Course Structure and Syllabus

2nd Year
B.Tech in Petroleum Engineering

(To be implemented for Batch 2022-26)

भारतीय पेट्रोलियम एवं ऊर्जा संस्थान
Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh - 530003

2nd Year B.Tech in Petroleum Engineering

Course Structure

Third Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Numerical Methods & Transform Calculus	4	0	0	4	Institute Core
2	Fluid Mechanics & Multiphase Flow	3	1	0	4	Institute Core
3	Object Oriented Programming	2	0	3	4	Institute Core
4	Sedimentary and Petroleum Geology	3	1	0	4	Dept. Core
5	Transport through porous media	3	0	0	3	Dept. Core
6	Fuel Lab	0	0	3	2	Dept. Practical
7	EAA III	0	0	0	0	P / F
	Total	**15**	**2**	**6**	**21**	

Fourth Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Elements of Reservoir Engineering	3	1	0	4	Dept. Core
2	Geo-Mechanics	3	1	0	4	Dept. Core
3	Drilling and Fracturing Technology	3	1	0	4	Dept. Core
4	Hydrocarbon Production Engineering-I	3	1	0	4	Dept. Core
5	Well Logging	3	0	0	3	Dept. Core
6	Geology & Geophysics Lab	0	0	3	2	Dept. Practical
7	Drilling Engineering Lab	0	0	3	2	Dept. Practical
8	EAA IV	0	0	0	0	P / F
	Total	**15**	**4**	**9**	**23**	

Third Semester

Course Type	Course Code	Name of Course	L	T	P	Credit
Institute Core	IC2101	**Numerical Methods & Transform Calculus**	4	0	0	4

Pre-Requisites: Calculus, Linear Algebra, and Differential equations

Course Objective

1. This course is to introduce the basic concepts of numerical methods for a variety of problems such as algebraicequations, linear systems of equations, approximation, ordinary differential equations.
2. To make the students understand the basic concepts of Laplace and Fourier transforms, Fourier series and theapplications of these transform techniques in solving initial and boundary valueproblems.

Learning Outcomes

At the end of the course, the student will be able to:

1. Understand the numerical error and applicability of a particular method.
2. Find roots of a nonlinear equation, and interpolate a function and analyze the variety of directand iterativemethods for solving systems of linear equations.
3. Identify different methods to find the approximate integration by quadrature rules.
4. Solve ordinary and partial differential equations by finite difference methods
5. Solve initial and boundary value problems by using Laplace and Fourier transform techniques.
6. Understand the approximation of a function in terms of Sine and Cosine functions.

Unit No.	Topics to be Covered	Learning Outcome
1.	**Numerical Methods:** **A. Finding roots of equations**: Bisection, Regula- falsi, Newton-Raphson, secant and fixed-point iteration techniques. Lagrange and Newton divided differences methods. Numerical differentiation. Numerical integration: Rectangle, Trapezoidal and Simpson's rules, Composite rules. **B. System of Linear Equations:** Gaussian elimination, Gauss-Jordan method, LU decomposition, Iterative methods: Gauss-Seidel and Gauss-Jacobi, Eigenvalue problems: power method. Numerical Solution of ODE: Taylor's, Euler's, Modified-Euler, Runge-Kutta methods.	The student will be able to understand numerical error and applicability of a particular method to find roots of a nonlinear equations, system of linear equations, interpolation of a function, numerical integration, and ODEs.
2.	**Transform Calculus:** **A. Laplace Transforms:** Definition, linearity property, conditions for existence, shifting properties, Laplace transform of derivatives and integrals, unit step function, Dirac-delta and error function, differentiation and integration of transforms, convolution theorem, inversion, periodic functions, evaluation of integrals by Laplace transforms, solution of initial and boundary value problems. **B. Fourier Series and Fourier Transforms:** Fourier series representation of a function and its convergent properties, half range series, sine and cosine series, Fourier integral representation of a function, Parseval's identity. Fourier transform, Fourier sine and cosine transforms, linearity, scaling, shifting properties,convolution theorem, Applications to initial and boundary value problems. **Introduction to Machine Learning:** Data, models and learning, empirical risk minimization, parameter estimation.	The student will be able to solve initial and boundary value problems by using Laplace and Fourier transform techniques. In addition, the student will be able to approximate a function in terms of Sine and Cosine functions

Numerical Methods:

Text Books:

1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980.
2. K. Atkinson, An Introduction to Numerical Analysis (2nd Edition), John-Wiley & Sons, 1989.
3. E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999).

References:

1. S.S. Sastry, Introductory Methods of Numerical Analysis - Prentice Hall of India

Transform Calculus:

Text Books:

1. R. K.Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa publisher
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publisher.

References:

1. W. Feller, An introduction to Probability theory and its applications
2. Peter V, O’Neil, Advanced Engineering Mathematics, 6th edition.

