Course Program at a glance

NEW COURSE PROGRAM

1st YEAR

1st SEMESTER

- **NGGN 101Y** General Mathematics I — Lec 4 Ex. 0 Lab 0 ECTS 7
- **NGGP 102Y** Physics — Lec 3 Ex. 0 Lab 0 ECTS 5
- **NGGN 103Y** Chemistry — Lec 3 Ex. 0 Lab 0 ECTS 5
- **NGGG 104Y** Introduction to Geology — Lec 2 Ex. 2 Lab 0 ECTS 8
- **NGGN 105Y** Introduction to Computing I — Lec 0 Ex. 0 Lab 2 ECTS 6

2nd SEMESTER

- **NGGN 201Y** Statistics — Lec 2 Ex.2 Lab 0 ECTS 6
- **NGMO 291E** Field Course 1 — Lec 0 Ex. 0 Lab 0 ECTS 2
- **NGGE 202Y** Geography and Digital Cartography — Lec 2 Ex. 0 Lab 2 ECTS 6
- **NGGP 203Y** Physics of the Earth's Interior – Geodynamics — Lec 3 Ex. 0 Lab 0 ECTS 4
- **NGGG 204Y** Palaeontology — Lec 3Ex. 0 Lab 2 ECTS 7
- **NGMO 205Y** Mineralogy — Lec 3 Ex. 0 Lab 2 ECTS 7

2nd YEAR

3rd SEMESTER

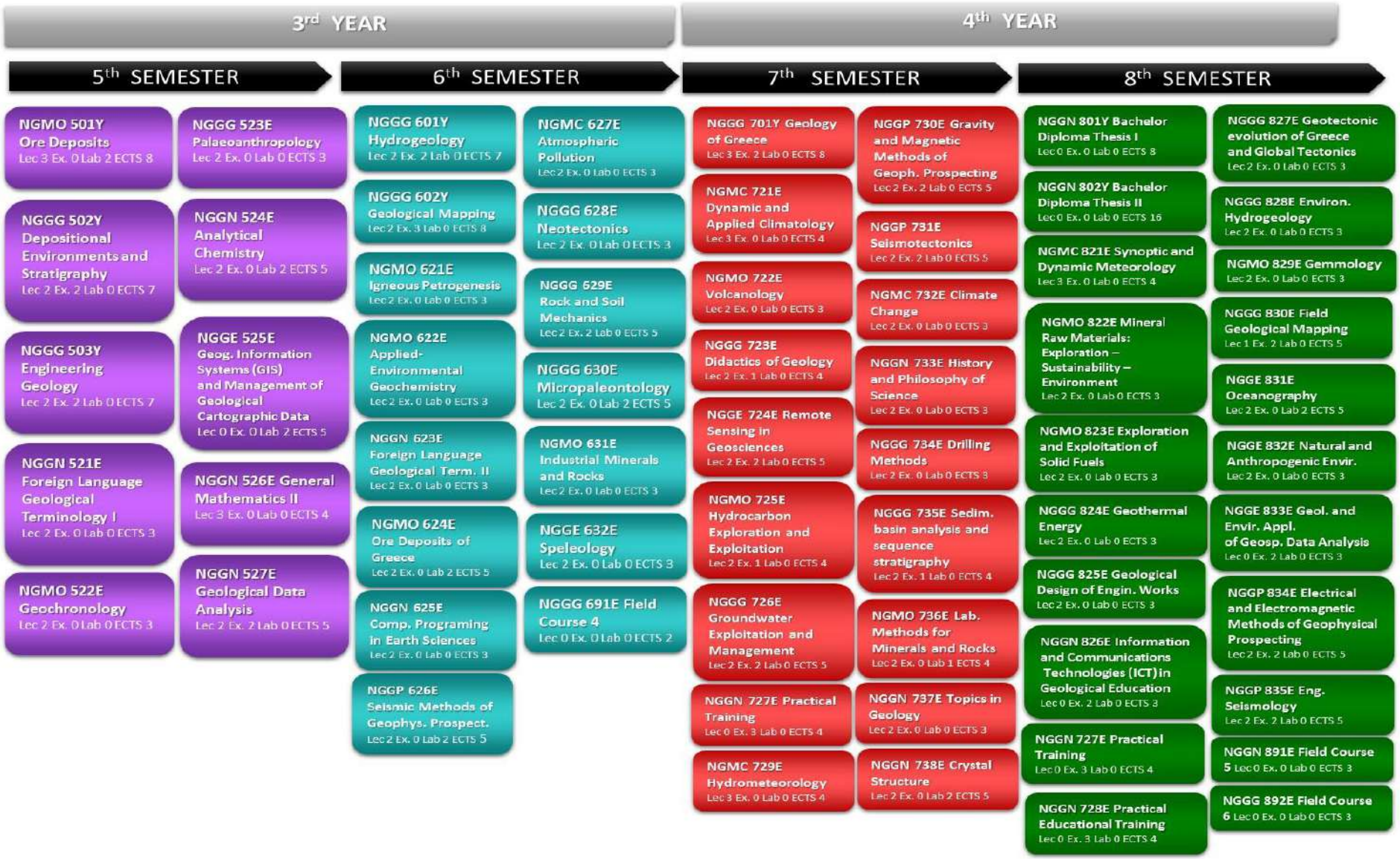
- **NGMO 301Y** Igneous Petrology — Lec 3 Ex. 0 Lab 2 ECTS 8
- **NGMC 302Y** Meteorology — Lec 2 Ex. 1 Lab 0 ECTS 4
- **NGGE 303Y** Physical Geography — Lec 2 Ex. 0 Lab 2 ECTS 6
- **NGMO 304Y** Sediments and Sedimentary Rocks — Lec 2 Ex. 0 Lab 2 ECTS 7
- **NGGP 305Y** Seismology — Lec 2 Ex. 0 Lab 2 ECTS 5

4th SEMESTER

- **NGMO 401Y** Petrology of Metamorphic Rocks — Lec 2 Ex. 0 Lab 2 ECTS 7
- **NGGE 491E** Field Course 2 — Lec 0 Ex. 0 Lab 0 ECTS 2
- **NGMC 402Y** General Climatology – Introduction to Paleoclimatology — Lec 3 Ex. 1 Lab 0 ECTS 5
- **NGMO 492E** Field Course 3 — Lec 0 Ex. 0 Lab 0 ECTS 2
- **NGMO 403Y** Geochemistry — Lec 2 Ex. 0 Lab 0 ECTS 3
- **NGGG 404Y** Structural Geology — Lec 3 Ex. 2 Lab 0 ECTS 8
- **NGGP 405Y** Applied Geophysics — Lec 2 Ex. 0 Lab 2 ECTS 7

Course Program in one glance

NEW COURSE PROGRAM



Course Program in one glance

OLD COURSE PROGRAM

1st SEMESTER					
Code	Course	Lec	Ex	Lab	ECTS
NGGN 101Y	General Mathematics I	4	0	0	7
NGGN 102Y	Physics	3	0	0	5
NGGN 103Y	Chemistry	3	0	0	5
NGGG 104Y	Introduction to Geology	2	2	0	8
NGGN 105Y	Introduction to Computing	0	0	2	6

2nd SEMESTER					
Code	Course	Lec	Ex	Lab	ECTS
NGGN 201Y	Statistics	2	2	0	6
NGGE 202Y	Geography and Digital Cartography	2	0	2	6
NGGP 203Y	Physics of the Earth's Interior – Geodynamics	0	0	4	
NGGG 204Y	Palaeontology	3	0	2	7
NGMO 205Y	Mineralogy	3	0	2	7
NGGN 291E	Field Course 1	0	0	0	2

3rd SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GMO 317Y	Igneous Petrology	2	-	2	4	5
GMC 318Y	General Meteorology	2	1	-	3	5
GGG 320Y	Invertebrate Palaeontology	2	-	2	4	5
GMO 321Y	Sedimentary Petrology	2	-	2	4	5
GGE 427Y	Physical Geography	2	-	2	4	5
GGN 450Y	Field Training	-	-	-	-	-
GGN 323E	Mathematics III	2	1	-	3	5
GGN 430E	Crystal Structure	2	-	2	4	3
GGN 107E	Analytical Chemistry	2	-	2	4	5
GGP 108E	History and Philosophy of Science	2	-	-	2	2

4th SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GMO 425Y	Metamorphic Petrology	2	-	2	4	5
GGG 426Y	Vertebrate Palaeontology	2	-	2	4	5
GGE 322Y	Introduction to Seismology	2	-	2	4	5
GGP 319Y	Introduction to Geophysics	2	-	2	4	5
GGN 450Y	Field Training	-	4	-	4	2
GGG 429E	Micropalaeontology	1	-	2	3	3
GMO 324E	Laboratory Methods for Studying Minerals and Rocks	1	-	2	3	3
GMC 431E	General Climatology - Climate of the Mediterranean and Greece	3	1	-	4	4
GGP 432E	Seismic Methods of Geophysical Prospecting	2	-	2	4	4
GGP 433E	Geological Data Analysis	2	2	-	4	4
GGN 498E	Field Training (1) (East Macedonia-Thrace)	-	2	-	2	2
GGN 499	Field Training (2) (Central Greece – Peloponessus)	-	2	-	2	2

Y = Compulsory, E = Optional, Lec = Lectures (hours per week), Ex = Exercises (hours per week), Lab = Laboratories (hours per week), GC = Greek Credits, EC = European Credits

Details on the prerequisite *courses are found in our website: www.geo.auth.gr*

Course Program in one glance

OLD COURSE PROGRAM

5th SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GMO 534Y	Ore Deposits I	3	-	2	5	6
GMO 535Y	General Geochemistry	2	-	-	2	3
GGP 536Y	Physics of the Lithosphere	2	-	2	4	5
GGG 537Y	Structural Geology	3	2	-	5	6
GGG 538Y	Stratigraphy and Historical Geology	2	2	-	4	6
GGN 550Y	Field Training	-	-	-	-	-
GGN 539E	Foreign Language Geological Terminology I	2	-	-	2	2
GGP 540E	Theory of Mechanical Oscillations and Elastic Waves	2	2	-	4	4
GMO 541E	Industrial Minerals and Rocks	2	-	-	2	2
GMO 542E	Geochronology	2	-	-	2	2
GMC 543E	Hydrometeorology	2	1	-	3	3
GGG 544E	Palaeoanthropology	2	-	-	2	2

6th SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GMO 645Y	Ore Deposits II	2	-	2	4	5
GGG 646Y	Hydrogeology	3	-	2	5	6
GGE 647Y	Sedimentology	2	-	2	4	5
GGG 648Y	Geological Mapping	1	-	2	3	4
GGG 649Y	Field Mapping	-	5	-	5	4
GGN 650Y	Field Training	-	4	-	4	2
GGN 651E	Foreign Language Geological Terminology II	2	-	-	2	2
GMO 652E	Igneous Petrogenesis	2	-	-	2	2
GMO 653E	Applied - Environmental Geochemistry	3	-	-	3	3
GGP 654E	Applied Seismology and Environment	2	-	2	4	4
GGP 655E	Gravity and Magnetic Methods of Geophysical Prospecting	2	-	2	4	4
GGE 656E	Digital Cartography & Geographical Information Systems (G.I.S.)	2	-	-	2	2
GMC 657E	Historical Climatology with an introduction to Palaeoclimatology	2	-	-	2	2
GGN 699Y	Field Training	-	2	-	2	2

7th SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GGG 758Y	Engineering Geology	2	2	-	4	5
GGG 759Y	Geology of Greece	3	2	-	5	7
GGN 750Y	Field Training	-	-	-	-	-
GMO 760E	Petroleum Geology	2	-	-	2	2
GMO 761E	Metamorphic Petrogenesis	2	-	-	2	2
GGP 762E	Electromagnetic Methods of Geophysical Prospecting	2	-	2	4	4
GGG 763E	Groundwater Exploitation and Management	2	-	2	4	4
GGG 764E	Neotectonics	2	-	-	2	2
GMO 765E	Volcanology	1	-	1	2	2
GMC 766E	Atmospheric Pollution and Climatic Changes	2	-	-	2	2
GMC 767E	Applied and Dynamic Climatology	2	1	-	3	3
GGE 768E	Oceanography	2	-	2	4	4
GGE 769E	Physical and Anthropogenic Environment	2	-	-	2	2
GGE 770E	Remote Sensing in Geosciences	2	2	-	4	4
GGN 895E	Finance - Innovation - Entrepreneurship	2	-	1	3	3
GGN 771E	Teaching of Geology	2	1	-	3	3
GGN 772E	Internship	-	3	-	3	4

8th SEMESTER						
Code	Course	Lec	Ex	Lab	GC	ECTS
GGG 871Y	Geotectonic Evolution of the Hellenic Area	2	2	-	4	5
GGN 850Y	Field Training	-	4	-	4	2
GGN 873Y	Diploma Thesis & Information Literacy	-	-	-	6	16
GMO 874E	Coal Geology	2	-	-	2	2
GGG 875E	Drilling Techniques	2	-	-	2	2
GGP 876E	Topics in Geophysics	2	-	-	2	2
GMC 877E	Topics in Meteorology - Climatology	2	-	-	2	2
GMO 878E	Topics in Mineralogy - Petrology - Economic Geology	2	-	-	2	2
GGG 879E	Topics in Geology	2	-	-	2	2
GGG 880E	Topics in Geography	2	-	-	2	2
GGG 881E	Geological - Environmental Surveys for Technical Constructions	2	-	-	2	2
GGG 882E	Geothermal Energy	2	-	-	2	2
GGG 883E	Rock and Soil Mechanics	1	-	2	3	3
GMC 884E	Synoptic and Dynamic Meteorology	2	1	-	3	3
GMO 885E	Mining Geology - Restoration of Quarries and Mines	2	-	-	2	2
GMO 886E	Economic Geology	2	-	-	2	2
GGG 887E	Sanitary Landfills	2	-	-	2	2
GGN 772E	Internship	-	3	-	3	4
GGN 773E	Educational Internship		3		3	5
GGG 890E	Educational Applications of Digital Technologies in Geology	2	2	-	4	4
GGN 898E	Field Training (1) (West Macedonia)	-	3	-	3	3
GGN 899E	Field Training (2) (Santorini)	-	2	-	2	2

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10 Course Syllabus

NEW COURSE PROGRAM: ACADEMIC YEAR (2020-2021)

1st Semester:

NGGN 101Y General Mathematics I: 1) MATRIX THEORY, DETERMINANTS, SYSTEMS Matrices (operations, inverse, rank), determinants (calculation, properties), systems (linear 2x2, 3x3 and non-linear). 2) REAL FUNCTIONS Functions of one and multiple variables, derivatives, partial derivatives. 3) ANALYTICAL GEOMETRY Coordinate systems (cartesian, polar, spherical, logarithmic). Equations of plane, line, surfaces. 4) VECTOR CALCULUS Vectors in three-dimensional space. Operations of vectors (addition, scalar, vector and triple product, mean value). Vector functions of one and multiple variables. Derivatives and partial derivatives of vector functions. Gradient of scalar fields. 5) APPLICATIONS in Geosciences. (Instructors: Ioannis Pytharoulis, Dimitrios Bampzelis)

NGGP 102Y Physics: Mechanics *Units*, Physical Quantities, Vectors, Newton's Laws, Work and kinetic energy, D ynamic energy (gravitational, elastic), Stress, Deformation and elasticity measures, Elasticity and plasticity, Density, Hydrostatic pressure, Pascal's principle, Fluid Pressure Electromagnetism Electric Field and Electric Charge, Electric Potential, Electric potential energy, Current, Specific Electrical resistivity, Electrical resistivity, Magnetism and Magnetic Field Waves and optics Simple Harmonic Motions (Frequency, Period, Harmonic Oscillations), Harmonic Waves, Acoustic Waves, Acoustic Wave Speed, Sinusoidal Electromagnetic Waves, Electromagnetic Spectrum, Light (Nature of Light, Reflection and Refraction, Polarization) (Instructors: Konstantinos Papazachos, Grigorios Tsokas, Konstantia Tolika).

NGGN 103Y Chemistry: Early quantum description of the atom. Electronic configuration of the atom, atomic orbitals. Periodic properties of the chemical elements. Covalent and ionic bond, formation and energetics, molecular orbitals. Atom hybridization, hybrid orbitals, correlation between hybridization and compound structure. Chemical reaction characterization, basic thermodynamics and kinetics. Electrolyte solutions, weak electrolyte dissociation, pH. Geological classification of the elements, isotopes and their applications. Physicochemical characteristics of water as solvent, water occurrence in chemical compounds. (Instructors: Pericles Akrivos , Antonios Chatzidimitriou).

NGGG 104Y Introduction to Geology: History and branches of Geology. Earth as a planetary body. Methods of geological research. The Earth's interior. • The rock cycle. Classification of rocks and their formation conditions. Age of Earth and dating geological events. Erosion, transport and deposition of sediments. Principles of stratigraphy and paleontology. Tectonic structures: faults, joints, folds. • Orogenic processes and principles of the Lithospheric Plate Theory. Geological systems. Applications of Geology. (Instructors: Alexandros Chatzipetros , Olga Koukousioura)

NGGN 105Y Introduction to Computing: Matlab: Introduction to programming with Matlab. Numbers and variables. Algorithms. Reading input files. Creating plots. EXCEL: Introduction to spreadsheets. Data input. Use of functions. Calculations. Creating plots. More specifically: 1. Introduction to programming using Matlab. 2. Using the Matlab editor. Code compilation and execution. 3. Simple examples of scientific coding 4. Numbers, variables and structures in Matlab 5. Text and number format 6. Reading data with Matlab 7. Creating plots with Matlab 8. Excel spreadsheets 9. Inserting data to Excel 10. Using functions in Excel 11. Creating plots in Excel. (Instructors: Eleni Katragkou, Dimitrios Bampzelis , Odysseus Galanis, Dominikos Vamvakaris).

