Course guides
2500203 - GECSISTERR - Earth System

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.
Degree: (ANG) GRAU EN ENGINYERIA AMBIENTAL (Syllabus 2020). (Compulsory subject).
Academic year: 2020 ECTS Credits: 6.0 Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: JOSE MOYA SANCHEZ
Others: MARC BERENGUER FERRER, MARIPAU FERNANDEZ POMBO, ALBERT FOLCH SANCHO, JOSE MOYA SANCHEZ

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14445. Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.
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.
14449. Apply the basic principles of general chemistry, organic and inorganic chemistry and their applications in engineering.
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.

General:
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.

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity (large size group) and 1 hour weekly with half the students (medium size group).

The 2 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 hour 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.
LEARNING OBJECTIVES OF THE SUBJECT

Our planet is a complex system comprised of various very dynamic subsystems (lithosphere, hydrosphere, atmosphere, cryosphere, biosphere and anthroposphere) that interact varyingly and intensely at different time scales. A basic description of the internal dynamics of each subsystem is added, along with their interactions to assure an overview of the global functioning of our planet and climate.

1. Have a global vision of the dynamics of our planet and its subsystems: composition and structure of the lithosphere, of the hydrosphere, from the atmosphere, the cryosphere and the biosphere.
2. Understand the transfer of mass and energy: a) in each subsystem (atmospheric circulation, ocean circulation, continental hydrology, tectonics plates, sediment transport, nutrient transfer); b) among them (water cycle, rock cycle, biogeochemical cycles); and c) of global balances.
3. Understand global climate, regional climates, and the factors that control them. Knowledge of: a) the climatic changes that occurred during the Quaternary at various time scales and current climate change, b) the causes of these changes and their consequences on subsystems terrestrial, and c) the influence of human activity on current climate change.

Earth System. Our planet is a complex macrosystem made up of several highly dynamic systems (lithosphere, hydrosphere, atmosphere, cryosphere, biosphere, and anthroposphere) that interact intensely and in a changing way at different time scales. A basic description of each of the subsystems and their internal dynamics is provided, as well as an overview to understand the global functioning of the planet and the climate.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours medium group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
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Total learning time: 150 h

CONTENTS

Section I: Introduction to the global dynamics of Earth

Description:

Specific objectives:
- Provide a first global view of the dynamics of our planet and its subsystems. Show the basic differences with the dynamics of other planets in the Solar System.

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m
Section II: Internal dynamics of terrestrial subsystems

Description:
Item 2. The lithosphere and the interior of the Earth.
- Composition and structure of the lithosphere and crust. Internal geodynamics and plate tectonics. Volcanism and seismicity. The internal cycle of rocks and lithosphere formation.
- Composition and discontinuities in the core and mantle. Convection currents (transfer of matter and heat). The geomagnetic field and its importance for the atmosphere, biosphere and human activity.
Problems on mass and energy flow 1: flows in the atmosphere, in the oceans and between them.
Topic 5. The continental hydrosphere. The water cycle on the continents. The river environment. The lake environment. The underground hydrosphere.
Tutorial 1 of the bibliographic work: on the search, analysis and synthesis of information.

Specific objectives:
- Understanding the composition, structure, formation and movements on a global scale of the lithosphere subsystem, the mantle and the core of the Earth.
- Knowledge and understanding of the oceanic branch of the hydrosphere subsystem. Composition, structure and global circulation in the oceans.
- Knowledge and understanding of the composition, structure and global circulation in the subsystem atmosphere.
- Understanding the internal dynamics of the atmosphere, the oceans and the interaction between them.
- Knowledge and understanding of the continental branch of the hydrosphere subsystem. Water cycle in emerging areas and related geomorphological processes.
- Knowledge and understanding of the set of glaciers as an essential and special part of the hydrosphere subsystem, particularly important during the last 2.6 million years on Earth.
- Knowledge and understanding of the unique characteristics of life, its global chemistry and energetics and between the main ecosystems. Introduction to the concept of Anthroposphere.
- Training on transversal competences of autonomous work: autonomous search, analysis and synthesis of information.

Full-or-part-time: 39h 36m
Theory classes: 12h
Practical classes: 2h
Laboratory classes: 2h 30m
Self study: 23h 06m
Section III: Interaction of natural terrestrial subsystems

Description:
Analysis of real cases 1: Droughts and large wildfires: different cases in Europe, Australia, North America and Siberia
Analysis of real cases 2: Causes and effects of hurricanes and hurricane storms: the case of Gloria rainstorm event.

