JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech. in PETROLEUM ENGINEERING
COURSE STRUCTURE & SYLLABUS (R18)

Applicable From 2018-19 Admitted Batch

I YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA101BS	Mathematics - I	3	1	0	4
2	PH102BS	Engineering Physics	3	1	0	4
3	CS103ES	Programming for Problem Solving	3	1	0	4
4	ME104ES	Engineering Graphics	1	0	4	3
5	PH105BS	Engineering Physics Lab	0	0	3	1.5
6	CS106ES	Programming for Problem Solving Lab	0	0	3	1.5
7	*MC109ES	Environmental Science	3	0	0	0
		Induction Programme				
		Total Credits	**13**	**3**	**10**	**18**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA201BS	Mathematics - II	3	1	0	4
2	CH202BS	Chemistry	3	1	0	4
3	ME203ES	Engineering Mechanics	3	1	0	4
4	ME205ES	Engineering Workshop	1	0	3	2.5
5	EN205HS	English	2	0	0	2
6	CH206BS	Engineering Chemistry Lab	0	0	3	1.5
7	EN207HS	English Language and Communication Skills Lab	0	0	2	1
		Total Credits	**12**	**3**	**8**	**19.0**

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA301BS	Probability and Statistics & Complex Variables	3	1	0	4
2	PE302PC	Chemical Process Calculations	3	1	0	4
3	PE303PC	General Geology	3	0	0	3
4	PE304PC	Surveying and Offshore Structures	3	0	0	3
5	SM305MS	Business Economics & Financial Analysis	3	0	0	3
6	PE306PC	Geology Lab	0	0	2	1
7	PE307PC	Basic Engineering (Mechanical + Electrical) Lab	0	0	4	2
8	PE308PC	Surveying Lab for Petroleum Engineers	0	0	2	1
9	*MC309	Constitution of India	3	0	0	0
		Total Credits	**18**	**2**	**8**	**21**

II YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	PE401ES	Elements of Mechanical Engineering	3	0	0	3

2	PE402PC	Chemical Engineering Fluid Mechanics	3	1	0	4
3	PE403PC	Petroleum Geology	3	1	0	4
4	PE404PC	Petroleum Exploration Methods	3	1	0	4
5	PE405PC	Process Heat Transfer	3	0	0	3
6	PE406ES	Mathematical Methods for Petroleum Engineering	0	0	2	1
7	PE407PC	Chemical Engineering Fluid Mechanics Lab	0	0	2	1
8	PE408PC	Process Heat Transfer Lab	0	0	2	1
10	*MC409	Gender Sensitization Lab	0	0	2	0
		Total Credits	**15**	**3**	**8**	**21**

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	PE501PC	Instrumentation and Process Control	3	1	0	4
2	PE502PC	Drilling Technology	3	0	0	3
3	PE503PC	Thermodynamics for Petroleum Engineers	3	0	0	3
4	SM506MS	Fundamentals of Management for Engineers	3	0	0	3
5	PE504PC	Well Logging & Formation Evaluation	3	0	0	3
6	PE505PC	Health, Safety & Environment in Petroleum Industry	3	0	0	3
7	PE506PC	Instrumentation & Process Control Lab	0	0	2	1
8	PE507PC	Drilling Fluids Lab	0	0	2	1
9	PE508PC	Energy & Environmental Engineering Lab	0	0	2	1
10	*MC510	Intellectual Property Rights	3	0	0	0
		Total Credits	**21**	**1**	**6**	**22**

III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	PE601PC	Petroleum Refinery Engineering	3	0	0	3
2	PE602PC	Petroleum Reservoir Engineering	3	1	0	4
3	PE603PC	Petroleum Production Engineering & Design	3	0	0	3
4		Professional Elective - I	3	0	0	3
5		Open Elective - I	3	0	0	3
6	PE604PC	Well Completion Testing & Servicing	3	0	0	3
7	PE605PC	Petroleum Reservoir Engineering Lab	0	0	2	1
8	PE606PC	Petroleum Product Testing Lab	0	0	2	1
9	EN608HS	Advanced Communication Skills Lab	0	0	2	1
10	*MC609	Environmental Science	3	0	0	0
		Total Credits	**21**	**1**	**6**	**22**

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	PE701PC	Petroleum Economics, Policies & Laws	3	0	0	3
2		Professional Elective – II	3	0	0	3
3		Professional Elective – III	3	0	0	3
4		Professional Elective - IV	3	0	0	3
5		Open Elective - II	3	0	0	3
6	PE702PC	Industrial Oriented Mini Project/ Summer Internship	0	0	0	2*

7	PE703PC	Seminar	0	0	2	1
8	PE704PC	Project Stage - I	0	0	6	3
		Total Credits	**15**	**0**	**8**	**21**

IV YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Professional Elective – V	3	0	0	3
2		Professional Elective - VI	3	0	0	3
3		Open Elective - III	3	0	0	3
4	PE801PC	Project Stage -II	0	0	14	7
		Total Credits	**9**	**0**	**14**	**16**

***MC - Environmental Science – Should be Registered by Lateral Entry Students Only.**
***MC – Satisfactory/Unsatisfactory**

Note: Industrial Oriented Mini Project/ Summer Internship is to be carried out during the summer vacation between 6th and 7th semesters. Students should submit report of Industrial Oriented Mini Project/ Summer Internship for evaluation.

IMPORTANT: For Open Elective – I, Students should not opt for Fundamentals of Management for Engineers offered by CSE/IT, instead they are requested to opt for another subject.

