Department of Mineral Resources Engineering

The purpose of the Department of Mineral Resources Engineering is to educate engineers through a broad range of scientific and technical activities related to mineral extraction and processing. Special emphasis is given to those mineral resources, which are important in the development of the national economy, plus covering the present and future needs of the country.

**Divisions**

- Exploration and Positioning
- Mineral Exploitation
- Mining Technology

**Laboratories**

- Applied Geology
- Applied Geophysics
- Applied Mineralogy
- Ceramics and Glass Technology
- Coal Beneficiation and Solid Fuels Technology
- Geodesy and Geomatics
- Inorganic and Organic Geochemistry and Organic Petrography
- Mine Design
- Ore Processing and Beneficiation
- Petrology and Economic Geology
- Reservoir Engineering
- Rock Mechanics

**Academic and Research Staff**

**Exploration and Positioning Division**


**Theodoros Markopoulos.** B.Sc. (1965) University of Gottingen - Germany, Dr. rer. nat. (1974) University of Gottingen - Germany, Professor.


Department of Mineral Resources Engineering


**Mineral Technology Division**


**Georgios Kostakis**, B.Sc. (1970) University of Munich - Germany, Dr. rer. nat. (1973) University of Munich - Germany, Professor.


Content of Undergraduate Courses

1st Semester

**Differential and Integral Calculus I**
MATH 101
Functions of one real variable, Limits and continuity of functions, Derivatives, Geometric interpretation of the derivative, Differentials, Applications of the derivative, Indefinite and definite integrals, Basic theorems of integral calculus, Applications of integrals (areas between two curves, volumes by revolution, length of a plane curve, area of a surface of revolution, moments and center of mass, centroid and center of mass, the theorems of Pappus, hydrostatic pressure, work), Exponential and logarithmic functions, Methods of integration, Improper integrals, Diriclet and Fresnel integrals, hyperbolic functions, inverse trigonometric functions, Taylor and Laurent series, basic differential equations, Fourier series.

**Introduction to Computer Programming**
MATH 105
Introduction to Algorithms, (design, correctness), Structured Programming, Programming with FORTRAN and C (control structures, I/O, formatting, subroutines-functions, arrays, numerical techniques), Programming assignments

**Geology**
MRED 101
Introduction to geology, composition/formation of the Earth's crust, introduction to elements of geomorphology, stratigraphy and structural geology, geological maps and geological sections (drawing and interpretation)

**Physics I**
PHYS 101
This course refers to the basic principles of kinematics and dynamics for a particle and for a rigid body. It describes the basic laws of thermodynamics and its mechanical applications and provides the student with the basics of electrostatics analysing Coulomb's and Gauss's laws and the concept of the field. Emphasis is given to the physical meaning of the physical concepts and to the student practicing both in solving theoretical problems and in conducting experiments in the laboratory.

**Inorganic Chemistry**
CHEM 101

**Introduction to Mineral Resources Engineering**
MRED 103
Introduction to Mineral Resources Engineering.

**Drawing**
MRED 105
Elements of engineering and topographical drawing.

**English I**
LANG 101
Basic English grammar and vocabulary targeted at a lower and intermediate level as they are presented at the Language Research and Resource Centre, use of self-access materials, grammar and writing tutorials.

**German I**
LANG 103
Introductory instruction of the German language with emphasis on oral skills, vocabulary expansion, grammar and written skills (basic knowledge of the German language required)

2nd Semester

**Differential and Integral Calculus II**
MATH 102
Functions of many variable plane analytic geometry, equations of surfaces, polar and spherical coordinates, elements of differential geometry and vector calculus, partial derivatives, div, grad, rho-Lagrange multipliers, differentials, multiple integrals, applications in physics and geometry, surface integrals, applications in fluid mechanics, Green's theorem, Stokes theorem, Gauss theorem, applications in mechanics.

