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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DEPARTMENT OF PETROLEUM ENGINEERING

III YEAR II SEMESTER

S. No.	Course Code	Course Title	L*	T	P	Credits
1	PCC	Petroleum Production Engineering	3	0	0	3
2	PCC	Petroleum Reservoir Engineering-II	3	0	0	3
3	PCC	Petroleum Refinery & Petrochemical Engineering	3	0	0	3
4	PEC	**PROFESSIONAL ELECTIVE – II** i. Offshore Engineering ii. Advanced Well Completion Engineering iii. Applied Mathematics in Reservoir Engineering	3	0	0	3
5	OEC	**OPEN ELECTIVE – II**(To be selected from open elective subjects offered by other branches)	3	0	0	3
6	PCC	Petroleum Analysis Laboratory	0	0	3	1.5
7	PCC	Petroleum Reservoir Engineering Laboratory	0	0	3	1.5
8	PCC	Drilling Simulation Laboratory	0	0	2	1
9		Summer Internship (4-6 weeks)	-	-	-	-
10	*MC	Mini Project(**Phase 2**)	-	-	-	-
11	*MC	Data Science (AICTE – NITTTR)	0	0	3	0
					Total Credits	**19**

OPEN ELECTIVE – II (offered for other Branches (except Petroleum Engineering))

i. Basic concepts in Petroleum Drilling and Completions
ii. Basic concepts in Petroleum Production Engineering
iii. Basic concepts in Petroleum Reservoir Engineering

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
PETROLEUM PRODUCTION ENGINEERING					

Learning Objectives:
The students will be made to learn:

- Fundamental concepts in petroleum production engineering.
- Reservoir fluids, efficient flow to the surface without damaging the reservoir dynamics/drive mechanisms.
- Various surface equipment's for process oil and gas after flow from wells.
- Sick well identification and remedial stimulation operations.
- Application of suitable artificial lifts on reservoir energy depletion.

UNIT-I
Petroleum production system over all view, Production from various types of reservoir based on drive mechanisms, field development method, Safety control system.
Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-II
Reservoir deliverability: Flow regimes - transient, steady state, pseudo steady state IPR for various types of wells.
Well bore performance – single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells.

UNIT-III
Choke performance – sonic & subsonic flow, single & multiphase flow in oil & gas wells; Well deliverability - nodal analysis, Well decline analysis.

UNIT-IV
Artificial lift methods: Sucker rod pumping system- Selection of unit and types of unit, Load & power requirements, Performance analysis; electrical submersible pumps: principle, design & operation;

Gas lift system: types, evaluation of potential compression requirements, study of flow characteristics, principles of compression, types of compressors, selection of gas lift valves, types of valves, principles of valve operation, setting & testing.

UNIT-V
Production Stimulation: Well problem identification; Matrix acidizing- Design for sandstone & carbonate reservoirs, Hydraulic fracturing – formation fracture pressure, geometry, productivity of fractured wells, hydro-fracture design, selection of fracturing fluid, propant, post frac evaluation.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

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

- Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.
- Identify formation damage and find remedial methods to bring the well back into production.
- Screen, design and operate artificial lifts on reservoir pressure depletions.
- Handle in case of any crisis at drilling/production installations.
- Process oil and gas before supply to refinery/consumers.

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice Hall, 1994.

Reference Books:

7. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
8. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
PETROLEUM RESERVOIR ENGINEERING-II					

Learning Objectives:

- To make the students learn fundamentals as well as advanced topics in reservoir engineering like The constant terminal rate solution and its applications to oil well testing, gas well testing, Gas and water coning, natural water influx, and immiscible displacement.

UNIT – I

The constant terminal rate solution of the radial diffusivity equation and its application to oil well testing: The constant terminal rate solution – Transient, semi steady state and steady state flow conditions – Dimensionless variables – General theory of well testing – The Mathews, Brons, Hazebroek pressure build up theory - Pressure build up analysis techniques – Multi Rate Drawdown testing – The effects of partial well completion – After flow analysis.

UNIT– II

Gas well testing: Linearization and solution of the basic differential equation for the radial flow of a real gas – The Russel, Goodrich et. al. Solution technique – The Al Hussainy, Ramey Craw-ford solution techniques – Non-Darcy flow – Determination of the non- Darcy coefficient F - The constant terminal rate solution for the flow of a real gas – General theory of gas well testing – Multi rate testing of gas wells.

