



Study Plan

School: School of Sciences and Technology

Degree: Master

Course: Geological Engineering (cód. 123)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
MAT7132	Mathematical Analysis III	Mathematics	6	Semester	162
PAO7150	Environmental Impact Assessment	Environment and Ecology Sciences	4	Semester	108
ERU7145	Soil Mechanics and Foundations II	Civil Engineering	6	Semester	156
GEO7151	Geological and Mining Exploration	Geological Engineering	6	Semester	156

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
FIS7164	Applied Geophysics	Physics	6	Semester	156
GEO7165	Geotechnics in Communication Networks	Geological Engineering	5	Semester	130
ERU7166	Building Materials I	Engineering	5	Semester	130
GEO7167	Subsurface Exploration	Geological Engineering	4	Semester	104
GEO7163	Geostatistics	Geological Engineering	5	Semester	130

Group of Free Options

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
GEO7155	Thematic Mapping	Geosciences	9	Semester	234
GEO7156	Slope Stability	Geological Engineering and Environmental Sciences and Ecology	5	Semester	130
GEO7157	Quarry Technology	Geological Engineering	6	Semester	156

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
GEO7162	Clays Technology	Geological Engineering	4	Semester	104
GEO7161	Industrial and Ornamental Rocks	Geological Engineering	5	Semester	130
GEO7159	Applied Geochemistry	Geology	5	Semester	130
ECN8388	Natural Resource Economics	Economy	6	Semester	156
GEO7160	Hygienic and Security at Work	Geological Engineering	5	Semester	130

Group of Free Options

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
GEO7168	Energetic Resources	Geological Engineering	6	Semester	156



2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
GEO7169	Mining Technology	Geological Engineering	6	Semester	156

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
GEO7152	Mine Evaluation and Planning	Geological Engineering	4	Semester	104
ERU7153	Hydrology	Engineering	6	Semester	156
GEO7154	Environmental Rehabilitation	Geological Engineering and Environmental Sciences and Ecology	6	Semester	156

Group of Free Options

Mandatory alternatives

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
	Dissertation				
	Internship				

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
Mandatory alternatives					
Component code	Name	Scientific Area Field	ECTS	Duration	Hours
	Dissertation				
	Internship				

Conditions for obtaining the Degree:

*** TRANSLATE ME: Para aprovação na componente curricular deste Mestrado, é necessário a aprovação (através de avaliação ou creditação), das seguintes unidades curriculares: { \ } newline

1.º Semestre { \ } newline

- 4 UC Obrigatórias num total de 22 ECTS { \ } newline

- Optativas num total de 8 ECTS, dos quais 4 ECTS podem ser em UC Optativas Livres { \ } newline

2.º Semestre { \ } newline

- 3 UC Obrigatórias num total de 20 ECTS { \ } newline

- UC Optativas num total de 10 ECTS dos quais 6 ECTS podem ser em UC Optativas Livres { \ } newline

3.º Semestre { \ } newline

- 2 UC Obrigatórias num total de 12 ECTS { \ } newline

- UC Optativas num total de 6 ECTS, dos quais 6 ECTS podem ser em UC Optativas Livres { \ } newline

{ \ } newline

Para obtenção do grau, também é necessária a aprovação em Dissertação, Trabalho de Projecto ou Relatório de Estágio, no total de 42 ECTS, no 3.º e 4.º Semestre. ***



Program Contents

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Mathematical Analysis III (MAT7132)

Elements of Differential Geometry in R^3 : Contours. Parameterization by arc length. Curvature and torsion. Frenet-Serret formulas. Tangent plane and normal line to a surface. Orientability. Introduction to Complex Analysis: Complex functions and analytic functions. Cauchy-Riemann equations. Laplace equation. Harmonic functions. Geometry of analytic functions. Complex integration. Fundamental Theorem of Calculus. Cauchy's theorem and its evolution. Cauchy integral formula. Ordinary Differential Equations: Exact equations and integrating factors. Equations of 1st order. 2nd order linear equations. Systems of ordinary Dif. Eq.: Linear systems and with constant coefficients. Stability of solutions. Fourier series. Periodic functions. Trigonometric series. Euler formulas for Fourier coefficients. Convergence and the sum of the Fourier series. Functions with a generic period $2L$. Expansion in series of sines and cosines. Periodic extensions. Complex Fourier series. Fourier integrals.

