT: 1. Genesis of ore deposits, sources of metals, transport and deposition of metals in magmatic, sedimentary and metamorphic processes.2. Magmatogenic ore deposits, origin of magma, plutonisam and volcanisam, ore forming processes. Liquid-magmatic deposits (Cr, Ni, Co, PGE) pegmatites, skarns, greisens (Mo, W, Sn,), hydrothermal deposits (Cu, Pb, Zn, Cd, As, Hg etc.). 3. Sedimentary ore deposits, chemical and physical weathering of rocks, transport of metals, geochemical barrier, genesis of uranium, gold, iron, manganese deposits, bauxites, clays, Ni-laterites, manganese nodules on the ocean floor. Metamorphogene and metamorphosed deposits. 4.Selected examples of world-class deposits, Bushveld (chromium, nickl, cobalt), Sudbury (Ni, Co, As) etc. and deposits in the geographically neighbour countries, Idrija (Hg), Žirovski Vrh (Uranium), Bor and Majdanpek (copper and heavy metals), Trepča and deposits in its surrounding (lead, mercury, cadmium), Obrovac (bauxites), etc. 5.Historical mining, civilization epochs (copper, bronze, and iron ages), intensity, routs, environmental impact, old metallurgy, toxic effects, accidents, examples in Dinarides.6. Modern mining, technical performance, influence on chemical environment and landscape. Reclamation and remediation of adverse effects, waste disposals and their construction. 7. Mining without excavation operations. Extraction by cyanides, acid extraction, underground incineration, deposition of wastes (fluids) into abandon oil and gas drill holes, biological mining.8. Industry, metallurgy, ore processing, pollution and its control (accidents, Minamata, Itai-itai diseases, nuclear incidents), metal deficits, metal substitutes, pollution caused by war and terrorist activity, depleted uranium (ammunition), Hg-explosives, acid rains.9. Recycling of the wastes, waste incineration, world trade of metals.10. Natural intricate pollution (arsenic in waters), deficiency and sufficiency of selenium, volcanic gases and vapors. Combustion of fossil fuels (coal, oil, gas), processing of oil shales. 11. Nuclear energy, nuclear waste, low, medium and high activity nuclear waste, radwaste depositories, conditions and criteria for efficient deposition of the radwaste.
PREREQUISITES FOR THE COURSE: Mineralogy, Petrology
TERMS FOR RECEIVING THE SIGNATURE: Colloquiums as a means for continuous control of the students participation and understanding of the presented teaching material. Positive grading of the colloquiums, and elaborated seminars are prerequisite for recognition of the coarse sign and affects the final judging.
EXAMINATION METHODS: Written and oral exams, mid-term exams, colloquiums, seminars, create the final grade.
REQUIRED LITERATURE:
1. A.M. Evans (1998). Ore geology and industrial minerals, Blackwell, , str. 388
2. J. E. Andrews, P. Brimblecombe, T.D. Jickels and P.S. Liss (1996). An Introduction to Environmental Chemistry. Blackwell, 208.

5325	**APPLIED PALAEONTOLOGY (Environmental sciences)**	**0+0+0**	**2+1+2**

COURSE CONTENT: *Introduction*: Taphonomy processes and preservation pottential. *Index fossils and biostratigraphy:* Definition of index fossils. Zones in biostratigraphy. Stratigraphic divisions and Earth history. Precambrian, Palaeozoic, Mesozoic and Caenozoic – main index groups. *Palaeoecology:* Abiotic factors in fossil environments: temperature, salinity, brightness, dissolved gasses, substrate quality, water energy. Biotic factors: palaeoproductivity, interspecific relations. Quantitative analysis of palaeocommunity. Biostatistic methods. Samples from the Miocene of the Paratethys. Geochemical and isotope methods. Geochemical research in Palaeozoic and Miocene rocks in Croatia. *Fossil fuels*: Coal and other solid fuels. Petroleum and natural gas. Source rocks, impermeable traps and reservoirs. Production in Croatia. *Fossils and ore deposits*: Samples from Croatia and other countries. *Lithogenetic fossils and building stone*: Fossils as rock builders. Biogene architectural stone in Croatia and abroad (Brač stone, Istria stone, Benkovac stone, Vrapče stone). Other applications.
PREREQUISITES FOR THE COURSE: General palaeontology (recommended; not obligatory).
TERMS FOR RECEIVING THE SIGNATURE: Regular attendance of lectures and exercises. Solved at least 50 % of colloquia, written essay and exercise homework.
EXAMINATION METHODS: Written (possible to solve through interexams) and oral (chosen topic for discussion, prepared in a form of seminar) exam.
REQUIRED LITERATURE:
1. R. Wynn Jones, *Applied palaeontology*. Cambridge University Press. 2006.
2. J. Velić, *Geologija ležišta nafte i plina*. Rudarsko-geološko-naftni fakultet, Zagreb, 2007 (selected chapters).
3. J. Sremac, *Opća paleontologija*, Skripta. PMF, Zagreb, 1999.

