Thermal Engines

1. **Course number and name:** 020MOTES4 Thermal Engines

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Roy Harb

4. **Instructional Materials:** Course handouts; PowerPoint slides

5. **Specific course information**
   a. **Catalog description:**
   A course that examines the fundamentals of the design and operation of internal combustion engines, focusing on fluid/thermal processes. The subjects covered include the analysis of the phenomena of aspiration, compression, combustion, expansion, expansion and formation of pollutants; heat transfer and friction phenomena; 2 and 4-stroke engines, supercharges and performance characteristics; thermochemistry of air-fuel mixtures; social implications of motorization.

   b. **Prerequisites:** General Chemistry (020CHGNI1 or 020CHGCI1) and Thermodynamics: Laws and Applications (020TPAES1) or Thermodynamics: Principles and Phase Change (020TPPES1).

   c. **Selected Elective** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   A student who successfully fulfills the course requirements will have demonstrated an ability to:
   - Develop an understanding of basic thermodynamic principles.
   - Analyze and optimize thermodynamic cycles.
   - Comprehend fundamentals of combustion and chamber design.
   - Develop an understanding of various energy conversion systems.
   - Analyze and predict thermal system performance.
   - Design thermal systems considering various factors.
   - Address environmental concerns and sustainability.
   - Use software tools for system simulation and modeling.

   b. **PI addressed by the course:**

PI	1.1	1.2	2.1	2.2	4.2
Covered	x	x	x	x	x
Assessed	x	x	x	x	x

7. **Brief list of topics to be covered**

- **Introduction:** Definition of thermal engine. Classification of thermal engines. Systems of the thermal engine. Characteristics of the engine. Engine technology.

- **Cycles of piston engines:** Cycle with gain of heat at constant volume and calculation of its thermal efficiency. Cycle with gain of heat at constant pressure and calculation of its thermal efficiency. Cycle with mixed gain of heat and calculation of its thermal efficiency. Mean pressure of thermodynamic cycle. Actual cycle of 4 stroke engine. Actual cycle of two stroke engine.
- **Fuel and combustion:** Main characteristics of fuel for gasoline and Diesel engine. Heat power, theoretical air requirement and air/fuel ratio. Calculation of combustion products of stoichiometric and lean mixture. Calculation of combustion products of rich mixture. Molecular variation during the combustion of liquid fuel. Molecular variation coefficient.
- **Engine fluid parameters of 4 stroke actual cycle:** 4 stroke engine cycle drawing. Calculation of engine fluid parameters at the end of the intake stroke. Volumetric efficiency. Calculation of engine fluid parameters at the end of the compression. Calculation of the engine fluid parameters at the end of the combustion. Calculation of the engine fluid parameters at the end of the power stroke (expansion).
- **Engine parameters:** Parameters of the theoretical cycle and actual cycle. Calculation of the indicated parameters. Parameters affecting the indicated efficiency. Mechanical losses. Mechanical efficiency and parameters affecting the mechanical efficiency. Calculation of the effective parameters of the engine. Variation of the effective power and the effective efficiency with respect to engine RPM.
- **Ecological study of internal combustion engine:** Emissions: description and effect on human and environment. Parameters affecting the toxic emissions during the combustion. Main processes to reduce the toxic emissions in gasoline and Diesel engine.
- **Tutorial:** Thermal calculation of an engine in order to determine its dimensions based on its effective power at a specified RPM, with a given compression ratio and fuel.