UNIT– III

Pressure build up testing of gas wells: Pressure build up analysis in solution gas drive reservoirs- Analysis of well tests using type curves- Interference and Pulse Tests - Flow after flow tests in gas wells- Isochronal & modified isochronal tests- Use of pseudo pressure in gas well test analysis- Injection Well Testing.

UNIT– IV

Gas and water coning: Basic Concepts in Coning, Coning in vertical and Horizontal wells, Critical rate and Breakthrough time calculations from various correlations-After breakthrough time calculations.

Natural water influx: The unsteady state water influx theory of Hurst and Van Everdingen and its application in history matching – The approximate water influx theory of Fetkovich for finite aquifers predicting the amount of water influx – Application of influx calculation techniques to steam soaking.

UNIT– V

Immiscible displacement: Physical assumptions and their implication – The fractional flow equation – Buckley-Leverette one dimensional displacement – Oil recovery calculation – Displacement under segregated flow conditions – Allowance for the effect of finite capillary transition zone in displacement calculations – Displacement in stratified reservoir.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

Outcomes:
The students will be able to:

- Carry out the interpretation of Well Test Data.
- Estimate the reserves of various sands of the reservoir along with water production.
- Calculate the formation damage and water in flux, accordingly proper stimulation jobs can be recommended.
- Learn how to acquire the data through well testing in dynamic and closed conditions.
- Estimate the long term profiles of the reservoirs.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17thImpression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham &Trotman Inc. 1986.
2. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.
3. Petroleum Reservoir Engineering, James W Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
PETROLEUM REFINERY & PETROCHEMICAL ENGINEERING					

Learning Objectives:

- To understand the properties and their significance of crude oils and petroleum fractions.
- To understand, design and analyze the various petroleum refinery processes including primary, secondary and supporting processes.
- To understand the process technologies for the petrochemical products.

UNIT-I

Introduction: Overall refinery operations & Indian scenario.
Refinery feed stocks: Crude oil classification - Composition and properties – Evaluation of crude oils.

UNIT-II

Petroleum Products and their specifications: LPG – Gasoline - Diesel fuels - Jet and turbine fuels – Lube oils - Heating oils – Residual fuel oils - Wax and Asphalt- Petroleum coke - All Product specifications - Product blending.

UNIT-III

Crude distillation: Atmospheric and Vacuum distillation units, Auxiliary equipment such as desalters, pipe-still heaters and heat exchanger trains etc.
Catalytic reforming and isomerization: Catalytic reforming processes (for petroleum and petrochemical feed stocks) – Isomerization Processes - Feed stocks - Feed preparation – Process variables - Yields.

UNIT-IV

Thermal & Catalytic cracking processes: Visbreaking- Delayed Coking –Fluid Catalytic cracking and Hydrocracking - Feed stocks — Catalysts - Process variables –Product Recoveries- Yield estimation.
Hydrotreating &Hydroprocessing: Naphtha, Kerosene, Diesel, VGO &Resid, Hydrotreating / Hydroprocessing – Feed stocks – Process description and Process variables.

UNIT-V

Petrochemical Industry: – Indian Petrochemical Industry- Feed stocks – Process description and Process variables - Naphtha cracking-Gas cracking and Gas reforming.
Chemicals from gas reforming: Methanol- Acetic acid- Ammonia and urea.
Chemicals from ethylene: Ethylene oxide-Monoethylene glycol - Ethyl benzene-Styrene.
Polymers: LDPE, HDPE & LLDPE and Polypropylene – PVC - Polystyrene.

Outcomes:

The students will be able to gain the knowledge for applications as follows:

- For a given crude assay, how to handle and store the crude oil.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

- What will be the yield, quality of the product, estimation for the primary processes and treatment considerations.
- Maximize the profitable products and minimize the quality giveaway.
- Ability to process the opportunity crudes (e.g. Blending with other crudes) to maximize the throughput and gross margin.
- Application of suitable Hydroprocessing/treatment technologies to meet product qualities and to minimize the CAPEX & OPEX (capital and operating expenditure).
- Application of suitable thermal/catalytic conversion (cracking) processes for Vacuum gas oil/Resid upgradation and to produce desired fuel blend components and petrochemical feed stocks.
- Application of suitable processes (such as alkylation, reforming, isomerization) for converting light ends/ naphtha cuts to meet the desired gasoline blends.
- Understanding of various petrochemical feed stocks and their origin from refining/gas processes.
- Knowledge of various petrochemical products in the market and best available technologies to produce them.

