B. Tech. Semester IV

Subject Name: Chemical Engineering Thermodynamics-II **Subject Code:BTCH13404**

Type of course: Professional Core Course

Prerequisite: Students having adequate knowledge of Chemical Engineering Thermodynamics-I

Rationale: The course provides fundamental insight into the underlying thermodynamic principles of solution thermodynamics, phase equilibria and Chemical reaction equilibria to solve complex problems

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	100
3	0	0	3	60	15	25	00	00	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage (%)
1.	**SOLUTION THERMODYNAMICS:** Theory Fundamental Property Relation, The Chemical Potential as a Criterion for Phase Equilibria, Partial Properties, Equations Relating Molar and Partial Molar Properties , The Partial Molar Gibbs Energy and the Generalized Gibbs-Duhem Equation, Partial Properties in Binary Solutions, Relations among Partial Properties, The Ideal Gas Mixture , The Partial Molar Gibbs Energy and Fugacity, Fugacity and Fugacity Coefficient: Pure Species, Fugacity and Fugacity Coefficient: Species in Solution ,The Ideal Solution Model , The Lewis/Randall Rule,Henry's law, Excess Properties , The Excess Gibbs Energy and the Activity Coefficient, Nature of Excess Property	15	40
2.	**PHASE EQUILIBRIUM:** Criterion of phase equilibrium, phase rule, Duhem's theorem, VLEQualitative Behaviour, Azeotropic Mixtures, Retrograde condensation, Simple Models for Vapour/Liquid Equilibrium, Raoult's Law, Dew Point and Bubble Point Calculations with Raoult's Law , Henry's law, VLE by Modified Raoult's Law, phase diagrams for miscible systems, phase diagrams for immiscible	20	45

	systems, phase diagrams for partially miscible systems, testing of vapour – liquid equilibrium data, Gibb's – Duhem equation for activity coefficient, Redlich – Kister equation, Van Laar equation, Margule's equation, evaluation of constants in these equations, P-x,y& T-x,y& x-y diagrams, flash calculations		
3.	**CHEMICAL REACTION EQUILIBRIA:** The reaction coordinates, Application of equilibrium criteria to chemical reactions, The Standard Gibbs free energy change and the equilibrium constant, Effect temperature on equilibrium constant, Evaluation of the equilibrium constant, Relation of equilibrium constant to composition for gas phase and liquid phase reactions, calculation of equilibrium conversion for single reaction, The phase rule and Duhem's theorem for reacting systems, introduction to multi-reaction equilibria	**10**	**15**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	20	20	20	15	00

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **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 Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Introduction to Chemical Engineering Thermodynamics	J. M. Smith, H. C. Van Ness & M. M. Abbot	McGraw Hill, ISBN-10: 935316849X	2019	8th
2.	A Textbook of Chemical Engineering Thermodynamics	K. V. Narayan	Prentice Hall India Learning Private Limited	2013	2nd
3.	Chemical Engineering Thermodynamics,	Y. V. C. Rao	Universities Press	1997	--

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Explain fundamentals of solution thermodynamics, phase equilibria and reaction equilibria	20
CO-2	Apply fundamental property relation to find thermodynamic properties of solutions	20
CO-3	Determine thermodynamic properties such as fugacity, fugacity coefficient, activity coefficient, constants of various model equations	20
CO-4	Draw the VLE diagrams of binary mixtures	20
CO-5	Determine equilibrium conversions of reacting systems and its dependence on various operating parameters	20

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO-1	2	3	2	3	2	3	3	3	2	3	3	3	3	3	1
CO-2	2	3	2	2	2	3	3	3	2	3	3	3	3	3	2
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
Rationale *	13	15	13	14	13	15	15	15	13	15	15	15	13	14	9

Rationale*: Explaining why it is matching this particular program outcome

List of Open Source/learning website:

https://nptel.ac.in/courses/103/101/103101004/
- Detail of coverage as per syllabus

https://nptel.ac.in/courses/103/103/103103144/
- Detail of coverage as per syllabus

https://nptel.ac.in/courses/103/104/103104151/
- Detail of coverage as per syllabus

https://www.amrita.edu/course/chemical-engineering-thermodynamics
- Detail of coverage as per syllabus

https://cosmolearning.org/courses/chemical-thermodynamics-kinetics/video-lectures/
- Detail of coverage as per syllabus

List of Open Source Software: DWSIM