

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



Undergraduate Studies

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Academic and Research Staff

Exploration and Positioning Division

Georgios Christidis, B.Sc. (1982) National and Kapodistrian University of Athens - Greece, M.Sc. (1989) University of Hull - UK, Ph.D. (1992) University of Leicester - UK, Associate Professor.

Dionysios Christopoulos, B.Sc. (1985) National Technical University of Athens - Greece, M.Sc. (1988) University of Princeton, New Jersey, USA, Ph.D. (1991) University of Princeton, New Jersey - USA, Associate Professor.

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

Stylios Mertikas, Dipl. Eng. (1973) National Technical University of Athens - Greece, M.Sc. (1983) University of New Brunswick - Canada, Ph.D. (1987) University of New Brunswick - Canada, Professor.

Vassilios Perdikatsis, B.Sc. (1969) University of Erlangen - Nurnberg, Germany, Dr. rer. nat. (1972) University of Erlangen - Nurnberg, Germany, Professor.

Department of Mineral Resources Engineering

Antonios Vafidis, B.Sc. (1981) Aristotle University of Thessaloniki - Greece, M.Sc. (1984) University of McGill - Canada, Ph.D. (1988) University of Alberta - Canada, Professor.

Mining Technology Division

Zacharias Agioutantis, Dipl. Eng. (1982) National Technical University of Athens - Greece, M.Sc. (1984) Virginia Polytechnic Institute & State University - USA, Ph.D. (1987) Virginia Polytechnic Institute & State University - USA, Professor.

Georgios Exadaktylos, Dipl. Eng. (1985) National Technical University of Athens - Greece, M.Sc. (1988) Virginia Polytechnic Institute & State University - USA, Ph.D. (1989) National Technical University of Athens - Greece, Professor.

Michael Galetakis, B.Sc. (1983) National Technical University of Athens - Greece, Ph.D. (1996) Technical University of Crete - Greece, Assistant Professor.

Konstantinos Kavouridis, Dipl. Eng. (1974) National Technical University of Athens - Greece, Ph.D. (1977) Imperial College - UK, Associate Professor.

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Emmanuel Manoutsoglou, B.Sc. (1982) University of Patras - Greece, Dr. rer. nat. (1990) F.U. Berlin - Germany, Assistant Professor.

Nikolaos Pasadakis, B.Sc. (1985) University of LVOV - Russia, Ph.D. (1991) University of LVOV - Russia, Lecturer.

Nikolaos Varotsis, Dipl. Eng. (1976) National Technical University of Athens - Greece, M.Sc. (1977) Herriot Watt University - UK, Ph.D. (1984) Herriot Watt University - UK, Professor.

Mineral Exploitation Division

Georgios Alevizos, B.Sc. (1986) Technischen Universität Berlin - Germany, Ph.D. (1997) Technical University of Crete - Greece, Lecturer.

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

Elias Stamboliadis, B.Sc. (1971) National Technical University of Athens - Greece, M.Sc. (1973) University of London - UK, Ph.D. (1977) University of McGill - Canada, Associate Professor.

Despina Vamvuka, B.Sc. (1982) University of Traian Vuia of Timisoara - Romania, M.Sc. (1983) University of Manchester - UK, Ph.D. (1988) University of Manchester - UK, Associate 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

Atomic Models, Introduction to Quantum Chemistry, Elementary Particles, Orbitals, Atomic Properties and the Periodic Table, Molecular Orbitals and Chemical Bonding, Hybridization of Atomic Orbitals, Molecular Structure, Bimolecular Forces, Chemical Thermodynamics, Oxidation, Reduction, Acids, Bases and Salts, Complex Ions and Coordination Compounds, Safety Rules in the Laboratory, Chemistry

laboratory Apparatus, Reactions and Identification of Cations and Anions, Types of Chemical Reactions, Chemical Equilibrium, Hydrolysis, Amphoterism, Volumetric Analysis and Titration, Preparation of a Complex Salt, Laboratory exercises.

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

topics emphasis is given to practical and technological applications. The course is completed by the students practicing both in solving theoretical problems and in conducting experiments in the laboratory.

