Course guide
2500240 - GEA0240 - Renewable Energy

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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). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: CLIMENT MOLINS BORRELL

Others: DANIEL ALARCÓN FERNÁNDEZ, IVET FERRER MARTI, ALBERT FOLCH SANCHO, JUAN PEDRO MARTÍN VIDE, CLIMENT MOLINS BORRELL, JUAN PABLO SIERRA PEDRICO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
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).
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.
14443. Apply the necessary legislation during the professional practice of environmental engineering.
14444. Apply business management techniques and labor legislation.

TEACHING METHODOLOGY

The subject consists of 4 face-to-face hours in the classroom, divided into two sessions of 2 hours each.

Part of the teaching hours are dedicated to theoretical classes, in which the teachers explain the basic concepts and materials of the subject and present examples.

The rest of the time is spent solving problems with greater interaction with the students. Practical exercises are carried out in order to consolidate the general and specific learning objectives.

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

Description of the use of energy and clean technologies in a context of global change and sustainability. Next, the technological bases, design, exploitation and maintenance of renewable energy facilities will be considered: hydraulic, solar (passive, thermal or photovoltaic), wind, tidal, wave, biomass, geothermal, etc.

1. Understand the operation of the different renewable energy production systems.
2. Evaluate the advantages and disadvantages of the different energy production systems.

Renewable energy. The technological, design, exploitation and maintenance bases of renewable energy facilities will be considered: hydraulic, solar (passive, thermal or photovoltaic), wind, tidal, wave, biomass, etc.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Conceptual framework of the subject

Description:
Basic objectives of the subject and approach. Traditional energies. renewable energies Energy mix.

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Photovoltaic solar energy

Description:
Introduction to photovoltaic solar energy. Physical principles. regulatory framework Current and future perspectives.
Elements that include a photovoltaic solar installation. Types of solar panels. Types of investors. batteries Types of photovoltaic solar installations (On-grid, hybrid and off-grid).
Dimensioning and capacity of a PV installation
Practical exercise in sizing a photovoltaic installation.

Full-or-part-time: 14h 23m
Theory classes: 2h
Practical classes: 4h
Self study : 8h 23m

Solar thermal energy

Description:
Introduction to solar thermal energy. Physical principles and types of energy generation. Current and future perspectives.
Exhibition of the different types of utilization of solar thermal energy and applications. Concentration plants and solar collectors. Elements of the different types of power stations.
Pre-dimensioning of the different types of solar thermal installations. Evaluation of production capacity.
Practical exercise in sizing a thermosolar installation.

Full-or-part-time: 14h 23m
Theory classes: 2h
Practical classes: 4h
Self study : 8h 23m

Wind energy

Description:
Wind energy today in Europe and the world. LCOE concept (levelized cost of energy). Onshore and offshore wind power. Current and future perspectives.
Physical principles for the extraction of energy from the wind. Power coefficient. Betz limit. Use drag or lift. Forces and aerodynamic torsor. Power curves, power coefficient depending on wind speed. Spatial and temporal distribution of wind
Vertical axis and horizontal axis turbines. Parts of the different wind turbines. Components of on-shore and off-shore turbines. Classification of wind turbines according to the IEC-61400 standard.
Production reports of a turbine. Evaluation of the resource and production of a turbine. Power curves. Control strategies.
Practical exercise in sizing a wind farm.

Full-or-part-time: 24h
Theory classes: 5h
Practical classes: 5h
Self study : 14h

Tidal and wave energy

Description:
Physical principles for the extraction of tidal energy. Potential energy (tidal range). Kinetic energy (tidal currents). Tidal data sources. Generation of tidal data (models).
Types of tidal power stations. Calculation of the production of a power plant. Examples of existing power stations. Types of tidal kinetic energy converters (TECs). Calculation of the production of a TEC. Conditions for production: Betz limit, starting speed and nominal power. Examples of TEC pilot plants.
Physical principles for the extraction of tidal energy. Potential energy (tidal range). Kinetic energy (tidal currents). Tidal data sources. Generation of tidal data (models).

