Course Syllabus

1. Course number and name: 020TDMES3 – Thermodynamics of Machines

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

3. Instructor's or course coordinator's name: Chantal MAATOUK

4. Text book :
    a. other supplemental materials:
    Professor text book and other supplemental materials.
    Thermodynamics. An engineering Approach. Yunus Çengel, Michael Boles. Fifth edition in SI units. Mc Graw Hill

5. Specific course information
    a. catalog description : During this course the students will develop their skills and knowledge in the following areas. Thermodynamic systems: properties and processes. Calculations of changes in a thermodynamic system. Calculations of applied thermodynamic systems. Study and design of energy conversion systems. The objective of this course is to give an advanced training to electrical and mechanical engineers on the utility of thermal machines and their operating principle. It seeks to be a bridge between the theoretical notions of thermodynamics and the concrete applications of industrial processes.

    b. prerequisites : Thermodynamics 2

    c. Required/Elective/Selected Elective: Selected Elective

6. Specific goals for the course
    a. specific outcomes of instruction,

- Apply fundamental principles of thermodynamics to any 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. KPIs addressed by the course.

KPI	a1	a2	k3
Covered	x	x	x
Assessed	x	x	x
Give Feedback			x

7. Brief list of topics to be covered and approximate lecture hours :
   - Course introduction, (1 Lecture)
   - Chapter 1- Basic notions of thermodynamics: Temperature and heat; Work and P(V) diagram; Basic thermodynamic processes. Heat, work and internal energy of fluids. Reversible processes. Ideal Gas. (2 lectures).
   - Chapter 2- First law of thermodynamics: 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, (2 lectures).
   - Chapter 2- First law of thermodynamics: 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), (2 lectures).
   - Chapter 3- 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, (3 lectures).
   - Chapter 4- Gas Power Cycles. Basic considerations in the analysis of power cycles; The Carnot cycle and its value in engineering; 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; Brayton cycle; Turbojet, (5 lectures).
   - Initiation to "Thermoptim" software. Case study, (5 lectures).
   - Chapter 5- 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).