**Physics II**
PHYS 102
This course refers to the basic principles of electromagnetism developing the concepts of magnetic field and analysing Ampere's and Faraday's laws. The course is completed with reference to the principles of geometrical and wave optics as well as to the interaction of electromagnetic waves and light with matter. In the above
Content of Undergraduate Courses

3rd Semester

**Numerical Linear Algebra**
MATH 201
Introduction to linear and matrix algebra, direct methods for solving linear systems, pivoting strategies, error analysis, condition number, determinants, eigenvalues and eigenvectors, diagonalization, iterative methods for solving linear systems.

**Ordinary Differential Equations**
MATH 203

**Mechanics II (Strength of Materials)**
MECH 201

**Physical Chemistry**
CHEM 201

The course is completed by experimental practice in the laboratory which in general includes: Phase equilibria and distillation, Liquid-gases equilibria and absorption, gas-solid equilibria and adsorption, Kinetic studies of homogeneous and heterogeneous reactions. Electrochemistry and fuel cells.

**Systematic Mineralogy**
MRED 201
Physical characteristics of minerals, origin, mode of occurrence and association of minerals, native elements, sulfides and sulfosalts, halides, oxides and hydroxides, carbonates, nitrates, borates, sulfates, chromates, molybdates, tungstates, phosphates, arsenates, vanadates, silicates.
Content of Undergraduate Courses

**Applied Geophysics I (Seisimcs)**
MRED 205
Seismic wave propagation, body and surface waves, instruments for seismic data acquisition, seismic reflection and refraction methods, seismic velocity, corrections to seismic data, synthetic seismograms, introduction to seismic imaging and interpretation, use of seismic methods for petroleum exploration, mineral exploration and geotechnical engineering, laboratory exercises.

**English III**
LANG 201
Self-access learning at the Language Center, thematic work modules on a student’s field of study, focus on language, texts, and writing skills.

**German III**
LANG 203
Introduction to German terminology for technical subjects.

**4th Semester**

**Numerical Analysis**
MATH 202
Solution of algebraic equations with one variable, interpolation and polynomial approximation, numerical differentiation, numerical integration, approximation theory, initial and boundary value problems for ordinary differential equations.

**Technical Thermodynamics**
MECH 306
Principles of classical thermodynamics, first law, second law analysis of engineering systems, chemical equilibrium, water air mixtures, phase diagrams, thermodynamics of reacting systems, combustion thermodynamic cycles, refrigeration, determination of combustion efficiency, combustion applications to heating, internal combustion engines, power generation systems.

**Petrology**
MRED 202
Composition of the earth’s crust, rock forming minerals, igneous, sedimentary and metamorphic rocks, optical petrography, and laboratory exercises.

**Electric Circuits**
MRED 210
Networks laws, ideal circuit elements, inductors, transformers, power supplies, electric power transfer, electric motors, high-voltage electric circuits, high-voltage equipment, safety procedures, fire-protection circuits, automatic control circuits.

**Applied Geophysics II**
MRED 204
Elementary potential theory as required for gravity, magnetic, electrical and electromagnetic studies of shallow and deep geological structures, instrumentation, data collection, data analysis, applications in mineral exploration, groundwater exploration, environmental monitoring, geotechnical engineering and archaeology, laboratory exercises.

**Field Trip II**
MRED 704
One-day field trip to Western Crete for observation of representative rock types and geological formations, five-day field trip to Santorini and/or Milos Island for observation of different volcanic and metamorphic rocks, visits to manifestations of present hydrothermal activity, geological mapping.

**English IV**
LANG 202
Study of texts and language for specific disciplinary fields, extensive use of the Web, ethics in engineering and academic report writing.

**German IV**
LANG 204
Advanced instruction of the German language equivalent to the level of Mittelstufe.

**Design of Physical Processes**
MRED 206
Basic physical processes in the production and exploitation of mineral resources, Balance of mass and energy, Design of installations, Equipment, Diffusion, Heat transfer, Distillation, Absorption, Balance of fluid and solid and gas and fluid, Exercises.

