ChE 122

Chemical Engineering Thermodynamics I

Course Description: Problem-solving techniques in solving chemical engineering problems; Mass and energy balances in unit operations and unit processes; Principles of phase equilibrium as applied to unit operations

Course Prerequisites: Math 55, ChE 101

Course Credit: 3.0 units (3 h lecture)

Program Educational Objectives (BS Chemical Engineering)

The program aims to educate students such that three to five years from graduation, they:

1. take leadership roles in their respective fields and/or effectively work in or manage a team;
2. are equipped with the extensive knowledge and relevant skills necessary to succeed in their chosen careers and to become responsive citizens;
3. are able to demonstrate strong research & innovative capability as they recognize and address opportunities and challenges in their respective spheres of influence;
4. have shown strong commitment to the ethical practice of their profession; to health, safety and environment; and service to society.

Course Outcomes

At the end of the course, the student should be able to:

1. Demonstrate the ability to analyze the energy exchanges in open and closed systems as they undergo simple processes by identifying process system boundaries, and apply the first law of thermodynamics;
2. Differentiate between reversible and irreversible processes and the repercussions of irreversibility on a process and its analysis;
3. Describe the behavior of a pure fluid as its temperature and pressure change, and illustrate processes on PVT diagrams;
4. Adeptly use equations of state for evaluating volumetric properties of pure fluids, both ideal and real;
5. Analyze the heat effects of industrial processes by evaluating the sensible heat of gas mixtures, estimate the latent heat of pure substances, and evaluate the heats of reaction at other than standard temperatures and pressures;
6. Explain the thermodynamic limits of processes in the light of the second law of thermodynamics;
7. Calculate entropy changes of an ideal gas as it undergoes a process, and set up and solve entropy balances for open systems;
8. Evaluate the thermodynamic efficiencies, and ideal and lost work of processes;
9. Estimate the thermodynamic properties of pure fluids (ideal and non-ideal) and two-phase systems of pure fluids using thermodynamic diagrams and property correlations;
10. Set up and solve energy balances for the flow of compressible fluids through ducts, turbines or compressors; and
11. Describe and analyze the processes involved in power production, refrigeration, and liquefaction and identify opportunities for improvements in process efficiency

Student Outcomes Satisfied by Course Outcomes

[a] Ability to apply knowledge of mathematics and science to solve engineering problems
[e] Ability to identify, formulate, and solve engineering problems
[k] Ability to use the techniques, skills, and modern tools for engineering practice

Course Content

Meeting	Topic	Sub-topics
1	Introduction and Review	Nature and Scope of Thermodynamics
		Units and Dimensions; Process Variables
		Definitions and Formalism
2-3	First Law of Thermodynamics	Statement of the First Law
		Energy Balance for Closed Systems
		Mass and Energy Balance for Open Systems
4-6	Properties of Pure Fluids	PVT Behavior of Pure Substances
		The Ideal Gas Model
		Property Tables and Diagrams
7-10	Heat Effects	Sensible Heat Effects
		Latent Heats of Pure Substances
		Standard Heats
		Heat Effects of Industrial Reactions
FIRST LONG EXAMINATION		
11-14	Second Law of Thermodynamics	Statements of the Second Law
		Heat Engines
		Entropy
		Entropy Balance for Open Systems
		Ideal and Lost Work
		The Third Law of Thermodynamics
15-18	Applications to Flow Processes	Duct Flow of Compressible Fluids
		Turbines
		Compression Processes
SECOND LONG EXAMINATION		
19-21	Production of Power from Heat	Steam Power
		Internal Combustion Engines
		Jet and Rocket Engines
		Thermodynamic Analysis
22-24	Refrigeration and Liquefaction	The Carnot Refrigerator
		Vapor-Compression Cycles
		Absorption Refrigeration
		Heat Pumps
		Liquefaction Processes
		Thermodynamic Analysis
DESIGN PROJECT		
25-28	Volumetric Properties of Pure Fluids	Virial Equations of State
		Cubic Equations of State
		Generalized Correlations
29-32	Thermodynamic Properties of Fluids	Property Relations of Thermodynamic Variables
		Residual Properties
		Generalized Property Correlations
		Two-Phase Systems
THIRD LONG EXAMINATION		
FINAL EXAM		

Course Assessment

Long Examinations	60%
Design Problem	15%
Class Activities	5%
Final Exam	20%

Course Policies

1. Class participation, both in-class and online, is highly encouraged. To promote an open atmosphere for discussion, please keep your phones and other unnecessary gadgets away during class time.
2. Everyone should come prepared to class. Not everything will be in the lectures; thus, the recommended pre-lecture videos and readings are expected, if not required.
3. Examinations
    a. LE's may be closed- or open-book exams. Necessary tables and figures shall be agreed upon prior to the examination date.
    b. Grievances regarding checked LE's shall be entertained only within three (3) working days upon the return of papers. All grievances (for any reason) will not affect the grades if they are raised after the 3-day grace period.
    c. There will be no make-up LE's. For those who missed an LE due to valid reasons, they must present an official excuse slip from the administration within one (1) week after the missed exam; otherwise, a score of zero will be given to the missed exam. The Final Exam will replace the missed exam. Only one (1) valid missed exam is allowed.
4. University rules on absence, cheating, dropping and LOA shall apply.
5. The instructors reserve the right to change class policies when deemed necessary.

Grading System

1.00	1.25	1.50	1.75	2.00	2.25	2.5	2.75	3.00	5.00
[92,100]	[88,92)	[84,88)	[80,84)	[76,80)	[72,76)	[68,72)	[64,68)	[60,64)	[0,60)

List of Instructors

Dr. Maria Lourdes Dalida
Dr. Terence Tumolva
Dr. Analiza Rollon
Dr. Jem Valerie Perez
Prof. Jhud Mikhail Aberilla
Engr. Michael Sean Deang
Mr. John Andrew Kane Jovellana

References

1. Smith, Van Ness and Abbott: *Introduction to Chemical Engineering Thermodynamics*
2. Balmer, R.: *Modern Engineering Thermodynamics*
3. Callen, HB: *Thermodynamics and Introduction to Thermostatistics Cengel and Boles: Thermodynamics: An Engineering Approach*
4. Dahm and Visco: *Fundamentals of Chemical Engineering Thermodynamics Green, DW: Perry's Chemical Engineering Handbook*
5. Koretsky, MD: *Engineering and Chemical Thermodynamics*
6. Moran, et al.: *Fundamentals of Engineering Thermodynamics*
7. Porier, B: *A Conceptual Guide to Thermodynamics*