2nd Semester:

NGGN 201Y Statistics: Introduction - variables: Continuous and discrete variables, Probability theory -distributions (Bernoulli, Binomial, Poisson, Normal, X2, t και F). Descriptive statistics: introduction, Frequency tables, boxplots, histograms. Basic statistics (mean, median, standard deviation, IQR). Scatter plots. Exercise Hypothesis testing: One sample t- Test, Tests for differences of mean value, test of Goodness of Fit (Chi Square test, F test), test Kolmogorov-Smirnov, Exercise, Analysis of two variables: Correlation, linear correlation, simple linear regression, non-linear correlation, Least squares, sampling error, ANOVA test, Exercise. Multiple variable analysis: Generalized correlation, multiple linear regression • Frequencies-Frequency Tables-Cumulative Frequencies • Classes-Frequency Distribution Table-SPSS examples • Descriptive Statistics - Data Analysis – Box plots - SPSS examples • Hypothesis testing - SPSS examples • Compute Variables - Scatter plots - SPSS examples • Linear Regression - Errors - SPSS examples • Least Square Regression - SPSS examples • Linear correlation - multipoint correlation - SPSS examples • Linear regression and ANOVA test – SPSS. (Instructors: Christina Anagnostopoulou, Odysseus Galanis, Eleni Karagianni, Despoina Kementzetzidou, Parthena Paradeisopoulou, Dominikos Vamvakaris).

NGGE 202Y Geography and Digital Cartography: • Introduction. History of Geography. Branches of Geography. Geography and new technologies. • Fundamental geographical concepts (geospatial data and information, scale, measurements, accuracy and reliability of measurements, errors). • Earth as a celestial body. The shape

and dimensions of the Earth. Earth's movements. Elements of Geodesy. • Coordinate reference systems. Geodetic Reference Systems and Projections in Greece and worldwide. • Topographic maps. • Morphological sections. Cartometry. • Elements of Surveying. • Introduction to Cartography. • Digital Cartography. Digital topographic and geological maps, digital geological data. • Introduction to Geoscience and the applications of geospatial technologies (Geographic Information Systems / GIS, Remote Sensing, Global Navigation Satellite Systems / GNSS). • Digital Elevation Models (DEMs). • Environmental Geography. (Instructor: Antonios Mouratidis).

NGGP 203Y Physics of the Earth's Interior – Geodynamics: 1) Earth and Solar System formation. Introduction to Radiometric dating- geochronology. 2) The Earth's gravity field. The shape of the Earth – Geoid, ellipsoid. 3) The Earth's magnetic field and its origin. Geomagnetic field variations. Paleomagnetism and its relation to Geodynamics. 4) Seismology and the internal structure of the Earth. Seismic wave propagation in the Earth. 5) Velocity structure, anisotropy. Crust, mantle and core of the Earth. Continental and ocean lithosphere. 6) Geodynamics: lithospheric plates and their kinematics. 7) Heat generation and conduction in the Earth. (Instructors: Eleni Aidona, Georgios Karakaisis, Anastasia Kiratzi)

NGGG 204Y Palaeontology: History of Paleontology. Fossils-Fossilization. Taphonomy. Types of Fossil accumulations-excavation-preservation. Systematics & Taxonomy – the paleontological species concept. • Palaeogeographic evolution of Earth, early history of Life, mass extinction. Fossils & Geological time. • Invertebrate Palaeontology: Sponges, Archaeocyaths, Brachiopods, Corals, Bivalves, Gastropods, Cephalopods, Echinoderms, Trilobites, Graptolites • Vertebrate Palaeontology: Fishes, Amphibians, Reptiles, Aves, Mammals, Human evolution • Significance - use of fossils in dating and reconstructing past environments. The Greek Fossil Record. (Instructors: Dimitrios Kostopoulos, Georgios Siridis, Evangelia Tsoukala, Olga Koukousioura, Georgios Lazaridis, Ioanna Sylvestrou).

NGMO 205Y Mineralogy: 1) INTRODUCTION: Objective of Crystallography. Definition of a crystal. Anisotropic-Isotropic-Homogeneous bodies. Definition of crystal zone. Law of Constancy of Interfacial Angles. 2) TRANSFORMATIONS IN SPACE – CRYSTAL SYMMETRY: Simple symmetry operations. Symmetry axes, planes and centers. 3) CRYSTAL CLASSES: Simple and combined forms. Natural and apparent symmetry. Point symmetry. Geometrical laws applied to the crystals of the 32 crystal classes. Haüy's law or law of rational indices. 4) PLANE INDICES: Identifying axial intercepts and plane indices. 5) CRYSTAL SYSTEMS: Crystallographic axes. Crystals of the 7 crystal systems. Inversion axes and inversion planes. 6) CRYSTAL INTERGROWTH – TWINNING: Parallel intergrowth. Twinning and Polysynthetic twinning. Pseudosymmetry. Epitaxy-Topotaxy-Heterotaxy. 7) CRYSTAL LATTICE – ATOMIC STRUCTURE AND ARRANGEMENT: Lattice points, lattice planes, unit cell. Bravais lattices. Relationship between lattice and regular intergrowth. Determination of crystal structure by X-ray methods. 8) HISTORICAL BACKGROUND – MINERAL DEFINITION: Objective of Mineralogy. Association with other scientific fields. Historical background. Mineral definition. 9) SUBSTITUTION – SOLID SOLUTIONS – EXSOLUTION: Atomic substitutions. Definition of Solid Solution. Exsolution phenomena. 10) ISOMORPHISM – POLYMORPHISM – POLYTYPISM: Definition and examples of Isomorphism, Polymorphism, Polytypism. Mechanisms of Polymorphism. 11) MAGNETIC – ELECTRIC PROPERTIES: Piezoelectricity. Pyroelectricity. Radioactivity. 12) BASIC CONCEPTS OF PETROLOGY: Fundamentals of Petrography. Igneous rocks. Sedimentary rocks. Metamorphic rocks. 13) MINERAL CLASSIFICATION AND CHEMICAL FORMULA: Native elements. Sulfides. Oxides – Hydroxides. Halides – Sulfates. Carbonates. Silicates. (Instructors: Anestis Filippidis, Nikolaos Kantiranis, Lamprini Papadopoulou, Triantafyllos Soldatos, Dimitrios Vogiatzis).

NGMO 291E Field Course 1: This field trip covers a variety of topics related to Introduction to Mineralogy and Introduction to Geology courses: • Rock identification in the field. • Classification of igneous, sedimentary and metamorphic rocks. • Identification of faults, joints and folds in the field. • Visit at an inactive marble quarry. • Contact metamorphism zone and its associated minerals. • Erosion, transport and deposition processes. • Use of geological compass to measure geometrical properties of geological surfaces.

3rd Semester:

NGMO 301Y Igneous Petrology: Introduction - Introduction to the subject of Petrology - Purpose - Research methods - Major groups of rocks Basic concepts of Optical Mineralogy Rock forming minerals Composition and Properties of Magma Origin of Magma Evolution of Magma Geochemistry of igneous rocks Magma chemistry and geotectonic environment Morphological types of igneous rocks Chemical classifications of igneous rocks Acid, intermediate, basic and ultrabasic rocks Foid bearing rocks - carbonatites - ophiolites – pyroclastic rocks.

NGMC 302Y Meteorology: 1) Introduction and structure of the atmosphere. Introduction to the subject of Meteorology. The atmosphere and its structure. Extent, composition and total mass of the earth's atmosphere. Vertical distribution of the atmosphere. The elliptical orbit of the earth around the sun. 2) Electromagnetic spectrum. Basic parameters of radiation. Radiation laws. Solar station. The

solar radiation in the atmosphere. The intensity of solar radiation on the surface of the earth and the factors that affect it. Earth radiation. 3) Temperature of the atmosphere. Temperature measurement. Heating the atmosphere. Variation of air temperature with height. The greenhouse effect. 4) Humidity of the atmosphere. Hygrometric parameters. Humidity measurement. Dew-point temperature. Absolute humidity. Water vapor mixing ratio and specific humidity. Relative humidity. Precipitable water. 5) Atmospheric pressure. Hydrostatic equation. The change in atmospheric pressure with height. Isobars. Isopleths of height and thickness. Measurement of atmospheric pressure. Wind and wind measurement. Forces that regulate the wind. 6) Atmospheric thermodynamics. Thermodynamic systems. Thermodynamic characteristics of dry and wet air. Equation of state for dry and moist air. Specific air heat. The first law of thermodynamics. Non adiabatic and adiabatic changes. Poisson equation and potential temperature. Upward and downward movements in the atmosphere. 7) Static of the atmosphere. Sample method. Investigation of static equilibrium in the atmosphere. Stability and instability of unsaturated and saturated air. 8) Condensation - clouds - precipitation. Cloud classification. Cloud cover. Fog and fog categories. Dew and frost. Rain, snow and hail. Precipitation categories depending on the way the rain clouds form. Rain generation mechanisms. 9) Atmospheric depressions. Characteristics of air masses. Frontal surfaces and fronts - Weather systems. Depressions and categories of depressions. Cyclones and cyclogenesis. Anticyclones and types of anticyclones.

NGGE 303Y Physical Geography: • INTRODUCTION, Physical Geography of our Planet, Physical Geography and Environment • THE SHAPE OF THE EARTH, Earth's structure, Major Relief Features of the Earth's Surface, Lithospheric plate movements and Orogenesis • WEATHERING, Physical weathering, Chemical Weathering, Weathering process as Geomorphological Factor • GLOBAL CLIMATES AND GEOMORPHOLOGY, Climate Classification and types, Global Precipitation, the geomorphological evolution in different climates, the climate of Greece as a factor of geomorphological evolution. • ECOSYSTEMS OF THE EARTH • GLOBAL SOILS, The Nature of the Soil, Soil development, Soils of the world, Soil erosion • HYDROGRAPHY – HYDROLOGY, Groundwater, Surface water, Drainage networks, Lakes, Water as a Natural Resource • FLUVIAL GEOMORPHOLOGY, The Work of Streams and Stream Gradation, Base Level, Valley formation, Fluvial Landscapes. • LANDFORMS MADE BY VOLCANIC ACTIVITY, Stratovolcanoes, Shield volcanoes, Volcanic activity of the Earth, Denudation process on Volcanoes, Main volcanos of Greece. • GLACIAL GEOMORPHOLOGY, Formation of a Glacier, Glacier Classification, Alpine Glaciers, Ice sheets, Glacial movement, Periglacial phenomena, Pleistocene Ice Ages. • LANDFORMS AND GEOLOGICAL STRUCTURE, Landforms and rock resistance, Landforms of Horizontal Strata and Coastal Plains, Landforms of Warped Rock Layers, Landforms on other geological structures. • TECTONIC GEOMORPHOLOGY, Fault Landforms, Active tectonics control in fluvial systems and basins. • KARST GEOMORPHOLOGY, Chemical and mechanical action of water on carbonate rocks, Surface karst landforms, Underground karst landforms, Karst hydrology, Karst types and cycles. • Coastal Geomorphology, The work of waves, Types of Coastlines. • AEOLIAN GEOMORPHOLOGY, Geomorphological action of the wind, Aeolian Processes, Sand Dunes, Loess.

NGMO 304Y Sediments and Sedimentary Rocks: 1. Origin of sedimentary rocks and sedimentation processes Sedimentation rates and factors affect their rate. Processes of sedimentary rocks origin (physical, chemical, biological) and sediments genesis (weathering-transportation-deposition-diagenesis). Weathering factors, weathering and climate, weathering and clay minerals. Forms of diagenesis, late diagenesis transplantation and anchimetamorphosis. 2. Texture of the sedimentary rocks. Clastic sediments texture. Statistical parameters. Textural maturity. Mineralogical maturity. Orientation. Porosity-Permeability. Carbonate rocks texture. 3. Components of clastic sediments. Quartz, feldspars, rock or mineral fragments, heavy minerals, zeolites, chain silicates, organic matter and other constituents. Cement materials. Mineral and rock alterations and transformations. Chemical composition of sedimentary rocks. 4. Petrographic types of sedimentary rocks 4.1. Clastic sediments: Conglomerate and Breccia. Sandstones: Diagenesis, classification, petrographic types. Mudstones: Components, classification, petrographic types, sedimentary rocks rich in iron. Clays: Diagenesis and petrographic types. Residual weathering rocks: Laterites and bauxites. Soil: Components, textural classes and soil genesis. Flysch - Molasse. Volcanoclastic sediments and zeolitic sedimentary rocks. Clastic sedimentary rocks of Greece. 4.2. Chemical and Biological Sediments: Evaporites. Carbonate sediments: Carbonaceous sedimentation, mineral components, carbonate mud, sand and formations, diagenesis and classification and petrographic types of carbonate sediments. Silica sediments. Phosphorites. Carbonaceous sediments. Chemical and biogenic sedimentary rocks of Greece.

NGGP 305Y Seismology: 1) INTRODUCTION: Main target of the science of Seismology. Research methods in Seismology. Scientific and social importance of Seismology. Short history of Seismology. 2) PRINCIPLES OF ELASTICITY THEORY AND ELASTIC WAVES: Traction vectors at a point, stress tensor, equilibrium conditions, principal stresses, units and values of stress inside the Earth. Strain at a point of a body, normal and shear stresses, rotation, stress-strain relations, elastic constants. Equation of motion, wave equation, equation of vector wave. Elastic body waves: Compressional and shear waves, reflection and refraction of body waves Snell's low. Surface waves: Rayleigh and Love waves, dispersion of surface waves. 3) INSTRUMENTS OF SEISMIC WAVE RECORDING: Basic principles of seismograph operation, eigen period of a pendulum and ways of changing it,

attenuation of a pendulum motion. Theory of seismometers: Equation of motion of the pendulum of a seismometer, response of this motion to the seismic motion. Electromagnetic seismometers and their calibration, digital seismographs and broad-band seismometers. 4) SEISMIC WAVES AND THEIR PROPAGATION INSIDE THE EARTH: Earthquake foci, epicenter, time of origin, travel time curves of seismic body waves, seismic waves velocity versus depth. Seismic wave propagation in the Earth's crust, mantle and core. Surface wave propagation, free oscillations of the Earth. Attenuation of seismic waves. 5) SEISMOMETRY: Measurement of the arrival time and the period of seismic waves. Fourier spectrum of seismic waves. Particle motion. Travel time curves, estimation of the epicentral distance and the origin time of an earthquake. Estimation of the coordinates of the earthquake foci: Estimation of the epicenter applying the graphical method (travel time differences of P and S waves) using more than two stations, application of the Wadati method for the estimation of the focal depth. Magnitude of an earthquake, different magnitude scales, magnitude saturation, correlation between different magnitude scales. Seismic energy. 6) EARTHQUAKE GENERATION AND THEIR SPACE-TIME DISTRIBUTION: Models of shallow depth and deep focus earthquake generation. Asperity and barrier model of seismic faults. Time distribution of seismicity: The seismic cycle, seismic sequences, accelerating and decelerating seismicity, induced seismicity. Time independent and time dependent seismicity. 7) EARTHQUAKE PREDICTION: Long term earthquake prediction: Seismic cycle for slip and time predictable models, the methods of seismic gaps and static stress (Coulomb stress) change. Intermediate term earthquake prediction: Method od decelerating inside and accelerating outside seismic deformation. Short term earthquake prediction: Earthquake precursors and their physical explanation. Social impact of earthquake prediction. 8) MACROSEISMIC EFFECTS OF EARTQUAKES: Effects on the soil, the water ((Seiches), the sea (tsunamis), and the structures. Effects on the humans and the animals. Estimation of the macro seismic effects, seismic intensity scales, seismic intensity curves. 9) ANTHROPOGENIC QUAKES: Artificial laboratory shock waves. Microseismic noise. Nuclear explosions: energy and magnitude of nuclear explosions, detection of nuclear explosion and their discrimination from earthquakes. Shocks due to chemical explosions.

4th Semester:

NGMO 401Y Petrology of Metamorphic Rocks: 1) INTRODUCTION: Definition of metamorphic rocks. Principal metamorphic modifications. General aspects of metamorphic rocks. Chemical composition classes of metamorphic rocks. Factors of metamorphism. 2) CONTACT METAMORPHISM: Definition of contact metamorphism. Factors that control the width of the contact aureole. Structures of metamorphic rocks. Rock types and mineral assemblages of metamorphic rocks. 3) REGIONAL OR OROGENIC METAMORPHISM: Definition of orogenic metamorphism. Prograde and retrograde metamorphism. Metamorphic fabrics. Structures of orogenic metamorphic rocks. Relationship between metamorphism and deformation. Pretectonic – syntectonic – posttectonic crystallization. Polymetamorphism. 4) CLASSIFICATION OF METAMORPHIC ROCKS: Macroscopic, structural and mineralogical characteristics of metamorphic rocks. 5) MINERAL ASSEMBLAGES OF METAMORPHIC ROCKS: Chemically equivalent assemblages. Compositional diagrams. 6) CHARACTERISTICS OF OROGENIC METAMORPHISM: Mineral zones and index minerals. Geothermal gradient. Isograds. Metamorphic facies. Reaction isograds. Petrogenetic grids. 7) MINERAL ASSEMBLAGES IN OROGENIC METAMORPHISM: Orogenic metamorphism of pelites, calcareous pelites and argillaceous carbonates, mafic, ultramafic and siliceous carbonates. Petrogenetic significance of aluminosilicate minerals. Sillimanite isograds. 8) GEOTECTONIC SETTING OF OROGENIC METAMORPHISM: Orogenic belts. Continental collision zones. Metamorphism at active continental margins. Metamorphism at subduction zones. Metamorphism at extensional zones. Migmatites. Ocean-floor metamorphism. Burial metamorphism. Dynamic metamorphism. 9) CONDITIONS OF METAMORPHISM: Low and high temperature and pressure limits of metamorphism. 10) METAMORPHIC REACTIONS: Principles of metamorphic reactions. Metamorphic processes. 11) MICROSCOPIC CHARACTERISTICS OF METAMORPHIC REACTIONS: Porphyroblast development. Recrystallization and annealing. Criteria of equilibrium.

