



**CURRICULUM FOR
BACHELOR OF STUDIES (BS)
IN PETROLEUM TECHNOLOGY
2024**

Department of Petroleum Technology
University of Karachi

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ABOUT THE PROGRAM

VISION

To educate and equip the students with tools for exploration and production of hydrocarbon resources in the most viable and economical manner by using fundamental principles as well as state-of-the-art technology.

MISSION

The mission is to produce qualified and well-versed petroleum technologists equipped with fundamental sciences, able to find viable solutions, and skills to enter executive technical positions in industry, R&D institutes, public sector organizations and academia.

SCOPE

A key source of energy is oil and natural gas. Efficient recovery of these resources requires Petroleum technologists with a sound knowledge of fundamentals and latest technological developments relevant to this field. The mission of the petroleum education is to produce graduates who can not only satisfy the current needs of the country's petroleum industry, but are also able to develop technologies indigenously. Preparing effective and efficient professionals through research and to develop the methods to utilize all the available natural resources in order to fulfill the energy needs of Pakistan in coming years. This will contribute in socio-economic development of Pakistan and the region.

OBJECTIVE

The program emphasizes on building strong base in petroleum discipline and detailed understanding of core areas with practical knowledge that comprehends with use of professional software and Laboratory practices. The program is competent to enhance capabilities for higher education and to fulfill the requirements of the petroleum industry. The main objectives are to develop: i) Understanding and comprehension of regional energy resources and the future trends for the welfare of the society. ii) Critical thinking in the graduates so that they can identify and solve new problems. iii) Effective communication skills and ability to work independently as well in team. iv) Professionalism, ethical values and determination among graduates to continue life-long learning.

**DEPARTMENT OF PETROLEUM TECHNOLOGY
UNIVERSITY OF KARACHI
SCHEME OF STUDIES**

SEMESTER I

Sr no.	Course Code	Subject	Cr. Hrs.	Type	Status
1	300.1 (U)	Urdu	2+0	Compulsory Gen. Education	
2	300.1 (I.S)	Islamic Studies OR Ethics (Non-Muslim)	2+0	Compulsory Gen. Education	
3	300.1 (CCE)	Civics and Community Engagement	2+0	Compulsory Gen. Education	
4	300.1 (N. Sc)	Natural Sciences	3+0	Compulsory Gen. Education	
5	301	Interdisciplinary-I	2+1	Interdisciplinary	Already approved
6	301	Interdisciplinary-II	2+1	Interdisciplinary	Already approved
7	PET 311	Elements of petroleum engineering	3+0	Major-I	Already approved

18 Cr.Hrs

SEMESTER II

Sr no.	Course Code	Subject	Cr. Hrs	Type	Status
1	300.2 (PS)	Pakistan Studies	2+0	Compulsory Gen. Education	
2	300.2 (ICP)	Ideology & Constitution of Pakistan	2+0	Compulsory Gen. Education	
3	300.2 (F. Eng)	Functional English	3+0	Compulsory Gen. Education	
4	300.2 (Entr)	Entrepreneurship	2+0	Compulsory Gen. Education	
5	300.2 (Soc. Sc)	Introduction to Social Science	2+0	Compulsory Gen. Education	
6	302	Interdisciplinary-I	3+0	Interdisciplinary	Already approved
7	302	Interdisciplinary-II	3+0	Interdisciplinary	Already approved
8	PET 312	Drilling Engineering- I	2+1	Major- 2	Already approved

18 Cr.Hrs

SEMESTER III

Sr no.	Course Code	Subject	Cr. Hrs	Type	Status
1	400.1 (Q.R))	Quantitative Reasoning	3+0	Compulsory Gen. Education	
2	400.1 (E.W)	Expository writing	3+0	Compulsory Gen. Education	
3	401	Interdisciplinary-I	3+0	Int Disc	Already approved
4	401	Interdisciplinary-II	3+0	Int Disc	Already approved
5	PET 411	Drilling Engineering- II	2+1	Major-3	Already approved
6	PET 413	Mud Engineering	2+1	Major-4	Already approved

18 C.Hrs

SEMESTER IV

Sr no.	Course Code	Subject	Cr. Hrs	Type	

1	400.2 (QR)	Quantitative Reasoning	3+0	Compulsory Gen. Education	
2	400.2 (ICT)	Application of Inf. & Comm. Technologies	3+0	Compulsory Gen. Education	
3	402	Interdisciplinary-I	2+1	Interdisciplinary	Already approved
4	402	Interdisciplinary-II	2+1	Interdisciplinary	Already approved
5	PET 412	Well Logging and Formation Evaluation	2+1	Major-5	Already approved
6	PET 414	Fluid Mechanics	2+1	Major-6	Already approved

18 Cr.hrs

SEMESTER V

Sr no.	Course Code	Subject	Cr. Hrs	Type	Status
1	PET 541	Well Completion and Workover	2+1	Major-7	Already approved
2	PET 543	Gas Engineering	3+0	Major-8	Already approved
3	PET 545	Reservoir Engineering- I	2+1	Major-9	Already approved
4	PET 547	Refining Technology- I	2+1	Major-10	Already approved
5	PET 549	Environment & Safety Management	3+0	Major-11	Already approved
6	500.1	Field Experience/Internship	0+3	Compulsory	

18 Cr.hrs

SEMESTER VI

Sr no.	Course Code	Subject	Cr. Hrs	Type	Status
1	PET 542	Production Engineering – I	2+1	Major-12	Already approved
2	PET 544	Well Testing	2+1	Major-13	Already approved
3	PET 546	Refining Technology- II	2+1	Major-14	Already approved
4	PET 548	Petroleum Management and Legislation	3+0	Major-15	Already approved
5	PET 550	Reservoir Engineering - II	2+1	Major-16	Already approved
6	500.2	Capstone Project	0+3	Compulsory	

18 Cr.hrs

SEMESTER VII

Sr No.	Course Code	Subject	Cr. Hrs	Type	Status
1	PET 651	Instrumentation and Control	2+1	Major-17	Already approved
2	PET 653	Corrosion Engineering	3+0	Major-18	Already approved
3	PET 655	Petroleum Economics and Statistics	2+1	Major-19	Already approved
4	PET 657	Production Engineering- II (pre-requisite PET-542)	2+1	Major-20	Already approved
5	PET 659	Reservoir Simulation	2+1	Major-21	Already approved
7	PET 650	Thesis (Optional)	0+3	Major (Opt)	Already approved

15 Cr hrs

SEMESTER VIII

Sr no.	Course Code	Subject	Cr. Hrs	Type	Status
1	PET 654	Enhanced Oil Recovery and Artificial Lift Method	3+0	Major-22	Already approved
2	PET 656	Petrochemical	2+1	Major-23	Already approved
3	PET 658	Geostatistics and Basic Modelling	2+1	Major-24	Already approved
4	PET 660	Unconventional HC Resources	2+1	Major-25	Already approved

5	PET 662	Advanced Drilling and Offshore Tech (pre-requisite PET-312,PET-411)	2+1	Major-26	Already approved
7	PET 645	Project (Optional)	0+3	Major (Opt)	Already approved
8	PET 650	Thesis (Optional)	0+3	Major (Opt)	Already approved

15 Cr. hrs

- Inter-disciplinary courses will be opted from allied departments
- Internship and Capstone project may be completed during the semester breaks.

