UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Scienze della Terra e del Mare
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	GEORISK AND GEORESOURCES
SUBJECT	APPLIED PETROGRAPHY
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50569-Discipline mineralogiche, petrografiche e geochimiche
CODE	05671
SCIENTIFIC SECTOR(S)	GEO/09
HEAD PROFESSOR(S)	RANDAZZO LUCIANA Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**RANDAZZO LUCIANA** Monday 15:00 17:00 Studio docente in Via Archirafi 26 (4° piano)

DOCENTE: Prof.ssa LUCIANA RANDAZZO

PREREQUISITES	Basic knowledge of chemistry and physics, good knowledge in mineralogy and petrography
LEARNING OUTCOMES	KNOWLEDGE AND UNDERSTANDING Basic knowledge of natural stone materials of the main Italian mining districts, as well as on artificial and/or transformed stone materials. Main investigation techniques (mineralogical, petrographic and chemical analysis for compositional and structural characterization) and their application in specific case studies. Data processing and representation. Acquisition of an appropriate technical-scientific language. Ability to connect natural resources to each specific territorial context for the preparation of localized sustainable development plans. APPLYING KNOWLEDGE AND UNDERSTANDING Ability to macroscopic recognize stone materials. Acquisition of skills on micro-invasive sampling techniques and subsequent preparing of specific technical data sheets. Preparation of specific diagnostic plans for the characterization of materials. MAKING JUDGEMENTS Critical interpretation and discussion of analytical data (mineralogical, petrographic, chemical-physical or physical-mechanical), their relevance and significance. Ability to judge different methodological hypotheses according to the problems derived from the specific case study. COMMUNICATION SKILLS Acquisition of adequate technical-scientific language in the presentation of the results. Ability to underline the extent of the effects deriving from the characterization study, both in the design phase and in the executive phase. LEARNING SKILLS Skills for professional updating through the consultation of scientific publications of national and international relevance and participation in specialized seminars. Ability to develop links with other disciplines and to independently acquire further knowledge on the basis of an interdisciplinary preparation.
ASSESSMENT METHODS	Oral examination. The interview is based on a minimum number of 3-5 open questions in order to evaluate the skills acquired by the student. The use of an adequate technical language, critical and synthetic skills and the creation of adequate conceptual connections contribute to the definition of the overall evaluation. In particular, the oral interview will focus on assessing the skills to achieve the following minimum objectives: 1. Basic knowledge on the different categories of natural and artificial building materials derived from georesources; 2. Basic knowledge of the main laboratory techniques; 3. Detailed knowledge of the main processes of alteration and degradation; 4. Knowledge on the main uses of natural resources; 5. Specific knowledge of territorial contexts for the preparation of sustainable development plans; 6. Knowledge of the principles of environmental sustainability and circular economy. The student who will demonstrate the achievement of: - 3/6 objectives in the oral interview will have a grade between 18 and 22; - 4/6 objectives in the oral interview will have a grade between 23 and 26; - 5/6 objectives in the oral interview will have a grade between 27 and 29; - 6/6 objectives in the oral interview will have a grade between 30 and 30 cum laude.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide knowledge concerning the petrophysical and technological properties of rocks used as building materials (natural and artificial), the chemical-physical conditions for the production of materials derived from georesources through pyrotechnological processes, such as glass, binders, ceramics and bricks. Knowledge on the most widespread analytical methods for the characterization of solid crystalline and amorphous materials: optical microscopy (OM), X-ray powder diffraction (XRPD), Fourier transform infrared spectroscopy (FT-IR); chemical analysis of solid materials by means of X-ray fluorescence (XRF) and Inductively coupled plasma mass spectrometry (ICP-MS); microtextural analysis and image analysis of solid materials using scanning electron microscopy (SEM-EDS) and electron probe micro-analysis (EPMA), determination of the main petrophysical characteristics by mercury intrusion porosimetry (MIP), water absorption by immersion and capillarity, mechanical and flexural strength. The technological, industrial, environmental and economic impact of rocks and artificial materials will also be assessed: LCA - Life Cycle Assessment (evaluation of the life cycle of materials), recycled materials (sterile and / or waste) and their reuse in various industrial sectors (ceramic, chemical and tanning) with a view to environmental sustainability and circular economy. Main applications / Case studies: 1) Building materials and ornamental stones 2) Aggregates and cements 3) Glass and silicate melts: classification and raw materials for glass production 4) Bricks and ceramics: clayey and fluxing raw materials 5) Nanostructured materials: consolidants and protectives for the conservation of Cultural Heritage.

