

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05) CHEMICAL ENGINEERING THERMODYNAMICS – I SUBJECT CODE: 2140502 B.E. 4th SEMESTER

Type of Course: Engineering Science

Prerequisite: Zeal to learn the subject

Rationale: It is the basic subject for Chemical Engineering Students

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) | | |
| | | | | PA | ALA | ESE | OEP | | | |
| 3 | 1 | 0 | 4 | 70 | 20 | 10 | 30 | 0 | 20 | 150 |

Content:

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---------|--|---------------|------------------|
| 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, 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. | 11 | 40 |
| 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. | 10 | |
| 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 vapourization, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature Dependence of ΔH° , Heat effects of Industrial Reactions. | 8 | 60 |
| 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. | 7 | |
| 5 | THERMODYNAMICS 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 | |
| 6 | THERMODYNAMICS OF FLOW PROCESS: Fundamental equations and relationships flow in pipes, maximum | 6 | |

| | | | |
|---|---|---|--|
| | velocity in pipe flow, nozzles, Single and Multistage compressors and ejectors. | | |
| 7 | REFRIGERATION AND LIQUEFACTION: Carnot refrigerator, Vapour compression cycle, Absorption refrigeration, Choice of refrigerant, Heat pump, Liquefaction processes. | 6 | |

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | |
|------------------------------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level |
| 18 | 24 | 23 | 5 | 0 |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. Van Ness, 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:

After learning the course the students should be able

1. Develop a fundamental understanding of the basic principles of chemical engineering thermodynamics and calculations.
2. Examine and select pertinent data, and solve energy transformations problems.
3. Give examples of important application of thermodynamics laws in chemical engineering and biotechnology processes.

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.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.