Course Type	Course Code	Name of Course	L	T	P	Credit
Institute Core	CH20002	**Fluid Mechanics & Multiphase Flow**	3	1	0	4

Course Objective

1. To understand the basic concept of fluid flow and its application to chemical process industries including pipe flow and fluid machinery.

Learning Outcomes

At the completion of this course, every student should be able to:

1. Explain the basic concepts in fluid mechanics; describe the physics and formulate mathematical description of viscous flows.
2. Identify the fundamental concepts in boundary layer theory, and turbulence.
3. Formulate physical model and mathematic model to solve typical fluids problems of engineering importance.

Unit No	Topics to be Covered	Learning Outcome
Section A:		
1.	Definition of Fluid, Lagrangian and Eulerian methods of description; Velocity Field: Streamline and stream function, Vorticity, Stress Field; Rheology: Newtonian/non- Newtonian Fluids.	Students will be introduced to various fluids and their properties.
2.	Viscous/Inviscid, Laminar/Turbulent, Compressible/ Incompressible, Internal/External, Rotational/Irrotational.	Students will acquaint with various flow field.
3.	**Fluid Statics:** Pressure variation in static fluids, manometer, capillary hydrostatics.	Students will have a strong foundation on static fluid.
4.	Macroscopic mass and momentum balance using integral control volume method, Euler & Bernoulli equations, Internal Incompressible Viscous Flow. Fully developed laminar flow in pipes, Couette and annular flows; Hagen Poiseulle Equation.	Students will be able to apply Euler and Bernouli equation to compute pressure drop, friction losses in flow systems of different configurations.
5.	Eddy viscosity, Universal velocity profile; Skin and Form Friction, friction factor and friction factor versus Reynolds number relation, Calculation of Head Losses in pipes and fittings, Converging and diverging nozzles, Solution of single and multi-path pipe flow systems.	Students will be familiar with head losses in pipes, fittings, converging and diverging nozzles.
6.	Flow around immersed bodies, Drag and Lift, Drag coefficient.	Basic understanding and applications of external incompressible flow.
7.	Valves, Pumps, Compressors, Flow meters(Head/Area): Venturi, Orifice, Rotameter.	Students will be introduced to various flow measuring instruments and pumps.
Section B:		
8.	Introduction to Hydrodynamics of Gas-liquid flow: Homogeneous flow model, Separated flow model, Bubble formation and dynamics, Mass bubbling and liquid entrainment.	Students will understand hydrodynamics of gas-liquid and liquid-liquid two-phase flow system.

Text Books:

1. Introduction to Fluid Mechanics by R. W. Fox & Alan T. McDonald, Wiley; 6th edition (2003).
2. Fundamentals of Multiphase Flow by C. E. Brennen, Cambridge University Press; 1st edition (2009).

References:

1. Fluid Dynamics and Heat Transfer by James G. Knudsen and Donald L. Katz, McGraw-Hill; First Edition (1958).
2. Coulson & Richardson's Chemical Engineering: Fluid Flow, Heat Transfer & Mass Transfer, Vol.1., Butterworth-Heinemann; 6th edition (1999).

Course Type	Course Code	Name of Course	L	T	P	Credits
Institute Core	IC2103	**Object Oriented Programming**	2	0	3	4

Course Objective

1. The fundamentals of object-oriented concepts, OO programming, and database concepts.
2. Model real world problems with Object Oriented constructs and solve them.

Learning Outcomes

1. Analyse a given problem and model it using objects, inheritance, and other OO constructs.
2. Implement a given OO model using the Python language.

Unit No.	Topics to be Covered	Learning Outcome
1.	Fundamental concepts of object oriented programming: Introduction to the principles of object- oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers).	Students will understand: the need for OOP, how the OO constructs help to decompose the complex problems.
2.	Object design implementation in a programming language, e.g., C++ or java or Python. (Currently, Python is used.).	Familiarize with Python basics, built-in data structures, functions, etc. Implement object oriented concepts using Python.
3.	Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases.	Familiarize with modelling data, creating Python application to interact with a database.

Text Books:

1. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
2. Programming Python: Powerful Object-Oriented Programming (4th Edition), Author: MarkLutz, O'Reilly.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core	PE2101	**Sedimentary & Petroleum Geology**	3	1	0	4

Course Objective

The primary objective of the course is to introduce the students with the origin, accumulation and migration aspects of hydrocarbons, depositional environment of sediments, their stratigraphic positions. Also student will gain knowledge about some hydrocarbon fields in India.

Learning Outcomes

The students learn to understand and to use the following:

- Understand the principles of sedimentology for both clastic and carbonate reservoir rocks.
- Brief idea about the hydrocarbon system.
- Chemical and physical properties of hydrocarbons
- Subsurface environments
- Reservoir Characterization

Unit No.	Topics to be Covered	Learning Outcome
1.	Sedimentary basin, sedimentary rocks, clastic rocks, carbonate rocks, evaporates, sedimentary facies, examples.	Sedimentology for both clastic and carbonate reservoir rocks
2.	Origin of petroleum, carbon cycle, formation of a petroleum deposit, seal and cap rocks, distribution of petroleum within a trap, trap types.	Brief idea about the hydrocarbon system
3.	Physicochemical properties of petroleum, Source rock characteristics, types, preservation of organic matter, formation and maturation of Kerogen. Primary and secondary migration of hydrocarbons.	Understand types of organic matter, their transformation to kerogen and classification of kerogen on the basis of H:C ratio
4.	Subsurface mapping, other parameters of relevance in subsurface environment like Temperature, Pressure, Stress, Lithostatic and Hydrostatic pressure, overpressure, subsurface waters.	Understand the subsurface environments
5.	Reservoir porosity, permeability, Reservoir continuity, Diagenesis and Reservoir Quality, carbonate and fractured reservoirs.	Reservoir Characterization

Text Book:

1. Elements of Petroleum Geology. R. C. Shelley. Academic Press; 3rd edition (November 2014)
2. Principles of Sedimentology and Stratigraphy. Sam Boggs Jr. Pearson; 5th edition (February 2011)

Reference:

1. Geology of Petroleum. Levorsen A. I. CBS; 2nd edition (January 2004)
2. Tissot, B.P. and Welte, D.H. (1984): Petroleum formation and occurrence, Springer–Verlag.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core	PE2102	**Transport in Porous Media**	3	0	0	3

Course Objective

The objective of this course is to impart knowledge on the concepts that governs the flow and transport processes in porous media. Also, this course aims to introduce about the basic concepts and techniques that are involved in computational modelling of flow and transport processes in porous media.

Learning Outcomes

Upon successful completion of this course, students will:

- have a detailed understanding on the fundamental concepts that defines porous media and its properties.
- have developed conceptual and theoretical knowledge on single phase and multiphase fluid flow process in porous media
- have acquired conceptual and theoretical knowledge on solute and heat transport processes that occurs in porous media.
- be introduced to different computational modelling techniques used to simulate flow and transport processes in porous media.

Unit No.	Topics to be Covered	Learning Outcome
1.	**Properties of Porous Media**: Industrial application of porous media; pore structure; volume averaging and Representative Elementary Volume (REV); single and multiple continuum; porosity, tortuosity, permeability, Kozeny-Carmen equation; Mercury porosimetry, helium pycnometry, BET analysis.	Students will learn fundamental concepts involved in defining porous media as a single and multiple continuums. Will learn about different properties of porous media and evaluation of it by experimental methods.
2.	**Fluid flow in porous media**: Continuity/mass balance equation for porous media; momentum equation – Darcy equation, Darcy-Brinkman equation, Darcy-Forchheimer equation. Steady state fluid flow in porous media; transient single phase fluid flow equation in porous media.	Students will learn: about physical meaning of continuity and different momentum equations and its suitability; to derive single phase fluid flow equation by coupling continuity and momentum equations.
3.	**Multiphase fluid flow in porous media:** Relative permeability, wettability, capillary pressure, IFT, multiphase fluid flow equation in porous media	Students will learn about fundamental concepts involved in multiphase flow in porous media, and will also learn to derive the equations for multiphase fluid flow in porous media.
4.	**Transport in porous media:** Transport of solute in porous media by advection and diffusion process; sorption; straining; coupled advection-dispersion-reactive transport processes in porous media and its governing equation; Tracer analysis. Heat transport in porous media by conduction, convection, and radiation processes; Energy balance equation. Introduction to solute and heat transport in fractured porous media.	Students will develop a broad understanding on the different solute and heat transport processes that occurs in porous media. Students will learn to mathematically represent the solute and heat transport process in porous media through PDE's along with boundary conditions. Students will be introduced to transport process in fractured porous media.

5.	**Computational modeling of flow and transport in porous media**: Introduction to numerical modelling by finite difference discretization and Lattice Boltzmann model. IMPES method for simulating multiphase flow; Methodology for simulating coupled flow and transport process in porous media.	Students will be introduced to modelling and simulation of flow and transport process in porous media by different computational techniques. Students will learn about the methodology to numerically solve: multiphase flow equations; and coupled flow & transport processes in porous media

Text Book:

1. Dynamics of Fluids in Porous Media: Jacob Bear
2. Porous media Transport Phenomena: Faruk Civian
3. Modeling Phenomena of Flow and Transport in Porous Media: Jacob Bear

References:

1. Essential of Heat and Fluid Flow in Porous Media: Arunn Narasimhan
2. Modelling and Applications of Transport Phenomena in Porous Media: Jacob Bear and J-M. Buchlin

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Practical		**Fuel Lab**	0	0	3	2

Course Objective

An ability to identify, analyse and characterize the fuels.

Learning Outcomes

1. To give an insight into fuel systems.
2. Understand the fuel product specifications, various test methods used to qualify different types of fuels.
3. Describe various parameters that are utilized to characterize the fuels.

Unit No.	Topics to be Covered	Learning Outcome
1.	ASTM distillation.	Determination of distillation characteristic (boiling, volatility) of petroleum products.
2.	Reid vapour pressure (RVP).	Determination of volatility of petroleum products.
3.	Gum content (existent).	Characterization of nonvolatile residue present in fuels.
4.	Smoke point.	Identification of smoking tendency of light petroleum products.
5.	Aniline point.	Characterization of degree of aromaticity of petroleum products.
6.	Flash point.	Identification of fire hazardous of fuels.
7.	Moisture content by Dean & Stark method.	Determination of % of moisture present in liquid fuels.
8.	Kinematic viscosity by Dynamic viscosity.	Identification of viscosity, film thickness of liquid lubricants and hydrocarbon fuels.
9.	Redwood viscometer.	Identification of Kinematic viscosity of a liquid fuel sample.
10.	Pour point.	Characterization of the ability fuels to flow under cold operating conditions.
11.	Conradson / Ramsbottom Carbon residue.	Characterization of % carbon residue in fuels.
12.	Rotational viscometer.	Identification of viscosity of liquid lubricants and hydrocarbon fuels.
13.	Gaseous fuels: Orsat Analysis.	Identification of oxygen, carbon monoxide and carbon dioxide content in fuels.
14.	Calorific Value by Junkers calorimeter	Determination of heat of combustion and the calorific value of gaseous fuels.
15.	Gas chromatography.	Analysis of composition of fuels.

Fourth Semester

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core		**Elements of Reservoir Engineering**	3	1	0	4

Course Objective

The objective of this course is to introduce the fundamental concepts and essential elements involved in reservoir engineering, which helps the students to apply the learnt concepts for performing any advance analysis in reservoir engineering discipline.

Learning Outcomes

Upon successful completion of this course, the students will learn:

- Different properties of reservoir rock and reservoir fluids which governs the oil recovery process
- Concepts and mechanisms involved in flow of multiphase fluids in reservoir rocks.
- Phase behaviour of hydrocarbon fluids during its flow from reservoir to surface and classification of reservoirs based on initial P-T conditions.
- Concepts and mechanisms of different oil recovery process.
- How reserves are classified, and different methods adopted for estimation of reserves.

Unit No.	Topics to be Covered	Learning Outcome
1.	**Introduction to reservoir engineering** – Generation, migration and accumulation of hydrocarbon, types of reservoir rock; role of reservoir engineers. **Properties of reservoir rock:** porosity; permeability; saturation; Darcy's equation – Definition and limitations; Klinkenberg effect; laboratory determination of porosity and permeability; calculation of average permeability for bedding planes; rock compressibility.	Students will get to know about the importance and role of reservoir engineers in upstream activities. Students will develop a broad understanding about reservoir rock and its properties. Students will also learn about the experimental procedure and equations used to evaluate the reservoir rock properties.
2.	**Properties of reservoir fluids**: Reservoir fluid types; density, viscosity, API gravity; fluid compressibility; bubble point pressure; dew point pressure; saturated and under saturated reservoirs; standard temperature and pressure conditions; Formation Volume Factor for oil, gas and water; solution gas oil ratio; gas oil ratio, water oil ratio.	Students will learn about different properties of reservoir fluids at reservoir and surface conditions.
3.	**Multiphase fluid flow in reservoirs:** Relative permeability; Darcy's equation for multiphase flow; wettability; capillary pressure; imbibition and drainage; IFT; Flow regimes within reservoir – transient, steady state and pseudo-steady state	Students will learn about the concepts involved in the flow of multiphase fluid in petroleum reservoirs.

4.	**Phase behavior of hydrocarbons:** Construction of P-V and P-T diagram for pure hydrocarbon substance and multicomponent hydrocarbon mixtures from PVT cell studies; phase behavior diagram of hydrocarbon mixtures; phase change of hydrocarbon fluid during its flow from reservoir to surface; classification of reservoirs based on initial P-T conditions – undersaturated oil reservoir, gas-cap reservoirs, reterograde condensate gas reservoirs, wet gas and dry gas reservoirs; formation of primary and secondary gas cap; determination of compressibility factor for single component and multicomponent hydrocarbon gases by graphical and EoS modelling methods.	Students will understand: • how P-T diagram for hydrocarbon mixtures are constructed from lab experiments. • how the hydrocarbon phase changes with w.r.t pressure and temperature. • how reservoirs are classified based on initial P-T conditions. • how to calculate compressibility factor for single and multicomponent hydrocarbon gases.
5.	Primary, secondary and tertiary oil recovery process; primary driving mechanisms – rock and fluid expansion, gas cap drive, solution gas drive, water drive, gravity drainage and combination drive; derivation of material balance equation for primary driving mechanisms; classification of reserves; reserves estimation method – analogy, volumetric, material balance, reservoir simulation, decline curve analysis – hyperbolic, harmonic and elliptic; PRMS	Students will understand: • Concepts and mechanisms involved in different oil recovery process; • How to derive material balance equation and to use decline curve analysis for estimating the oil reserves and oil recovery performance; and • How reserves are classified as per PRMS and how the reserves volume are estimated by different methods.