NGMC 402Y General Climatology – Introduction to Paleoclimatology: Introduction: Weather and Climate, Objectives and climatology sectors, Climate factors. Solar Radiation: Solar Energy, Energy and transportation, Atmosphere and soil interactions, Energy Balance, Solar duration. Temperature: Temperature parameters, Temperature earth distribution, Temperature distribution over the Mediterranean and Greek region, Solar and water Temperatures. Precipitation: Spatial distribution of Clouds and precipitation, physical factors of the precipitation distribution, daily and annual rainfall distribution, Geographical distribution of rainfall. General Atmospheric Circulation: Winds, Local winds, horizontal pressure distribution, horizontal pressure distribution, air masses, classification, main atmospheric systems. Climate description: Analysis and geographical distributions of the climates on a global scale. Different climatic areas and climates over the planet. Climatic classifications. Paleoclimatology: Geological centuries and climate evolution. Proxy data for climate reconstruction, dating methods. The main physical causes for climate change

(continent movements, volcanos, Milankovitch circles, solar activity).

NGMO 403Y Geochemistry: Introduction- Subject of Geochemistry Goldschmidt Geochemical classification of the elements Chemical Bonds and their relationship with the composition and properties of minerals – Ionic radius – Coordination number and ionic radius ratio - Ionic substitution in crystals - Isomorfism, polymorfism and solid solutions Solar System Elements - Meteorites The evolution of the Earth's composition - The Earth's internal structure – Total composition of the Earth - The original geochemical differentiation of the proto-Earth - Formation and development of the Earth's solid crust Origin and crystallization of magmas Geochemical characteristics of primary magmas - Behavior of trace elements during fractional crystallization or partial melting of the rocks - Rare earth elements - Spider diagrams Geochemistry of sedimentary rocks Reactions in aqueous solutions - Water as a solvent - Acids and bases dissociation - Salt solubility - Solubility product - Saturation index - Solution and precipitation of calcium carbonate - Chemical weathering of silicate minerals Geochemistry of the metamorphic rocks Mobility of the elements during metamorphism Isotopic Geochemistry Elements Stable and radioactive isotopes, main radiochronological methods Use of isotopes to determine the source of magma.

NGGG 404Y Structural Geology: • Introduction το Structural Geology • Tectonic and atectonic structures • Orogenesis and continent formation • Structure of Earth's crust and fundamental principles of the plate tectonics theory • Rock deformation: strain ellipsoid, deformation types. • Tectonic structures: brittle tectonics (brittle deformation structures, stress field), ductile tectonics (folds, schistosity). • Tectonic lineaments. • Kinematic analysis. • Texture analysis: rose diagrams and stereographic projections. • Experimental structural geology. • Applications of structural geology. • Introduction to quantitative structural geology • Strike and dip direction rose diagrams • Orthographic projections of surfaces and lineaments • Densification of data in Schmidt networks • Solving of geological problems • Use of new technology in structural geology • Structural modelling.

NGGP 405Y Applied Geophysics: 1) Introduction to Geophysics 2) Seismic methods: Refraction-Reflection, principles, measurements, applications, case studies, use of seismic methods to applied and theoretical research (i.e. structure of basins, geotechnical investigation etc.) 3) Gravimetric measurements: corrections of the gravity field. Bouguer anomalies in applied and theoretical research (isostasy, study of the Earth's crust, investigation for hydrocarbons, etc.) 4) Magnetic measurements: Principles, measurements, applications, case studies, use of magnetic methods to the applied and theoretical research. 5) Electrical and electromagnetic methods: Principles, measurements, applications, case studies, use of electrical and electromagnetic methods in mining exploration, hydrogeology, geotechnical and environmental investigations. 6) Well Logging and radiometric methods: Principles, measurements, applications, case studies Structure and contain of exercises Seismic refraction and reflection method. Basic data processing, identification of first arrivals of seismic waves and calculation of the seismic velocity of the geological strata. Interpretation of seismic sections. Gravity method: Basic processing and interpretation of gravity measurements, gravity anomalies of simple structures, gravitational maps. Magnetic method: Basic processing and interpretation of magnetic data, magnetic anomalies of simple structures, magnetic maps. Electrical methods: Interpretation of electrical profiling and electrical tomography data. Electromagnetic methods: Interpretation of electromagnetic data from VLF profiles and Georadar sections. Well-logging data interpretation (resistivity and gamma logs) applied to hydrogeology. Field demonstration of basic applied geophysical Field demonstration at locations of the Univ. Campus of the application of applied geophysical methods. Location: Univ. Campus Content Field demonstration of the application of geophysical methods with the participation of students in groups that includes the collection of measurements in the field using the following geophysical techniques: seismic refraction, electrical Tomography, magnetic method, GPR Evaluation method for students (if done separately from the course). The students deliver a relevant report with the basic interpretation of the collected field data.

NGGE 491E Field Course 2: Day 1 Thessaloniki - Lamia Thessaloniki - Tempi - Larissa - Kalampaka - Xyniada Basin - Lamia Points of Interest along the way • Thessaloniki Plain, Brief History of the geomorophological evolution during the Holocene, Giannitsa Lake, Drainage Works of 1930's. • Litochoro, Mount Olympus alluvial fans, torrential incision, Mount Olympus uplift. • Pyrgetos, Fluvial Terraces of Pinios River, Pinios River Delta plain. Tempi, epigenetic valley, geomorphological evolution of the valley, river terraces, karst solution, karstic water table, karstic springs, freshwater invertebrates • Basin of Thessaly, Meteora, formation, sediment deposition, erosion Antinitsa Monastery Fossil Cretaceous limestones, shallow / deep sea sediments - Radiolarites • Road sections to Lamia, Ophioliths / adjacent deep sea sediments • Staying overninght in Lamia. Day 2 Lamia Lamia - Gorgopotamos - Thermopylae - Agia Paraskevi - Lamia • Lamia Archaeological Museum. Guided Tour - briefing on the presence of prehistoric man in the area. Panorama and geomorphology of the area. • Agia Paraskevi, Prehistoric Settlement, Geoarchaeological Research Methods, Holocene Stratigraphy, Paleontology, mollusks of fresh - brackish - marine waters, Paleogeographical - Paleoenvironmental evolution of the area. • Gorgopotamos, Gorge exit, Gorgopotamos railway bridge, Tectonic uplift of Mt. Oiti, channel incision. • Thermopylae, Thermal springs, Thermopylae – Sperchios falt zone, chemical deposits (travertine), modern sedimentation, Visit to the Thermopylae battlefield, Paleogeographic evolution of the area. • Return

to Lamia • Staying overninght in Lamia Day 3 Lamia - Nea Kios Lamia - Arkitsa - Kastro - Kopaida - Aliartos - Thebes - Erythres - Mandra - Megara - Kakia Skala - Corinth Isthmus - Kechrees - Isthmia - Argos - Nea Kios Points of Interest along the way • Arkitsa, Falt Mirror • Kastro - Copaida - Aliartos, karstic geomorphology, Poljie, Ancient Minyans, Ancient Glas fortified Acropolis, drainage of Kopaida Lake, Karst phenomena, sinkholes. • Corinth Canal, canal construction, fossil geological layers, fossil collection and identification. • Posidonia, elevation of tectonic rocks. • Kechrees, Submerged ancient harbor due to active tectonics. • Arrival in Nea Kios. • Nea Kios Environmental Education Center, information on the educational activities of the center. • Staying overninght in Nea Kios. 4th day New Kios Nea Kios - Mycenae - Epidaurus Asklepieion - Ancient Theater – Ligourio Natural History Museum - Nea Kios • Nea Kios beach, sampling methods for the study of invertebrates and foraminifera, environmental - paleoenvironmental indicators • Mycenae, Mycenaean Dam, fluvial geomorphology • Mycenaean Acropolis, Lion Gate rift, Cyclopean walls construction materials. • Ligourio - Natural History Museum. • Epidaurus Asklepieion. Fossiliferous limestone with ammonites. • Return to Nea Kios. • Staying overninght in Nea Kios. 5th day Nea Kios - Mesolongi Nea Kios - Dervenakia - Corinth - Diakofto - Rack railway - Kalavryta - Diakofto - Rio Antirio Bridge - Antirrio - Mesolongi - Klisova - Mesolongi. • Dervenakia, narrow morphology, fossil limestones with Nummulites • Acrocorinth, morphology • Active tectonis and uplifted sediments of the Northern Peloponnese • Diakofto Village, Boarding on the rack railway, Route to the Vouraikos River Gorge, river incision, channel knick points. • Kalavryta - Diakofto, (by bus), Vouraikos valley morphology • Rio-Antirio Cable-stayed Bridge, Geological conditions and construction problems • Klisova Lagoon, importance – function of the lagoon, invertebrate fauna found. • Staying overninght in Mesolongi 6th day Mesolongi - Thessaloniki Messolongi - Amfilochia - Filippiada - Kokkinopilos - Agios Georgios - Louros River Valley - Ioannina - EGNATIA street - Thessaloniki • Aetoliko lagoon, lagoon circulation, anoxic conditions • Lakes Ozeros, Amvrakia • Amphilochia - Amvrakikos Bay, Beaches and Cliff coasts • Red-clay, Bad-lands • St. George, Karstic Springs, Roman Aqueduct of Nicopolis • Louros River Valley Arrival to Thessaloniki.

NGMO 492E Field Course 3: • Geology of the Circum Rodhope Zone, of the Serbian-Macedonian massif and the Rhodope massif • Mineralogy, petrography, age and origin of the plutonic rocks of Kavala, Philippi, Xanthi, Paranesti and the volcanic rocks of Sounio, Alexandroupolis, Ferres. • Metamorphic rocks of the Rhodope massif and Circum Rodhope Zone. • Sedimentary rocks of the Rhodope massif and Circum Rodhope Zone. • Discussion of individual petrological issues for each one of the magmatic rocks mentioned above (genesis, enclaves, xenoliths, alterations, contacts, country rocks, chemistry, Magma origin and evolution, geotectonic environment, etc.). • Discussion and summary of the origin of all magmatic rocks, as well as their relationship to metamorphism. • Discussion on the role of sedimentary rocks in understanding paleogeography and geotectonic evolution of the area. • Geodynamic setting of the Rhodope massif during the Eocene-Miocene period.

5th Semester:

NGMO 501Y Ore Deposits: 1. General principles and terminology 2. Processes of formation of ore minerals 3. Mineralizing fluids in the crust 4. Hydrothermal alterations 5. Classification of ore deposits 6. Geotectonic environment of formation, description and metallogenic models for the major types of ore deposits: 6.1. Magmatic-hydrothermal deposits 6.1.1. Deposits related with ultramafic and mafic rocks 6.1.2. Pegmatitic ore deposits 6.1.3. Skarn ore deposits 6.1.4. Intrusion related deposits 6.1.5. Replacement Pb-Zn deposits 6.1.6. Porphyry deposits 6.1.7. Epithermal deposits 6.1.8. Volcanogenic massive sulfide deposits 6.2. Lateritic residual processes (laterites, bauxites) 6.3. Supergene oxidized and enriched deposits 6.4. Sedimentary and karst deposits 6.5. Vein deposits in metamorphic terrains 6.6. Marble deposits.

NGGG 502Y Depositional Environments and Stratigraphy: •History of Stratigraphy. Interrelation between Sedimentology and Stratigraphy. •The concept of Accommodation Space. Base Level changes as driving force to the transport and deposition of sediments. Causes of Accommodation Space and Base Level change (Geotectonic, Isostatic, Climatic – Milankovich Cysles). •Sediment transport and depositional processes in humid and temperate environments [Alluvial fans, river deposits, lake deposits, deltaic and coastal deposits, mass flows, turbidites, contourites, carbonate sediments, red clays, Radiolarites]. •Sediment transport and depositional processes in arid environments [wadis, playas, dunes, Sabha zones, evaporites, carbonate sediments - coral reefs]. •Sediment transport and depositional processes in glacial environments [Ice cover sediments, alpine glacier sediments, river - lake and wind-blown sediments of glacial environments, Tilites, Loess, glacial sediments of Continental shelf and deep sea, dropstones]. •Facies Analysis [Lithofacies, Biofacies]. Paleo-environmental indicators, interpretation of past depositional environments. •Basic principles and Characteristics of sedimentary rocks: bedding – Bed, sedimentary Layers, sedimentary Contacts, Conformities – Unconformities, Types of Unconformities. •Laws - Principles of Stratigraphy (Superposition, Original Horizontality, Lateral Continuity, Cross-Cutting Relationship, Fossil Faunas Succession, Actualism). •Criteria for Identifying original place of Layered rocks (Upper-lower surface of a bed, Organic markers-Inorganic Structures, Indicators of original Horizontality). •Lithostratigraphy (Lithostratigraphic profiles, Description

and recording of a field section and a borehole core, Lithostratigraphic Correlation, Lithostratigraphic Column, Examples). •Biostratigraphy (Stratigraphy and Fossils - Index Fossils, Biostratigraphic Units - Biozone Types, Biostratigraphic Correlation, Examples). •Chronostratigraphy - Geochronology (Relative and absolute dating methods, Geological time scale, subdivisions and Units, Examples). •Other stratigraphic methods (Magnetic stratigraphy, Seismic stratigraphy, Isotopic and chemical stratigraphy, Wire loggings, examples). •Filling of Accommodation Space (spatial and temporal, dimension geometry of depositional structures, General Concepts of Sequence Stratigraphy and Basin Analysis.

NGGG 503Y Engineering Geology: - Introduction (Topics of Engineering Geology-The role of Engineering geology in engineering works) - Site investigation tools - Engineering geology of soils (consistence, soil description, Physical characteristics) - Engineering geology of soils (shear strength, Mohr-Coulomb failure criterion) - Engineering geology of rocks (Physical, Mechanical properties of rocks and discontinuities) - Rock mass strength-Geotechnical classification (GSI, RMR, Q) - Engineering Geology of Sedimentary, Igneous and Metamorphic rocks. - Landslides - Slope stability - Dams – Foundations. For every tutorial the associated exercise includes all data and geo- information, a presentation (PowerPoint) with all the necessary theoretical background and a supplementary assisting booklet with supporting information. The topics of the tutorials are: - The importance of the geological model in major construction projects. The consequences from its ignorance or misinterpretation. - Evaluation of site investigation program: Construction of geological and engineering geological sections from sampling boreholes, laboratory and in-situ tests - Geostatic stresses (Total and Effective stresses, Pore pressures) - Putting numbers to Geology I. Shear strength of soils. Mohr-Coulomb parameters, laboratory tests (triaxial, shear test, consolidation test) in soils. Total and effective stress, pore pressures. - Putting numbers to Geology II. Uniaxial compressive test of intact rock – UCS. Deformation modulus of intact rock (Ei). Rock mass strength (σcm). Hoek-Brown failure criteria and equivalent evaluation of cohesion and angle of friction with the use of rock mass classification GSI. Deformation modulus of the rock mass (Em). - Putting numbers to Geology III. Shear strength of rock joints (when the failure of the rock mass is controlled by them). Shear tests. Evaluation of angle of friction from the Barton – Bandis failure criterion. – Slope Cuts. Rock slope stability. Kinematic analysis. Definition of Factor of Safety. Groundwater effects. Rock slope support - Dams I. Selection of Dam axis location and Dam type. Dam axis and reservoir Permeability. Slope stability. Foundation problems and mechanisms of failures. The role of Geology. - Dams II. Permeability and seepage below the dam. Lugeon tests. Grout curtain against seepage and internal erosion - Tunnels. Evaluation of Engineering geological conditions along a tunnel. Behaviour types. Groundwater inflows. - Geotechnical classifications in tunneling. GSI, RMR and Q classifications - Seismotectonics and engineering projects. Evaluation of seismic hazard. Evaluation of liquefaction susceptibility of soil deposits.

NGGN 521E Foreign Language Geological Terminology I: 1) The Earth, Geological time 2) Geological history 3) Paleontology 4) Hydrogeology 5) Glossary of Geomorphology 6) Glacial-Eolian Environments 7) Minerals 8) Rocks 9) Glossary of Seismology 10) Glossary of Geophysics 11) Atmospheric composition, Atmosphere Circulation, Atmospheric pollutants 12) Climatic system 13) Climate models.

NGMO 522E Geochronology: • Geology and time • Relative age determination • Absolute age determination • Atoms-Isotopes-Radioactivity • Methods of analysis-Mass spectrometer • Rb-Sr Method • K-Ar and Ar-Ar methods • U-Pb method • Sm-Nd method • C-14 method • Re-Os method • Case studies • Exercises.

NGGG 523E Palaeoanthropology: Primates (origin, general characteristics). Morphological characters. Physical Anthropology and skeletal material. Evolutionary trends in Primates. Cercopithecoidea. Miocene hominoids. Pliocene hominids. Australopithecians. Appearance and evolution of the genus *Homo*. Evolutionary stages of *Homo habilis, Homo erectus, Homo heidelbergensis,* Primitive *Homo sapiens*, Neanderthal, modern *Homo sapiens*. Taphonomy. Brain evolution. The Petralona (Chalkidiki) hominid skull. Paleoanthropological findings from famous sites and the Greek area.

NGGN 524E Analytical Chemistry: Basic principles of analytical chemistry and classical and instrumental chemical analysis techniques. Chemical reactions and chemical equations, solutions, solubility of substances and solution concentration, reaction rate and chemical equilibrium, equilibrium of weak acids and bases, heterogeneous chemical equilibrium and solubility product, complex ion equilibrium, statistical and experimental data handling, characterization and validation of analytical method. Analytical Chemistry laboratory safety, chemical reagents. Titration techniques. Major instrumental techniques of chemical analysis, such as: ultraviolet - visible molecular absorption spectroscopy, atomic spectrometry, automatic chemical analysis techniques, chromatographic techniques.

NGGE 525E Geographical Information Systems (GIS) and Management of Geological Cartographic Data: •Introduction to Geographic Information Systems (GIS) •GIS Structure and Functions. GIS software •Categories and structure of GIS input data and metadata •Coordinate transformations and map georeferencing •Georeferencing and resampling of images •Creation/Digitization and management of data in vector format (points, polylines, polygons) •Geospatial databases •Conversion of geospatial data between different formats and reference systems •Recovery, access and processing of digital elevation models (DEM) •Extraction of morphological parameters from DEMs (slope, aspect, curvature etc.) •Spatial interpolation of

vectordata •2D and 3D representation of geospatial information - Map composition - Map production •WebGIS and interactive maps Structure and material of laboratories / laboratory-tutorial exercises •GIS software •Categories and structure of GIS input data •Coordinate transformations •Georeferencing of maps •Digitization of point data •Digitization of linear data •Digitization of polygons •Georeferencing and resampling of images •Recovery, access and processing of digital elevation models (DEM) •Spatial interpolation of vector data •2D and 3D representation in a GIS •Map composition •Map production.

