FIRST SEMESTER 2016-17
Course Handout

02/08/2016

Course No. : **CHE F213**
Course Title : **Chemical Engineering Thermodynamics**
Instructor-in-Charge : **DR. RAMAN SHARMA**
Instructors (Tutorial) : **Dr. Pradipta Chattopadhaya,**
Dr. Raman Sharma
Mr. Tapas Kumar Patra

1. 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. [Review of work, heat, reversible and irreversible processes, First Law applications to closed and open systems, Second Law, Entropy, and applications related to power and refrigeration, Heat effects, Availability and Exergy analyses, Equations of state and generalized correlations for PVT behaviour, Maxwell relations and fluid properties estimation; Residual and excess properties, Partial molar quantities; Gibbs-Duhem Equation, Fugacity and Activity Coefficient models, Vapour-Liquid equilibria]

2. Scope & Objective

The purpose of this course is to provide a comprehensive treatment of thermodynamics (maintaining the standard of rigor demanded by sound thermodynamic analysis) 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 for the transfer of chemical species between phases.

3. Text Book (TB)

Smith, J M, H C Van Ness and M M Abbott, (Adapted by: B I Bhatt), Introduction *to Chemical Engineering Thermodynamics (7th ed.)*, Tata McGraw Hill, 2005.

Reference Books (RB)

RB1 Rao, Y V C, *Chemical Engineering Thermodynamics*, Universities Press, 1997.
RB2 Narayanan K V, *A Textbook of Chemical Engineering Thermodynamics*, Prentice Hall of India, 2006.
RB3 Sandler, Stanley I., *Chemical, Biochemical and Engineering Thermodynamics*, 4th Edition, Wiley (India Pvt. Ltd. : Wiley Student Edition), 2006.

RB4 Cengel, Y A and M A Boles, *Thermodynamics : An Engineering Approach (SI Units),* 7th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., (Special Indian Edition, 2011: Sixth Reprint, 2013!)

4. Course Plan

Module: Lecture No.	Learning Objectives	Topics to be covered	Reference (TB) Ch./Sec. #
M1:1	Introduction	Scope and Objectives of course, Methodology	1 (Assignment)
M2: 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
M3: 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
M4: 9 – 11	Heat Effects: Heat of Reaction	Sensible heat effects, Latent heat, Standard heats of reaction, formation and combustion, Temperature dependence of H°, Heat effects of industrial reactions	4.1 to 4.7
M5: 12 – 15	Second Law: Entropy and Third Law	Statements of second law, Heat engines, Thermodynamic temperature scale, Entropy, □S for an ideal gas, Entropy balance for open Systems, Ideal work, Lost work, Third law	5.1 to 5.10
M6: 16 – 20	Thermodynamic Properties of Fluids	Property relations for homogeneous phases,	6.1 to 6.7

		Residual properties and their calculations by cubic equations Two-phase systems, Thermodynamic diagrams and tables, Generalized property correlations for gases.	
M7: 21 - 24	Applications of Thermodynamics to Flow Processes	Duct flow of compressible fluid, Turbines, Compression processes	7.1 to 7.3
M8 & M9: 25+	Production of Power from Heat ǀ Refrigeration & Liquefaction	Steam power plant, Internal-Combustion engines, Jet engines; Rocket engines ǀ Carnot refrigerator, Vapour-Compression cycle, Choice of refrigerant, Absorption refrigeration, Heat pump, Liquefaction processes	Chapters 8 & 9 **[Assignments]**
M10: 26 – 30	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
M11: 31 - 35	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
M12: 36 – 40	Solution Thermodynamics: Applications	Liquid-phase properties from VLE data, Activity coefficients from VLE data, Models for Excess	12.1 to 12.4

		Gibbs energy, Property changes of mixing, Heat effects of mixing processes	

5. Evaluation Scheme

EC No.	Evaluation Component (EC)	Duration	Weightage (%)	Weightage (Marks)	Date, Time	Remarks
1	Mid Semester Test	1.5 hrs	30	90	<TEST_1>	CB
2	Tutorial Tests / Surprise Quizzes / Assignments, *etc.*	-	30	90	-	CB/OB
3	Comprehensive Exam	3 hrs	40	120	<TEST_C>	CB+OB

CB = Close Book **OB** = Open Book

Chamber consultation hour will be announced in the class.

- The **notices,** if any**,** concerning the course, will be displayed on the notice board of the Department of Chemical Engineering **only**.
- **Make-up** will be granted for **genuine cases only**. Certificate from authenticated doctor, say from the Medical Center, must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). Prior permission of IC is compulsory.
- **No make-up will be granted for the surprise tests, if conducted!**

Instructor-in-charge | **CHE F213**