PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL AND METALLURGICAL ENGINEERING
ABET COURSE SYLLABI

ICM1003 THERMODYNAMICS

Credits and contact hours: 10 UC credits / 10 hours (3 h. Lectures; 1,5 h. Labs; 5,5 h. Independent learning experiences)

Instructor's name: Juan de Dios Rivera

Course coordinator's name To be defined

Textbook: "Thermodynamics: An Engineering Approach w/ Student Resources DVD", Cengel, Y. A. and M. A. Boles, Ed. McGraw-Hill, 4th Ed., New York, 2002.

Course Catalog Description: Thermodynamics is a fundamental discipline of Engineering sciences that study the processes that occur when one or more systems interact with the surroundings producing changes in the temperature, concentration or other potential. These processes are usually accompanied by the transformation of one form of energy into another one. Thermodynamics provides the laws that rule these transformations. In this course the student will learn to apply the First and Second law of Thermodynamics to pure substances undergoing processes in closed or open systems. This will allow the calculation of work and heat exchanged and the efficiency of different systems of interest, like internal combustion engines, power plants and refrigeration systems.

Prerequisite Courses: None

Co-requisite Courses: MAT1630 Calculus III

Status in the Curriculum: Required

Course Learning Outcomes:

1. To understand the four fundamental laws of thermodynamcis.
2. To apply the zeroth law to the analysis and design of thermometers.
3. To apply energy and entropy balance to simple compressible systems..
4. To understand how energy is transformed in different Engineering applications.
5. To apply knowledge and skills to analyze different heat-work conversion processes.

Relation of Course to ABET Criteria:

a. Knowledge of mathematics, science and engineering
e. Identify, formulate, and solve engineering problems
f. Professional and ethical responsibility
j. Knowledge of contemporary issues
k. Techniques, skills, and modern tools for engineering practice.

Topics covered: Chapter 1. Fundamental concepts and zeroth law.

1.1. Motivation, definitions, relevance, units, applications.
1.2. Fundamental concepts and definitions (system, properties, equilibrium, process, equation of state).
1.3. Zeroth law, thermal equilibrium, temperature scales, thermometers.
1.4. Thermodynamic equilibrium, work, expansion, compression, processes (reversible/irreversible, with/without friction), thermodynamic efficiency.
1.5. Thermodynamic properties and tables.

Chapter 2. First Law

2.1. Types of work, Joule's experiment, energy, preliminary formulation and application of the First Law.
2.2. First Law general formulation, analysis of open, steady state systems and its application to the design of process equipment.
2.3. Analysis of simple process in transient state (uniform flow uniform state, filling and emptying processes).
2.4. Units, important properties (internal energy, enthalpy, sensible heat, specific heat).
2.5. Ideal gas and its properties.
2.6. Analysis of different ideal gas processes (isothermal, isochoric, isobaric, polytrophic).
2.7. Real gases, phase diagrams, critical point, residual volume, Boyle's temperature, generalized compressibility factor. Outcomes 2 and 3.
2.8. Equations of state for real gases I (virial equation, attraction-repulsion forces).
2.9. Equations of state for real gases II (van der Waals equation, Redlich-Kwong equation).

Chapter 3. Second Law

3.1. Fundamental concepts (process directionality, thermal reservoir, Clausius and Kelvin-Planck postulates, thermal efficiency, coefficient of operation).
3.2. Carnot cycle (Carnot principle, thermodynamic temperature scale, Carnot efficiency).
3.3. Entropy (Clausius inequality, entropy, Mollier diagrams).
3.4. Exergy and irreversibility (energy available and non-available, lost work).
3.5. Entropy balance, entropy and probability, Third law.
3.6. Thermodynamic relations (Gibbs and Helmholtz functions, Maxwell relations, Clapeyron ecuation).

Chapter 4. Heat engines

4.1. Power cycles I (Carnot cycle limitations, Rankine cycle, effect of operation variables).
4.2. Power cycles II (modifications to Rankine cycle). Outcomes 4 and 5.
4.3. Internal combustion engines (Otto cycle, Diesel cycle, standard air cycle, rigorous analysis).
4.4. Refrigeration and heat pump (reverse Carnot cycle, vapor compression cycle, Joule-Thompson coefficient).

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