Degree Title	B.S. Petroleum Technology
Total Credit Hours	138 Credit Hours
Degree Qualifying CGPA	2.2 / 4.0
Pass percentage	50%
Duration	4 years
Semester	8

Gen Education courses	30 Cr. Hrs
Major courses	78 Cr. Hrs
Inter Disciplinary Courses	24 Cr. Hrs
Field Experience	3 Cr. Hrs
Capstone Project	3 Cr. Hrs

**DEPARTMENT OF PETROLEUM TECHNOLOGY
UNIVERSITY OF KARACHI**

SCHEME OF STUDIES

SEMESTER-I

Year	Semester	Course No.	Course Title	Credit Hours
I	I	PET 311	ELEMENTS OF PETROLEUM ENGINEERING	3+0

Objective:

To familiarize the students with the basics of Petroleum Engineering and the portfolio of national and international petroleum industry.

Learning Outcomes:

After studying this course, the learners will be able to:

- *Describe the role of the petroleum engineer, and the skill set that is required to function in this role.*
- *Acquire knowledge about the oil field vocabulary, history and demonstrate familiarity with various field operations and techniques used in reservoir, drilling, and production engineering.*
- *Define the methods for the calculation and measurement of rock and fluid properties.*

Contents

Introduction to petroleum engineering: Definition, scope and responsibilities of petroleum engineer, Petroleum industry: Highlights of national and international petroleum industry national and international energy requirements, Sources of energy, Role of Petroleum as an energy source. Brief history of the international petroleum industry, Influence of petroleum on international politics. Overview of petroleum engineering including geological, geochemical and geophysical prospecting. Drilling mechanisms, formation evaluation, reservoir engineering, production engineering, processing, transportation, refining, and petrochemicals. Utilization of products, Highlights of local petroleum industry. Origin, discovery, development and prospects of hydrocarbons, Petroleum play, and Distribution of petroleum resources on local and international level. Introduction to Reservoir Engineering, Reservoir rock and flow properties, and Formation evaluation. Introduction to drilling engineering, Introduction to drilling operations: The onshore and offshore. Operations, The rig functions, well planning, bits, drilling fluid and casing accessories. Introduction to production engineering, processing, transportation and refining, well completion, Flow in pipes and surface production facilities, Production forecasting, reserve categories, Environmental concerns, Corrosion and its control.

Books Recommended

1. Pietrok, Daphine. Introduction to Petroleum Exploration and Engineering: Handbook of Offshore Oil and Gas Operations: Oil and Gas Industry Business Model. N.p., Independently Published, 2021.

2. Analytical Techniques in the Oil and Gas Industry for Environmental Monitoring. United Kingdom, Wiley, 2020.
3. Heinze, Lloyd, et al. "Petroleum Engineering Enrollment: Past, Present and Future." SPE Annual Technical Conference and Exhibition. SPE, 2019.
4. Sanni, Moshood. Petroleum engineering: principles, calculations, and workflows. Vol. 237. John Wiley & Sons, 2018.
5. Raszewski, Slawomir, ed. The international political economy of oil and gas. Springer, 2017.
6. Dalvi, Samir. Fundamentals of Oil & Gas Industry for Beginners. Notion Press, 2015
7. Lyons, William C., and Gary J. Plisga. Standard handbook of petroleum and natural gas engineering. Elsevier, 2011.
8. Jones, David SJ, and Peter P. Pujadó, eds. Handbook of petroleum processing. Springer Science & Business Media, 2006.

SEMESTER-II

YeCosgrove,	Semester	Course No.	Course Title	Credit Hours
I	II	PET 312	DRILLING ENGINEERING-I	2+1

Objective:

To learn the basics of drilling operations.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Fundamental concepts of drilling engineering. Functions of various components of drilling system.*
- *Identify, compute, analyze and solve drilling problems.*
- *Formulate the pressure requirement at every stage of the drilling operation from the pump to the bit and back to the surface based on rheological models and drilling hydraulics procedures and the API recommended practices.*

Contents

Introduction. Purpose of drilling, planning the well. Rotary drilling its introduction and basic operations. Basic rig components and brief introduction to their function mud pumps rating and capacities. Rotary drilling bits. Bits types, standard classification of bits. Bit selection and evaluation. Development in the drilling system. Air, natural gas, and aerated mud used as drilling fluids. Calculation of air and horsepower requirements. Pressure relations in the earth and borehole. The hydrostatic heads of liquids, the hydrostatic heads of mud and cement slurries. Total overburden pressure, formation pressures. Pressure relations in boreholes. Casing Design, standardization of casing, API casing performance properties, casing design criteria, special design consideration. Casing landing.

Labs:

- Calculate the volume of drilling fluid.
- Determine the characteristics of the given pin and bag for the given sizes of the drill collar's joint.
- Determine the number of drill collars and heavy-weight drill pipe.
- Determine the increase in viscosity of drilling fluid by adding a starch as a viscofier.
- Determine the sizing of hydro-cyclones on a drilling rig.
- Design the drill stem for the given data.
- Estimate the performance of hydro-cyclone.
- Determine the Free point.

Books Recommended

1. Tolouei-Rad, Majid, ed. Drilling Technology. BoD–Books on Demand, 2021.
2. Xue, Qilong. Data Analytics for Drilling Engineering. Springer International Publishing, 2020.
3. Talalay, Pavel G. Thermal ice drilling technology. Springer, 2019.
4. Sun, Baojiang. Multiphase Flow in Oil and Gas Well Drilling. John Wiley & Sons, 2016
5. Wang, Da, et al. The China continental scientific drilling project: CCSD-1 well drilling engineering and construction. Springer, 2015.
6. ASME Shale Shaker ASME Shale Shaker Committee. Drilling fluids processing handbook. Elsevier, 2011.
7. Bourgoyne, Adam T., et al. Applied drilling engineering. Vol. 2. Richardson: Society of Petroleum Engineers, 1986.

SEMESTER-III

Year	Semester	Course No.	Course Title	Credit Hours
II	III	PET 411	DRILLING ENGINEERING-II	2+1

Objective:

To study advanced drilling techniques and associated drilling operations.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Formulate well drilling plan taking into consideration the pore pressure and the fracture gradient of the formation.*
- *Define the process and importance of cementing and casing. Design operational procedures for cementing. Understand the significance and equipment of well control and establish a procedure for well control strategies.*
- *Built foundation in the principles and practices of directional drilling, calculations, and planning for directional and horizontal wells.*

Contents

Introduction. Factors affecting penetration rate. Directional drilling and deviation control Definitions and reasons for directional drilling. Planning the directional well trajectory, Planning the kick-off and trajectory change, Deflection tools, Deviation Control Brief introduction to horizontal drilling. General coring methods and equipment Routine core analysis. Practical use of core analysis data Formation damage causes and prevention of formation damage. Drill stem testing general procedure and general considerations. Test tool components and their arrangement. Analysis of test data. Oil well cementing. Techniques, Types of cement, cement additives. Factors considered for the selection of cement type. Cementing volumes. Squeeze cementing. Stage cementing. Drilling economics-equipment cost, slim hole drilling. Air gas drilling, methods of reducing drilling casts. Payment of drilling charges.

Labs:

- Case histories of different wells
- Field visits to the drilling sites

Books Recommended:

1. Tolouei-Rad, Majid, ed. Drilling Technology. BoD–Books on Demand, 2021.
2. Xue, Qilong. Data Analytics for Drilling Engineering. Springer International Publishing, 2020.
3. Talalay, Pavel G. Thermal ice drilling technology. Springer, 2019.
4. Sun, Baojiang. Multiphase Flow in Oil and Gas Well Drilling. John Wiley & Sons, 2016
5. Wang, Da, et al. The China continental scientific drilling project: CCSD-1 well drilling engineering and construction. Springer, 2015.
6. Fang, Huacan, and Menglan Duan. Offshore operation facilities: equipment and Procedures. Gulf professional publishing, 2014.

