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 GEOPHYSICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50567-Discipline geofisiche
CODE	03598
SCIENTIFIC SECTOR(S)	GEO/11
HEAD PROFESSOR(S)	MARTORANA RAFFAELE Professore Associato 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	**MARTORANA RAFFAELE** Wednesday 14:30 16:30 Via Archirafi 20, 3° piano

DOCENTE: Prof. RAFFAELE MARTORANA

PREREQUISITES	Knowledge and control of the main topics of Mathematics, Physics, Geology and Geophysics.
LEARNING OUTCOMES	KNOWLEDGE AND UNDERSTANDING: - Basic theoretical, experimental and practical knowledge in geophysical disciplines; - Sufficient familiarity with the scientific method of investigation; - Ability to use mathematical and experimental tools for the analysis of geological processes from a physical point of view; ABILITY TO APPLY KNOWLEDGE AND UNDERSTANDING: - Ability to use mathematical and experimental tools for the analysis of geological processes from a physical point of view; MAKING JUDGMENTS: Students will acquire skills to apply geophysical methods in different issues of Applied Geophysics; COMMUNICATION SKILLS: Students will gain the ability in teamwork and ito adapt in different work environments. LEARNING SKILLS: The acquired knowledge and learning skills will allow to deal higher level courses (Master’s Degree, Postgraduate). The training acquired will also allow to increase knowledge with self-updates. The expected learning outcomes are developed throughout the training course through lectures and practice.
ASSESSMENT METHODS	The student's assessment includes an oral test in which questions on course topics are presented, with particular attention to the integrated vision of physical phenomena exploited by geophysical methods and inversion techniques. The design capacity of a geophysical study will be evaluated, consisting in the choice of the method, the techniques of data acquisition and processing aimed at any specific geologic issue. The student will have to demonstrate the knowledge of basic survey methods and geophysical measurement techniques applied to the environment (geology, hydrogeology, geomorphology), cultural heritage and engineering. Particular attention will be given to seismic, electrical and georadar methodologies. In addition, basic knowledge of magnetometry and gravimetry will be required. The exam score is assigned by a vote expressed in thirtieths. The active participation of students in the lessons, exercises and work done individually in the form of exercises and relationships assigned during the course can weigh up to 15/30 on the final evaluation. To pass the exam, and then get a score of not less than 18/30, the student must demonstrate a basic achievement of the goals. The objectives achieved are considered elementary when examining / demonstrates that they have acquired a basic knowledge of the topics described in the program, is able to operate with minimal links between them, shows that they have acquired a limited degree of autonomy; His language is enough to communicate with the examiners. To achieve a score of 30/30 and praise, the student must demonstrate that he has achieved the objectives well. The goals achieved are considered excellent when the student demonstrates full knowledge of the subjects of the program, how to apply the acquired knowledge also in different / new / advanced contexts as opposed to those of the teaching itself, talks with lexical competence also within the specific reference language and is capable of elaborating and expressing independent judgments based on acquired knowledge.
EDUCATIONAL OBJECTIVES	Objective of the course is to provide solid base knowledge of physics and mathematics applied to geophysical problems, both theoretical and experimental. The student should have acquired the following skills: 1) make connections between different geophysical methods, 2) recognize or establish relationships between different physical parameters of the subsoil, 3) classify geophysical methods based on the physical fields exploited, the physical parameters of rocks under investigation, the use of active or passive sources. 4) make assumptions based on data obtained from geophysical surveys, 5) draw conclusions based on the results and on verified assumptions, 6) identify best suited the geophysical methods to solve specific geological problems, applying the acquired knowledge to real situations.
TEACHING METHODS	Lectures, Acquisition of geophysical field measurements, compatibly with the resources of the degree course. Data processing workshop, aimed to correct inversion and interpretation of geophysical data.
SUGGESTED BIBLIOGRAPHY	Mussett A.E., Khan M.A. (2003): Esplorazione del sottosuolo. Una introduzione alla geofisica applicata. Zanichelli, 421 pp. Santarato et al. (2015): Lezioni di Geofisica Applicata.Edizioni libreriauniversitaria.it Dal Moro G. 2012. Onde di superficie in geofisica applicata. Acquisizione e analisi di dati secondo tecniche MASW e HVSR. Flaccovio Ed.

