COURSE STRUCTURE and SYLLABUS

For

B. Tech. in Petroleum Engineering

TO BE IMPLEMENTED FROM SESSION 2021-22

Indian Institute of Petroleum and Energy

2nd Floor, Main Block, AUCE (A), Andhra University

Visakhapatnam, Andhra Pradesh - 530003

COURSE STRUCTURE

Semester-I				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credits**
1	BS 10001	Engineering Mathematics – I (Calculus)	3 - 1 - 0	4
2	BS 10002	General Chemistry	3 - 1 - 0	4
3	BS 10003	Engineering Mechanics	3 - 1 - 0	4
4	BS 10005	Earth Energy and Environment	2 - 0 - 0	2
5	BS 10009	Fundamentals of Electrical Systems	3 - 1 - 0	4
6	BS 10006	English for Communication	1 - 0 - 2	2
7	BS 10011	Engineering Drawing & Computer Graphics	1 - 0 - 3	3
8	BS 19002	Physical Chemistry Lab	0 - 0 - 3	2
9	EA 10001	EAA – 1	0 - 0 - 2	0
		Total	**16 - 4 - 8**	**25**
Semester-II				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credits**
1	BS 10007	Engineering Mathematics – II (Linear Algebra, Differential Equations & Complex variables)	3 - 1 - 0	4
2	BS 10008	Strength of Materials	3 - 1 - 0	4
3	CH 10001	Polymers & Surfactants	3 - 0 - 0	3
4	BS 10004	Programming and Data Structure	3 - 1 - 3	6
5	PE 10002	Introduction to Petroleum Engineering	2 - 0 - 0	2
6	BS 10010	Fundamentals of Biological Systems	2 - 0 - 0	2
7	BS 19012	Organic Chemistry Lab	0 - 0 - 3	2
8	BS 19009	Electrical Systems Lab	0 - 0 - 3	2
9	EA 10002	EAA – 2	0 - 0 - 2	0
		Total	**16 - 3 - 9**	**25**

Semester-III				
S. No.	Subject Code	Subject Name	L-T-P	Credits
1	BS 20001	Transform Calculus & Probability	3-1-0	3
2	BS 20007	Numerical Methods	2-0-2	3
3	BS 20002	Fluid Mechanics & Multiphase Flow	3-1-0	4
4	PE 20001	Sedimentary & Petroleum Geology	3-1-0	4
5	PE 30003	Drilling and Fracturing Technology	3-1-0	4
6	BS 20005	Innovations Lab	0-0-3	2
7	BS 20006	Workshop	0-0-3	2
8	EA 10003	EAA III	0-0-2	0
		Total	**13-3-11**	**22**
Semester-IV				
S. No.	Subject Code	Subject Name	L-T-P	Credits
1	BS 20006	Statistical Techniques	3-0-0	3
2	PE 20007	Elements of Reservoir Engineering	3-1-0	4
3	PE 30002	Hydrocarbon Production Engineering- I	3-1-0	4
4	PE 20003	Geomechanics	3-1-0	4
5	PE 20005	Well Logging	3-0-3	5
6	BS 20009	Fuel Laboratory	0-0-3	2
7	PE 20008	Petroleum Geology Lab	0-0-3	2
8	EA 10004	EAA IV	0-0-2	0
		Total	**15-3-11**	**24**

Semester-V				
S. No.	Subject Code	Subject Name	L-T-P	Credits
1	BS 30001	Industrial Psychology & Professional Ethics	2-0-0	2
2	PE 30011	Advanced Reservoir Engineering	3-1-0	4
3	PE 30006	Hydrocarbon Production Engineering II	3-1-0	4
4	PE 30007	Advanced Drilling Technology	3-0-0	3
5	BS 20004	Object Oriented Programming	2-0-3	4
6	PE 30004	Drilling & Fracturing Lab	0-0-3	2
7	PE 20004	Transport in Porous Media	3-0-0	3
		Total	16-2-6	22
Semester-VI				
S. No.	Subject Code	Subject Name	L-T-P	Credits
1	PE 30012	Oil and Gas Well Testing	3-0-0	3
2	PE 40005	Offshore and Deep sea technology	3-0-0	3
3	PE 40003	Enhanced Oil Recovery	3-0-0	3
4	PE 30008	Pipeline Engineering	3-0-0	3
5		Elective I	3-0-0	3
6	BS 30003	Economics	2-0-0	2
7	PE 30009	Reservoir Engineering Lab	0-0-3	2
8	PE 40002	Production Engineering Lab	0-0-3	2
		Total	17-0-6	21

Semester-VII
S. No.	Subject Code	Subject Name	L-T-P	Credits
1	PE 40008	Health Safety and Environment (HSE)	2-0-0	2
2	PE 40001	Reservoir Simulation	3-1-0	4
3		Elective II	3-0-0	3
4	BS 40002	Data Analytics and AI for Process Industry	3-0-0	3
5	CH 40001	Project Engineering and Management	3-0-0	3
6	BS 48001	Industrial Training	0-0-0	2
7	BS 47001	Project I	0-0-6	4
		Total	**14-1-6**	**21**

Semester-VIII
S. No.	Subject Code	Subject Name	L-T-P	Credits
1		Elective III	3-0-0	3
2		Elective IV	3-0-0	3
3		Elective V	2-0-0	2
4	PE 40004	Reservoir Simulation Lab	0-0-3	2
5	BS 47002	Project II	0-0-9	6
6	BS 48002	Comprehensive Viva-Voce	0-0-0	2
		Total	**8-0-12**	**18**

ELECTIVES

Elective-I (6th Semester)	Petroleum Explorations	Bio Energy	Waste Water Management	Management Techniques for Industrial Sector
Elective-II (7th Semester)	Unconventional Hydrocarbon Resources	Solar Energy, Photovoltaic Energy	Advanced Separation	Advanced Material Design	Instrumentation and Process Control (*for PE students only*)
Elective-III (8th Semester)	Petroleum Engineering System Design	Nuclear wind and geothermal energy	Hazardous Waste treatment and safety devices	Analytical Techniques
Elective-IV (8th Semester)	Natural Gas Engineering	Petroleum Refinery Engineering	Air Pollution	Advanced Reservoir Modelling	Tribology & Introduction to Lubricants
Elective-V (8th Semester)	Prospecting, Filed Development and Asset Management	Petrochemical Technology	Nano Materials for Hydrocarbon Industry	Process Modelling and Simulation

*Note: **Electives will be offered based on the availability of resource person**

COURSE SYLLABUS

Semester-I

Subject Code	Subject Name	L-T-P	Credits
BS 10001	**Engineering Mathematics – I (Calculus)**	3 - 1 - 0	4

Functions of single variable: Sequences in real numbers, limits and continuity of real valued functions on intervals, extreme values of functions in interval, Intermediate value property and differentiation, Mean Value Theorems, Indeterminate forms, Taylor's formula, conver-gence of series, root test, ratio test, Cauchy condensation test, alternating series, Liebnitz's test, absolute and conditional convergence, power series, radius of convergence, Taylor series, Riemann integration, Riemann integrable functions, Mean value theorems of Integrals, Improper integrals, Beta and Gamma functions and their convergence, comparison test, abso-lute convergence.

Functions of several variables: Continuity, partial derivatives, directional derivatives and gradient, differentiability, chain rule, tangent plane and normal line, Euler's theorem on ho-mogeneous functions, Taylor's theorem, extreme values, Lagrange multipliers, double and triple integrals, volume and area, change of variables, surface area, surface integrals, line inte-grals, Green's theorem, vector fields, divergence and curl of a vector field, Stoke's theorem, Divergence theorem.

Reference:

1. G. B. Thomas Jr, M. D. Weir and J. R. Hass, Calculus, Pearson Education (2009).
2. Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
3. James Stewart, Calculus, Thomson (2003).
4. N. Piskunov, Differential and Integral Calculus Vol.1-2, Mir publishers, (1974).
5. Tom M. Apostol, Calculus Vol. 1-2, Wiley, (2007).
6. S.R. Ghorpade, B.V.Limaye, A course in Calculus and Real Analysis, Springer(2017)
7. S.R. Ghorpade, B.V.Limaye, A course in Multivariable calculus and Analysis, Springer(2017)

Subject Code	Subject Name	L-T-P	Credits
BS 10002	**General Chemistry**	3 - 1 - 0	4

Thermodynamics of Chemical Processes: Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution. Electrochemical Systems: Electrochemical cells and EMF, Applications of EMF measurements: Thermodynamic data, activity coefficients, solubility product and pH, corrosion.

Kinetics of Chemical Reactions: Reversible, consecutive and parallel reactions, Steady state approximation, Chain reactions, Photochemical kinetics.

Basic hydrocarbon chemistry: Alkane, Alkene, Alkyne: structure, stereochemistry, physical and chemical properties, chemical reactivity, separation.

Fundamentals of Microwave, IR and UV-VIS Spectroscopy: Basic concepts of spectroscopy, Selection rule, Determination of molecular structure.

Reference:

1. Physical Chemistry by G.W. Castellan (Addison Wesley Publishing Company)

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Subject Code	Subject Name	L-T-P	Credits
BS 10003	**Engineering Mechanics**	3 - 1 - 0	4

Moment of a force about a point and about an axis: Couple moment; Reduction of a force system with a force and a couple.

Equilibrium: Free body diagram; Equations of equilibrium; Problems in two and three dimensions; Plane frames and trusses.

Friction: Laws of Coulomb friction, problems involving large and small contact surfaces; Square threaded screws; Belt friction; Rolling resistance.

Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; Central force motion.

Properties of areas: Moments of inertia and product of inertia of areas; Polar moment of inertia; Principal axes; Principal moments of inertia.

Reference:
1. Engineering Mechanics Statics and Dynamics by Irving H Shames.

