

20PEB203					Thermodynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide the understanding of fundamentals of thermodynamics and its different concepts
- To explain the laws of thermodynamics and its application
- To provide the understanding of phase diagram, reservoir fluid behaviour and PVT analysis of hydrocarbon fluids

UNIT 1 Thermodynamic Potentials**5 Hrs.**

Internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; Thermodynamic property relations, Maxwell relations, Partial derivatives and Jacobian method; Residual properties; Partial molar properties, Ideal and non-ideal solutions, Standard states definition and choice, Gibbs-Duhem equation, Excess properties of mixtures.

UNIT 2 Phase Equilibria**8 Hrs.**

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity; Application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap; Effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid, liquid equilibrium; Activity coefficient- composition models, thermodynamic consistency of phase equilibria.

UNIT 3 Hydrocarbon reservoir fluids and their phase behavior**6 Hrs.**

Hydrocarbon (Petroleum) Reservoir Fluid composition and their physical Properties; Thermodynamic behavior of naturally occurring hydrocarbon (Oil, gas, condensate) system.

UNIT 4 PVT Analysis of Hydrocarbon fluids**7 Hrs.**

Collection of reservoir fluid samples for PVT study, PVT analysis: Constant composition expansion, flash liberation, differential liberation, separator test for PVT data of hydrocarbon fluids. Evaluation and correlation of physical and chemical properties of reservoir fluids including laboratory and empirical methods.

Total 26 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1- Analyse fundamental concepts relevant to thermodynamics.
- CO2- Analyse the concepts of work, power, and heat in thermodynamics; determine work and heat sign conventions; determine work involved with moving boundary systems (graphical and analytical methods).
- CO3- Analyse the first and second law of thermodynamics, Carnot cycle and thermodynamic properties of pure substances.
- CO4- Create the phase diagram of single and multicomponent system.
- CO5- Analyse the Hydrocarbon reservoir fluids and their phase behavior.
- CO6- Analyse the PVT analysis of Hydrocarbon fluids.

TEXT/REFERENCE BOOKS

1. Introduction to Chemical Engineering Thermodynamics – Smith, J.M., Van Ness, H.C., & Abbot M. C, McGraw Hill VII Edition 2004.
2. A Text Book of Chemical Engineering Thermodynamics Narayanan K. V – Prentice Hall of India Pvt. Ltd. 2001.
3. Petroleum Reservoir Rock and Fluid Properties – Abhijit Y. Dandekar- Taylor and Francis- 2006.
4. Equations of State and PVT Analysis: Applications for improved Reservoir Modelling – Tarek Ahmed

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** <Question: <Short Notes, Problems, Numerical>**PART B:** <Justification, Criticism, Long answers, Interpretation >**Exam Duration: 3 Hrs****20 Marks****80 Marks**