Text Books:

1. Petroleum Refining: Technology and Economics, J.H. Gary and G. E. Handwerk, 4th Edition, Marcel Dekkar, Inc., 2001.
2. Elements of Petroleum Processing, D S Jones, Wiley 1995.
3. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.

Reference Books:

1. Petroleum Refining Engineering, WL Nelson, 4th Edition, McGraw Hill Company, 1958.
2. Chemical Technology of Petroleum, W. S. Gruese and D.R. Stevens, McGraw Hill, 1960.
3. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers, 1970.
4. Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company, 1989.
5. Chemistry of Petrochemical Processes, Sami Mater, Lewis F. Hatch, 2nd Edition, Gulf Professional Publishing, 2001.
6. Chemicals from Petroleum: An Introductory Survey, Waddams, A.L., 4th Edition, Gulf Publishing, 1978.
7. Handbook of Petrochemicals Production Processes, R.A. Meyers, TRW,Inc., 2005.
8. Petrochemical Processes Handbook, Hydrocarbon Processing, 2010.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
OFFSHORE ENGINEERING					

Learning Objectives

- Introduce different types of deep water offshore structures and challenges
- Introduce Concept of wave theory for linear and nonlinear waves.
- Estimation of wave loads on small and large bodies
- Estimation different types of loads on offshore structures such as gravity, wind, wave and current loads
- Detailed design of fixed offshore structures
- Concepts of floating structures
- Fundamental aspects of semisubmersible, TLP, spar and installation methodologies
- Design aspects of risers

UNIT-I

Overview of offshore structures: Introduction- Functions of offshore structures- Offshore structure configurations- Bottom-Supported fixed structures- Compliant structures- Floating structures- Deepwater challenges - 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.Analysis and design aspects of Jack-up rigs.

UNIT-IV

Floating offshore platform design: Introduction- Floating platform types- Design of floaters- Floating production storage and offloading systems, Mobile offshore drilling units (MODU), Station keeping of MODU’s, Single Point Mooring (SPM) and Single Buoy Mooring (SBM) systems.

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

DEPARTMENT OF PETROLEUM ENGINEERING

UNIT-V

Semi submersibles- Tension leg platforms- Spar design- Hull structure- Construction and installation. Deep water station keeping technologies,

Drilling and production risers: Drilling risers- Production risers- Vortex induced vibration of risers- Design aspects.

Outcomes:

The student will be able to:

- Identify type of offshore structure and recommend a specific offshore structure for a given site condition and requirements of the platform.
- Estimate water particle kinematics using linear Airy's wave theory and estimate maximum wave force and overturning moment for a fixed vertical circular cylinder.
- Use of diffraction theory for a large body
- Analysis and design of fixed offshore structure
- Perform mass distribution of different structures such as floating structure, TLP and Spar.
- Design aspects of Risers.

Text Book:

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

Reference Books:

1. Offshore Operation facilities, Huacan Fang, MenglanDuan, 1st Edition, Gulf professional Publishing.
2. Handbook of Offshore Oil and Gas Operations, James Speight, 1st Edition, Gulf professional Publishing.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED WELL COMPLETION ENGINEERING					

Learning Objectives:

- Introduction of basics of reservoir engineering and well completion operations
- Concept of sand controls preventions and techniques
- Introduction factors affecting well completion and design selection
- Detailed design basis of well completion equipment
- Fundamental of well completion techniques and installation system

UNIT-I

Basics of well reservoir engineering in well completion: IPR, perforation, well stimulation techniques including fracturing. Sand controls- introduction- rock strength analysis- sand control prediction and mitigation techniques including installation of screens, gavel pack job-sand consolidation methods

UNIT-II

Well completion life: Introduction- types of well completion- factors affecting well completion- TPR- flow through tubing, well completion fluid properties and production and injection tubing sizing analysis.

UNIT-III

Material selection and stress analysis: Selection of control lines for Injection of corrosion inhibitors, scale inhibitors and use of other seals. Load and stress analysis of tubing including burst pressure, collapse, axial load calculation and some design factors.

UNIT-IV

Well completion equipment: Introduction- types of completion equipment- surface and subsurface equipment. Rating of SSSV, packer, landing nipple locks and sling sleeve and side pocket mandrel selection. Selection of control lines and subsea isolation valve.