Subject Code	Subject Name	L-T-P	Credits
BS 10005	**Earth Energy and Environment**	2 - 0 - 0	2

- Understanding the interconnection in earth energy and environment systems uses the principles of Geology, Biology, Engineering and Socioeconomic dynamics- Understanding of the global changes in different time scales specially emphasizing on technology and socio-political approaches applied to earth, oceans, water, energy, food and population will also be addressed.
- Information on statutory Bodies & Regulations. basics of International protocols (viz Paris Agreement etc.), MINAS standard, changes in fuel quality specification with respect to Sulphur, Benzene etc
- **The following are the components:** Anthropogenic and natural changes in the atmosphere, ocean and terrestrial and freshwater ecosystem.
- Greenhouse gases and climate change, deforestation, species extinction, human population growth and resource usage.
- Understanding the human-environment, interaction with a focus on culture, history, economics, policy and the role of the state.
- **Case studies:** Environmental degradation, loss of biodiversity, and resource sustainability, complex environmental problems caused by human activities in interaction with natural changes in the earth system.

Reference:
1. Environmental Studies: From Crisis to Cure, R. Rajagopalan, OUP India, 3rd Edition.

Subject Code	Subject Name	L-T-P	Credits
BS 10009	**Fundamentals of Electrical Systems**	3 - 1 - 0	4

- Conventional sources of electrical power generation- Thermal, Hydro and Nuclear Power generation. Typical schematic diagram of generation, transmission and distribution. Concept of voltage and current sources, solution of DC resistive circuits based on Mesh current and Node voltage methods.
- Solution of DC resistive circuits using Thevenin's and Norton's Theorems. Solution of circuit problems (containing resistive elements) using different techniques having voltage and current sources.

- Basic concept of single phase (1-phase) ac voltage generation. Evaluation of average and effective (rms) values, form-factor and peak factors of sinusoidal quantities, periodic wave forms, significance of rms value of a wave form. Concept of phasor, joperator, representation of sinusoidal quantities by a phasor diagram, Phasor addition and subtraction, Complex representation of impedance (R-L, R-C, R-L-C), concepts real, reactive and apparent power in an ac circuit steady state solutions of ac R-L-C circuits. Steady state solution of 1-phase circuit problems.

- Three-phase power generation, concept of balanced load, relationships between (i) line vine voltage and phase voltage (ii) line current and phase current in a balanced load, phasor diagram, calculations of real, reactive and apparent powers, steady state solution of 3-phase circuit problems.

- Working principle of Wattmeter. Three phase power measurement of a balanced or unbalanced load using two-wattmeter method. Transformer construction, working principle of transformer, an emf equation of a transformer. Losses in a transformer, significance of transformer ratings. Open and short circuit tests of a transformer and computation of transformer parameters, approximate equivalent circuit of transformer, significance voltage regulation. Mathematical expression of voltage regulation, maximum efficiency of a transformer, solution of numerical problems on transformer.

- Working principle of Induction Motor (IM), classification of IM, concept of rotating magnetic field in an IM, slip, rotor frequency, understanding the loading of an IM, losses in an IM, significance of IM rating.

- Per-phase approximate equivalent circuit of a balanced 3-phase IM, Power flow diagram of an induction motor from input power to the shaft power. Expressions for (i) input power (ii) air-gap power and torque developed (iii) mechanical power and torque developed (iv) shaft power and shaft torque.

- Torque-speed characteristics of an IM, efficiency of IM, solution of numerical problems on IM.

Basic Electronics

- Semiconductor Physics; Semiconductor Devices (Diode, Zener Diode, Transistors etc.); ransistor characteristics and biasing. Half-wave & Full-wave rectifiers.

- Operational Amplifiers; realization of filters (low-pass, high-pass, band-pass and band stop filters). Different classes of power amplifiers (Class-A, Class-B, Class-AB).

Subject Code	Subject Name	L-T-P	Credits
BS 10006	**English for Communication**	1 - 0 - 2	2

This foundational course aims to help students coming from different language backgrounds acquire fluency in both spoken and written English in the workplace. Various ways of analysis of Root Cause analysis and project report writing. The course includes three components **Language, Speaking and Writing**. Lectures and Sessional will be conducted to improve the skills required these three areas. Lectures will be aimed to introduce the learners to the basic concepts in communication, while sessional will give practical experience. The purpose of this course is to help students to communicate English more efficiently.

Section A (Lecture topics): Introduction to communication; Language and grammar skills; Speaking and writing skills

Section B (Sessional): Building Vocabulary; Building sentences; Grammar, Pronunciation drills; Phonetics, vowels; Diphthongs, consonants; Stress; Rhythm and intonation; Conversational skills; Meta Language, the writing process; Writing with a thesis; Writing topic sentences; Writing a paragraph and linking paragraph.

Reference:

1. Technical Communication: English Skills for Engineers by Meenakshi Raman and Sangeeta Sharma (OUP

India)

Subject Code	Subject Name	L-T-P	Credits
BS 10011	**Engineering Drawing & Computer Graphics**	1 - 0 - 3	3

- Introduction to IS code of drawing
- Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute
- Projection of lines – traces, true length
- Projection of planes and solids
- Isometric projection
- Introduction to CAD tools - Basics of Auto-CAD/Solid Works; Creation of Points, Curves, Surfaces, Solids, Dimensioning using CAD tool
- Introduction of Development and Intersection of surfaces (Development of surfaces Development of prisms, pyramids and cylindrical & conical surfaces using CAD tools)
- Usage and interpretation of drawings of different Equipment and 3D plot plan models

Subject Code	Subject Name	L-T-P	Credits
BS 19002	**Physical Chemistry Lab**	0 - 0 - 3	2

- Measurement of surface tension, CMC of a surfactant
- Measurement of the coefficient of viscosity for water and polymer
- Conductometric titration
- pH-metric/potentiometric titration
- Solubility product
- Kinetics of ester hydrolysis
- Estimation of Fe2EDTA titration
- Codes / standards /Laboratory Accreditations /ASTM Methods requirement and applications

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Semester-II

Subject Code	Subject Name	L-T-P	Credits
BS 10007	**Engineering Mathematics – II (Linear Algebra, Differential Equations and Complex variables)**	3 - 1 - 0	4

Linear Algebra:

Algebra of matrices, Vector spaces, subspaces, linear dependence of vectors, basis and dimensions, linear transforms, matrix representation of a linear transform, rank-nullity theorem, rank and inverse of a matrix, solution of a algebraic equations-consistency conditions, Gaussian elimination and Gauss-Jordon methods, Hermitian, skew Hermitian and unitary matrices, eigenvalues and eigenvectors, Cayley-Hamilton theorem, diagonalizability, bilinear forms.

Differential equations:

First order differential equations: Exact Equations, integrating factors, Reducible to exact differential equations, linear and Bernoulli's form, Orthogonal trajectories, Lipschitz condition, Picard's theorem, Examples of non-uniqueness.

Homogeneous and non-homogeneous second order ODE's with constant coefficients, Characteristic equation, Linear dependence and Independence, Existence of solutions, Wronskian, method of variation of parameters, general linear differential equations with constant coefficients, Method of undetermined coefficients, Cauchy-Euler equations, System of differential equations.
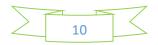
Complex Variables:

Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy's integral theorem, independence of path, existence of indefinite integral, Cauchy s integral formula, derivatives of analytic functions, Taylor s series, Laurent s series, Zeros and singularities, Residue theorem, evaluation of real integrals.

References:
1. G. Strang, Linear Algebra and its applications
2. K. Hoffman and R. Kunze, Linear Algebra, Pearson publisher.
3. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
4. S.L. Ross, Differential Equations, Third Edition, Wiley-India (2004).
5. R. V. Churchill, J. W. Brown, Complex Variables and Applications, Mc-GrawHill, (1990).
6. S. Ponnusamy, H. Silverman, Complex Variables with Applications, Birkhauser, (2006).

Subject Code	Subject Name	L-T-P	Credits
BS 10008	**Strength of Materials**	3 - 1 - 0	4

- **Concept of stress and strain:** Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; Normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; Analysis of axially loaded members
- **Material of construction**: Reactors, Tubes etc.,
- **Torsion:** Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation.
- **Flexural loading:** Shear and moment in beams; Load, shear and moment relationship; Shear and moment diagrams; Flexure formula; Shear stress in beams; Differential equation of the elastic curve, deflection of beams

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- **Transformation of stress and strain:** Transformation of stress and strain; principal stresses; principal strains; Mohr's circle for stress and strain.
- **Combined loading:** Axial and torsional; axial and bending, Axial, torsional and bending
- **Column:** Buckling of slender columns, Euler bucking load for different end conditions.

Reference:
1. Elements of Strength of Material by Timoshenko and Young (East West Press)

Subject Code	Subject Name	L-T-P	Credits
CH 10001	**Polymers & Surfactants**	3 - 0 - 0	3

To provide an overview of polymers with an emphasis of solution polymers, surfactants and its behaviour in aqueous solution, and, the properties of polymer-surfactant solutions which can be used for different industrial applications including the oil and gas industry.

Unit I
- Basics of Polymer: definition, classification, manufacturing, important characterizing properties
- Major Available Technologies
- Solution polymer, Surface active polymer
- Rheological behaviour, surface chemistry

Unit II
- Basics of Surfactants: Self-assembly and association, phase behaviour and structure Rheological behaviour, surface chemistry
- Types of surfactants, Mixed surfactant system

Unit III
- Basics of Polymer-surfactant systems: general aspects, associating polymers, phase behaviour
- Surface chemistry, rheological behaviour
- Surfactants and polymers containing oxyethylene groups

Subject Code	Subject Name	L-T-P	Credits
BS 10004	**Programming and Data Structure**	3 - 1 - 3	6

- Introduction to digital computers; Introduction to programming variables, assignments; expressions; input/output; Conditionals and branching; Iteration; Functions; Recursion; Arrays;
- Introduction to pointers; Character strings; Time and space requirements; Searching and sorting; Structures; Introduction to data-procedure encapsulation; Dynamic allocation; Linked structures.
- Introduction to data structures â stacks and queues. (A programming language like C/C++ may be used as a basis language. The same language must be used in the laboratory).