Professional Elective - I

PE611PE	Surface Production Operations
PE612PE	Horizontal Well Technology
PE613PE	Transport Phenomena

Professional Elective – II

PE711PE	Optimization of Upstream Processes
PE712PE	Chemical Reaction Engineering
PE713PE	Offshore Engineering

Professional Elective – III

PE721PE	Shale Gas Reservoir Engineering
PE722PE	Petroleum Reservoir Stimulation
PE723PE	Petroleum Reservoir Modelling & Simulation

Professional Elective – IV

PE731PE	Pipeline Maintenance Engineering
PE732PE	Natural Gas Processing
PE733PE	Petrochemical Engineering

Professional Elective – V

PE811PE	Sub-Sea Engineering
PE812PE	Natural Gas Hydrates and Coal Bed Methane
PE813PE	Membrane Technology

Professional Elective – VI

PE821PE	Enhanced Oil Recovery Techniques
PE822PE	Multi-Phase Flow in Porous Media
PE823PE	Petroleum Management, Marketing & Finance

PE701PC: PETROLEUM ECONOMICS, POLICIES & LAWS

B.Tech. IV Year I Sem.	L	T/P/D	C
	3	0/0/0	3

Course Objectives:

- To emphasize the importance of time value of money in petroleum projects.
- To introduce the students to the theory and practices of Petroleum Economics to perform economic feasibility studies on prospective oil and gas properties.
- To understand the economic and decision analysis parameters in petroleum business.
- To understand the background of functioning of petroleum industry as an economic entity.
- To understand petroleum fiscal system within the context of India.

Course Outcomes: The students would understand the basic features and technical foundations of Petroleum Economics, Policies & Laws and bridge the gap between the theory and the real world through practical applications based on up-to-date oil and gas projects.

UNIT-I

Introduction to the oil industry: World supply and demand- Structure of the oil industry- Characteristics of crude oils and properties of petroleum products- Resources and development of natural gas.

Principles, methods & techniques of engineering economics: Time value in capital expenditures, Depreciation and depletion in oil projects- Financial measures and profitability analysis.

UNIT-II

Analysis of alternative selections and replacements- Risk, uncertainty and decision analysis- Break even and sensitivity analysis- Optimization Techniques.

Application and project evaluation: oil fields exploration and drilling operations-Oil fields estimation of oil reserves and evaluation of an oil property- Oil fields production operations- Oil transportation- Crude oil processing.

UNIT-III

Demand and marketing of petroleum products: The petroleum products in the principal consuming countries- The distribution of petroleum products- The marketing of petroleum products.

UNIT-IV

Natural gas: Natural gas supply in the world- Transportation- International Markets and prices.

Petrochemicals: General characteristics- economics of the two large basic units- The market for the principal finished products- Problems of today.

UNIT-V

Petroleum or Oil & Gas Rules and Regulations in India – The Oil fields Regulations and Development Act – New Exploration Licensing Policy (NELP) –Open Acreage Licensing Policy (OALP) - Functions of Directorate General of Hydrocarbons – Petroleum and Natural Gas Regulatory Board.

TEXT BOOKS:

1. Petroleum Economics and Engineering, H. K. Abdel-Aal, Bakr A. Bakr, M.A. Al-Sahlawi, 2nd Edition, Marcel Dekker Inc., 1992.
2. Petroleum Economics, Jean Masseron, 4th Edition, Editions TECHNIP, 1990.

(The instructor can download information required from internet to teach the topics in UNIT-V).

PE711PE: OPTIMIZATION OF UPSTREAM PROCESSES (PE – II)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective:

- To develop understanding of the principles, techniques, standard tools of production optimization
- To formulate multi-objective optimization problem with constraints based on production requirements
- To gain exposure to application of optimization techniques for performance in case of multi-phase flow and also in case of wells per productivity perspective.

Course Outcome: The student would be equipped with the advance knowledge of various optimization techniques to be used in Petroleum Industry to enhance the production considering various constraints.

UNIT- I

Introduction: Production systems modeling and optimization – overview

Production system modeling: Production system – System Modeling – Nodal Analysis

Optimization objective and Constraints: Economics Objectives- Environmental Objectives – Technical Objectives – Constraints

UNIT- II

Properties of Reservoir Fluids: Fluid Properties- Pressure Temperature Phase Diagram- Equation of State – Oil models

Single Phase Flow in Wells and Pipelines: Governing Equations – Pressure Drop Analysis

UNIT- III

Multi-Phase Flow in Wells, Pipelines and Chokes: Flow Regimes – Slip and Hold-Up- Gradient Curves – Intake Pressure Curves for Describing Performance –Multi Phase flow through Chokes

Inflow Performance: Then importance of Inflow Performance-Governing Equations – Inflow Performance Relationship –Formation Damage and Skin –Multi Layer Inflow Performance.

UNIT- IV

Oil Well Productivity: Optimizing well Productivity- Oil Completions- Production Rate of a Vertical Well Operating at given Tubing Head Pressure- Production Rate of Vertical Well Operating through a Surface Choice- Summary of Analysis Methods.

UNIT- V

Field Development: Planning and Field Management- Short Term Optimization of Well Performance – Long Term Optimization of Well Performance – Productivity of Horizontal Wells

TEXT BOOK:

1. Modelling and Optimization of Oil and Gas Production Systems, JD Jansen & PK Currie, TU DELFT, 2004

REFERENCE BOOK:

1. Production Optimization using Nodal Analysis, Beggs H.D., Oil and Gas Consultants International Publications, Tulsa 1991

PE712PE: CHEMICAL REACTION ENGINEERING (PE – II)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: To provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions.

Course Outcome: This course provides necessary knowledge for selection of the chemical reactors for a particular process, design and simulation of existing reactor.

UNIT - I

Overview of chemical reaction engineering- classification of reactions, variables affecting the rate of reaction definition of reaction rate. Kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

Interpretation of batch reactor data- constant volume batch reactor:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

UNIT - II

Constant volume batch reactor– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

UNIT - III

Introduction to reactor design- general discussion, symbols and relationship between C_A and X_A. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

Design for single reactions- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

UNIT - IV

Design for parallel reactions- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

Multiple reactions-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

UNIT - V

Temperature and Pressure effects- single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

TEXT BOOK:

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely & Sons, 1999.

REFERENCE BOOKS:

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

PE713PE: OFFSHORE ENGINEERING (PE – II)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: This course covers general introduction to explain the essential features of core activities, Project Overview, Codes and Standards practice, Installations and Vessels, offshore structures.

