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 II SEMESTER

S. No.	Course Code	Course Title	L*	T	P	Credits
1	PEC	**PROFESSIONAL ELECTIVE –VI** i. Production Optimization using Nodal Analysis ii. Deepwater Technology iii. Any other course subjective availability from NPTEL database (12 Weeks) other than regular offered courses	3	0	0	3
2	PEC	**PROFESSIONAL ELECTIVE –VII** i. Asset Management ii. Petroleum Economics, Policies and Regulations iii. Any other course subjective availability from NPTEL database (12 Weeks) other than regular offered courses	3	0	0	3
3	OEC	**OPEN ELECTIVE – III** (To be selected from open elective subjects offered by other branches)	3	0	0	3
4	PR	Project (Industrial/In-house) (**Phase 2**)	3	0	0	8
5	*MC	Physical Fitness Activities	0	0	2	0
					Total Credits	**17**

TOTAL CREDITS= 40 + 42 + 40 + 38 = 160

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

i. Shale Gas Technology
ii. Basic concepts of Enhanced Oil Recovery Techniques

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		3	0	0	3
PRODUCTION OPTIMIZATION USING NODAL ANALYSIS					

Learning Objectives:

- To analyze oil and gas well problems using nodal systems analysis for both flowing and artificial lift wells.
- To understand the various pressure losses including the flow in pipes and restrictions associated with the oil and gas well plants and to assess their performance.
- To improve the performance of the oil and gas wells by calculating the pressure drop that will occur in all the systems using the nodal analysis approach.
- To understand and assess the performance of an artificial lift system used to efficient produce oil and gas.

UNIT-I:

Production systems analysis: Introduction, Pressure losses in complete system, Node locations, Systems analysis approach, Determination of flow capacity, Effect of flow-line size and tubing size, Well restricted by inflow and piping system, Finding optimum tubing size, Effect of gas rate on outflow and effect of perforating density on inflow.

UNIT-II:

Reservoir performance: Introduction; Well performance equations (Factors affecting productivity index and inflow performance, Drawdown, Effect of depletion and IPR behavior of gas wells); Predicting present time IPRs for oil wells (Vogel method, Fetkovich method, Jones, Blount and Glaze method, Constructing IPRs when no stabilized tests are available, IPR construction for special cases); Predicting future IPRs for oil wells (Standing method, Fetkovich method and Combining Vogel and Fetkovich); Predicting present time IPRs for gas wells (Use of back pressure equation, Jones-Blount-Glaze method, and Predicting future IPRs for gas wells); Well completion effects (Open hole completions, perforated completions and Gravel-packed completions).

UNIT-III

Flow in pipes and restrictions: Introduction, Basic equations and concepts (Single-phase, two-phase flow variables, modification of the pressure gradient equation for two-phase flow); Fluid property calculations (density, velocity, viscosity, isothermal compressibility, interfacial tension, formation volume factor; predicting flowing temperatures in wells and pipelines); Well-flow correlations (Poettmann and carpenter method, Hagedorn and brown method, Duns and Ros method, Orkiszewski method, Flow in annuli, Flow in directional wells, Pipeline flow correlations); Pressure drop through restrictions (Surface chokes, subsurface safety valves, and pipe fittings).

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UNIT-IV

Total system analysis: Introduction, Tubing size selection, Flow-line size effect, Effect of stimulation, Systems analysis for wells with restrictions (surface chokes and subsurface safety valves), Evaluating completion effects, Nodal analysis of injection wells, Effect of depletion, Relating performance to time, Analyzing multi-well systems.

UNIT-V:

Artificial lift design: Introduction; Continuous flow gas lift, Well performance, Valve spacing, Gas lift valve performance and Otis design procedure; Submersible pump selection, Sucker rod or beam pumping; Hydraulic pumping.

Outcomes:

The course will aid the students in get into the following field applications with ease.