UNIT-V

Well completion installation system: Introduction-onshore and subsea well completion installation system. Well bore cleanup operations-well fluid displacement. Filtration prior to well flow

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

Outcomes:

The student will be able to:

- Understand the basic idea about reservoir engineering and well completion.
- Different types of well completion.
- Use of completion equipment.
- Types of installation in onshore and offshore areas.

Text Books:

1. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.
2. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.

Reference Books:

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.
3. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
APPLIED MATHEMATICS IN RESERVOIR ENGINEERING					

Learning Objectives:

The subject aims to provide the student with:

- Mathematics fundamental necessary to formulate, solve and analyze engineering problems.
- An understanding of Fourier series and Laplace Transform to solve real world problems.
- An understanding of complex integration.
- An understanding of partial differential equations that can be solved using analytical means with application to reservoir engineering.

UNIT-I

Diffusion equation: Derivation of one-dimensional non-linear diffusivity equation with quadratic pressure-gradient term; Dimensionless form; Derivation of transient diffusivity equation in radial coordinates in non-dimensional form; Superposition in space and time; Well boundary conditions using bottom hole pressure and specified flow rate.

UNIT-II

Laplace transform: Linearity of the Laplace Transform operator; Existence conditions; Laplace transform of a time derivative, periodic functions and Dirac-Delta function; First and second Shift theorems; Convolution; Application of Laplace transforms in solving linear differential equations with initial conditions and system of linear simultaneous differential equations.

UNIT-III

Petroleum engineering applications of Laplace Transforms: Line source solution; Bessel and modified Bessel equations; Finite well radius solution; Constant pressure inner boundary condition; Incorporating storage, skin and dual-porosity; Numerical inversion of Laplace Transforms.

UNIT-IV

Fourier transforms: Fourier transform theorem: Linearity, Fourier series of periodic functions; Trigonometric series; Euler's formulae; Half range series; Shift theorem, Similarity theorem, convolution theorem, Parseval's theorem and derivatives; Fourier Sine and Cosine transforms; One-dimensional pressure diffusion; Heat equation; Elliptic problem; Radial problems; Inverting Fourier Transforms numerically: Discrete Fourier transforms and Fast Fourier transforms.

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

DEPARTMENT OF PETROLEUM ENGINEERING

UNIT-V

Complex Integration, Cauchy‘s Integral theorem and its application; Integral formula for simply and multiply connected domains and its applications; Taylors and Laurents’ series and their application; Singular points; Liouvilles theorem with applications; Residue theorem and applications; Contour Integration; Boundary value problems.

Outcomes:

- Analyze and solve reservoir engineering problems using Laplace Series.
- Analyze and solve reservoir engineering problems using Fourier series.
- Understand analytic function of a complex variable and able to apply Cauchy integral theorem and residue theorem to solve contour integrations.
- Be competent in solving linear PDEs using classical analytical solution methods.

Text Books:

1. A text book of Engineering Mathematics (Vol-I and II), P.N.Wartikar and J.N.Wartikar, 07th edition, Pune VidhyarthiGrihaPrakashan, Pune, 2013.
2. A text book of Engineering Mathematics, by N.P.Bali& Manish Goyal, 09th edition, LaxmiPrakashan, 2014.
3. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, Willey Eastern Ltd. Mumbai, 2013.
4. Higher Engineering Mathematics by B. S. Grewal, 33rd edition, Khanna Publication, New Delhi, 1996.
5. Advanced Engineering Mathematics by H. K. Dass, 12th edition, S. Chand Publication, New Delhi, 2003
6. Higher Engineering Mathematics by B. V. Ramana, 12th edition, Tata McGraw Hill, Delhi, 2011.

Reference Books:

1. B.S. Grewal; Higher Engineering Mathematics; Khanna Publishers.
2. ErusingKreyszig; Advanced Engineering Mathematics; New International Ltd.
3. J. Brown and R. Churchill; Complex Variables and Its applications; McGraw-Hill Higher Education.
4. Frank Ayres; Theory and Problems of Matrices; Schaum Outline Series.
5. K.P. Gupta; Special Functions; Krishna Prakashan Media.
6. H.S. Kasana; Complex Variables (Theory and Applications); - PHI.
7. Srimanta Pal, Subodh C. Bhunia; Engineering Mathematics; Oxford University Press.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3

BASIC CONCEPTS IN PETROLEUM DRILLING AND COMPLETIONS

(offeredfor other Branches (except Petroleum Engineering))

Learning Objectives:

- understand the planning of drilling a well, the process of drilling and various equipment used for drilling and design of the drill string. To know the drilling fluid importance and its properties and hydraulics.
- To understand different types of casings lowered in a well, the requirement of cementation in a well and cement slurry design.To understand different tools used for directional drilling and various techniques, fishing, stuck pipe and well control concepts.
- Fundamentals of well testing. Knowledge of surface and subsurface equipment.Planning and designing of wellcompletion after testing of the hydrocarbon zones available.Knowledge of subsurface circulating equipment and packers. Testing of multi zones in a well with DST/RFT with logging tools as well as surface testing equipment.