7. ASME Shale Shaker ASME Shale Shaker Committee. Drilling fluids processing handbook. Elsevier, 2011.
8. Bourgoyne, Adam T., et al. Applied drilling engineering. Vol. 2. Richardson: Society of Petroleum Engineers, 1986.

Year	Semester	Course No.	Course Title	Credit Hours
II	III	PET 413	MUD ENGINEERING	2+1

Objective:

To facilitate the drilling operations.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Aver mud preparation before drilling mud density selection of drilling fluids, their functions properties and types.*

Contents

Introduction. Rotary drilling rig components. Hoisting and rotating systems. The fluid circulating and power systems. Bottom hole assemblies, well control and blowout prevention equipment and methods. Drilling fluids, their function properties and types. The components and chemistry of drilling fluids. Basic drilling mud calculations. Selection of drilling fluids to avoid reservoir damage. Casing designs, their functions and selection. Types and methods in cementing operations. Function and properties of cement slurries. Recent advances in drilling techniques. Safety on drilling rigs.

Labs:

- Determination of the volume of mud tanks.
- Determination of the viscosity by Marsh Funnel.
- Determination of the selection of screen mesh for Shale shaker.
- Determination a drilling mud of 10 ppg and verify using Mud balance.
- Prepare a drilling mud of 10 ppg and increase its weight by adding starch.
- Calculate the volume of drilling fluid.
- Field visit.

Books Recommended

1. Bunni, Nael G., and Lydia B. Bunni. Risk and insurance in construction. Routledge, 2022
2. Khalifeh, Mahmoud, and Arild Saasen. Introduction to permanent plug and abandonment of wells. Springer Nature, 2020.
3. Goud, Milap. Mud engineering simplified. Become Shakespeare Com, 2017.
4. Skalle, Pål. Exercises within Drilling Fluid Engineering. Bookboon, 2012
5. ASME Shale Shaker ASME Shale Shaker Committee. Drilling fluids processing handbook. Elsevier, 2011.
6. Guo, Boyun, and Gefei Liu. Applied drilling circulation systems: hydraulics, calculations and models. Gulf Professional Publishing, 2011.

SEMESTER IV

Year	Semester	Course No.	Course Title	Credit Hours
II	IV	PET 412	WELL LOGGING AND FORMATION EVALUATION	2+1

Objective:

Study of log and their interpretation as diagnostic tool in formation evaluation.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define and describe the basic principles of wireline logging measurements and formation evaluation parameters. Perform Interpretation on well logs to determine the zone of interest(s) and to estimate the hydrocarbon volumes and other formation evaluation parameters in the zone of interest.*
- *Understand the principles and functions of logging tool and design a wireline logging job.*
- *Investigate the effects of logging environment on open and cased whole logs and perform required quantitative environmental corrections.*

Contents

Introduction Basic Concepts. Logging environment, porosity, permeability, fluid saturations, formation density, resistivity, invasion process and resistivity profiles. Electrical Logs. SP logs, conventional, normal, lateral and microdevices. Nuclear Logs. Gamma ray, neutron and formation density logs Sonic or acoustic log. Cross plots of various logs. Quantitative Analysis. Formation water resistivity and saturation determination. Lithology and porosity determination.

Labs:

- Determine the resistivity of oil bearing formation.
- Determine the saturation of hydrocarbon.
- Determine the porosity, permeability and saturation of the rock.
- Determine the natural radioactivity of formation.
- Determine the litho logy thinks of bed.
- Determine the gross thickness of bed.
- Interpretation of different commercial logs in different formation.

Books Recommended:

1. Dabbs, David J., ed. Diagnostic immunohistochemistry e-book: theranostic and genomic applications. Elsevier Health Sciences, 2021
2. Wang, Hua, M. Nafi Toksöz, and Michael C. Fehler. Borehole Acoustic Logging-Theory and Methods. Springer International Publishing, 2020.
3. Liu, Hongqi. Principles and applications of well logging. Berlin, Heidelberg: Springer Berlin Heidelberg, 2017.
4. Li, Tatsien, et al. Mathematical Model of Spontaneous Potential Well-Logging and Its Numerical Solutions. Germany, Springer Berlin Heidelberg, 2013
5. Schmidt, Kevin, Chris Phillips, and Anton Chuvakin. Logging and log management: the authoritative guide to understanding the concepts surrounding logging and log management. Newnes, 2012.
6. Parasnis, Dattetraya Shripad. Principles of applied geophysics. Springer Science & Business Media, 2012.

Year	Semester	Course No.	Course Title	Credit Hours
II	IV	PET 414	FLUID MECHANICS	2+1

Objective:

To develop the concepts of fluid mechanics, and their applications.

Learning Outcomes:

- Understand the basic principles of fluid mechanics and its application on types of flow.
- Perform a basic analysis of static and dynamic fluid systems.
- Carry out basic design calculations of fluid engineering systems (pumps, compressors etc.)

Contents

Introduction. Fluid Properties. Properties of fluids, Determination of viscosity and its application to lubricated bearings. Fluid Statics. Pressure intensity and pressure head, and their measurements. Hydrostatic forces on a submerged surface. Buoyancy and flotation. Fluid Kinematics. Classifications of fluid flow. Equation of continuity Bernoulli's equation. Fluid mass under acceleration. Forced vortex. Flow Measurement. Venturimeter, orifices, mouthpieces, nozzles, Pitot tube and sharp crested weirs/notches. Steady flow through pipes. Darcy Weisbach equation. Losses in pipelines, Hydraulic and energy gradient. Transmission of Energy. Uniform flow in open Channels. Chezy's and Manning's Equations. Economical rectangular and trapezoidal cross-sections. Compressible fluids. Isothermal and adiabatic flow. Continuity and energy equations, Steady Flow of gasses through venturimeter and pipes.

Labs:

- Determine the properties of fluid and hydrostatic pressure.
- Find out the losses in pipes.
- Characterize different types of flow meters.
- Find out Reynolds Numbers.
- Determine various types of expansion & contraction fitting.

Books Recommended:

1. Elger, Donald F., Barbara C. Williams, and Clayton T. Crowe. Engineering fluid mechanics. John Wiley & Sons, 2022.
2. Zierp, Jürgen, and Karl Bühler. Principles of fluid mechanics: fundamentals, statics and dynamics of fluids. Springer Nature, 2022
3. Longo, Sandro, Maria Giovanna Tanda, and Luca Chiapponi. Problems in Hydraulics and Fluid Mechanics. Berlin/Heidelberg, Germany: Springer, 2021
4. Anderson, Dale, et al. Computational fluid mechanics and heat transfer. CRC press, 2020
5. Modi, P. N., and S. M. Seth. Hydraulics and Fluid Mechanics Including Hydraulics Machines. Rajsons Publications Pvt. Ltd., 2019.
6. Aris, Rutherford. Vectors, tensors and the basic equations of fluid mechanics. Courier Corporation, 2012.

SEMESTER-V

Year	Semester	Course No.	Course Title	Credit Hours
III	V	PET 541	WELL COMPLETIONS AND WORKOVER	2+1

Objective:

To understand the well completion and workover operations.

Learning Outcomes:

Students aware:

- *Completion design. Major types of completion configuration.*
- *Knowledge about borehole, casing. Light and heavy operation on live wells.*

Contents

Introduction to well completion; Main factors influencing completion design, Overall approach to a well's flow capacity, Major types of completion configurations, Main phases in completion. Connecting the pay zone and the borehole; Drilling and casing the pay zone, Evaluating, and restoring the cement job, Perforating, Treating the pay zone. The equipment of naturally flowing wells; General configuration of flowing well equipment, the production wellhead, The production string or tubing, Packers, Downhole equipment, Subsurface safety valves, Running procedure. Well servicing and workover; Main types of operations, Light operations on live wells, Heavy operations on live wells, Operations on killed wells.

