GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Chemical Engineering)
Subject Code: 3130507
Semester –III
Subject Name: Chemical Engineering Thermodynamics-I

Type of course: Engineering Science

Prerequisite: None

Rationale: Knowledge of thermodynamics from a chemical engineering view point is essential to study principles and applications of laws of thermodynamics to real systems. This subject is also useful to calculate thermodynamic properties of any chemical species and their mixtures.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**INTRODUCTION AND FIRST LAW OF THERMODYNAMICS:** The scope of thermodynamics, Dimensions and units, Measures of amount or size, Force, temperature, pressure, work, energy, heat, etc. Internal Energy, Enthalpy, The first law of thermodynamics, Thermodynamic state, state functions, Energy balance for closed systems, Equilibrium, The Phase rule, The reversible process, Heat capacity, Application of first law of thermodynamics to steady state flow process.	9
2	**VOLUMETRIC PROPERTIES OF PURE FLUIDS :** PVT behavior of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Cubic, Vanderwaals EOS, Redlich/Kwong (RK) EOS etc., Calculation of constants in terms of Pc, Tc, Vc. Generalized Correlations for gases and liquids.	9
3	**HEAT EFFECTS:** Sensible heat effects, Temperature dependence of the heat capacity, Latent heats of pure substances, Approximate methods for the estimation of the latent heat of vaporization, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature Dependence of ΔH^{o}, Heat effects of Industrial Reactions.	6
4	**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.	6
5	**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.	5

6	**THERMODYNAMICS OF FLOW PROCESS:** Fundamental equations and relationships, flow in pipes, maximum velocity in pipe flow, nozzles, Single and Multistage compressors and ejectors.	**5**
7	**REFRIGERATION AND LIQUEFACTION:** Carnot refrigerator, Vapor compression cycle, Absorption refrigeration, Choice of refrigerant, Heat pump, Liquefaction processes.	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
18	**24**	**23**	**5**	**0**	**0**

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. "Introduction to Chemical Engineering Thermodynamics"; J. M. Smith, H. C. Vanness, M. M. Abbott, The McGraw-Hill Companies, Inc.
2. "Chemical, Biochemical and Engineering Thermodynamics"; S.I. Sandler, Wiley India Edition.
3. "A text book of Chemical Engineering Thermodynamics"; K. V. Narayanan, Prentice-Hall of India Pvt. Ltd.
4. "Chemical and Process Thermodynamics"; B.G. Kyle, Prentice-Hall Inc.
5. " Introduction to Thermodynamics"; Y.V.C. Rao, 2nd Edition, Wiley Eastern Limited

Course Outcomes:

Students should be able to

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Develop fundamental understanding of the basic principles of thermodynamics and related calculations.	20
CO-2	Demonstrate the use and applications of the first and second laws of thermodynamics.	25
CO-3	Evaluate changes in different thermodynamic properties for pure fluids using equations of state (EOS).	20
CO-4	Apply mass and energy balance to closed and open systems.	15
CO-5	Apply thermodynamic principles to the analysis of chemical processes and equipment such as turbines, compressors, heat pumps etc.	10
CO-6	Solve problems of refrigeration and liquefaction processes.	10

List of Tutorials: Numerical/problems based on topics of each theme of content.

List of Open Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL.
2. Students can refer to the CDs which are available with some reference books for the solution of problems using softwares. Students can develop their own programs for the solutions of problems.
3. XSEOS–an Open Software for Chemical Engineering Thermodynamics