**Political Economy**
KEP 102
This course includes an analysis of basic concepts and relations of Political Economy, as well as a brief review of recent economic history. It refers more specifically to the theory of value, surplus-value and prices, as well as to the relation between competition and distribution, to fundamental trends and contradictions of growth, and to the phenomena of economic crisis.

**Industrial Sociology**
KEP 302
Lectures on Sociology of Labour and Sociology of Development, with particular reference on historical approach of production systems and on recent changes concerning industry (crisis and restructuring strategies, "flexible" production and labour organization, labour market, inter-firm relations, local productive systems,
Content of Undergraduate Courses

Research and technological development, innovations, know-how, industrial policy...

**Geology of Greece**

MRED 208

**5th Semester**

**Elements of Equipment Design**

MECH 110
Fundamentals of machines, maintenance, strength, fatigue, materials, connecting components: rivets, screws, bolts, welding, rotating components: axles, shafts, mounting parts, rolling bearing elements, power, transmission components: belts, pulleys, chains, gears, engineering drawings and graphics.

**Surface Mining I**

MRED 303
Introduction and definitions, mine planning methods, principles of equipment selection and operation, analysis of the main equipment (bucket wheel excavators, belt conveyors etc.) used in continuous mining methods, detailed mine planning of lignite and coal deposits, actual problems during development and operation of lignite mines.

**Engineering Geology-Soil Mechanics**

MRED 307
Introduction to engineering geology and Soil Mechanics (geotechnical classification, mechanical properties of rocks and soils), geological conditions in construction works (foundations, roads, water management projects, dams, tunneling, mining, etc.), hazardous geologic phenomena, treatment, supporting measures and works, laboratory and field tests, exercises.

**Mineral Processing I**

MRED 309
Mass balance, degree of separation, particle size, crushing, grinding, screening, classification, comminution circuits, agglomeration, solid-liquid and solid-air separation, waste disposal.

**Philosophy and History of Sciences**

KEP 203
Science as a social-cultural phenomenon. The role of science in the social structure. Theoretical issues concerning knowledge, logic and the methodology of scientific research. Sciences in History. Differentiation, integration and inter-disciplinarity of science. Traditions and innovations in the development of science. The subject of scientific activity. Theories, orientations and approaches in the philosophy of science.

**Art and Technology**

KEP 301
Technology and Art in the social structure. Technology as objectification, as a framework for the human impact on nature and for the relations among people, as a forerunning conception-knowledge and as an instrument implicating upon Nature. The particularity of the aesthetic moment. The aesthetic moment as a specific activity in the division of labor (Art). Art and technology in the history of civilization. Metaphysical discourse on "Apollonean" and "Dionysian" elements.

**Sociology**

KEP 101
Introductory lectures on Sociology, with particular reference on concepts of the social framework of production, such as: society, socioeconomic change and evolution, social classes and social stratification, institutions (political, economic, educational...).

**Micro-Macroeconomic Analysis**

KEP 201
Analysis of commodity supply and demand, the theory of the consumer and of the firm, macroeconomic topics regarding income and employment determination, the role of investment and the impact of international exchange.

**Investment Decision Analysis**

KEP 102
Method, the simulation analysis, portfolio, selection and internal rate of return, advanced capital budgeting.

**Hydrogeology and Water Management Projects**

KEP 204
Multivariable analysis, classification, grouping, main measurements.

**Introduction to the Legal Systems and to the Technical Legislation**

KEP 101
A. Introduction to the legal system. Basic law classification. Elements of public and European law. Elements of civil law (general principles of civil law, contract law, property law). Elements of labour law (individual contract of employment, collective bargaining, labour accidents) commercial law, industrial property (trade-mark, patent), intellectual property, elements of environmental law.
B. Elements of public works law (undertaking and elaboration of public works projects, undertaking and construction of public works, contractor's counter value, procedures to receive a public work, contractual liability, procedures to resolve conflicts in public works, organisation of public works contractors).
### Content of Undergraduate Courses

#### Methodology of Operations Research
**MPD 102**

Historical perspective, operations research and decision support systems, methodological framework, models for decision making under certainty and uncertainty, case studies.