Text Books:

1. Reservoir Engineering Handbook: Tarek Ahmed
2. Petroleum Reservoir Engineering, Physical properties: James W. Amyx, Daniel M. Bass, Jr., Robert L.Whiting
3. Fundamental of Reservoir Engineering: Dake L.P

Reference:

1. Properties of Petroleum Reservoir Fluids: Emil J. Burcik
2. Applied Petroleum Reservoir Engineering: Craft B.C. and Hawkins M.F

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core		**Geomechanics**	3	1	0	4

Course Objective

The goal of this course is to introduce fundamental topics of continuum mechanics and rock mechanics and their dedicated applications (poroelastic deformation, reservoir operation, hydraulic fracturing, wellbore stability, compaction, subsidence, etc.). The main objective is to quantify response of reservoir rock during drilling and production.

Learning Outcomes

- Understand and apply fundamental continuum mechanics concepts for oil and gas reservoir rock formation.
- Critically analyse the underlying physics, concepts, assumptions and arguments, and develop a geomechanical model of a reservoir to address a wide range of problems that are encountered during the life cycle of a hydrocarbon reservoir.

Unit No.	Topics to be Covered	Learning Outcome
1.	Physico-mechanical properties of rocks;	Rock physical properties include density, porosity, and permeability, etc. Rock mechanical properties mainly include elastic modulus, Poisson's ratio, and rock strength, In-situ stresses
2.	Elasticity	Strain, Stress Constitutive Equations, Elastic properties, stress equilibrium equations
3.	Poroelasticity	Biot’s poroelastic theory for static properties, The effective stress concepts, Poroelastic relations, Pore volume Compressibility
4.	Failure Mechanics	Basic concepts, Compressive strength criteria, Shear failure criterion, Failure criteria depending on the intermediate stress, Pore collapse
5.	Geological aspects of rock mechanics	Rock mass classification, In-situ stresses
6.	Stresses around borehole, and borehole failure criteria	In situ stresses and stress distribution around openings; Stresses around borehole: general linear elastic solution, poroelastic formation; Borehole failure criteria.
7.	Reservoir Compaction: Subsidence and well problems	Subsidence and well problems; Stress change in depleting reservoir, Consolidation theory

Text Book:

- Zoback, Mark D. Reservoir geomechanics. Cambridge university press, 2010.
- Fjar, Erling, Rune Martin Holt, Per Horsrud, and Arne Marius Raaen. Petroleum related rock mechanics.Elsevier, 2008.

Reference:

- Jaeger, John Conrad, Neville GW Cook, and Robert Zimmerman. Fundamentals of rock mechanics. JohnWiley & Sons, 2009.
- Coussy, Olivier. Poromechanics. John Wiley & Sons, 2004.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core		**Drilling and Fracturing Technology**	3	1	0	4

Course Objective

1. The aim of the course is to provide students with a fundamental understanding of petroleum well drilling and fracturing procedures, its mechanics, and design methodology.
2. The course gives an overview of drilling rig operations and related equipment; offshore drilling and advanced drilling tools; drill-string design; drill bit technology; drilling hydraulics; drilling mud design; pore pressure and fracture pressure calculations; basic casing design; basic well control; well planning.
3. It also gives an understanding of fracturing mechanics and its fluids.

Learning Outcomes

1. Understand the concepts and equipment required in hoisting systems, including determination of loads and hoisting power, the mechanics and design of drill bits.
2. Explain the process of mud preparation, circulation and cleaning, including understanding of mud types, mud chemistry and mud hydraulics.
3. Explain the process and importance of casing design.
4. Utilise knowledge of key safety features in well control procedures.
5. Explain well problems and their solutions.
6. Explain the mechanics of fracturing, fracturing fluids and its proppants.

Unit No.	Topics to be Covered	Learning Outcome
1.	Well Planning: Introduction to oil well drilling, Drilling planning approaches. Preparation of Well Plan, Geotechnical Order (GTO).	Understand well planning procedure.
2.	Introduction to drilling methods and practices: Drill string and rotary system; design of block and tackle system, draw works drum; top drive drilling; well tubular; drill bits and bit mechanics; rock- tool interaction, methods of coring.	Understand the concepts and equipment required in hoisting systems, including determination of loads and hoisting power, the mechanics and design of drill bits
3.	Drilling fluid and Mud hydraulics fundamentals: Drilling fluid classifications, characteristics, additives, compatibility with borehole condition. Hydraulic models, mud pumps, flow rate and pressure calculations. Mud logging.	Explain the process of mud preparation, circulation and cleaning, including understanding of mud types, mud chemistry and mud hydraulics.
4.	Cements and casing: Classifications, cementing methods and calculations, casing design practices, casing loading practices, buckling criteria, calculation of well-head loads, casing while drilling.	Explain the process and importance of casing design.
5.	Well problems and solutions: Fatigue failure, Pipe sticking, Lost-circulation, Sloughing shale, Swabbing, surge, gas cap drilling. Oil Well Fishing: Fish classification, tools and techniques.	Utilise knowledge of key safety features in well control procedures.
6.	Well Kick, Blow out and Well Control methods.	Explain well problems and their solutions.