Problems on mass and energy flow 2: Flows in continental areas
Topic 10. The coasts. Coastal environments: general circulation of currents (waves and tides) and sediments on the coast, type of sedimentary environments. Shallow coastal and marine ecosystems. Local changes in sea level (tectono-eustatic changes and subsidence in deltas and estuaries).
Analysis of real cases 3: Past, present and future of the Ebro Delta and the Mar Menor

Problems on mass and energy flow 3: flows at coasts

Problems on mass and energy flow 4: Flows on the sea floor and ocean floor.

Debates on engineering and sustainable economics 1: biomimetics

Tutorial 2 of the bibliographic work: on the communication of results.

Specific objectives:
- Identify the main characteristics of the climate system.
- Characterize the transfer of mass and energy between the atmosphere, the hydrosphere (fluid and solid), the solid surface of the Earth and the biosphere.
- Understand the climatic zonation of the planet and its relationship with the orbital parameters of the Earth.
- Understanding a type of extreme interaction between climate and the biosphere
- Identify and characterize the external geodynamics of the Earth (interaction with the lithosphere of other subsystems of the Earth).
- Identify soils and, in particular, the pedogenic soils such as the skin of the solid Earth.
- Understand the biogeoclimatic zoning of the Earth on continents.
- Understanding of extreme geodynamic phenomena.
- Understanding of external geodynamics in emerging continental areas.
- Identify shallow coastal and marine areas as those with the greatest joint interaction between the subsystems of our planet.
- Understanding a type of interaction between various subsystems in the coastal or near-coastal zones
- Understanding of external geodynamics at the coasts
- To know the sea and ocean floor and the biogeochemical processes that take place in 70% of the solid surface of the planet.
- Understand the global transfer of matter and energy on the sea floor and ocean floor.
- Understanding the geodynamics on the sea floor and on the ocean floor.
- Introduction to sustainable engineering and economics.
- Training in transversal competence in oral and written communication.

Full-or-part-time: 55h 12m
Theory classes: 9h
Practical classes: 11h
Laboratory classes: 3h
Self study : 32h 12m
Section IV: Global dynamics of Earth, temporal evolution and interaction with the anthroposphere.

Description:
Debates on sustainable engineering and economics 2: Blue Bubble World
Oral presentation of bibliographic reports in group: session 1
Oral presentation of bibliographic reports in group: session 2
Topic 13. Interactions on a global scale and changes in the Earth system. Equilibrium and disequilibrium of complex dynamical systems. Interdependence of terrestrial subsystems on a global scale. Typology of global changes in subsystems and theoretical analysis of their influence: changes in the sedimentary system, changes in the extent of glaciers, changes in sea level, changes in biological activity.
Topic 14. Evolution of the Earth system during the Quaternary. Paleoclimatic records and climate change in geological history and during the Quaternary. Causes and consequences of past climate changes: glaciations and global sea level changes, changes in the ocean circulation, changes in morphoclimatic zones, changes in the biosphere (biodiversity and ecosystems).

Specific objectives:
- Understand the concept of a biogeochemical cycle on a global scale.
- Characterize the main cycles, their interdependence and their relationships with the interaction of the Earth's subsystems.
- Training on oral reporting
- Identify and understand the global thermodynamics of simple and complex systems, their states of equilibrium and imbalance (change), and characterize the thermodynamics of the Earth System.
- Know and understand the temporal evolution of the Earth system on a geological scale and, particularly, in the last 2.6 million years.
- Know and understand natural climate changes.
- Identify and understand the influence of human activity on the recent evolution of the Earth (Neolithic to present) and on the current climate change.

Full-or-part-time: 44h 24m
Theory classes: 10h
Laboratory classes: 8h 30m
Self study : 25h 54m

GRADING SYSTEM
The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.
Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).
The teachings of the laboratory grade is the average in such activities.
The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

EXAMINATION RULES.
The delivery of any evaluable deliverable is mandatory. In case of non-delivery of any of these activities in the term indicated by the profesorado, the student will obtain the qualification of 'not presented' in the subject.
BIBLIOGRAPHY

Basic:

Complementary: