JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For

B. TECH PETROLEUM ENGINEERING

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

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IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L*	T	P	Credits
1	PCC	Design of Surface Facilities	3	0	0	3
2	PCC	Enhanced Oil Recovery Techniques	3	0	0	3
3	PEC	**PROFESSIONAL ELECTIVE – III** i. HSE in Petroleum Industry ii. Petroleum Engineering Mathematics iii. Subsea Engineering	3	0	0	3
4	PEC	**PROFESSIONAL ELECTIVE – IV** i. Mathematics of Reservoir Simulation ii. Advances in Well Control iii. Pipeline Engineering	3	0	0	3
5	PEC	**PROFESSIONAL ELECTIVE –V** i. Statistics for Petroleum Engineers and Geoscientists ii. Advances in Seismic methods for Hydrocarbon Exploration	3	0	0	3
6	PCC	Petroleum Equipment Design & Simulation Laboratory	0	0	3	1.5
7	PCC	Petroleum Reservoir Simulation Laboratory	0	0	3	1.5
8	PR	Presentation Seminar (SIP Report)				1
9	PR	Project (Industrial/In-house) (**Phase 1**)				2
10	*MC	IPR & Patenting	2	0	0	0
11	*MC	Physical Fitness Activities	0	0	2	0
					Total Credits	**21**

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IV Year - I Semester		L	T	P	C
		3	0	0	3
DESIGN OF SURFACE FACILITIES					

Learning Objectives:

- To understand the different components of petroleum production system.
- To understand and analyses the flow pattern used in petroleum production system
- To enable students to understand the surface equipment used for separation in petroleum production system.
- To enable students to understand the surface storage system, transportation facilities used in petroleum production system.
- To enable students to understand the treatment process used in petroleum production system.

UNIT-I
Processing of oil and gas: Oil and gas properties, stage separation, separator function and design

UNIT-II
Demulsification, desalting of crude oils and heater treaters: Types of emulsions, destabilization of emulsion, heater treaters, desalters, function and design.

UNIT-III
Artificial lift techniques: Need for artificial lift and their methods.
Design of gas-lift production system for continuous and intermittent gas-lift systems.

UNIT-IV
sucker-rod pumping: Classification, components of the sucker rod system. Design of sucker rod pumps.

UNIT-V
Design of electrical submersible pumps and other artificial lift equipment.

Outcomes:
On completion of this course, the students will be able to:

- Recognize and understand the different components of petroleum production system.
- Analyze the different flow pattern used in petroleum production system
- Understand and compare the different surface equipment used for separation in petroleum production system.
- Compare and relate the different treatment processes used in petroleum production system.
- Interpret the storage system patterns and transportation facilities used in petroleum production system.

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Text Books:

1. Hill, A. D., Economides, C. E., Zhu, D., Economides, M. J., (2012) Petroleum Production Systems, Prentice Hall, ISBN: 9780137033812
2. Kumar, S., (1987) Gas Production Engineering, Gulf Publishing Company, Texas. ISBN: 0872015777.

Reference Books:

1. Campbell, J. M., (1998) Gas Conditioning and Processing (Vol I, II, III), Campbell & Co., USA. ISBN: 9996395420
2. Arnold, K. and Stewart, M., (1989) Surface Production Operations-2, Gulf Publishing Company, Houston. ISBN: 0884158225.
3. Ikoku, Chi U., (1984) Natural Gas Production Engineering, John Wiley & Sons Inc. ISBN: 0894646397.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ENHANCED OIL RECOVERY (EOR) TECHNIQUES					

Learning Objectives:

- Understanding of secondary / tertiary recovery of crude oils of specific reservoirs.
- Following the selection criteria to which reservoir suits for specific EOR techniques.
- Post project monitoring.
- Knowledge of maintenance of injection wells / Production wells.
- Knowledge of ignition of injection wells in case of thermal EORs.
- Knowledge of handling of chemicals like CO_2, Surfactants, Polymers etc.
- Handling of injection wells in case of any leakage or blowout situations.

UNIT-I

Introduction: Different Secondary and tertiary oil recovery techniques. Methods to improve the recovery factor at pore scale and macro scale, Displacement and sweep efficiency.

