GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Chemical Engineering
Subject Code: BE03005011
Subject Name: Chemical Engineering Thermodynamics – I

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	PCC

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.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Relate fundamentals of thermodynamics with chemical engineering.
02	Utilize basic principles of chemical engineering thermodynamics for PVT behavior of fluid.
03	Analyse exergy transformation problem of thermodynamic system.
04	Predict thermodynamic properties of fluids in homogeneous phase
05	Apply thermodynamics laws to chemical engineering processes.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	15	0	60	120	04	70	30	20	30	00	150

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of 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, Thermodynamic	6	13
	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.		
2.	**VOLUMETRIC PROPERTIES OF PURE FLUIDS :** PVT behavior of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Cubic, Vander Waals EOS, Redlich/Kwong (RK) EOS etc., Calculation of constants in terms of Pc, Tc, Vc. Generalized Correlations for gases and liquids.	8	18
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 $\Delta H0$, Heat effects of Industrial Reactions.	6	13
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.	8	18
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.	7	16
6.	**THERMODYNAMICS OF FLOW PROCESS:** Fundamental equations and relationships, flow in pipes, maximum velocity in pipe flow, nozzles, Single and Multistage compressors and ejectors.	4	9
7.	**REFRIGERATION AND LIQUEFACTION:** Carnot refrigerator, Vapor compression cycle, Absorption refrigeration, Choice of refrigerant, Heat pump, Liquefaction processes.	6	13

	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**25**	**25**	**5**	**---**	**---**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per 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.

References/Suggested Learning Resources:

(a) 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

(b) Open source software and 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 software. Students can develop their own programs for the solutions of problems.
3. XSEOS–Open Software for Chemical Engineering Thermodynamics

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

Suggested Activities for Students: 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.

•List of suggested activities for Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 25 h	Based on evaluation of critical problems and solutions

12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

Note:

- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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