Course Outcome: The students would acquire knowledge for designing offshore structures. They shall also understand, how the physical environment affects such designs and how the structures respond to the environmental actions.

UNIT- I

Overview of offshore structures: Introduction- Deepwater challenges- Functions of offshore structures- Offshore structure configurations- Bottom-Supported fixed structures- Compliant structures- Floating structures- Classification societies and industry standard groups.

Novel and small field offshore structures: Introduction- Overview of oil and gas field developments- Technical basis for developing novel offshore structures- Other considerations for developing novel offshore structures- Novel field development systems- Future field development options.

UNIT- II

Ocean environment: Introduction- Ocean water properties- Wave theory- Breaking waves- Internal waves- Sea spectrum- Sea states- Wave-driven current- Loop current- wind and wind spectrum- Offshore environment by location.

Loads and responses: Introduction- Gravity loads- Hydrostatic loads- Resistance loads- Current loads on structures- Steady and dynamic wind loads on structures- Wave loads on structures- Applicability of Morison force vs Diffraction force- Steady wave drift force- Slow-Drift wave forces- Varying wind load- Impulse loads- Response of structure- Applicability of response formula.

UNIT- III

Fixed offshore platform design: Field development and concept selection activities- Basic and detailed design of a fixed jacket-Tower-type offshore platform- Special topics.

Floating offshore platform design: Introduction- Floating platform types- Design of floaters- Floating production storage and offloading systems.

UNIT- IV

Semi submersibles- Tension leg platforms- Spar design- Hull structure- Construction and installation. Fundamental aspects of the design of FPSO.

UNIT - V

Drilling and production risers: Introduction- Drilling risers- Production risers- Vortex induced vibration of risers- VIV suppression devices- Riser clashing- Fatigue Analysis.

TEXT BOOK:

1. Handbook of Offshore Engineering, S. Chakrabarti, Volume 1 & 2, Elsevier, 2005.

PE721PE: SHALE GAS RESERVOIR ENGINEERING (PE – III)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives:

- To understand the global significance and distribution of shale gas reservoirs
- To gain knowledge in petro-physical properties, pore pressure prediction, performance analysis, production and testing of shale gas reservoirs.
- To study gas shale asset life cycle and environmental issues and challenges.

Course Outcomes:

- With the knowledge gained on the different aspects of shale gas reservoirs such as organic geo-chemistry, mineralogy, petrophysical properties, geomechanics, reservoir engineering, the students will be able to evaluate and map shale gas pockets in sedimentary basins. Further, they will be able to devise the production mechanisms to extract shale gas.
- Knowing the shale gas environmental issues and challenges such as high water demands and ground water contamination risks posed by hydro-fracturing fluids and waste, the students will be able to address these problems during the exploration of shale gas reservoirs.

UNIT - I

Gas Shale – Global significance, Distribution – Organic matter – Rich Shale Depositional environments – Geochemical assessment of unconventional shale gas resource system.

UNIT - II

Sequence stratigraphy of unconventional resource shales – Pore Geometry in gas shale reservoirs. Petro-physical evaluation of gas shale reservoirs.

UNIT - III

Pore pressure prediction of shale formations using well log data: Overpressure generating mechanisms – Overpressure estimation methods – Role of tectonic activity on shale pore pressure – Geo-mechanics of gas shales.

Performance analysis of unconventional shale reservoirs: Shale reservoir production – Flow rate decline analysis – Flow rate and pressure transient analysis – Reservoir modeling and simulation – Speciality short term tests – Enhanced oil recovery.

UNIT - IV

Resource estimation for shale gas reservoirs– Methodology – Reservoir evaluation of shale gas plays. Wettability of gas shale reservoirs: Wettability – Imbibition in gas shales – Factors influencing water imbibition in shales – Quantitative interpretation of imbibition at the field scale – initial water saturation in gas shales.

UNIT - VI

Gas shale challenges over the asset life cycle: Asset life cycle – Exploration phase – Appraisal phase – Development phase – Production phase – Rejuvenation phase.

Gas shale environmental issues and challenges: Overview – water use – the disposal and reuse of fracking waste water – Ground water contamination – Methane incisions – Other air emissions – social impacts on shale gas communities – Waste water injection – Earth quakes – Regulatory developments.

TEXT BOOK:

1. Fundamentals of Gas Shale Reservoirs, Edited by Reza Rezace, John Wiley & Sons, 2015.

REFERENCE BOOK:

1. Shale Oil and Gas Handbook: Theory, Technologies and Challenges, Sohrab Zendehboudi & A. Bahadori, Elsevier Science, 2016.

PE722PE: PETROLEUM RESERVOIR STIMULATION (PE – III)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: This subject discusses the various well stimulation treatments that are frequently used to stimulate old or poorly producing wells. It will cover the stimulation techniques as tools to help manage and optimize reservoir development. The course includes; acidizing and fracturing quality control, conducting the treatment, monitoring pressures, and other critical parameters, during and after the treatment.

Course Outcome: The student would be familiarized with the selection of stimulation techniques best suited for various formation types and situations, application of basic non-acid and acidizing concepts and also basic hydraulic fracturing concepts.

UNIT - I

Reservoir justification of stimulation treatments: Introduction- Fundamentals of pressure transient analysis- Well and reservoir analysis.

Elements of rock mechanics: Basic concepts- Pertinent rock properties and their measurement- In-Situ stress and its determination.

UNTI - II

Modeling of hydraulic fractures: Conservation laws, and constitutive equations- Fracture propagation models- Fluid-Flow modeling- Acid fracturing.

Fracturing fluid chemistry: Water-Base fluids- Oil-Base fluids- Multiphase fluids- Additives- Execution.

UNIT - III

Fracturing fluid proppant and characterization: Rheology- Shear and temperature effects on fluid properties- Foam fracturing fluids- Slurry rheology- Proppant transport- Fluid loss- Formation and fracture damage- Proppants.

Pre-Treatment data requirements: Types of data- Sources of data- Dynamic downhole testing.

Fracturing diagnosis using pressure analysis: Basic relations- Pressure during pumping- Analysis during closure- Combined analysis pumping and closure- Field procedures.