7.	Hydraulic fracturing: Breakdown pressure; fracture propagation theories; fracture direction, geometry, width, conductivity; Leak-off, tip screenout; fracturing of horizontal wells. Fracturing fluid: characteristics, additives, Properties of proppant and its transport.	Explain the mechanics of fracturing, fracturing fluids and its proppants

Text Books:

1. Petroleum Engineering: Drilling and Well Completion: Carl Gatlin.
2. Applied Drilling Engineering: Adams T Bourgoyane.
3. Drilling Engineering: A complete Well Planning and approach.
4. Hydraulic Fracturing, Michael Berry Smith, Carl Montgomery.

References:

1. Well Control Problems Solutions: Neal A J.dams.
2. Oil Well Drilling: H Rabia.
3. Oil Well Drilling Technology: Mc. Gray& Cole.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core		**Hydrocarbon Production Engineering-I**	3	1	0	4

Course Objective

To impart fundamental knowledge related to fluid flow from reservoir to surface, identification of parameters affecting flow from reservoir to surface facilities and optimization of the parameters, to learn concepts related to well completion and workover practices, and design of hydrocarbon processing equipment at the surface.

Learning Outcomes

- Determination of Productivity Index and flow potential of the wells.
- Generation of IPR, TPR curves for the wells and optimization.
- Determination of surface operating point for the given field data.
- Diagnose and solve problems encountered in production wells.
- To gain basic knowledge of well completion, workover and servicing techniques.

Unit No.	Topics to be Covered	Learning Outcome
1.	Well completion techniques; servicing and work-over operations, on shore and off shore	• Cased hole and open hole completions, selection and use of completion and workover fluids. • Components of Christmas tree, valves, flowlines. • Well problems identification and solution. • Components of CTU, workover rig and snubbing unit.
2.	Production from undersaturated, two phase, and natural gas reservoirs; steady state and transient flow, pseudosteady state flow. Software related to Production /Decline Curve	• Significance and application of IPR. • Flow equations for natural gas reservoir
3.	Well deliverability; Inflow and vertical flow performance; Nodal Analysis, horizontal wells; material balance and production forecasting; production decline analysis.	• Significance of TPR, and gradient curves. • Basic concepts and practice problems related to well deliverability, nodal analysis, decline curve analysis
4.	Well bore flow performance: two phase flow regimes, pressure gradient models, hold-up behavior, flow in horizontal well bore and in chokes.	• Basic concepts and practice problems for two phase flow in horizontal and vertical wellbore. • Sonic and sub sonic flow equations and concepts.
5.	Design of surface gathering system, crude stabilization, phase separation, dehydration, gas sweetening, produced water treatment, crude storage, evaporation loss and safety systems.	• Design and concepts of separators, heater treater, dehydration units. • Basic knowledge of processing of crude oil and natural gas in the field. • Significance of VRU

Text Book:

1. Economides M.J., Hill A.D., Economides C.E., Zhu D., Petroleum Production Systems, Prentice Hall /Pearson Education India 2012.
2. Guo B., Lyons W.C., and Ghalambor A., Petroleum Production Engineering: a Computer AssistedApproach, Gulf Professional Publishing 2011

Reference:

1. Arnold K. and Stewart M., "Surface Production Operations", Vol. I and II, Gulf Professional Publishing,2008.
2. Beggs H.D., Production Optimization using Nodal Analysis. OGCI Publications. 1991.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Core		**Well Logging**	3	0	0	3

Course Objective

The course gives insights into the role of borehole measurements in the search for and evaluation of hydrocarbon reservoirs. The course covers a number of measurement methods, and how these are used to determine important rock parameters such as porosity, permeability, water saturation and the rock types along the borehole.

Learning Outcomes

The students learn to understand and to use the following:

- Fundamental petrophysical concepts and equations. How does the composition of the rock influence the measurements we do and important petrophysical parameters like porosity, permeability and saturation.
- The most important log measurements used in boreholes: Resistivity, natural gamma radiation, neutron porosity, density, photoelectric absorption, acoustic measurements, formation pressures, nuclear magnetic resonance and more.
- The measurement environment in a borehole and environmental corrections of the data.
- Find how the measured properties can be used to determine the porosity, permeability, water/hydrocarbon saturation, shale content and rock type.