Programming & Data Structure LAB:

- Familiarization of a computer and the environment and execution of sample programmes
- Expression evaluation
- Conditionals and branching
- Iteration
- Functions
- Recursion
- Arrays
- Structures
- Linked lists
- Data structures

Reference

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (MIT Press)

Subject Code	Subject Name	L-T-P	Credits
PE 10002	**Introduction to Petroleum Engineering**	2-0-0	2

- Origin of petroleum
- Resource and Reserves Classification, HELP, NELP, OALP
- Flow of petroleum through rock
- Reservoir rock properties – Permeability and porosity
- Exploration techniques
- Composition of oil, gas, and water
- Elementary concepts of Reservoir modelling techniques, Drilling & Well completion, Pumping System & Artificial Lift, Water flooding, Enhanced Oil Recovery, Transportation of crude oil and natural gas, Application of the products, derived from petroleum, Unconventional Reserve, Offshore and subsea completions
- Challenges and broader economic and environmental impacts
- Major international hydrocarbon reserves
- Petroleum Economics and drivers in global scale

Subject Code	Subject Name	L-T-P	Credits
BS 10010	**Fundamentals of Biological Systems**	2-0-0	2

Unit 1: Cellular Biology (10 Lectures) Ultra structure of bacteria, plants and animal cells; cell division, cell cycle and apoptosis; ATP synthesis and Glycolysis; Respiration and photosynthesis.

Unit 2: Chemical Biology (10 Lectures) Proteins: structure and sequencing; Enzymes: mechanism, kinetics and inhibition; DNA: structure and sequence, replication, recombination; RNA synthesis; Genetic code and protein biosynthesis; Recombinant DNA technology.

Unit 3: Bio-Thermo-Fluidics and Transport Processes (8 Lectures) Noncovalent interactions and free energy changes in biological processes; Fundamentals of momentum, heat and mass transport as applied to biological systems; Human body as a thermodynamic system; Blood Rheology, Fluid mechanical aspects of some diseases and organs; Bio-Micro devices.

Unit 4: Impact of Biology on Society and Mankind (2 Lectures) Crop management, Disease control, Biological Hazards and safety; Unsolved Problems in Biology.

References:

1. Lehninger Principles of Biochemistry, Nelson and Cox, Biochemistry by Berg, Tymoczko and Stryer, Biochemistry by Voet and Voet, Molecualr Cell Biology by Lodish et al, Molecular Biology of Genes by Watson et al., Gene IX by Benjamin

Subject Code	Subject Name	L-T-P	Credits
BS 19012	**Organic Chemistry Lab**	0-0-3	2

- Identification of organic compounds from a binary mixture by qualitative analysis
- Estimation of glucose/cane sugar. Estimation of base content and acid content of commercially available antacid and vitamin C respectively
- Determination of solubility of solid sample in different solvent

- Recrystallization of solid compound from a solution
- Esterification reaction
- Extraction
- Chromatographic separation
- Quantitative analysis of organic compound
- Determination of melting point

Subject Code	Subject Name	L-T-P	Credits
BS 19009	**Electrical Systems Lab**	0-0-3	2

- To measure the armature and field resistance of a DC machine. in R-L-C series circuit exited by single phase) AC supply.
- Verification of circuit theorems – Thevenin's and superposition theorems (with DC sources only).
- Measurement of current, voltage and power
- Open circuit and short circuit tests on a single phase transformer
- Connection and starting of a three phase induction motor using direct on line (DOL) or star – delta starter
- Connection and measurement of power consumption of a fluorescent lamp and voltage – current characteristics of incandescent lamps.
- Determination of open circuit characteristics (OCC) or a DC generator.
- Two wattmeter method of measuring power in three phase circuit (resistive load only).
- Familiarization with electronic components and usage of multimeter
- Familiarization with oscilloscope, signal generator and further usage of multimeters
- Frequency-response and square-wave testing of R-C, C-R and R-L networks
- Voltage Rectifiers2. To calibrate a test (moving iron) ammeter and a (dynamometer) Wattmeter with respect to standard (DC PMMC) ammeter and voltmeters
- Studies on Common-Emitter amplifiers
- Studies on analog circuits using OP-AMP
- Studies on logic gates

Semester-III

Subject Code	Subject Name	L-T-P	Credits
BS 20001	**Transform Calculus & Probability**	3-1-0	3

- 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.
- 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.
- 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.
- 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.

Text and Reference 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.
4. W. Feller, An introduction to Probability theory and its applications
5. Peter V, O'Neil, Advanced Engineering Mathematics, 6th edition.

Subject Code	Subject Name	L-T-P	Credits
BS 20007	**Numerical Methods**	2-0-2	3

- 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.
- 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.
- 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, Eigen value problems: power method, QR method, Gershgorin's theorem.
- Linear and nonlinear Least Squares, Newton-Raphson Method in two variables.
- Numerical Solution of ODE: Taylor's, Euler's, Modified-Euler, Runge-Kutta methods.

- Numerical Solutions of PDE: Heat, Wave and Laplace equations
- Exposure of packages like MATLAB/C/C++/Fortran

Text and Reference 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. S.S. Sastry, Introductory Methods of Numerical Analysis - Prentice Hall of India
4. E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999).

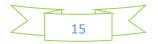| Subject Code	Subject Name	L-T-P	Credits
BS 20002	**Fluid Mechanics & Multiphase Flow**	3-1-0	4

- Definition of Fluid, Lagrangian and Eulerian methods of description; Velocity Field: Streamline and stream function, Vorticity, Stress Field; Rheology: Newtonian/non-Newtonian Fluids
- Classification of Fluid Flow: Viscous/Inviscid, Laminar/Turbulent, Compressible/ Incompressible, Internal/External, Rotational/Irrotational
- Fluid Statics: Pressure variation in static fluids, manometer, capillary hydrostatics; 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
- Turbulent flow: 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.
- External Incompressible Viscous Flow: Flow around immersed bodies, Drag and Lift, Drag coefficient
- Flow Devices and Instruments: Valves, Pumps, Compressors, Flow meters (Head/Area): Venturi, Orifice, Rotameter
- Introduction to Hydrodynamics of Gas-liquid flow: Homogeneous flow model, Separated flow model, Bubble formation and dynamics, Mass bubbling and liquid entrainment

Text and Reference Books:

1. Introduction to Fluid Mechanics by R. W. Fox & Alan T. McDonald
2. Fundamentals of Multiphase Flow by C. E. Brennen, Cambridge University Press
3. Fluid Dynamics and Heat Transfer by James G. Knudsen and Donald L. Katz, McGraw-Hill, New York.
4. Coulson & Richardson's Chemical Engineering: Fluid Flow, Heat Transfer & Mass Transfer, Vol.1.

Subject Code	Subject Name	L-T-P	Credits
PE 20001	**Sedimentary & Petroleum Geology**	3-1-0	4

- Origin of petroleum, carbon cycle, formation of a petroleum deposit, seal and cap rocks, distribution of petroleum within a trap, trap types, subsurface mapping, physicochemical properties of petroleum, other parameters of relevance in subsurface environment like Temperature, Pressure, Stress, Lithostatic and Hydrostatic pressure, overpressure, subsurface waters.
- Sedimentary basin, sedimentary rocks, clastic rocks, carbonate rocks, evaporates, sedimentary facies, examples.
- Source rock characteristics, types, preservation of organic matter, formation and maturation of Kerogen.
- Primary and secondary migration of hydrocarbons.

- Reservoir porosity, permeability, Reservoir continuity, Diagenesis and Reservoir Quality, carbonate and fractured reservoirs.
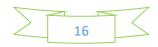
Text and Reference Book:

1. Elements of Petroleum Geology by R. Shelley

Subject Code	Subject Name	L-T-P	Credits
PE 30003	**Drilling and Fracturing Technology**	3-1-0	4

- 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.
- Preparation of Well Plan, Geotechnical Order (GTO)
- Drilling fluid: classifications, characteristics, additives, compatibility with borehole condition.
- Mud hydraulics fundamentals: hydraulic models, mud pumps, flow rate and pressure calculations.
- Mud logging.
- Cements and casing: classifications, cementing methods and calculations, casing design practices, casing loading practices, buckling criteria, calculation of well-head loads, casing while drilling.
- Well problems and solutions.
- 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.

Subject Code	Subject Name	L-T-P	Credits
BS 20006	**Workshop**	0-0-3	2

- Performing Processes: Casting, forging, rolling, drawing, extrusion, press tool work, plastic moulding and powder metallurgy
- Joining Processes: Welding, brazing and crimping Semi-finishing and finishing processes: Machining (Turning, shaping, drilling, Milling and grinding)
- Non-traditional Processes: Abrasive jet machining, Ultrasonic machining
- Carpentry
- Product Quality: Possible defects and their detection, assessment and remedy

	Semester-IV		

Subject Code	Subject Name	L-T-P	Credits
BS 20006	**Statistical Techniques**	3-0-0	3

- **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.
- **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.
- **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.
- **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).
- **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.

References:
1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
2. J. S. Milton & J. C. Arnold, Introduction to Probability and Statistics, McGraw Hill.
3. D C Montgomery, Design and Analysis of Experiments, Wiley 2014.
4. Alexander Mood, Franklin Graybill D. Boes, Introduction to the theory of Statistics, McGraw Hill.

Subject Code	Subject Name	L-T-P	Credits
PE 20007	**Elements of Reservoir Engineering**	3-1-0	4

- Introduction to Reservoir Engineering, Reservoir Rock Properties, Reservoir Drive Mechanism & Recovery Factor, Reserve Estimation, PRMS System

- Properties of Pure and hydrocarbon substances. Two, Three, and Multi-Component Mixtures, Phase Diagrams.

- Reservoir engineering properties of Fluids: Ideal and real gases, Gas and oil formation volume factor, compressibility factor, density and viscosity, gas gravity and isothermal compressibility.

- Black oil properties from field data and correlations: Bubble point pressure, solution gas oil ratio, oil density, compressibility, formation volume factor, Analysis of TBP distillation data.

- Vapor-liquid Equlibria. Single and multicomponent Equlibria. Equation of state, solution of cubic equations. Numerical algorithms for property estimation.

Subject Code	Subject Name	L-T-P	Credits
PE 30002	**Hydrocarbon Production Engineering- I**	3-1-0	4

- Well completion techniques; servicing and work-over operations, on shore and off shore.
- Software related to Production /Decline Curve
- Production from undersaturated, two phase, and natural gas reservoirs; steady state and transient flow, pseudosteady state flow.
- Well deliverability; Inflow and vertical flow performance; Nodal Analysis, horizontal wells; material balance and production forecasting; production decline analysis.
- Well bore flow performance: two phase flow regimes, pressure gradient models, hold-up behavior, flow in horizontal well bore and in chokes.
- Design of surface gathering system, crude stabilization, phase separation, dehydration, gas sweetening, produced water treatment, crude storage, evaporation loss and safety systems.