LABS:

- Determine the folds of increase between unfractured and fractured reservoirs.
- Determine the wellbore performance.
- Determine the choke performance.
- Carry out production decline analysis.
- Determine the nodal analysis of production.
- Demonstration of downhole equipments.
- Demonstration of installation of packers.
- Demonstration of installation of SSSV.

Books Recommended:

1. Kuncoro, Priyo. Technical Drilling And Completion Project (Including Cost Allocation And HSE Reviews) Book Two. Deepublish, 2021.
2. Wan, Renpu. Advanced well completion engineering. Gulf professional publishing, 2011.
3. Wan, Renpu. Advanced well completion engineering. Gulf professional publishing, 2011
4. Bellarby, Jonathan. Well completion design. Elsevier, 2009.
5. Watson, David, Terry Brittenham, and Preston L. Moore. Advanced well control. Vol. 10. Richardson, Tex: Society of Petroleum Engineers, 2003.

Year	Semester	Course No.	Course Title	Credit Hours
III	V	PET 543	GAS ENGINEERING	3+0

Objective:

To study gas measurement, processing, transmission and distribution.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Describe natural gas composition, its properties, ideal and real gas behavior.*
- *Understand the natural gas processing and its importance.*
- *Analyze gas flow performance, metering, transmission and distribution, its problems and possible solutions. Perform natural gas flow and compression calculations.*

Contents

Introduction: Properties of natural gas. Production, transportation, storage and gauging of gas. Sales gas customer requirement. Choke Performance: CPR Curve, Sonic and Subsonic Flow, Flow Calculation. Surface Facilities: Principle of Separator, Design of Separator: Vertical, Horizontal; Two Phase Separation, Three Phase Separation. Facilities designing for gas processing: Gas field development, design of gathering systems, field treatment and processing of natural gas e.g.: gas dehydration and gas sweetening. Compressors and horsepower requirements. Flow through pipelines and pressure drop. Gas hydrates, LNG, Storage of natural gas. Gas to liquids (GTL). Gas metering separator selection. Corrosion prevention methods. Unconventional Production of Natural Gas: Shale Gas, Gas Hydrates, Coal bed Methane, Oil Shale, Pyrolysis of Carbonaceous Materials etc. Calorific values of gas. Introduction to LPG and LNG.

Books Recommended:

1. Speight, James G. Gas Engineering: Vol. 2: Composition and Processing of Gas Streams. Germany, De Gruyter, 2022.
2. Carroll, John. Natural Gas Hydrates: A Guide for Engineers. United Kingdom, Elsevier Science, 2020
3. Baron, Hervé. The Oil & Gas Engineering Guide. France, Editions Technip, 2015
4. Nasr, G.G., and Connor, N.E. Natural Gas Engineering and Safety Challenges: Downstream Process, Analysis, Utilization and Safety. Germany, Springer International Publishing, 2014.
5. Lyons, William C. Standard Handbook of Petroleum and Natural Gas Engineering: Volume 1. Ukraine, Elsevier Science, 1996.

Year	Semester	Course No.	Course Title	Credit Hours
III	V	PET 545	RESERVOIR ENGINEERING-I	2+1

Objective:

To introduce the principles of Reservoir Engineering.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Discuss the fundamentals of reservoir engineering. Distinguish between various reservoir flow systems and geometry.*
- *Derive and apply different flow equations (Darcy equation, diffusivity equation, frontal advance, etc.).*
- *Interpret the hydrocarbon recoveries from reservoirs under derive mechanisms through both Volumetric and material balance methods.*

Contents

Introduction Fundamental of Reservoir Engineering, classification of reservoir flow systems, geometry of the reservoir steady state and unsteady state flow, Darcy's law of fluid flow through porous media. Dimensional analysis of Darcy's law. Basic flow equations, Pressure distribution and pressure gradient for linear, radial, and spherical flow conditions. Reservoir rock and fluid properties. Average permeability calculations for beds in series and beds in parallel for linear and radial reservoir geometry. Determination of average pressure in radial flow system. Readjustment time, productivity index, specific productivity index and injectivity index. Relationship between well-bore radius and flow rate in radial flow system. Continuity equation and its derivation. Diffusivity equation and its different forms. Volumetric evaluation of oil and gas in place and empirical reserve estimates. Different types of reservoir drive mechanisms.

Labs:

- Contouring with the help of elevation points manually as well as using software (Surfer/Kingdom/Geographic).
- Reservoir volume calculation through a depth structure map by planimetry method manually.
- Apparent molecular weight calculation of a mixture of gas manually. Make a formulated spreadsheet in MS Excel.
- Calculate acentric factor by Edmister equation manually. Make a formulated spreadsheet in MS Excel enabling iterations/macros.
- Make formulated spreadsheets for the following gas properties (use iterations, logical formulas and macros where needed): Volume, Density, Specific Gravity, Flow rate and Total Heating Value.
- Gas Deviation Factor (Z) Calculation by Pseudo-Critical-Pressure, Pseudo-Critical-Temperature, Pseudo-Reduced-Pressure and Pseudo-Reduced-Temperature. Highlight the value of Z on Standing and Katz Chart.
- Corrected Gas Deviation Factor calculations through heptane-plus fraction related empirical adjustment factors (FJ, EJ, and EK) by Sutton's method, manually.
- Make a formulated spreadsheet of Corrected Gas Deviation Factor through heptane-plus fraction related empirical adjustment factors (FJ, EJ, and EK) using Sutton's method.

Books Recommended:

1. Alyafei, Nayef. Fundamentals of reservoir rock properties. QScience. com, 2021.
2. Lie, Knut-Andreas. An introduction to reservoir simulation using MATLABS/GNU Octave: User guide for the MATLABS Reservoir Simulation Toolbox (MRST). Cambridge University Press, 2019
3. .Ertekin, Turgay, Qian Sun, and Jian Zhang. Reservoir simulation: problems and solutions. Richardson: Society of Petroleum Engineers, 2019.
4. Al-Safran, Eissa M., and James P. Brill. Applied multiphase flow in pipes and flow assurance: oil and gas production. Richardson, TX, USA: Society of Petroleum Engineers, 2017.
5. . Dandekar, Abhijit Y. Petroleum reservoir rock and fluid properties. CRC press, 2013
6. Grant, Malcomm. Geothermal reservoir engineering. Elsevier, 2013.
7. Lake, Larry, ed. Reservoir characterization. Elsevier, 2012
8. Ahmed, Tarek, and Paul McKinney. Advanced reservoir engineering. Elsevier, 2011.

Year	Semester	Course No.	Course Title	Credit Hours
III	V	PET 547	REFINING TECHNOLOGY – I	2+1

Objective:

To enable the students to understand refinery

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define and describe the crude oil composition, refinery products and processes.*
- *Design and conduct the Laboratory tests for determining the properties of refined product.*
- *Illustrate and compare the procedure for separation and distillation of crude oil.*

Contents

Introduction. Evaluation of oil stocks. Properties of crude oils, API gravity, dynamic viscosity, density color etc. Composition, paraffinic, olefinic, naphthenic, aromatics. Introduction to processing fractional distillation of crude oil, properties of different section/cuts/distillate, naphtha, gasoline, diesel etc. Arrangements of towers, study accessories of distillation towers, bubble point tray, sieves, downcomer. ASTM and TBP distillation. Reflexes, cold reflex, hot reflex. Vacuum distillation. Stabilization. Natural and Refining Gases.

