Energy Systems

Instructors:
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Course Format:
2 hours lecture (30 lectures)

Period:
Spring Semester (March-June)

Language:
English

Recommended previous knowledge:
Good knowledge of Physics, Thermodynamics, Heat Transfer, Fluid Machinery

Contents:
The students will be introduced to the main principles of energy conversion systems, with particular reference to steam and gas turbine power plants, combined cycle power plants, reciprocating internal combustion engines and hydroelectric power generation.
More specifically, the following topics will be addressed:
Introduction
Overview of energy sources, energy conversion systems, national and world energy needs.
Analysis of energy conversion systems based on 1st and 2nd Law of Thermodynamics.
Thermodynamic cycles: external and internal irreversibilities, definition of Rankine-Hirn and Joule-Brayton cycles.
Steam power plants
Analysis of ideal and real thermodynamic cycles. Choice of operating parameters and techniques to improve plant's efficiency: steam reheating, regenerative feed heating. Plant layouts.
Gas turbine power plants
Analysis of ideal and real thermodynamic cycles. Choice of operating parameters and techniques to improve plant's efficiency: regenerative heat exchanger, reheaters, intercoolers. Plant layout of heavy-duty and aeroderivative turbines.
Combined cycle power plants
Analysis of "topping" (gas turbine) and "bottoming" sections, efficiency, power ratio between gas and steam turbine, plant layout. Thermodynamic optimization of bottoming sections with variable temperature heat input.
Reciprocating internal combustion engines
Classification; ideal and real thermodynamic cycles; power output, mechanical efficiency, volumetric efficiency and engine operating parameters; air intake system; supercharging and turbocharging; fuel metering in SI engines; fuel injection in CI engines; operating characteristics and performance maps; load matching: power generation and ground propulsion.
Hydroelectric power generation
Hydraulic turbines: classification, operating parameters, performance characteristics, cavitation. Hydroelectric plant layouts. Pumped storage hydroelectricity.

Learning Outcomes:
After completing the course, the students should acquire a good knowledge of the fundamental operating principles of energy conversion systems, and they should be able to analyse the layout and evaluate performance and efficiency of thermal and hydroelectric power plants.

Reading Resources:
- Lecture notes
- M.J. Moran et al., *Fundamentals of Engineering Thermodynamics*, Wiley, 2010
- A. Bejan, Advanced Engineering Thermodynamics, Wiley, 2006
- R. Stone, *Introduction to Internal Combustion Engines*, Palgrave Macmillan, 2012
- G. Ferrari, *Internal Combustion Engines*, Progetto Leonardo, 2011
- R.E.A. Arndt, *Hydraulic turbines*, in *The Engineering Handbook - Second Edition*, *chapter 73*, CRC Press, 2005.

Performance Record:
Written and oral examination

Further Information:
http://didattica.uniroma2.it/

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