INDIAN INSTITUTE OF PETROLEUM AND ENERGY
2nd Floor, Main Building, A.U. College of Engineering (A),
Andhra University, Visakhapatnam-530 003.

B.TECH SECOND YEAR SYLLABUS PETROLEUM ENGINEERING 2021 Batch

3rd SEMESTER

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Transform Calculus & Probability	3	1	0	3	
2	Numerical Methods	2	0	2	3	
3	Fluid Mechanics & Multiphase Flow	3	1	0	4	
4	Sedimentary & Petroleum Geology	3	1	0	4	
5	Drilling and Fracturing Technology	3	1	0	4	
6	Innovations Lab	0	0	3	2	
7	Workshop	0	0	3	2	
8	EAA III	0	0	2	P/F	
	Total	**14**	**4**	**10**	**22**	

4th SEMESTER

Sl. No.	Course Name	L	T	P	Credits	Remarks
1	Statistical Techniques	3	0	0	3	
2	Elements of Reservoir Engineering	3	1	0	4	
3	Hydrocarbon Production Engineering- I	3	1	0	4	
4	Geomechanics	3	1	0	4	
5	Well Logging	3	0	3	5	
6	Fuel Laboratory	0	0	3	2	
7	Petroleum Geology Lab	0	0	3	2	
8	EAA IV	0	0	3	P/F	
	Total	**15**	**3**	**12**	**24**	

3rd SEMESTER

Course Type	Course Code	Name of Course	L	T	P	Credit
	BS 20001	Transform Calculus & Probability	3	1	0	3

Course Objective

1. To make the students understand the basic concepts of Laplace and Fourier transforms, Fourier series and the applications of these transform techniques in solving initial and boundary value problems.
2. To introduce the fundamentals of probability theory and study different kinds of distributions and their properties such as mean, variance and moments, etc.
3. To explore topics like functions of random variables, jointly distributed random variables and independent random variables.

Learning Outcomes

1. At the end of the course, the student will be able to:
2. Solve initial and boundary value problems by using Laplace and Fourier transform techniques.
3. Understand the approximation of a function in terms of Sine and Cosine functions.
4. Learn all three types of definitions of a probability measure.
5. Know the variety of distributions and their PMFs and PDFs
6. Find the probabilities of a variety of random variables taking the values on the subsets of the set of Real numbers.
7. Able to check whether the given sequence of random variables is independent or not.

Unit No.	Topics to be Covered	Learning Outcome
1	Laplace Transform: Definition of Laplace transform, linearity property, conditions for existence of Laplace transform, first and second shifting properties, Laplace transform of derivatives and integrals, unit step function, Dirac-delta function 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.	The student will be able to, solve initial and boundary value problems by using Laplace transform techniques.

2	Fourier Series: Orthogonal and Orthonormal functions, periodic functions, representation of a function in terms of orthonormal functions, Fourier series representation of a function and its convergent properties, half range series, sine and cosine series, complex form of a Fourier series, Fourier integral representation of a function, Parseval's identity.	The student will be able to, understand the approximation of a function in terms of Sine and Cosine functions.
3	Fourier Transform: Fourier transform, Fourier sine and cosine transforms, linearity, scaling, frequency shifting and time shifting properties, self-reciprocity of Fourier transform, convolution theorem, Applications to boundary value problems.	The student will be able to, solve initial and boundary value problems by using Fourier transform techniques.
4	Probability: Sample space, events, classical, relative frequency and axiomatic definitions of probability, addition rule, conditional probability, multiplication rule, independence, total probability, Bayes' theorem. Random variables: Discrete, continuous and mixed random variables, cumulative distribution, probability mass and probability density functions, Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal and Gamma distributions. Functions of random variables, expectation, variance, moments, jointly distributed random variables and joint cumulative probability distribution functions, jointly continuous random variables, independent random variables, covariance, sum of random variables.	The student will learn all three types of definitions of a probability measure and applications of Bayes' theorem The student will learn the variety of distributions and their PMFs and PDFs The student will be able to check whether the given sequence of random variables is independent or not.