	Leucci G. (2015): Geofisica applicata all'archeologia e ai beni culturali. Flaccovio Ed. Loke M. H. (2001): Tutorial : 2-D and 3-D electrical imaging surveys. Dr. M.H.Loke. 129 pp. Daniels D. J. (1986): Surface-penetrating Radar. The Institution of Electrical Engineers, London, 300 pp. Software open source utilizzato in laboratorio con manuali.

SYLLABUS

Hrs	Frontal teaching
4	FORWARD AND INVERSE PROBLEMS IN GEOPHYSICS Geophysical modeling and dimension. Notes on the finite difference and finite element methods. Inverse problem: steps that regulate an inversion algorithm. Discretization of the investigated volume. Methods of 2D and 3D inversion with the Gauss-Newton least squares algorithm. Jacobian.
2	SEISMIC METHODS: INTRODUCTION Propagation of the elastic waves. Velocity of different wave phases. Relationship between wave velocities and elastic parameters of rocks. Seismograms and seismic sections. Paths of the seismic phases for layered models: direct waves, reflected waves and critically refracted waves.
3	PALMER METHOD (GRM) Data acquisition, picking, travel-time graphs. delay times. time-velocity and time-depth functions. Optimal shift.
5	SEISMIC REFRACTION TOMOGRAPHY forward problem, beginning model, slowness, gridding, raytracing and inversion. Application cases.
2	IN-HOLE SEISMIC In-hole geophones. Down-hole seismic. Acquisition and data processing. Evaluation of vertical profiles of Vp, Vs and Poisson ratio. Cross-hole and Up-hole seismic. In-hole seismic tomography.
4	SURFACE WAVES METHODS Surface waves, Rayleigh and Love waves. Dispersion of surface waves. Multichannel Analysis of Surface Waves (MASW) technique: acquisition, f-k spectrum, velocity spectrum, dispersion curves and inversion. Refraction Microtremor (REMI) technique.
4	Environmental seismic noise. The soil transfer function. The HVSR method. The SESAME protocol. Micro-tremor data processing. Peak frequencies and amplification of horizontal seismic motion.
2	VERTICAL ELECTRICAL SOUNDING (VES). Choice of acquiring parameters, apparent resistivity curves, inversion of data and interpretation.
4	ELECTRICAL RESISTIVITY TOMOGRAPHY Resistivity-meters and accessories. Main electrode arrays and geometrical factors. Pseudosections and electrical resistivity tomography. Techniques of 2D and 3D data acquiring; the roll-along technique. Forward problem: finite difference and finite element methods. Inverse problem: Least squares methods, Gauss-Newton equation, Jacobian. Applications to hydrological, archaeological and engineering problems.
2	INDUCED POLARIZATION Electrode and membrane polarization. Time Domain I.P. measures. Chargeability. Frequency Domain IP measures. Induced Polarization Tomography (IPT).
3	ELECTROMAGNETIC METHODS Main properties of electromagnetic waves. The Ground Penetrating Radar (GPR). Instrumentation and principles of operation. Data acquisition, processing and interpretation. Transmitting and receiving antennas. Different antennas by frequencies. GPR tomography: time-slices and depth-slices. Application examples.
3	Time Domain electromagnetic methods (TDEM). Equation of induced electromagnetic potential.0 Voltage decay curve (early, intermediate and late stage). Apparent resistivity curve. TDEM data inversion techniques and interpretation. Instrumentation and application examples. Frequency Domain Electromagnetic Methods (FDEM, Slingram). Anomalies generated by a Slingram survey. Application examples. Instrumentation.
2	GEOPHYSICAL LOGS Seismic, electric, radioactive, electromagnetic logs, Instrumentation. Interpretation

Hrs	Workshops
4	Execution or simulation of a refraction seismic tomography. Data processing, inversion and interpretation of results.
4	Execution or simulation of MASW surveys. Data elaboration and interpretation.
4	Registration of environmental seismic noise. HVSR method interpretation.

Hrs	Workshops
4	Execution or simulation of electrical resistivity tomography and induced polarization tomography. Data processing, inversion and interpretation of results.