GEOPHYSICS

Degree: Technical Engineer in Surveying (Bachelor)
Year: ***2nd***
Semestre: A
Subject: Geophysics
Type: Core
Credits (ECTS): 6

1) OBJECTIVES:

- Developing the main areas of geophysics: gravimmetry, seismology and geomagnetism.
- Understanding the relation between geophysics and topography and geodesy.
- Introducing the student to the geophysical instrumentation and the field geophysical methodology.

2) THEORY LESSONS:

INTRODUCTION

Unit 1. Introduction to Geophysics.
1.1. Definition of Geophysics.
1.2. Earth's physics: fields and main physical properties.
1.3. Brief development of Geophysics.
1.4. Classification of Geophysics.
1.5. Institutions and associations related to Geophysics.
1.6. Geophysics and Geodesy.
1. 7 Objectives of this subject.

GRAVIMMETRY

Unit 2. Theory of the Earth's gravity field.
2.1. Coordinate systems
2.2. Newton's Universal Gravity law.
2.2.1. Components of an attraction force.
2.2.2. Potential of an attraction force.
2.3. Centrifuge force and its potential
2.4. Gravity's force. Potential function of the gravity force.
2.6. Geometry of the gravity field:
2.6.1. Equipotent surfaces and plumb lines.
2.6.2. Gravity gradient and gravity field curvature.
2.7. Geoid.

Unit 3. Normal gravity field. Reference ellipsoids. Altitude systems
3.1. Gravity field models.
3.2. Reference ellipsoids.
3.3. Normal gravity field:

3.3.1. Normal potential of gravity.
3.3.2. Clariaut's formula.
3.4. Gravity formulae
3.5. The concept of altitude.
3.6. Altitude systems:
3.6.1. Ellipsoidal altitudes
3.6.2. Altitudes referred to gravity field (orthometric, normal and dynamic).

Unit 4. Anomalous potential. Anomalies of gravity.
4.1. Anomalous potential
4.2. Anomalies of gravity
4.3. Gravity reductions:
4.3.1. Free air reduction
4.3.2. Bouger's reduction
4.3.3. Topographic reduction
4.4. Bouger and free air reduction
4.5. Geoid's determination:
4.5.1. Stoke's formula
4.6. The Earth's models

Unit 5. Isostasy. Regional, local and residual anomalies.
5.1. Isostasy
5.2. Isostasic hypothesis:
5.2.1. Airy's
5.2.2. Pratt's
5.2.3. Veining Meinesz's
5.4. Isostasic corrections
5.5. Anomalies and their geologic interpretation:
5.5.1. Regional anomalies and crust structure.
5.5.2. Interpretation of local anomalies
5.5.3. Residual anomalies.

Unit 6. Absolute and relative measurement to gravity.
6.1. Absolute measurement of gravity:
6.1.1. Pendular method
6.1.2.Free fallen method
6.2. Some ideas about the World gravity network and some national gravity network.
6.3. Relative measurements
6.3.1. Pendular method
6.3.2. Gravimeter
6.4. Classification for gravimeters
6.5. Functioning principles of a gravimeter.
6.6. Elements and devices of a gravimeter.

Unit 7. Time variations of gravity. Gravimetric reference systems.
7.1. Time variations of gravity due to geodynamic causes.
7.1.1. Global variations
7.1.2. Region variations
7.1.3. Local variations
7.2. Time variations of gravity due to non-tectonic causes:

7.2.1. Atmospheric effects.
7.2.2. Hydrogeologic effects.
7.2.3. Anthropic effects.
7.3. Observations of the terrestrial tides.
7.4. Gravimetric network:
7.5. National gravimetric network.