Subject Code	Subject Name	L-T-P	Credits
PE 20003	**Geomechanics**	3-1-0	4

- Physico-mechanical properties of rocks; Elastic and time dependent behaviour; Constitutive Equations; Elastic moduli; Poroelasticity; Biot's poroelastic theory for static properties The effective stress concepts.
- Geological aspects of rock mechanics, Rock mass classification; Theories of rock failure; Elasticity failure mechanics, Compressive strength criteria, shear failure – Mohr Coulomb criterion, Failure criteria based on intermediate stress, Stress analysis; In situ stresses and stress distribution around openings; Stresses around borehole: general linear elastic solution, poroelastic formation; Borehole failure criteria.
- Reservoir Compaction**:** Subsidence and well problems; Stress change in depleting reservoir, Consolidation theory.

Text and Reference Book:
1. Reservoir Geomechanics by Mark Zobac, Cambridge University Press, 2007.

Subject Code	Subject Name	L-T-P	Credits
PE 20005	**Well Logging**	3-0-3	5

- Introduction to well logging, Logging operations: Tools and Methods. Theory and physics of well·log measurements.
- Depth correlation, log interpretation, core-log integration, rock typing, and resource determination.
- 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.
- Well·log interpretation in clay·free, shaly·sand, and organic·shale formations.
- Multiwell correlations with application to volumetric calculations.
- Development of computer models for well·log analysis.
- Demonstration of computer software for well logging.

Well Logging (Lab)
- Introduction to well testing and data acquisition, interpretation of log data.
- Structure contour mapping, isopach mapping, cross-sections, net pay and in place hydrdocarbons.
- Case studies

Text and Reference Book:

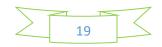1. Theory, Measurement, and Interpretation of Well Logs", Bassiouni, SPE Textbook Series, Vol. 4, (1994)

Subject Code	Subject Name	L-T-P	Credits
BS 20009	**Fuel Laboratory**	0-0-3	2

ASTM distillation, Reid vapour pressure (RVP), Gum content (existent), Smoke point, Aniline point, Flash point, Moisture content by Dean & Stark method, Kinematic viscosity by Dynamic viscosity; Redwood viscometer, Pour point, Conradson / Ramsbottom Carbon residue, Rotational viscometer. Gaseous fuels: Orsat analysis, Calorific Value by Junkers calorimeter. Gas chromatography

Subject Code	Subject Name	L-T-P	Credits
PE 20008	**Petroleum Geology Lab**	0-0-3	2

Megascopic and microscopic study of common sedimentary rocks; 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; Preparation of litho stratigraphic columns, litho stratigraphic correlation, geological cross sections; Preparation of structural contour map and location of Oil Water Contact (OWC); Interpretation of isopach map and depositional model; Local field trips.

	Semester-V		

Subject Code	Subject Name	L-T-P	Credits
BS 30001	**Industrial Psychology & Professional Ethics**	2-0-0	2

- Understanding human experience and behavior: Definition, schools, methods, branches and application of Psychology for Engineers.
- Basic Psychological Processes:
- Intelligence, Thinking, Attention, Learning
- Motivation and Emotion: Theories, Motivating people at Workplace
- Personality: Definition, Approaches and Theories
- Psychological Disorders, Mental health and Workplace
- Psychological Problems of Everyday Life: Stress and coping
- Introduction to Psychometric and types of tests
- Attitude and work behaviour, Group dynamics, Intergroup relations, conflict resolution.
- Industrial Psychology and Organizational Behaviour: Concepts, Hawthorne Studies, Application, Personnel Selection, Job satisfaction
- Leadership and Management
- Professional Ethics (includes code of conduct)

Texts Books:
1. Baron, R.A. (2001). Psychology. Prentice-Hall of India Private Limited.
2. Blum, M.L. and Naylor, J.C. (1984). Industrial Psychology. New Delhi. CBS Publishers and Distributors.

Reference Books:
1. C. T. Morgan, R. A. King, J. R. Weiss and J. Schopler. (1986). Introduction to Psychology.7th ed. McGraw Hill.
2. Newstrom, J.W. & Davis, K. (2002). Organizational Behaviour- Human Behaviour at Work. New Delhi. Tata McGraw-Hill Pub. Co. Ltd.
3. Schultz, D. P., & Schultz, E. S. (2008). *Psychology and Work today*. Newyork. Mac Milan publishing company.

Subject Code	Subject Name	L-T-P	Credits
BS 20004	**Object Oriented Programming**	2-0-3	4

- 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)
- Object design implementation in a programming language, e.g., C++ or java or Python
- Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases

Subject Code	Subject Name	L-T-P	Credits
PE 20004	**Transport in Porous Media**	3-0-0	3

- Pore structure and volume averaging. Single phase flow: Darcy's Law, Ergun, Kozeny and Brinkman Equations. Immiscible and miscible fluid flow. Wettability, multiphase flow and relative permeability.
- Dispersion in single and multiple continua. Tracer analysis

- Lattice Boltzmann model, MD/MC simulation
- Straining and interception of fines
- Deformable porous media
- Mercury porosimetry, Helium Pycnometry, BET analysis
- Heat convection/radiation and phase change in porous media

Text and Reference Book:

1. Dynamics of Fluids in Porous Media by Jacob Bear

Subject Code	Subject Name	L-T-P	Credits
PE 30011	**Advanced Reservoir Engineering**	3-1-0	4

- Reservoir drive mechanisms: solution gas drive, gas cap drive, natural water drive, compaction drive and pore compressibility.
- Water flooding: microscopic efficiency of immiscible displacement, macroscopic displacement efficiency of linear water flood, fractional flow and frontal advancement, immiscible displacement in two dimensions, displacement pattern and sweep efficiency, water flood design, role of reservoir geology in the design and operation of water floods, introduction to EOR.
- Radial steady state and transient flow, linearization of equations for small and constant compressibility; well in flow equation; steady state and pseudo steady state solutions.
- Natural water influx, application of water influx theory in history matching, steam soaking

Subject Code	Subject Name	L-T-P	Credits
PE 30006	**Hydrocarbon Production Engineering II**	3-1-0	4

- Artificial lift; ESP, SRPs, PCP
- Gas lift: well construction, design, performance curve; pump assisted lift.
- Formation damage: mechanisms, skin factors.
- Matrix acidizing: transport of acid to mineral surface; reaction stoichiometry and kinetics; sandstone and carbonate acidizing; acid selection; models; wormhole formation, growth, and propagation model for carbonate acidizing; treatment design - volume, injection rate, placement and diversion, additives; acid fracturing
- Hydraulic fracturing: fracture geometry and design; fractured well performance in conventional low-permeability, unconventional tight-sand, and shale reservoirs.
- Surface flow testing, Sand flow in well bore and management: cavity, gravel pack, and frac pack completions.

Text Book:

1. Economides M.J., Hill A.D., Economides C.E., Zhu D., Petroleum Production Systems, Prentice Hall / Pearson Education India 2012.

Reference books:

1. Arnold K. and Stewart M., "Surface Production Operations", Vol. I and II, Gulf Professional Publishing, 2008.
2. Clegg J.D. (ed), Petroleum Engineering Handbook Vol. IV, Production Operations Engineering, SPE 2007.
3. Guo B., Lyons W.C., and Ghalambor A., Petroleum Production Engineering: a Computer Assisted Approach, Gulf Professional Publishing 2011.
4. Beggs H.D., Production Optimization using Nodal Analysis. OGCI Publications. 1991.
5. Allen T.O. and Roberts A.P., Production operation, Well Completions, Workover, and Stimulation Volume 1 and 2, OGCI Publication 1994.

Subject Code	Subject Name	L-T-P	Credits
PE 30007	**Advanced Drilling Technology**	3-0-0	3

- Directional drilling: deflection tools and orientation, well profiles, down hole survey and correction, measurement and logging while drilling, telemetry system, down hole motors, power calculation, steerable system, geo-steering.
- Offshore drilling: Fixed and floating platforms, jack-up rig, ships and semi submersibles; platforms and subsea completions.
- Rig stability: vibration, design of block and tackle system, draw works drum; top drive drilling.
- Hydraulics design: horse power calculations, bit hydraulics, highly inclined wells.
- Underbalanced drilling systems, surface and downhole equipment, aerated liquid drilling, over- balanced drilling.
- Gas drilling systems: surface and downhole equipment, gas flow mechanics, pressure requirement.
- Other methods of drilling.
- Introduction to software's.

Text Books:
1. Rabia H., Oil Well Drilling Engineering, Principles and Practices. Graham & Trotman 1985.
2. Gidley J.L., Holditch S.A., Nierode D.E., Veatch R.W. (Jr.) (ed) Recent Advances in Hydraulic Fracturing. SPE Monograph Series Vol.2, 1990.

Reference Books
1. Bourgoyne A.T (Jr). Millheim K.K., Chenevert M.E., Young F.S. (Jr.), Applied Drilling Engineering, SPE 1986.
2. Mitchell R.F. and Miska S.Z., Fundamentals of drilling engineering, SPE 2010.
3. Mitchel R.F. (ed), Petroleum Engineering Handbook Volume II: Drilling Engineering. SPE 2007.
4. Helander D.P., Fundamentals of Formation Evaluation. OGCI Publications 1983.
5. Azar J.J. and Samuel G.R., Drilling Engineering. PennWell Corp 2007.

Subject Code	Subject Name	L-T-P	Credits
PE 30004	**Drilling & Fracturing Lab**	0-0-3	2

- Formulation of mud and fracturing fluid; characterization of mud and fracturing fluid through viscometry and rheometry.
- Fluid loss tests for mud and cement.
- Routine measurements of density, viscosity, sand content.
- Thickening time measurements, atmospheric consistometer for cement.
- Increase of density of mud through particle addition (mud balance); particle settling in transparent mud.
- Proppant transport
- Stress-strain measurements

Semester-VI

Subject Code	Subject Name	L-T-P	Credits
PE 30012	Oil and Gas Well Testing	3-0-0	3

- Introduction to well testing; constant terminal rate solution; superposition theorem; pressure build-up analysis; draw down tests; effects of partial well completion, after flow analysis.
- Radial flow of real gas; gas-well testing; non-Darcy flow, multi rate testing, pressure build-up analysis in solution gas drive reservoirs.
- Wellbore effect
- Multirate test, Multiwell test
- Injection Well Testing
- Well Test analysis by Type Curve
- Pressure Derivative Method
- Drill Stem Test (DST)

Text Books:
1. Dake L.P., Fundamentals of Reservoir Engineering. Elsevier Science 1985.

