

M.Sc. in Environmental & Energy Engineering

Course name: Fuel Cells & Distributed Generation Systems

Teaching Sector: ING-IND/09

CFU: 6

Objectives:

This course shows the fundamental know-how related to fuel cell and distributed generation systems. The attention is mainly focused on thermodynamic theory, component performance and economic aspects. Fuel cells are presented putting emphasis on different fuel cell typology, hybrid system layouts, technological and environmental aspects. Different small size systems (reciprocating engines, microturbines, stirling engines, fuel cells, renewable systems) are considered for distributed generation applications. For this part of the course, special attention is devoted to combined heat and power generation providing students with laboratory experiences.

Essential contents:

- Fuel cells (basic structure, brief history, technological status, cost considerations); Fuel cell types (polymeric, alkaline, phosphoric acid, molten carbonate, solid oxide); Fuel cell electrochemistry (ideal and losses).
- Fuel cells: influence of main operative properties (pressure and temperature), materials, performance, fuel processing (external and internal reforming).
- Hybrid systems with low temperature fuel cells (PEM, AFC, PAFC) and high efficiency (>60%) hybrid systems with high temperature fuel cells (MCFC; SOFC).
- Distributed generation systems: basic thermodynamic aspects for reciprocating engines, microturbines and stirling engines.
- Distributed generation systems: co-generation and tri-generation.

Skills to be transferred to students:

- Understanding of basic fuel cell behaviour.
- Understanding of basic hybrid system characteristics.
- Understanding of distributed generation system behaviour (basic level).

Teaching typology:

- 42 hours: theoretical lessons.
- 6 hours: laboratory activities.

Exam typology: Oral exam (final)

References:

- Fuel Cell Handbook (Seventh Edition), US Department of Energy, Morgantown, WV (USA), 2004.
- A. Massardo, P. Costamagna, Fuel Cell and Hybrid Systems - Lectures, Thermochemical Power Group (TPG) – www.tpg.unige.it.
- Larminie J., Dicks A., Fuel Cell Systems Explained (Second Edition), John Wiley & Sons Ltd, Chichester (UK), 2003.
- J.O.M. Bockris, S. Srinivasan, Fuel cells: their electrochemistry, Mc Graw- Hill, NY, 1969.
- G. Lozza, Gas Turbines and Combined Cycles (Second Edition) – In Italian, Esculapio Ed., 2006.