5401	**MINERALOGY I (Chemistry, Physics)**	**2+1+0**	**0+0+0**

COURSE CONTENT: Mineral definition, three-dimensional periodicity, crystal lattice, unit cell, crystal systems. Morphology, symmetry elements without translation, crystal form, habit, zone. Law of constancy of interfacial angles, spherical projection, stereographic projection, Wulff net. Theory of rational indices for crystal faces, notations for planes and lines, point groups (Herman-Mauguin symbols, names), general form. Cubic crystals forms. Forms in other systems, tetragonal and hexagonal system. Holohedral classes of orthorhombic, monoclinic and triclinic systems, problems with symmetry determinations. Crystal structure definition, atomic coordinates, symmetry elements with translation. Bravais lattices, space groups, Internaltional crystallographic tables. Chemical bonds-crystal structure dependence, coordination number, coordination polyhedron, isomorphism, polymorphism. Solid solutions, exsolution, crystal defects. X-ray diffraction, Bragg law, Laue equations, principles of unit cell dimensions determination.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: EXAMINATION METHODS: attending classes, preliminary exams consisting of theoretical part and crystal models projections, homework assignments
EXAMINATION METHODS: oral and written exam
REQUIRED LITERATURE:
1. Borchardt-Ott, W. (1995): Crystallography, Springer Verlag, Berlin, 307.
2. Klein, C. (2002): Mineral Science. John Wiley & Sons, New York, 641 str.
3. Nesse, W.D. (2000): Introduction to Mineralogy. Oxford University Press, Oxford, 442.

5402	**MINERALOGY II (Chemistry, Physics)**	**0+0+0**	**2+1+0**

COURSE CONTENT: Physical properties of minerals (appearance of minerals, crystals, aggregates, density, cleavage, parting, fracture, hardness, colour, streak, lustre). Principles of mineral genesis, igneous, sedimentary and metamorphic processes and their correlation with plate tectonic concept. Crystallochemical principles of mineral classification. Review of important mineral species (their properties, genetic and paragenetic characteristics, and application).
PREREQUISITES FOR THE COURSE: Mineralogy I
TERMS FOR RECEIVING THE SIGNATURE: EXAMINATION METHODS: attending classes, preliminary exams, homework assignments
EXAMINATION METHODS: oral and written exam
REQUIRED LITERATURE:
1. Klein, C. (2002): Mineral Science. John Wiley & Sons, New York, 641 str.
2. Nesse, W.D. (2000): Introduction to Mineralogy. Oxford University Press, Oxford, 442.
3. Bermanec, V. (1999): Sistematska mineralogija – mineralogija nesilikata. Targa, Zagreb. 264 str.
4. Slovenec, D., Bermanec, V. (2003); Sistematska mineralogija – mineralogija silikata. Denona, Zagreb. 359 str.

5404	**GEOLOGY**	**0+0+0**	**2+2+0**

COURSE CONTENT: Definition of mineral; crystallography-internal order in crystals, Bravais lattices; crystallization; crystal morphology (crystal symetry, crystallographic axes, crystal systems, crystal classes). Crystal chemistry (atoms, ions, bonding forces in crystals); chemical composition; (isomorphism, polymorphism, mineraloids); physical properties of minerals (crystal habits and aggregates, cleavage, parting, fracture, hardness, tenacity, specific gravity, luster, color,

luminescence, electrical and magnetic properties); systematic mineralogy. Igneous rocks (constitution of Earth, where and how magmas form, composition of magma, plate tectonic, crystallization of magma and Bowen's reaction series, texture and structure of igneous rocks, mineral composition, classification and identification of igneous rocks). Sedimentary rocks (sedimentary cycle-wheatering, erosion, transport, depositon, lithification; texture and structure, compositon and classifications, identification). Metamorphic rocks (conditions of metamorphism, types of metamorphism; texture and structure, metamorphic minerals, classification and identification). Geologic structures. Mass wasting. Karst and water in the karst. Glaciers and glacial environments. Oceans and the sea floor. Deltas and coasts. Mountain belts and the continental crust. Graund waters and springs. Earthquakes. Earth's interior. Deserts and the sand dunes. Plate tectonics. Stratigraphy of Dinarides. Dinaridic Paleozoic successions; Dinaridic Triassic successions; Dinaridic Jurassic successions; Dinaridic Cretaceous successions; Dinaridic Paleogene successions; Tethian and Paratethian Neogene successions.