#### 6th Semester

**Mineral Deposits I**
**MRED 306**

Magma and magmatic deposits, hydrothermal fluids, deposition of the ores, depositional textures, deposits related to plutonism and volcanism, deposits related to sedimentation, deposits related to metamorphism, ore microscopy, field trip exercises, emphasis to metallic ores.

**Geochemistry**
**MRED 304**

Introduction to geochemistry of igneous, metamorphic rocks with special emphasis to the geochemistry of sedimentary rocks, introduction to geothermodynamics, diagenesis, environmental geochemistry (case studies), tutorials, laboratory exercises and analytical techniques.

**Mineral Processing II**
**MRED 302**

Liberation, sampling, separation test evaluation, optical sorting, heavy media, washability curve, gravity concentration, magnetic separation, electrostatic separation, froth flotation, elements of surface chemistry, leaching and bioleaching, gold metallurgy, feasibility of mineral processing operations.

**Applied Fluid Mechanics**
**MRED 308**

Principles of fluid mechanics, fluid statics, fluid dynamics, mass balance, momentum and energy balance equations, rheological equations (Navier-Stokes, Euler, Bernoulli), applications (pipes, channels, submerged bodies, nozzles, fluid engines), similitude, laminar flow of real fluids (Couette, Hagen-Poiseuille, Stokes), turbulent flow or real fluids (mathematical description, flow near walls, flow in circular pipes), flow through porous media (one-phase flow, two-phase flow), motion of particles through fluids (mechanics, one-dimensional flow).

**Geostatistics**
**MRED 310**

Probability, random variables, probability distributions, mean, standard deviation, least squares method, regression, correlation, semivariograms, spectral analysis, filters distributions in the 3-D space, directional data analysis, moving average, kriging, trend surfaces, multivariable analysis, classification, grouping, main variables analysis, exercises.

**Hydrogeology and Water Management Projects**
**MRED 312**

Sources and origin of ground water-hydrologic cycle, relationship between underground water and sea water, flow and reserves of ground water, karst hydrology and hydrogeology, measurement of hydraulic parameters-characteristics of the aquifers, mining projects in surface and groundwater environment, laboratory and field tests and exercises.

**Field Trip IV**
**MRED 708**

Seven-day field trip to Eastern Crete for geophysical measurements.

**Management Systems for Engineers**
**MPD 222**

Introduction to the principles of management, theory and methodology of systems, communication, management techniques, examples and case studies.

**Investment Decision Analysis**
**MPD 422**

Financial mathematics, investment decision under certainty, net present value, the payback method, the accounting rate of return, the index of profitability, the internal rate of return, advanced capital budgeting techniques, investment decision under uncertainty, the risk-adjusted discount rate method, the certainty equivalent method, the statistical decision method, the decision tree method, the simulation analysis, portfolio, selection and management, risk and return, market model, CAPM, ART, case studies.

**Introduction to Philosophy**
**KEP 104**

A brief overview of the history of philosophy. Main categories and laws of dialectic in the areas of knowledge. Theory of ontology and logic (formal and dialectical). Elements of social philosophy. The social structure as an organic whole, social consciousness and its forms.

**History of Civilization**
**KEP 202**

Review of History of Civilization with particular reference on some periods. Analysis and synthesis of basic concepts and questions on civilization. Critical discussion of theories about recent cultural changes (post-modernism, etc.).
Content of Undergraduate Courses

7th Semester

**Applied Geostatics**
MRED 401
Geostatistics and energy raw materials (fuels), statistical description of data in the 3-D space, sampling, quality control, variograms and other functions, estimation with normal kriging, universal kriging, Markov-Bayes kriging, tonnage estimation by conventional and geostatistical methods, conditional simulations and multivariable simulations, risk estimation, applications on boreholes, geophysical and energy, interpretation of the results.

