Heat power plants

Academic Year: (2023 / 2024) **Review date: 17-06-2023**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: SORIA VERDUGO, ANTONIO

Type: Compulsory ECTS Credits : 3.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Thermal Engineering
Heat Transfer

SKILLS AND 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.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE1 Módulo TE. Applied knowledge on thermal engineering.
CE14 Módulo TE. Knowledge of thermal power production machines and plants, as well as their industrial and environmental range.
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 advanced issues in thermal engineering and fluid mechanics.
RA1.2 a systematic understanding of the key aspects and concepts of heat transfer.
RA1.3 coherent knowledge of their branch of engineering including some at the forefront of thermal engineering and fluid mechanics.
RA1.4 awareness of the wider multidisciplinary context of engineering.
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve advanced problems within the field of thermal engineering and fluid mechanics using established methods.
RA2.3 the ability to select and apply relevant analytic and modelling methods in the field of thermal engineering and fluid mechanics.
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 thermal engineering and fluid mechanics.
RA3.2 an understanding of design methodologies, and an ability to use them.

RA4.1 the ability to conduct searches of literature, and to use data bases and other sources of information.
RA5.1 the ability to select and use appropriate equipment, tools and methods.
RA5.2 the ability to combine theory and practice to solve advanced problems of heat transfer.
RA5.3 an advanced understanding of applicable techniques and methods within the field of thermal engineering and fluid mechanics, and of their limitations;
RA6.1 function effectively as an individual and as a member of a team.

OBJECTIVES

The goal of this course is to show and explain the thermodynamic cycles used in thermal power plants, in addition to the linked technology. The final goal is to acquire the capacities to analyze the behavior of thermal power plants. In order to reach this goal the student has to acquire knowledge, competences and attitudes.

With regard to the knowledge, at the end of the course the student must be able to:
- Identify the basic components of a thermal power plant, their function and their working conditions.
- Know the processes and parameters that define the power plants, and evaluate their performance.
- Know the state of the art technology of each case.
- Analyze the energy saving possibilities and the environmental impact of each power plant, especially in terms of global warming potential of their pollutants emissions.

With regard to the competences, they can be classified into two groups: the specific competences on one hand and general competences or skills on the other hand.
With regard to the competences, at the end of the course the student must be able to:
- Set out the thermodynamic design of a power plant.
- Identify and distinguish devices (turbomachines, boilers, combustion chambers) and power plant subsystems.
- Know the application field of every thermal power plant.
- Evaluate environmental consequences of the use of each power generating technology.

With regard to the general competences, during the course the skills develop are:
- The capability of solving problems.
- The capability of searching, communicating and distinguishing the relevant information to characterize a thermal power plant.
- The capability of working in teams and to share the work in order to face complex problems.

With regard the attitudes the student should have after the course:
-Critical attitude with respect the identification process and evaluation of the performances of elemental devices of the power plant installation.
-Cooperation attitude in order to get information from other agents and knowledge to accomplish complex tasks.
This is a course that involves a fundamental basis and a technological basis.

DESCRIPTION OF CONTENTS: PROGRAMME

INTRODUCTION:
- Generalities and classification of power plants (vapor cycle, gas cycle, reciprocating engines: Diesel, Otto and dual cycles). Fuel types (solids, liquids and gases). Review of heat transfer modes.

POWER CYCLES
- Simple Brayton and Rankine power cycles and improved cycles.
  -Simple Brayton, inter-cooling, reheating, regenerative, complex cycles, closed cycles. Efficiency and optimization.
  -Simple Rankine, reheating, regeneration (vapor extraction and drenage). Complete cycles. Efficiency and optimization.. Examples: Organic Rankine Cycles, Geothermal power plants.
- Operative fundamentals and turbomachinery architecture.
  - Kinematics and pressure variation in turbomachinery. Velocities composition.
  - Operation curves in incompressible and compressible flow.
-Fundamentals of boilers, combustion chambers
  - Water-tube boiler.
  - Burners and combustion chambers.
- Operation and architecture of other devices.
  -Dearetors and feedheaters.
  -Condensers
  -Refrigeration towers
- Combined cycle
  -Operation and design parameters.
  - HRSG, state of the art: reheating and pressure levels. Design parameters and operation performances.
- Exergy and thermoeconomy

LEARNING ACTIVITIES AND METHODOLOGY

The educational methodology includes:
1) Lectures covering the main topics of the course. In order to facilitate the learning process the student will receive support material and information to let them complete and focus on the relevant topics or interesting topics for them.
2) Resolution of problems, related to the knowledge that must be acquired and above all related to the specific competences the student must develop.
3) Resolution of exercises that will allow the student to consolidate the knowledge and contrast the results with the reality. This will develop the capacity of self-evaluation and the students will acquire skills and develop technical creativity.
4) Lab seasons and reports elaboration.

ASSESSMENT SYSTEM

The evaluation is based in the next criteria:
- Resolution of problems and homeworks.
- Individual project.
- Partial exam.
- Lab sessions.
- Final exam.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- F.P. Incropera, D. P. DeWitt Fundamentals of heat and mass transfer, Pearson.
- M.J. Moran, H.N. Shapiro Fundamentals of Engineering Thermodynamics, Reverté.