2. Craft B.C. and Hawkins M.F., Applied Petroleum Reservoir Engineering (revised by Terry R.E. and Rogers J.B.) Prentice Hall 2014

Subject Code	Subject Name	L-T-P	Credits
PE 40005	**Offshore and Deep sea technology**	3-0-0	3

- Offshore oil and gas operations and ocean environment. Sea floor marine soils, Geotechnical aspects. Various forces acting on offshore structure; Stability of offshore structure.
- Offshore fixed platforms, mobile units, Station keeping methods like mooring & dynamic positioning system.
- Offshore drilling from fixed platform, jack-up, ships and semi submersibles. Use of conductors and risers. Well completion.
- Offshore production: Oil processing platforms, water injection platforms, storage, SPM and SBM transportation and utilities.
- Deep water applications of subsea technology: drilling rig, well construction issues, cementations, casing and mud design, mud window for vertical / horizontal drilling, gas hydrates; Deep water completion, risers, Wellheads and manifolds.
- Deep water production system: Subsea transducers / sensors, control module, phase separators.
- Emerging deep water technologies, equipment and systems, remote operation vessels, safety of divers.
- Well abandonment, environmental concerns.
- Case Studies.

Text / Reference Books:
1. Yong Bai, Qiang Bai, Subsea Engineering Handbook. Gulf Professional Publishing (2012).
2. James Speight, Handbook of Offshore Oil and Gas Operations. Gulf Professional Publishing (2014).
3. Yong Bai, Qiang Bai, Subsea Pipelines and Risers. Elsevier Science (2005).
4. Andrew Clennel Palmer, Roger A. King, Subsea Pipeline Engineering. PennWell Books (2008).

5. Charles Sparks, Fundamentals of Marine Riser Mechanics: Basic Principles and Simplified Analyses. Pennwell Corp (2007).
6. Subrata Chakrabarti, Handbook of Offshore Engineering, Volume I and II. Elsevier Science (2005).

Subject Code	Subject Name	L-T-P	Credits
PE 40003	**Enhanced Oil Recovery**	3-0-0	3

- General classifications and description of EOR processes; Microscopic displacement of fluids in a reservoir; Mobilization of trapped phases—alteration of viscous/capillary force ratio, Role of phase behavior.

- Waterflood performance—frontal-advance equations; Viscous waterflood in a linear system; Chemical flooding in a linear system; displacement of slugs, dispersion during miscible displacement; Viscous Fingering - Instability in Displacement Fronts; Volumetric Displacement Efficiency

- Mobility Control Processes: Physical and Chemical Characteristics of Polymers, Flow of Polymers Through Porous Media, Polymer-Augmented Waterflood, In-Situ Permeability Modification, Field Experience; Mobility Control To Maintain Chemical Slug Integrity; Foam as an EOR Agent; WAG Process.

- Miscible Displacement Processes: Principles of Phase Behavior Related to Miscibility, FCM and MCM Process, Measurement and Prediction of the MMP or MME in a Multiple-Contact Process, Performance Modeling, CO_2 Injection, Design Procedures and Criteria, Field Experience.

- Chemical Flooding: Micellar/Polymer Process, Surfactants, microemulsions, Phase Behavior and IFT, Displacement Mechanisms, Surfactant Loss from Rock/Fluid Interactions and Phase Partitioning, Performance Modeling, Design Procedures and Criteria, Field Experience. Alkaline Flooding

- Thermal Recovery Processes: Heat Losses During Steam Injection, Cyclic Steam Stimulation, Reservoir Heating by Steam Injection, Cyclic Steam Stimulation of a Gravity-Drainage Reservoir, Estimation of Heated Radius, Estimation of Oil Recovery from Steamdrive, Production of Bitumen by Steam Injection, In-Situ Combustion

- Carbon Capture and Sequestration (CCS).

Text / Reference Book:

1. Don W. Green and G. Paul Willhite, Enhanced Oil Recovery. Society of Petroleum Engineers (2018).

2. Larry W. Lake, Russell Johns, Bill Rossen, Gary Pope, Fundamentals of Enhanced Oil Recovery. Society of Petroleum Engineers (2015).

Subject Code	Subject Name	L-T-P	Credits
PE 30008	**Pipeline Engineering**	3-0-0	3

- Introduction: pipelines, risers, valves, pigging, flow metering equipment; pipeline vs. other forms of transportation.
- Flow dynamics; multiphase flow and slugging; hydrate, wax, and scale deposition.
- Stress analysis; vibration, buckling and collapse.
- Steel materials: types, overview of manufacturing processes.
- Offshore pipeline construction, lay barge configurations, pipe coating, pipe laying procedures, underwater welding.
- On shore pipe line construction. Installation: route location survey, GIS image processing, S-lay, J- lay, and tow-in, control of sag and over bend.

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Visakhapatnam, Andhra Pradesh – 530003

- Design of cathodic protection system; thermal coatings, field joint coatings.
- Assessment of cracks, dents, and corrosion defects in pipeline under static and dynamic loading conditions.
- Crude conditioning with additives.
- Safety and security of oil pipelines
- Pipeline network analysis, software's.

Text Books:
1. Mohitpour M., Golshan H., Murray A., Pipeline Design & Construction: A Practical Approach, ASME 2007.
2. Guo B, Song S, Ghalambor A., Lin T., Chacko J, Offshore pipelines, Gulf Professional Publishing 2005.

Subject Code	Subject Name	L-T-P	Credits
BS 30003	**Economics**	2-0-0	2

Introduction, Demand and Supply Analysis, Production and Cost, Price Output Determination, Capital Market and Investment Decisions, Outline of Welfare Economics, Resource Accounting and Sustainability, Income Determination and Fluctuations, Trade, Aid and Development. Economic Systems & Indian Economic Policies.

Geopolitics and world petroleum market; role of OPEC, national oil companies and bilateral contracts; Fundamentals of petroleum business – strategic issues. Dynamics of petroleum pricing; Financial measures and profitability analysis; Risk, uncertainty, and decision analysis; Implications of fiscal and trade policies and regulations for petroleum industry Petroleum Economics.

Text Books:

1. Contemporary Engineering Economics, by, Chan S. park, Prentice Hall of India (PHI), 3rd Edition

2. Petroleum Economics and Engineering, by, Abdel Aal, Bakr, and, Al-Sahlavi, 2nd edition

3. Economics of worldwide Petroleum Production, by, Richard D. Seba, 3rd Edition

Reference Books:

1. Principles of Economics, by, Samuleson and Nordhaus

2. Principles of Economics, by, N. G. Mankiw

3. Engineering Economics, by, R. Paneerselvam, PHI

4. Petroleum Economics, by, Masseron Jean, 4th edition

Subject Code	Subject Name	L-T-P	Credits
PE 30009	**Reservoir Engineering Lab**	0-0-3	2

- Core permeability studies using gas permeameter and liquid permeameter.
- Determination of the effective porosity of core sample by saturation method.
- Analysis of BHP Chart.
- Determination of the surface tension and contact angle of liquid hydrocarbon systems.
- Characterization of crude oil through viscometry.
- Coring from the rock; study of thin section under microscope with digital camera and automatic point counter.

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Visakhapatnam, Andhra Pradesh – 530003

- Core flooding, and measurement of relative permeability.

Subject Code	Subject Name	L-T-P	Credits
PE 40002	**Production Engineering Lab**	0-0-3	2

Flow experiments:
1. Phase separation in transparent acrylic set-up (Both horizontal and cyclone type)
2. Pressure drop in two / three phase flow in transparent pipe
3. Measurement of gas flow rate in pipeline using orifice meter and turbine meter
4. Formation damage and matrix acidizing
5. Rock-fluid interaction in rotating disc apparatus

Fluid properties
1. Hydrocarbon dew point determination
2. Sulphur (H2S) quantification in gas
3. Calorific analysis of natural gas
4. Analysis of produced brine (pH, TDS, concentration of scale forming ions)
5. Determination of water and sediment in crude oil by centrifuge
6. Capillary
7. True Boiling Point curve for crude oil
8. Karl-Fischer measurement to determine water content of crude oil sample
9. Measurement of total acid number

Fluid Flow Design
1. Bernoulli s experiment; Flow through square and circular pipes; horizontal nozzles; pipe fittings; V-notch, packed bed; Venturimeter, orifice meter; rotameter; pitot tube; Pipe flow Viscometer; Characteristics of centrifugal pump.
2. Design studies on valves, pipe fittings and piping network.
3. Mechanical design of pressure vessel, flange, reinforcement for opening, support

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	Semester-VII		

Subject Code	Subject Name	L-T-P	Credits
PE 40008	**Health Safety and Environment (HSE)**	2-0-0	2

- Safety in Chemical and Petroleum Industry; Setting & layout of chemical plant.

- Forms of hazards: chemical, toxic, explosion, electrical, mechanical, radiation, noise hazards.

- Control and prevention of hazards.

- Toxicity, Asphyxiation, respiratory and skin effect of petroleum hydrocarbons, sour gases. Thresh- hold limits.

- Analysis of documented accidents: Leakage of drilling, fracturing and completion fluids, Blow out, effect of corrosive atmosphere

- Characteristics of chemical with special reference to safe storage & handling.

- Layout of storage, modes of transport, associated hazards control and prevention.

- Safety audit: objective, procedure, engineering standards, Factories Act and Regulation, regulating agencies. Statutory Bodies & Regulations viz. PESO, OISD, ISO standards

- Offshore safety. Offshore oil spill and oil spill control.

- Safety and Environmental Management Systems, SEMS

- Risk Analysis: hazard and operability (HAZOP) studies. hazard analysis (HAZAN), fault tree analysis, consequence analysis, scenario and probabilistic assessment.

