Course guide
2500220 - GEA0220 - Instrumentation, Remote Sensing and Big Data

Last modified: 08/07/2024

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Compulsory subject).
BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING / BACHELOR'S DEGREE IN MINERAL RESOURCE ENGINEERING AND MINERAL RECYCLING (Syllabus 2024). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: CAROLINA PUIG POLO

Others: CÀROL PUIG POLO

REQUIREMENTS

Having completed and passed the Geographic Information Systems (GIS) course

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14446. Solve mathematical problems that may arise in engineering by applying knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, optimization, ordinary differential equations.
14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
14448. Manage the basic concepts about the general laws of mechanics and thermodynamics, concept of field and heat transfer, and apply them to solve engineering problems.
14450. Describe the global functioning of the planet: atmosphere, hydrosphere, lithosphere, biosphere, anthroposphere, biogeochemical cycles (C, N, P, S), soil morphology and apply it to problems related to geology, geotechnics, edaphology and climatology.
14453. Describe and apply the techniques of analysis of physical, chemical and biological parameters; Integrate the experimental evidence found in field and / or laboratory data with the theoretical knowledge and interpret its results.
14457. Identify the fundamentals of structure theory, sustainable procedures for construction and dismantling of buildings and civil works; and describe the technology bases of the materials used in construction.
14458. Apply the methodologies of studies and evaluations of environmental impact and, in general, of environmental technologies, sustainability and waste treatment and of the management of international standards of environmental quality. Life cycle analysis, carbon footprint and water footprint and assess natural hazards (river, coastal floods, droughts, fires, soil erosion and landslides).
14459. Describe the components and modes of transport and the impact of their externalities on the environment; identify the principles of environmental management of transport systems and sustainable planning of the territory; and introduce the tools for the management and operation of transport systems.
14461. Analyze, design, simulate and optimize processes and systems with environmental relevance, both natural and artificial, and their resolution techniques, as well as recognize techniques for analysis and evaluation of climate change.
14465. Identify renewable energy generation techniques and energy transition concept.

Generical:
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.
14442. To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.

TEACHING METHODOLOGY

The course consists of 2.3 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 2.3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1.2 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Satellite, aerial, terrestrial sensors. Punctual instrumentation vs. distributed detection. Point sensors in rivers and territory. Sensor networks. Weather networks. Statistical techniques for processing data series. Passive and Active Remote Sensing (Radar and others). Multispectral and hyperspectral sensors, combination of bands. Satellite missions of interest, Organizations / companies producing R.S. Relationship between TD and climate change. TD Applications in Environmental Engineering. Big Data.

1. Know the systems and methods of collecting environmental data: physical, chemical sensors, remote sensing.
2. Understand the concepts of passive and active remote sensing and know the main existing sensors, as well as the largest satellite missions interest.
3. Apply environmental data management tools: statistical techniques and visualization using GIS.

Instrumentation, Remote Sensing and Big Data. Introduction to the systems and methods of collecting environmental data (atmosphere, inland, sewage and marine waters, soils): concept of active and passive remote sensing and description of the main satellite missions and other data collection systems.
Study of the main statistical techniques for the treatment and management of the data series obtained.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

1. Introduction to

Description:
Introduction to the subject
A bit of history and latest developments

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

2. Physical Principles of Remote Sensing

Description:
In this topic, we will study the interaction of electromagnetic waves with the Earth's surface and their spectral response in different parts of the electromagnetic spectrum.

Specific objectives:
The electromagnetic spectrum: terms and units of measurement.
Characteristics of energy radiation in the optical spectrum.
Characteristics of energy radiation in the thermal infrared spectrum.
The microwave region

Related activities:
LAB1: Visualization and interpretation of satellite images. Tools of work

Full-or-part-time: 10h
Theory classes: 2h
Practical classes: 2h
Self study : 6h

3. Platforms and Sensors

Description:
In this section, Earth observation satellites and sensors will be discussed, highlighting the main distinctions according to the type of sensor (passive or active) that generates the image, as well as the characteristics of these images. The Earth observation programs, especially the Copernicus program, will also be covered.

Specific objectives:
Types of sensors: active and passive.
Types of resolution: spatial, spectral, radiometric, and temporal.
Satellite characteristics: orbits and swaths.
Landsat Program. Copernicus Program. Commercial satellites with high spatial resolution.
Earth observation satellites and sensors meteorological, maritime, and other types of sensors.