UNIT-II

Gas injection: Introduction, Predictive performance, Gas injection in carbonate reservoirs, Inert gas injection, Candidates for gas injection.
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_2 flood, Guidelines for selection of miscible CO_2 projects, Immiscible CO_2 flooding conclusions.

UNIT-III

Polymer flooding: Introduction, Polymer products and theory of use, Planning polymer flood projects.
Polyacrylamides: Introduction, Polyacrylamides chemistry, Application of PAM/AA in enhanced oil recovery, Factors affecting flow in porous media, Field considerations- Site factors, Field operation.

UNIT-IV

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, Effect of divalent ions, Reservoir selection- Documented alkaline flooding - field tests.
Surfactants flooding: 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, Surfactant gas flooding for oil recovery, Interfacial phenomena in surfactant gas flooding, Mechanism of surfactant loss in porous media, Present status of the use of surfactants in oil recovery.

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UNIT-V

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 steam flood modeling, Parametric studies in steam flooding, Economics of the steam flooding process.

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

Microbial enhanced oil recovery: Microorganisms, Historical development of microbial enhancement of oil recovery, Laboratory experiments - potential of microbial enhancement oil recovery, Field application of microbial enhancement of oil recovery.

Outcomes: The students can:

- Have the knowledge of that specific reservoir before designing of any EOR project.
- Understand operation and maintenance of EOR techniques.
- Be aware of safety precautions while handling of various types of chemicals used in EOR.
- Know monitoring the reservoir after post project activities.
- Handle the wells during work over operations.

Text Books:

1. Applied Enhanced Oil Recovery, AurelCarcoana, Prentice Hall, 1992.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.

Reference Books:

1. Enhanced Oil Recovery Processes and Operations, E.C. Donaldson, G. V. Chillingarian, T.F. Yew, Elsevier, 1998.
2. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
3. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
4. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, PennWell, 1980.
5. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.
6. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001.
7. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
8. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.

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		3	0	0	3
HSE IN PETROLEUM INDUSTRY					

Learning Objectives:

- Knowledge of environment issues and all related Acts.
- Knowledge of drilling fluids and its toxic effects with environment.
- Proper disposal of drilling cutting after appropriate treatment.
- Treatment of produced water and makeup water and its disposal as per state pollution control board norms.
- Knowledge of oil mines regulations and proper implementation in drilling & production mines as per Act.
- Knowledge of HAZOP in drilling rigs & production installations.
- Knowledge of disaster management to fight any fire accident at drilling rig/ production installation/production platform.

UNIT-I

Introduction to environmental control in the petroleum industry: Overview of environmental issues- A new attitude-Air emissions.
Drilling and production operations: Drilling- Production.

UNIT-II

The impact of drilling and production operations: Measuring toxicity- Hydrocarbons- Salt- Heavy metals- Production chemicals- Drilling fluids- Produced water- Nuclear radiation- Air pollution- Acoustic impacts- Effects of offshore platforms- Risk assessment.
Environmental transport of petroleum wastes: Surface paths- Subsurface paths- Atmospheric paths, Planning for environmental protection.
Waste treatment methods: Treatment of water- Treatment of solids- Treatment of air emissions- Waste water disposal: surface disposal.

UNIT-III

Oil mines regulations: Introduction-Returns, Notices and plans- Inspector, management and duties- Drilling and workover- Production- Transport by pipelines- Protection against gases and fires- Machinery, plants and equipment- General safety provisions- Miscellaneous-Remediation of contaminated sites- Site assessment-Remediation process.

UNIT-IV

Toxicity, physiological, asphyxiation, respiratory, skin effect of petroleum hydrocarbons and their mixtures - Sour gases with their threshold limits-Additives during acidizing, sand control and fracturing.

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UNIT-V

Hazard identification- Hazard evaluation- HAZOP and what if reviews- Developing a safe process and safety management- Personal protection systems and measures.

Classification of fires- The fire triangle- Distinction between fires and explosions- Flammability characteristics of liquids and vapors- Well blowout fires and their control- Fire fight equipment- Suppression of hydrocarbons fires

Outcomes:

The students will be able to:

- Be conversant with the knowledge of various Acts related to safety, Health and environment in petroleum industry.
- Have the knowledge of various drilling fluids handling and safe disposal such toxic products.
- Gain Knowledge of disaster management to fight any crisis.
- Apply Hazop to petroleum equipment operation and assess risk involved
- Mitigate occupational health hazards in the industry.

Text Books:

1. Environmental Control in Petroleum Engineering, John C. Reis, Gulf Publishing Company, 1996.
2. Application of HAZOP and What if Reviews to the Petroleum, Petrochemical and Chemical Process Industries, Dennis P. Nolan, Noyes Publications, 1994.
3. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India and Oil Mines Regulations-1984, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India.

Reference Books:

1. Guidelines for Process Safety Fundamentals in General Plant Operations Centre for Chemical Process Safety, American Institute of Chemical Engineers, 1995.
2. Guidelines for Fire Protection in Chemical, Petrochemical and Hydrocarbon Processing Facilities, Centre for Chemical Process Safety, American Institute of Chemical Engineers, 2003.
3. Guidelines for Hazard Evaluation Procedures Centre for Chemical Safety, Wiley- AIChE, 3rd Edition, 2008.
4. Guideline for Process Safety Fundamentals in General Plant Operations, Centre for Chemical Process Safety, AIChE, 1995.
5. Chemical Process Industry Safety, K S N Raju, Mc Graw Hill, 2014.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
PETROLEUM ENGINEERING MATHEMATICS					

Learning Objectives:

- To develop logical understanding of the subject.
- To develop mathematical skill so that students are able to apply mathematical methods & principals in solving problem from Petroleum Engineering field.
- To make aware students about the importance and symbiosis between Mathematics and Engineering.
- To challenge students to further develop and extend their critical thinking skills by applying strategies which will help them interpret, analyze, evaluate, infer, and synthesize concepts studied in this course and develop greater knowledge and understanding of mathematics and to attain the skills necessary for success in the of higher mathematics including GATE examination.

UNIT-I

Linear algebra: Matrix algebra, Systems of linear equations, Row reduction; Matrix operations; Determinants and their properties; Cramer's rule; Eigen values and eigen-vectors; Diagonalization of a matrix; Symmetric matrices; Linear transformations.

UNIT-II

Calculus: Functions of single variable, Limit, continuity and differentiability, Taylor series, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

UNIT-III

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation**.**

UNIT-IV

Probability and statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

UNIT-V

Numerical methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.

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Outcomes:

- Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces.
- Define and illustrate the concepts of sample space, events and compute the probability and conditional probability of events
- Derive numerical methods for approximating the solution of problems of continuous mathematics
- Able to convert complex partial differential equations into a simpler set of algebraic equations.
- Able to show the understanding of impact of Engineering Mathematics on Petroleum Reservoir Applications.
- Able to demonstrate their understanding of mathematical ideas from multiple perspectives, such as by
  i. using the internal connections between geometry, algebra, and numerical computation,
  ii. applying the connections between theory and applications, or
  iii. distinguishing between a formal proof and a less formal arguments and understanding the different roles these play in mathematics.

Text Books:

1. Dennis G. Zill, Warren S. Wright: Advanced Engineering Mathematics, 4th edition,Jones and Bartlett Publishers, 2010
2. E. Kreyszig : Advanced Engineering Mathematics, 8th Edition John Wiley and sons 1999.
3. Higher Engineering Mathematics by B.S. Grewal, Khanna publishers, 39th edition.
4. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, John willy 2000.

Reference Books:

1. T. M. Apostol : Calculus Vols I and II, 2nd Edition, John Wiley and sons, 1967 and1969.M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, PearsonEducations, 2008
2. Numerical Methods for Scientific and Engineering Computation, M.K.Jain, New Age Publication.
3. Numerical Methods, GermundDahlquist, Ake Bjorck, Dover Publication.
4. Engineering Mathematics by M.K. Venkataraman
5. Engineering Mathematics by P. Kandaswamy, et al.

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		3	0	0	3
SUBSEA ENGINEERING					

Learning Objectives:

- To understand the subsea development operations.
- To learn the hydraulic / equipment / system design considerations.
- To learn the process control and power supply consideration.
- To understand the reliability issues& design challenges involving subsea systems.

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.

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-III

Installation & Vessels: Introduction – Typical installation vessels – Vessel requirements & selection – Installation - positioning & Analysis.

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.

UNIT-IV

Wax &Asphaltenes: Introduction - Wax - Wax management – Wax remediation – Asphaltenes – Asphaltenes control design philosophies.

Hydrates: Introduction – Physics & Phase behaviour – Hydrate prevention – Hydrate remediation – Hydrate control design philosophies – Recovery of thermodynamic hydrate inhibitors.

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UNIT-V

Heat Transfer & Thermal Insulation: Introduction – Heat transfer fundamentals – U value – Steady state heat transfer – Transient heat transfer – Thermal management strategy & Insulation.

Subsea Corrosion & Scale: Introduction – Pipeline internal corrosion – Pipeline external corrosion – Scales – Overview of Erosion & Sand management.

Outcomes:

The students will be 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.

Text Books:

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

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		3	0	0	3

MATHEMATICS OF RESERVOIR SIMULATION

Learning Objectives:

- To develop oil and gas reservoir simulators using numerical tools so that the reservoir engineering principles can be applied widely in the petroleum industry.
- To initiate a rigorous mathematical study of the both parabolic dominant as well as hyperbolic dominant single-phase fluid flow equations (the fundamental governing equations) that describe fluid flow through a petroleum reservoir.
- To learn the finite difference approximation for solving the non-linear diffusivity equation that includes the heterogeneous and anisotropic petroleum reservoirs.

UNIT-I

Differential equations for flow in reservoirs: Single-phase flow (Differential operators, general equation for single-phase flow, boundary conditions); Types of second-order differential equations (Parabolic, hyperbolic and elliptic equations); Differential equations for two-phase flow (pressure and saturation equations).

UNIT-II

Introduction to finite difference technique: Taylor series expansion; First-difference quotients; Second-difference quotients; Truncation error; Grid systems (Block-centered grid, Point-centered grid, variable grid); Round-off error; Numerical stability (consistency, convergence and stability).

UNIT-III

Numerical solution of parabolic problems in one dependent variable (using diffusivity equation of a petroleum reservoir): The forward difference equation, von Neumann stability criteria by harmonic analysis; Implicit difference equations (Backward difference equation, tri-diagonal algorithm and Crank-Nicolson difference equation); Explicit difference equations (Time-centered explicit equation, Dufort-Frankel approximation); Alternate-direction methods (Peaceman-Rachford method, Douglas-Rachford method, Brian and Douglas method).

UNIT-IV

Numerical solution of first-order hyperbolic problems in one dependent variable (using Buckley-Leverett equation of a petroleum reservoir): Difference equations (Distance-weighting, Time-weighting, General form of difference equation, Linearization of difference equation); Stability; Truncation error analysis (Local truncation error, numerical dispersion, superposition of numerical and physical dispersion); Unstable solutions.

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UNIT-V

Numerical solution of elliptic problems in one dependent variable (using steady state fluid flow equation of a petroleum reservoir): Elliptic difference equations; Direct solution method; Iterative methods; Point and line relaxation methods; Alternate-Direction Iteration method; Strongly implicit procedure.

Outcomes:

- Be familiar with the modeling assumptions and derivations that lead to PDEs.
- Recognize the major classification of PDEs and the qualitative differences between the classes of equations
- Reservoir simulation being the necessary tool for the petroleum engineers helps to understand the recovery of petroleum hydrocarbons in an efficient manner.
- With the advances in computing capabilities and the used numerical method, the complex petroleum reservoir rock-fluid interaction can be tracked and visualized using the scientific computations.
- Insights from this course are expected to help in managing the reservoir assets and making reliable predictions about production rates.

Text Books:

1. Peaceman D W. (1977). Fundamentals of Numerical Reservoir Simulation, Elsevier Scientific Publishing Company, New York, 1977, 191 pages.
2. Ewing R E. (1983). The Mathematics of Reservoir Simulation, SIAM Philadelphia, 197 pages.
3. Guy C and J Jaffre. (1986). Mathematical Models and Finite Elements for Reservoir Simulation: Single phase, Multi-phase and Multi-component Flows through Porous Media, Elsevier Science Publishers (ISBN: 0 444 70099 4), Netherlands, 389 pages.
4. Aziz K and A Settari. (1979). Petroleum Reservoir Simulation, Applied Science Publishers, London, 1979.

Reference Books:

1. Bear J., and Y Bachmat. (1991). Introduction to Modeling of Transport Phenomena in Porous Media, Kluwer Academic Publishers, Dordrecht, The Netherlands.
2. Bear J. (1972). Dynamics of Fluids in Porous Media, New York, 1972.
3. Collins R E. (1961). Flow of Fluids through Porous Materials, Van Nostrand-Reinhold, New York, 1961.
4. Thomas J W. (1995). Numerical Partial Differential Equations, Finite Difference Methods, Springer-Verlag, New York.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCES IN WELL CONTROL					

Learning Objectives:

- Introduction to basics of Well control and Pressure Control theory.
- Concept of Kick and Well Control techniques.
- Detailed description of Well Control Equipment.
- Well Control during Workover operations.
- Detailed Description on Subsea Well control and Intervention Operations.

UNIT-I

Basics of formation: Pore pressure – Overburden and Effective Stress Concepts- Conventional Pressure-Prediction Concepts-Pressure Control theory - Swab and Surge Pressure, Abnormal Pressure-Formation Integrity tests – Fracture gradient determination -ECD -MAASP

UNIT-II

Kick Detection and Well Control Methods: Causes of Kick- Detection and Containment-Shut in pressure analysis –Increasing mud Density, Primary, Secondary and tertiary well control - Barriers, Well killing procedures - Drillers method – Wait and weight method – Volumetric method – Bull heading – Kill sheet calculations.

UNIT-III

Well Control Equipment: Safety valves –SSSV - FOSV-IBOP, Surface BOPEquipment- Low Pressure and High pressure equipment, Special kick problems.

Fishing operations: Requirement for fishing and procedures for various fishing problems,Procedures to free the pipes.

UNIT-IV

Well Control During Completion and Work Over Operations: Completion and workover Fluids characteristics –Well control Surface Equipment – Well Control barriers and Integrity Envelopes, Well control during Work over - Coil Tubing – Slick-line / wire line - Stimulation Operations.

UNIT-V

Subsea Well Control System: Subsea BOP – LMRP, Risers, Well Control in deep water drilling and Completion, Subsea test tree, Subsea Tree, Subsea Intervention – Riserless Operations.

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Outcomes:
The student will be able to:

- Understand the basic well Control concept during drilling.
- Different methods of well control.
- Importance of Well Control equipment and maintenance.
- Barriers and Use of Well Control Equipment during Workover Operations.
- Understand the Subsea Control system and Subsea Intervention.

Text Books:

1. Well Engineering and construction, Hussain Rabia, Entrac Petroleum, 2001.
2. Advanced Well control,David Watson, Terry Brittenham and Preston L Mooore, SPE Text Book Series, 2003
3. Well Control for completions and Interventions, Howard Crompton, Gulf Professional Publishing, First Edition, 2018.

Reference Books:

1. Drilling Enginering, Heriott –Watt University.

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		3	0	0	3
PIPELINE ENGINEERING					

Learning Objectives:

- Operations and maintenance of flow lines or trunk pipe lines.
- Understanding of well fluids for proper designing of flow lines/trunk pipe lines.
- Obtaining the permissions to laying of pipe line as per the State/DGMS regulations.
- Operation and maintenance of gas compressors.
- Handling of flammable fluids like gas, oil condensate to check the accident free operation.
- Protection from internal/external corrosion of pipe lines by suitable methods.

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.

Pipeline construction: Construction – Commissioning.

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: 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- Reciprocation compressors.

Coolers: Gas coolers – Air-cooled heat exchangers –Heat transfer equations for coolers – Fan air mass flow rate – Required fan power – Gas pressure drop in coolers – Iterative procedure for calculations based on unknown T_2.

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UNIT-IV

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

Pipeline protection, Instrumentation and Pigging: Pipeline coating – Cathodic protection – Cathodic protection calculations for land pipelines – Internal corrosion – Flow meters and their calibration – Sensors – Pigs.