NGGN 526E General Mathematics II: 1) VECTOR CALCULUS Theory of curves in the three dimensional space (vector equation, parametric equations, tangent, perpendicular plane). Divergence and rotation of vector fields. 2) INTEGRAL CALCULUS Integrals of functions of one variable, line integral, conservative fields. 3) FIRST ORDER DIFFERENTIAL EQUATIONS Separation of variables, homogeneous, linear, Bernoulli, Riccati, exact, integrating factors. 4) APPLICATIONS in Geosciences.

NGGN 527E Geological Data Analysis: Course objectives-introduction, different types of geological data, geological data analysis process. Filtering procedures. Smoothing filters – differential filters. Filter class, application of moving filters, effect of filtering. Examples of application to noisy data, application to highlight changes. Polynomial fitting of geological data. Selection of the polynomial, fitting evaluation. Data isodistribution. Geostatistical data analysis. Basic statistical concepts. Spatial covariance and correlation. Interpolation in 1D. Interpolation techniques (nearest neighbor, linear, polynomial, spline etc.). Advantages and disadvantages, examples of application. Interpolation in two dimensions. Interpolation techniques, pros and cons. Using of covariance matrix to construct maps. Examples of application. Spectral analysis. Basic concepts, sampling frequency, power spectra. Application to geological. Design and application of spectral filters. Content The laboratory courses include application of the methods taught in theory by writing code in the Matlab programing language. Students are asked to write a Matlab code that actually analyzes geodata based on techniques taught in theory and also are asked to interpret the results. In particular, laboratories include the application of the following methods: Smoothing filters, differential filters, polynomial regression and data isodistribution, calculation of covariance and correlation, interpolation in one dimension, interpolation in two dimensions and map construction, spectral analysis (FFT) of data and application of spectral filters.

6th Semester:

NGGG 601Y Hydrogeology: • Introduction to the science of Hydrogeology (history, evolution), Statistical concepts in Hydrology. • The hydrologic cycle. River basin and its characteristics (shape, basin analysis, water divide, drainage network analysis). • Surface Hydrology. Hydrological balance and estimation of its parameters (precipitation, evapotranspiration, surface runoff, infiltration), Hydrologic balance in a river basin. • Flood Hydrograph, Estimation of peak flood. • Mechanical properties of water (density, viscosity, compressibility, capillary effect). Continuity principle and Bernoulli equation. • Storage of groundwater in geological formations, Porosity (total and effective porosity). Vertical distribution of groundwater, Divisions of groundwater (hygroscopic, gravitational, capillary), Specific yield and specific retention, Unsaturated (vadose) and saturated zone. The concept of permeability. • Aquifers, Types of aquifers (confined, unconfined, artesian). Properties of aquifers (storativity, homogeneity and isotropy). • Groundwater movement. The concept of hydraulic head. Hydraulic gradient. Darcy's Law and its limitations. Hydraulic conductivity and methods for its calculation. Aquifer transmissivity. Groundwater flows (laminar, turbulent). Forces on the porous medium (quick sand phenomena). • Groundwater level measurements, Isopiezometric maps and flow networks, Groundwater level fluctuations. Subsidence due to overexploitation. • Geological formations as aquifers: Porous aquifers in granular rocks, aquifers in fractured rocks, karst aquifers and their characteristics. • Springs: Types of springs, hydrograph, Karst springs. • Groundwater flow simulation. • Groundwater Quality-Hydrochemistry.

NGMO 621E Igneous Petrogenesis: Composition and physical properties of magma. Process of magma generation. Magma evolution processes. Behavior of the main elements, trace elements and radiogenic isotopes during the processes of magma generation and evolution. Mixing calculations. Use of the main elements and trace elements to simulate the processes of genesis and evolution in petrogenesis. Magma generation and geotectonic environment.

NGGG 602Y Geological Mapping: • Fundamental principles of geological maps. • Topography and its relationship to the geological structures. • Geological maps – 3D measurements. • Geological cross sections. • Identification of geological contacts. • Unconformities and their representation in geological maps. • Mapping deformational structures (faults and folds). • Geological mapping of special cases (igneous, metamorphic and diapiric rocks, deposits, tectonites). • Field geological mapping. • Hands-on training in the field on geological mapping. • Fieldwork safety. • Methods of geological work, use of compass and geological problems in the field. • Compilation of geological maps and cross sections in the field. • Compilation of a technical report annexed to the geological map.

NGMO 622E Applied-Environmental Geochemistry: • APPLIED GEOCHEMISTRY: Geochemical cycle, primary and secondary environment, pathfinder-indicator elements,

geochemistry of rocks, geochemistry of soils, geochemistry of river/stream sediments, geochemistry of waters, vegetation geochemistry, gas geochemistry, prospecting of hydrocarbons. • ENVIRONMENTAL GEOCHEMISTRY: Ores and environment, energy raw materials and environment, trace elements and environment, environmental uses of industrial minerals and rocks. • ENVIRONMENTAL MINERALOGY: Asbestos, health effects due to the mineral constituents of the dust. • LEGISLATION AND ENVIRONMENT: Environmental studies, mineral raw materials and environmental impact study, national and European environmental legislation.

NGGN 623E Foreign Language Geological Terminology II: 1) Tectonic plates 2) Tectonic deformation 3) Fresh Water of the Continents 4) Engineering Geology 5) Lacustrine Environments 6) Fluvial Environments 7) Ore Deposits 8) Metallogenesis 9) Seismology 10) Geophysics, Applied Geophysics 11) Climate change, Forecasts/Pojections 12) Hydrosphere 13) Energy balance.

NGMO 624E Ore Deposits of Greece: A historical overview of the mining activity in Greece • Geotectonic evolution and metallogenesis in Greece • Classification of Greek deposits in different metallogenic provinces • Cr deposits and volcanogenic massive sulfides deposits of in Mesozoic ophiolitic complexes • Deposits associated with Cenozoic magmatism: porphyry and epithermal deposits, skarn deposits, carbonate replacement deposits, intrusion related systems • Deposits hosted in metamorphic rocks. • Lateritic residual deposits (laterites, bauxites) • Supergene oxidized Fe, Mn deposits enriched in Au • Karst-type deposits • Alluvial deposits • Submarine metal-rich hydrothermal fields in the South Aegean Volcanic Arc • Comparison between global and Greek deposits.

NGGN 625E Computer Programing in Earth Sciences: Introduction to programming using examples in the Geosciences. The course is designed to be accessible to Geoscience students in any field of science. Provides instruction in the techniques of upper-level languages such as Fortran and as well as an introduction to the programming techniques used in open source R. Includes strong component of visualization and graphing. • Variables - Fixed quantities. Integrated types of Fortran 95, Numeric operators. Price return command. Code writing rules. - Exercises • Built-in arithmetic functions. Exercises • Control commands - Logical expressions. Relational operators. Reasonable operators. Exercises • Commands - Repeat loops, Flow change commands. Exercises • Arrays, Built-in functions within arrays. Exercises • Introduction to R language - Basic concepts • Data objects in R language: Arrays and data frames • Mathematical calculations in R language- Graphs • Simple Programming in R language.

NGGP 626E Seismic Methods of Geophysical Prospection: Basic principles of the propagation of seismic waves, energy and attenuation. Seismic waves velocity. Relationship between geophysical-petrophysical and geological-geotechnical-environmental parameters. Velocity-density Relationship. Seismic Refraction: Study of layered structures. General applications Seismic measurements in boreholes. Crosshole-downhole methods. Surface waves recording. The MASW method Seismic reflection. Basic pronciples. Reflection in layered structure. Migration. Stacking. Interpretation of seismic sections MASW applications and measurements in boreholes.

NGMC 627E Atmospheric Pollution: 1) Definition of air pollution. Historical aspects on air pollution. Chemical composition of the earth's atmosphere. The role of trace constituents. The evolution of the composition of the Earth's atmosphere. 2) Biogeochemical cycles of carbon, nitrogen and sulfur. 3) Introductory concepts in air pollution. Natural and man-made emissions. Primary and secondary pollutants. Dry and wet deposition. Chemical transformations. Lifetime of air pollutants. The cycle of air pollution. Classification of gaseous pollution at various spatial scales. 4) The main atmospheric pollutants, their sources and their effects on the environment. 5) Meteorological components for the study of air pollution. The atmospheric boundary layer. Physical processes in microclimate - atmospheric turbulence. Atmospheric diffusion and dispersion. 6) The role of atmospheric stability conditions in dispersion. Physical processes in local and meso-scale transport processes and their relation to air pollution levels. Physical processes in synoptic and global scale transport processes and their relation to air pollution levels. 7) Introduction to the fundamental air pollution problems. Urban and suburban pollution problems. Smog and photochemical smog. 8) Transboundary, hemispheric and global pollution problems. Acid deposition. Increase in tropospheric ozone. Stratospheric ozone depletion and the ozone hole. Enhancement of the greenhouse effect. Radiative forcing and global warming potential. 9) Analysis and measurement of atmospheric pollutants.

NGGG 628E Neotectonics: • Quantitative and qualitative neotectonics analysis • Analysis and relative dating of microstructures • Brittle tectonics (fault systems, segmentation, 3D structure) • Active faults • Morphotectonics • Paleoseismology and archeoseismology • Earthquake geology • Case studies of active fault zones worldwide • Neogene and Quaternary deformation stages in Greece • Neotectonic evolution of Greece and the broader Mediterranean area • Applied Neotectonics and neotectonics mapping • Exercises and applications of neotectonics in technical studies • Methods of faulting hazard assessment • Use of relevant computer applications.

NGGG 629E Rock and Soil Mechanics: 1. The goal of Soil and Rock Mechanics course is to provide the necessary knowledge to the students in order to compose geotechnical studies for the construction of civil works. 2. The content of this course is the following: A) Theory: 1) Physical and mechanical characteristics of the soil and classification of the it according to the procedures, 2) stresses distribution, 3) bearing capacity, 4) settlement and compactibility of soil, 5)

earth pressure and retaining structures, 6) trench stability, 7) field tests, 8) Eurocodes, 9) geotechnical design 2) Qualitative description of rock, joints, rock mass. Physical and Mechanical characteristics of rocks. Shear strength of rock and rock mass. Rock deformability. Shear strength of rock joints. Failure criteria. Geotechnical classification of rock masses. Stability analysis of rock masses in slopes, tunnels and foundations. B) Laboratory experience: Practice on laboratory soil and rock tests, according - Normal characteristics and properties of soil - Grain size analysis - Atterberg limits - Oedoimetric compression test - Uniaxial compressive strength (UCS) - Proctor compaction test - Direct shear test - Triaxial test - Point load test.

NGGG 630E Micropaleontology: • Introduction in Micropaleontology, Historical evolution of Micropaleontology, Basic groups of microfossils, way of life of microorganisms • Foraminifera: benthic and planktonic, Ostracoda, Coccolithophores, Radiolaria, Diatoms, Silicoflagellates, Dinoflagellates • Morphology and classification of microfossils • Evolution and stratigraphical distribution/biostratigraphy of microfossils • Environmental Micropaleontology, paleoenvironmental/paleoclimatic reconstruction and interpretation, contribution in sedimentation • Applied Micropaleontology • Examples of geoenvironmental applications from the Greek territory.

NGMO 631E Industrial Minerals and Rocks: Classification of industrial minerals and rocks. o Genesis of industrial minerals and rocks deposits o Main applications of industrial minerals and rocks. Industrial minerals deposits: Asbestos, Quartz raw materials, Feldspars, Magnesite, Talc. Industrial rocks deposits: Perlite, Clays, other than bentonite and Kaolin, Bentonite, Kaolin, Phosphorites, Zeolitic tuffs and Marbles.

NGGE 632E Speleology: Speleogenesis in carbonate and non-carbonate rocks. Hydrologic, lithologic, tectonic and geomorphic control in speleogenesis. Cave morphology. Cave classification. Cave deposits, classic sediments, chemical sediments, ice. Cave geochemistry. Cave climate and paleoclimate. Cave paleontology. Protection and exploitation of caves. The caves of Greece.

NGGG 691E Field Course 4: Geology of the Rhodope massif and the Circum Rhodope belt in Thrace • Geotectonic evolution, Tertiary magmatism and metallogenesis in the Rhodope massif • Tectonics: Drama-Philippi basin, Maronia-Makri fault, Petrota basin • Ore deposits: K. Nevrokopi Mn-oxides deposit, Maronia porphyry Cu-Mo deposit, Perama epithermal high-intermediate sulfidation Au deposit, Xylagani VMS Fe-Cu-Au deposit • Hydrogeology: Springs of river Aggitis (Maara) Drama, Spring of Aghia Varvara of Drama, Spring of Kefalari (Boirani), Marshes of Philippi.

7th Semester:

NGGG 701Y Geology of Greece: Greece in the frame of the world geotectonic system. •Geotectonic zones of Greece. •Detailed description (lithostratigraphy, magmatism, tectonic structure) of the Hellenic hinterland, the internal Hellenides zones and the external Hellenides zones. •Post-alpine formations of Greece. •Local geological subjects. •Geological cross sections of Greece. •General principles of Geodynamics – the geotectonic cycle. •Geotectonic evolution of the Tethyan orogenetic system in Greece.

NGMC 721E Dynamic and Applied Climatology: Atmospheric General Circulation: Introduction (Pressure Gradient – Thermal gradient – winds). zonal and meridional flow, westerlies and trade winds, Hadley cell, Ferrel and Polar cells. Polar Frond and Jetstreams. Thermal winds, katabatic winds, Fohn winds, Monsoons, Regional winds: Etesian and Libas Greek winds (Exercises) High- and low-pressure systems: Permanent Highs and Lows in North and South Hemisphere; Non-permanent Highs and Lows in North and South Hemisphere. The Intertropical Convergence Zone (ITCZ) (Exercises on analysis of Meteorological and climatological maps). Air Masses: Categories of air masses based on the source region (Arctic, Polar, Tropical and Equatorial), their moisture and thermal properties (Exercises on the classification of air masses using data of weather balloon) Teleconnection patterns: Description – Characteristics of the most well-known teleconnection Ptterns (El nino, NAO, etc) their impacts on the European Climate. Weather Types and Circulation Types: Classification and description of weather and Circulation types. Applied Climatology: The impact of Climate on human beings and environment Urban Climatology: Thermal heat island, topoclimatology of urban regions Agricultural Climatology, climate and plants, phototropism, optimum plant temperatures. Forest Climatology, the impact of climate on fire forest, Alarm climate Fire forest Indices.

NGMO 722E Volcanology: ERUPTION DYNAMICS: Volcano-tectonic environments. Spreading center volcanism. Subduction zone volcanism. Intraplate volcanism. Earth's internal heat energy and interior structure. Physicochemical controls. Variability of eruptions. Eruption model. VOLCANIC LANDFORMS: Volcano types. Scoria cones. Shield volcanoes. Stratovolcanoes. Calderas. Lava domes. ERUPTION PRODUCTS: Lava flow types. Flow features. Lava and water. Tephra and pyroclastic rocks. Pyroclastic flows. Lahars. Volcanic gases. Climate effects. ERUPTION TYPES: Fissure eruption. Hawaiian eruption. Strombolian eruption. Vulcanian eruption. Plinian eruption. Peléan eruption. Hydrovolcanic eruption. HISTORICAL ERUPTIONS: Krakatau. Mt. Pelée. Paricutin. Mt. St. Helens. Nevado del Ruiz. Lake Nyos. SANTORINI: Geological setting. Volcanic activity and origin. Minoan eruption. Post-minoan activity (Palea and Nea Kameni). Monitoring. Kolumbo submarine volcano. Atlantis legend. CENOZOIC VOLCANISM IN GREECE: Age. Volcanic provinces. Cenozoic magmatism. South Aegean volcanic arc. PLANETARY VOLC.: Silicate volcanism (Mercury, Venus, Mars, Moon, Io). Cryovolcanism (Enceladus, Titan, Triton, Europe).

NGGG 723E Didactics of Geology: Historical development of Geology. •Aims of Education and Science Teaching. The curriculum. •Learning Theories. •The Design of Instruction. Aims and Objectives of Teaching Geology. •Teaching Methodology of Geology. •Teaching Tools. •Rating - Educational Evaluation. •The experiment in Science Teaching. Examples of Teaching and Assessment Tests. • Microteaching.

NGGE 724E Remote Sensing in Geosciences: Introduction to Remote Sensing - Earth Observation. History and Physical Basis of Remote Sensing. The concept of analysis in Remote Sensing. • Optical Remote Sensing – Optical satellite imagery characteristics. • Microwave Remote Sensing. • Spaceborne and airborne Remote Sensing Systems. • Applications to Atmosphere-Cryosphere-Hydrosphere-Geosphere-Biosphere. • Georeferencing and orthorectification of satellite imagery. • DEM from satellite or other spaceborne remote sensing data. • Classification of satellite imagery. • Environmental change detection methods. • Radar interferometry and applications to geosciences • Land and marine environment monitoring techniques (soil erosion, flooding, coastal bathymetry extraction, changes in natural and anthropogenic environment, etc.). • Terrestrial remote sensing systems. • The European Space Agency (ESA) and other Space Agencies. Current Earth Observation Programs. Introduction to Big Data analysis and applications.