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Environmental Impact Assessment (PAO7150)

The concepts of environmental assessment and sustainability. The evaluation system of reference - Mankind health and well-being. The EIA concept in the frame of the environmental management concept - strategic evaluation, auditing, certification. Transdisciplinary horizontal evaluation as a demand of the sustainability concept. The evaluation concept - reference systems, scales, operation, values, reproducibility. The sociocultural paradigms and evaluation and decision making. Outrage. EIA legal framework: national and EU legislation. Other national models, Relations with the planning and permit processes. EIA phases: screening, scoping, reference situation, impact evaluation and mitigation,, post evaluation; Public participation. Main types of impacts. Reference situation characterization methodologies (without project). Impact evaluation and prediction methodologies, Universes of impact, Impact aggregation. EIA methodologies and mitigation methodologies.

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Soil Mechanics and Foundations II (ERU7145)

Introduction to the Eurocode 7. Characteristics of geotechnical design. Ultimate limit states and serviceability limit state. Safety check. Geotechnical characterization. In-situ tests. Shallow foundations. Bearing resistance; influence of geometry and loading on its value. Immediate and deferred settlements. Safety check. Deep foundations. Types of piles, construction aspects and their influence on behaviour. Design against vertical loads. Load tests and their importance on the safety check. Settlements evaluation. Earth pressures. Coefficient of thrust. Rankine theory. Coulomb method. Safety check of retaining structures to the ultimate limit states of overturning, sliding resistance, and bearing resistance of the foundation. Slope stability. Types of sliding. Stability analysis: infinite slopes and slopes of homogeneous material. Methods of slices of Fellenius and Bishop. Stabilization methods.



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Geological and Mining Exploration (GEO7151)

1. Mineral and mining economy.
2. Legislation of exploration and mining.
3. Resources and reserve concepts.
4. General notes on survey campaign preparation.
5. Introduction to prospecting methods.
6. Geological survey.
7. Geophysical survey
8. Geochemical survey.
9. Drilling and evaluation
10. Case studies of mineral resources prospecting/exploration in Portugal.

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Applied Geophysics (FIS7164)

I – Introduction - Forward and inverse problems in Geophysics. Physical properties. The signal in A. G.

II – Electrical methods – Electrical properties of rocks. Archie's Law. Concept of geoelectrical section. Wenner, Schlumberger, and dipole-dipole configurations. Electrical resistivity profiles and electrical soundings and their interpretation.

III – Gravimetric methods - Universal attraction. Geological and non-geological causes of gravity acceleration changes. Gravity meters. Gravity maps and profiles and their interpretation. Gravity response of some simple shapes.

IV- Seismic methods –Elements of Elasticity theory. Elastic constants and their physical meaning. Waves, wave reflection and wave refraction; Snell's Law. P and S waves. Reflection and refraction methods. Seismometers and geophones. Seismic refraction method; time-distance graphs and their interpretation.

V – Well logging – Electrical logs and nuclear logs.

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Geotechnics in Communication Networks (GEO7165)

Framework of the role of geotechnics in such ventures, given the various stages between the early studies and their exploitation. Introduction to the figure of the Specifications as a document regulating the development of design and construction of the project.

Geotechnical requirements for determining and implementing the various phases of development of such projects:

- Phase of initial recognition;
- Phase of the project;
- Construction phase;
- Exploration Phase

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Building Materials I (ERU7166)

Aggregates. Cement. Lime. Concrete. Ceramics. Natural stones. Ferrous and nonferrous materials. Plastics. Timber. Bitumen materials. Paints.



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Subsurface Exploration (GEO7167)

- 1- Introduction
- 2- Drilling planning
- 3- Drilling with trade
- 4- Percussion drilling
- 5- Drilling geometry
- 6- Rotation drilling with probe recovery
- 7- Samplers
- 8- Casing
- 9- Underwater drilling
- 10- Rotary drilling
- 11- Oil drilling
- 12- Drilling muds
- 13- Roto-percussion drilling
- 14- Mine drilling
- 15- Geotechnical recognition using drilling
- 16- Drilling for water abstraction
- 17- Filters
- 18- Equipment manufacturers

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Geostatistics (GEO7163)

Introduction to different types of Geosciences data and to its collection and preparation. Introduction to Geostatistics. R language as a tool for application in Geostatistics. Exploratory data analysis. Spatial data prediction. Theory of regionalized variables. Analysis of the spatial data structure: experimental variogram and modeling of the variogram. Geostatistical estimation or prediction: kriging. Basics of multivariate data analysis. Main types of kriging: general characterization and exercises in R. Geostatistical Simulation: general characterization and exercises in R.

