UNIVERSITÀ degli STUDI di CATANIA

DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Master's Degree in Mechanical Engineering
Academic Year 2016/2017 - 2° Year

PROGETTO DI MACCHINE

ING-IND/08 - 9 CFU - 2° Semester

Teaching Staff

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LEARNING OBJECTIVES

The course is divided into two parts. The first part of the course concerns the design of wind turbines, while the second is devoted to the study of reciprocating internal combustion engines. The course provides the basis for the aerodynamic design of wind turbines (horizontal and vertical axis wind turbines) and the evaluation of their performance. With regard to reciprocating internal combustion engines (ICE) the course provides students with the basis for the design, focusing on key aspects such as Performance Optimization, Engine Cycle Simulation, ICE Combustion, Pollutant Formation and Control. During the course will be carried out numerical simulations on the computer.

DETAILED COURSE CONTENT

RECIPROCATING INTERNAL COMBUSTION ENGINES

Classification. Maximum efficiency, internal thermodynamic efficiency and organic efficiency.

- Thermodynamic and thermo-chemistry of continuous systems process. - First principle of thermodynamics. Second principle of thermodynamics. Combustion at constant volume and/or constant pressure.

- Feeding air. - Filling in 4-strokes engines: general data, detailed study, analysis of the distribution equipment. Filling in 2-strokes engines: general data, outlines of washing, analysis of the washing process.

- Feeding fuel in spark-ignition engines. General requirements. Elementary carburettor. Injector.

- Feeding fuel in the compression-ignition engines. Requirements in terms of atomization and penetration of the jet. Mechanical injection systems. Injection Systems. Common Rail System.

- Biofuels.

- Supercharging: historical hints. Supercharging with compressor mechanically dragged or set in action by a drainage gas turbine. Use of volumetric compressors and turbo super-feeders.

- Combustion – General data: speed of reaction and ignition temperature. Normal development of the combustion.

- Combustion in spark-ignition engines - Parameters that influence the speed of flame propagation. Anomalies of combustion: pre-ignition, self-ignition, misfiring, detonation. Standardized and not conventional methods of measurement of the intensity of detonation. Octane number. ICE-SI Combustion: theories and experimental analysis of the various stages of the combustion, effects of the turbulence scale.

- Combustion in compression-ignition engines - Delay in the ignition, state of pressures, of injected and burnt masses, coarseness. Cetane number. Analysis of the combustion in case of open room and pre-room, atomization, and penetration of the fuel injected, turbulence and dragging motions of loads.

- Emissions of polluting agents: harmful effects, mechanisms of formation, influence of geometric-constructive parameters and of operation parameters. Legislation and test cycles.

- Numerical evaluation of the Heat Release in ICE-SI;

- Numerical evaluation of the Limit Cycle of a ICE-SI;

- Numerical evaluation of ICE pollutants.

WIND TURBINES DESIGN

Wind turbine technology. Fundamental concept of wind turbine engineering.

Wind turbines mathematical models. Airfoil characterization. Lift and drag coefficient.

Blade Element Momemtum Theory. Wind rotor performance evaluation. Application to Horizontal Axis Wind Turbines and to Vertical Axis Wind Turbines. Power curves. Power and Torque coefficients. Wind Rotor Solidity. Off design performance evaluation.

-Fluid Dynamic Design of an Horizontal Axis Wind Turbine;

-Fluid Dynamic Design of a Vertical Axis Wind Turbine.

SUBSONIC WIND TUNNEL DESIGN

Type of wind tunnels.

Wind tunnel components: Test section, diffuser, corners, Fan, Settling chamber. Honeycomb and screens.

Subsonic Wind tunnel design. Power consideration. Section loss coefficients. Energy Ratio. Test section Flow quality.

-Fluid Dynamic Design of a Subsonic Wind Tunnel.

TEXTBOOK INFORMATION

[1] J.B. Heywood: "Internal combustion engine fundamentals", Mc Graw Hill
[2] G.Ferrari: "Motori a Combustione Interna", Società Editrice Esculapio
[3] Battisti L.: Gli impianti motori eolici, Green Place Energies
[4] Sphera DA, editor. Wind turbine technology: fundamental concepts of wind turbine engineering.
[5] Barlow, Rae, Pope: Low Speed Wind Tunnel Testing. John Wiley & Sons, Inc. Third Edition