Unit No.	Topics to be Covered	Learning Outcome
1.	Introduction to well logging, Logging operations: Tools and Methods. Theory and physics of well-log measurements.	• Fundamental concepts. • Theory, Physics and tools of Resistivity, natural gamma radiation, neutron porosity, density, photoelectric absorption, acoustic measurements, formation pressures, NMR logging
2.	Depth correlation, log interpretation, core-log integration, rock typing, and resource determination.	Interpretation of well logs for followings: • Rock typing • Rock properties • Fluid properties
3.	Quantitative interpretation of well logs to estimate rock and fluid properties, including porosity, net pay thickness, fluid saturations, fluid type/ density, volumetric/ weight concentrations of minerals, and dynamic petrophysical properties such as permeability and saturation-dependent capillary pressure.	
4.	Well-log interpretation in clay-free, shaly-sand, and organic-shale formations	
5.	Multiwell correlations with application to volumetric calculations.	Multiwell correlations and volumetric calculations.
6.	Development of computer models for well-log analysis. Demonstration of computer software for well logging.	Computer models and software for well log analysis and interpretation

Text Book:

1. Theory, Measurement, and Interpretation of Well Logs. Zaki Bassiouni, SPE Textbook Series, Vol. 4, (1994)

Reference:

1. Geological Interpretation of Well Logs. Malcolm H Rider, Whittles Publishing Services (January 1999)
2. Well Logging and Formation Evaluation (1st Edition). Toby Darling, Gulf Professional Publishing (February2005)

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Practical		**Geology & Geophysics Lab**	0	0	3	2

Course Objective

To train the students in field observations and measurements, identification of sedimentary rocks, preparation and interpretation of different types of maps focusing on petroleum bearing formations.

Learning Outcomes

The students will be able to independently locate themselves in the field, take strike and dip of the formations, distinguish different types of petroleum source, reservoir and cap rocks, interpret structural contour and isopach maps based on field data.

Unit No.	Topics to be Covered	Learning Outcome
1.	Megascopic and microscopic study of common sedimentary rocks.	Distinguish different types source, reservoir and cap rocks based on megascopic and microscopic observations
2.	Location of observed outcrops on the Topo sheet. Geological mapping and Traversing. Measurement of the strike, dip and apparent and true thickness of the outcrops. Preparation of the geological map of the area. Geological cross sections.	Independently locate themselves in the field, take strike and dip of the formations; calculate true thickness of outcrops; interpret geological maps.
3.	Interpretation of well logs	1. Determine the porosity and shale, sand zone by analyzing the well log plot . 2. Distinguish the usage differences between logs 3. Production monitoring prediction and mitigation the problems occurs during production. 4. Resistivity analysis and effective Perforation Methods. 5. Lithology reconstruction, determination of reservoir properties and location of Oil Water Contact (OWC).
4.	Software	Learn the software used in well logging interpretation

Text Books:

1. Analysis of Geological Structures by N.J. Price and J.W. Cosgrove.
2. Basic methods of Structural Geology by S. Marshak and G. Mitra.
3. Atlas of Sedimentary Rocks Under the Microscope by A. E. Adams, C. Guilford, and W. S. MacKenzie.

References:

1. Mapping of Geological Structures by K. McClay.
2. Principles of Stratigraphy by C.O. Danbar and J. Rodgers.
3. Sedimentary Rocks in the Field: A Colour Guide by D. A. V. Stow.
4. Stratigraphy: Principles and Methods by Schoch, Robert, M.
5. Elements of petroleum geology by Selley, R.C.

Course Type	Course Code	Name of Course	L	T	P	Credit
Dept. Practical		**Drilling Engineering Lab**	0	0	3	2

Course Objective

On hand training to determine various drilling fluid properties and cement slurry design.

Learning Outcomes

- Understanding of the API recommended methods to determine various drilling fluid properties.
- Ability to develop and design a drilling fluid system and cement slurry.

Unit No.	Topics to be Covered	Learning Outcome
1.	Formulation of mud and fracturing fluid; characterization of mud and fracturing fluid through viscometry and rheometry.	Development and design of drilling and fracturing fluids.
2.	Fluid loss tests for mud and cement	Determination of filtration characteristics of drilling fluid
3.	Routine measurements of density, viscosity, sand content	Knowledge of sand content density, viscosity determination as per API recommended procedure.
4.	Thickening time measurements, atmospheric consistometer for cement.	Design and analysis of cement slurry.

