

Course Type	Course Code	Name of Course	L	T	P	Credit
DC6	PEC208	Reservoir Fluid Thermodynamics	3	0	0	9

Course Objectives

The objective of this course is to give fundamental concepts which will form the foundation on which art of Petroleum Engineering is based.

Describe the basic concepts in so far as reservoir fluids are concerned.

Learning Outcomes

- Basic concepts of Petroleum Reservoir and its fluids and the treatment of more complex systems.
- Exposure to the fundamentals of operations of different types of compressor used the field of Petroleum Engineering.

COURSE CONTENT:

Unit No.	Topic	Contact Hrs	Learning Outcome
1.	Introduction to Reservoir fluid thermodynamics and PVT behavior of oil and gas.	5	Basics of Reservoir Fluids and its related properties including PVT as wells as the concept of gas evolved from oil when pressure falls below bubble point
2.	Work Calculations: Types of compressors, selection, Thermodynamics of compressors, compressor calculation for compression/ expansion of ideal and non-ideal gases, compression cycles and horse power calculations - single, double and multistage with and without clearance.	8	Knowledge about the different types of compressors used in the petroleum Industry and to calculate the energy required to drive the compressor to transport and store Natural gas and other produced gas.
3.	Thermodynamics of Gases and Liquid Hydrocarbons: Free energy & work function, Mollier diagrams, perfect & imperfect gaseous mixtures, Equation of state, Law of corresponding states, Joule Thompson effect, Arrhenius equation and activation energy. Fugacity and fugacity coefficient of gases and gaseous mixtures, Lewis fugacity rules and Third law of thermodynamics.	9	Thermodynamic properties related to reservoir fluids and to calculate enthalpy change during production and transportation of reservoir fluid by using Mollier Diagram.
4.	Solution Thermodynamics: Vapour liquid equilibria, equilibrium constant, partial molar properties, chemical potential, Raoult's law and Henry's law, ideal and non ideal solutions, Activity and activity coefficients, Gibb's Duhem equation, Gibb's adsorption equation.	9	Knowledge of variation of reservoir fluid properties with respect to the variation of components.
5.	Phase Rule: Phase rule of single, two, three, multi component and multi phase systems, phase behaviour in different conditions, Thermodynamic aspects of phase equilibria. Calculation of phase equilibria. Ternary and pseudo ternary phase diagrams.	6	To know about the phase behaviour in different conditions during production of oil & gas. Able to calculate amount of Liquid and gas and its composition at separator condition
6.	Fluid Flow Thermodynamics: Single phase flow & multiphase flow through vertical, incline and horizontal conduits. Pressure traverse curves and their applications. Venturi flow, nozzle flow, pipe internal flow, annular flow and nozzle flow thermodynamics of multiphase & multicomponent system.	5	Able to calculate pressure drop and other related properties during flow of oil and Gas through different configured pipelines
Total contact hours		42	

Text Books:

- i. Thermodynamics of Hydrocarbon Reservoirs – Abbas Firoozabadi
- ii. Properties of Petroleum Reservoir Fluids – Emil J. Burcik
- iii. Applied Hydrocarbon Thermodynamics – Vol. 1 – Wayne C. Edmister, Byuang IK Lee
- iv. Applied Hydrocarbon Thermodynamics – Vol. 2 – Wayne C. Edmister

Reference Books

- i. Engineering Thermodynamics – P K Nag
- ii. Introduction to Chemical Engineering Thermodynamics – Smith, Van Ness and Abbott
- iii. Introduction to Chemical Engineering Thermodynamics – G. Halder
- iv. Chemical Engineering Thermodynamics – Y V C Rao
- v. Chemical and Engineering Thermodynamics – Stanley I. Sandler