Text Books:

1. R. K.Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa publisher.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publisher.
3. Sheldon Ross, A first course in probability, Pearson 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
	BS 20007	Numerical Methods	2	0	2	3

Course Objective

1. This course is to introduce the basic concepts of numerical methods for a variety of problems such as algebraic equations, linear systems of equations, approximation, ordinary and partial differential equations.

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 polynomial or a nonlinear equation, and interpolate a function.
3. Analyze the variety of direct and iterative methods for solving systems of linear equations.
4. Identify different methods to find the approximate integration by quadrature rules.
5. Solve ordinary and partial differential equations by finite difference methods.

Unit No.	Topics to be Covered	Learning Outcome
1.	Numerical errors, Error propagation, Taylor's series. convergence, order, and stability. Finding roots of equations: Bisection, Regula-falsi, Newton-Raphson, secant methods and their convergence. Basic concepts of iteration and solutions.	The student will be able to, understand the numerical error and applicability of a particular method to find roots of a polynomial or a nonlinear equation.
2.	Interpolation by polynomials: Lagrange and Newton divided differences methods, error of the interpolating polynomial, piecewise linear and cubic spline interpolation. Numerical differentiation and integration of functions, Rectangle, Trapezoidal and Simpson's rules, Composite rules, error formulae, Gaussian quadrature rules.	The student will be able to, identify different methods to interpolate and to approximate the integration by quadrature rules.
3.	Matrices, vectors, Norms, ill-conditioning, System of Linear Equations, Gaussian elimination, Gauss-Jordan method, LU and Cholesky decomposition, Iterative methods: Gauss-Seidel and Gauss-Jacobi, Eigenvalue problems: power method, QR method, Gershgorin's theorem. Linear and	The student will be able to, analyze the variety of direct and iterative methods for solving systems of linear equations.

	nonlinear Least Squares, Newton-Raphson Method in two variables.	
4.	Numerical Solution of ODE: Taylor's, Euler's, Modified-Euler, Runge-Kutta methods. Numerical Solutions of PDE: Heat, Wave and Laplace equations .	The student will be able to, solve ordinary and partial differential equations by finite difference 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.

Course Type	Course Code	Name of Course	L	T	P	Credit
Core	BS 20002	Fluid Mechanics & Multiphase Flow	3	1	0	4
Course Objective						
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 descriptions 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	Credit
Core	PE20001	Sedimentary & Petroleum Geology	3	1	0	4

Course Objective

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

Learning Outcomes

1. Understand the principles of sedimentology for both clastic and carbonate reservoir rocks.
2. Brief idea about the hydrocarbon system.
3. Chemical and physical properties of hydrocarbons.
4. Subsurface environments.
5. 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 Books:

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).

References:

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
Theory	PE 30003	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 screen-out; 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
Core	BS20006	Workshop	0	0	3	2

Course Objective

1. To study the basics of workshop engineering practice.
2. To identify the hand tools and instruments and acquire measuring skills.
3. To acquire practical skills by performing the experiments in different shops of workshop.

Learning Outcomes (LO)

1. The student will be able to use different manufacturing (machining, welding, foundry, sheetmetal working, etc) processes required to manufacture a product from the raw materials.
2. Learn to use different measuring, marking, cutting tools used in workshop.
3. Get to know about various safety precautions while working in workshop

Unit No.	Topics to be Covered	Learning Outcomes
1	**Safety Precautions in workshop** **Welding Shop** 1. To study about various welding processes and the tools and equipment's use in welding shop. 2. To prepare a joint (lap/ butt/ T) using gas welding.	Students will get to know about various safety precautions while working in workshop. Students will learn about welding methodology and metal joining processing by using welding.
2	**Foundry Shop** 3. To study about tools and equipments use in foundry shop and how to make a mould. 4. To prepare an aluminium sand casting using the mould prepared by the students.	Students will get to know about mould making and foundry process.