UNIT-V

Pipeline mechanical design: Codes and standards – Location classification – Pipeline design formula – Expansion and flexibility – Joint design for pipes of unequal wall thickness – Valve assemblies – Scraper traps – Buoyancy control – Crossings – Depth of cover – Aerial markings – Warning signs.

Materials selection: Elements of design – Materials designation standards.

Outcomes:

The students will be able to:

- Understanding pipeline designing and maintenance.
- Repair and maintenance of pipeline in short time to avoid production loss.
- Plan for suitable corrosion protection methods to improve the life of the pipeline.

Text Books:

1. Pipeline Design and Construction: A Practical Approach, M. Mohitpour, 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.

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DEPARTMENT OF PETROLEUM ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
STATISTICS FOR PETROLEUM ENGINEERING AND GEOSCIENTISTS					

Learning Objectives:

- To help the students to understand the fundamental concepts probability and statistics.
- To understand various hypothesis testing for sampling analysis.
- To help students in modelling of reservoir characteristics.

UNIT-I

Fundamentals Of Statistics And Probability: Events, Randomness, Sample, Conditional Probability and Independence, Bayes Theorem, discrete and Continuous Probability Distributions, Joint Probability, Conditional Probability.

UNIT-II

Statistical Test And Distribution Techniques: Binomial, Poisson, Gamma, Exponential, Hypergeometric, Multinomial, Chi- Square, t, F tests, Hypothesis Testing Involving one and univariate population.

UNIT-III

Statistical Modeling: Point and Interval Estimation, Linear Models, Regression Analysis and parametric Estimation Multivariate Techniques, Factor Analysis, Linear Discriminant Analysis.

UNIT-IV

GeostatisticalApplications: Expectations, Moment Generating and Characteristic Functions, Semi-variogram, Auto correlation, Linear Estimation, Kriging &cokriging Equations.

UNIT-V

Nonlinear estimation, Semi- variogram and Normalized Data, Non parametric Estimation, Conditional Simulation, Multivariate Simulation.

Outcomes:

The student will be able to:

- Estimate probability of occurrence.
- Test number of hypothesis for uncertainty analysis
- Modeling of deterministic variables.
- Develop a stochastic model for subsurface resource mapping.
- Creating continuous surface for discrete measurements

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Text Books:

1. Statistics and data analysis in Geology, John C Davis, Wiley Student Edition, 621pp.

Reference Books:

1. Probability & Statistics, Spiegel M.R, Schiller J, srinivasan R. A. Schaum's Outlines Series, McGraw Hill, 408pp.
2. JimbaOluwafemi Solomon, Basic Geostatistics.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCES IN SEISMIC EXPLORATION METHODS FOR HYDROCARBON EXPLORATION					

Learning Objectives:
The syllabus for seismic exploration is aimed at the student to have a clear knowledge of seismic exploration in India. The student should know in detail about the seismic which are used in Petroleum exploration which are the back bone of the whole gamut of Oil exploration including acquisition, processing an interpretation

UNIT – I
Introduction: Seismic DataAcquisition,Land Data Acquisition, Marine DataAcquisition, Fundamentals of Seismic Prospecting Seismic WaveFundamentals:Compressional Waves(P-waves), Shear Waves(S-waves),AirWave, RayleighWaves, LoveWaves, Direct and HeadWaves, GroundWaves Characteristics of SeismicEvents, Reflections, CriticalReflection, Refractions, Diffractions. Introduction to OBC, and3 Component seismic surveys

UNIT –II
Seismic refraction surveys- Geometry of refracted path, Methodology of refraction profiling- Recording instruments & energy sources- Corrections applied to refraction data Interpretation of refraction data- Seismic Reflection Surveys:Geometry of reflected ray path: Single horizontal reflector- Common depth point (CDP) profiling & stacking- 2D, 3D, & 4D seismic surveys- Field procedures & principles. Time corrections applied to seismic data(static correctios)

UNIT – III
Seismic DataProcessing: Objective of Seismic data processing, Basic Data ProcessingSequence,Preprocessing: Geometry,De-Multiplexing, Reformatting, Re-sampling, Geometry Merging, Static corrections, Amplitude Recovery,Geometric Spreading Correction, sorting, De-convolution, Velocity Analysis, NMO, DMO and Residual StaticCorrections, Common depth point (CDP) profiling & stacking, Migration Both prestack and post stack migration, Prestack Depth Migration

