Power plants and heat engines

Academic Year: (2023 / 2024) **Review date: 24-01-2022**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: GONZALEZ GOMEZ, PEDRO ANGEL

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Thermal Engineering
Heat Transfer

OBJECTIVES

The aim of this course is to understand the thermodynamic cycles and technology used in heat engines and power plants. This includes the capability of analyzing the behaviour of thermal engines, turbomachinery, boilers, burners and combustion chambers as components of these systems.
A the end of the course the student must be able to:
- Identify the basic elements of a power plant, their functionality and working conditions.
- Understand the parameters and processes involved in these installations and evaluate their performance
- Understand the technology corresponding to each case.
- Analyze the energy saving possibilities and the environmental impact for each heat engine and power plant described in the course.

As for the different competences acquired through the lectures, it is worth to distinguish between specific and general skills.

With regard to specific competences the student must be able to:
- Define the thermodynamic layout and magnitudes of a power plant.
- Identify the different types of reciprocating engines and power plant components (turbomachinery, boilers, combustion chambers, etc.) and subsystems.
- Establish the applicability frame of the different heat engines.
- Evaluate the environmental impact of the use of different technologies for power generation.

The general skills trained during the course are:
- Problem solving methodology.
- The identification of the relevant information that characterize power generation installations.
- Group work abilities to face complex engineering subjects

After completing the course, the student should have:
- A critical attitude towards identifying and evaluating the operation of basic equipment of an installation.
- A collaborative attitude that will allow obtaining information and knowledge from other agents to perform complex tasks.

DESCRIPTION OF CONTENTS: PROGRAMME

This is a course that includes a base of foundations and a technological base.

The program is divided into the following parts:

FIRST PART (power plants based on Brayton and Rankine cycles):

- Brayton and Rankine cycles for power production, improved cycles.
  -Brayton simple, inter-cooled, with reheating, regenerative, complex and closed cycles. Study of the different types of combustion chambers. Triangle of speeds in compressor and turbine, as well as operating limitations in gas turbines due to the thermal resistance of the blades. Blade cooling systems.
  -Rankine simple, reheating, regeneration (extractions of steam and drainages). Complete cycles. Study of the parts of a boiler and the different types of condensation. Analysis of the operation of the

Feed Water Heater in the regenerative power generation cycles. Parameters Drain Cooling Approach and Terminal Temperature Difference.
- Combined cycles:
  - Study of the operation of combined cycles. Recovery boiler analysis of 1 pressure level. Description of recovery boilers with two and three pressure levels.

SECOND PART

-Motors of internal combustion: Description and analysis of internal combustion thermodynamic cycles. Forced ignition engines (MIF) and spontaneous ignition engines (MIE). Engine architecture. Description of operation of the main parts of a combustion engine: cylinder-piston assembly, distribution (camshaft, crankshaft), valve adjustment, cooling. Yields in MCI, specific, indicated, mechanical. Overfeeding of MCI, variable geometry.

THIRD PART

- Principles of exergy and exergoeconomics applied to power generation cycles.

FOURTH PART

-Technologies:
  -Fundamentals of nuclear energy (Position of nuclear energy in the world and in Spain, fuel, uranium enrichment, types of reactors (PWR, BWR), thermodynamic cycle, reaction control, refrigeration.

  -Fundamentals of concentration solar power plants: Global energy production. CO2 emissions. Paris Conference on Climate. European energy state. Concentrating solar energy: Solar energy, absorption temperature effect, heat transfer fluid, energy storage system, concentration technologies, parabolic trough, linear fresnel, Solar tower, dish Stirling.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:
1) Magisterial classes, where the knowledge that students should acquire will be presented. To facilitate their development, students will receive support material and information on basic and reference manuals that will allow them to complete and deepen relevant topics that are of interest to them.
2) Problem solving, in relation to the knowledge that will be presented and especially in relation to the specific skills that students must develop.
3) Resolution of exercises by the student that will serve to strengthen and contrast with reality the knowledge obtained, allowing them to self-assess their knowledge, acquire the necessary skills and develop technical creativity.

The sharing of solutions given by students to engineering problems and their joint correction should serve to strengthen knowledge and develop the ability to analyze and communicate the relevant information for problem solving. In addition, the sharing will favor the exchange of critical opinions both between teacher and students and between students.

ASSESSMENT SYSTEM

Continuous assessment:

-Laboratory sessions: 10%
-Partial exam: 30%

-Final exam: 60%, minimum grade 4 out of 10

% end-of-term-examination: 60

% of continuous assessment (assigments, laboratory, practicals…): 40

BASIC BIBLIOGRAPHY

- Breeze, Paul A. Power generation technologies, Elsevier, 2005
- El-Wakil, M Power plant technology, McGraw-Hill, 1984
- Heywood J.B. Internal combustion engine fundamentals, McGraw-Hill, 2008
- Horlock J.H. Combined power plants, Pergamon Press, 1992
- Moran M.J., Shapiro H.N. Fundamentos de termodinámica técnica, Reverte, 2004