UNIT-I

Overview of drilling: Drilling plan - GTO -Types of drilling, Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation - Measurement while drilling & logging while drilling data -Direct measurements of pore pressure – Drilling fluid properties - Drilling fluid hydraulics calculations - Bit Hydraulics Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient.

UNIT-II

Wellbore stability – e in-situ stress - Determination of rock properties, Failure criteria – Stress distribution around a wellbore - safe mud weights to prevent hole collapse, Kick tolerance Use of kick tolerance to calculate wellbore pressures.

Casing: Functions of casing – Types of casing – Casing properties and specifications – Casing connections – Factors influencing casing design – Combination strings – Tension criterion - Compression loads – Biaxial effects – Triaxial analysis.

Cementation: Introduction to cement slurries - Cementing nomenclature - Cement additives.

UNIT III

(a) Directional drilling: Well planning - Deflection tools and techniques - Face orientation - Direction control with rotary assemblies - Navigation drilling systems; Horizontal wells – Well profile design considerations – Torque and drag –Extended reach well design – Multilateral wells. Kicks – BOP - Special kick problems and procedures to free the pipes and Fishing operations

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF PETROLEUM ENGINEERING

(b) Well completion: Types of wells- Types of completion. Perforation methods.
Packers: Function – Application.

UNIT IV

Completion equipment (SSD, SSSV, mandrels, locks etc.) –Subsea well completions, Permanent gauges - Memory gauges - Intelligent completion equipment. Tubing string design

UNIT-V

Drill Stem Testing: General Procedure and considerations - Test tool components and arrangement - Analysis of Test data. HPHT and horizontal well completions, work over operations, CTU & Slick line operations.

Outcomes:

At the end of this course the student should be able to understand:

- The different details mentioned in the GTO
- drilling and design of the drill string, drilling hydraulics.
- Casings, cement slurry design, directional drilling and various techniques, fishing, stuck pipe and well control concepts.
- Different types of wells, well testing, surface and subsurface equipment.
- Planning and designing of well completion, different perforation techniques.
- Subsurface circulating equipment and different types of packers
- Testing of multi zones, DST/RFT with logging tools as well as surface testing equipment.

Text Books:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.
3 Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
4 Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.

Reference Books:

1. Drilling Engineering, J.J. Azar and G. Robello Samuel, Pennwell Books, 2007.
2. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
3. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.

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

DEPARTMENT OF PETROLEUM ENGINEERING

4. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.
5. Formulas and Calculation for Drilling, Production and Workover, Norton J. Lapeyrouse, 2nd Edition, Gulf Publishing, 2002.
6. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, 1991.
7. Well Engineering and Construction, Hussain Rabia, Entrac Consulting, 2002.
8. Fundamentals of Drilling Engineering, Robert F. Mitchell, Stefan Z. Miska, Society of Petroleum Engineers, 2011.
9 Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
10. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
11. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.
12 Well Testing, John Lee, Society of Petroleum Engineers, 1982.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3

BASIC CONCEPTS OF PETROLEUM PRODUCTION ENGINEERING

(offeredfor other Branches (except Petroleum Engineering))

Learning Objectives:

The students will be made to learn:

- Fundamental concepts in petroleum production engineering.
- Reservoir fluids, efficient flow to the surface without damaging the reservoir dynamics/drive mechanisms.
- Various surface equipment's for process oil and gas after flow from wells.
- Sick well identification and remedial stimulation operations.

UNIT-I

Petroleum production system over all view, Production from various types of reservoir based on drive mechanisms, field development method, Safety control system.

Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-II

Reservoir deliverability: Flow regimes - transient, steady state, pseudo steady state IPR for various types of wells.

Well bore performance – single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells.

Choke performance-basic concepts.

UNIT-III

Separation systems: Working and operating principles of vertical and horizontal separators

transportation systems: Working and operating principles of pumps, compressors, pipelines-series, parallel and loop.