**Drilling, Blasting and Introduction to Underground Development**
MRED 403
Properties of industrial explosives, drilling and blasting techniques for surface and underground mines, design of surface and underground blasting, introduction to underground mining, computational exercises.

**Geodesy Engineering**
MRED 405
Definition and classification of geodesy, historic development, earth and its motions, precession, nutation and polar motion, gravity field of the earth, gravity potential, spherical harmonics, actual shape of the earth, geoid, biaxial ellipsoid, time, methods for determining and disseminating time, applications to geophysics, maps, mercator, Lambert, Greek Geodetic reference systems, instruments, methods of positioning, applications to geophysics, mining, environmental monitoring, geodynamics etc.

**Reservoir Engineering**
MRED 407
Introduction to petroleum engineering, elements of petroleum chemistry, properties of hydrocarbon gases and liquids, properties of two phase systems, hydrocarbon phase behavior, reservoir fluid sampling, PVT and physical property analysis of reservoir fluids, interpretation of PVT reports, properties of the porous media, porosity, permeability, Darcy's law.

**Topics in Environmental Protection and Reclamation**
MRED 409
Basic principles of ecology, geochemical cycles, air pollution, water pollution, waste management methodologies, statistical analysis of environmental data, wastewater treatment, solid-waste management.

**Quality Control in Mineral Resources**
MRED 411
Introduction to quality control, definitions and terms about quality assurance, ISO series, TQC, sampling theory and statistical quality control, laboratory accreditation, case studies from the mineral industry, metallurgy, cement, ceramic and construction material industry.

**Evaluation of Industrial Minerals**
MRED 413
Description of industrial minerals and rocks, properties, physical, chemical and technological characteristics, evaluation criteria for diverse applications.

**Physico-Chemical Characterization of Fossil Fuels**
MRED 415
Origin, occurrence and properties of the organic matter in the geosphere, natural gas, hydrates, petroleum, tar sand, oil shale and coal, basics of petroleum chemistry and refining, analytical methods for the characterization of fossil fuels, gas chromatography, liquid chromatography, mass spectroscopy, UV and IR spectroscopy, environmental impact from fossil fuels exploitation, analytical determination of the organic pollutants in environmental samples.

**Material Science**
MRED 417
Crystalline and non-crystalline materials, phase distribution in solids, grain surface properties, surface tension, surface energy, atom mobility, Fick's law, molecular diffusion, generation of crystals, mechanical properties of crystals, transformation.

8th Semester

**Design of Quarries and Geotechnical Excavations**
MRED 406
Theories of mechanical cutting of rocks, control blasting, design principles of open pit quarries, selection of equipment, marble open pit exploitation, physicomechanical properties of marble, mechanical excavation of tunnels.

**Rock Mechanics**
MRED 408
Application of continuum mechanics theory to rocks, stress and strain in two and three dimensions, equations of state, failure criteria, creep, support of underground openings, rock classification systems, laboratory and computational exercises.
## Content of Undergraduate Courses

### Remote Sensing
**MRED 412**
Definition and historic outline, remote sensor platforms, remote sensing applications, fundamental considerations of energy distribution, interaction mechanisms, atmospheric effects, aerial photography, photographic LANDSAT imagery, thermal infrared imagery, microwave imagery, ground truth data collection, rectification of digital LANDSAT imagery, future extraction from digital imagery, spatial and spectral analysis of digital image, applications to geosciences.

### Coal Geology (Geology of Energy Resources)
**MRED 402**
Introduction to energy resources of Greece (hydrocarbons, uranium, solid fuels) Reserves and evaluation of resources, exploration and exploitation of coal deposits, environment of peat, lignite and coal deposit formation, logging of coal drill holes, exploration techniques, geological problems relevant to exploration, coal petrology, assessment of coal basins for various uses, tutorials and laboratory exercises.