UNIT – IV
Interpretation – Structural Interpretation of reflection data, 2D and 3D interpretation Correlation of seismic processed data with the well data with the help of synthetic seismogram, Identification of different geological boundaries, Marking and correlation of faults, preparation of time and depth structures maps. Identification of different structures from interpreted seismic data. Reserves calculations of identified structures. Stratigraphic interpretation of seismic data: Identification of pinchouts, unconformity traps, Reef traps etc.

UNIT – V
Virtual Reality centres, Introduction to seismic visualizationcentres. Virtual reality and their use in better interpretation of seismic data. Introduction to 2D-3C and 3D-3C and OBC methods and their acquisition and interpretation and processing. 4D seismic.

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Outcomes:
The outcome of Elective this should enable the student to have a clear understanding of the seismic exploration, viz its acquisition methods, processing and interpretation, People opting this elective should become totally conversant in all aspects of seismic exploration

Text Books:

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4th Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and AsgerEriksen, 4th Edition, John Wiley, 2011.

Reference Book:

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991

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IV Year - I Semester		L	T	P	C
		0	0	3	1.5
PETROLEUM EQUIPMENT DESIGN & SIMULATION LABORATORY					

Learning Objectives:
The students will be trained in the design and simulation of various equipment used in petroleum industry.

The following numerical experiments have to be simulated using C/C++/Simulink using MATLAB/UNISIM for design and simulation:

1. Oil- Water separator.
2. Gas- Oil-Water separator.
3. Lean / rich amine heat exchanger.
4. Air cooled heat exchanger.
5. CO_2 and H_2S absorber unit using, MEA/DEA amine solution.
6. Stripping unit.
7. Single stage flash vaporization unit.
8. Three stage flash vaporization unit.
9. Liquid pumping system & simulation of water-hammer phenomena.
10. Gas Compressor unit.

Outcomes:
The students shall be able to carry-out the following tasks independently:

- Design and simulation of the two-phase and three phase separators.
- Design and simulation of compressors.
- Design and simulation of flash vaporization units.
- Design and simulation of absorber-stripper unit for removal of CO_2 and H_2S from natural gas.
- Size /rate the pipeline & pumping systems for liquid pumping & simulate water hammer conditions.
- Carryout detailed thermal sizing or rating of shell & tube exchangers as per TEMA specifications and API guidelines.
- Generate sized equipment data sheets as per the industry standards with required information for detailed design / manufacture.

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IV Year - I Semester		L	T	P	C
		0	0	3	1.5
PETROLEUM RESERVOIR SIMULATION LABORATORY					

Learning Objectives:

- The main objective is to simulate the exploitation of a real reservoir without the costs of real life trial and error, e.g. to test different production scenarios to find an optimal one before the reservoir is actually put on production.
- To develop reservoir simulation models for new reservoirs to maximize recovery of oil and gas and to make investment decisions.
- To develop reservoir simulation models for existing reservoirs to study production decline and production forecasts.

Reservoir Simulation Experiments:

The students will be trained in the software Package ECLIPSE, or any other equivalent software to model and solve reservoir engineering problems.

1. File organization and structure
2. Selection of suitable by grid sensitivity studies.
3. Screening Criteria
   i. Fluid properties
   ii. Rock properties
4. Well Pattern and Boundary Conditions
5. Aquifer modeling (single and multiphase fluid flow: Oil-Water/Oil-Water-Gas)
6. History matching consisting of adjusting the parameters of the model such as permeability and porosity until the computed results for the historical period are close to historical data
7. Prediction of properties permeability, relative permeability, saturation etc.

Outcomes:

After the laboratory course, the students will be able to:

- Explain reservoir simulation fundamentals- the underlying equations and the numerical techniques used to solve them.
- Design a reservoir simulation model, construct the data set, execute the simulator, and view simulation results visually using post-processing software.
- Plan and conduct the calibration of a reservoir simulation model.
- Apply reservoir simulation technology to solve production and reservoir engineering problems in individual wells or patterns.
- Apply reservoir simulation technology to solve production and reservoir engineering problems in entire fields or reservoirs.
- Present results of an engineering study effectively in a written report.

