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## Supplement to machines

### Finalità

The course completes the knowledge yielded during Macchine AB, as for fluid machinery and primary energy converters. The discipline is dealt with according to the Italian engineering tradition: a unique theory for hydraulic/steam/gas as well as for open/closed cycle processes is developed. Models are updated in view of engineering methods utilised in the 21st century. Applications are practice oriented.

### Programma

Energy systems and economics: history of prime movers, hydropower fundamentals; thermal power plants, the laws of thermodynamics, figure of merit for direct cycles, fuels and their properties, nuclear energy.

Analysis of fluid machinery: compression and expansion processes, efficiencies, Stodola's plot, internal and mechanical turbine characteristics; matching pumps to loads; perfect and semi-perfect gas, polynomial models; energy balance across chemical reactions, high temperature dissociation, adiabatic combustion temperature; regeneration in power plants; similarity applied to fluid machinery; 2D aerodynamics, lift & drag.

Power plants: design criteria for hydropower (storage & run of river) plants; feed water heating, humidity, reheating in steam power plants; nuclear reactors (BWR, PWR, LMFBR), nuclear steam cycles; cycles and open processes for gas turbine power plants, component matching, off design and control methods; power sharing, afterburning, multiple pressures in combined cycle power plants, STIG; internal combustion engine fundamentals, fuel-air cycles, gas exchange process, combustion development, energy balance.

Fluid machinery and power plant components: stage efficiencies, power breakdown in Curtis stages, 3D effects in axial turbomachines, capacity limits of steam turbines, heat exchangers for steam plants, condensers & subcooling, air condensers, cooling towers, air pre-heaters; axial thrust balancing and seals in turbomachines; vanes and velocity triangles, diffusers, suction head and cavitation in hydraulic turbines; dynamic compressors, stall, surge, multistage compressors, choking, rotating stall; gas turbine combustion chambers, heat recovery steam generators; positive displacement compressors, reciprocating and rotary, reciprocating pumps, flow ripples, dampers, rotary pumps for fluid power systems.

### Attività d'esercitazione

Gas & water steam models.

Applications on pump-piping matching procedures, combined cycle power plants.

Preliminary design of: Pelton & Banki turbines, water tube steam generator, condensing system, centrifugal pump, steam turbine, reciprocating compressor.

### Modalità d'esame

oral

### Testi consigliati

C. Caputo – Gli impianti convertitori di energia – Masson, Milan

C. Caputo – Le macchine volumetriche – Masson, Milano

C. Caputo – Le turbomacchine – Masson, Milan