UNIT - IV

Considerations in fracture design: Size limitations- Considerations with predetermined size or volume- Benefits of high proppant concentrations- Effect of reservoir properties- Effects of perforations on fracture execution.

Fracture-Height predictions and post-treatment measurements: Linear fracture-mechanics modeling for fracture height- Fracture-height prediction procedures- Techniques to measure fracture height.

Matrix acidizing of sandstones: Criteria for fluid selection- Organization of the decision tree- Preflush and postflush- Acidizing sandstones with mud acid- Other acidizing formulations- Matrix acidizing design.

UNIT - V

Fluid placement and diversion in sandstone acidizing: Techniques of fluid placement- Diverting agents.

Matrix acidizing treatment evaluation: Derivation of bottom hole parameters from wellhead measurements- Monitoring skin evolution during treatment.

Principles of acid fracturing: Comparison of acid Fracturing Vs Fracturing with propping agent and nonreactive fluids- Factors controlling the effectiveness of acid fracturing treatments- Acid fluid loss- Acid spending during fluid injection- Treatment design.

TEXT BOOK:

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

REFERENCE BOOKS:

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.

PE723PE: PETROLEUM RESERVOIR MODELLING AND SIMULATION (PE – III)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives:

- To understand the importance and the fundamental concepts of reservoir simulation.
- To use a reservoir simulation package to solve complex fluid flow problems.
- To conduct a reservoir simulation study.

Course Outcomes: The student would be able to

- Apply various techniques to solve differential equations.
- Use numerical reservoir simulation to solve complex fluid flow problems.
- Execute a reservoir simulation project and suggest development plans for the reservoir.

UNIT - I

Introduction: Milestones for the engineering approach-Importance of the engineering and mathematical approaches.

Single-phase fluid equations in multidimensional domain: Properties of single-phase fluid-Properties of porous media- Reservoir discretization- Basic engineering concepts- Multidimensional flow in Cartesian coordinates- Multidimensional flow in radial-cylindrical coordinates.

UNIT - II

Flow equation using CVFD terminology: Introduction- Flow equations using CVFD terminology- Flow equations in radial-cylindrical coordinates using CVFD terminology- Flow equation using CVFD terminology in any block ordering scheme.

UNIT - III

Simulation with a block-centered grid: Introduction- Reservoir discretization- Flow equation for boundary grid blocks- Treatment of boundary conditions- Calculation of transmissibilities- Symmetry and its use in solving practical problems.

Simulation with a point distributed grid: Introduction- Reservoir discretization- Flow equation for boundary grid points-Treatment of boundary conditions-Calculation of transmissibilities - Symmetry and its use in solving practical problems.

UNIT - IV

Well representation in simulators: Introduction- Single block wells- Multi block wells- Practical considerations dealing with modeling and well conditions.

Single-phase flow equations for various fluids: Pressure dependence of fluid and rock properties-General single-phase flow equation in multi dimensions.

UNIT - V

Linearization of flow equation: Introduction- Nonlinear terms in flow equations- Nonlinearity of flow equations for various fluids- Linearization of nonlinear terms- Linearized flow equations in time.

Methods of solution of linear equations: Direct solution methods- Iterative solution methods.

TEXT BOOK:

1. Petroleum Reservoir Simulation: A Basic Approach, Jamal H. Abou – Kasem, S. M. Fariuq Ali, M. Rafiq Islam, Gulf Publishing Company, 2006.

REFERENCE BOOKS:

1. Principles of Applied Reservoir Simulation, John R. Fanchi, Elsevier, 2005.
2. Practical Reservoir Simulation, M.R. Carlson, Penn Well, 2003.

3. Reservoir Simulation: Mathematical Techniques in Oil Recovery, Zhangxin Chen, Cambridge University Press, 2008.
4. Mathematics of Reservoir Simulation, Richard E. Ewing, Society for Industrial and Applied Mathematics (SIAM), 1983.

PE731PE: PIPELINE MAINTENANCE ENGINEERING (PE – IV)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives:

- To familiarize the students with the various elements and stages involved in transportation of oil and gas.
- To understand international standards and practices in piping design.
- To know various equipment and their operation in pipeline transportation.
- To understand modern trends in transportation of oil and gas

Course Outcome: The students would get an understanding of the key steps in a pipeline's lifecycle: design, construction, installation, asset management and maintenance.

UNIT-I

Elements of pipeline design: Fluid properties – Environment - Effects of pressure and temperature - Supply / Demand scenario - Route selection - Codes and standards - Environmental and hydrological considerations – Economics - Materials / Construction – Operation - Pipeline protection - Pipeline integrity monitoring.

Pipeline route selection, survey and geotechnical guidelines: Introduction - Preliminary route selection - Key factors for route selection - Engineering survey - Legal survey - Construction / As-built survey - Geotechnical design.

UNIT-II

Natural gas transmission: General flow equation – Steady state - Impact of gas molecular weight and compressibility factor on flow capacity - Flow regimes - Widely used steady-state flow equations – Summary of the impact of different gas and pipeline parameters on the gas flow efficiency – Pressure drop calculation for pipeline in series and parallel – Pipeline gas velocity – Erosional velocity – Optimum pressure drop for design purposes – Pipeline packing – Determining gas leakage using pressure drop method – Wall thickness / pipe grade – Temperature profile – Optimization process – Gas transmission solved problems.

UNIT-III

Gas compression and coolers: Types of compressors – Compressor drivers – Compressor station configuration – Thermodynamics of isothermal and adiabatic gas compression – Temperature change in adiabatic gas compression – Thermodynamics of polytropic gas compression – Gas compressors in series – Centrifugal compressor horsepower – Enthalpy / Entropy charts (Mollier diagram) – Centrifugal compressor performance curve – Influence of pipeline resistance on centrifugal compressor performance-Reciprocating compressors – Gas compression solved problems – Gas coolers – Air-cooled heat exchangers – Coolers heat transfer equations – Fan air mass flow rate – Required fan power – Gas pressure drop in coolers – Iterative procedure for calculations based on unknown T_2.