NGMO 725E Hydrocarbon Exploration and Exploitation: • The basic introductory concepts of Petroleum Geology are presented together with the properties of the source rocks and "kerogen", the geochemical methods for determining their quality, the hydrocarbons migration, the characteristics of the reservoir rocks and especially their petrophysical properties (porosity, saturation, and permeability), the different cap rocks and the diagenetic phenomenon. • The term "hydrocarbon reserves ", the concepts of resources and reserves, and the distinction between proven reserves [1P], "probable reserves" and "possible reserves" are explained. The techniques for estimating and calculating the reserves are also presented. • Examples of the various types of hydrocarbon traps of the three major categories: Structural Traps, Stratigraphic Traps and Combined Traps are described and examined. • All techniques and activities for oil and gas exploration are presented. There are three (3) primary methodologies used to find hydrocarbons in the subsurface: Geophysical, Remote Sensing, and wildcatting (exploratory drilling). • The 'Mud Logging' practice, heavily related to the mud circulation system, is described in detail. 'Mud Logging' is the creation of a detailed record, the 'well log' of a borehole by examining the cuttings of rock brought to the surface by the circulating drilling mud. Information about the lithology and fluid content of the borehole while drilling is provided. Mud logging includes observation and microscopic examination of drill cuttings, and evaluation of gas hydrocarbon and its constituents, basic chemical and mechanical parameters of drilling mud, as well as compiling other information about the drilling parameters. • The different technologies for the extraction of samples, or "cores", from the formation using special bits or wireline-conveyed coring tools are presented. • Students are introduced to the different types of Reservoir Simulation Models and to hydrocarbons extraction models. • The geology of Prinos Oil field and South Kavala Gas field, discovered near Thassos Island in North Aegean Sea, are presented. Are also presented the geology and the hydrocarbon potential of the offshore and onshore sedimentary basins in Western Greece and Southern Crete. The active petroleum systems within the EEZ of Cyprus, the Levantine basin, and the SE Mediterranean area are presented. • The course provides a technical training for the E&P industry. The course includes introductory to advanced training in key disciplines including Geology, Geophysics, Petrophysics, Drilling, Reservoir, Production, Facilities, Management, and Economics using Schlumberger's software tools including Petrel, Techlog, GeoX, PetroMod, ECLIPSE, Merak, Petrel GPM Carbonate Simulator and Petrel GPM Clastic Simulator.

NGGG 726E Groundwater Exploitation and Management: Works of groundwater exploitation from antiquity to the present (springs, wells, qanat, boreholes). •Pumping tests (constant flow-Dupuit method, non-constant flow-Theis and Jacob methods), recovery test, Radius of influence. •Characteristics of a pumped borehole (characteristic curve, critical discharge, specific drawdown, linear and nonlinear aquifer losses). •Groundwater uses - Water needs assessment. •Natural Recharge - Groundwater Balance - Groundwater Reserves. •Artificial recharge of aquifers (purpose, hydrogeological conditions for the application of artificial recharge, methods, the clogging problem). •Coastal aquifers - Seawater Intrusion - Ghyben-Herzberg Law - Measures of protection. •Groundwater aquifers management (groundwater aquifer functions, renewable and non-renewable groundwater, over-extraction, groundwater exploitation, groundwater management). •Types of aquifers in Greece. •Pumping test analysis- (Steady flow) • Pumping test analysis- (Unsteady flow- Theis method) •Pumping test analysis- (Unsteady flow-Cooper-Jacob method) •Radius of influence- Recovery test •Characteristics of pumped borehole •Coastal aquifers-Interface fresh and seawater •Calculation of water needs •Groundwater reserves-Groundwater balance •Design of borehole Field Trip In the frame of the course, a one-day field trip takes place in the Axios River basin. The field trip includes pumping test of borehole with constant rate and recovery test.

NGGN 727E Practical Training: The students work together with and under the guidance of the supervisor of the host organization, either public or private, for a short stay of 2 months. In parallel, a member of the School of Geology supervises the internship work program, the progress and the final report.

NGGN 728E Practical Educational Training: The purpose of the teaching of sciences with emphasis on the courses "Geology-Geography", "Geology-Management of Natural Resources". • Brief principles for managing a school class and respecting diversity in education. • Practice in teaching

methodology, design, organization and conduct of teaching. . • Educational activities. From theory to practice. • Course assessment guide. Student Assessment guide • Practical exercise in Secondary Schools (Gymnasiums and High Schools). Observation of pilot courses conducting by experienced teachers. Supervised teaching (a full course or micro-courses). As part of their practical exercise students will have the opportunity to talk with experienced teachers about designing and realization of a lesson, the courses assessment and the students assessment. • Participation in educational activities of the School of Geology for all levels of education, lifelong learning, and popularization of Geology. • Presentation by each student of his/her personal dossier that includes: • his/her notes from the pilot courses he/she attended, • the electronic file of his/her supervised teaching (a course or two micro-courses), • his/her assessment by the school teacher, • the activities of the Department in which he/she is participated.

NGMC 729E Hydrometeorology: The hydrologic cycle and its components. • Precipitation: causes of precipitation, measurement of precipitation (rain gages, types of rain gages) and data analysis. Rainfall distributions and return periods. Storm analysis. • Snow: snow water equivalent, snow characteristics, snowmelt modeling over a watershed, snow cover distribution, critical temperature for rain-snow transition. • Droughts: definition, types and timing of droughts. Drought indices. • Soil moisture: soil structure, soil classification, soil water relationships, factors affecting water movement into and through the soils. • Floods: flood analysis, hydrograms, extreme river flow analysis, rainfall-runoff relationships (crosscorrelation). Assessment of flood vulnerability. Plotting flood sensitivity maps: implementation at basin level.

NGGP 730E Gravity and Magnetic Methods of Geophysical Prospecting: Earth's gravity field. General relations of the gravity field, Newton's Law, basic principles of the gravity prospecting, density of rocks and minerals, gravity measurements and corrections, reductions of the readings and estimation of the free air and Bouguer anomalies, techniques for regional-residual separation, estimation of the density of the near surface strata of the Earth, processing and interpretation methods. Principles of the Magnetic Method of Geophysical Prospecting, quantities measured in magnetic surveying, magnetic susceptibility of rocks and minerals, instruments for magnetic surveying, design and conduct of a magnetic survey, processing and interpretation of the magnetic total field measurements or its first vertical difference, aeromagnetic surveying. Case studies of magnetic surveying in mineral exploration, in hydrocarbon reserves exploration, in studying and determining the Earth's geological and tectonic subsurface structure, in Archaeology and Environmental studies.

NGGP 731E Seismotectonics: Stress & Strain (Stress, Stress tensor, Principal stresses, Maximum Shear Stress & Failure, Differential Stress, Equation of Motion, Strain, Constitutive equations, 1.9 Strain Energy) Earthquakes and Faulting – (Earthquake Generation, Crustal Faults, Fault Geometry, Elastic Dislocation and Seismic Cycle, Energy Release, Stress Drop and Seismic Moment, Stick Slip, Seismicity and Scaling Laws) Earthquake Source Models– (Point Source, Forces at the Earthquake Source – Double Couple, Shear Rupture & Dislocation, Point Shear Rupture, Geometry of shear rupture, far field displacement, Source representation on focal sphere, Source time function, Spectral properties of the source tine function, Seismic Energy Radiation) Point source mechanism – (Focal sphere, Fault plane solutions based on first arrivals, Waveform modeling) Rupture Kinematics & Propagation – (Source dimensions, Rectangular Fault –Haskell's model, Rupture Propagation, Corner Frequency, Directivity effects, Rupture initiation, propagation & termination) Finite Source – Simple Dynamic Models – (Waveform spectral analysis, Source Time Function, Slip distribution, Kinematic and dynamic models, Moving dislocation, Circular fault (static model, Brune's model), Energy release, Scaling Laws) Seismotectonics (Plate tectonics, Mid Oceanic Ridges, Subduction Zones, Intraplate Earthquakes (oceanic and continental), Rupture and Deformation) Active Tectonics in Greece and Surrounding Area.

NGMC 732E Climate Change: Changes in Earth's climate history due to natural causes. The impact of humans on the planet's climate. Description of Anthropocene. Greenhouse gases - greenhouse effect - relation to the present global warming. Present and future climate assessment tools. Introduction to Climate Models (Statistical and Dynamic downscaling - Evaluation methods, spatial and temporal model analysis) Climate scenarios (Their evolution through time). Future projections - estimates of key climate parameters in the region of Europe, the Mediterranean and Greece. Estimated climate change in extreme weather events. Introduction to the impacts of future climate change on humans, ecosystems, the environment and society.

NGGN 733E History and Philosophy of Science: The problem of defining science. Science as a methodology, as organized knowledge, as a problem-solving tool, as a social issue. Scientific research, Scientific observations, Scientific deduction and induction. Science and technology. Science and the Society. The role of the scientist in the society. Historical evolution of scientific thought: In the prehistoric period, In the classic era, In the Hellenistic times, In the Middle Ages, In Renaissance and Enlightenment Until the twentieth century, The last century. Historical evolution of Geology. Basic epistemological issues.

NGGG 734E Drilling Methods: Introduction to drilling techniques (historic review, basic concept and principles) •Methods of drilling •Drilling planning for geotechnical purposes •Methods of sampling •Borehole logging •Evaluation of boreholes and in situ testing •Hydro mastic projects •Methods of Borehole/Well drilling •Borehole/Well completion •Borehole/Well development •Well logging.

NGGG 735E Sedimentary basin analysis and sequence stratigraphy: The state of the Lithosphere and its influence to Sedimentary Basin Formation •Pull-apart Basins – Lithospheric Stretching •Compressional Basins •Strike-slip Basins. •Other types of Basins, e.g., Lithospheric Sagging etc. •Interpretational tools in Sequence Stratigraphy •System

Tracts •Recognition of Sequence Boundaries •Composition and Interpretation of Chronostratigraphic charts and Wheeler diagrams.

NGMO 736E Laboratory Methods for Minerals and Rocks: INTRODUCTION: Stages in the study of a mineral or a rock. Data we need to gather. Analytical methods that can be used. • PREPARATION OF THIN, POLISHED AND THIN-POLISHED SECTIONS: Types of thin sections. Sample cutting. Thin section laboratory preparation. Materials used in thin section preparation. • EXAMINATION OF THIN SECTIONS UNDER THE POLARIZING MICROSCOPE: Information received from each kind of thin section. • MINERAL STAINING: When is mineral staining used. Types of chemical stains. Staining of potassium feldspar and carbonate minerals. Identification of minerals by Fluorescence. • POINT COUNTING: Study of minerals under the polarizing microscope. Quantitative determination of mineral components in a thin section by point counting. • MINERAL SEPARATION: Mechanical separation by hand. Magnetic separation of minerals. Mineral separation based on density with the use of heavy liquids. Mineral separation by flotation. • MINERAL MICROANALYSIS (SEM-EDS, SEM-WDS): Operating principle and description of an electron microscope. Operating principle of a scanning electron microscope. Type of detectors. Sample preparation. Applications of SEM-EDS. • ATOMIC ABSORPTION SPECTROSCOPY: Operating principle of atomic absorption spectroscopy. Sample preparation. Applications of atomic absorption spectroscopy. • X-RAY DIFFRACTION (XRD): Operating principle of X-ray diffraction. Bragg's law. Sample preparation. Applications of X-ray diffraction. • X-RAY FLUORESCENCE (XRF): Operating principle of X-ray fluorescence. Sample preparation. Applications of X-ray fluorescence.

NGGN 737E Topics in Geology: Selection of Geology – Geography – Meteorology – Petrology - Seismology - Applied Geology – Applied Geophysics – Climatology - Ore Deposits topics • Special literature search tools, methods and search engines • Organize Subject and Content • Creating a Digital Presentation • Writing a Scientific Text - Practices and Rules • Presentation of a Scientific Topic - Practices and Rules • Evaluation – Self-evaluation.

NGGN 738E Crystal Structure: Difference of amorphous-crystalline materials. Elements of crystal structure and relation to physical properties. Symmetry (Point Symmetry Groups / Space Symmetry Groups), lattice, unit cell, Crystalline Systems, Bravais frameworks, Exercises. • Crystallographic planes, Crystallographic directions, Examples / Exercises on Miller Indexes. • X-ray sources, Linear and Continuous Spectrum, X-ray Absorption, X-ray Devices, Examples. • Scatter, Structure Factor, Subtractions, Examples of P, I, F framework types. • X-ray diffraction, Bragg Law, Exercises. • Data processing, phase separation, indexing, determination of crystalline constants. Phase Identification with PC Identification Programs, Databases (PDF) Applications / Exercises. Analysis of the powder pattern profile and determination of the crystalline structure. Rietveld method. Finding crystalline structure of unknown compounds. Crystallographic Softwares. • Exercises in Research X-ray Diffractometers (XRD), X-ray Photoelectron Spectroscopy (XPS).

8th Semester:

NGGN 801Y Bachelor Diploma Thesis I: The Bachelor Diploma Thesis I aims at introducing the student to the scientific research and / or the scientific literature, by communicating their results, both in writing and orally, in accordance with the current practice of the international scientific community. The current course's main object is the review of the scientific literature and the presentation of its results related to a specific scientific object.

NGGN 802Y Bachelor Diploma Thesis II: The Bachelor Diploma Thesis II aims at introducing the student to the scientific research and / or the scientific literature, by communicating their results, both in writing and orally, in accordance with the current practice of the international scientific community. The current course's main object is to conduct scientific research in a selected topic and the presentation of its results.

NGMC 821E Synoptic and Dynamic Meteorology: 1) INTRODUCTION Definition and aim of Synoptic and Dynamic Meteorology, historical overview. Sources of data (meteorological observations, weather forecasts) and educational information in the internet. 2) SYNOPTIC METEOROLOGY Surface and upper air meteorological observations. Construction and analysis of surface and upper air weather charts, weather forecasting. Identification and analysis of cyclones, anticyclones, troughs, ridges, jet streams and fronts on weather charts. Rossby waves. Use of thermodynamic diagrams in weather analysis. 3) DYNAMIC METEOROLOGY Meteorological coordinate systems. Lagrangian and Eulerian time derivatives. The equations of motion in the atmosphere. Scale analysis. Balanced flow (geostrophic wind, gradient wind, cyclostrophic wind, thermal wind).

NGMO 822E Mineral Raw Materials: Exploration – Sustainability – Environment: Mineral Raw Materials and Classification according to the Greek Mining Code • Sustainability of mineral raw materials and their relationship to the evolution of culture • European Mineral Raw Materials Policy • High-tech metals (Critical Metals) • Mining of Conflict Minerals • Market and prices of mineral raw materials • Factors and parameters of economic evaluation and estimation of mineral deposits • Methods and stages of exploration with emphasis on geological and mineralogical methods • Sampling, preparation and processing of the samples • Reserves-resources of mineral raw materials • Environmental impact from the exploitation of mineral raw materials • Reuse of old mining wastes - Recycling of metals • Circular economy.

NGMO 823E Exploration and Exploitation of Solid Fuels: "EXPLORATION AND EXPLOITATION OF SOLID FUELS": How Coal Is Formed. The Chemistry of Coal. Understanding

Coal Geology and Geological Structures. Coal Stratigraphy and Coal Petrography. Types of Coal deposits and depositional environments of Coal accumulations. Exploration and reserves calculation. Characteristics of the Coal deposits and Mining methods. Overview of the global Coal industry. Uses. Energy production from biomass. Detailed Course Content: The four main types of Coals [peat, lignite, bituminous coal, anthracite] are formed from the accumulation of plant debris, usually in a swamp environment. The rate of plant debris accumulation must be greater than the rate of decay. Once a thick layer of plant debris is formed, it is buried by sediments [mud, sand, etc]. These are typically washed into the swamp by a flooding river. The weight of these materials compacts the plant debris and aids in its transformation into coal. The process will take a long time. Peat is an organic sediment, soft, recently accumulated, partially carbonized. Burial, compaction, and coalification will transform it into coal. Coal properties are related to three independent geological parameters, namely: coal rank, which is the measure of the degree of organic metamorphism (coalification) of a coal, ranging from low-rank peat to high-rank meta-anthracite and can be determined through a number of chemical and physical parameters, the maximum temperature and the coal quality parameters including the impact of waste rock on the value of mining projects. The course introduces students to the notions of Bituminization and Coalification, as well as to the methods of determining the degree of Coalification. 'Coal petrology' which is a microscopic technique used to determine a coal's rank (degree of coalification) and type (amount and category of macerals), is also presented, together with GCV (gross calorific value) [which is the quantity of heat produced by combustion when the water produced by combustion is allowed to return to the liquid state] and NCV (net calorific value) [which is the quantity of heat produced by combustion when the water produced by combustion remains gaseous]. The course also covers the chemical and physical properties of coal, and their proximate and ultimate analysis. Exploration methods, drilling, borehole logging, deposit evaluation, and quality assessment are presented. Students are introduced to solid fuels production software programs and to the biomass energy production basics. Finally, all uses of coal and the related environmental issues from mining and exploitation are analyzed.

NGGG 824E Geothermal Energy: Introduction to geothermal energy (historic review, basic concept and principles) •The heat of the earth and heat flow •Favorable geothermal conditions (globally and locally) •Geothermal systems and fields – Natural processes •Classification of geothermal systems •Geothermal exploration methods and techniques •Chemical characteristics, quality and classification of geothermal fluids •Exploitation of geothermal resources – Renewability and sustainability •Environmental impacts and technical problems regarding the use of geothermal energy •Benefits and advantages of geothermal energy •The geothermal status of Greece (exploration, legislation, identified geothermal fields) •Geothermal energy applications around the world •Geothermal energy use in Greece.

NGGG 825E Geological Design of Engineering Works: General principles – Guidelines of geological designs for engineering works and •Design and execution of site investigation program •Measurements and analysis of tectonic data •Rock mass classification •Design parameters – putting numbers in geology •Engineering geological design of roadworks •Engineering geological design of slope stability •Engineering geological design of foundations of embankments and bridges •Engineering geological design of tunnels •Engineering geological design of dams.

NGGN 826E Information and Communications Technologies (ICT) in Geological Education: • Digital representations. • The role of media in the creation of multiple representations and visualizations for teaching / learning. • Interactive environments. • The structure and role of interactive technological environments (simulation, microworld, modeler) in teaching / learning. • The model of inventive / exploratory learning. • Simulated experiments on computing environments. • Digital animation and interactive environments in Geology: Ways of using these technologies in the fields of geology, virtual laboratories and simulations in all branches of Geology. • Digital Geographical and Geospatial education – ICT in Geography education. • ICT in teaching Meteorology and Climatology. • ICT in the teaching of Mineralogy-Petrology-Mining/deposits exploration. • ICT in the teaching of Geology. • ICT for Earthquakes and Volcanoes.

NGGN 727E Practical Training: The students work together with and under the guidance of the supervisor of the host organization, either public or private, for a short stay of 2 months. In parallel, a member of the School of Geology supervises the internship work program, the progress and the final report.