Labs:

- Binary distillation.
- CCR (ASH Content).
- Calculate the smoke point of a given sample.
- Calculate the total acid number (TAN).
- Open cup testing flash and fire point of a given sample (less volatile samples).
- ASTM-D-86, of the given sample gasoline, diesel, kerosene.
- Close cup testing, (volatile samples).
- Determination of salt content in the crude oil.

Books Recommended:

1. Speight, James G. Hydrotreating and Hydrocracking Processes in Refining Technology. CRC Press, 2023.
2. Da Silva, Marcio Wagner. Crude Oil Refining: A Simplified Approach. CRC Press, 2022
3. Kulkarni, Sunil Jayant. Petroleum and Refining Sector: Towards Cost Effective and Sustainable Practices. Literatureslight Publishing, 2019
4. El-Gendy, Nour Shafik, and Hussein Mohamed Nabil Nassar. Biodesulfurization in petroleum refining. John Wiley & Sons, 2018
5. Srivastava, Som Prakash. Developments in lubricant technology. John Wiley & Sons, 2014.

Year	Semester	Course No.	Course Title	Credit Hours
III	V	PET 549	ENVIRONMENT AND SAFETY MANAGEMENT	3+0

Objective:

To familiarize the students with environmental hazards, and safety management in petroleum industry.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *To understand the importance of maintaining a safe workplace.*

- Describe and categorize safety standards, policies, and equipment needed to deal with hazardous
- Environment and processes within engineering limits.
- Define and describe the relevant OSHA & EIA regulations.

Contents

Introduction Environment impact assessment of oil and gas field, Environmental hazards of petroleum industry including exploration drilling, production, refining, distribution and storage. Risk assessment, risk securing techniques, concept of air and water pollution in petroleum industry, contamination of groundwater by non- aqueous phase liquids, flaming impact. Oil spills and its control, solid waste and sludge control, impact for drilling activity, emissions during drilling, production, storage and LPG plant operation, noise pollution in oil exploring and exploiting prevention and control. Occupational health and safety management procedures, Safety and awareness, audit and inspection, management commitment to safety, employee commitment, development and safety assessment, design procedure for operation, maintenance, modification and emergencies, safety by contractor. Accident investigation and concept of total loss control, accident and incident reporting, investigation and follow-up, monitoring and auditing, and reappraisal of the system. National environmental quality standard and their implementation.

Books Recommended:

1. Avramescu, Sorin Marius, et al., eds. Engineered nanomaterials: health and safety. BoD–Books on Demand, 2020
2. Epstein, Marc J. Making sustainability work: Best practices in managing and measuring corporate social, environmental and economic impacts. Routledge, 2018.
3. . Geller, E. Scott. Working safe: How to help people actively care for health and safety. CRC Press, 2017.
4. Griffith, Alan, and Tim Howarth. Construction health and safety management. Routledge, 2014.
5. Matanovic, Davorin, ed. Risk analysis for prevention of hazardous situations in petroleum and natural gas engineering. IGI Global, 2013.
6. Reis, DR John C. Environmental control in petroleum engineering. Elsevier, 1996.

SEMESTER-VI

Year	Semester	Course No.	Course Title	Credit Hours
III	VI	PET 542	PRODUCTION ENGINEERING-I	2+1

Objective:

To familiarize the students with surface facilities and subsurface equipment for production optimization.

Learning Outcomes:

After studying this course, the learners will be able to: -

- Describe the basic components and methods used to complete and produce oil and gas wells.
- Analyze one and two phase flow behavior and flow regimes through different flow models.
- Define and describe the concepts of IPR and TPR and apply them to estimate and predict the deliverability of oil/gas wells.

Contents

Introduction Definition and scope of production engineering. Introduction to Petroleum Production system; Components and working principles. Well Completions; various completion designs, reservoir, and mechanical consideration, completion fluids. Subsurface Operations; Perforation, Packers Installation, SSSV Installation. Down hole Equipments; production packers, tubing strings, liners, subsurface completion and production control equipment. Surface Production Facilities; Wellheads Components-running/installation, Piping systems, valves, chokes, fittings. Separators, stock tanks, Gathering systems and individual well flow rate allocation. Inflow performance Relationship (IPR) models; Straight line and curve IPR. Wellbore/ Tubing performance of oil and gas wells; Single phase and multi-phase well flow models, Pressure traverse and

pressure drop estimation. Deliverability of oil and gas wells; Use of IPR and TPR (Tubing Performance Relationship). Basic Prosper Modeling.

Labs:

- Draw a production profile using Microsoft Excel.
- Determination of Oil Inflow Performance.
- Interpret the pressure-time plot for a typical DST chart.
- Identify the components of Christmas tree. Also give the functions of each component.
- Identification of subsurface completion Equipment and studying their functions.
- Explain how a surface controlled subsurface safety valve (SCSSV) works.
- Description of the setting procedure of packer hydraulically.
- Modeling a naturally flowing oil well using PROSPER.
- Visit to hydrocarbon producing well side fields.

Books Recommended:

1. Poston, Steven W., Marcelo Laprea-Bigott, and Bobby D. Poe. Analysis of Oil and Gas Production Performance. Society of Petroleum Engineers, 2019.
2. Holdaway, Keith R., and Duncan HB Irving. Enhance Oil and Gas Exploration with Data-Driven Geophysical and Petrophysical Models. John Wiley & Sons, 2017.
3. Kelland, Malcolm A. Production chemicals for the oil and gas industry. CRC press, 2016.
4. Revie, R. Winston, ed. Oil and gas pipelines: Integrity and safety handbook. John Wiley & Sons, 2015.
5. Speight, James G. Shale gas production processes. Gulf Professional Publishing, 2013.
6. Guo, Boyun. Petroleum production engineering, a computer-assisted approach. Elsevier, 2011.
7. Guo, Boyun. Petroleum production engineering, a computer-assisted approach. Elsevier, 2011.

Year	Semester	Course No.	Course Title	Credit Hours
III	VI	PET 544	WELL TESTING	2+1

Objective:

To acquire and analyze flow rate and pressure data for reservoir diagnostics..

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define and develop equations for fluid flow in porous media and to solve the governing equations.*
- *To determine reservoir properties by well testing. Justify the limitations of well test interpretation.*
- *Discuss various techniques of pressure transient and well deliverability testing with application.*

Contents

Introduction to well tests in different types of reservoir, designing, execution, interpretation analytical solutions of the diffusivity equation for constant rate and constant pressure under transient and pseudo-steady State flow regimes. Skin effect due to well damage and storage. Analytical/Numerical solution of diffusivity equation including damage and storage presented in the graphical form and its use as a diagnostic plot. Principle of superposition and Homer’s approximation. Build-up test, Determination of reservoir permeability, skin factor, flow, and efficiency, etc. Pseudo-skin analysis of hydraulically fractured reservoirs. Determination of static drainage area pressure by Musket methods. Modification of liquid equation for gases and for multiphase flow transient equation for gases including wellbore damage, storage, and turbulent factor D. Pseudo pressure and pseudo time determination and calculation K, S, and D by conventional and modern methods. Two-phase flow testing using pseudo pressure function, Drawdown analysis, Multivariate Testing Multi-well Testing. Use of type curves and Derivative Curves specialized plotting for different flow regimes. Discussion of Ramey’s, Gringarten’s, and Bourdet’s Type curves. Interference Test Analysis, Pulse Testing of the Hydraulically Fractured Wells. Testing of the heterogeneous reservoir, Composite systems, and layered reservoirs (with cross flow). Naturally fractured reservoirs. Use of type curves in all types of well-testing techniques. Pressure derivative approach.

