Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2023-2024

Course Handout Part II

Date: 11-08-2023

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	:	CHE F213
Course Title	:	Chemical Engineering Thermodynamics
Instructor-in-Charge	:	Dr. Ramendra Kishor Pal

Course Description:
Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and non-reacting systems; statistical concepts, and brief exposure to irreversible thermodynamics; extensive problem assignments throughout.

Scope & Objective:
This course aims to comprehensively treat thermodynamics from a chemical engineering viewpoint. The most important problems the chemical engineer must be able to cope with will be emphasized, viz. heat and work requirements for many physical and chemical processes, determination of equilibrium constants for chemical reactions and the transfer of chemical species between phases.

Learning objectives:

- Students will be able to estimate the energy requirements for various processes taking place in chemical engineering and evaluate the feasibility of a process.
- Students will be able to predict the PVT behaviour for various substances which deviate from ideal behaviour
- Students will be able to predict the phase behaviour of ideal and non-ideal systems
- Students will be able to study the reaction equilibrium

Text Book:
J. M. Smith, H.C. Van Ness, M. M. Abbott, and M. T. Swihart, "Introduction to Chemical Engineering, Thermodynamics", McGraw Hill, 8th ed., 2020.

Reference Books:
YVC Rao, "Chemical Engineering Thermodynamics", Universities Press, 1997.

KV Narayanan, "A Textbook of Chemical Engineering Thermodynamics". Prentice Hall of India, 2001.

Jefferson W. Tester, Michael Modell, "Thermodynamics and Its Applications", Prentice Hall, 1997.

K. D. Dahm, D. P. Visco Jr., Jayant Singh, "Fundamentals of Chemical Engineering Thermodynamics", Cengage Learning, 2015

Course Plan:

Lecture No.	Learning Objectives	Topics to be covered	Chapter in the Text Book
1	Introduction	Scope and Objectives of course, methodology	Chap. 1
2 – 4	First Law of Thermodynamics: Basic Concepts	First law, Closed System, State and State functions Equilibrium, Phase rule, Reversible Process, Const-V and Const-P Processes Enthalpy, heat capacity, First law for Open systems	2.1 to 2.12
5 – 8	Volumetric Properties of Pure Fluids	PVT behaviour of pure substances, Virial Equations, Ideal gas, Applications of Virial Equations, Cubic Equations of State, Generalized correlations for gases and liquids	3.1 to 3.7
9 – 11	Heat Effects: Heat of reaction	Sensible heat effects, Latent heat Standard heats of reaction, formation, combustion Temperature dependence of $\Delta H°$, heat effects of industrial reactions.	4.1 to 4.7
12 – 16	Second Law: Entropy and Third Law	Statements of second law, Heat engines, Thermodynamic temperature Scale, Entropy, ΔS for an ideal gas, Entropy balance for Open Systems, Ideal work, Lost work, Third law .	5.1 to 5.10
17 – 21	Thermodynamic Properties of Fluids	Property relations for homogeneous phases, Residual properties and their calculations by cubic equations Two-phase systems, thermodynamic diagrams and tables Generalized property correlations for gases.	6.1 to 6.7
22 – 24	Applications of Thermodynamics to Flow Processes	Duct flow of compressible fluids, Expansion Processes, Compression Processes.	7.1 to 7.3
25 – 28	Introduction to vapour/liquid Equilibrium	Nature of Equilibrium, Phase rule, Duhem's theorem VLE; Qualitative behaviour, Simple models for VLE VLE by Modified Raoult's law, K-value correlations	10.1 to 10.6
29 – 33	Basic concepts of Solution Thermodynamics: Theory	Fundamental Property Relation, Chemical potential and Phase equilibrium, Partial Properties, Ideal gas mixtures, Fugacities of pure species, Fugacities of Species in solution, Generalized Correlations, Ideal Solution, Excess Properties	11.1 to 11.9
34 – 37	Solution Thermodynamics: Applications	Liquid-phase properties from VLE data, Activity coefficients from VLE data, Models for Excess Gibbs energy, Property changes of Mixing, Heat effects of Mixing processes	12.1 to 12.4

38 – 42	Chemical Reaction Equilibria	Reaction coordinate, Equilibrium criteria for chemical reactions, Equilibrium constants and their variation with temperature, Evaluation of Equilibrium constants, Relation of Equilibrium Constants with Compositions, Equilibrium conversions for Single Reactions, Phase Rule and Duhem's theorem for Reacting Systems and Multireaction Equilibria	13.1 to 13.9

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Tutorial Tests (2 best of 3)	Will be discussed in Tutorial Sessions	20	TBA	Open Book
Continuous Evaluations	Will be discussed during lecture hours and tutorial sessions	10	TBA	Open Book
Mid Semester Exam	1.5 h	25	09/10 - 9.30 - 11.00AM	Open Book
Comprehensive Exam	3 h	45	06/12 FN	Open Book

NOTE: A total of three tutorial tests will be conducted. Two best of three will be considered.

Chamber Consultation Hour: At 1 PM every Saturday (Chamber: **D 321**).

Notices: Will be updated via CMS

Make-up Policy: Make-up will be granted only for genuine cases with valid justification and only with prior permission from Instructor-in-charge.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Dr. Ramendra Kishor Pal
INSTRUCTOR-IN-CHARGE