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Evaluation

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

Hydroelectric exploitations

Description:
- History of hydraulic energy - Concept of power - Altimetric profile: transport phase and transformation phase - Concept of energy transformation with a forced pipe
"Types of turbines Characteristics and operation of a shunt jump in a channel. Dam and load chamber Concept of flowing and regulated energy"
- Fluent Jump Improvement: Pressure Leads - Balancing Water Ram and Chimney - Reversible Jump Concepts
Exercise of producing a flowing jump Exercise of producing a jump of all lines under pressure Exercise of a reversible jump

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Geotermic energy

Description:
Introduction to geothermal energy. Types of geothermal exploitation. Flow and storage of heat in the subsoil. State of geothermal energy in Catalonia.
Geothermal heat pumps. Types of very low enthalpy geothermal uses. Elements of an installation. Thermal response test.
Examples of very low enthalpy geothermal installations. Practical exercise on design and installation of geothermal exchangers.

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Energy of biological origin

Description:
Introduction to biomass energy. Types of biomass and uses. Current situation
Production of biofuels, dimensioning and energy balance.
Biofuel plant technical visit
Practical exercise in sizing a biogas production plant.

Full-or-part-time: 19h 12m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 11h 12m

GRADING SYSTEM

The subject will be assessed through two partial exams in addition to the practical work, which will have a weight of 50% in the final grade.

The rating of the practices is the average of the activities of this type. There will be five.

The assessment tests consist of a part with questions about concepts associated with the learning objectives of the subject in terms of knowledge or understanding, and a set of application exercises.

Final mark = 0.1*(5 assignments)+0.25*Exam 1+0.25* Exam 2.

Re-assessment (RE)
Qualification and admission criteria for reassessment (Re):

Students who have failed the ordinary evaluation and who have regularly taken the evaluation tests of the failed subject will have the option of taking a re-evaluation test in the period set in the academic calendar. Students who have already passed, or students rated as not submitted or who have not handed in all the exercises/problems (Pr) and the papers and reports (Tr) may not take the reassessment test of a subject.

The reassessment (RE) will consist of a single exam that covers all the content of the course. The maximum grade for the reassessment will be five (5.0) and the final grade for the course will be the maximum grade between the ordinary assessment and the reassessment exam, that is, MAX(EO/RE).

The non-attendance of a student summoned to the re-evaluation test, held in the set period, may not lead to another test at a later date. Extraordinary evaluations will be carried out for those students who, due to accredited force majeure, have not been able to take any of the continuous evaluation tests. These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be carried out within the corresponding school period.

EXAMINATION RULES.

If any of the laboratory or continuous assessment activities are not carried out in the scheduled period, it will be considered a zero score. The tests will be carried out individually, with multiple choice questions that can be theoretical or problem type questions. The exams can include short questions to be developed by the students and exercises to be solved.

BIBLIOGRAPHY

Basic:

- Banks, D. An introduction to thermogeology : ground source heating and cooling. Oxford: Wiley-Blackwell Publishing, 2008. ISBN 9781405170611.
- Cuesta, L.; Vallarino, E. Aprovechamientos hidroeléctricos. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos, 2000. ISBN 9788438001691.
- Flotats, X. y Feliu, A.. Los gases renovables. Un vector energético emergente [on line]. Fundación Naturgy, 2019 [Consultation: 22/11/2023]. Available on: https://www.researchgate.net/publication/341931046_Los_Gases_Renovables_Un_vector_energetico_emergente. ISBN 9788409152704.
- Manwell, J.F.; McGowan, J.G.; Rogers, A.L. Wind Enery Explained: Theory, Design and Application [on line]. 2nd ed. Chichester: John Wiley & Sons, 2010 [Consultation: 22/11/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=589269. ISBN 2009.
- Smets, A...[et al]. Solar energy : the physics and engineering of photovoltaic conversion, technologies and systems. Cambridge: UIT Cambridge,, 2016. ISBN 9781906860325.
- Neill, S. P.; Hashemi, M. R. Fundamentals of ocean renewable energy : generating electricity from the sea. London: Academic Press, 2018. ISBN 9780128104491.