Labs:

- Estimate the subsurface well pressure (hydrostatic, pore, and overburden).
- Determine the well profile.
- Estimate water oil ratio by the periodic production test in oilfield units from the stock tank.
- Estimate the productivity index (PI) at various well-flowing pressure (Pwf) and flow rate (q).
- Determine the flow rate (q) at any draw-down pressure of oil and gas well by flow after flow test.
- Estimate different reservoir parameter plots for an oil reservoir through Drill stem test (DST) analysis.
- Determine the absolute open flow potential (AOF) for gas reservoirs through DST.

Books Recommended:

1. Escobar, Freddy. Novel, integrated and revolutionary well test interpretation and analysis. BoD–Books on Demand, 2019
2. Wan, Renpu. Advanced well completion engineering. Gulf professional publishing, 2011
3. Chaudhry, Amanat. Oil well testing handbook. Elsevier, 2004.
4. Bourdet, Dominique. Well test analysis: the use of advanced interpretation models. Elsevier, 2002.
5. Bourdet, Dominique. Well test analysis: the use of advanced interpretation models. Elsevier, 2002.
6. Horne, Roland N. Modern well test analysis. American, 1990.

Year	Semester	Course No.	Course Title	Credit Hours
III	VI	PET 546	REFINING TECHNOLOGY – II	2+1

Objective:

To enable the students to understand advance refinery operations.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define and describe the crude oil composition, refinery products and processes.*
- *Design and conduct the Laboratory tests for determining the properties of refined product.*
- *Illustrate and compare the procedure for separation and distillation of crude oil.*

Contents

Introduction Thermal cracking. Tiebreaking, Coking. Cracking, hydrocracking, fluidization. Asphalt production. Chemical Treatment. Techniques to improve quality of Gasoline, Kerosene etc. Production of Lubricating oils and waxes. Additives. Hydrotreating of various petroleum fractions. Petroleum and Principal Components: classification and composition. Chemistry of Petroleum Products.

Labs:

- Differential distillation.
- Freezing point of wax.
- Re-refining of used lubricating oil by different adsorbents.
- Softening point of bitumen.
- Evaluate the viscosity index of the lubricating oil.
- Copper strip tarnish test.
- To determine the quantity of sculpture in Petroleum.
- ASTM color of petroleum product.

Books Recommended:

1. Speight, James G. Hydrotreating and Hydrocracking Processes in Refining Technology. CRC Press, 2023.
2. Da Silva, Marcio Wagner. Crude Oil Refining: A Simplified Approach. CRC Press, 2022
3. Kulkarni, Sunil Jayant. Petroleum and Refining Sector: Towards Cost Effective and Sustainable Practices. Literatureslight Publishing, 2019.

4. El-Gendy, Nour Shafik, and Hussein Mohamed Nabil Nassar. Biodesulfurization in petroleum refining. John Wiley & Sons, 2018.
5. Rangaiah, Gade Pandu, ed. Multi-objective optimization: techniques and applications in chemical engineering. Vol. 5. World Scientific, 2016.
6. Srivastava, Som Prakash. Developments in lubricant technology. John Wiley & Sons, 2014.

Year	Semester	Course No.	Course Title	Credit Hours
III	VI	PET 548	PETROLEUM MANAGEMENT & LEGISLATION	3+0

Objective:

Student aware about petroleum management steps, petroleum policies.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Student's aware petroleum management skills.Principles of economic evaluation.*
- *Risk analysis.Capital budget techniques.*
- *Legislation of Pakistan given to area for oil & gas companies. (leasing, agreements, laws)*

Contents

Introduction, project management context; project management. Processes integration management; project plan development, project plan execution, overall change control. Scope management; initiation, scope planning, scope definition, scope verification, scope change control. Time management; activity definition, activity sequencing, activity duration estimation, schedule development, schedule control. Cost management; quality planning, staff acquisition, team development. Communications management; communications planning, information distribution, performance reporting, administrative closure. Risk management; risk identification, risk quantification, risk response development, risk response control. Procurement management; procurement planning, solicitation planning, source selection, contract administration, contract close-out. Closing; administrative closure, contract close-out, lessons learnt. Petroleum policies, concession agreements and joint ventures. Petroleum rights, production rules, taxes and royalties. Economics risk zones, pricing policies. Petroleum Land administration, negotiating with landlords, lease. Introduction to the standards and practices of economic analysis in the petroleum industry, Brief review of the principles of economic evaluation, ROR and NPV analysis, Definition of risk and uncertainty, decision, analysis, decision tree analysis and estimation of future money values, Analysis involves reserve estimation and forecasting of capital investment, operating cost and manpower requirement, Petroleum taxation regulations (policies and laws), profitability criteria, cut off criteria unit operations, SPE-Petroleum resource and reserve classification, Before tax cash flow models, after cash flow models, Capital budgeting techniques, Investment selection decision making, Evaluation nomenclature, time value of money, basic interest equations, present and net present value, ABC transaction, payout, payback time and rate of return, Engineering economics, factors and their uses, Evaluation of alternatives.

Books Recommended:

1. Petroleum Reservoir Management: Considerations and Practices. United States, CRC Press, 2021.
2. Worthington, Paul F. The Law on Petroleum Unitization: Legislating for Effective Regulatory Governance. United Kingdom, Edward Elgar Publishing, 2020
3. Chandler, John A. P. Petroleum Resource Management: How Governments Manage Their Offshore Petroleum Resources. United Kingdom, Edward Elgar Publishing Limited, 2018.
4. Chandrasekaran, Srinivasan. Health, Safety, and Environmental Management in Offshore and Petroleum Engineering. Germany, Wiley, 2016.
5. Regulation of the Upstream Petroleum Sector: A Comparative Study of Licensing and Concession Systems. United Kingdom, Edward Elgar Publishing Limited, 2015.
6. . Aven, Terje, and Vinnem, Jan-Erik. Risk Management: With Applications from the Offshore Petroleum Industry. Germany, Springer London, 2007

Year		Semester	Course No.	Course Title	Credit Hours
III		VI	PET 550	RESERVOIR ENGINEERING-II	2+1

Objective:

Study of advanced concepts of Reservoir Engineering.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Understand the reservoir engineering terminologies.*
- *Compute the recoveries from a natural gas reservoir through volumetric and material balance methods for closed and water influx reservoir.*
- *Understand the fundamentals of gas-condensate reservoir and apply different techniques to estimate its reserves.*

Contents

Introduction. Volumetric calculation methods of initial hydrocarbon in place and reserve estimation. Rectangular, pyramidal and trapezoidal shape factor of volumetric calculations. Derivation of Material Balance Equation. M.B. Equation as an equation of a straight line. P/Z Vs G_p plot, Energy Plot, Cole Plot. Applications and limitations of Material Balance method. Performance evaluation of different reservoir drive mechanisms of oil and gas reservoirs. Different types of aquifer models with their applications and limitations. Aquifer modeling, fitting, history matching and its use in Material Balance method. Decline Curve Analyses technique with its applications and limitations focusing on Exponential, Harmonic and Hyperbolic Decline.

Labs:

- Reserve estimation by volumetric method manually as well as using spreadsheet software.
- Reserve estimation through Reservoir volume calculation by shape factor manually.
- Reserve estimation through reservoir volume calculation by shape factor using spreadsheet software by applying logical formulas.
- Identification of gas reservoir drives mechanism through pressure history and cumulative production history plot.
- Estimate the Initial-Gas-In-Place (IGIP) through pressure history and cumulative production history plot after incorporating the water encroachment.
- Perform Material Balance of a Gas Reservoir through History Matching and Aquifer Modelling manually.
- Perform Material Balance of a Gas Reservoir through History Matching using IPM (MBAL) software of Petroleum Experts Run Future Gas Production Prediction and Simulation of modeled gas reservoir of Labs 7 using IPM (MBAL) software of Petroleum Experts.
- Perform Material Balance of an Oil Reservoir through Aquifer Modelling and History Matching. Also predict Future Oil Production and run simulation using IPM (MBAL) software of Petroleum Experts.