UNIT-IV

Basic concepts on artificial lift methods: Sucker rod pumping system, electrical submersible pumps, hydraulic piston pumping, progressive cavity pumping, plunger lift, hydraulic jet pumping, and Gas lift system.

UNIT-V

Production Stimulation: Well problem identification, Matrix acidizing, Fundamentals of Hydraulic fracturing.

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

DEPARTMENT OF PETROLEUM ENGINEERING

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

- Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.
- Identify formation damage and find remedial methods to bring the well back into production.
- Screen, design and operate artificial lifts on reservoir pressure depletions.
- Handle in case of any crisis at drilling/production installations.
- Process oil and gas before supply to refinery/consumers.

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice Hall, 1994.

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3

BASIC CONCEPTS IN PETROLEUM RESERVOIR ENGINEERING

(offeredfor other Branches (except Petroleum Engineering))

Learning Objectives:

- To impart knowledge in the basic concepts like PVT analysis for oil, Material balance applied to oil reservoir, Darcy's law and applications, well inflow estimation for stabilized flow conditions.
- To make them suitable as reservoir engineers for petroleum industry.

UNIT-I

Some basic concepts in reservoir engineering: Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor-Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor- Hydrocarbon phase behaviour, Basic concepts in PVT analysis.

UNIT-II

Material balance applied to oil reservoirs: General form -The material balance expressed as a linear equation- Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water drive- compaction drive under related pore compressibility phenomena.

UNIT-III

Darcy's law and applications: Darcy's law and field potential- Sign convention- Units and unit's conversion- Real gas potential – Datum pressures- Radial steady state flow and well stimulation- Two phase flow- Effective and relative permeabilities

UNIT-IV

The basic differential equation for radial flow in a porous medium- Derivation of the basic radial differential equation – Conditions of solution – The linearization of the equation for fluids of slightly and constant compressibility.

UNIT-V

Well inflow estimation for stabilized flow conditions: Semi steady state solution – Steady state solution – Example of the application of the stabilized inflow equations – Generalized form of inflow equation under semi steady state conditions.

Outcomes:

The students will be able to:

- Understand the basic concepts in petroleum reservoir engineering.
- Acquire the knowledge on drive mechanisms and how to apply the material balance to oil reservoirs.
- Applying of Darcy's law in field potential.
- Estimate the reserves of various sands of the reservoir from well data.
- Learn the differential equation for radial flow in a porous medium.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

- Calculate the formation damage and can recommend suitable stimulation operations to reverse the wells.
- Learn the well inflow estimation for stabilized flow conditions.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17thImpression 1998).
2. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

Reference Books:

1. Reservoir Engineering Handbook, Tarek Ahmed, 3rdEdition, Gulf Professional Publishing, 2006.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham &Trotman Inc. 1986.
3. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.
4. Petroleum Reservoir Engineering, James W Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5
PETROLEUM ANALYSIS LABORATORY					

Learning Objectives:

- The objective of the petroleum analysis lab is to determine the physical and transport properties like Reid vapor pressure, Viscosity, Smoke point, Flash point & Fire point, Aniline point, Cloud & Pour point, Softening point, Calorific value, Water content of different petroleum products by conducting laboratory experiments using different apparatus and to determine the distillation characteristics of petroleum products.

List of Experiments:

1. Determination of Distillation characteristics of Crude Oil, Gasoline, Diesel and Kerosene.
2. Determination of Reid Vapor Pressure of Crude oil & Gasoline.
3. Determination of Viscosity of Diesel and Transformer oils.
4. Determination of Smoke Point of Kerosene.
5. Determination of Carbon Residue of petroleum oils.
6. Determination of Flash & Fire points of gasoline, kerosene and other products.
7. Estimation of Water content in petroleum products.
8. Estimation of Calorific value of solid, liquid and gaseous fuels.
9. Determination of Aniline point of Gasoline and Diesel oil.
10. Determination of Softening point of bitumen.
11. Determination of Cloud & Pour Points of petroleum products.
12. Detection of Corrosiveness of petroleum products

Outcomes:

- The students will be able to handle various apparatus/equipment in determining the physical and transport properties of different petroleum products and also will be able to analyze the various products of petroleum components.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5
PETROLEUM RESERVOIR ENGINEERNG LABORATORY					

Learning Objectives:

- The students are made to understand experimental determinations of reservoir (Oil as well as gas) properties such as Porosity, Absolute & Relative permeability, Capillary pressure, Fluid properties like Density, Viscosity and Surface tension etc.