3	**Machine Shop** 5. To study about various machine tools (lathe, milling, shaper, drilling, grinding and EDM drill) available in machine shop. 6. To study about various machining process performed on lathe machine tool in detail and to study the cutting tools used for various machining processes in lathe. 7. To perform facing, step turning, taper turning and knurling on a given work-piece material.	Students will get to know about using various machine such as Lathe, milling, grinding. In lathe machine they will perform various turning operations
4	**To study about the carpentry, fitting and sheet-metal shop.** 8. To study about the job holding devices, machine tools. 9. To study about the measuring, marking, cutting and plain tools.	Learn to use different measuring, marking, cutting tools used in workshop.

TEXT BOOKS:

1. Hajra S. K. and Chaudhary, Workshop Technology I & II, Khanna Publisher.
2. Raghuvansi B. S., Workshop Technology I & II.

REFERENCES:

1. Chapman W. A. J., Workshop Technology Vol. 1, 2, 3 & 4, Butterworth-Heinemann.
2. Gupta I. C., Engineering Metrology, Dhanpat Rai & Sons.
3. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House.
4. Gupta K. M., Material Science and Engineering, Umesh Publication.
5. Callister W. D., Material Science & Engineering, John Wiley & Sons.

4th SEMESTER

Course Type	Course Code	Name of Course	L	T	P	Credit
	BS 2006	Statistical techniques	3	0	0	3

Course Objective

1. The main objective of this course is to introduce statistical concepts and methods for solving engineering problems. Students will learn to organize, describe, analyze, and present data. It will develop students' ability in statistical modeling, inferring unknown parameters, and predicting future observations using existing data.

Learning Outcomes

1. Understand the distributions of sample mean and sample variances.
2. Evaluate the point and interval estimations of functions of unknown parameters from the given random sample.
3. Test a hypothesis by measuring and examining a random sample of the population being analysed.
4. Predict the outcome of a response variable by using several explanatory variables.
5. Learn the associated techniques for selecting, testing and validating simple and multiple linear regression models using data. Understand the testing of hypotheses corresponding to the multiple population means.

Unit No.	Topics to be Covered	Learning Outcome
1.	**Sampling distributions:** Chi-square, t and F distributions, random sample, sample mean and sample variance, the central limit theorem, distributions of the sample mean and the sample variance for a normal population.	The student will be able to, understand the distributions of sample mean and sample variances.
2.	**Estimation:** Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for properties, problems.	The student will be able to, evaluate the point and interval estimations of functions of unknown parameters from the given random sample.

3.	**Testing of Hypotheses:** Null and alternative hypotheses, the critical and acceptance regions, two types of errors, power of the test, the most powerful test and Neyman-Pearson fundamental lemma, tests for one sample and two sample problems for normal population (t, F, Z tests), tests for proportions, Chi-square goodness of fit test and its applications, problems.	The student will be able to, test a hypothesis by measuring and examining a random sample of the population being analysed.
4.	**Regression Analysis:** Simple linear regression (Description of the model, Least squares estimation, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters, correlation); Multiple linear regression model (Description of the model, matrix approach of Least squares, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters).	The student will be able to, predict the outcome of a response variable by using several explanatory variables. The student will learn the associated techniques for selecting, testing and validating simple and multiple linear regression models using data.
5.	**Design and Analysis of Experiments:** Analysis of variance (One-way classification of fixed effect model, comparing variances, pair wise comparison), randomized complete block design, Latin square design, random effect models, Factorial design, blocking and confounding, Nested and split plot design, Examples from chemical process.	The student will be able to, understand the testing of hypotheses corresponding to the multiple population means.

Text Books:

1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
2. D C Montgomery, Design and Analysis of Experiments, Wiley 2014.