Books Recommended:

1. Alyafei, Nayef. Fundamentals of reservoir rock properties. QScience. com, 2021.
2. Ertekin, Turgay, Qian Sun, and Jian Zhang. Reservoir simulation: problems and solutions. Richardson: Society of Petroleum Engineers, 2019
3. Lie, Knut-Andreas. An introduction to reservoir simulation using MATLABS/GNU Octave: User guide for the MATLABS Reservoir Simulation Toolbox (MRST). Cambridge University Press, 2019.
4. Al-Safran, Eissa M., and James P. Brill. Applied multiphase flow in pipes and flow assurance: oil and gas production. Richardson, TX, USA: Society of Petroleum Engineers, 2017.
5. Dandekar, Abhijit Y. Petroleum reservoir rock and fluid properties. CRC press, 2013
6. Grant, Malcomm. Geothermal reservoir engineering. Elsevier, 2013.
7. Lake, Larry, ed. Reservoir characterization. Elsevier, 2012.
8. Ahmed, Tarek, and Paul McKinney. Advanced reservoir engineering. Elsevier, 2011.

SEMESTER-VII

Year	Semester	Course No.	Course Title	Credit Hours
IV	VII	PET 651	INSTRUMENTATION AND CONTROL	2+1

Objective:

To study the instrumentation and controlling of different equipment to be used in Petroleum Industry

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define and describe the basic laws governing the operation of different transducers, relevant circuits and their working.*
- *Understand the basic principles and importance of process control in industrial process plants.*
- *Calibrate, configure and troubleshooting of different measuring instruments.*

Contents

Introduction to Instrumentation, Principles of measurement of temperature, pressure level, flow, weight power, speed, position; etc., study of common sensors, transmitters, controllers, actuators, recorders, switches, etc., methodology for calibration, failsafe modes of operation, alarm, trip and interlock system, emergency shut-down systems, Fire and gas detection, Pressure relief and venting systems Review of Laplace transform control system (introduction) first and higher order systems and their dynamic linearization overall transfer function testability theoretical and practical controllers final control elements introduction to frequency response techniques measuring instruments for temperature, pressure, and level control of heat exchangers and distillation columns.

Labs:

- Establish characteristics of the Resistive Temperature Detector (RTD) temperature sensor.
- Demonstrate the principle of Ultrasonic sensors and their application as range sensors.
- Execute two and three input logic gates in Siemens Simatic Step 7 software.
- Implement two and three input logic gates in Siemens S7-300 PLC.
- Design and perform operation and application of SR and RS flip flops in Siemens S7-300 PLC.
- Originate and accomplish the operation and application of various timers in Siemens S7-300 PLC.
- Draft and review the operation and application of different counters in Siemens S7-300 PLC.
- Originate PLC Ladder Logic Diagram for controlling operation of an overhead tank.

Books Recommended:

1. Shreesha, C., and Ravindra D. Gudi. Control Instrumentation Systems. Springer Singapore, 2020.
2. George, V. I., and B. K. Roy. Advances in Control Instrumentation Systems. Springer Singapore, 2020.
3. Liptak, Bela G., et al. Instrument engineers' handbook, volume two: Process control and optimization. CRC press, 2018.
4. King, Myke. Statistics for process control engineers: a practical approach. John Wiley & Sons, 2017.
5. Bentsman, Joseph. Introduction to Signal Processing, Instrumentation, and Control: An Integrative Approach. World Scientific Publishing Company, 2016.
6. Hughes, John M. Real World Instrumentation with Python: Automated Data Acquisition and Control Systems. " O'Reilly Media, Inc.", 2010.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VII	PET 653	CORROSION ENGINEERING	3+0

Objective:

To enable the students to understand corrosion principles and control.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define fundamentals of corrosion and its types. Use standard corrosion testing methods and prevention technologies.*
- *Understand corrosion causes, measurements, monitoring and prevention strategies.*
- *Acquire and interpret relevant corrosion-related data from the literature and analyze a range of practical corrosion-related problems.*

Contents

Introduction. Principles of corrosion control: design, material selection, surface coatings, treatment of environment, anodic and cathodic protection. Material degradation (corrosion control) in oil and gas production. Protection of oil and gas pipelines. Forms of maintenance, scheduling of maintenance, Corrosion Mechanism causes of corrosion cells, Polarization and factors of polarization, High-temperature corrosion, Stress corrosion cracking (sulfide stress corrosion cracking, chloride stress corrosion cracking, caustic stress corrosion. cracking, environmentally inducted cracking, Hydrogen damages, Corrosion losses, Corrosion Control, Corrosion detection methods (corrosion coupons, corrosion resistance probes, caliper measurements, ETT, sonic testing, casing potential profile tool), Corrosion control methods (material selection environment modification, inhibitor treatment), Evaluation of inhibitor treatment program, Cathodic protection, properties of galvanic anodes, design of impressed current, G/B, Criteria of CP, interference, anodic protection.

Books Recommended:

1. Broomfield, John P. Corrosion of steel in concrete: understanding, investigation and repair. Crc Press, 2023..
2. Mudali, U. Kamachi, et al., eds. A Treatise on Corrosion Science, Engineering and Technology. Springer, 2022.
3. Singh, Ambrish, ed. Corrosion Inhibitors. BoD–Books on Demand, 2019.
4. Pedferri, Pietro, and Marco Ormellese. Corrosion science and engineering. Vol. 720. Cham, Switzerland: Springer, 2018.
5. Bahadori, Alireza. Corrosion and materials selection: a guide for the chemical and petroleum industries. John Wiley & Sons, 2014.
6. Marcus, Philippe, ed. Corrosion mechanisms in theory and practice. CRC press, 2011.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VII	PET 655	PETROLEUM ECONOMICS & STATISTICS	2+1

Objective:

To study the feasibility and viability of petroleum projects.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Understand and use the fundamentals of economic principles in Petroleum Industry.*
- *Apply engineering economics techniques to evaluate feasibility of proposed exploration,*
- *Development and production projects.*

Contents

Introduction. Principles of economics, supply and demand, price theory, consumer behavior and cost analysis. Time value in capital, Petroleum economics: Oilfield project evaluation such as exploration, drilling and production operations. Estimation of oil reserves and evaluation of an oil property, Simple law of probability and probability distribution (binomial, Poisson, normal, log normal) their properties and characterization. Volumetric probability distribution, pricing trends for oil and gas. Alternatives in oil transportation, Risk, uncertainty and decision analysis in petroleum exploration and engineering, Classification of geological data, Graphical presentation of data, Measures of central tendency and Dispersion, Construction of data using Moments, Bivariate data Regression, Correlation, Partial and Multiple Correlation, Test of significance: z, t, F and X, AVOVA table and test of significance, Introduction to Monte Carlo statistical simulator for volumetric estimates and probability distributions.

Labs:

- Constructing, Optimization, economic models, and solutions.
- Construction of Decision tree and its solution.
- Calculation of dry hole risk and allowable number of dry holes.
- Problems in Numerical Analysis, Probability and Statistics. Problems in oilfield project evaluation solutions by using Monte Carlo simulator.