PREREQUISITES FOR THE COURSE: None

TERMS FOR RECEIVING THE SIGNATURE: attendance to lectures (66%) and exercises (80%), all tasks to be accomplished on time

EXAMINATION METHODS: oral exam

REQUIRED LITERATURE:

1. Tajder, M. i Herak, M. 1972: Petrologija i geologija. Školska knjiga, Zagreb.
2. Vrkljan, M. 2001: Mineraolgija i petrologija. Osnove i primjena. RGNF, Zagreb
3. Herak, M.1990: Geologija. Školska knjiga, Zagreb
4. Mrinjek, E. 2004: Geologija (skripta), Zagreb

5405	**MINERALOGY AND PETROLGY (Geography)**	**0+0+0**	**2+1+0**

COURSE CONTENT: Introduction (definition of mineral, history of mineralogy, economic importance of minerals). Crystallography (internal order in crystals, Bravais lattices); crystallization. Crystal morphology (crystal symetry, crystallographic axes, crystal systems, crystal classes). Crystal chemistry (atoms, ions, bonding forces in crystals); chemical composition. Crystal structure (isomorphism, polymorphism, mineraloids). Physical properties of minerals (crystal habits and aggregates, cleavage, parting, fracture, hardness, tenacity, specific gravity, luster, color, luminescence, electrical and magnetic properties). Systematic mineralogy (mineralogy and structure of silicate minerals – in general). Systematic mineralogy (non-silicate minerals). Igneous rocks (introduction, constitution of Earth, where and how magmas form, composition of magma, plate tectonic). Igneous rocks (crystallization of magma and Bowen's reaction series, texture and structure of igneous rocks, mineral composition, classification and identification of igneous rocks). Sedimentary rocks (introduction, sedimentary cycle-wheatering, erosion, transport, depositon, lithification). Sedimentary rocks (texture and structure, compositon and classifications, identification). Metamorphic rocks (introduction, conditions of metamorphism, types of metamorphism). Metamorphic rocks (texture and structure, metamorphic minerals, classification and identification). Methods of mineral and rock determinations.

PREREQUISITES FOR THE COURSE: None

TERMS FOR RECEIVING THE SIGNATURE: attending classes, preliminary exams, seminars

EXAMINATION METHODS: oral exam

LITERATURE:

1. Tajder, M. i Herak, M. 1972: Petrologija i geologija. Školska knjiga, Zagreb.
2. Vrkljan, M. 2001: Mineraolgija i petrologija. Osnove i primjena. RGNF, Zagreb

5406	**GEOLOGY**	**2+1+0**	**0+0+0**

see 5404

5407	**GEOLOGY AND PALEONTOLOGY (Biology)**	**2+2+0**	**0+0+0**

COURSE CONTENT: Geology as a natural science discipline and its relation to other disciplines, especially biology. Formation and structure of the Earth. Types of rocks. Structures of lithosphere. Tectonics and dynamics of the Earth (plate tectonics). Geological maps. Basic principles of paleontology. Macro- and microfossils – typical avertebrata and vertebrata fosills important in evolution of life on the Earth. Basic principles in micro- and macropaleobotany.

PREREQUISITES FOR THE COURSE: None

TERMS FOR RECEIVING THE SIGNATURE: attendance to lectures and exercises, colloquia, seminars, homework

EXAMINATION METHODS: written and oral exam

REQUIRED LITERATURE:

1. Chernicoff, S., Fox, H. A. & Tanner, L. H.: Earth: Geologic principles and history.29 + 570. Houghton Mifflin Comp. Boston, New York, 2002.
2. Gould, S.J.: The Book of Life. An Illustrated History of the Evolution of theLife on Earth. W.W. Norton & Comp., 256 pp., New York, London, 2001.
3. Willis,K.J. & McElwain, J.C.: The Evolution of Plants. X+378. Oxford Univ. Press, New York, 2002.

5408	**GENERAL PALEONTOLOGY (Molecular biology)**	**0+0+0**	**1+1+0**

COURSE CONTENT: Fossils and processes of fossilization. Preservation potential. Fossil deposits. Taphonomic processes. Classification in paleontology. Bacteria, Archaea, Eukarya (Protoctista). Eukarya 2 (Fungi, Plantae). Eukarya 3 (Animalia 1). Eukarya 4 (Animalia 2). Application of paleontology in historical geology. Biostratigraphic zones and index fossils. Principles of paleoecological analysis. Facies fossils and taphofacies.
PREREQUISITES FOR THE COURSE: None
TERMS FOR RECEIVING THE SIGNATURE: EXAMINATION METHODS: attendance to classes, colloquia, essay
EXAMINATION METHODS: written and oral exam
REQUIRED LITERATURE:
1. Doyle,P.: Understanding Fossils. Wiley, Chichester, 1996
2. Raup,D.M. & Stanley, S.M. : Principles of Palaeontology. Freeman, San Francisco, 1978.
3. Sremac,J.: Opća paleontologija. Skripta, PMF, Zagreb, 1999.