NGGN 728E Practical Educational Training: The purpose of the teaching of sciences with emphasis on the courses "Geology-Geography", "Geology-Management of Natural Resources". • Brief principles for managing a school class and respecting diversity in education. • Practice in teaching methodology, design, organization and conduct of teaching. • Educational activities. From theory to practice. • Course assessment guide. Student Assessment guide• Practical exercise in Secondary Schools (Gymnasiums and High Schools). Observation of pilot courses conducting by experienced teachers. Supervised teaching (a full course or micro-courses). As part of their practical exercise students will have the opportunity to talk with experienced teachers about designing and realization of a lesson, the courses assessment and the students assessment. • Participation in educational activities of the School of Geology for all levels of education, lifelong learning, and popularization of Geology. • Presentation by each student of his/her personal dossier that includes: • his/her notes from the pilot courses he/she attended, • the electronic file of his/her supervised teaching (a course or two micro-courses), • his/her assessment by the school teacher, • the activities of the Department in which he/she is participated

NGGG 827E Geotectonic evolution of Greece and Global Tectonics: Geodynamic evolution of the Alpine system •Apline geotectonic cycle •Comparative orogenic evolution of the Hellenides •Theories and models for the evolution of the Hellenides in the broader Mediterranean region •Neotectonic evolution and active geotectonic status of Greece •Significant tectonic structures globally •Structure and geometry of active continental margins.

NGGG 828E Environmental Hydrogeology: Introduction to the basic concepts of Hydrogeology – Terminology •Soil properties•Groundwater quality •Evaluation of hydrochemical data-Hydrochemical types of groundwater •Interaction of water and environment •Pollution and contamination of groundwater •Pollution sources and transport of pollution (advection, diffusion, hydrodynamic dispersion) •Soil as recipient of solid wastes - Sanitary Landfill- Site selection •Vulnerability of aquifers to external pollution •Disposal of wastewater on land, Soil-Aquifer-Treatment •Salinity of groundwater due to seawater intrusion •Impacts of climate change on groundwater •Protection and remediation of aquifers

NGMO 829E Gemmology: 1. About gems - Historical background in their manufacture, uses, transportation and trade 2. Physical, chemical, optical properties - Cutting style of gems 3. Diamond (colorless and colored), Corundum (Ruby, Sapphire), Beryl (Emerald, Aqua Marina, Morganite, Heliodorus) 4. Quartz varieties (e.g. crystal quartz, amethyst, citrine, agate, onyx, carnelian), Jasper, Opal, Obsidian, Chrysoberyl (e.g. alexandrite), Zoisite (e.g. tanzanite), Spinel, Zircon, Topaz, Spodumene (e.g. kunzite) 5. Garnet (e.g. tsavorite, demantoid), Tourmaline (e.g. paraiba-type, rubellite), Olivine (Peridot), Lapis Lazuli, Turquoise, Jade (Nephrite and Jadeite), Feldspar (e.g. amazonite, labradorite, moonstone) 6. Gemstones with optical effects (e.g. color change, star-effect) 7. Organic Precious Materials (Pearl, Coral, Amber or Electro, Ivory, Jet, Nacre, Fossil Wood, Horn, Bone) 8. Geology of gems (e.g. primary deposits in kimberlite, pegmatite, marble, amphibolite, skarn; secondary deposits in alluvial depositions) - Organic gems growth 9. Gems' provenance - Gemstones of Greece 10. Gem Treatments (heat treatment, irradiation, clarity enhancement etc.) 11. Synthetic gems - Imitations 12. Classic gemological methods (e.g., microscope -inclusions, specific gravity, refractive index, fluorescence under UV lamps) - Grading 13. Application of non- or micro-destructive methods for gem analysis (e.g. spectroscopic and chemical methods).

NGGG 830E Field Geological Mapping: •Types of special geological mapping •Principles of large-scale geological mapping •Tectostratigraphy based on geological mapping •Identification of geological and tectonic structures in geological maps •Construction of detailed geological cross sections •Contribution of geological maps in understanding the geotectonic structure and evolution •Technical specifications of geological mapping studies •Methods of digital field mapping •Large-scale field mapping of a specific area •Preparation of a digital geological map and drafting its accompanying technical report.

NGGE 831E Oceanography: • Introduction. History of Oceanography. The origin of the ocean water. • Geography of the hydrosphere. Oceans and seas. Geographical boundaries of the oceans. Dimensions of the ocean basins. Bathymetric characteristics. Definitions of underwater morphological characteristics. • Geomorphology of the Ocean Basins and Continental Margins and their relation to Geotectonics. • Physicochemical characteristics of water. Chemical composition of seawater. The Biogeochemical cycle. Seawater Temperature and Salinity. • The sound in the water. Propagation and attenuation of sound in water. Sounding Devices. • Light in water. Propagation of light in water. The sunlight in the sea. The color of the sea. Measurements of the optical characteristics of water. • The density of the seawater. International Equation of State of seawater. Ocean masses. • Ocean Circulation and Currents. Ocean Currents and Marine Sedimentation. • Waves. The Airy Theory. The Stokes' Theory. The Solitary Waves Theory. Wave Braking Theories. Wave refraction. • Tides. Tidal measurements. Practical environmental applications of tital and sea-lever monitoring. Daily Field Exercise on "Coastal Oceanography" • Exercise Implementation Area: Peraia Beach Thessaloniki. On this particular beach is a pier 150m long, reaching depths up to 4 m, acting as a safe and stable platform for instrumental measurements implementation with student groups. • Field Exercise Content: -Coastal Oceanography, equipment and tools used in coastal research and their applications, field measurements and sampling: • Use of instruments for Water Sampling, • Use of CTD (Conductivity-Temperature-Depth) instrument, • Use of Sonar for depth measurements and water-depth profiling, • Use of ROV for depth/underwater photography. - Demonstration of the use of instrumentation and software in coastal research. Most of the measured parameters are included in the context of Laboratory Exercises and the collected data are processed later in the class.

NGGE 832E Natural and Anthropogenic Environment: Introduction - Historical recursion. Purpose and contents of the lesson, method and methodology, performance evaluation. • Project description. Selection, formulation and presentation of micro-teaching topics related to the environment, physical processes and anthropogenic action. • The concept of system, geomorphological systems. • Natural and anthropogenic environments in the light of climate change. • Inland and coastal waters. Wetland systems. Coastal environments, lagoons. Examples of anthropogenic interventions. • Inland and coastal waters. Streams, rivers, deltaic zones. Examples of anthropogenic interventions in Greece (Nestos, Strimonas rivers etc). • Inland and coastal waters. Lakes, reservoirs, natural habitat drainage. Examples of anthropogenic interventions in Greece. (lakes Lagada-Volvi, lake Karla, etc). • Inland and coastal waters. Examples of anthropogenic interventions in Greece. The Axios-Aliakmon system, the lakes and rivers of Western Greece. • Marine and ocean environment. Anthropogenic interventions and their impact. • Selection of main project on topics related to anthropogenic impacts on the environment, contemporary environmental problems, and more general issues related to Geosciences and the environmental

education. • Anthropogenic. Residential areas and industrial areas, development projects etc. • Natural and man-made disasters (floods, erosion, landslides, fires, drought / desertification, permafrost, earthquakes, volcanic eruptions, tsunamis, hurricanes, tornadoes, snowstorms, solar storms).

NGGE 833E Geological and Environmental Applications of Geospatial Data Analysis: • GIS Toolboxes • 3D representation and analysis of geospatial data • Imaging and spatial analysis of earthquake epicenters, other geological and GNSS data • Management of meteorological and climatic data • Extraction and classification of drainage basins and hydrographic networks from digital elevation models • Calculation of erosion / deposition rate in coastal areas • Calculation of perimeter, area, and volume of a water body • Assessment of susceptibility to landslides • Assessment of flood susceptibility, hazard and risk • Delineation of locations suitable for waste landfill sites • GIS and Remote Sensing synergies for quarry monitoring • GIS and Remote Sensing synergies for the detection and delimitation of oil spills • GIS and programming.

NGGP 834E Electrical and Electromagnetic Methods of Geophysical Prospecting: Scope of the course and importance of electrical and electromagnetic geophysical techniques in geophysical investigations. Short introduction, field of applications through field examples. Electrical and electromagnetic properties of rocks, definitions and their relationship with the geological, hydrogeological, mining characteristics. Electrical properties of rocks, minerals and geological formations. Basic relations between electrical and other petpophysical properties. Field demonstration of electrical and electromagnetic methods Field demonstration at locations of the Univ. Campus of the application of electrical and electromagnetic methods. Content Field demonstration of the application of geophysical methods with the participation of students in groups that includes the collection of measurements in the field using the following geophysical techniques: electrical profiling, electrical sounding, 2D electrical and IP tomography, self-potential, VLF and GPR Evaluation method for students (if done separately from the course). The students deliver a relevant report with the basic interpretation of the collected field data.

NGGP 835E Engineering Seismology: 1. INTRODUCTION – SEISMICITY MEASURES Seismology and society – strongest earthquakes globally and during the 20th century - Economic consequences of earthquakes. Most destructive earthquakes in Greece. Earthquake prediction. Early warning systems. Quantitative measurement of seismicity. Magnitude distribution of earthquakes (Gutenberg-Richter). The importance of b parameter for estimating the seismicity level. 2. GROUND MOTION MEASURES Accelerographs – accelerometers. Factors defining the strong motion (focus, magnitude, path, site). PGD, PGV, PGA. Duration and energy characteristics of strong motion. 3. ATTENUATION RELATIONSHIPS Seismic waves attenuation – Elastic medium: Geometric dispersion – anelastic attenuation – quality factor Q. Velocity and acceleration spectra – attenuation models, use in seismic hazard assessment. Use of GMPEs in seismic codes. Effect of path and local site effects. 4. SITE EFFECTS Definitions. Methods to evaluate site effects. a) Experimental – empirical: ambient noise (Kanai 1956), Spectral ratios over a reference station (SSR). Horizontal over vertical spectral ratio (HVSR). Coda waves technic b) Theoretical: simple models, analysis of ground response (1D or 2D). 5. MACROSEISMIC EFFECTS Macroseismic observations – macroseismic intensity. Isoseismal maps. Isotropic and anisotropic radiation. Relations connecting intensity with magnitude and distance for Greek earthquakes. Near real time shake maps after strong earthquakes. Epicenter and magnitude estimation based on macroseismic observations of historical earthquakes. 6. SEISMIC HAZARD Seismic hazard measurements: Maximum expected values of intensity, magnitude, PGA and PGV. Maximum and dominant values of expected ground motion. Probabilistic and deterministic methods of seismic hazard assessment. 7. STRUCTURES RESPONSE Structure motion equation (single degree of freedom oscillator). Technical structure parameters (oscillation period, damping factor and plasticity index). Elastic and inelastic response spectrum. Design ground motions. Seismic response and design spectra. Structured pseudospectra. Hellenic Seismic Code. Dynamic and static seismic response estimation. Soil classification. Seismic zones. 8. MICROZONATION STUDIES Detailed assessment of ground response for an area. Evaluation of required variables for earthquake planning. Calculation and representation of various parameters distribution at sub-zones of the study area. Seismic hazard scenarios. Composition of microzonation studies.

NGGN 891E Field Course 5: Geology of Attikocycladic zone. Geology of Cyclade Islands. • Pre-volcanic basement of Santorini • Minoan eruption phases, 1613 B.C. • Main phases of the Minoan eruption, Riva • Paleosoil • Rock slope stability of volcanic formations • Akrotiri volcanism, 2 Ma – 500 ka • Akrotiri faults • Scoria cones, 450 – 340 ka in Red Beach • Slope stabilty-hazard and risk assessment of rockfalls along Red Beach • Akrotiri Archeological Site • Vlihada (Minoaneruption, 1613 B.C., 4thphase) • Perissa- Pre-volcanic basement • Fira fault • Nea Kameni (Nea Kameni lavas, 1570 – 1950 A.D.) • Palea Kameni (Palea Kameni lavas, 47 B.C. – 726 A.D.) • Thirasia (Observations along caldera walls) • Oia (Observations along caldera walls) • Skaros (Observations along caldera walls) • Seismicity of the broader area – Monitoring Network – The earthquake of 1956 • Stromatolites – Kolumbo • Mikros Profitis Ilias – Peristeria Volcano, 530 – 430 ka • Fault in gand the Kolumbo line • Megalo Vouno (Scoria cone, 60 – 40 ka) • Oia Ammoudi Red Ignimbrite, 40 ka, Riva – Lava – Scoriae • Oia Ammoudi– Rock slope stability measures • Oia (Goulas) – Undermining of old castle of Goulas foundation and slope stability of pyroclastic slopes • Kolumbo tephra 1650 A.D. • Kolumbo cape - Tuffrings, 60 – 40 ka, Stromatolites, faults.

NGGG 892E Field Course 6: Geological cross-section of NE-SW direction across the Hellenides in northern Greece, identification – study of the Hellenides geotectonic zones (composition, structure, evolution) and their geotectonic significance. Study of the engineering geological behavior of

the Hellenides geologic formations in construction works (dams, tunnels, roadworks) failure phenomena and landslides. Exercises on the respective subjects handed in on site by the students. Indicative examples: hand in Road slope slide Stability analysis of cut slopes (measurements of discontinuities, mechanisms of failure) Rock mass classifications Tunnel failure mechanisms.

OLD COURSE PROGRAM

For the courses of the 1st and 2nd Semester please see the NEW course program.

3rd Semester:

GMO 317Y Igneous Petrology: Introduction – About the object and aims of igneous petrology – Research methods – Main categories of rocks. Elements of Optical Mineralogy. Mineral components of rocks. Composition and Properties of magma. Origin of magma. Evolution of magma_I. Geochemical elements of igneous rocks. Magma Chemistry and Geotectonic Environment_I. Morphological types of igneous rocks. Chemical classifications of igneous rocks. Acidic, intermediate, basic and ultrabasic rocks. Feldspathoid rocks - carbonatites - ophiolites - pyroclastics. (Instructor: Antonios Koronaios).

GMC 318Y General Meteorology: The atmosphere. The earth movements. Solar and terrestrial radiation. Air temperature. Air humidity. Atmospheric thermodynamics. Air stability. Clouds and precipitation. Atmospheric pressure and winds. Atmospheric disturbances - Weather systems. General circulation of the Atmosphere. Exercises and laboratory on the meteorological observation. (Instructors: Prodromos Zanis, Ioannis Pytharoulis, Dimitrios Bampzelis).

GGG 320Y Invertebrate Paleontology: Invertebrate Palaeontology: Introduction to Palaeontology. Fossils and fossilization. Palaeontology and dating. Theory of evolution. Classification of invertebate fossils (Porifera, Cnidaria, Bryozoa, Vermes, Mollusca, Arthropods, Echinoderms, Graptolites)use of fossils in Stratigraphy and paleoecology. (Instructor: Georgios Syrides).

GMO 321Y Sedimentary Petrology: Origin. Sedimentation processes. Texture. Statistical parameters. Constituents of sediments. Classification. Clastic sediments (Conglomerates-Breccias-Sandstones-Mudrocks-Clays). Diagenesis of sandstones, mudrocks and clays. Flysh-Molasse. Laterites-bauxites. Volcaniclastic sediments (Tuffs). Chemical and biogenic sediments (Evaposites-Limestones-Dolomites-Travertines-Silisic sediments-Phosphorites-Carbonaceous sediments). Sedimentary rocks of Greece. Laboratory exercises. (Instructors: Andreas Georgakopoulos Nikolaos Kantiranis).

GGE 427Y Physical Geography: Geomorphology. Origin, evolution, description and classification of the morphological types on the surface of the Earth. Elements of Oceanography.(Instructor: Konstantinos Vouvalidis).

GGN 350Y Field Training C

GMC 323E General Mathematics III: Difference equations (linear difference equations, stability), linear systems of difference equations. 1st order Differential Equations (separation of variables, homogeneous, linear, Bernoulli, Riccati), exact differential equation of 1st order, integrating factor, linear differential equations of 2nd or higher order. Applications of difference equations and differential equations. (Instructor: Ioannis Pytharoulis)

GGN 430E Crystal Structure: Introduction to geometry and symmetry of lattice. Kinematics theory of refraction. Scattering. Atomic factor of structure. Temperature impact. Methods of structure determination: Principles of monocrystal refraction, Grain mount refractometry, Identification of crystal bodies, Application of Rietveld methods. Application of computer languages to structure condition of the compounds. Applications to Mineralogy and Geology. (Instructor: Georgios Vourlias).

GGN 107E Analytical Chemistry: Concentration of solutions. Homogenous and heterogeneous equilibrium of ionic solution (weak acid - base, water, precipitates and complex ions). Properties and reactions of cations of V groups, including detailed analysis of each group. Gravimetric analysis (principals and quantitative determination of iron and calcium). Titrimetry (principals and acid-base, precipitation, argentimetry, complexometric and redox titrations. UV-Vis molecular spectroscopy. AA spectroscopy.(Instructor: Anastasia – Stella Zotou).

GGP 108E Philosophy of Science: Philosophy and Science relation. The methodology and nature of scientific knowledge. Methods of acquiring scientific knowledge. Social character of scientific knowledge. Necessity of studying scientific problems. Philosophic problems of specific sciences with emphasis on Geology. Historical evolution of scientific knowledge. (Instructor: Georgios Karakaisis, Vasileios Karakostas)

4th Semester:

GMO 425Y Metamorphic Petrology: Fundamental principles. Compositional groups. Origin of metamorphic rocks. Factors of metamorphism. Types of metamorphism. Classification of metamorphic rocks. Grades of metamorphism. Mineralogy of metamorphic rocks. Graphical representation of the mineral parageneses. Thermal metamorphism. Regional metamorphism. Geotectonic regimes of regional metamorphism. Migmatites. Oceanic metamorphism. Burial metamorphism. Dynamic metamorphism. (Instructor: Lamprini Papadopoulou).

