



# UNIVERSITÀ DEGLI STUDI DI PALERMO

|                         |                                                       |                        |                  |
|-------------------------|-------------------------------------------------------|------------------------|------------------|
| DEPARTMENT              | Scienze della Terra e del Mare                        |                        |                  |
| ACADEMIC YEAR           | 2023/2024                                             |                        |                  |
| MASTER'S DEGREE (MSC)   | GEORISKS AND GEORESOURCES                             |                        |                  |
| INTEGRATED COURSE       | TECHNICAL GEOLOGY AND GEOTECHNICS - INTEGRATED COURSE |                        |                  |
| CODE                    | 18134                                                 |                        |                  |
| MODULES                 | Yes                                                   |                        |                  |
| NUMBER OF MODULES       | 2                                                     |                        |                  |
| SCIENTIFIC SECTOR(S)    | GEO/05, ICAR/07                                       |                        |                  |
| HEAD PROFESSOR(S)       | CAPPADONIA CHIARA                                     | Professore Associato   | Univ. di PALERMO |
| OTHER PROFESSOR(S)      | CAFISO FABIO                                          | Professore a contratto | Univ. di PALERMO |
|                         | CAPPADONIA CHIARA                                     | Professore Associato   | Univ. di PALERMO |
| CREDITS                 | 9                                                     |                        |                  |
| PROPAEDEUTICAL SUBJECTS |                                                       |                        |                  |
| MUTUALIZATION           |                                                       |                        |                  |
| YEAR                    | 1                                                     |                        |                  |
| TERM (SEMESTER)         | 1° semester                                           |                        |                  |
| ATTENDANCE              | Not mandatory                                         |                        |                  |
| EVALUATION              | Out of 30                                             |                        |                  |
| TEACHER OFFICE HOURS    | CAPPADONIA CHIARA<br>Wednesday 15:00 17:00            |                        |                  |

**DOCENTE:** Prof.ssa CHIARA CAPPADONIA

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PREREQUISITES      | The student must know mathematics and physics, developed in the three-year degree, and general skills related to geological subjects with particular regard to applied geology, geotechnics and geomorphology also acquired in the three-year degree cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| LEARNING OUTCOMES  | <p>Knowledge and understanding:</p> <p>Knowledge of the general regulatory framework relating to the role of the geologist in the areas of competence as per art. 40 and 41 of the Presidential Decree 328/2001 (environment, geo-resources, groundwater and surface water, soil defence and civil protection, technical and geotechnical geology; types of geological survey; modelling geological for hazard and risk assessments. Knowledge of software to support the analysis of geological data Ability to apply knowledge and understanding Ability to organize investigation plans; Ability to elaborate geological data to realise maps issues for urban and territorial planning and the definition of models geological.</p> <p>Ability to apply the skills of the geologist in the field of soil defence: planning of accommodation interventions. Ability to assess the vulnerability of aquifers. Technical characterization of loose rocks aimed at defining the conditions of stability of the slopes. Knowledge of software to support the analysis of geological data</p> <p>Autonomy of judgment</p> <p>Evaluation of the geologist's problems; planning of phases of study and proposal of design solutions and recommendations based on available data.</p> <p>Communication skills</p> <p>Verbal and written presentation of the results of the investigations. Graphic presentation e data synthesis</p> <p>Learning skills</p> <p>Research, information and updating skills. Ability to research and synthesize the available scientific and technical literature.</p> |
| ASSESSMENT METHODS | The evaluation method consists of an oral test. The level of acquisition and conscious competence relating to the contents covered in the two modules will be evaluated (out of thirty). Exercises to be solved will also be proposed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TEACHING METHODS   | Lectures and practical laboratory activities (2nd CFU). Compatible with the resources available to the degree program, we will carry out laboratory activities (in part or whole) in the field.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## MODULE ROCKS MECHANICS

*Prof. FABIO CAFISO*

### SUGGESTED BIBLIOGRAPHY

- Hoek E., Bray (1977) - Rock Slope Engineering.
  - Bruno G. (2012) - Caratterizzazione geomeccanica per la progettazione ingegneristica
  - Lunardi P. (2010) – Progetto e costruzione di gallerie
  - Viggiani C. (1999) – Fondazioni
- Durante il corso il docente fornirà agli studenti materiale didattico in formato PDF.

|                               |                                               |
|-------------------------------|-----------------------------------------------|
| <b>AMBIT</b>                  | 21015-Attività formative affini o integrative |
| <b>INDIVIDUAL STUDY (Hrs)</b> | 43                                            |
| <b>COURSE ACTIVITY (Hrs)</b>  | 32                                            |

### EDUCATIONAL OBJECTIVES OF THE MODULE

The first part of the course provides the principles of soil mechanics under full saturation, highlighting the interaction between the mineral and the pore phase present in the soil and the distribution of strain between them, according to the effective stress principle of Terzaghi, whether the load is only geostatic, that in the presence of one-dimensional or two-dimensional steady fluid flow induced by external loads or changes in the configuration of the sites. The problems related to deformability and soil rupture are then addressed, highlighting the parameters of the soil involved and laboratory tests aimed at determining them experimentally.

In the second part of the course the substantial differences between soil and rock mechanics will be addressed, developing in detail the geotechnical aspects related to fissured rock masses, with particular reference to: characteristics of the surfaces of discontinuities; "in-situ" geological data collection; statistical processing methodologies of "in-situ" measured data; graphical presentation of geological data. After, the mechanical properties of the fissured rock will be studied, with particular reference to shear resistance along the joints, highlighting the major failure criteria. Then, we will study the stability problems in jointed rock masses, using the "hard-discontinuous" model, to recognize failure mechanisms. We will proceed with the statistical study of the trajectories of blocks falling from rock masses and with the mapping of areas subjected to rock falling risk; at last, we will develop the risk mitigation works, that are divided into the three types: "active", "passive" and "mixed".