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IV Year - I Semester		L	T	P	C
		0	0	0	1
PRESENTATION SEMINAR (SIP REPORT)					

Learning Objectives:

- To give a clear, organized and accurate oral presentation of Summer Training Report.
- To provide verbally/ through power point presentation of condensed large amounts of technical information into concise, condensed analysis.
- Sharing the practical knowledge obtained during training with fellow students.

The presentation and evaluation of the summer training report for 50 marks should be conducted by a committee constituted by the College/University.

Outcomes:
The students will extend their abilities to:

- Get themselves good clarity in the technical topics being presented.
- Develop good communication skills.
- Practice the behaviors of effective speakers.
- Assess strengths in speaking and set goals for future growth.

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IV Year - I Semester		L	T	P	C
		0	0	0	2
PROJECT (INDUSTRIAL/IN-HOUSE)					

Learning Objectives:
The students are guided to learn the following aspects:

- Understanding &evaluating the design / operation / environmental aspects of a petroleum equipment/ process.
- Understanding & evaluating the technology aspects of various alternatives available, called "Best Available Technologies (BAT)", through literature & references and select a suitable equipment/ process with optimum capacity.
- Carrying-out the basic design of the process using steady state simulation.
- Preparation of equipment layout & plot plan drawing.
- Preliminary cost estimation of CAPEX and OPEX.
- Presentation &project management skills.

The project work shall consist of any one of the following:

a) The project work should consist of a comprehensive design project of any one of the petroleum upstream processes concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery in the form of a report.
b) Modeling & Simulation of any petroleum upstream unit concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery.
c) Any experimental work with physical interpretations.

Each student will carry out the project (**Phase 1**)under the guidance of an instructor / faculty, he/she is given a project at the beginning of I Semester of IV year B. Tech. Program.Project (**Phase 1**)should consists of the followingitems:

1. Project topic
2. Introduction
3. Literature review
4. Gaps
5. Objective and scopes
6. Expected outcome

The project shall be presented for the mid-term review. A report shall be submitted in a standard format. The report will be assessed by the internal committee for the completion of project (**phase 1**).

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		2	0	0	0
IPR & PATENTS					

Course Objectives:

- To know the importance of Intellectual property rights, which plays a vital role in advanced Technical and Scientific disciplines
- Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latest developments

Course Outcomes:

- IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents
- Studentget an insight on Copyrights, Patents and Software patents which are instrumental for further advancements

UNIT I

Introduction to Intellectual Property Rights (IPR): Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

UNIT II

Copyrights and Neighboring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

UNIT III

Patents: Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Compulsory Licensing — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations

UNIT IV

Trademarks: Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing Off Action.

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UNIT V

Trade Secrets & Cyber Law and Cyber Crime: Introduction to Trade Secrets – General Principles - Laws Relating to Trade Secrets –
Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements – Breach of Contract –Law of Unfair Competition – Trade Secret Litigation – Applying State Law.
Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions – E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers.

Text Books:

1) Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
2) Deborah E.Bouchoux: Intellectual Property, Cengage Learning, New Delhi.

References:

1) PrabhuddhaGanguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
2) Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
3) Kompal Bansal &Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
4) Cyber Law - Texts & Cases, South-Western's Special Topics Collections.
5) R.Radha Krishnan, S.Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
6) M.Ashok Kumar and MohdIqbal Ali: Intellectual Property Rights, Serials Pub.

Outcomes:

The student shall be able to carry out independently the following tasks:

- Preparation of project feasibility reports for petroleum processes/plants.
- Gather & use various sources such as market data, literature, customer feed-backs etc. to evaluate the Best Available Technologies in the market and select suitable process meeting the site conditions, environmental regulations, product quality etc.
- Simulation of overall plant including estimation of utility consumptions.
- Generation of equipment diagrams and MSD (Material Selection Diagrams).
- Manage a comprehensive project in a planned manner, within specified time and present the salient features of the result to the audience with confidence and clarity.

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IV Year - I Semester		L	T	P	C
		0	0	2	0
Physical Fitness Activities					