Universidad Zaragoza

Academic Year: 2025/26

60804 - Energy Technology

Teaching Plan Information

Academic year: 2025/26
Subject: 60804 - Energy Technology
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 532 - Master's in Industrial Engineering
ECTS: 4.5
Year: 1
Semester: First semester
Subject type: Compulsory
Module:

1. General information

The objective of the subject is the learning of advanced concepts related to the fields of Thermal Engineering and Thermotechnology, combining the study of energy sources, energy production systems based on fossil and renewable resources, the configuration of large thermoelectric plants, and the management and technical-economic viability of energy production facilities for the supply to intensive industrial processes in thermal demands.

2. Learning results

Upon completion of this subject, the student will be able to:

- Know the Spanish, European, and global energy structure.
- Know the main characteristics of fossil fuels and their energy uses.
- Know the main renewable energy resources and how to perform calculations about their sizing or production.
- Know conventional thermoelectric generation technologies and perform calculations of the most common power cycles and of each of the main component systems of power plants.
- Know, select and size energy production systems to meet the demands for heat, cold, and electricity of a consumer centre through cogeneration, trigeneration, or separate heat and/or cold production systems and electricity purchase.
- Understand energy management in the industry, and propose energy saving solutions in industrial systems of production, transformation, and consumption.

3. Syllabus

Theory program

1- Introduction/review

- Energy sources and energy technology. Brief history and current context of energy use. Delimitation of the subject
- Review: Units. Energy terminology. Thermodynamic properties and energy balances of technical systems. Second law of thermodynamics. Primary energy and final energy.
- Primary and final energy statistics by activity sectors. Data sources.
- Earth's energy balance. Quantification of fossil resources. Proven reserves. Reserves/consumption ratios. Production peaks
- Typical sizes, costs, and yields of energy equipment
- Review: economic analysis of energy projects

2- Steam power plants

- Context: types and implementation of thermal power plants
- General description and performance of a steam power plant
- Power cycle. Review on Rankine cycle and general arrangement. Turbines. Surface heaters. Degasser
- Cooling circuit. Types and comparison of systems. Water condensers. Cooling towers. Air condensers
- Steam generator. Water-vapor circulation. Combustion systems. Exchange banks. General provision. Fuel, air and gas systems. Throw and fans. Mills and feeding system. Air-gas preheaters
- Gas cleaning equipment. Emission limits. Electrostatic filters. Desulfurization systems. Low NOx combustion. Selective NOx Reduction Systems

3- Combined Cycle Power Plants

- Justification, advantages and disadvantages vs. simple cycles. Classification and configurations. Energy balances and yields. Commercial combined cycles.
- Review: gas turbine power cycles. Simple thermodynamic model. Specific power and performance. Detailed models.

Simple cycle improvements.
- Gas turbines: partial load performance and variation with atmospheric conditions. Description of industrial turbine components. Examples of commercial gas turbines. Gas turbine power plants: history and current functions.
- Recovery boiler: function and differences with power boilers. Temperature difference pinch. Cycle configuration according to pressure levels. Effect of temperature and vapor pressure. Thermal calculations.

4- Industrial energy, cogeneration and alternative engines (in practical sessions)

- Concept of cogeneration and terminology. Yields and characterization indices.
- Cogeneration systems. Generalities, characteristics and applications. Cogeneration with steam turbine. Cogeneration with gas turbine and combined cycle. Cogeneration with MACIs. Reciprocating internal combustion engines. Cogeneration with MACIs.
- Sizing and calculation of cogeneration systems. Legal restrictions in Spain.
- Notions about advanced problems and system operation.

5- Fossil fuels

Coal. Oil and liquid derivatives. Natural gas and LPGs. Other fossil fuels

- Features as energy source. Emissions. Energy uses
- Extraction, refining and treatment, transportation and distribution. Energy infrastructure
- Particular characteristics. Conventional compositions. Standards, specifications and classifications.
- Fuel interchangeability

6- Renewable sources and technologies

- Solar energy. Solar resource. Solar collectors. Thermal solar power plants. Photovoltaic cells and panels
- Wind energy. Wind resource. Wind turbines
- Biomass energy. Dry and wet biomass. Resource, properties and characterization. Management and treatments of biomass. Thermochemical processes. Combustion. Gasification and pyrolysis.
- Biogas production. Liquid biofuels. Ethanol and derivatives. Biodiesel

Internship program

The practices will be oriented towards application problems and sizing of energy supply to processes and services related to the proposed practical work. The following topics could be discussed:

- Industrial boilers and heat networks
- Cogeneration systems
- Cogeneration with MACI
- Cogeneration with steam turbine
- Cogeneration with gas turbine and combined cycle
- Photovoltaic installations
- Thermal solar panels
- Thermal solar panels
- PVT Panels
- Biomass boilers

Recommended bibliography and resources

This subject offers a very broad content that is taught quite briefly. For this reason, all the interesting books are specialized in a certain aspect of the subject and deal broadly with a very small part of the subject. They are interesting as a reference or expansion, but not as direct study material. Class presentations and other specific documents prepared for this purpose are recommended as study material and provided to students through the ADD.

https://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=60804

4. Academic activities

Due to changes in the Master's degree curriculum, this course has no assigned teaching activities during the current academic year.

5. Assessment system

Assessment will be carried out through a global exam conducted within the period established for that purpose in the academic calendar.

6. Sustainable Development Goals

7 - Affordable and Clean Energy
9 - Industry, Innovation and Infrastructure
13 - Climate Action