COURSE TITLE	**CHEMICAL ENGINEERING THERMODYNAMICS-II**
COURSE CODE	**01CH1503**
COURSE CREDITS	**4**

Objective:

1 To impart knowledge of Chemical Engineering Thermodynamics principles to various chemical processes as well as concepts of multiphase equilibrium in pure and multicomponent systems.

2 To impart knowledge of Chemical Engineering Thermodynamics principles to various chemical processes as well as concepts of multiphase equilibrium in pure and multicomponent systems.

Course Outcomes: After completion of this course, student will be able to:

1 Understand the properties of the real solution.

2 Calculate the Vapor-Liquid Equilibrium data for ideal and non-ideal solution.

3 Analyze the equilibrium condition of different phases.

4 Find the equilibrium constant for liquid and gas phase reaction.

Pre-requisite of course: Basic of Chemical Engineering Thermodynamics-I

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	1	0	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Properties of Solution** Fundamental Property Relation, The Chemical Potential and Equilibrium,, Partial Properties, The Ideal-Gas-State Mixture, Fugacity and Fugacity Coefficient: Pure Species,, Fugacity and Fugacity Coefficient: Species in Solution, Generalized correlations for the Fugacity coefficient, Excess Properties,, The Excess Gibbs energy & activity coefficient	8
2	**Phase Equilibrium** The Phase rule, Vapor/Liquid Equilibrium, P-x-y and T-x-y diagrams for homogeneous systems,, Simple models for VLE, Raoult's law, Dew point and bubble point calculations with Raoult's law for binary mixtures,, VLE by modified Raoult's law, VLE from K-value correlations,, flash calculations, Equilibrium and phase stability, Liquid/Liquid Equilibrium	8

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Contents : Unit	Topics	Contact Hours
3	**Thermodynamic Formulations for Vapor/Liquid Equilibrium** The Gamma/Phi Formulation of VLE,, Dew point and bubble point calculations with Modified Raoult's law for binary mixtures,, Correlations for Liquid-Phase Activity Coefficients,, Fitting Activity Coefficient Models to VLE Data,, Consistency test for VLE data	12
4	**Chemical Reaction Equilibria** Reaction coordinate, application of equilibrium criteria to chemical reactions,, Standard Gibbs-energy change and the equilibrium constant, Effect of temperature on the equilibrium constant,, evaluation of equilibrium constants. Relation of equilibrium constants to composition: gas-phase reactions,, liquid-phase reactions, equilibrium conversions for single reactions in homogeneous phase.	10
Total Hours		**38**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Tutorial 1** Determination of fugacity coefficient of pure species.	2
2	**Tutorial 2** Determination of fugacity coefficient of species in solution	2
3	**Tutorial 3** Determination of Vapor-liquid equilibrium (T-x-y) data using Raoult’s law.	2
4	**Tutorial 4** Determination of Vapor-liquid equilibrium (P-x-y) data using Raoult’s law.	2
5	**Tutorial 5** Determination of Vapor-liquid equilibrium (T-x-y) data using Modified Raoult’s law.	2
6	**Tutorial 6** Determination of Vapor-liquid equilibrium (P-x-y) data using Modified Raoult’s law.	4
7	**Tutorial 7** Determination of VLE data using any simulation tool.	2
8	**Tutorial 8** Determination of activity coefficient using different correlations.	2
9	**Tutorial 9** Consistency test for VLE data.	2
10	**Tutorial 10** Determination of equilibrium constants for liquid phase reaction.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
11	**Tutorial 11** Determination of equilibrium constants for gas phase reaction.	2
Total Hours		**24**

Textbook :

1 "Introduction to Chemical Engineering Thermodynamics"; J. M. Smith, H.C., , J. M. Smith, H.C.,, McGraw-Hill Education, 2005

2 "A text book of Chemical Engineering Thermodynamics" , K. V. Narayanan,, Prentice-Hall of India Pvt. Ltd., , 2004

3 "Introduction to Thermodynamics", 2nd Edition, , Y.V.C. Rao, , Wiley Eastern Limited,, 2004

References:

1 "Chemical and Process Thermodynamics";, "Chemical and Process Thermodynamics";, B.G. Kyle, , Prentice-Hall Inc., , 2006

2 "Introduction to Thermodynamics", 2nd Edition, , "Introduction to Thermodynamics", 2nd Edition, , Y.V.C. Rao, , Wiley Eastern Limited,, 2004

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	25.00	25.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Supplementary Resources:

1 https://nptel.ac.in/courses/103103144

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Supplementary Resources:

2 https://nptel.ac.in/courses/103104151

3 https://www.coursera.org/learn/thermodynamics-intro#syllabus

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