UNIT-IV

Liquid flow and pumps: Fully developed laminar flow in a pipe – Turbulent flow – Centrifugal pumps – Retrofitting for centrifugal pumps (Radial-flow) – Pump station control – Pump station piping design.

Transient flow in liquid and gas pipelines: Purpose of transient analysis – Theoretical fundamentals and transient solution technique – Applications – Computer applications.

Pipeline mechanical design: Codes and standards – Location classification – Pipeline design formula – Expansion and flexibility – Joint design for pipes of unequal wall thickness.

UNIT-V

Materials selection and quality management: Elements of design – Materials designation standards – Quality management.

Pipeline construction: Construction – Commissioning.

Pipeline protection, Instrumentation, pigging & Operations: Pipeline coating – Cathodic protection – Cathodic protection calculations for land pipelines – Internal corrosion – Flow meters and their calibration – Sensors – Pigs-Pipeline Operations and maintenance.

TEXT BOOKS:

1. Pipeline Design and Construction: A Practical Approach, M. Mahitpour, H. Golshan and M.A. Murray, 2nd Edition, ASME Press, 2007.
2. Pipeline Engineering, Henry Liu, Lewis Publishers (CRC Press), 2003.

REFERENCE BOOKS:

1. Piping Calculation Manual, E. Shashi Menon, McGraw-Hill, 2004.
2. Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair, George A. Antaki, CRC Press, 2003.
3. Pipeline Planning and Construction Field Manual, E. Shashi Menon, Gulf Professional Publishing, 2011.
4. Pipeline Rules of Thumb Handbook, E. W. McAllister, 7th Edition, 2009.
5. Liquid Pipeline Hydraulics, E. Shashi Menon, Mareel Dekker Inc., 2004.
6. Gas Pipeline Hydraulics, E. Shashi Menon, Taylor & Francis, 2005.

PE732PE: NATURAL GAS PROCESSING (PE – IV)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives:

- To enhance student's knowledge about natural gas produced in the reservoirs, surface handling and processing equipment
- To educate student about knowledge of natural gas, basic chemical properties and physical laws
- To update student with the understanding of operations of separators, heaters and glycol dehydrators.

Course Outcomes: The student would be able to describe the basic components of processing equipment and explain various gas plant operational procedures.

UNIT- I

Overview of natural gas Industry: Introduction- The world picture for natural gas- Natural Gas in India - Nonconventional gas reserves in India- Sources of natural gas- Natural gas compositions – Classification- Processing and principal products - Product specifications- Combustion characteristics- Overview of gas plant processing- Roles of gas plants - Plant processes.

Field operations and inlet receiving: Field operations- Gas hydrates Inlet receiving- Safety and environmental considerations.

UNIT- II

Gas treating: Introduction- Solvent absorption processes- Physical absorption- Adsorption- Cryogenic fractionation- Membranes- Nonregenerable hydrogen Sulfide scavengers- Biological processes- Safety and environmental considerations.

Gas dehydration: Introduction- Water content of hydrocarbons- Gas dehydration processes - Safety and environmental considerations.

UNIT- III

Hydrocarbon recovery: Introduction- Process components- Recovery processes - Safety and environmental considerations.

Nitrogen rejection: Introduction- Nitrogen rejection for gas upgrading- Nitrogen rejection for enhanced oil recovery- Safety and environmental considerations.

Trace component recovery or removal: Introduction-Helium-Mercury- (BTEX) Benzene, Toluene, Ethylbenzene, and Xylene.

UNIT- IV

Liquids processing: Introduction- Condensate processing- NGL processing- Safety and environmental considerations.

Sulfur recovery: Introduction- Properties of sulfur- Sulfur recovery - Sulfur storage- Safety and environmental considerations.

Transportation and storage: Introduction-Gas – Liquids.

UNIT- V

Liquefied Natural Gas: Gas treating before liquefaction- Liquefaction cycles- Storage of LNG- Transportation- Regasification and cold utilization of LNG- Economics - Plant efficiency - Safety and environmental considerations.

TEXT BOOK:

1. Fundamental of Natural Gas Processing, Arthur J. Kidnay, William R. Parrish, Taylor and Francis, 2006.

REFERENCE BOOKS:

1. Natural Gas: A Basic Handbook, James G. Speight, Gulf Publishing Company, 2007.
2. Gas Conditioning and Processing, John M. Campbell, Volume 2, 7th Edition, Campbell Petroleum Series, 1992.
3. Gas Conditioning and Processing, Robert N. Maddox, Volume 3, 3rd Edition, Campbell Petroleum Series, 1982.
4. Petroleum & Gas Field Processing, H. K. Abdel – Aal, Mohamed Aggour and M. A. Fahim, Marcel Dekker, Inc., 2003.
5. Engineering Data Book 12th Edition (Electronic), FPS Version, Volume I & II, Gas Processers Suppliers Association (GPSA), 2005.
6. Handbook of Natural Gas Transmission and Processing, Saeid Mokhatab, William A. Poe, James G. Speight, Gulf Professional Publishing, 2006.
7. Surface Production Operations, Ken Arnold, Maurice Stewart, Volume 2, 2nd Edition, Elsevier Science, 1989.
8. Field Handling of Natural Gas, J. Leecraft, 4th Edition, PETEX, 2007.
9. Plant Processing of Natural Gas, Doug Elliot, J.C. Kuo, Pervouz Nasir, 2nd Edition, PETEX, 2012.

PE733PE: PETROCHEMICAL ENGINEERING (PE – IV)

B.Tech. IV Year I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives: The course is designed to

- Impart knowledge to the students about the latest developments in petrochemical engineering.
- To understand the various feed stocks of petro-chemical and its products.
- To get acquainted with basic manufacturing processes of various petro-chemical products.

Course Outcome: The student would be in a position to have a knowledge of feed-stocks used in the petro-chemical engineering, various techniques used to produce various petrochemical products.

