Thermodynamics: Laws and Applications

1. **Course number and name:** 020TPAES1 Thermodynamics: Laws and Applications

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Chantal Maatouk

4. **Instructional Materials:** PowerPoint slides - Professor text book

   Textbooks/References:
   - Professor text book and other supplemental materials.
   - Thermodynamics. An engineering Approach. Yunus Çengel, Michael Boles. Fifth edition in SI units. Mc Graw Hill.
   - Fundamental of engineering thermodynamics. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margeret B. Bailey. Wiley.

5. **Specific course information**
   a. **Catalog description:**
      This course is designed to provide students with a comprehensive understanding of the foundational principles of thermodynamics and their practical applications in engineering systems. It integrates theoretical concepts with real-world scenarios, enabling students to apply thermodynamic principles to solve engineering problems and design efficient systems.

   b. **Prerequisite:** Thermodynamics 1 (020TH1NI2 or 020TH1CI2).

   c. **Required** 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:
      - Apply fundamental principles of thermodynamics to an energy system.
      - Analyze a system of a certain complexity, allowing the study of an industrial process or apparatus.
      - Analyze, design and optimize, with the appropriate calculations, a thermodynamic system for the production of mechanical energy, in steady state operating conditions.
      - Analyze, design and optimize, with the appropriate calculations, a refrigeration system operating in steady state.
      - Choose the appropriate working fluid for thermodynamic systems, in compliance with environmental laws and regulations.

b. PI addressed by the course:

PI	1.2	1.3	6.1	6.2	6.3	6.4
Covered	x	x	x	x	x	x
Assessed		x	x	x	x	x

7. Brief list of topics to be covered

- **Course introduction** (1 Lecture)
- **Introduction and basic concepts**.
- **Forms of Energy**. This section introduces the concept of energy and defines its form. Properties of pure substances. This section introduce the concept of pure substance, discuss the physics of phase change processes apply the ideal gas equation of state in the solution of typical problems and introduce the compressibility factor of real gases.
- **First law of thermodynamics**. In closed systems: Energy balance; Energy change of a system (ΔE_{system}); Mechanisms of energy transfer*;* Forms of energy: heat and work; Specific heats; Internal energy, enthalpy and specific heats of ideal gases; Internal energy, enthalpy and specific heats of solids and liquids, (3 lectures). In open systems: Control volumes; Conservation of mass principle; Energy balance for a control volume; Energy analysis of steady-flow systems; Some steady state engineering devices (Nozzles and diffusers, Turbines and compressors, throttling valves, Mixing chambers, Heat exchangers, Pipe and duct flow), (3 lectures).
- **Second law of thermodynamics**. Kelvin-Planck statement of the second law; The second law of thermodynamics: Kelvin-Planck statement; Clausius statement of the second law; Reversible and irreversible processes; Carnot cycle; Carnot heat engine; Carnot refrigerator and heat pump; Entropy; Isentropic processes; Property diagrams involving entropy; The *T* ds relations; Isentropic processes of ideal gases; Reversible steady flow work; Proof that steady-flow devices deliver the most and consume the least work when the process is reversible, (4 lectures).
- **Gas Power Cycles**. Basic considerations in the analysis of power cycles; Air-standard assumptions. Otto cycle: The ideal cycle for spark-ignition engines; Diesel cycle: The ideal cycle for compression-ignition engines; Stirling and Ericsson cycles (5 lectures).
- **Refrigeration Cycles**. Refrigerators And Heat Pumps; The Reversed Carnot Cycle; The Ideal Vapor-Compression Refrigeration Cycle; Actual Vapor-Compression Refrigeration Cycle**;** Selecting The Right Refrigerant; Heat Pump Systems; Innovative Vapor-Compression Refrigeration Systems, (5 lectures).