



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3173616

Semester – VII

Subject Name: Chemical Engineering Thermodynamics

Type of course: Professional Core Course

Prerequisite: Studied previous semesters subjects and should have knowledge of basic properties and law of conservation of energy

Rationale: The main objective of this subject is to understand the laws of thermodynamics and its application in different domain of chemical technology.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs
1	INTRODUCTION AND FIRST LAW OF THERMODYNAMICS: Systems and variables, Work, Heat, Internal Energy, Thermodynamic Equilibrium, Reversible and Irreversible Processes; Phase-Rule; Significance of Chemical Engineering Thermodynamics, Closed and Open Systems, Application of first law of thermodynamics to steady state flow process..	6
2	PROPERTIES OF PURE SUBSTANCES : PVT behavior of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Van der waals, Redlich/Kwong (RK), RKS Equation, PR Equation etc., Calculation of constants in terms of Pc, Tc, Vc, Principles of corresponding states.	6
3	SECOND LAW OF THERMODYNAMICS: Statements of second law of thermodynamics, Heat engines, Thermodynamic Temperature Scales, Concept of entropy, Entropy changes of an Ideal Gas, Third law of thermodynamics.	5
4	THERMODYNAMIC PROPERTIES OF FLUIDS: The fundamental property relations for homogeneous phases, Maxwell's equations, Residual properties, Mathematical relations among thermodynamic properties, Two phase systems, Thermodynamic diagrams.	6
5	SOLUTION THERMODYNAMICS: Ideal Solutions; Partial molar quantities; Gibbs-Duhem Equation; Criteria for Thermodynamic Equilibrium; Phase Equilibrium Criteria, Nonideal Solutions; Residual and Excess Properties; Fugacity and Activity Coefficient models	7
6	PHASE EQUILIBRIA: Introduction, The Nature of Equilibrium, The Phase Rule; Duhem's Theorem, VLE-	7



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	Qualitative Behaviour, P-x-y, T-x-y, x-y diagram, Azeotropic Mixtures, Raoult's Law, Dewpoint and Bubblepoint Calculations with Raoult's Law, Henry's law, VLE by Modified Raoult's Law, Flash Calculations,	
7	CHEMICAL REACTION EQUILIBRIA: Criteria of chemical reaction equilibrium, Equilibrium extent of reaction, Equilibrium constant, Effect of temperature and pressure on K, Evaluation of K by various methods, Evaluation of equilibrium extent of reaction for exothermic, endothermic, reversible, irreversible reactions and various combinations. Thermodynamic analysis of some important industrial reactions	8

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	20	15	15	--

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Smith J.M, Van Ness H.C., Abbott M. M, "Introduction to Chemical Engineering Thermodynamics", the McGraw Hill Companies, Inc., USA, 7th Ed., 2005.
2. K. V. Narayanan "A Text book of chemical Engineering thermodynamics", Prentice-Hall of India Pvt. Ltd
3. B.G. Kyle, "Chemical Process Thermodynamics", 2nd Edn. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. Y.V.C. Rao, "Introduction to Thermodynamics"; 2nd Edition, Wiley Eastern Limited.
5. Elliot J. R. and Lira C.T., "Introductory Chemical Engineering Thermodynamics", Prentice Hall, 1999.
6. Perry's chemical engineers handbook, 7th edition, McGraw Hill, USA, 2000.
7. Stanley I. Sandler, "Chemical, Biochemical and Engineering Thermodynamics", Wiley India Pvt. Ltd., 4th ed., 2007.
8. Stanley M. Walas, "Phase-Equilibria in Chemical Engineering", Wiley India Private Limited

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Develop fundamental understanding of the basic principles of thermodynamics and related calculations.	10%
CO-2	Demonstrate the use and applications of the first and second laws of Thermodynamics.	15%
CO-3	Evaluate changes in different thermodynamic properties for pure fluids using Equations of state (EOS).	20%



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CO-4	Apply fundamental property relations to find thermodynamic properties of solutions	20%
CO-5	Analyze phase equilibria and application of Raoult's law and its variation to obtain VLE for binary systems.	20%
CO-6	Determine equilibrium conversions of reaction systems and its dependence on various operating parameters	15%

List of Open Source Software/learning website:

- Literature and Research articles available on internet
- NPTEL Lectures
- XSEOS—an Open Software for Chemical Engineering Thermodynamics