UNIT - I

Introduction: Petrochemical industry -Structures of petrochemical complexes-Feedstock for petrochemicals-Profile of petrochemicals and their end products-Indian Petrochemical industries - Profile of Indian petroleum and petrochemical Industry.

UNIT - II

Petrochemical Feed stocks -Naphtha cracking -Gas cracking and Gas reforming.
Chemicals from gas reforming: Methanol- Acetic acid- Ammonia and urea.
Production of ethylene & propylene: Separation of cracking products- Emerging technologies.

UNIT - III

Chemicals from C_2 and C_3 olefins: Ethylene oxide- MEG- Ethyl benzene-styrene. Acrylonitrile–butyraldehydes and butanols, 2-ethyl hexanol.
Polymers based on olefins: LDPE, HDPE & LLDPE and Polypropylene- and polystyrene.
C_4 based Chemicals and others: Butadiene–1-Butene–n-Butenes-Isobutylene–n-Butene–Octenes–1,4-Butanediol–Chloroprene–Isoprene- Maleic anhydride.

UNIT - IV

Aromatic production: Petroleum feedstock for aromatic hydrocarbons-Aromatic hydrocarbon production- catalytic reforming-Reactions in catalytic reforming-Reforming catalyst -Reforming process -Process variables in catalytic reforming-Pyrolysis gasoline as aromatics feedstock-Aromatic separation from reformate and pyrolysis gasoline- Emerging technologies for the production of BTX.

UNIT - V

Production of Chemicals based on aromatics: Phthalic anhydride–Linear alkyl benzene–Phenol—Nitrobenzene and aniline
Chemicals for Fibres: Cyclohexane– Caprolactam – Adipic acid –Adiponitrile–Hexamethylene diamene and Dimethyl terephthalete, Terephthalic acid –Polyester fibre (Polyethylene terephthalate)–Nylon 66–Nylon 6– Acrylic fibres.

TEXT BOOK:

1. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., New Delhi. 2007.

REFERENCE BOOKS:

1. Chemistry of Petrochemical Processes, Sami Matar and Lewis F.Hatch, 2nd Edition, Gulf Publishing Company, Houston, 2000.
2. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers, 1970.
3. Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company, 1989.
4. Petrochemical Production Processes, N.Naderpour, SBS Publishers, 2009.
5. Petrochemicals, B. K. Bhaskara Rao, Oxford & IBH Publishing, 2002.

PE811PE: SUB-SEA ENGINEERING (PE – V)

B.Tech. IV Year II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives:

- To understand the Subsea Development operations.
- To learn the hydraulic / equipment / system design considerations.
- To learn about the Process Control and power supply consideration.
- To understand the reliability issues & design challenges involving Subsea systems.

Course Outcomes:

- Able to do flow assurance calculations and size the piping & distribution system.
- Deliver the Equipment & System design required for a given Subsea Project Requirement.
- Anticipate reliability issues such as hydrate, wax formation, corrosion etc. during design

UNIT - I

Overall View of Subsea Engineering: Introduction – Subsea production Systems – Flow Assurance & System Engineering – Subsea Structures & Equipment – Subsea Pipelines.

Subsea Field Development: Subsea Field Development Overview – Deepwater or Shallow-Water Development – Wet Tree & Drain Tree Systems – Subsea Tie-back Development – Stand-Alone Development – Artificial Lift methods and Constraints – Subsea Processing – Template, Clustered Well Systems & daisy Chain –Subsea Field development Assessment.

UNIT - II

Subsea Distribution System: Introduction – Design Parameters – SDS Component Design requirements.

Installation & Vessels: Introduction – Typical Installation Vessels – Vessel requirements & selection – Installation Positioning & Analysis.

UNIT - III

Subsea Control: Introduction – Types of Control Systems – Topside Equipment – SCMMB – SCM – Subsea Transducers & Sensors – HIPPS – SPCS – IWOCS.

Subsea Power Supply: Introduction – Electrical Power System – Hydraulic Power System.

UNIT - IV

Subsea System Engineering: Introduction – Typical Flow Assurance Process - System Design & Operability.

Hydraulics: Introduction – Composition & Properties of Hydrocarbon – Emulsion – Phase Behaviour – Hydrocarbon Flow – Slugging & Liquid handling – Slug Catcher Design – Pressure Surge – Line Sizing.

Heat Transfer & Thermal Insulation: Heat Transfer Fundamentals – U value – Steady State Heat Transfer – Transient Heat Transfer – Thermal management Strategy & Insulation.

UNIT - V

Hydrates: Introduction – Physics & Phase Behaviour – Hydrate Prevention – Hydrate Remediation – Hydrate Control Design Philosophies – Recovery of Thermodynamic Hydrate Inhibitors.

Wax & Asphaltenes: Introduction - Wax - Wax Management – Wax remediation – Asphaltenes – Asphaltenes Control Design Philosophies.

Subsea Corrosion & Scale: Introduction – Pipeline Internal Corrosion – Pipeline External Corrosion – Scales – Overview of Erosion & sand Management.

TEXT BOOKS:

1. Subsea Engineering Handbook, Yong Bai & Qiang Bai, Gulf Professional Publishing, New York, 2012.
2. Offshore Drilling and Completions Training Manual by Drill – Quip, Inc.
3. Manual on Subsea Technology by IOGPT, ONGC.

PE812PE: NATURAL GAS HYDRATES AND COAL BED METHANE (PE – V)

B.Tech. IV Year II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objectives: This course is designed to introduce a basic study of natural gas hydrates and coal bed methane and their properties. The student will be imparted the knowledge of:

- Overview of NGH and classification of NGH, Hydrate formation by using different methods, inhibiting hydrate formation, Different physical and chemical properties of NGH, Deacting with hydrates using heat and pressure,
- Overview of scenario of CBM, The geology of coal, Basic principles of sorption and isotherms and Reservoir characterization of CBM.

Course Outcomes: After successful completion of the course the students will be able to:

- Have good knowledge in dealing with NGH, Model different hydrate formation using both hand calculations and computer methods, understand different properties of NGH, Design line heaters foe effective transportation, have knowledge of different equilibriums of liquid water and solids with natural gas and Understand the challenges of NGH.
- Master the fundamentals of coal bed methane, construct different isotherms, evaluate different logs for CBM reservoirs and Make reservoir analysis.

