UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Geophysics

2627-2-E3402Q011

Aims

Knowledge and understanding:
Provide the student with knowledge and understanding of important physical phenomena related to the Earth System, with particular attention to the near surface, consistently with the mainly geological-environmental and applicative focus of the degree course. Provide the student with the knowledge necessary to plan, execute and present an analytical/numerical calculation project related to a topic of interest for geophysics.

Ability to apply knowledge and understanding:
Develop the ability to plan, execute and present a project related to the processing of data of geophysical interest. Develop the ability to apply the acquired knowledge to geophysical problems of moderate difficulty using quantitative methods.

Making judgements:
Developing the ability to independently evaluate the planning of geological surveys, the collection of necessary data, and the quality and reliability of the acquired data. Through the analysis of real-world case studies, the aim is to provide the knowledge required to develop critical thinking skills.

Communication skills:
Developing the ability to accurately communicate technical information to specialist audiences.

Learning skills:
Developing the skills to interpret mathematical language and relate it to the physical processes described.

Contents

Earth rotation and its variations. Earth shape. Gravitational field of the Earth. Geoid. Tides. Gravimetric surveys. Magnetic field of the Earth and its temporal variations. Solar wind. Elettro-magnetic induction. Geomagnetic

surveys. Electric resistivity and conductivity. Fundamentals of geoelettric prospects. Seismic surveys. Equations of the elastic waves (1D). Thermal properties of rocks. Thermal energy transfer in the soil. Geothermic surveys. Rock radioactivity. Equation of radioactive decay. Radioactive surveys. Seismology. Mechanisms for generation of earthquakes.

Laboratory time for addressing the main geophysical challenges illustrated during the theoretical lectures, thought the implementation of computational tools and shared computational resources.

Detailed program

Gravity and rotational motion: Universal gravitational law. Gravitational force and acceleration between bodies. Gravitational potential energy and work. Centripetal acceleration. Geopotential. Geoid. Satellite measurements of Earth gravity. Tides. Inertial moment. Angular momentum rotational energy conservation. Changes in the Earth rotation period. Chandler's oscillation. Gravimetric analysis. Absolute gravity measurements: pendulum, free fall method, push and free fall method. Relative gravity measurements: Gravimeter. Corrections to gravity measurements: latitudinal, tidal, free air correction, Bouguer plate correction, topographic correction. Gravity anomaly interpretation.

Magnetism: Magnetic force. Magnetic potential. Magnetic dipole field. Gauss method. Magnetic moment. Magnetization. Magnetic susceptivity. Lorentz force. Magnetic properties of materials. Diamagnetism. Paramagnetism. Ferromagnetism. Magnetic anisotropies. Single and multiple domains. Rock magnetization: induced and permanent (sedimentary and thermopermanent) magnetization. Geomagnetism. Inclination and declination. International geomagnetic reference field. Temporal variations of the magnetic field: secular variations, field inversions, diurnal variations. Models. Magnetic dynamo. Magnetic analysis. Magnetometer. Measurement corrections: temporal, latitudinal, altitudinal. Magnetic anomaly interpretation. Konigsberger ratio.

Geothermy: Thermal gradient. Adiabatic gradient, melting temperature gradient. Heat transport. Thermal conductivity. Heat flux equation. Heat fluxes into the soil. Convection. Basics of geodynamical modelling (continuity equation, Navier-Stokes equation, convection-diffusion heat equation). Geothermal measurements. Thermistors: thermocouples, thermistors. Transient regimes for the estimation of thermal conductivity.

Electricity: Coulomb force. Electric potential. Electric tension. Electric resistance. Electrical properties of materials. Geoelectricity. Electric analysis. Four electrod method.

Radioactivity: Atomic structure. Isotopes. Radioactive decay: alpha and beta. Decay constant. Half-life time. Radioactive datation: radiocarbon, rubidium-strontium, potassium-argon, lead-uranium. Mass spectrometer.

Seismicity: Elasticity. Hooke law. Stress tensor. Deformation matrix: longitudinal deformation and distortion. Young modulus. Rigidity modulus. Seismic waves. Pressure waves (P waves). One dimensional wave equation. Propagation velocity. Wave energy and damping. Shear waves (S waves). Surface waves (Love and Rayleigh waves). Wave propagation: refraction and reflection. Critical angle. Seismometer and seismogram. Measurement errors. Fundamentals of passive seismic analysis and internal structure of the Earth. Earthquakes. Intensity and magnitude. Parameter determination: direct and inverse method.

LABORATORY ACTIVITIES

Hands-on activities about the conception, realization and presentation of a scientific project related to a relevant themes in Solid Earth Geophysics. Hands-on activities for the solution of geophysical inverse problems through analytical and numerical methods, and their comparison. Use of shared computational resources. Hands-on activities for: (1) gravity anomalies; (2) Earth's rotation; (3) Heat flow; (4) Radioactivity and rock dating; (5) Seismic waves propagation; (6) Earth's structure; (7) Seismic event detection and localization.

Prerequisites

Physics: content of the 1st year class.
Math: content of the 1st year class.
Physical geography: content of the 1st year class.
Geological principles: content of the 1st year class.

Teaching form

a) 6 CFU: 24 two-hour lectures, in person, Delivered Didactics

b) 2 CFU: 12 two-hour lab activities, in person, Interactive Teaching

Textbook and teaching resource

Instructor's notes (available on the elearning web page)

William Lowrie *Fundamental of Geophysics*, Cambridge University Press, 2007.

Recordings of the theoretical lectures.

Semester

First

Assessment method

Examination type:

Written (technical exercises, mandatory, and project report, optional) and oral (discussion on topics covered during class) examinations.

Candidates must submit the technical exercises related to the topics of the laboratory lectures, final report of a project, as illustrated during the laboratory time, at least one week before the oral examination. To be admitted to the oral exam it is necessary to pass the written part with a minimum grade of 15/30. This will grant access to a maximum of two oral tests.

Evaluation

The final degree is up to a maximum of 30/30.

The evaluation of the technical exercises and the report is based both on the actual project and on its presentation and discussion. In particular, the following are evaluated:

(technical exercises)

- answers to the scientific questions posed during the laboratory lectures

(project report)

- the data analysed;
- how much the script used has been modified compared to the one used in the lab sessions;
- the clarity of presentation, the completeness of the information (including that in the inserted images).

The assessment of knowledge on the topics covered in class is based on:

- clarity of expositions;
- understanding of physical processes;
- proficiency in the language used;
- personal processing capacity starting from the acquired concepts.

Office hours

Contact the instructors via email at claudia.pasquero@unimib.it, nicola.pianaagostinetti@unimib.it

Sustainable Development Goals

QUALITY EDUCATION