### Coal Beneficiation
**MRED 410**
Formation and classification (petrographic classification, rank classification), physical and chemical properties (chemical analysis, chemical structure, mineral matter, porosity), preparation/cleaning (crushing and particle size distribution, physical and chemical cleaning, drying), briquetting (briquetting a bituminous coal and anthracites with binding materials, briquetting of subbituminous coals and lignite, properties of briquetting, carbonization of briquettes, thermal briquetting), carbonization (behavior during heating, carbonization at low temperatures, carbonization at high temperatures, formed coke processes, byproducts of carbonization), liquefaction (principles of coal liquefaction processes), gasification (principles of coal gasification, gasification processes, underground gasification), laboratory exercises.

### Ceramics
**MRED 414**
Characteristics of ceramic materials, ceramic phases, sintering, glazing, structure of ceramics, ceramic raw materials, properties, structural ceramic products, pottery and white ware, refractory.

### Reservoir Engineering
**MRED 416**
Flow in porous media, linear and radial flow, diffusivity Equation for radial flow in the porous media, steady state, and unsteady state flow, displacement of oil by water, fluid-rock interactions, wettability, relative permeability, phase distribution in the porous media, capillary pressure, drainage and inhibition displacement mechanisms, material balance equation, applications of the MBM for the estimation of the reserves and the prediction of future production.

### Mining Technology
**MRED 418**
System’s analysis of continuous and non-continuous surface mining methods, operational analysis of the conventional mining equipment and of complex mining systems, reliability and availability of equipment, operational design of loading-transportation systems, operations programming and equipment maintenance, special topics: handling and transportation of materials, dewatering and pumping of surface mines.

### Health and Safety in Mining and Underground Works
**MRED 420**
Design of equipment for injury prevention, emissions and toxic substances, dust control and monitoring, hazard detection, principles of ventilation and lighting, surveillance and statistical activities, human factors, training and education.

### Stability of Underground and Surface Excavations
**MRED 422**
Rock elasticity, rock plasticity, plastic limit analysis of excavations and applications, poroelasticity, rock discontinuities, analytical methods for slope stability problems (elasticity - plasticity - poroelasticity), numerical analysis of slopes, analytical methods for underground stope stability analysis, numerical analysis of stability of underground systems of openings.

### Chemical Kinetics and Catalysis
**MRED 424**
Definitions, thermodynamics of chemical reactions, energy balance, chemical equilibrium, kinetic equations, effect of temperature, catalysis and adsorption, heterogeneous catalysts, solid catalysts, reactions between solids, reactions between liquids and solids, oxidation, corrosion, dehydration.

### Geomechanics - Geotechnical Construction
**MRED 426**
Introduction to geomechanics, Stress and strain, Elastic foundation, analysis of construction geomaterials, Bearing capacity, Slope stability, Use of piles in foundations.
Content of Undergraduate Courses

**Microscopy of Minerals and Artificial Materials**  
*MRED 428*  
Advanced microscopy with polarized microscopes of transmitted and reflective light (indices of reflection, chemical reactions on mineral surfaces). Quantitative determination of minerals with point counting. Procedures for making thin and reflective sections of microphotography.

**Introduction to Metallurgy**  
*MRED 404*  
Mass and energy balance, Metallurgical processes, Reactor design, Best metallurgical techniques in pyrometallurgy, hydrometallurgy and biohydrometallurgy, Waste minimization, Legislation, Issues regarding production of steel, nickel (ferronickel), alumina and aluminium, gold, copper and lead will be covered.

**Field Trip III**  
*MRED 708*  
Seven-day field trip to Western and Central Greece, visits to mineral deposits, open cast and underground mining operations, beneficiation plants.

**9th Semester**

**Drilling Engineering**  
*MRED 509*  
Description of drilling operations for oil and gas well drilling, equipment description, cements and cementing operations, casing design and placement, properties of drilling fluids, drilling hydraulics and optimization, drill bits, directional and horizontal drilling equipment and operations and equipment, completion procedures, open hole logging.