References:

1. J. S. Milton & J. C. Arnold, Introduction to Probability and Statistics, McGraw Hill.
2. Alexander Mood, Franklin Graybill D. Boes, Introduction to the theory of Statistics, McGraw Hill.

Course Type	Course Code	Name of Course	L	T	P	Credit
Core	PE20007	Elements of Reservoir Engineering	3	1	0	4

Course Objective
1. 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
1. Different properties of reservoir rock and reservoir fluids which governs the oil recovery process 2. Concepts and mechanisms involved in flow of multiphase fluids in reservoir rocks. 3. Phase behaviour of hydrocarbon fluids during its flow from reservoir to surface and classification of reservoirs based on initial P-T conditions. 4. Concepts and mechanisms of different oil recovery process. 5. 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:**	Students will understand:

	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.	How P-T diagram for hydrocarbon mixtures are constructed from lab experiments. How the hydrocarbon phase changes with w.r.t pressure and temperature. 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
UG	PE 30002	Hydrocarbon Production Engineering- I	3	1	0	4

Course Objective
1. 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. 2. To learn concepts related to well completion and workover practices, and design of hydrocarbon processing equipment at the surface.

Learning Outcomes
1. Determination of Productivity Index and flow potential of the wells. 2. Generation of IPR, TPR curves for the wells and optimization. 3. Determination of surface operating point for the given field data. 4. Diagnose and solve problems encountered in production wells. 5. 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 Books:

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 Assisted Approach, Gulf Professional Publishing 2011.

References:

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
Core	PE20003	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						
1. Understand and apply fundamental continuum mechanics concepts for oil and gas reservoir rock formation. 2. 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. John Wiley & Sons, 2009.
- Coussy, Olivier. Poromechanics. John Wiley & Sons, 2004.

<table>
<tr><th>Course Type</th><th>Course Code</th><th>Name of Course</th><th>L</th><th>T</th><th>P</th><th>Credit</th></tr>
<tr><td>Core</td><td>PE 20005</td><td>Well Logging</td><td>3</td><td>0</td><td>3</td><td>5</td></tr>
<tr><td colspan="7">Course Objective</td></tr>
<tr><td colspan="7">1. The course gives insights into the role of borehole measurements in the search for and evaluation of hydrocarbon reservoirs.
2. 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.</td></tr>
<tr><td colspan="7">Learning Outcomes</td></tr>
<tr><td colspan="7">1. 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.
2. 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.
3. The measurement environment in a borehole and environmental corrections of the data.
4. Find how the measured properties can be used to determine the porosity, permeability, water/hydrocarbon saturation, shale content and rock type.</td></tr>
</table>

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

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.	• Rock properties • Fluid properties
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 Books:

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

References:

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 (February 2005).

Course Type	Course Code	Name of Course	L	T	P	Credit
Basic	BS 20009	Fuel Laboratory	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.

Text Books:

1. Theory, Measurement, and Interpretation of Well Logs", Bassiouni, SPE Textbook Series, Vol. 4, (1994).
2. Fuels & Combustion by Samir Sarkar, 3rd Edition, Universities Press.ISBN 9788173716690.

References:

1. Fuels & Combustion by SP Sharma &Chander Mohan,Tata McGraw Hill Education, ISBN 9780070966277.

Course Type	Course Code	Name of Course	L	T	P	Credit
Lab	20008	Petroleum Geology Lab	0	0	3	2

Course Objective

1. 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

1. 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.	Preparation of litho stratigraphic columns, litho stratigraphic correlation.	Correlate different strata based on lithologic set-up; Describe the utility of stratigraphy in hydrocarbon exploration.
4.	Preparation of structural contour map and location of Oil Water Contact (OWC). Interpretation of isopach map and depositional model. Local field trips.	Prepare structural contour maps and interpret the deformation history of the area and identify sequence of events; preparation of and interpretation isopach maps .

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.