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Thematic Mapping (GEO7155)

Introduction: Cartography as science applied to geosciences. Structural Mapping: Identifying, mapping and characterizing large-scale geological structures. Structural contours maps and 3D dimensional models of structures. Mapping using GPS and GIS. Mapping of mineral resources: Fundamentals of mineral cartography; mining maps (metallogenic provinces and mineral occurrences); classification of occurrences and their representation in a mining district; detailed mineral mapping; infrastructure maps; mining works surveys (trenches, galleries); Geotechnical Mapping: The Geotechnical Mapping in Urban and Regional Planning. Typology of geotechnical maps and Geotechnical Units. Remote Sensing, field survey and use of GIS applied to Geotechnical Mapping. Geotechnical Units and Zoning Maps. Classification of terrains. Application examples: Natural Resources; Suitability for Construction; Hazards; Environmental Protection; Exploitation of Construction Materials; Regional and Urban Planning.



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Slope Stability (GEO7156)

Geotechnical Engineering:

Introduction: Fundamentals about the methodology of study and data processing concerning to slope stability problems; Methods of analysis on stability of slopes.

Selection of the stabilization design on soil slopes and rock slopes.

Stabilization of soil slopes: Modification of slope geometry; Drainage and surface protection; Mass reinforcement.

Stabilization of rock slopes: Fragmentation and removal of blocks; Slope geometry modification; Mass reinforcement; Measures to reduce the risk of rockfall.

Instrumentation and monitoring of slopes: Parameters to be measured; Type of instrumentation.

Soil Bioengineering:

Introduction to Soil Bioengineering.

Construction methods; Preparatory work: Sowings; Plantations; Techniques with herbaceous.

Techniques with woody plants; Techniques with vegetal associations; Combined methods of construction; Maintenance work.

Constructive design.

Shipyards management.

Maintenance.

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Quarry Technology (GEO7157)

Theoretical

I - Legal framework of the national mining sector.

II - Economic background of the natural stone sector.

III - Development stages of a dimension stone quarry.

IV - Cycle characterization quarry works in extractive units carbonated ornamental stone, slates, granite and similar rocks.

V ? Open pit aggregate exploitation. Technical parameters for design of a mining unit.

VI - Cycle quarry works characterization in extractive units for the production of aggregates.

VII - Introduction for executing a quarry plan. Mining plan, PARP and Health and Safety Plan.

Practice

Exercises about management, planning and various technical aspects.

Technical visits to extractive units producing dimension stone and aggregates production.

Internship in quarry (where available).

MaxamPor training (15 hours) on industrial explosives and practice in quarry.



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Clays Technology (GEO7162)

Theoretical:

- I – Brief notions about the clays extractive industry in Portugal
- II – Clays minerals classification;
- III – Origins of clays minerals and clays deposits;
- IV – Principal properties with a view to industrial applications of clays;
- V – Clays processing and improvement processes;
- VI – Industrial applications;
- VII – Analysis techniques and methods used in the study of clays and clays minerals;

Practice:

Laboratory work:

- Granulometric analysis; Application of Stokes Law and the centrifugation method;
- Cationic change capacity;
- Moisture content; lost on ignition;
- pH;
- Consistency limits;
- Specific surface;
- Density;
- Retraction tests;
- Expansibility;
- Oil absorption;
- Blue methylene;
- Workability and extrusion aptitude;
- Mechanical resistance to flexion;
- Rheological tests;
- Colour;
- Aspect of samples after thermic treatment;
- Dilation test.

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Industrial and Ornamental Rocks (GEO7161)

Theoretical

1. Introduction

- National and global framework of ornamental stones, aggregates and ores; varieties, trade and industry. Definitions, occurrences and applications.

Dimension Stones

- #### 2- Transformation of marble, limestone, granite and schist as ornamental rocks (processes and equipment):

Aggregates and Ores

- #### 3- Characterization of concentration (ponderal yield, recovery, degree of release and content of concentrate).
- #### 4- Production of aggregates and ores (processes and equipment).

Practice

- 1 - Design of ornamental stones transformation plants
- 2- Design of crushing lines.
- 3 - Aggregates characterization tests (European Standard):
- 4 – Technical visits to ornamental stones factories, crushing lines and ores concentration units.



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Applied Geochemistry (GEO7159)

1. Introductory study of metals in contaminated environments.
2. Structure and chemical composition of Earth.
3. Geochemistry in the interaction of geospheres.
4. Geochemistry and the solubility of elements.
5. Geochemistry of weathering.
6. Oxide-reduction process: sedimentation and pH and Eh, Interpretation of Eh-pH diagrams
7. Sorption and ionic exchange on the surface of minerals.
8. Geochemistry of aquatic sediments: river and lake sediments: mineralogical composition, geochemistry of major and metallic elements.
9. Environmental Geochemistry of potentially toxic metals: metals sources (anthropogenic and natural), mobility and fate of metals in natural environments, cases studies of ?natural? pollution?.
10. Pollution forms of natural environments: acidification, oxidation, nutrients in excess, pathogenic organisms and toxins.
11. Methods of remediation of contaminated environments.
12. Analytical methods for the geochemical study of contaminated environments.