- Onshore and Offshore Emergency Management Plans.

- Safety System: Manual & automatic shutdown system, blow down systems. Gas detection system. Fire detection and suppression systems. Personal protection system & measures.

- HSE Policies. Disaster & crisis management in Petroleum Industry.

- Environment: Environment concepts, impact on eco-system, air, water and soil. The impact of drilling & production operations on environment, Environmental transport of petroleum wastes

- Waste treatment and disposal methods, remediation of contaminated sites.

Text / Reference Books:

1. David S. Gloss and Miriam Gayle ardle, Introduction to Safety Engineering. John Wiley and Sons, New York (1984).
2. Phil Hughes and Ed Ferrett, Introduction to Health and Safety at Work. Elsevier (2009).
3. Recommended Practice for Development of a Safety and Environmental Management, API (2004).
4. Program for Offshore Operations and Facilities, 3rd ed. API RP 75. API, Washington D.C.
5. Ian Sutton, Offshore Safety Management Implementing a SEMS Program. Elsevier (2014).
6. Ulrich Hauptmanns, Process and Plant Safety. Springer (2013).
7. Genserik L. L. Reniers, Multi-Plant Safety and Security Management in the Chemical and Process Industries (2010).

Subject Code	Subject Name	L-T-P	Credits
PE 40001	**Reservoir Simulation**	3-1-0	4

- Concepts of modelling and simulation; Introduction to reservoir simulation
- Introduction to integrated reservoir modeling: use of geophysical, geological, petro physical and engineering data with geostatistical methods to create reservoir description.
- Multiphase fluid flow equations: parabolic and hyperbolic form; Non-Darcy effects in flow equations; Heat flow equations.
- Finite difference based discretization in single phase one dimensional Cartesian and radial flow; Grid construction; Irregular grids and variable coefficients; Treatment of non-linearities.
- Introduction to Black Oil and Compositional Model.
- Multiphase flow in one dimension: Simultaneous Solution method, Implicit Pressure Explicit Saturation method, Sequential Solution method.
- Solution of tridiagonal, block-tridiagonal and pentadiagonal form of linear equations.
- Flow of single phase in two dimensions; Alternating direction explicit and implicit methods; Method of grid construction.
- Multiphase flow in two and three dimensions.
- Stream tube and related models; Automatic time step control; Simulation of naturally fractured reservoirs;
- History matching: Inverse modeling, parameterization, objective function formation, calibration and tuning algorithm, Bayesian formulation and uncertainty quantification, optimization algorithms.
- Introduction to field-scale model, and proprietary simulators.

Text / Reference Books

1. K. Aziz, A. Settari, Petroleum Reservoir Simulation. Applied Science Publisher (2006).

2. Turgay Ertekin, J.H. Abou-Kassem, and G.R. King, Basic Applied Reservoir Simulation. Society of Petroleum Engineers (2001).

3. Shahab D. Mohaghegh, Data-Driven Reservoir Modeling. Society of Petroleum Engineers (2017).

4. James R. Gilman and Chet Ozgen, Reservoir Simulation: History Matching and Forecasting. Society of Petroleum Engineers (2013).

Subject Code	Subject Name	L-T-P	Credits
BS 40002	**Data Analytics and AI for Process Industry**	3-0-0	3

- Introduction: Introduction to Data Analytics and Artificial Intelligence- Some illustrations of AI problems- Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python.

- Data warehousing: Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization.

- Descriptive Statistics: Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-Linear Regression.

- Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical Clustering-Decision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.

- Introduction to Big Data and Hadoop: Managing Big Data-Hadoop Ecosystem Tools (Sqoop and Hive)

- Introduction to Spark: Big Data Analysis using SparkR-SparkSQL-Case studies
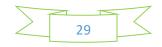
Text/Reference Books:

1. Thomas A. Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis. Springer 2012.
2. Wes McKinney, Python for Data Analysis. O'Reilly 2013.
3. Keith R. Holdaway, Harness Oil and Gas Big Data with Analytics: Optimize Exploration and Production with Data-Driven Models. Wiley (2014).
4. Robert Haining, Spatial Data Analysis: Theory and Practice. Cambridge University Press (2003).

Subject Code	Subject Name	L-T-P	Credits
CH 40001	**Project Engineering and Management**	3-0-0	3

Stages of Project Implementation; Project Milestone: Planning, Analysis, Selection, Implementation; Generation and Screening of project ideas. Feasibility studies. Project Analysis and introduction to various component of Project cost and their estimation; Elements of Coat of Project, Cost of Production; Financing of projects: Debt-Equity ratio etc... Depreciation concept, Capital cost estimation, Working capital estimation, Project Evaluation, break-even analysis, ROI, IRR., Discounted cash flow analysis. Project Management and Scheduling, Network Technique for project management: CPM and PERT, Project Risk Assessment, Social Cost benefit analysis, Venture capital and Private Equity.

Text Book:

1. Projects: Planning, Analysis, Selection, Financing, Implementation, and Review by P. Chandra
2. Plant Design and Economics for Chemical Engineers by M. S. Peters and K. D. Timmerhaus
3. Project Engineering of Process Plants by H.F. Rase

Semester-VIII

Subject Code	Subject Name	L-T-P	Credits
PE 40004	**Reservoir Simulation Lab**	0-0-3	2

- Establish reservoir simulation workflow: reservoir structure, rock properties, fluid properties (PVT, relative permeability, capillary pressure), fluid contacts, model initialization, well completion, production data.

- Set-up Eclipse database with correct syntax, fluid description, wells, faults; Control of time step and convergence.

- Specific examples on (i) gas condensate reservoir, (ii) waterflood in oil reservoir, (iii) oil in gas cap reservoir with aquifer influx.

- History matching of model reservoir data.

- Modelling of Thermal EOR / SAGD using STARS (CMG).

ELECTIVES

ELECTIVE-I

Subject Code	Subject Name	L-T-P	Credits
PE 30013	**Petroleum Explorations**	3-0-0	3

Principles and methods of geological and geochemical exploration, pathfinders and trace elements in rocks and soils. primary and secondary dispersion patterns, geochemical anomalies and their interpretation
Geophysical Explorations: Gravity method; Magnetic method; Electrical Methods; Seismic Methods: Field procedure, Data acquisition, Data processing, Data processing sequence, Advanced processing,
Data processing using software; Interpretation of images, Detection of hydrocarbons.

Subject Code	Subject Name	L-T-P	Credits
PE 30014	**Bio Energy**	3-0-0	3

Introduction to Bioenergy; Current status, merits & demerits. Feedstock: starch, oilseed, lignocellulogic and algae based, fuel logistics of Biomass, Biological conversion technologies, enzyme hydrolysis, ethanol fermentation, comparisons of fossil fuels and bio fuels, Fundamentals of anaerobic digestion, Microbial fuel cells, Bio-refinery, Economic, Social and Ecological Impacts of Bioenergy at Local, National and Global Levels, Life cycle assessment, current and emerging challenges to bioenergy development, Govt policies and standards.
Text Books:

1. Y. Li, and S. K. Khanal, Bio Energy: Principles & Applications: Wiley-Blackwell 2016.

2. S. Lee, and Y T Shah, Bio Fuels and Bio Energy: Processes and Technologies, CRC Press, 2012

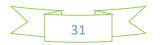| Subject Code	Subject Name	L-T-P	Credits
CH 30010	**Waste Water Management**	3-0-0	3

Introduction to water and wastewater engineering, Methods for characterisations of wastewater properties, physical, chemical and biological process for wastewater treatment, primary, secondary and tertiary treatment including suspended growth and attached growth methods. Advanced oxidations process for removal of recalcitrant components in wastewater, nutrient removal, sludge treatment and its removal, progress in zero-discharge techniques. Case studies related to treatment of Industrial and municipal effluents, standards and regulations.

Text Books:
1. W. Eckenfelder (Jr.) Industrial Water Pollution Control, McGraw Hill 1999.
2. G. Tchobanoglous, .L. Burton, and H.D. Stensel, Wastewater Engineering Treatment and Reuse (Metcalf & Eddy),McGraw Hill 2002.
3. A. P. Sincero and G.A. Sincero

Subject Code	Subject Name	L-T-P	Credits
PE 30015	**Management Techniques for Industrial Sector**	3-0-0	3

Will be offered later

ELECTIVE-II

Subject Code	Subject Name	L-T-P	Credits
PE 30010	**Unconventional Hydrocarbon Resources**	3-0-0	3

- **Coalbed Methane:** Introduction, formation and properties, exploration, isotherm studies, reserve estimation, drilling and production system, artificial lift, hydraulic fracturing of coal seam, produced water separation and disposal, surface facilities, well testing.

- **Natural Gas Hydrates:** Introduction, formation and properties, thermodynamics, kinetics and phase behavior, gas extraction methodologies.

- **Shale Gas/ Oil:** Introduction, geology, important occurrences, petrophysical properties, hydro fracturing, horizontal wells, production profiles.

- **Non-Conventional Oil:** Introduction to Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales; origin and occurrence worldwide, resources, reservoir characteristics, new production technologies.

- **Others:** Coal conversion to gas, underground coal gasification

Reference Books:
1. Carrol J., Natural Gas Hydrates: A guide for engineers, Gulf Professional Publishing 2011.
2. Warner H.R, Jr. (ed), Petroleum Engineering Handbook Vol. VI, Emerging and Peripheral Technologies, SPE 2007.
3. Thakur P., Aminian K., Schatzel S. (ed) Coal Bed Methane: From Prospects to Pipeline, Elsevier 2014.
4. Islam M.R., Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Gulf Professional Publishing 2014

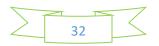| Subject Code	Subject Name	L-T-P	Credits
CH 40010	**Solar Energy, Photovoltaic Energy**	3-0-0	3

Introduction; Nature and availability of solar energy; Principle of operation of solar cells – materials and processing, thin film, unconventional materials and systems; Concentrators; Cells and system characteristics; Power conditioning, energy storage, and grid connection; Maximum power point tracking, PV to grid – single and three phases; Economy and Life cycle costing. Solar thermal energy. Water pumping: dc and ac pump drive; Peltier refrigeration.