Course Structure (1st Year)

First Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1.	Engineering Mathematics – I (Calculus)	3	1	0	4	
2.	General Chemistry	3	1	0	4	
3.	Engineering Mechanics	3	1	0	4	
4.	Introduction to materials	3	0	0	3	
5.	Engineering Graphics	1	0	3	3	
6.	English for Communication	1	0	2	2	
7.	Electrical Technology	2	0	0	2	Modular
8.	Basic Electronics	2	0	0	2	
9.	Chemistry Lab	0	0	3	3	
10.	EAA I	0	0	0	P/F	
	Total	18	3	8	27	

Second Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1.	Engineering Mathematics – II	3	1	0	4	
2.	Strength of materials	3	1	0	4	
3.	Physics	3	1	0	4	
4.	Programming and Data Structure	3	0	3	5	
5.	Earth Energy and Environment	2	0	0	2	Modular
6.	Fundamentals of Biological System	2	0	0	2	
7.	Electrical and Electronics Lab	0	0	3	2	
8.	Workshop	0	0	3	2	
9.	EAA II	0	0	0	P/F	
	Total	16	3	9	25	

Course Structure (2nd Year)

Third Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Numerical Methods & Transform Calculus	4	0	0	4	Institute Core
2	Fluid Mechanics & Multiphase Flow	3	1	0	4	Institute Core
3	Object Oriented Programming	2	0	3	4	Institute Core
4	Sedimentary and Petroleum Geology	3	1	0	4	Dept. Core
5	Transport through porous media	3	0	0	3	Dept. Core
6	Fuel Lab	0	0	3	2	Dept. Practical
7	EAA III	0	0	0	0	P / F
	Total	**15**	**2**	**6**	**21**	

Fourth Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Elements of Reservoir Engineering	3	1	0	4	Dept. Core
2	Geo-Mechanics	3	1	0	4	Dept. Core
3	Drilling and Fracturing Technology	3	1	0	4	Dept. Core
4	Hydrocarbon Production Engineering-I	3	1	0	4	Dept. Core
5	Well Logging	3	0	0	3	Dept. Core
6	Geology & Geophysics Lab	0	0	3	2	Dept. Practical
7	Drilling Engineering Lab	0	0	3	2	Dept. Practical
8	EAA IV	0	0	0	0	P / F
	Total	**15**	**4**	**9**	**23**	

Course Structure (3rd Year)

Fifth Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Advanced Reservoir Engineering	3	1	0	4	Dept. Core
2	Advanced Drilling Technology	3	1	0	4	Dept. Core
3	Hydrocarbon Production Engineering-II	3	1	0	4	Dept. Core
4	Offshore and Deep sea Technology	3	0	0	3	Dept. Core
5	Petroleum Exploration	3	0	0	3	Dept. Elective
6	Fracturing Lab	0	0	6	2	Dept. Practical
7	Reservoir Engineering lab	0	0	6	2	Dept. Practical
	Total	**15**	**3**	**12**	**22**	

Sixth Semester						
Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Oil & Gas well Testing	3	0	0	3	Dept. Core
2	Enhanced Oil Recovery	3	0	0	3	Dept. Core
3	Pipeline Engineering	3	0	0	3	Dept. Core
4	Data Analytics and AI for Process Industry	3	0	0	3	Dept. Elective
5	Open Electives- 01	3	0	0	3	Open Elective
6	Production Engineering Lab	0	0	6	2	Dept. Practical
7	EOR Lab	0	0	6	2	Dept. Practical
8	Project 1	0	0	6	2	Project
	Total	**15**	**0**	**18**	**21**	

Course Structure (4^{th} Year)

Seventh Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Reservoir Simulation	3	1	0	4	Dept. Core
2	HSE	2	0	0	2	Dept. Core
3	Industrial Psychology & Professional Ethics	2	0	0	2	Modular
4	Economics	2	0	0	2	
5	Open Electives- 02	3	0	0	3	Open Elective
6	Reservoir Simulation Lab	0	0	6	2	Dept. Practical
7	Industrial Training	0	0	6	2	
8	Project 2	0	0	6	2	
	Total	**12**	**1**	**18**	**19**	

Eight Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Open Electives- 03	3	0	0	3	Open Elective
2	Open Electives- 04	3	0	0	3	Open Elective
3	Open Electives- 05	3	0	0	3	Open Elective
4	Project 3	0	0	18	6	
5	Comprehensive Viva	0	0	6	2	
	Total	**9**	**0**	**24**	**17**	

List of Electives

Open Electives- 01

1. Unconventional Hydrocarbon Resources
2. Bio Energy
3. Waste Water Management
4. Management Techniques for Industrial Sector
5. Principles of Energy Conversion

Open Elective- 02

1. Solar Energy, Photovoltaic Energy
2. Advanced Separation
3. Advanced Material Design
4. Waste to Energy Conversion

Open Elective- 03

1. Petroleum Engineering System Design
2. Nuclear Wind and Geothermal Energy
3. Hazardous Waste Treatment and Safety Devices
4. Analytical Techniques

Open Elective- 04

1. Natural Gas Engineering
2. Advanced Reservoir Modelling
3. Petroleum Refinery Engineering
4. Air Pollution Control
5. Tribology & Introduction to the Lubricants
6. Energy Storage System

Open Elective- 05

1. Prospecting, Field Development and Asset Management
2. Petrochemical Technology
3. Nano Materials for Hydrocarbon Industry
4. Process Modelling and Simulation
5. Hydrogen Energy