UNIT - I

Introduction: Overview of natural gas hydrates**-** Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units.

Hydrate types and formers: Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane- Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition- Other hydrate formers- Mixtures- Examples.

Hydrate formation hand calculation methods: Gas gravity method- K-Factor method- Baillie-Wichert method- Comments on these methods- Examples.

UNIT - II

Hydrate formation computer methods: Phase equilibrium- Van der Waals and Platteeuw- Parrish and Prausnitz-Ng and Robinson methods- Calculations- Commercial software packages- Accuracy of these programs- Dehydration- Examples.

Inhibiting hydrate formation with chemicals: Freezing point depression- Hammer schmidt equation- Nielsen-Bucklin equation- New method- Brine solutions- Comment on the simple methods- Advanced calculation methods- Inhibitor vaporization- Comment on injection rates- Kinetic inhibitors- Examples.

Combating hydrates using heat and pressure: Use of heat- Heat loss from a buried pipeline- Line heater deign- Two-Phase heater transfer- Depressurization- Melting a plug with heat- Examples.

UNIT-III

Physical properties of hydrates: Molar mass - Density- Enthalpy of fusion- Heat capacity- Thermal conductivity- Mechanical properties- Volume of gas in hydrate- Ice versus hydrate- Examples.

Water content of natural gas: Equilibrium with liquid water- Equilibrium with solids- Examples.
Dehydration Prcesses : TEG and Molecular Sieves dehydration Processes.

UNIT - IV

Introduction: Overview of coal bed methane (CBM) in India – CBM vs Conventional Reservoirs.
Geological influences on coat formation of coals – Coal chemistry – Significance of rank – Cleat system and natural fracturing.

UNIT - V

Sorption: Principles of Adsorption-The Isotherm construction-CH_4 retention by coal seams-CH_4 content determination in coal seams-The isotherm for recovery prediction-Model of the micro-pores-coal sorption of other molecular species.

Reservoir Analysis: Coal as a reservoir-Permeability-Porosity-Gas Flow-Reserve Analysis-Well spacing and drainage area-Enhanced recovery.

TEXT BOOKS:

1. Natural Gas Hydrates: A Guide for Engineers, John J. Carroll, Gulf Professional Publishers, 2003.
2. Coal Bed Methane: Principles and Practice, R. E. Rogers, 3rd Edition, Prentice Hall, 1994.

REFERENCE BOOKS:

1. Natural Gas Hydrates in Flow Assurance, E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, Elsevier, 2010.
2. Clathrate Hydrates of Natural Gases, E. Dendy Sloan, Jr., C. Koh, 3rdEdition, CRC Press, 2007.
3. Coal Bed Methane, Robert A. Lamarre, American Association of Petroleum Geologists, 2008.

PE813PE: MEMBRANE TECHNOLOGY (PE – V)

B.Tech. IV Year II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: This course will give the basic principles of membrane separation processes.
Course Outcome: The student will understand the underlined principles and importance of ultrafiltration, reverse Osmosis, electrodialysis, nano-filtration, etc., in industrial waste water treatment.

UNIT - I

Introduction: Separation process, Introduction to membrane processes, definition of a membrane, classifications membrane processes.
Preparation of Synthetic membranes: Types of Membrane materials, preparation of Synthetic membranes, phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

UNIT - II

Characterization of membranes; Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.
Transport in membranes: introduction, driving forces, non-equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

UNIT - III

Membrane Processes: Introduction, osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nanofiltration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bioploar membranes, Fuel Cells

UNIT - IV

Concentration driven membrane processes: gas separation: gas separation in porous and non-porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors,

UNIT - V

Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model, osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction. Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

TEXT BOOKS:

1. Membrane Separations, M.H.V. Mulder, Springer Publications, 2007
2. Rate-Controlled Separations, P. C. Wanket, Elsevier Applied Science, London,1994.

REFERENCE BOOKS:

1. Membrane Technology in the Chemical Industry, S.P. Nunes, K.V. Peinemann, Wiley-VCH
2. Membrane Processes in Separation and Purification, J.G.Crespo, K.W.Bodekes, Kluwer Academic Publications.
3. Membrane Separation Processes, K. Nath, PHI Pvt. Ltd., New Delhi,2008.

PE821PE: ENHANCED OIL RECOVERY TECHNIQUES (PE – VI)

B.Tech. IV Year II Sem.	L	T/P/D	C
	3	0/0/0	3

Course Objectives:

- Introduce the student to the theory and practices of improved oil recovery.
- Emphasize the potential of enhanced oil recovery methods in reservoir exploitation.

Course Outcomes:

- Understand the basic features and technical foundations of the most common EOR methods.
- Apply screening criteria to a given reservoir to select an optimum EOR method both technically and economically.
- Use rock, fluid and reservoir data to specify the process and operating parameters of an EOR method application.

UNIT - I

Introduction: Oil recovery processes.

Gas injection: Introduction- Predictive performance- Gas injection in carbonate reservoirs- Inert gas injection- Candidates for gas injection.

UNIT - II

Miscible flooding: Introduction- Sweep efficiency- High pressure gas injection- Enriched gas drive- LPG slug drive- Predictive technique- Field applications.

Carbon dioxide flooding: Process description- Field projects- CO_2 sources- problem areas- designing a CO_2flood- Guidelines for selection of miscible CO_2 projects- Immiscible CO_2 flooding Conclusions.

Polymer flooding: Introduction- Polyacrylamides chemistry- Application of PAM/AA in enhanced oil recovery- Factors affecting flow in porous media- Field considerations- Site factors- Field operation.

UNIT - III

Alkaline flooding: Introduction- Types of caustic used- Entrapment of residue oil- Displacement mechanisms in alkaline flooding- Crude oil properties-Alkali consumption- pH of injected caustic- Effect of sodium ions and sodium chloride.