Analytical Chemistry

CHEM 102

Sampling, common apparatus and basic techniques, errors and statistics in analytical chemistry, solvent extraction, principles of chromatography, liquid chromatography, gas chromatography, thin layer chromatography, spectro-analytical methods, mass spectrometry, atomic absorption spectrometry, x-ray fluorescence, nuclear methods. Laboratory activity: working practices, titrimetric analyses, water hardness, pH-meters and ion selective electrodes, spectrophotometric analysis.

Mechanics I (Statics)

MECH 102

General principles. Force vectors. Equilibrium of a particle. Force system resultants. Equilibrium of rigid body (Moments, Couples, reduction of a System of forces). Structural analysis. Internal forces. Centre of gravity and centroid. Moments of inertia. Forces in beams and cables.

General Mineralogy (Principles and Methods)

MRED 102

Crystal morphology, crystal structure, elements of crystal chemistry and physical chemical mineralogy, elements of x-ray crystallography, laboratory exercises.

Field Trip I

MRED 702

Participation in five local one- or two-day trips for identifying and mapping geological structures, developing geological sections, etc.

English II

LANG 102

Grammar and vocabulary skills, academic reading and writing skills, conversation tutorials.

German II

LANG 104

Advanced instruction of the German language equivalent to the level of Zertifikat

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

Introductory concepts initial value problems. Separable and homogeneous differential equations. General linear 1st order differential equations Bernoulli, Riccati and exact differential equations. Integrating factors. Equations of 2nd order: linear with constant coefficients, Euler equation, reduction to 1st order. Laplace transformation methods. Systems of differential equations. Methods of solution, solvability of two-degree differential equations.

Mechanics II (Strength of Materials)

MECH 201

Concept of stress. Internal forces. Stress and Strain distribution. Factor of safety. Indeterminate problems. Thermal strain problems. Torsion. Pure bending. Asymmetric bending. Transverse loading. Combined loading. Transformation of stress and strain. Mohr circles.

Physical Chemistry

CHEM 201

The physicochemical properties of matter. Ideal gases: laws, Equation of state of ideal gases, Kinetic theory of ideal gases, Gas diffusion, applications. Real gases: PVT behaviour of real gases, Equations of state for real Gases. Virial and van der Waals equations of state. Law of corresponding states. The critical region. Mixtures of ideal or nonideal gases. Chemical Kinetics: Rate equations, Reaction rate constant and Arrhenius theory, order of reaction, experimental methods in reaction kinetics determination in batch, CSTR and PFR reactors, Chemical reaction mechanisms, Heterogeneous catalytic reactions, applications in reactor engineering and design. Thermodynamics: First Law and applications, Chemical thermodynamics. Second Law and applications, Enthalpy, entropy, free energy, chemical potential, Chemical-reaction equilibria and calculations. Phase equilibria.

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 (Seismics)

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

Structure and geodynamic Evolution of the Aegean Region. Classical and new structural models for the Evolution of the Hellenides. Autochthonous and Paraautochthonous. West-, Central- and Inner Hellenic Nappes. Vardar Zone and Zircum-Rhodope Belt. Post-alpine Formations. Present Geodynamic Situation.

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, socio-economic 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.

Introduction to the Legal Systems and to the Technical Legislation

KEP 204

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 of 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, semi-variograms, 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 Geostatistics

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, physicommechanical 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 of 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 slope 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, SO₂, NO_x 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

Mineral processing plant design by the use of MODSIM simulator. What is MODSIM and how to use it. The graphics editor. Data entry. Specifying the data in the plant feed streams. Specifying parameters for the unit models. Examples of unit models. Running the simulator and getting results. Coal washing plants. Writing subroutines for unit models. Troubleshooting.

Analytical Environmental Geochemistry

MRED 527

Field sampling (grid and other sampling), homogenization and specimen preparation. Statistical evaluation of samples, Grain size Separation methods, classification and sorting. Analysis of geochemical samples, precision and accuracy of analysis, error and error propagation, sensitivity and detection limit. Treatment and Solubilization of geochemical samples. Analytical methods: (Flame emission spectrophotometry, A.A. (Atomic Absorption

spectrophotometry). ICP--ES and ICP-MS (Inductively Coupled Plasma Emission and Mass Spectrometry), colorimetric methods, XRF (X-Ray fluorescence Spectrometry), XRD (Powder X-Ray-Diffraction), SEM (Scanning Electron Microscopy) Electron Microprobe Analysis. Examples of analytical environmental Geochemistry.

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.