Related activities:
LAB1: Visualization and interpretation of satellite images. Tools of work

Full-or-part-time: 15h
Theory classes: 4h
Practical classes: 2h
Self study : 9h

4. Analysis and Interpretation of Images in the Optical Frequency

Description:
In this topic, the image analysis techniques, which are key to conducting any analysis, will be examined more closely. Data analysis has changed significantly in recent decades, and the number of options to choose from, when it comes to analyzing remote sensing images, provides a wide variety of tools for every purpose. The most common techniques as well as the newest ones have been selected.

Specific objectives:
Spectral index:
Vegetation Indexes, water and burned area with images inside the optician.
Ice and snow spectral indices
Concept of supervised and unsupervised classification. Unsupervised classification type. Type of supervised classification.
Unsupervised classification
Supervised classification

Related activities:
LAB 2A: Vegetation, Water, and Burned Area Indices
LAB 2B: Ice and Snow Indices
LAB 3: Classification of Multispectral Images

Full-or-part-time: 30h
Theory classes: 4h
Practical classes: 8h
Self study : 18h

5. Remote sensing at microwave frequency

Description:
In this topic, you will explore a detailed overview of radar technology history. All the necessary fundamentals to understand how electromagnetic waves work will be covered. Additionally, a lab session will be conducted where radar data will be explored in various application scenarios.

Specific objectives:
- History of radar technology and the discovery of electromagnetic waves
- Geometry of image acquisition in airborne and spaceborne radar systems
- Land applications of radar remote sensing
- Applications of radar remote sensing over water
- Application of radar remote sensing for risk manag

Related activities:
LAB 4: Introduction to SAR Images. Floods and Deforestation

Full-or-part-time: 20h
Theory classes: 4h
Practical classes: 6h
Self study : 10h

6. Remote Sensing Applications

Description:
Applications of remote sensing to agriculture
Floods, volcanoes, earthquakes, droughts, fires, ...
Remote sensing applied to natural hazards

Full-or-part-time: 15h
Theory classes: 2h
Practical classes: 4h
Self study : 9h

7. Instrumentation and Remote Sensing

Description:
Instruments for marine and inland waters
extensometers, clinometers * In probing: extensometers, inclinometers, sliding probes, piezometers. Cable extensometer.

Full-or-part-time: 22h
Theory classes: 6h
Self study : 16h

8. Big Data and Remote Sensing

Description:
Remote sensing techniques provide enormous amounts of data that fall into the complex category of "Big Data". Analyzing these data is fundamental for understanding the dynamic processes occurring on the Earth's surface.
In this topic, we will work with Google Earth Engine and Python programming.

Specific objectives:
Theory, methods, and applications:
Store, process, and analyze large volumes of remote sensing data.
Extract information from the data, such as patterns, trends, and spatial relationships.
Visualize the data in a clear and accessible manner.

Related activities:
LAB: Remote Sensing and Big Data. Google Earth Engine.

Full-or-part-time: 34h
Theory classes: 6h
Practical classes: 8h
Self study : 20h

GRADING SYSTEM

This course is passed through Continuous Learning and Assessment (CLA).

The Grading Method is summarized below. Additional details of the method will be provided on the first day of class.

#The regular grade for the course is obtained from the continuous assessment grades, which consist of three types of marks:
• Ne: exam grade. Two tests with a weight of 40% for the first and 60% for the second.
• Nlab: laboratory grade, and
• NTre: assignment grade

The final grade (NF) for the course is calculated as:
NF = 75% * Ne + 10% * Nlab + 15% * NTre

The weight of each practice assignment will be detailed on the course's Atenea. Each practice assignment must be submitted within the indicated deadline; late submissions will not be accepted without justified cause and prior notice.
Grading criteria and admission to the re-evaluation:
Students who fail the regular assessment, have regularly attended the course evaluation tests, and have sufficiently attended the practices (>80%), will have the option to take a re-evaluation test during the period set in the academic calendar.
This test will evaluate both the theoretical part of the course and the practical part corresponding to the laboratories.
Students who have already passed the course or those graded as not presented will not be allowed to take the re-evaluation test. The maximum grade for the re-evaluation exam will be five (5.0). The non-attendance of a student summoned to the re-evaluation test, held during the set period, will not give rise to another test at a later date.

EXAMINATION RULES.

If any of the laboratory or continuous assessment activities are not performed in the scheduled period, it will be considered a zero score.

BIBLIOGRAPHY

Basic:
- Chuvieco Salinero, Emilio; Huete, Alfredo. Fundamentals of satellite remote sensing. Boca Raton [etc.]: Taylor & Francis, 2010. ISBN 9780415310840.
- Woodhouse, Iain H. Introduction to microwave remote sensing. Boca Raton: Taylor & Francis, 2006. ISBN 0415271231.