**Environmental Remote Sensing**  
*MRED 501*  
Image Analysis, geometric corrections of a digital image, contrast enhancement, Supervised and unsupervised classification, theory of evidence, neural networks, in image classification, applications of remote sensing to the environment.

**Geothermics**  
*MRED 503*  
Exploration, exploitation of geothermal fields, geotectonic evolution of the earth’s crust, description of geothermal areas in Greece, geochemistry and mineralogy of deep geothermal drillings, geothermometry, laboratory exercises.

**Underground Mining Methods & Tunnel Construction**  
*MRED 505*  
Terminology of mining methods, description of types of exploitation faces, mining methods classification, underground methods of marble quarrying, open stopping, cut-fill stopping, caving stopping, CAD of mining methods, ventilation principles, hoisting systems, history of tunneling, tunnel design, tunnel construction (NATM, TBM etc.), tunnel support, soft ground engineering, numerical analysis of tunnel and underground excavations stability, laboratory exercises on CAD, numerical modeling, analogue modeling.

**Formation Evaluation with Geophysical Methods**  
*MRED 507*  
Principles of well logging techniques, gamma ray, self potential, density, neutron, sonic and electrical logs, instrumentation, data collection, interpretation of petroleum well logs.

**Materials Technology**  
*MRED 511*  
Mechanical properties of metals, alloys and thermal processes, structure, properties and applications of ceramics and polymers, composite materials, semi-conductors, corrosion and degradation of materials, material selection.

**New Technologies of Coals Evaluation for Power Production**  
*MRED 517*  
Coal characteristics affecting combustion, emerging clean combustion technologies (fluidized-bed, sulfur oxide and nitrogen oxide control technologies, demonstration projects), coal characteristics affecting gasification, classification of gasification processes, gasification processes (fixed-bed, fluidized-bed, entrained-bed, molten-bath), underground gasification, purification of combustion and gasification flue gases (particulate matter, SOx, NOx and other pollutant compounds’ cleaning technologies, hot gas cleaning technologies), environmental impacts of air pollutants, water pollutants and solid wastes, air pollution, water pollution and solid waste control technologies.

**Organic Geochemistry**  
*MRED 515*  
Introduction to organic chemistry relevant to hydrocarbons, saturated and unsaturated hydrocarbons (cyclic and noncyclic), polynuclear aromatic compounds, environments of deposition, oil generation and oil migration from source rocks, biomarkers, diagenesis, rock-eval pyrolysis, organic petrology, tutorials and laboratory exercises.
Content of Undergraduate Courses

Applications of Numerical Methods in Geomechanics
MRED 519
Problem formulation, governing differential equations, the finite element method, the boundary element method, applications in simulation of mining, rock mechanics and soil mechanics problems.

Summer Practical Exercise
MRED 709
Each student should complete at least one month of practical training in a company or institution related to mineral resources engineering.

Fracture Mechanics
MRED 521
Fundamentals of Fracture Mechanics, Historical Notes, Stresses and Strains in Continua, Crack Modes, Mathematical Analysis of Cracks, Experimental Fracture Mechanics, Applications in Rock Engineering, Applications in Seismology.

Petrology of Aggregates and Construction Materials
MRED 513
Characterization and type of aggregate and construction materials, specification and selection of construction materials, properties and uses of natural stones, types and properties of mortars, quality control of mortars, types and properties of concretes.

Computer Aided Mine Planning and Design
MRED 523
Introduction to the computer applications in the mineral industry (historical background), data storage and manipulation, modeling of deposits, 2D and 3D visualization techniques, GIS, open pit and underground design, feasibility and environmental impact studies.

Mineral Processing Plant Design
MRED 525

Analytical Environmental Geochemistry
MRED 527

Mineral Deposits II
MRED 529
Geological occurrence, origin, properties and uses of industrial mineral deposits, exercises, field trips.

10th Semester

DIPLOMA THESIS
A minimum of 209 credits are required for the award of the diploma.