SEISMOLOGY

Unit 8. Seismic wave: internal and superficial
8.1. Mechanics of an elastic environment
8.2. Internal and superficial seismic waves: wave's equations.
8.3. P and S wave propagation:
8.3.1. Reflection and refraction. Critic refraction.
8.3.2. Trajectory and arrival time.
8.3.3. Propagation trough an spherical body.
8.4. Superficial waves:
8.4.1. Wave dispersion
8.4.2. Modes of the Love waves
8.4.3. Dispersion curves
8.5. Inelastic attenuation

Unit 9. Domocrones. Internal structure of the Herat.
9.1. Definition of domocrone.
9.2. Earth's crust and outer mantle.
9.3. Inner mantle and core
9.4. Density and elastic parameters.
9.5. Inelastic properties.
9.6. State equation and composition

Unit 10. Focal parameters of an earthquake
10.1. Seismographers.
10.2. Localization, time and origin.
10.3. Intensity and magnitude. Scales.
10.4. Earthquake's mechanics.
10.5. Fracture parameters
10.6. Movements provoked by a punctual source.
10.7. Determination of:
10.7.1. Fault's plane orientation
10.7.2. Seismic moment
10.7.3. Focus dimensions

Unit 11. Seismicity and seismic risk
11.1. Geographic distribution of earthquakes. Tectonic relation.
11.2. Time distribution of the earthquakes.
11.3 Seismic activity
11.4 Premonition systems, replicas, earthquakes' swarms.
11.5 Hazard and seismic risk.
11.6 Earthquake prediction.
11.7 Seismicity in the Iberic peninsula.

GEOMAGNETISM

Unit 12. Internal magnetic field and external magnetic field.
12.1 The inner gravitational field of the earth and its components.
12.2 Terrestrial dipole. Non-dipolar field. Magnetic coordinates.
12.3 Harmonic analysis of the geomagnetic field.
12.4 International Geomagnetic Reference Field. (IGRF)
12.5 Secular variation
12.6 Origin of the electromagnetic field: models.
12.7 External magnetic field.
12.8 Correction of the magnetic measurement.
12.9 Magnetosphere and Ionosphere.

Unit 13. Geomagnetic measurement. Magnetic anomalies
13.1 Magnetic susceptibility of the rocks and minerals.
13.2 Magnetism of the rocks: Induced and remaining magnetization.
13.3 Types of measurements.
13.4 Magnetometers.
13.5

3) PRACTICES:

Practice 1. Microgravimeter LCR

Practice 2. Software applications for gravimetric data management.
Practice 3. Calculation of a given height by means of the gravity's vertical gradient.

Practice 4. Study and analysis of the gravimeter's instrumental drift.
Practice 5. Treatment and determination of data from gravimetric profiles (absolute g, free air anomalies and Bouger's anomalies) and its relation to the geology of the studied zone.
Practice 6. Gravimetric modelization

Practice 7. Identification of the seisms phases in a short term seismogram

Practice 8. Identification of the teleseisms phases in a long term seismogram

Practice 9. Accelerogramme analysis

Practice 10. Management of magnetic field data for drawing the map.

4) BOOKS:

- Blakeley, Richard J. 1996, *Potential theory in gravity and magnetic applications Cambridge : Cambridge University Press.*
- Fowler, C. M. R., 1996, *The Solid Earth: An Introduction to Global Geophysics, Cambridge, New York, Cambridge University Press.*
- Heiskanen, W. A. y Moritz, H., 1985, *Geodesia Física, Madrid, Instituto Geográfico*.
- Milsom, J., 1995, *Field Geophysics, Chichester, Inglaterra, John Wiley and Sons.*

- Sheriff, R. E., y Geldart, L. P., 1991, *Exploración sismológica*, *vv. I y II, México, Editorial Limusa*.
- Torge, W., 1989, *Gravimetry*, *Berlín, Walter de Gruyter.*
- Udías, A. y Mezcua, J., 1997, *Fundamentos de Geofísica*, *Madrid, Alianza Universidad Textos, Alianza Editorial*.

5) EVALUATION:

The evaluation consits of:
- Practical exam: presentation of the practices log book.
- Final exam (written).

The log book must reflect the overall work carried out by the student during the practice sessions, including data such as results of the exercises, theoretical approach and mistakes done.
The final mark will be a ponderated average between the practice and the written exam marks.