- Selecting tubing size.
- Selecting flow-line size.
- Gravel pack design.
- Surface choke sizing.
- Subsurface safety valve sizing.
- Analyzing an existing system for abnormal flow restrictions.
- Artificial lift design.
- Well stimulation evaluation.
- Determining the effect of compression on gas well performance.
- Analyzing effects of perforating density.
- Predicting the effect of depletion on producing capacity.
- Allocating injection gas among gas life wells.
- Analyzing a multiwall producing system.
- Relating field performance to time.

Text Books:

1. Dale Beggs H. (2003). Production Optimization Using Nodal Analysis. OGCI and Petroskills Publications (ISBN: 0-930972-14-7), Tulsa, Oklahoma.
2. BoyunGuo. (2007). Petroleum Production Engineering, A Computer-Assisted Approach (Gulf Professional Publishing, ebook ISBN: 9780080479958), 312 pages. DOI: https://doi.org/10.1016/B978-0-7506-8270-1.X5000-2

Reference Books:

1. Gilbert W E. (1954). Flowing and Gas-Lift Well Performance. API Drill. Prod. Practice.
2. Nind T E W. (1964). Principles of Oil Well Production. McGraw-Hill.
3. Brown K E., and H D Beggs. (1978). The Technology of Artificial Lift Methods, vol 1, Penn Well Publ. Co., Tulsa, Oklahoma.

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		3	0	0	3
DEEP WATER TECHNOLOGY					

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

Introduction: Definition, Global deep water reserves & development activity. Technological advances.

Dynamics of Offshore Structure: Analysis of Waves and fluid induced forces on offshore structures, Current and wind forces, soil mechanics of seabed & structures.

UNIT – II

Deep water Exploration & Drilling: Seismic/Seabed Survey, constraints in deep water survey like geo-hazards, gas hydrate etc., deep water Drilling with emphasis on the additional inputs to normal offshore Drilling operation.

Deep water Production System: Fixed Structures, Compliant Towers, Subsea systems, Floating Production Systems like FPSOs, FPSSs, TLPs, Spar Platform and FSOs.

UNIT – III

Deep water applications of Subsea Technology: Subsea completion, X-mas tree, control systems, Manifolds, Templates, ROVs, deep-water installation vessels with DP system.

UNIT – IV

Deep water Pipelines & umbilical: Issues in deep water Pipeline Design, Rigid and Flexible flow lines, Pipe-in-pipe, deep-water Risers and their configurations, Pipeline installation methods, Umbilical – functions, configurations and installation, Flow assurance strategies.

UNIT – V

Emerging deep water Technologies: Autonomous Underwater Vehicles (AUVs) Seismic-while-drilling, Dual-activity-drilling, Innovative Floating Production Concepts, Subsea processing, subsea separation (VASPS, SUBSIS, Twister),Deep water complications.

Out comes:

The Students will be able to:

- Understand induced forces on/Off-shore Structures and soil mechanics of Sea bed.
- Deliver the equipment and design required for deep water drilling and production operations.
- Applications of deep water production technology.
- Understand and utilize the deep water control and flow system.
- Apply subsea processing and separation concepts.

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Text Books:

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

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		3	0	0	3
ASSET MANAGEMENT					

Learning Objectives:

- The students will learn the general principles of asset management, integrated petroleum, reservoir management and integrated oil & gas asset management.
- Introduces the student to the processes and modeling paradigms needed to develop the skills to increase reservoir output, profitability and decrease speculation.
- Develop references to recognize the technical diversity of modern reservoir management teams.
- Develop an overview of reservoir management, fluids, geological principles used to characterization and two key reservoir parameters.
- Expose to modeling tools and additional exercises are included on a companion website.
- Seamlessly brings together concepts and terminology, creating an interdisciplinary approach for solving everyday problems.

UNIT-I

Asset Management: The corporate dimension – Data gathering – Interpreting the main data.