Text/Reference Books:
1. Hans S. Rauschenbach, Solar Cell Array Design Handbook: The Principles and Technology of Photovoltaic Energy Conversion. Springer (2013).
2. C. Hu and R.M. White, Solar Cells: From Basic to Advanced Systems. McGraw Hill (1983)

Subject Code	Subject Name	L-T-P	Credits
CH 40004	**Advanced Separation**	3-0-0	3

- Thermodynamics: Phase equilibria, non-ideal thermodynamic property models, activity coefficient models for the liquid phase; Single equilibrium stages: Multicomponent Liquid-Liquid, Solid- Liquid, Gas-Liquid, Vapor-Liquid-Liquid systems.
- Multicomponent multistage separations: Approximate methods, Equation tearing procedures.
- Enhanced distillation; Supercritical extraction.
- Vapor-liquid flow pattern and rate based models for distillation.
- Membrane separations; Adsorption, ion exchange, and chromatography.

Text/Reference Books

1.   Charles Holland, Fundamentals of Multicomponent Distillation. McGraw Hill (1997)

2.   J. D. Seader and E.J. Henley, Separation Process Principles. Wiley (2006).

Subject Code	Subject Name	L-T-P	Credits
PE 40009	**Advanced Material Design**	3-0-0	3

Materials characterization using optical and neutron spectroscopies; Multiscale atomistic modeling; Use of density functional theory to predict temperature dependent thermodynamic properties of new materials e.g., complex hydrides, and kinetic processes in diffusion; Introduction to molecular simulations; Semiconductor and oxide nanostructure for optoelectronic devices, high energy solar cells; Quantum dots; Thermoelectric materials.

Text/Reference Books

1.   Edward L. Wolf, Nanophysics and Nanotechnology. Wiley Verlag (2006).

2.   Peter Würfel, Physics of Solar Cells: From Basic Principles to Advanced Concepts. Wiley (2009).

3.   Charles Kittel, Introduction to Solid State Physics. Wiley (2012).

4.   D. C. Rapaport, The Art of Molecular Dynamics Simulation. Cambridge University Press (1995).

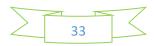| Subject Code	Subject Name	L-T-P	Credits
BS 30002	**Instrumentation and Process Control**	3-0-0	3

Instrumentation:
* Static and dynamic characteristic of instruments.
* Measurement of temperature, pressure, vacuum, fluid flow rate, level and control valves.

Process Control:
* Modeling considerations for control purposes.
* State Space and Transfer function models.
* Dynamic behavior of first and higher order systems.
* Concept and dynamic behavior of feedback control. Frequency response analysis. Stability analysis of feedback systems. Design of feedback controllers.
* Feedforward, Ratio, Adaptive and inferential control, dead-time and inverse response compensator.
* Control systems with multiple loops.

Text/Reference Books:

1.   G. Stephanopoulos, Chemical process control: An introduction to theory and practice, Prentice Hall India 2008.

2.   D. E. Seborg, T. F. Edgar, D. A. Mellichamp, and F.J. Dyle III, Process dynamics and control, Wiley 2010.

3.   D. Patranabis, Principles of industrial instrumentation, Tata McGraw Hill 2008.

ELECTIVE-III

Subject Code	Subject Name	L-T-P	Credits
PE 40010	**Petroleum Engineering System Design**	3-0-0	3

- Rig selection and design: Drilling rig, Work-over rig, Loading and stability of rig
- Casing and Drill string design
- Crude oil treatment: Heater treater, Electrostatic Heater treater, Design of Heater treater.
- Design Gas lift system: Continuous and Intermittent system.
- Design of SRP, ESP and PCP system.
- Design of Pump and Compressor, Coil tubing unit.

Subject Code	Subject Name	L-T-P	Credits
PE 40011	**Nuclear Wind and Geothermal Energy**	3-0-0	3

- Basic nuclear models, radioactivity, nuclear reactions – energy systems based on fission & fusion reactions; Reactor heat generations and removal; Nuclear Fuel cycle from Uranium / Thorium supply, enrichment, fuel management and waste disposal; Interaction of ionizing radiation with matter, radiation detection, shielding, and effects on human health.

- Introduction to wind resources: wind speed and terrain properties, power density; Measurement of wind speed and turbulence; Wind turbine / rotor design: Thrust, torque, speed, and power; Turbine material design and structural analysis; Integration of variable power production into electrical systems: Control of rotor speed, maximum power in low wind speeds, constant power in high wind speeds; Offshore wind farm: Dynamic wind and wave loadings, grid integration, operational and maintenance strategies; Cost of energy from wind turbine during lifetime.
- Nature, occurrence, types and classification of geothermal fields; Basics of geothermal exploration, drilling and production, and conversion methods;
- Analysis of energy system proposals with reference to engineering, economic, socio-political, and environmental objectives.

Text/Reference Books:
1. James F. Manwell, Jon G. McGowan, Anthony L. Rogers, Wind Energy Explained: Theory, Design and Application. Wiley-Blackwell (2009).
2. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook. Wiley (2001).
3. Arnold Watson, Geothermal Engineering: Fundamentals and Applications. Springer (2014).
4. J.R. Lamarsh, A.J. Baratta, Introduction to Nuclear Engineering. Pearson Education India (2014).
5. Robert E. Masterson, Nuclear Engineering Fundamentals: A Practical Perspective. CRC Press (2017).

Subject Code	Subject Name	L-T-P	Credits
CH 40006	**Analytical Techniques**	3-0-0	3

Spectroscopy: Introduction, Spectroscopy methods: Infrared, UV-Visible, Fluorescence, Nuclear Magnetic Resonance, Atomic Absorption.
Spectrometry: Mass, Matrix-assisted laser desorption/ionization (MALDI)
Microscopy: Introduction, Atomic Force Microscopy, Field Emission Scanning Electron Microscope with EDXS (Energy-dispersive X-ray spectroscopy), Transmission Electron Microscopy, Laser Scanning Confocal Microscopy, Confocal Raman.
Thermal analysis: Differential Scanning Calorimetry, Thermal Gravimetric Analysis
Chromatography: Introduction, Thin-Layer Chromatography, Types of Column Chromatography: Affinity and

Ion Exchange, Gel Permeation and HPLC, Gas Chromatography–Mass Spectrometry

Text / Reference Books:
1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press; 8th Edition
2. D. A. Skoog and D. M. West, Fundamentals of analytical chemistry, Cengage Publishers; 9th Edition.
3. G. D. Christian, P. K. Dasgupta and K. A. Schug, Analytical Chemistry, Wiley Publishers; 7th Edition
4. R. M. Silverstein, F. X. Webster, D. J. Kiemle and D. L. Bryce, Spectrometric Identification of Organic Compounds, Wiley Publishers; 8th Edition.
5. D. B. Williams and C. B. Carter, Transmission electron microscopy-a text book for material science, Springer Publishers; 2nd Edition
6. Introduction to Polymer Science. Charles E. Carreher. Jr. CRC Press; 6th Edition

Subject Code	Subject Name	L-T-P	Credits
CH 40011	**Hazardous Waste Treatment and Safety Devices**	3-0-0	3

- Fundamental knowledge of hazardous waste, their sources, generation, identification, classification and characterization.
- Health and safety related problems of hazardous waste, routes of migration.
- Minimization Technologies of hazardous waste.
- Hazardous waste treatment and its disposal.
- Regulatory aspects of hazardous wastes: regulation on storage handling and transportation of hazardous waste.
- Clean-up of hazardous waste contaminated sites.
- Risk assessment and hazardous waste management.
- Management of hazardous waste case studies: pesticides and containers.
- Management of hazardous nuclear waste

Text / Reference Books:

1. Michael D. Lagrega, Phillip L. Buckingham, Jeffrey C. Evans, Hazardous Waste Management. Waveland Pr Inc. (2010).

2. S. Bhatia, Solid and Hazardous Waste Management. Atlantic (2007).

3. Mackenzie Davis, David Cornwell, Introduction to Environmental Engineering. McGraw Hill Indian Edition (2017).

ELECTIVE-IV

Subject Code	Subject Name	L-T-P	Credits
PE 40003	**Natural Gas Engineering**	3-0-0	3

- Importance of Natural Gas; Composition of Natural Gas, Natural Gas Reservoir, Unconventional gas reserve. Properties of Natural Gas: Phase Behaviour, properties of Natural Gas, Formation Volume Factor, etc., Determination of natural gas properties such as specific gravity, pseudocritical properties, viscosity, compressibility factor, gas density, formation and expansion volume, and compressibility.

- Production of Natural Gas: Overview of well Completion and wellbore Performance.

- Natural Gas Processing & surface facilities: Gas Compressor, Compressor design, Gas Flow Measurement, Principle of Separator, Design of Separator. Dehydration of Natural Gas, Design of Dehydration, Sweeting processes and sulphur recovery, Processing of LPG, CNG system, Conversion of gas to liquid

- Gas Gathering system, transportation and Storage: Gas Gathering system, Transmission of Natural gas, Transportation and Measurement, Pipeline Design. Flow through pipeline, issues and solutions. Underground storage. Natural Gas Metering

- Gas Supply/Distribution: City Gas/CNG development, CNG stations, Design aspects for City Gas Network and CNG Stations, Maintenance and safety of City Gas Networks and CNG equipment.

- LNG: Import of LNG, LNG liquefaction plant and shipping, LNG regasification, LNG Plant.

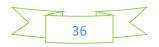| Subject Code	Subject Name	L-T-P	Credits
PE 40012	**Advanced Reservoir Modelling**	3-0-0	3

Geostatistical modeling, quantification of connectivity, lithofacies, porosity, permeability using variogram, krigging techniques; Construction of heterogeneous reservoir models, constrained to well and seismic data; Upscaling and ranking; Stochastic simulation and modeling; Overview of uncertainty analysis and integrated studies; Case studies.

Text/Reference Books

1. M.J. Pyrez and C.V. Deutsch, Geostatistical Reservoir Modeling. Oxford University Press.

2. J. Caers, Modeling Uncertainty in Earth Sciences. Wiley Blackwell.

3. Matlab Reservoir Simulation Toolbox. SINTEF.

4. S. Cannon, Reservoir Modeling: A Practical Guide. Wiley

5.

