UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA

DIM-IND-523 Energy Engineering

SEMESTER: Spring

CREDITS: 7.5 ECTS (5 hrs. per week: 4 Theory + 1 Lab, on average)

LANGUAGE: Spanish or English

DEGREES: MII

Course overview

This course aims to equip students with the basic knowledge to understand both energy sources and systems to convert them into power, heating and cooling and to assess the technical and economic feasibility of energy systems. The course will provide to the students with tools to discuss energy policy scenarios with technical criteria to evaluate energy systems, knowing and proposing improvements in power plants of all types and determine the strengths and weaknesses of the different energy sources, both from production and from logistics and processing.

Prerequisites

There are not any prerequisites needed to study the subject. However, as the subject is inserted in an engineering syllabus, it is supported on concepts previously seen in other subjects: energy and mass balances, heat exchangers and renewable resources.

Course contents

Theory:

1. Introduction. Energy, classifications and types. Environmental implications of power generation. Social and geostrategical aspects of energy sources. Assessment of scenarios and energy policies. Assessment of economic feasibility of energy projects.
2. Exergy analysis. Introduction. Exergy analysis in power and refrigeration cycles. Exergy analysis in control volumes. Exergy efficiency.
3. Combustion. Introduction. Combustion reactions. Mass balance. Energy balance.
4. Fossil fuel power plants. Coal power plants (steam cycle). Combined cycle power plants. Repowering of coal power plants. Clean combustion in power plants. CO_2 capture.

5. **5.** Advanced cooling and heat pump cycles. Chilling at low temperatures. Advanced heat pumps. Chilling with non-conventional technology. Absorption refrigeration.
6. **6.** Advanced power plants. Combined heat and power. Organic Rankine cycles. Supercritical CO_2 cycles. Other power plants. Electric generation from renewable sources. Massive energy storage.
7. **7.** Nuclear energy. Introduction. Nuclear reactions. Systems and components of a nuclear reactor. Nuclear fuel cycle. Nuclear wastes. Ionizing radiations. Nuclear fusion. Nuclear power plants: types and Generations. Current nuclear power plants: Generation II and III. Forthcoming nuclear power plants: Generation III+, IV and fusion.
8. **8.** Fossil fuels. Introduction. Oil and derivatives production and distribution. Natural gas production and distribution. Coal production and distribution. Non-conventional hydrocarbons production. CO_2 storage.
9. **9.** Hydrogen as energy carrier. Introduction. Hydrogen generation. Hydrogen storage. Hydrogen direct combustion. Fuel cells.
10. **10.** Energy systems modeling. Introduction. Heat exchangers and ducts. Volumetric machines. Turbomachines. Systems integration.

Laboratory:

There will be four 2-hour sessions at the last four weeks of the semester.

P1. System modelling with Engineering Equation Solver (EES).
P2. Heat pump/chiller device.
P3. Power cycle device.
P4. Fuel measurements or energy conversion..

Textbook

- Teaching material (slides, texts, problems, former exams) at Moodle.
- E. Cassedy and P. Grossman. Introduction to Energy: Resources, Technology and Society. Cambridge University Press, 1998
- R.W. Haywood. Analysis of Engineering Cycles. Pergamon Press, 1991.

Grading

The overall grade is obtained as follows:

- Final exam 50%.
- Mid-term exam 20%.
- Team work and presentation 15%.
- Lab. sessions reports 15%.

If the previous weighted average results higher than 5 the subject score will be such average; in the opposite case the score will be the minimum between such average and the end of term exam score.