List of Experiments:

1. Determination of effective porosity by gas expansion method.
   Equipment: Helium Porosimeter (Nitrogen gas can be used in place of helium).
2. Determination of porosity and pore size distribution by mercury injection.
   Equipment: Mercury Porosimeter.
3. Measurement of surface tension & interfacial tension with the ring Tensiometer.
   Equipment: Tensiometer.
4. Determination of fluid density using Pycnometer and hydrometer methods.
   Equipment: Pycnometer and hydrometer.
5. Liquid viscosity measurement using capillary tube viscometer (Ostwald type).
   Equipment: Capillary tube viscometer.
6. Determination of capillary pressure of reservoir rock (core) using porous plate method.
   Equipment: Capillary pressure cell.
7. Measurement of contact angle (between oil, water and solid surface) using imaging method.
   Equipment: The image system set-up.
8. Measurement of air permeability.
   Equipment: Constant head Permeameter with the Hassler cell.
9. Absolute permeability measurement of water.
   Equipment: The Darcy apparatus.
10. Determination of relative permeability of oil-water using unsteady state method.
    Equipment: Relative permeability apparatus.
11. Determination of relative permeability of gas-oil using unsteady state method.
    Equipment: Relative permeability apparatus.

Outcomes:

- The students will become conversant in experimental procedures to acquire process, analyze and interpret the reservoir and reservoir fluid data.
- This laboratory work makes the students to become good reservoir engineers.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	2	1
DRILLING SIMULATION LABORATORY					

Learning Objectives:

- Drilling simulation lab familiarizes student not only the normal drilling operations but also abnormal conditions in drilling.
- The student can get acquaintance with the drilling operations preventing abnormal conditions like Wall kicks, Blowouts, Mud losses etc.
- The student can have the knowledge how to handle the BOP, Panels, Choke manifold, Remote panel etc., in case of any emergency situation.
- Drilling simulation lab covers all abnormal drilling operations that help the student to have total knowledge of the drilling in live conditions.

The following experiments are to be carried out using a drilling simulator:

1. **Familiarization and line-up of operational components – I**: Sand pipe manifold, draw work console, drilling console.
2. **Familiarization and line-up of operational components – II:** Blow out preventer (BOP) panel, remote panel.
3. **Familiarization and line-up of operational components – III:** Choke manifold.
4. **Operation of major components – I:** Mud pumps, operating slow circulation rate, operating the rotary table,
5. **Operation of major components – II:** Pulling weight on bit running in and pulling out of hole, remote choke panel operating.
6. **Kick identifications:** Setting flow alarms (deviation mud volume), setting flow alarms for return mud volume, identifying kick warning signs.
7. **Well shut in procedures:**Utilizing shut in procedures to kill well, well control computations.
8. Studies on the effect of weight on drill bit and rotary speed on the rate of penetration and wear of the bit.
9. Studies on the effect of mud density on the penetration and wear of the bit.
10. Studies on the effect of flow rate on the penetration and wear of the bit.

Outcomes:

The student will be able to:

- Familiarizewith abnormal drilling operations and handle any drilling situation without any panic.
- Be conversant with the BOP, control panel, remote control panel etc.
- To identify the abnormal activities much in advance and plan to prevent the Kick, Blowout etc.
- Become a very good drilling engineer by improving the rate of drilling even in critical conditions.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
SUMMER INTERNSHIP					

Students shall undergo summer training (summer internship program) in a petroleum oil & gas producing industry/ petroleum machinery manufacturing industry for 4-6 weeks and submit a report.

Learning Objectives:

The student is guided (through the Industry representative) to learn the following aspects:

- Application of the engineering skills, learned in class room, in real world.
- Working as a team to deliver the results along with senior engineering professionals, technicians, managers etc.
- Work safely in industrial environment.
- Result oriented approach in plant operation, troubleshooting and engineering work.
- Present and / or report the work / project outcomes to various disciplines, departments & interest groups with confidence.

Outcomes:

The student shall be able to independently carryout the following tasks:

- Work safely in Industrial environment.
- Work with various interest groups, disciplines, professionals, managers, technicians etc.
- Polish the engineering skills by applying the knowledge in day-to-day operation, trouble-shooting and minor-modifications.
- Building relations with University and Industry that will help mutual cooperation over long-term.