Subject Code	Subject Name	L-T-P	Credits
PE 40003	**Petroleum Refinery Engineering**	3-0-0	3

- Origin of petroleum crude oil. Evaluation of crude oil – evaluation and characterization of crude oil: TBP and other distillation tests. Petroleum products, their properties, specification and testing – different properties like flash point, fire point, smoke point, aniline point, carbon residue, kinematic viscosity, pour point, freezing point etc. Use of crude book data.

- Petroleum refinery distillation – pre-fractionation and atmospheric distillation of crude. Process design for atmospheric distillation. Stabilization of naphtha. Vacuum distillation of RCO.

- Reforming of naphtha. Isomerization and Alkalization, Other secondary processes like Vis-breaking, Furfural/Phenol/NMP extraction, Solvent dewaxing, propane deasphalting. Delayed coking process. FCC unit.
- Hydrotreatment processes in refining: Hydro-Desulfurisation, Hydrofinishing, Hydrocraking, and Production of lube oil base stock. Residual Hydrocracking.
- Refinery equipment: furnaces, distillation columns, reactors, pumps, compressors and piping.
- Elements of design of stream reformer naphtha cracker, catalytic reformer etc.
- Environmental impact of refineries.

Text Book:

1. Petroleum Refinery Engineering by W. L. Nelson
2. Petroleum Refining, Technology & Economics by J. H. Gray & G. E. Handwerk
3. Petroleum Refinery Distillation by R. N. Watkins
4. Modern Petroleum Refining Processes by B. K. B. Rao

Reference Book:

1. The Chemistry & Technology of Petroleum by J. G. Speight

Subject Code	Subject Name	L-T-P	Credits
CH 40009	**Air Pollution**	3-0-0	3

- Introduction to principal aspects of air pollution; History of air pollution; Sources of air pollution; Effects of major air pollutants; Current policies, standards and objectives; Air pollution legislation.
- Meteorology as applied to air pollution and dispersion of air pollutants; Atmospheric chemistry, Aerosol behavior; Transport and dispersion modeling. Commercial air quality models (ADMS and USEPA).
- Monitoring of emissions and air pollutants in ambient air; Engineering control of stationary sources; Modeling and control of emission from road transport and from industrial sources. Selection of control equipments; Process change, fuel change; pollutant removal and disposal of pollutants; Control devices and systems, removal of dry particulate matter, liquid droplets and mist removal, gaseous pollutants and odor removal;
- Indoor air pollution; Personal exposure to air pollution.
- Economics and trends in air pollution control.

Text / Reference Books

1. Richard C. Flagan, John H. Seinfeld, Fundamentals of Air Pollution Engineering. Prentice Hall (1988).
2. M Rao, H.V.N. Rao, Air Pollution. McGraw Hill, Indian Edition (2017) A. P. Sincero and G.A. Sincero

Subject Code	Subject Name	L-T-P	Credits
	Tribology & Introduction to Lubricants	3-0-0	3

The fundamentals of lubricants business

- Lubricant value chain
- Types of Lubricants- Automotive, Industrial, Marine, Railroad, Air
- Applications of lubricants – Automotive (Trucks, Cars, 2-Wheelers, Tractors, Gear Oils, Natural Gas Engine Oils etc.) and Industrial (Cutting Oils, Rust Preventives, Rolling Oils, Compressor Oils, Hydraulic, Drilling Oils etc.)
- Properties of Lubricants
- Bio-Lubricants

- Tribology with specialization in Lube Technologies

Fundamentals of Base Oils

- Type of Crude Oils
- Refinery process – Brief introduction
- Base Oil Groups
- Properties of Base Oils

Fundamentals of Additives

- Properties & key characteristics
- Composition of additives for various applications
- Additive Chemistry
- Types of additives
- Performance contribution of additive to Lubricants

Lubricants – Automotive

- Understanding of Key specifications like API, JASO, ACEA
- Global Specifications and Viscometrics
- India- Current scenarios of Lubricants in India & Future trends

Lubricants-Industrial, Marine, Railroad, Air
sector Indian Lubricant Market-

- Current size & key players
- Growth Potential

New trends impacting lubricants, base Oils and additive industry

- BS IV to BS VI Transition by 2020
- Transition towards high-quality lighter lubricants
- New slate of Base Oils over next 10 years

Finance and Cost optimization of Lubricants

- Tools and techniques: value engineering and collaborative optimization
- Global best practices to drive down the total costs of ownership

ELECTIVE-V

Subject Code	Subject Name	L-T-P	Credits
PE 40007	**Prospecting, Filed Development and Asset Management**	2-0-0	2

Life cycle of a hydrocarbon field; Govt. Policies, Process of award of upstream areas to companies by Government, regulatory bodies and its functionalities such as of DGH, OISD, DGMS, PPAC, DSF, Field development workflow; Probabilistic reserve estimation; Project economic evaluation: Capital expenditures (drilling costs, equipment cost, installation costs etc.) and Operating expenditures (maintenance, intervention, flow assurance measures etc.); Production profile of each field architecture; Offshore field architectures and production systems, Reservoir depletion and field performance, Production scheduling, EOR screening; Flow assurance, Flow design of well; Seabed boosting; Data processing and management; Field processing facilities and product control; Production optimization and integrated asset modeling. Reservoir management case studies.
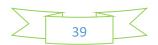
Text / Reference Books:
1. K. Shah, O. Izgec, Real Time Reservoir Management. Society of Petroleum Engineers (2012).
2. J. Fanchi, Integrated Reservoir Asset Management: Principles and Best Practices. Gulf Publishing.
3. A. Satter, J. Baldwin, R. Jespersen, Computer Assisted Reservoir Management. Pennwell (2000).
4. Nadine Bret-Rouzaut, Jean-Pierre Favennec, Oil and Gas Exploration and Production: Reserves, Costs, Contracts. Technip 2011.
5. Ganesh Thakur, Abdus Satter, Integrated Waterflood Asset Management. Pennwell Corp.
6. Abdus Satter, Ganesh Thakur, Integrated Petroleum Reservoir Management: A Team Approach. Pennwell Publisher 1994.
7. T. Ahmed, D. Nathan Meehan, Advanced Reservoir Management and Engineering. Gulf Professional Publishing (2012)

Subject Code	Subject Name	L-T-P	Credits
CH 40008	**Nano Materials for Hydrocarbon Industry**	2-0-0	2

- Introduction to metallic nanoparticles, metal oxide nanoparticles, carbon nanotubes, magnetic nanoparticles, nanoporous materials.
- Synthesis: Chemical, electrochemical, thin films – CVD, PVD, Langmuir-Blodgett, mechanical (attrition), sol-gel, nanolithography.
- Functionalization: Ligand incorporation, biomolecule conjugation, polymer coating.
- Physical and chemical properties at nanoscale; Nanomaterial characterization: SEM, TEM, AFM, scanning probe microscopy, scanning tunneling microscopy, diffraction and scattering techniques, vibrational spectroscopy.
- Use of nanomaterials in exploration and reservoir characterization, drilling, cementing, production, stimulation, petroleum refining, fuel production, and chemical sensing.
- Use of nanomaterials in lubricants

Text/Reference Books:
1. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications. Wiley VCH (2013).
2. Dieter Vollath, Nanoparticles – Nanocomposites Nanomaterials: An Introduction for Beginners. Wiley VCH (2013).
3. Ratna Tantra, Nanomaterial Characterization: An Introduction. Wiley (2016).
4. Daniel L. Fedlheim and Colby A. Foss, Metal Nanoparticles: Synthesis, Characterization, and Applications. CRC Press (2001).

Subject Code	Subject Name	L-T-P	Credits
BS 40004	**Petrochemical Technology**	2-0-0	2

- Survey of petrochemical industry; Availability of different feed stocks; Production, purification and separation of feed stocks;
- Chemicals from methane; Production and utilization of synthesis gas, oxo reactions, etc.; Production of and chemicals from acetylene; Naphtha cracking;
- Chemicals from C2, C3, C4 and higher carbon compounds; Polymers - properties, production and utilization;
- Catalytic reforming of naphtha and isolation of aromatics; Chemicals from aromatics; Synthetic fibres, detergents, rubbers and plastics; Petroleum coke;
- Integration of Petroleum Refining and Petrochemicals

Text Books:
1. Hydrocarbon Chemistry by G. A. Olah and A. Molnar
2. A. Text on Petrochemicals by B. K. B. Rao
3. Petroleum Refining, Technology and Economics by J. H. Gary and G. E. Handwerk

Reference Books:
1. Industrial Organic Chemicals by H. A. Wittcoff and B. G. Reuben
2. Handbook of Petrochemicals and processes by G. M. Wells

Subject Code	Subject Name	L-T-P	Credits
PE 40013	**Process Modeling and Simulation**	2-0-0	2

- Introduction: fundamentals of process modeling and simulations. Review of analytical and numerical techniques. Macroscopic mass, momentum and energy balances. Microscopic balances for mass, energy, and momentum, and associated constitutive relationships. Steady state and unsteady state modeling of chemical process equipment: flow systems, separators, reactors and heat exchangers. Grid generation; Introduction to SIMPLE, PISO. Finite volume approach. Introduction to simulators: Ansys Fluent, Open Foam.
- Formation of lumped parameter models, absolute and deviation variables, linearization, transfer function models, introduction to MATLAB Simulink.
- Modeling of disperse phase systems. Application of population balances in modeling particulate/disperse phase systems. Modeling of crystallizers, liquid-liquid extraction, polymerization reactors etc. Introduction to stochastic processes. Modeling of stochastic processes using Kinetic Monte Carlo simulation. Modeling of mixing. Effect of mixing on conversion and yield of reactions.

Text/Reference Books:
1. Finlayson B.A., Nonlinear Analysis in Chemical Engineering. McGraw Hill 1980.
2. Davis M.E., Numerical Methods and Modelling for ChE. Wiley 1984.
3. B. W. Bequette, Process Dynamics--Modeling, Analysis and Simulation, Prentice Hall, Englewood Cliffs, NJ, 1998.
4. W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd Ed., McGraw Hill, 1990.
5. B. A. Ogunnaike and W. H. Ray, Process Dynamics, Modeling and Control, Oxford University Press, UK, 1994.