GGG 426Y Vertebrate Paleontology: History of Vertebrate Paleontology. Fossils-Fossilisation-Taphonomy. Types of Fossil accumulations-excavation-preservation. Basics of evolutionary theory. The species concept. Linnean and phylogenetic systematics. Mass extinction. Geological time and early history of Life. The Cambrian explosion and the emergence of vertebrates. Earth during Palaeozoic- from

agnatha to gnathostoma. The emergence of tetrapodes. The end of palaeozoic-Batrachomorpha & Herpetomorpha. The first amniotes. Anapsids & Diapsids. The Mesozoic era-from dinosaurs to birds. The C/P extinction. From synapsids to mammals. Afrotheria nad Laurasitheria. The origin of primates and the Miocene apes. From Sahelanthropus to Homo sapiens. The greek primate record. Greek vertebrates and their bearing to geology, biology, palaeogeography and palaeoenvironment. (Instructor: Dimitrios Kostopoulos).

GGP 211Y Introduction to Seismology: Elasticity And Seismic Waves, Body Waves, Surface Waves, Seismic Recording Instruments, Seismic Wave Propagation (Crust, Mantle, Core), Seismometry,Seismic Source Parameter Estimation, Earthquake Magnitude, Space-Time Distribution Of Earthquakes, Earthquake Generation And Earthquake Prediction, Macroseismic Effects Of Earthquakes. (Instructors: Panagiotis Hatzidimitriou, Anastasia Kyratzi).

GGP 319Y Introduction to Geophysics: Earth and the Solar system. Earth movements with geophysical significance. The Earth's gravity field and isostasy. Gravity anomalies and their significance. The Earth's magnetic field and palaeomagnetism. Heat and temperature of the Earth's interior. (Instructors: Eleni Aidona, George Karakaisis).

GGN 428Y Field Training D

GGG 429E Micropalaeontology: Introduction. Foraminifera. Radiolaria. Ostracoda. Diatoms. Geological and paleobiological implications of Micropaleontology. (Instructor: Evagelia Tsoukala, Olga Koukousioura).

GMO 324E Laboratory Methods on Studying Minerals and Rocks: Techniques of thin and polished section preparation. Examination of thin sections under the polarized microscope. Staining of minerals. Point-counting of thin sections. Separation techniques of minerals and rocks. Micro-analysis. Atomic absorption spectrophotometry analysis. Mineralogical analysis by means of X-Ray diffraction. X-Ray fluorescence spectrometry. (Instructors: Nikolaos Kantiranis, Lamprini Papadopoulou).

GMC 431E Climatology-Climate of Mediterranean and Greece: Weather-Climate-Climatic parameters and factors. Solar radiation, sunshine. Temperatures on earth surface. Atmospheric humidity. Clouds and precipitation. Local winds. Ocean currents. El Ninio Phenomenon. Classification and geographical distribution of climates. The Mediterranean Climate. Location and geomorphology of Greece. Air masses. Atmospheric pressure. Pressure systems and winds over the Greek area. Isolation, cloudiness, fog, air and soil temperature. Absolute and relative air humidity, geographic distribution of the precipitation over the Greek area. Storms and hail. Snow and snow-covered ground. Classification of climate in Greece. (Instructors: Christina Anagnostpoulou, Konstantia Tolika).

GGP 432E Seismic Methods of Geophysical Prospecting: 1)All class material is available in electronic form to all students through the course web page 2)The teacher communicates with students through email and facebook. (Instructors: Konstantinos Papazachos, Georgios Vargemesis).

GGP 433E Geological Data Analysis: Time series analysis, spatially distributed data, multivariate methods, examples in geological and meteorological data analysis using computer applications. (Instructors: Panagiotis Tsourlos, Georgios Vargemesis).

GGN 499E Field Exercises: Field Training: Sterea Ellada – Peloponesse / 6 days. (Instructors: Georgios Syrides, Konstantinos Vouvalidis, Olga Koukousioura).

GGN 500E Field Exercises: Field Training : Eastern Macedonia – Trace/ 4days. (Instructors: Antonios Koronaios, Konstantinos Vouvalidis).

5th Semester:

GMO 534Y Ore Deposits I: Principles. Processes of formation of mineral deposits. Magmas and mineral deposits. Magmas and mineralising fluids. Magmatic segregation deposits. Pegmatites. Contact metasomatism. Hydrothermal processes. Hydrothermal alteration. Porphyry copper deposits. Volcanogenic deposits. Submarine exhalative and volcanogenic processes. Weathering. Residual concentration (laterites, bauxites). Oxidation and supergene sulphide enrichment. Sedimentary deposits. Metamorphosed and metamorphic deposits. Classification of mineral deposits. Morphology of ore-bodies. Ore textures and structures. (Instructors: Anestis Fillipidis, Vasileios Melfos).

GMO 535Y Geochemistry: The subject and history of Geochemistry. The Earth in relation to the Universe. Formation of basaltic-gabbroic melts. Magmatic gasses. Geochemical classification of the elements. Crystal chemistry. Geochemistry of igneous rocks. Geochemistry of sedimentary rocks. Geochemistry of metamorphic rocks. The nature of the hydrosphere. The nature of the atmosphere. (Instructor: Antonios Koronaios).

GGP 536Y Physics of the Lithosphere: Structure of the Crust and Upper Mantle (distribution of the velocities and attenuation of seismic waves, gravity distribution, variation of elastic parameters, density and pressure. Deformation and kinematics of the lithosphere (seismological and other geophysical methods). (Instructors: Anastasia Kiratzi, Georgios Karakaisis).

GGG 537Y Structural Geology: Rock deformation. Petrofabrics. Geological structures. Tectonics. Brittle deformation. Folds. Microtectonics and schistosity. Statistial methods. Geotectonics, orogenies, epirogenies. (Instructors: Alexandros Chatzipetros, Aggelos Maravelis).

GGG 538Y Stratigraphy and Historical Geology: Introduction. Stratification. Unconformities. Lithostratigraphy. Biostratigraphy. Chronostratigraphy. Geochronology. Stratigraphic Correlation. Phases. Study of all geological

periods. (palaeogeography, palaeontology, palaeobiogeography, tectonic events, palaeoclimatology). (Instructor: Georgios Syrideis).

GGN 550Y Field Training E: The field Training refers to the objects of the Lectures of the Semester.

GGN 539E Foreign Language Geological Terminology i: AUTHentic texts of different genres of Geology on the following topics: What is Geology? Geologic structures, Crustal deformation, Rocks, Magmatic evolution, The water Cycle and Climate, Active faulting in multi-fractured seismogenic areas; examples from Greece-Introduction. The texts are accompanied by detailed-reading activities and special geological vocabulary learning activities. (Instructors: Vasileios Melfos, Konstantinos Vouvalidis, Aggelos Maravelis Agni Daffa).

NGGP 835E Engineering Seismology: 1. INTRODUCTION – SEISMICITY MEASURES Seismology and society – strongest earthquakes globally and during the 20th century - Economic consequences of earthquakes. Most destructive earthquakes in Greece. Earthquake prediction. Early warning systems. Quantitative measurement of seismicity. Magnitude distribution of earthquakes (Gutenberg-Richter). The importance of b parameter for estimating the seismicity level. 2. GROUND MOTION MEASURES Accelerographs – accelerometers. Factors defining the strong motion (focus, magnitude, path, site). PGD, PGV, PGA. Duration and energy characteristics of strong motion. 3. ATTENUATION RELATIONSHIPS Seismic waves attenuation – Elastic medium: Geometric dispersion – anelastic attenuation – quality factor Q. Velocity and acceleration spectra – attenuation models, use in seismic hazard assessment. Use of GMPEs in seismic codes. Effect of path and local site effects. 4. SITE EFFECTS Definitions. Methods to evaluate site effects. a) Experimental – empirical: ambient noise (Kanai 1956), Spectral ratios over a reference station (SSR). Horizontal over vertical spectral ratio (HVSR). Coda waves technic b) Theoretical: simple models, analysis of ground response (1D or 2D). 5. MACROSEISMIC EFFECTS Macroseismic observations – macroseismic intensity. Isoseismal maps. Isotropic and anisotropic radiation. Relations connecting intensity with magnitude and distance for Greek earthquakes. Near real time shake maps after strong earthquakes. Epicenter and magnitude estimation based on macroseismic observations of historical earthquakes. 6. SEISMIC HAZARD Seismic hazard measurements: Maximum expected values of intensity, magnitude, PGA and PGV. Maximum and dominant values of expected ground motion. Probabilistic and deterministic methods of seismic hazard assessment. 7. STRUCTURES RESPONSE Structure motion equation (single degree of freedom oscillator). Technical structure parameters (oscillation period, damping factor and plasticity index). Elastic and inelastic response spectrum. Design ground motions. Seismic response and design spectra. Structured pseudospectra. Hellenic Seismic Code. Dynamic and static seismic response estimation. Soil classification. Seismic zones. 8. MICROZONATION STUDIES Detailed assessment of ground response for an area. Evaluation of required variables for earthquake planning. Calculation and representation of various parameters distribution at sub-zones of the study area. Seismic hazard scenarios. Composition of microzonation studies.

GMO 541E Industrial Minerals and Rocks: Terminology. Classification of industrial minerals and rocks. Origin of industrial minerals and rocks. Deposits of industrial minerals (asbestos, quartz crystals and quartz raw materials, feldspars, magnesite, talc). Deposits of industrial rocks (perlite, clays and clay minerals, bentonite, kaolin, phosphates). (Instructors: Anestis Filippidis, Nikolaos Kantiranis).

GMO 542E Geochronology: Geology and time, Relative age determination, Absolute age determination, Atoms-Isotopes-Radioactivity, Methods of analysis-Mass spectrometer, Rb-Sr Method, K-Ar and Ar-Ar methods, U-Pb method, Sm-Nd method, C-14 method, Re-Os method, case studies. (Instructor: Triantafyllos Soldatos).

GMC 543E Hydrometeorology: Definitions-objectives. The water budget. Elements of the surface cyclone of water. Meteorological contributions to surface cycle of water (rain, mechanisms, types, calculation of rain water of an area). Storm models. Probable rainfall maxima. Evaporation-Calculation methods. (Instructor: Theodoros Mavrommatis).

GGG 544E Palaeoanthropology: Primates. Evolution trends. Cercopithecids. Miocene Hominoids; their relationships and significance to the human evolution. Pliocene homimids. Australopithecids. Appearance and evolution of the genus Homo. Evolution stages of Homo erectus. Primitive Homo sapiens, Neanderthals, recent Homo sapiens. Skull of Petralona and other paleoanthropological findings of the Greek area. (Instructor: Evangelia Tsoukala).

NGGE 525E Geographical Information Systems (GIS) and Management of Geological Cartographic Data: •Introduction to Geographic Information Systems (GIS) •GIS Structure and Functions. GIS software •Categories and structure of GIS input data and metadata •Coordinate transformations and map georeferencing •Georeferencing and resampling of images •Creation/Digitization and management of data in vector format (points, polylines, polygons) •Geospatial databases •Conversion of geospatial data between different formats and reference systems •Recovery, access and processing of digital elevation models (DEM) •Extraction of morphological parameters from DEMs (slope, aspect, curvature etc.) •Spatial interpolation of vectordata •2D and 3D representation of geospatial information - Map composition - Map production •WebGIS and interactive maps Structure and material of laboratories / laboratory-tutorial exercises •GIS software •Categories and structure of GIS input data •Coordinate transformations •Georeferencing of maps •Digitization of point data •Digitization of linear data •Digitization of polygons •Georeferencing and resampling of images •Recovery, access and processing of digital elevation models (DEM) •Spatial interpolation of vector data •2D and 3D representation in a

GIS •Map composition •Map production. (Instructor: E. Papageorgiou)

6th Semester:

GMO 645Y Ore Deposits II World mineral deposits: Classification of metallic mineral deposits. Greek metallic mineral deposits. Specific metallic mineral deposits. Deposits of iron and the ferro-alloy metals. Deposits of the nonferrous metals. Deposits of precious metals. Deposits of minor metals and related non-metals. Deposits of fissionable metals. (Instructors: Anestis Fillipidis, Vasileios Melfos).

GGG 646Y Hydrogeology: Surface Hydrology, Hydrological balance, Groundwater Hydrology, Properties of Aquifers, Groundwater flow, Piezometric maps,Net flows, Karst Hydrogeology. (Instructor: Konstantinos Voudouris).

GGE 647Y Sedimentology: Structure and texture of sediments. Depositional environments and models. Clastic and nonclastic sediments. Elements of applied sedimentology. (Instructor: Konstantinos Albanakis).

GGG 648Y Geological Mapping: 1 Fundamentals About Geological Maps 2 Topography – Landscape 3 Geological Maps – Measurements In 3dimensions 4 Geological Cross-Sections 5 Geologica Contacts 6 Unconformities 7 Folds 8 Faults 9 Igneous,Metamorphic And Diapiric Rocks, Ore Deposits,Surficial Deposits, Tectonites And Fault Rocks 10 Design Methods – Calculations. (Instructor: Alexandros Chatzipetros).

GGG 649Y Field Mapping: Field Geology. Student's practice and training on the geological mapping in the field. Safety in the field. Methods of mapwork, use of compass and solution of geological problems in the field. Construction of geological maps and cross-sections in the field. Report of geological mapping. (Instructor: Alexandros Chatzipetros).

GGN 650Y Field Training ST

GGN 651E Foreign Language Geological Terminology ii: English: AUTHentic texts of different genres of Geology on the following topics: The earth's crust, Rigid deformations, Plastic deformations, Continental drift, Plate motions, Faults, Seismic waves, Ophiolites. The texts are accompanied by detailed-reading comprehension activities, practice in the special geologic vocabulary and direct and reverse translation. German: Articles from scientific journals. Texts and exercises in German. Educational Material Types. (Instructors: Vasileios Melfos, Konstantinos Albanakis, Theodoros Mavrommatis, Agni Daffa).

GMO 652E Petrogenesis of Igneous Rocks: Structure and composition of the Earth's interior. Distribution of igneous rocks. Magma composition and physical properties. Magma genesis and geotectonics. Use of major, trace and rare earth elements in petrogenesis. Isotope geochemistry. Origin and evolution of igneous rocks. basaltic magma-granitic magma-partial melting. Phase equilibriums. Phase diagrams. (Instructor: Antonios Koronaios).

GMO 653E Applied - Environmental Geochemistry: Applied Geochemistry (geochemical cycle, indicator elements, geochemistry of rocks - soils - river sediments - water - vegetation - gases, hydrocarbons research). Environmental Geochemistry (ores - energy raw materials - trace elements and environment, environmental uses of industrial minerals and rocks). Environmental mineralogy. Legislation and environment (Instructors: Anestis Filippidis, Vasileios Melfos).

GGP 654E Applied Seismology and Environment: Parameters of earthquake generation. Methods for the determination of fault plane solutions and focal parameters in Greece and broader area. Seismic hazard assessment in the area of Greece. (Instructors: Eleftheria Papadimitriou, Emmanuel Skordilis).

GGP 655E Gravity and Magnetic Methods of Geophysical Prospecting: The Earth's gravity field, General formulae of the gravity field, Newton's law, gravitational prospecting methods, density if rocks and minerals, measured quantities, measuring instruments, gravity surveying and removal of drift and tidal effects, reductions of gravity measurements and production of Free Air and Bouguer anomalies, regional residual separation, estimations of the density of the near surface layers, processing and interpretation methods. Megnetic method of geophysical prospecting, measured quantities, magnetic susceptibility of rocks and minerals, instruments for magnetic surveying, measuring techniques for the total magnetic field and its spatial derivatives, airborne measurements. Examples from mineral and hydrocarbon exploration, applications in studying the subsurface geological and tectonic setting, applications in Archaeology and environmental studies. (Instructor: Georgios Tsokas).

NGGE 525E Geographical Information Systems (GIS) and Management of Geological Cartographic Data: •Introduction to Geographic Information Systems (GIS) •GIS Structure and Functions. GIS software •Categories and structure of GIS input data and metadata •Coordinate transformations and map georeferencing •Georeferencing and resampling of images •Creation/Digitization and management of data in vector format (points, polylines, polygons) •Geospatial databases •Conversion of geospatial data between different formats and reference systems •Recovery, access and processing of digital elevation models (DEM) •Extraction of morphological parameters from DEMs (slope, aspect, curvature etc.) •Spatial interpolation of vectordata •2D and 3D representation of geospatial information - Map composition - Map production •WebGIS and interactive maps Structure and material of laboratories / laboratory-tutorial exercises •GIS software •Categories and structure of GIS input data •Coordinate transformations •Georeferencing of maps •Digitization of point data •Digitization of linear data •Digitization of polygons

•Georeferencing and resampling of images •Recovery, access and processing of digital elevation models (DEM) •Spatial interpolation of vector data •2D and 3D representation in a GIS •Map composition •Map production. (Instructor: E. Papageorgiou)

GMC 657E Historical Climatology with Elements of Palaeoclimatology: Theories of climatic change. Evolution of earth's climates during the geological centuries. Evolution of climate during the last millenniums (since the end of the last ice age). Climate evolution during the historical years. Climate evolution during the period of instrumental meteorological observation. Climate in the last century. Human impacts on climate. Climate in the future. (Instructors: Theodoros Mavrommatis, Konstantia Tolika).

GGN 699E Field Exercises (Rhodope Massif / 3 days (Instructor: Vasilios Melfos).

7th Semester:

GGG 758Y Engineering Geology: The course of Engineering Geology (7th semester of undergraduate studies) is taught with 2 hours of lectures and 2 hours of tutorials. Lectures: 12-13 lectures are given. The topics that are taught are: 1st Lecture: Introduction (Topics of Engineering Geology-The role of Engineering geology in engineering works) 2nd Lecture: Site investigation tools 3rd Lecture: Engineering geology of soils (consistence, soil description, Physical characteristics) 4th Lecture: Engineering geology of soils (shear strength, Mohr-Coulomb failure criteria) 5th Lecture: Engineering geology of rocks (Physical, Mechanical properties of rocks and discontinuities) 6th Lecture: Rock mass strength-Geotechnical classification (GSI, RMR, Q) 7th Lecture: Engineering Geology of Sedimentary, Igneous and metamorphic rocks. 8 th Lecture: Landslides 9 th Lecture: Slope stability 10 th Lecture: Tunnels 11 th Lecture: Dams 12 th Lecture: FoundationsTutorials (3 teaching groups): 10-12 series of tutorials are given (15 tutorials in total). For every tutorial the associated exercise includes all data and geo-information, a presentation (PowerPoint) with all the necessary theoretical background and a supplementary assisting booklet with supporting information. (Instructor: Vasileios Christaras, T. Macedon).