UNIT-II

Developing a decision making frame work: Populating asset management plans – Creating a strategic outline and business case for investment – The corporate asset management plan; Developing an integrated asset management and capital planning system: Overview.

UNIT-III

Reservoir management concepts – Reservoir management process – Data acquisition, analysis and management.

Reservoir performance analysis and forecast – Reservoir management economics – Reservoir management case studies.

UNIT-IV

Industrial asset management strategies for the oil and gas sector: Over view of Onshore and Offshore assets – Integration and optimization methodology – A case study in OPEX of the assets – Evaluation of asset performance.

UNIT-V

An asset management model – Typical oil field workflow – Workflows for asset management – An automated approach to data quality management – Change management – Risk based asset management model.

Outcomes:

The students will be able to:

- Understand the working principles of an oil and gas asset management.
- Optimize the functions of each segment of an asset.
- Understand the concepts & terminology and develop an interdisciplinary approach for solving everyday problems.

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Text Books:

1. A guide to Asset Management and Capital Planning in Local authorities, CIPFA, 2008.
2. The Big Picture: Integrated Asset Management Cedric Bouleau et al, Oil field Review, 2007/2008.
3. Integrated Petroleum Reservoir Management, A team approach, AbdusSatter and Ganesh C. Thakur, Pennwell Books, Tulsa, 1994.
4. Integrated Reservoir Asset Management: Principles and Best Practices: Fanchi John R Fanchi, Ph.D, Publisher: Elsevier Science¸ Imprint-Gulf Professional Publishing, 2010. (SBN-10 -012382088X;

Reference Book:

1. Handling Risk and Uncertainty in Petroleum Exploration and Asset Management, American Association of Petroleum Geologists, 2015.

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		3	0	0	3
PETROLEUM ECONOMICS, POLICIES AND REGULATIONS					

Leaning Objectives:

- Understand the importance of petroleum sector in the world economy, both the macro and micro-economic environment and as applicable to India.
- Understand the commercial aspect and capital budgeting and capital efficiency related to the oil and gas industry value chain from exploration to consumers.
- Carry out a project risk evaluation, breakeven and sensitivity analysis and develop a model to know which petroleum projects is viable and relative priority.
- Understand geopolitical risks and opportunities and hedging strategies to mitigate market and price risks.
- Understand the regulations regarding refining, processing, storage, transportation distribution, marketing& sale of petroleum products.
- To have an overview of the regulatory frame related to exploration as per NELP.

UNIT-I

Macro-Economic Approach of Petroleum Industry: Political environment related to petroleum industry and issues related to government and corporate interests, Need for understanding petroleum economics required to make investment decisions; Introduction, Role and value of Oil & Gas, Evolution of national oil companies, Organization of petroleum exporting countries.

UNIT-II

Principles, Methods and Techniques of Petroleum Engineering Economics: Introduction, outline and key terminologies and generic issues of micro-economic analysis applicable to all sectors of the oil and gas supply chain, Capital budgeting and capital efficiency, Sources of revenue and cost and profitability analysis, Operating expenditures (OPEX) and their fixed, variable and marginal components, Economic indicators and yardsticks used to rank asset values (NPV, IRR, etc.)

Managing and Mitigating Uncertainty and Risk: Risk, uncertainty and decision analysis, Analysis of alternative selections and replacements**,** Managing and Mitigating uncertainty and Risk -Breakeven and sensitivity analysis, Optimization Techniques, Geopolitical risks and opportunities and hedging strategies to mitigate market and price risks, Asset valuation process: fair market value, probability and risk.

UNIT-III

Application and Project Evaluation: Project lifecycles, optimum economic life and multi-year cash flows, Oil fields exploration and drilling operations, estimation of oil reserves and evaluation of an oil property, Project financial analysis, Project development - utilization oil fields - production operations - Oil transportation - Crude oil processing.

