PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
SCHOOL OF ENGINEERING
DEPARTAMENT OF CHEMICAL ENGINEERING AND BIOPROCESSES
ABET COURSE SYLLABI

IIQ1003 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: L. Valenzuela / R. Pérez / H. Jorquera

Course coordinator's name To be defined

Textbook: Lecture Notes On Thermodynamics, Joseph M. Powers, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Indiana, USA. Available at: http://ocw.nd.edu/aerospace-and-mechanicalengineering/thermodynamics/lectures/Thermodynamics

Course Catalog Description: Thermodynamics is a science devoted to the study of energy interactions between a system and its surroundings whenever changes in mass, pressure, temperature, composition, etc. happen.

Thermodynamics provides universal laws describing those energy interactions in a quantitative framework.

By the end of this course students will be able to:

a) Apply 1st and 2nd Law analysis to open and closed systems composed of pure substances.
b) Compute heat, work and thermodynamic efficiency for several systems such as internal combustion engines, power generation cycles and refrigeration cycles.

Prerequisite Courses: None

Co-requisite Courses: MAT1630 Calculus III

Status in the Curriculum: Required

Course Learning Outcomes:

1. Understanding of Thermodynamic Laws.
2. Applying Zero-Law concepts to the analysis and design of thermometers.
3. Applying energy and entropy balances to simple systems (pure fluids).
4. Understanding how energy is converted and used in different Engineering applications.
5. Analyzing, solving and designing several processes of heat – work conversion.

Relation of Course to ABET Criteria:

a. Knowledge of mathematics, science and engineering
c. Design a system, component, or process
e. Identify, formulate, and solve engineering problems
g. Effective communication
k. Techniques, skills, and modern tools for engineering practice.

Topics covered:

Chapter 1: Fundamentals and Zero Law.

1.1. Basic definitions: system, surroundings, properties, equilibrium, process, equation of state,
1.2. Zero Law, thermal equilibrium, thermometers, temperature scales.
1.3. Thermodynamic equilibria, work, expansion-compression processes, friction/frictionless processes, thermodynamic efficiency.
1.4. PVT properties, thermodynamic tables.

Chapter 2: First Law.

2.1. Work, Joule experiment, energy, preliminary formulation, applications.
2.2. General Formulation, control volume analysis of open systems, application to process equipment design.
2.3. Analysis of steady state processes, analyses of transient processes (filling and discharge processes).
2.4. Internal energy, enthalpy, sensible and latent heat.
2.5. Ideal gases and their properties. Analysis of isothermal, isochoric, isobaric, adiabatic and polytropic processes.
2.6 Real gases, phase diagrams, critical point, compressibility factor.
2.7. Virial, van der Waals and Redlich-Kwong EOS, compressibility chart.

Chapter 3: Second Law.

3.1. Fundamentals: reservoir, process direction, Clausis and Kelvin-Planck statements, thermal efficiency, coefficient of operation.
3.2. Carnot cycle, postulates and efficiency, thermodynamic temperature.
3.3. Clausius inequality, entropy function.
3.4. Exergy and irreversibility, available work, lost work.
3.5. Entropy balance, entropy and probability, Third Law.
3.6. Thermodynamic relationships, Maxwell equations, Gibbs and Helmholtz functions, Clapeyton equation.

Chapter 4: Applications

4.1. Power cycles. Carnot’s limitations, Rankine cycle, effect of operation variables. Modifications to Rankine cycle.
4.2. Internal combustion engines, Otto and Diesel cycles, standard air cycle, detailed analysis.
4.3. Refrigerators and heat pumps. Inverse Carnot cycle, vapor compression cycle, Joule-Thomson coefficient.
4.5. Other applications: geothermal power plant, nuclear power plant, co-generation, fuel cells.

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
SCHOOL OF ENGINEERING
DEPARTAMENT OF CHEMICAL ENGINEERING AND BIOPROCESSES
ABET COURSE SYLLABI