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Natural Resource Economics (ECN8388)

1. Economic Exploitation of Natural Resources
2. Management of Renewable Natural Resources
3. Economic Management of Fisheries
4. Economic Management of Forests
5. Economic Management of Water Resources
6. Economic Management of Exhaustible Resources
7. Economics and Environment

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Hygienic and Security at Work (GEO7160)

- 1 ?Works accidents legislation.
- 2 - Risk analysis
- 3 - Administrative and organizational aspects related to health and safety.
- 4 - Security at work Technical Audits at safety
- 5 - Industrial Health
 - 5.1 - Chemical Hazards (solids, liquids, gaseous and vapors)
 - 5.2- Physical risks (noise, thermal / ventilation, vibrations)
- 6 ? Ventilation
- 7 - Industrial Safety
 - 7.1- Electrical hazards
 - 7.2- Fire
 - 7.3 - Ergonomy / loads and handling.



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Energetic Resources (GEO7168)

(Energy resources and society.

Energy resources and economy.

Coal: Genesis, typologies and exploitation.

Hydrocarbons (oil and gas): Genesis, migration and accumulation.

Unconventional hydrocarbons.

Methane hydrates.

Nuclear resources: Genesis and exploitation.

Geothermal resources: Genesis and exploitation.

The future of energy.

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Mining Technology (GEO7169)

Theoretical

1 - Introduction

1.1 - General information

1.2 - Valuing phases of a mineral deposit

2 – Mining works cycle

2.1 - Introduction

2.2- Drilling

2.3 – Charging and Blasting

2.4 - Ventilation

2.5 - Scaling

2.6- Supported methods

2.7- Loading and transport

2.8- Water management and sediment control system

2.9- Electricity supply and compressed air system

3 – Underground mining methods

1-Open stopes; 2- Timbered stopes; 3- Filled stopes; 4- Shrinkage stopes; 5- Caving methods; 6-

Combined methods

IV - Safety and Health in the mining industry. Accidents prevention and control.

V - Environmental risks from the mining industry

Practice

I - Mineral reserve calculation methods

II – Blasting project in galleries and tunnels

III – Pumping calculation

IV - Calculation of loading and transport cycles

V - Technical visits in principals underground portuguese mines. Internship if applicable.

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Mine Evaluation and Planning (GEO7152)

Introduction to mine industry, exploitation and processing methods.

Inventorying and evaluation of geological resources, products and markets.

Sustainable exploitation planning, management and valuation of geological resources.

Marketing.

Geological and mining data collection, processing and analysis procedures.

Representativity and integration of information.

Preparing technical reports.

Case studies.



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Hydrology (ERU7153)

- 1 - The water cycle;
- 2 - The Watershed: characterization;
- 3 - Precipitation: depth and intensity, precipitation measures, statistical analysis of precipitations time series, short term rainfall;
- 4 - Evaporation and Evapotranspiration: measures and estimation;
- 5 - Infiltration: quantification;
- 6 - Surface Runoff: Measures, evaluation, hydrograph study, hydrograph decomposition;
- 7 - Hydrologic Balance: sequential;
- 8 - Floods: estimation methods of the peak runoff and estimation methods of the flood hydrograph; Discharge for the dimension oh hydraulics works; Evaluation of superficial water resources.

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Environmental Rehabilitation (GEO7154)

Introduction to the concepts of environmental rehabilitation and ecological restoration. The objectives, criteria, benchmarks of recovery.

Impacts due to mining, quarries and gravel pits. Correction of impacts related to noise and vibration.

Management of toxic and radioactive waste. Treatment of degraded areas.

Correction of impacts on water systems. Surface Water.

Rehabilitation of Aquifers.

Contamination of soils, sediments and water by heavy metals from mines. Decontamination of land.

Tailings dams.

Correction of impacts on air quality, soil, landscape and ecological systems.

Introduction to Environmental Geotechnics. Sustainable development.

Correction of impacts in Linear Works (road and rail).

Characterization and classification of waste management and waste disposal.

Management and recovery of waste in geotechnical works. Legislative framework for the recovery of waste.

Geological Storage of CO₂.

Methods of environmental recovery of coastal and estuarine areas.