The last part of the course is dedicated to: the study of foundations of engineering structures, depending on the geological and geotechnical soil model, distinguishing between "shallow foundations" and "deep foundations" (pile foundations and caisson foundations); the definition of the geological and geotechnical soil model, that has a great influence on the execution tunnel methods.

## SYLLABUS

| Hrs | Frontal teaching                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5   | Definitions and fields of application of geotechnics; mechanics of loose rocks and stones; cracked rock masses; structural characteristics of discontinuity surfaces; survey methodology and statistical processing techniques of data collected with geostructural surveys. Representation of discontinuity surfaces through stereographic projections and applications. Mechanical properties of stone rocks: compressive, tensile and shear strength along discontinuous surfaces. Breaking criteria of Patton, Barton, Ladanyi and Archambault, Hoek and Bray. |
| 5   | Geomechanical classifications. Analysis of the stability conditions of cracked rock masses: "rigid-discontinuous" model. Kinematically possible displacements and breaking mechanisms. Evaluation of the "dangerousness" of a rock mass: identification, location, geometric and geostructural relief of the stone elements in unstable equilibrium and stability analysis                                                                                                                                                                                         |
| 3   | Types of interventions to mitigate the risk of falling rocks: "passive", "active". Rockfall barriers with high energy absorption, rockfall detectors, valleys and rockfall tunnels. Network and cable panels. "Injected bulb" type tie rods. Harnesses with ropes anchored to tie rods and direct tackle.                                                                                                                                                                                                                                                          |
| 3   | Mitigation of rockfall hazard. Barriers and tie rods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Hrs | Workshops                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 16  | Geostructural survey and statistical processing of orientation, spacing, persistence, openness, termination, roughness. Study of the trajectories of boulders falling from rocky fronts: general; two-dimensional and three-dimensional "lumped mass" forecasting criteria; statistical analysis of the results obtained, assessment of the "vulnerability" of urbanized areas and mapping of areas at risk of falling rocks.                                                                                                                                      |

## MODULE TECHNICAL GEOLOGY

*Prof.ssa CHIARA CAPPADONIA*

### SUGGESTED BIBLIOGRAPHY

Materiale di approfondimento distribuito dal docente durante il corso.

L. Scesi, M. Papini, P. Gattinoni, L. Longoni GEOLOGIA TECNICA - Idrogeologia applicata - Dinamica dei versanti - Strade, opere in sotterraneo, dighe Casa Editrice Ambrosiana

F. Cestari –INDAGINI GEOGNOSTICHE IN SITO. Ed. Dario Flaccovio

A. Lagonegro e C. Romano - GEOLOGO: MANUALE PER LA PROFESSIONE– Ed. DEI

|                               |                                                           |
|-------------------------------|-----------------------------------------------------------|
| <b>AMBIT</b>                  | 50570-Discipline geomorfologiche e geologiche applicative |
| <b>INDIVIDUAL STUDY (Hrs)</b> | 86                                                        |
| <b>COURSE ACTIVITY (Hrs)</b>  | 64                                                        |

### EDUCATIONAL OBJECTIVES OF THE MODULE

Knowledge of local and general regulations concerning the areas of expertise (environment, geo-resources, groundwater and surface water, soil protection and civil protection, technical and geotechnical geology; types of geological investigation; hazard and risk). Software for geological data analysis. Organization of investigation plans; Geological data processing and drawing of thematic maps for urban and territorial planning and the definition of geological models. Ability to apply the geologist's skills in soil protection: planning of interventions. Ability to assess the vulnerability of the aquifers. Technical characterization of the rocks. Communication skills Research and synthesis skills of available scientific and technical literature.

## SYLLABUS

| Hrs | Frontal teaching                                                                                                                                                                                                                                                     |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Introduction: the Geologist, professional activity and responsibilities.                                                                                                                                                                                             |
| 4   | Current Italian technical codes and regulations.                                                                                                                                                                                                                     |
| 3   | Basin Master Plan for geo-hydrological risk mitigation (PAI). Study and implementation of Direttiva Crolli Regione Siciliana e Valutazione di compatibilità geomorfologica.                                                                                          |
| 4   | Environmental regulations: strategic environmental assessment, environmental impact assessment, integrated environmental authorization, soil protection, water protection. Rules on waste management and remediation of polluted sites reclamation of polluted sites |
| 2   | The geological data collection to palm the mining activity: problems and methods. Piano Cave della Regione Siciliana                                                                                                                                                 |
| 4   | Planning of the field investigations for the geological-technical report. Data analysis and interpretation.                                                                                                                                                          |
| 2   | Regulations and paths for geotechnical characterisation through laboratory tests                                                                                                                                                                                     |
| 2   | Risk and hazard on the territory. Municipal civil protection plans.                                                                                                                                                                                                  |
| 3   | Geological studies for the preparation of urban planning tools                                                                                                                                                                                                       |
| 2   | Soil and rocks from excavation                                                                                                                                                                                                                                       |
| 1   | Engineering geology report preparation criteria and methods                                                                                                                                                                                                          |
| 4   | Applied hydrogeology for sustainable water resources management: aquifers modelling. Boreholes and springs.                                                                                                                                                          |
| Hrs | Workshops                                                                                                                                                                                                                                                            |
| 25  | Engineering Geology Report drafting in accordance with the official provisions.                                                                                                                                                                                      |
| 7   | Main software to support the geological investigations and to evaluate the slope stability as the Factor of Safety                                                                                                                                                   |