UNIT-IV

Valuing Petroleum Assets, Portfolios and Companies: Asset valuation process: fair market value, probability and risk, Risk adjustments when valuing petroleum reserve categories, Theportfolio approach to asset and corporate management, Portfolio characterization, balance and diversification.

Demand and Marketing of Petroleum Products: Crude oil fundamentals, Price of crude, Crude oil prices in transactions, Internal Markets and Prices, Marketing and sale of Motor, Aviation, Lubricant,

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Asphalt and Propane Transportation: Fundamentals of transportation, Pipelines, Oil tankers, Downstream transportations, Distribution of petroleum products.

UNIT-V

Oil & Gas Policies and Regulations: Petroleum, Oil & Gas rules and regulations in India, The Oil fields regulations and development Act, New Exploration Licensing Policy (NELP), Functions of directorate general of hydrocarbons, Petroleum and Natural Gas Regulatory Board.

Outcomes:

On completion of the course the students should be able to**:**

- Explain the inter-relations between Oil industry petroleum sector and its impact on national and global economy.
- Evaluate a strategic policy framework of a firm and comment on its relative position within the industry.
- Develop the capability to analyze the global oil and gas industry, focusing on its strategic, economic and fiscal position.
- Demonstrate decision making skills in analyzing basic financial results related to petroleum industry.
- Capable of analyzing the petroleum industry involving pricing, risk profiling, optimization and profitability choosing appropriate techniques.
- Develop generic marketing plans for petroleum products downstream.
- Understand and apply the regulatory framework and related to petroleum industry in the area of licensing and exploration.

Text Books:

1. Petroleum Economics and Engineering, Third Edition, Hussein K. Abdel-Aal, Mohammed A. Alsahlawi, CRC Press, 2013. (ISBN: ISBN; 1466506660, 9781466506664)
2. The Global Oil & Gas Industry: Management, Strategy and Finance, Andrew Inkpen& Michael H. Moffett, 2011. (ISBN-10: 1593702396, ISBN-13: 978-1593702397)

Reference books:

1. Petroleum Economics, Jean Masseron, Technip; 4threvised Edition, 2000. (ISBN-10: 2710805979; ISBN-13: 978-2710805977)
   (The instructor can download information required from internet to teach the topics in UNIT VI).

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		3	0	0	3

SHALE GAS TECHNOLOGY
(offeredfor other Branches (except Petroleum Engineering))

Leaning Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Performance analysis of unconventional shale reservoirs: Shale reservoir production – Flow rate decline analysis – Flow rate and pressure transient analysis – Reservoir modeling and simulation – Specialty short term tests – Enhanced oil recovery.
Resource estimation for shale gas reservoirs – Introduction – Methodology – Reservoir evaluation of shale gas plays.

UNIT-V

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

Outcomes:

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

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Text Book:

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

Reference Book:

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

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		3	0	0	3

BASIC CONCEPTS OF ENHANCED OIL RECOVERY (EOR) TECHNIQUES
(offeredfor other Branches (except Petroleum Engineering))

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.
3. 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.
9. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
10. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
11. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, PennWell, 1980.
12. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.
13. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001.
14. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
15. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.

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		3	0	0	8
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.

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

d) 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.
e) Modeling & Simulation of any petroleum upstream unit concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery.
f) Any experimental work with physical interpretations.

Each student will continue the project of phase 1 under the guidance of an instructor / faculty.
Project (**Phase 2**)should consists of the following items:

1. Experimental design/procedure/methodology
2. Conceptual/Mathematical/Numerical model
3. Results and Discussion
4. Future scope for development/improvement
5. References

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 external examiner for the completion of project (phase 2).
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).
- Sizing of all plant equipment and preliminary cost estimation using cost indexes, charts& literature.
- Preliminary cost estimation of piping, instrumentation, electrical equipment, civil works & construction as % of equipment cost, to determine Installation cost of the equipment/ plant.
- Preliminary utility & chemical consumption estimation and using this data estimating the operating cost.
- 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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Physical Fitness Activities					