	6) Forensic applications
TEACHING METHODS	Oral lessons and lab activities
SUGGESTED BIBLIOGRAPHY	1) Dispense fornite dal docente. 2) G. Artioli (Ed.). Scientific Methods and Cultural Heritage. Oxford University Press, 2010. 3) C. Klein, A. Philipotts. Earth Materials, 2nd Edition. Cambridge University Press, 2017. 4) A.M.W. Hunt (Ed.). The Oxford Handbook of archaeological ceramic analyses. Oxford University Press, 2017. 5) R. Alaimo, R. Giarrusso e G. Montana. I materiali lapidei dell'edilizia storica di Palermo. Editrice IlionBooks, 2008, Enna. 6) Jeremy P. Ingham - Geomaterials Under the Microscope, 2013 Manson Publishing Ltd 7) Donald H. Campbell - Microscopical Examination and Interpretation of Portland Cement and Clinker, Second Edition, 1999 Portland Cement Association.

SYLLABUS

Hrs	Frontal teaching
4	Geomaterials: definitions and classification. Mining activities of stone materials and aggregate materials: technologies used for the extraction and processing of building stones and related legislation. Petrographic and geochemical methodologies to support the extraction plans of aggregates materials. Main mining districts in Sicily and Italy. Review of the main ornamental rocks used from classical antiquity to the present day and from quarries located in the Mediterranean area.
6	Theoretical bases and specific procedures of the analytical protocol aimed at the characterization of natural and transformed stone materials and their degradation products: X-Ray Powder Diffraction (XRPD), Polarized Light Microscopy (PLM), X-Ray Fluorescence (XRF), Scanning Electron Microscopy equipped with Energy Dispersion Spectrometry (SEM-EDS), Fourier Transform Infrared Spectroscopy (FT-IR); Mercury Intrusion Porosimetry (MIP), colorimetric analysis (CIELab).
4	Main typologies and mechanisms of alteration and degradation of natural and artificial stone materials in urban environment. Composition and kinetics of formation of "black crusts". Degradation by cyclic crystallization of soluble salts. Stone materials from underwater environments and forms of deterioration (biofouling and bioerosion). Experimentation of innovative conservation procedures.
2	Granites and their alteration products. Ultramafic rocks and their alteration products. Main physical, chemical, biological and anthropic degradation phenomena.
2	Asbestos minerals: industrial applications, remediation regulations and analytical methods for verifying the impact on human health (Phase-contrast microscopy (PCM), SEM-EDS, XRD, FT-IR).
4	Mineralogical, petrographic, chemical and technological characterization (plasticity, linear shrinkage and color after drying and firing) of clayey raw materials for the production of bricks and ceramics. Provenance studies and archaeological implications.
2	Clayey raw materials for bio-architecture (Green Building). Examples of use in the industrial field (chemical and tanning industry).
4	Minero-petrographic and chemical analysis of ancient aerial mortars (lime or gypsum-based) and stuccos. Determination of the origin of raw materials (binder and sandy aggregate) and evaluation of the degradation mechanisms. Criteria for the formulation of restoration mortars.
4	Natural hydraulic lime (NHL) and cements: general information on production processes. Classification of cements according to legislation (general notes). Minero-petrographic characterization methods (Alkali content; Loss on Ignition L.O.I.; mineralogical analysis (XRPD); Chemical analysis (XRF); Bulk density by helium pycnometer; Fineness test (Blaine test); Cement modules). Aggregates for concrete and their characterization according to UNI regulations (Classification, characteristics, content of harmful substances, freezing). Principles of Mix Design (Optimal combination of aggregates, selection of additives). The "ASR" reaction (Alkali-Silica Reaction), macroscopic and microscopic effects. Main forms of alteration of cement and concrete: petrographic quality control.
2	HT (High-Technology) industrial ceramics: applications in the energy (generation, storage and conservation of energy) and environmental (filtration and purification of industrial waste) sectors.
2	High purity quartz used in the Microelectronics and Electronics, Solar Energy, Optics industries. Glass and silicate melts: classification and raw materials for glass production.
4	Environmental sustainability and sustainable development: the Life Cycle Assessment (LCA) as a monitoring tool for the efficient and rational management of raw materials. The pillars of sustainability: Environment (natural capital, resources), Society (human and social capital), Economy (financial and manufacturing capital). Sustainable Development Goals 2030. Concepts of Efficiency, Pollution / Disposal and Depletion of resources. Recycled materials (sterile and / or waste) and their reuse in various industrial sectors (ceramic and chemical) with a view to environmental sustainability and circular economy: application examples.

Hrs	Workshops
8	Preparation of samples to be analyzed for the evaluation of the main petrophysical characteristics, water absorption by capillarity and immersion, salt crystallization tests. Experimentation of procedures for the conservation and evaluation of their effectiveness through FT-IR, Colorimetry, Contact angle, IR Thermography, Ultrasound tests.

Hrs	Workshops
8	Thin section observations by optical microscopy and description schemes of ceramic materials, mortars (with different types of binder) and cements. Aggregates for concrete manufacturing: quality control.