

MECH 432: Energy Systems

Catalog description: 4.0 units

Thermodynamics of power cycles, refrigeration, air-conditioning, and combustion processes; analysis, design, and testing of systems involving both conventional and renewable energy sources for power generation, heating, and cooling applications. 3.0 hours discussion, 3.0 hours laboratory.

Prerequisites: MECH 338

Course objectives: For students to

1. Apply the principles of thermodynamics and heat transfer to the analysis of vapor and gas power cycles, refrigeration cycles, air conditioning systems, combustion systems, and solar thermal energy systems
2. Test the performance of thermal-fluid equipment by conducting laboratory experiments, analyzing/reducing the acquired data, and interpreting the results

Course outcomes: Students shall be able to

1. Analyze the performance of vapor power (Rankine) cycles with reheat and regeneration
2. Analyze the performance of spark-ignition ICE engines (Otto cycle)
3. Analyze the performance of compression-ignition ICE engines (Diesel cycle)
4. Analyze the performance of gas turbine (Brayton) cycles with intercooling, reheat, and regeneration
5. Analyze the performance of vapor-compression refrigeration cycles
6. Analyze the performance of air conditioning systems with simple heating or cooling, evaporative cooling, humidification, and dehumidification
7. Analyze the performance of combustion chambers undergoing complete combustion
8. Analyze simple flat-plate solar collector systems
9. Conduct thermal-fluid experiments, analyze acquired data, and interpret the results

Topics covered

1. Brief review of introductory thermodynamics
2. Vapor power cycles: Rankine cycle with reheat and regeneration, binary cycles, cogeneration
3. Gas power cycles: Otto, Diesel, Stirling, and Brayton cycles; reheat, intercooling, and regeneration processes; turbocharging, compressors, jet engines, combined cycles
4. Refrigeration cycles: vapor-compression, absorption, reversed-Brayton, and thermoelectric; types of refrigerants, multistaging and cascading, heat pumps
5. Psychrometrics: gas mixtures, humidity, dew point, dry-bulb and wet-bulb temperatures, mixture enthalpy, adiabatic saturation, psychrometric chart, conservation of mass and energy, simple heating and cooling, humidification and dehumidification, evaporative cooling, adiabatic mixing, cooling towers

6. Combustion: chemical reactions, mass balance, air-fuel ratio, enthalpy of formation, conservation of energy, adiabatic flame temperature, entropy of reacting systems, fuel cells
7. Solar thermal energy systems: solar radiation, absorption and transmission, flat-plate collectors

Class/Laboratory schedule

One hundred fifty minutes of lecture and one hundred fifty minutes of laboratory per week

Contribution of course to meet the professional component

This course contributes to the student's ability to work professionally in the thermal systems area.

Relationship of course to Mechanical Engineering Program Outcomes

This course contributes principally to Program Outcomes A, B, and D. Students must achieve a grade of C or better in the laboratory portion to pass the course and satisfy Program Outcome B.