GGG 759Y Geology of Greece: Detailed study of the internal and external Hellenides (lithostratigraphy, magmatism, structural tectonics). (Instructor: A. Hatzipetros, E. Thomaidou).

GGN 750Y Field Training Z

GMO 760E Petroleum Geology: Formation of sedimentary basins, sedimentation in basins, diagenesis and characteristics of sedimentary rocks, formation of oilfields, pore pressure and stress conditions through the geological column. The principles of the petroleum system comprising hydrocarbon play concept, source rocks, maturation, migration, reservoirs, traps, and seals. Outline of exploration and production techniques in the petroleum industry. The principles related to evaluating potential reservoirs and the environmental and economical impact of the utilization of hydrocarbon resources. The course covers mechanical and chemical compaction, cap rocks (shales and salt) – overpressure, fluid flow in porous media, petrophysics (well logs and cores), stress conditions in reservoirs, reservoir models, production geology, sandstone reservoirs, carbonate reservoirs and case studies. The course covers the fundamentals of petroleum systems analysis and its use in hydrocarbon exploration. The module includes basic organic geochemistry, concepts and examples of petroleum systems, and petroleum source rocks. Description of the drilling operation, complete review of surface equipment, practical aspects of hydrocarbon production, health, environment, safety and quality control. (Instructor: Andreas Georgakopoulos).

GMO 761E Petrogenesis of Metamorphic Rocks: The use of the Phase rule; Shreinemaker's analysis. Thermodynamics of the metamorphic reactions. Estimation of equilibrium conditions based on thermochemical data. Estimation of thermochemical parameters according to experimental results. Fugacity, activity, ideal solutions. Geothermometry. Geobarometry. Equilibrium constants in solid-gas mixtures. Metasomatism. Non-ideal solutions. Liquid phase during metamorphism. Application of statistical thermodynamic methods to petrological subjects. PT diagrams. (Instructor: Lamprini Papadopoulou).

GGP 762E Electromagnetic Methods of Geophysical Prospecting: Electrical methods of geophysical prospecting (electrical resistance of rocks, resistance methods,the equipotential lines method, methods of induced polarization, natural potential and telluric currents). Electromagnetic methods of prospecting. Magnetotelluric and radiometric methods. (Instructors: Panagiotis Tsourlos, Georgios Variemezis).

GGG 763E Groundwater Expoitation and Management: Pumping test analysis, Calculation of hydraulic parameters, Springs, Artificial recharge of aquifers, Coastal aquifer systems, Groundwater reserves, Economic data, Groundwater management, Groundwater resources in Greece. (Instructor: Konstantinos Voudouris).

GGG 764E Neotectonics: Microstructure analysis of Neogene and Quaternary. Extensional and compressional facies. Multiphase neotectonics. brittle deformation. Quantitative tectonics. Neotectonic evolution of the Greek and the broader Mediterranean area. (Instructor: Alexandros Chatzipetros).

GMO 765E Volcanology: Eruption dynamics, Volcanic landforms, Eruption products, Eruption types, Historical eruptions, Santorini, Volcanism in Greece, Volcanism on other planets. (Instructor: Triantafyllos Soldatos).

GMC 766E Atmospheric Pollution and Climatic Changes: Composition of the atmosphere and biogeochemical cycles.

Sources and lifetime of atmospheric pollutants. Classification of atmospheric pollution at different spatial scales. Physical processes of transport for air pollutants. Atmospheric diffusion and dispersion. Dry and wet deposition. Photochemical smog, acid rain and ozone hole. Enhancement of the greenhouse effect. Geological periods and the evolution of earth's climate. Proxy data. The causes of natural climate change. Anthropogenic effects on climate change. Projections of future climate change, climate models and emission scenarios. (Instructors: Konstantia Tolika, Prodromos Zanis).

GMC 767E Applied and Dynamic Climatology: Mean synoptic situation of the atmosphere. Air masses. Atmospheric centres of action (frequencies-trajectories). Weather types. Reasons for climate generation. Satellite Climatology. (Instructor: Christina Anagnostopoulou).

GGE 768E Oceanography: Physical and chemical properties of sea-water (salinity, temperature, density, optical properties). Dynamic oceanography (currents, waves, tides). Geomorphology and geological processes on the ocean floor, the continental margins, the continental shelf, the continental slope and the coastal zone. Description of instruments for measuring oceanographic parameters and methods for the investigation of submarine mineral raw material. (Instructor: Konstantinos Almpanakis).

GGE 769E Physical and Anthropogene Environment: Physical environment. Creeks, rivers, lakes, lagoons, deltaic zones, systems of erosion and deposition of materials. Anthropogene environment. Drainage and drying of physical wetlands, river dispositions, artificial lakes and reservoirs, land uses and changes, residential and industrial regions,development works, populous and social changes. (Instructor: Kalliopi Koliadimou).

GGE 770E Remote Sensing to Geosciences: Photographic and non-photographic imaging sensors. remote Sensing platforms. Conventional airphotos and telemetric (non-conventional) images. Visual and digital analysis of telemetric images such as LANDSAT, SPOT, ErS, TErrA, IKONOS etc. Applications of remote Sensing to geomorphology, lithology, structural and tectonic geology, economic geology and multitemporal monitoring of continental and marine environment. Imaging RADAR interferometry and its capability to localize spatial displacements deriving from natural disasters such as earthquakes, volcanic eruptions, landslides. (Instructor: Eleni Papageorgiou).

GGN 771E Didactics of Geology: Historical development of Geology. Aims of Education and Science Teaching. The curriculum. Learning Theories. The Design of Instruction. Aims and Objectives of Teaching Geology. Teaching Methodology of Geology. Teaching Tools. Rating - Educational Evaluation. Organization and Conduct of Teaching - Lesson Plan - The experiment in Science Teaching. Examples of Teaching and Assessment Tests. (Instructor: Dimitrios Kostopoulos).

NGGG 735E Sedimentary basin analysis and sequence stratigraphy: The state of the Lithosphere and its influence to Sedimentary Basin Formation •Pull-apart Basins – Lithospheric Stretching •Compressional Basins •Strike-slip Basins. •Other types of Basins, e.g., Lithospheric Sagging etc. •Interpretational tools in Sequence Stratigraphy •System Tracts •Recognition of Sequence Boundaries •Composition and Interpretation of Chronostratigraphic charts and Wheeler diagrams. (Instructor: Aggelos Maravelis)

GGN 772E Practical Training: The students work together with and under the guidance of the supervisor of the host organization, either public or private, for a short stay of 2 months. In parallel, a member of the School of Geology supervises the internship work program, the progress and the final report. (Instructor: Eleftheria Papadimitriou).

8th Semester:

GGG 871Y Geotectonic Evolution of the Broader Greek Area: Comparative orogenic evolution of Hellenides. Views and models proposed for the geotectonic evolution of Hellenides in the broader Mediterranean. Neotectonic evolution and recent tectonic regime of the Hellenic arc. (Instructors: Alexandros Chatzipetros, E. Thomaidou).

GGN 873Y Diploma Thesis.

GGN 872Y Field Training H

GMO 874E Coal Geology: Coal is an organic sedimentary rock that forms from the accumulation and preservation of plant materials, usually in a swamp environment. Coal is a combustible rock and along with oil and natural gas it is one of the three most important fossil fuels. It has a wide range of uses; the most important use is for the generation of electricity. For a coal seam to form, perfect conditions of plant debris accumulation and perfect conditions of subsidence must occur on a landscape that maintains this perfect balance for a very long time. Peat formation and coal petrology are examined. Are also examined chemical, optical and physical properties of coals, while methods for proximate, ultimate analyses and calorific value measurements are presented. Based upon composition and properties coals are assigned to a rank progression that corresponds to their level of organic metamorphism. Lignite has a low energy and high ash content. Investigation of the microscopic texture and structure of peat and coal contributes to the understanding of the origin of coal. Greek lignite reserves and production are also discussed. Lignite is unsuitable for export and is used to generate electricity in power stations located at or near the mine. (Istructors: Andreas Georgakopoulos).

GGG 875E Drilling Technigues: General topics of the course: Types of boreholes. Coring techniques. Water boreholes (wells). Shallow and deep exploration boreholes in geothermal fields. Vertical and directional boreholes. Types

of drilling. Drilling technology and procedure. Behavior of various lithological formations during drilling. Logging in boreholes. Borehole equipment and development of water boreholes. Tests. (Instructors: Nikolaos-Panagiotis Chatzigogos, Konstantinos Voudouris).

GGP 876E Topics in Geophysics: Selected modern topics in Geophysics are studied by the students under the instructor's supervision. (Instructors: Georgios Karakaisis, T. Tsapanos).

GMC 877E Topiics in Meteorology-Climatology: Extending the understanding in specific topics in the field of meteorology and climatology aiming at a first acquaintance with the meteorological and climatological data analysis and the interpretation of the results. Developing modern topics on meteorology and climatology. (Instructors: Konstantia Tolika, Dimitrios Babzelis).

GMO 878E Topics in Mineralogy-Petrology-Economic Geology: Selected modern topics in Mineralogy or Petrology or Economic Geology are studied by the students under the instructor's supervision. (Instructor: Vasileios Melfos, Triantafyllos Soldatos).

GGG 879E Topics in Geology: This course concerns the guidance of students towards writing and presenting a paper/report on selected geological topics. The candidate has the technical responsibility to guide the students to assort the international bibliography, to check the presentations for the assigned topic and finally to review the written report. (Instructors: Nerantzis Kazakis, Aggelos Maravelis).

GGG 880E Topics in Geography: Selected modern topics of Geography are studied by the students under the instructor's supervision. (Instructor: Konstantinos Vouvalidis).

GGG 881E Geological-Environmeental Surveys of Constructions: The taught topics are: General design principles – Guidelines, Design and execution of site investigation program, Measurements and analysis of tectonic data, Rock mass classification, Design parameters, Engineering geological design of roadworks (slope stability, foundations of embankments and bridges), Engineering geological design of tunnels, Engineering geological design of dams, Environmental design. (Instructor: Thomas Makedon).

GGG 882E Geothermal Energy: Internal earth heat and heat flow. Areas with increased heat flow. Geothermal energy and potential. Geothermal fields and internal procedures. Geothermy of high-medium-low enthalpy and chemical composition of the fluids. Geothermy and environment. Methodology of geothermal exploration. Mechanical equipment. Exploitation of geothermal fiels and utilization of the geothermal potential. Corrosion and sealing problems. Main geothermal fields in Greece. Geothermal energy worldwide. (Instructor: Maria Papachristou, Konstantinos Voudouris).

GGG 883E Rock and Soil Mechanics: The soil mechanics course aims to train students of the School of Geology - Direction of "Applied Geology", on soil mechanics basics, which are useful for thlae elaboration of engineering geological studies for the safe construction of engineering projects either and the safe design of residential areas. This lesson of soil mechanics, includes the following topics: (a): theory: ¨ 1) physical and mechanical characteristics of soil and geo-engineering classification of soil in accordance with the international standards, 2) distribution of stresses, 3) bearing capacity 4) compression of soil and settlement 5) earth pressure and retaining walls 6) landslides and slope stability analysis, 7) site investigation, 8) Eurocode, geotechnical planning. B: Internship: Internship in various laboratory tests on soil mechanics, in accordance with international standards. (Instructor: Vaseilios Christaras).

GMC 884E Synoptic and Dynamic Meteorology: Introduction. Meteorological coordinate systems. Thermodynamic diagrams. Atmospheric observations at synoptic stations: surface and upper air. Synthesis and analysis of weather charts. Discontinuities in the atmosphere. Jet stream. Rossby waves. Development of cyclones and anticyclones. Equations of atmospheric motion. Balanced motions. (Instructor: Ioannis Pytharoulis).

GMO 885E Mining Geology: Mining legislation. Mine-mapping. Excavation methods. Sampling, preparation and processing of samples. Surface and underground mining. Methods of ore reserves classification and estimation. Economotechnical reports. Impacts to the environment from the exploitation of primary minerals. Drawing and restoration of regions of surficial or underground exploitation. Writing of restoration proposal. (Instructor: Al. Drakoulis).

GMO 886E Economic Geology: Raw materials. Prospecting and identification methods of mineral deposits. Factors and parameters of economic evaluation and estimation of mineral deposits. Exploitation programming. Specific problems in mining programs. Marketing and prices of raw materials. Raw materials policy. Recycling of raw materials. Impacts to the environment from the exploitation of primary minerals. Drawing and restoration of regions of surficial or underground exploitation. Writing of restoration proposal. (Instructor: Vasileios Melfos).

NGGG 828E Environmental Hydrogeology: Introduction to the basic concepts of Hydrogeology – Terminology •Soil properties•Groundwater quality •Evaluation of hydrochemical data-Hydrochemical types of groundwater •Interaction of water and environment •Pollution and contamination of groundwater •Pollution sources and transport of pollution (advection, diffusion, hydrodynamic dispersion) •Soil as recipient of solid wastes - Sanitary Landfill- Site selection •Vulnerability of aquifers to external pollution •Disposal of wastewater on land, Soil-Aquifer-Treatment •Salinity of groundwater due to seawater intrusion •Impacts of climate change on groundwater •Protection and remediation of aquifers (Instructor: Konstantinos Voudouris)

GGG 887E Environmental Hydrogeology: Water quality, Interaction between groundwater and environment,

Pollution sources, Sanitary landfills (operation, selection site criteria), Aquifer vulnerability assessment, Protection zones, Disposal of liquid wastes.Operation, Pollution sources and loads. Pollution procedure of underground water. Geological, hydrogeological and physical planning criterions for SL suitability. Impacts. Geotechnical problems in the construction and operation of SL. Grading of criterions for SL selection. SL reformation, environment protection. (Instructors: Neratzis Kazakis, Konstantinos Voudouris).

GGN Practical Training: The students work together with and under the guidance of the supervisor of the host organization, either public or private, for a short stay of 2 months. In parallel, a member of the School of Geology supervises the internship work program, the progress and the final report. (Instructor: Eleftheria Papadimitriou).

GGG 890E Educational Applications of Digital Technologies in Geology: Digital representations: The role of media in the crearion of multiple representations and visualizations for teaching / learning. Interactive environments: The structure and role of interactive technological environments (simulation, microworld, modeler) in teaching / learning. The model of inventive / exploratory learning. Simulated experiments on computing environments. Digital animation and interactive environments in Geology: Ways of using these technologies in the fields of geology, virtual laboratories and simulations in all branches of Geology. (Instructors: Antonios Mouratidis, Vasileios Melfos, Dimitrios Babzelis, Georgios Lazaridis, Dominikos Vamvakaris, Parthena Paradisopoulou).

GGN 898E Field Training (West Macedonia - Epirus - Sterea Ellada / 5 days): NE-SW directed geological cross-section through the Hellenides in Northern Greece, recognition-learning of teh geotectonic zones Of Hellenides (composition, structure, evolutio) and their geotectonic signioficance. Learning of great tchnical-geological constuctions (dams, tunels, road building), landslids. (Instructors: Thomas Makedon et al.).

GGN 899E Field Training (Santorini or Milos islands / 7 days).

NGGP 835E Engineering Seismology: 1. INTRODUCTION – SEISMICITY MEASURES Seismology and society – strongest earthquakes globally and during the 20th century - Economic consequences of earthquakes. Most destructive earthquakes in Greece. Earthquake prediction. Early warning systems. Quantitative measurement of seismicity. Magnitude distribution of earthquakes (Gutenberg-Richter). The importance of b parameter for estimating the seismicity level. 2. GROUND MOTION MEASURES Accelerographs – accelerometers. Factors defining the strong motion (focus, magnitude, path, site). PGD, PGV, PGA. Duration and energy characteristics of strong motion. 3. ATTENUATION RELATIONSHIPS Seismic waves attenuation – Elastic medium: Geometric dispersion – anelastic attenuation – quality factor Q. Velocity and acceleration spectra – attenuation models, use in seismic hazard assessment. Use of GMPEs in seismic codes. Effect of path and local site effects. 4. SITE EFFECTS Definitions. Methods to evaluate site effects. a) Experimental – empirical: ambient noise (Kanai 1956), Spectral ratios over a reference station (SSR). Horizontal over vertical spectral ratio (HVSR). Coda waves technic b) Theoretical: simple models, analysis of ground response (1D or 2D). 5. MACROSEISMIC EFFECTS Macroseismic observations – macroseismic intensity. Isoseismal maps. Isotropic and anisotropic radiation. Relations connecting intensity with magnitude and distance for Greek earthquakes. Near real time shake maps after strong earthquakes. Epicenter and magnitude estimation based on macroseismic observations of historical earthquakes. 6. SEISMIC HAZARD Seismic hazard measurements: Maximum expected values of intensity, magnitude, PGA and PGV. Maximum and dominant values of expected ground motion. Probabilistic and deterministric methods of seismic hazard assessment. 7. STRUCTURES RESPONSE Structure motion equation (single degree of freedom oscillator). Technical structure parameters (oscillation period, damping factor and plasticity index). Elastic and inelastic response spectrum. Design ground motions. Seismic response and design spectra. Structured pseudospectra. Hellenic Seismic Code. Dynamic and static seismic response estimation. Soil classification. Seismic zones. 8. MICROZONATION STUDIES Detailed assessment of ground response for an area. Evaluation of required variables for earthquake planning. Calculation and representation of various parameters distribution at sub-zones of the study area. Seismic hazard scenarios. Composition of microzonation studies. (Instructors: E. Papadimitriou, E. Skordylis)

NGGE 833E Geological and Environmental Applications of Geospatial Data Analysis: • GIS Toolboxes • 3D representation and analysis of geospatial data • Imaging and spatial analysis of earthquake epicenters, other geological and GNSS data • Management of meteorological and climatic data • Extraction and classification of drainage basins and hydrographic networks from digital elevation models • Calculation of erosion / deposition rate in coastal areas • Calculation of perimeter, area, and volume of a water body • Assessment of susceptibility to landslides • Assessment of flood susceptibility, hazard and risk • Delineation of locations suitable for waste landfill sites • GIS and Remote Sensing synergies for quarry monitoring • GIS and Remote Sensing synergies for the detection and delimitation of oil spills • GIS and programming. (Instructor: A. Mouratidis)