Solar Energy

Academic Year: (2023 / 2024) **Review date: 08/06/2023 16:42:00**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: MARUGAN CRUZ, CAROLINA

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Thermal Engineering
Heat Transfer

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Apply computational and experimental tools for analysis and quantification of energy engineering problems
CG4. Being able to do design, analysis, calculation, manufacture, test, verification, diagnosis and maintenance of energetic systems and devices.
CG7. Assess, control, and reduce the social and environmental impact of projects and facilities within the field of energy engineering.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE6 Módulo CRI. Ability for the analysis, design, simulation and optimization of processes and products.
CE8 Módulo CRI. Knowledge and ability for systems modelling and simulation.
CE20 Módulo CRI. Basic knowledge on environmental and sustainability technologies and their application.
CE5 Módulo TE. Ability for the design of electric power plants.
CE8 Módulo TE. Applied knowledge on renewable energies.
CE13 Módulo TE. Understanding the relation between the different variables seizing in the operation of electric power systems and the electric energy demand coverage.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.1 knowledge and understanding of the scientific principles underlying the branch of energetic technologies.
RA1.2 a systematic understanding of the key aspects and concepts of the branch of energetic

technologies.
RA1.3 coherent knowledge of their branch of engineering including some at the forefront of solar energy.
RA2.3 the ability to select and apply relevant analytic and modelling methods in the field of wind energy.
RA3.1 the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements within the field of energetic technologies.
RA5.1 the ability to select and use appropriate equipment, tools and methods.
RA5.2 the ability to combine theory and practice to solve problems within the field of energetic technologies.
RA6.1 function effectively as an individual and as a member of a team.
RA6.2 use diverse methods to communicate effectively with the engineering community and with society at large.
RA6.3 demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.

OBJECTIVES

By the end of the present course the students will be able to have:
1. - A systematic understanding of the key aspects and concepts of both, solar resource and solar energy systems.
2. -A coherent knowledge of working principles of the systems capable of transforming solar energy into heat or electricity and learning of the newer storage systems and hybridization methods of solar energy with other renewable energy sources.
3.- The ability to apply their knowledge and understanding to identify, formulate and solve thermal engineering problems using established methods in thermodynamics and power systems.
4.- The ability to apply their knowledge and understanding to develop and realise designs of solar facilities, with/without storage, to produce heat or electricity and to meet specified requirements.
5.- The ability to conduct searches of literature, and to use weather data bases and other sources of information.
6.- The ability to combine theory and practice to solve energy efficiency problems in solar facilities.
7.- Function effectively as an individual and as a member of a team.
8.- Recognise the need for, and have the ability to engage in independent, life-long learning.

DESCRIPTION OF CONTENTS: PROGRAMME

SOLAR RADIATION: Solar angles. Solar radiation. Solar resource.
SOLAR ENERGY COLLECTORS. Flat plate collector. Thermal analysis. Evacuated tube collector.
LOW TEMPERATURE SOLAR ENERGY FACILITIES. Components and f-chart method
THERMOSOLAR POWER. Concentrating collectors for heat production at HIGH temperature
PHOTOVOLTAIC ENERGY. Photovoltaic effect. Seminconductors. Solar cells. Types of PV. i-v curve.
PV APPLICATIONS:PV panels Related equipment: power trackers, inverters, batteries. Efficiency. Stand-alone/Direct-coupled/Grid connected system.

LEARNING ACTIVITIES AND METHODOLOGY

Lectures, in which the main theory of the course is presented. To facilitate the learning of the theory, a set of class presentations and notes will be delivered to the students together with a reference list of basic text books.

- Practical seminars in class and computer room. These practical sessions will also serve to solve the main practical questions raised by the students about the main processes related to solar energy.

- Visit to a solar power plant. Invited talk of an expert in pv/csp

- All students will solve problems and/or work on projects intended to improve their knowledge and check their learning progression.

- In addition to the questions and problems solved in class, there will be tutorial sessions scheduled at the teacher's office.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Voluntary online exercises and questions: 10 %
Project: 10%
Practical laboratory work: 20% of the final mark
Two partial exams (partial examination): 60% of the final mark.

If a student fails any of the partial examination (grade <5) he/she can do that part in the final exam.

Final exam at the end of the semester: 60% of the final mark.
Minimum mark to pass the course: 5/10

BASIC BIBLIOGRAPHY

- F.P. INCROPERA & DE WITT FUNDAMENTALS OF HEAT TRANSFER, Willey.

- John A. Duffie, William A. Beckman Solar Engineering of Thermal Processes, Wiley, 2013

- S.A. Kalogirou Solar Energy Engineering: processes and systems, Elsevier.

- Y.A. ÇENGEL & A.J. Ghajar HEAT and MASS TRANSFER: Fundamentals and Applications, McGraw-Hill.

ADDITIONAL BIBLIOGRAPHY

- James L. Threlkeld Thermal Environmental Engineering, Pretince-Hall, 1970

BASIC ELECTRONIC RESOURCES

- Christiana Honsberg and Stuart Bowden . Photovoltaic Education Network: http://www.pveducation.org/

- William B. Stine and Michael Geyer . Power from the sun: //www.powerfromthesun.net/book.html