In-situ combustion technology: Introduction-Reservoir characteristics- Ignition- Ignition methods, Process In-situ Combustion- Use of In-situ Combustion- Current status of In-situ Combustion.

UNIT - IV

Use of surfactants in oil recovery: Introduction- Classification of EOR surfactants- Mechanism of oil displacement by surfactant flooding- Ultra low interfacial tension in relation to oil displacement by surfactant flooding- Factors influencing oil recovery.

Steam flooding for enhanced oil recovery: Introduction- Theory- Screening criteria for steam flood prospects- Reservoir rock and fluid properties- heat losses and formation heating- oil recovery calculations- An overview of steamflood modeling, parametric studies in steam flooding- Economics of the steam flooding process.

UNIT - V

Microbial enhanced oil recovery: Microorganisms- Historical development of microbial enhancement of oil recovery- Laboratory experiments show the potential of microbial enhancement oil recovery- Field application of microbial enhancement of oil recovery-Microbes associated with oilfield problems.

Environmental factors associated with oil recovery: Introduction-Primary and secondary production-Chemical flooding-Micellar-polymer processes- Thermal processes- Gas flooding.

TEXT BOOKS:

1. Enhanced Oil Recovery: Processes and Operations, E. C. Donaldson, G. V. Chilingarian, T. F. Yew, Elsevier, 1998.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.

REFERENCE BOOKS:

1. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
2. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
3. Enhanced Oil Recovery, Marcel Latil, Editions Technip, 1980.
4. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, Penn Well, 1980.
5. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.
6. Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall, 1992.
7. Recent Advances in Enhanced Oil and Gas Recovery, Istvan Laktos, Academy Kiado, 2001.
8. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
9. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.
10. Modern Chemical Enhanced Oil Recovery: Theory and Practice, Gulf Professional Publishing, 2011.
11. Enhanced Oil Recovery, Teknica, Teknica Petroleum Services Ltd., 2001.

PE822PE: MULTI-PHASE FLOW IN POROUS MEDIA (PE – VI)

B.Tech. IV Year II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: The objective of this course is to introduce the basic theory and computational techniques for modeling multiphase flow in sub-surface porous media, especially applied to petroleum reservoir simulation. The students will also study conceptual and mathematical models that represent simplified scenario of petroleum reservoir.

Course Outcome: The students would gain knowledge on core sample characterization and properties measurement. They would get a feeling for time-scales of porous media flow, fluid pressure and chemical diffusion. They would understand the natural variability of porous media and the scale-dependence of flow properties. They know about pattern formation in porous media flow and about key coarsening instabilities like thermal or chemical convection etc.

UNIT - I

Introduction: Phases and porous media: Grain and pore size distribution- the concept of saturation – the concept of pressure – surface tension considerations – concept of concentration.

UNIT - II

Mass conservation Equation: Micro scale mass conservation – Integral form of mass conservation – Integral Theorems- point form of mass conservation – The macro scale perspective – The averaging theorem – Macro Scale mass Conservation – Applications

UNIT - III

Flow Equations: Darcy's Experiments, fluid properties – Equation of state for fluids- Hydraulic potential – single phase fluid flow- Two phase immiscible flow- The Buckley- Livertt Analysis.

UNIT - IV

Mass Transport Equations: Velocity in the species transport equations – Closure relations for the dispersion vector– Chemical Reaction Rate - Initial and boundary conditions.

UNIT – V

Simulation:1-D simulation of Air-Water Flow- 1-D Simulation of DNAPL water flow – 2-D simulation of DNAPL Water flow – Simulation of multi-phase flow and transport – 2-D single phase flow and transport – 3-D single phase flow and Transport– 2-D Three phase flow

TEXT BOOK:

1. Essential of multiphase flow in porous media, George F. Pinder and William G. Gray, Wiley Interscience, 2008.

REFERENCE BOOK:

1. Multiphase flow in porous media, Kluwer Academic publisher, 1995

PE823PE: PETROLEUM MANAGEMENT, MARKETING & FINANCE (PE – VI)

B.Tech. IV Year II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Course Objective: The objective of this course is to introduce the student about the nature and function of companies and other organizations involved in technical, financial, commercial and contractual activities in the world-wide upstream oil and gas industries. The nature of mid and downstream oil and gas activities will be briefly examined to set an overall context.

Course Outcome: The students are expected to be able to evaluate the primary uses of oil and gas and the significance of oil and gas within the global energy industry with the broad technical issues involved in the location and development of oil and gas reserves.

UNIT- I

The global oil and gas industry: Oil and gas industry background - Oil and gas reserves - Oil and gas in global economy - The major players - Oil and gas industry value chain- Upstream-mid stream and downstream- Fundamentals of petroleum industry - Industry evaluation and strategies - Nationalism and national oil companies - Role and value of oil and gas- Government and corporate interests- Evolution of national oil companies - Organization of petroleum exporting countries - Political environment related to petroleum industry.

UNIT- II

Access, leasing and exploration: Oil project life cycle - Oil and gas formation - Access and development rights - Historical precedent - The neutral zone concession - Oil leases- Reserves - Defining reserves - Lease auctions exploration and strategy - Partnership and firm-ins.

UNIT- III

Developing oil and gas projects: Project development and project opportunity- Joint development utilization- Project financial analysis- Project execution- Contractor relationships- Problems in project development.

UNIT- IV

Finance and financial performance: Business finance- Capital sourcing- Corporate finance- Public equity- Private equity- Venture capital- Debt- Project finance- Multilateral lending- State interest- Oil loans- Ruminations and valuations.

UNIT- V

Marketing of crude oil and petroleum products and transportation: Crude oil fundamentals- Price of crude- Crude oil prices in transactions- Marketing and sale of motor fuel- Aviations fuel- Lubricants- Asphalt and propane- Transportation-Fundamentals of transportation-Pipelines- Oil tankers- Downstream transportations.

TEXT BOOK:

1. The Global Oil & Gas Industry: Management, Strategy and Finance**,** Andrew Inkpen, Michael H. Moffett, Penn Well, 2011.