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

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
MINI PROJECT					

Learning Objectives:

- To develop innovative and original ideas
- To promote team work

Based on the studies carried out during the mini project (phase 1) the same team carryout the mini project (**Phase 2**)which involves process and mechanical design calculations of an equipment / process/system and constructing a working model based on the above calculations. The report to be submitted in a standard format along with the model. The model and report will be assessed by the concerned instructor / faculty for the completion of the mini project.

Outcomes:

After successful completion of the mini project, students will be able to:

- Practice acquired knowledge within the chosen area of technology for project development.
- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Work as an individual or in a team in development of technical projects.
- Communicate and report effectively project related activities and findings.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	0
DATA SCIENCES					

Course Objectives:

From the course the student will learn

- Provide you with the knowledge and expertise to become a proficient datascientist
- Demonstrate an understanding of statistics and machine learning concepts that are vital for datascience
- Learn to statistically analyze adataset
- Explain the significance of exploratory data analysis (EDA) in data science
- Critically evaluate data visualizations based on their design and use for communicating stories fromdata

Course Outcomes:

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

- Describe what Data Science is and the skill sets needed to be a data scientist
- Illustrate in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modelling, Fit a model to data

- Use R to carry out basic statistical modeling and analysis
- Apply basic tools (plots, graphs, summary statistics) to carry out EDA
- Describe the Data Science Process and how its components interact
- Use APIs and other tools to scrap the Web and collect data
- Apply EDA and the Data Science process in a case study

UNIT I

Introduction, The Ascendance of Data, Motivating Hypothetical: Data Sciencester, Finding Key Connectors, The Zen of Python, Getting Python, Virtual Environments, Whitespace Formatting, Modules, Functions, Strings, Exceptions, Lists, Tuples, Dictionaries defaultdict, Counters, Sets, Control Flow, Truthiness, Sorting, List Comprehensions, Automated Testing and assert, Object-Oriented Programming, Iterables and Generators, Randomness, Regular Expressions, Functional Programming, zip and Argument Unpacking, args and kwargs, Type Annotations, How to Write Type Annotations.

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF PETROLEUM ENGINEERING

UNIT II

Visualizing Data: matplotlib, Bar Charts, Line Charts, Scatterplots. Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Some Other Correlational Caveats, Correlation and Causation.

Gradient Descent: The Idea Behind Gradient Descent, Estimating the Gradient, Using the Gradient, Choosing the Right Step Size, Using Gradient Descent to Fit Models, Minibatch and Stochastic Gradient Descent.

UNIT III

Getting Data: stdin and stdout, Reading Files, Scraping the Web, Using APIs,

Working with Data: Exploring Your DataUsingNamedTuples, Dataclasses, Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction.

Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem

UNIT IV

Machine Learning: Modeling, Overfitting and Underfitting, Correctness, The Bias-Variance Tradeoff, Feature Extraction and Selection, k-Nearest Neighbors, Naive Bayes, Simple Linear Regression, Multiple Regression, Digression, Logistic Regression

UNIT V

Clustering: The Idea, The Model, Choosing k, Bottom-Up Hierarchical Clustering.

Recommender Systems: Manual Curation, Recommending What's Popular, User-Based Collaborative Filtering, Item-Based Collaborative Filtering, Matrix Factorization

Data Ethics, Building Bad Data Products, Trading Off Accuracy and Fairness, Collaboration, Interpretability, Recommendations, Biased Data, Data Protection

IPython, Mathematics, NumPy, pandas, scikit-learn, Visualization, R

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DEPARTMENT OF PETROLEUM ENGINEERING

Textbooks:

1) Joel Grus, "Data Science From Scratch", OReilly.
2) Allen B.Downey, "Think Stats", OReilly.

Reference Books:

1) Doing Data Science: Straight Talk From The Frontline, 1st Edition, Cathy O'Neil and Rachel Schutt, O'Reilly, 2013
2) Mining of Massive Datasets, 2nd Edition, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, v2.1, Cambridge University Press, 2014
3) "The Art of Data Science", 1st Edition, Roger D. Peng and Elizabeth matsui, Lean Publications, 2015
4) "Algorithms for Data Science",1st Edition, **Steele**, Brian, **Chandler**, John, **Reddy**, Swarna, springers Publications, 2016

e-Resources:

1) https://github.com/joelgrus/data-science-from-scratch
2) https://github.com/donnemartin/data-science-ipython-notebooks
3) https://github.com/academic/awesome-datascience