Books Recommended:

1. Cook, M. Petroleum Economics and Risk Analysis, A Practical Guide to E&P Investment Decision-Making. Netherlands: Elsevier Science 2021.
2. Haslam, Paul A., and Pablo Heidrich, eds. The political economy of natural resources and development: From neoliberalism to resource nationalism. Routledge, 2016
3. Bedrikovetsky, P. Mathematical Theory of Oil and Gas Recovery: With Applications to Ex-USSR Oil and Gas Fields. Netherlands, Springer Netherlands, 2013.
4. Speight, James G. An Introduction to Petroleum Technology, Economics, and Politics. United Kingdom, Wiley, 2011.
5. . Mathematical Methods and Modelling in Hydrocarbon Exploration and Production. Germany, Physica-Verlag, 2006.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VII	PET 657	PRODUCTION ENGINEERING-II	2+1

Objective:

To develop understanding of Problem well diagnostics and remedial measures.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Identify the methods, tools and designing parameters required for well completion.*
- *Analyze and predict well performance using different techniques.*
- *Investigate the causes of low well productivity and preventive strategies, characterize near*

Contents.

Introduction. Causes of low well productivity and its factors, near wellbore damage characterization. Well Stimulation; Introduction, types, Stimulation process and design. Stimulation Techniques; Hydraulic Fracturing. Introduction, productivity ratio, fracture area, fracturing fluid coefficients, fractures efficiency, fracturing hydraulics, fracture design and calculation. Acidizing. Introduction, types of treatment, acid-fracturing design. Sand Production: Introduction, Causes, problems, remedial techniques. Production Test, deliverability tests, Transient tests. Production Logging Tools (PLT) Well services and work over jobs;

Squeeze Cementing, well cleaning and servicing, Use of modern tools and methods for safe, efficient and economical well interventions. Produced Water Treatment and disposal. Flow Assurance.

Labs:

- Field visit to a producing well.
- Hydraulic fracturing exercise; design and its modelling.
- Acid fracturing job design and its modeling.
- Design of wellbore using PROSPER IPM software.
- Design of surface facilities using GAP IPM software.
- Nodal analysis of wellbore.
- Filed Visits.

Books Recommended:

- 1 Poston, Steven W., Marcelo Laprea-Bigott, and Bobby D. Poe. Analysis of Oil and Gas Production Performance. Society of Petroleum Engineers, 2019.
- 2 Holdaway, Keith R., and Duncan HB Irving. Enhance Oil and Gas Exploration with Data-Driven Geophysical and Petrophysical Models. John Wiley & Sons, 2017.
- 3 Kelland, Malcolm A. Production chemicals for the oil and gas industry. CRC press, 2016.
- 4 Revie, R. Winston, ed. Oil and gas pipelines: Integrity and safety handbook. John Wiley & Sons, 2015.
- 5 Speight, James G. Shale gas production processes. Gulf Professional Publishing, 2013.
- 6 Stewart, Maurice, and Ken E. Arnold. Surface Production Operations, Volume 1: Design of Oil Handling Systems and Facilities. Vol. 1. Elsevier, 2011.
- 7 Guo, Boyun. Petroleum production engineering, a computer-assisted approach. Elsevier, 2011.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VII	PET 659	RESERVOIR SIMULATION	2+1

Objective:

To develop basic understanding of hydrocarbon-reservoir performance under various operating conditions by using simulation software.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Define the basic concepts of reservoir simulation.*
- *Formulate fluid flow in porous media and to solve the governing equations, numerically using finite difference methods.*
- *Apply the concepts of reservoir engineering and reservoir simulation for petroleum field development through relevant software.*

Contents

Introduction to the concept of reservoir simulation, its advantages and limitations. Formulation of partial differential equations governing single phase and multiphase flow in porous media. Finite difference methods and solutions of linear equations applicable to the reservoir. Direct and iterative methods. Gridding, local grid refinement, and upscaling. Developing a model for a single phase, slightly compressible for infinite reservoir conditions. Selection of a reservoir simulator and computer-aided design. Use of a black oil simulator. Input data and data file preparation. Fine tuning for history matching. Performance prediction. Field application of reservoir simulation.

Labs:

- Make a three-dimensional rectangular reservoir manually. Do Cartesian Gridding in x, y, and z directions! Calculate the number of blocks and estimate the area and volume of the reservoir in different units.

- Build a three-dimensional rectangular reservoir on a commercial simulator ECLIPSE (Schlumberger). Do Cartesian Gridding in x, y, and z directions! Import/put the reservoir static properties. Visualize the variations of different properties in 2D and 3D Views.
- Build a PVT section of the given reservoir fluid in ECLIPSE. Generate phase envelope and calculate the fluid properties.
- Load production data, put production and injection wells, make scheduling and run the simulation. Show the results in tabular and graphical forms.
- Change the vertical production wells to horizontal production wells in Labs 4 and compare the results.
- Use the published data of the 7th SPE Simulation Project by remodeling in ECLIPSE. Find the oil, gas, and water production trend. Show the pressure depletion in 3D Add 1) Local Grid Refinement, 2) Wellbore Friction, and 3) Pressure Drop in the model made in Labs 6 and compare the results.

Books Recommended:

1. Lie, Knut-Andreas, and Olav Møyner, eds. Advanced modelling with the MATLABS reservoir simulation toolbox. Cambridge University Press, 2021
2. . Ursegov, Stanislav, and Armen Zakharian. Adaptive Approach to Petroleum Reservoir Simulation. Springer, 2021.
3. Ran, Qiquan. Unconventional Tight Reservoir Simulation: Theory, Technology and Practice. Springer Nature, 2020.
4. . Lie, Knut-Andreas. An introduction to reservoir simulation using MATLABS/GNU Octave: User guide for the MATLABS Reservoir Simulation Toolbox (MRST). Cambridge University Press, 2019
5. Cannon, Steve. Reservoir modelling: A practical guide. John Wiley & Sons, 2018.
6. Guo, Boyun. Petroleum production engineering, a computer-assisted approach. Elsevier, 2011.

SEMESTER-VIII

Year	Semester	Course No.	Course Title	Credit Hours
IV	VIII	PET 654	ENHANCED OIL RECOVERY AND ARTIFICIAL LIFT METHOD	3+0

Objective:

To enable the students to understand how to maximize recovery by applying external energy sources.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *To understand the fundamentals of water and immiscible gas injection and related selection Criteria.*
- *To aver the physical mechanisms of Enhanced Oil Recovery methods.*
- *To Design and conduct experiments/mathematical models to evaluate the feasibility of proposed flooding project.*

Contents

Introduction Factors Common to all Enhanced Recovery methods. Principles influence the efficiency of enhanced recovery. Linear displacement. Two and three-dimensional displacement. Injection well location. Areal sweep efficiency for pattern floods. Water Flooding. Selection of water injection as an EOR method. Displacement mechanics and performance calculations. Practical considerations in water injection Projects. Immiscible Displacement by Gas Injection. Preliminary studies and field evaluation of injection efficiency. Injection and production well completions. Surface installations, compression and treatment methods. Special applications of gas injection. Miscible Drive. Miscible slug flooding, thermodynamic miscibility, ternary diagram. Basic methods of miscible drive. Improved methods of miscible drive. Bas Recycling in Gas-

Condensate Reservoirs: Thermodynamics of gas recycling. Sweep efficiency, well locations, production control, production equipment, and determination of operating conditions. Thermal Recovery methods. Data required for the study of thermal recovery methods. Hot fluid displacement. In situ combustion. Other methods of Enhanced Recovery. Use of polymers. Foam injection. Use of surfactant solutions and Micro-emulsions. Carbon dioxide flooding. Calculations. Solution of EOR problems; development of computer algorithms and example calculations. Artificial Lift Methods; Introduction, Selection Criteria, Different techniques. Gas Lift; Mechanism and Consideration, Gas Lift Valve, Types of Gas Lift. Electrical Submersible Pump, Components, design calculations. Sucker Rod Pump, Design and Working. Pump calculations. Hydraulic Pump and Progressive Cavity Pump; Features and design Calculations.

Books Recommended:

1. Mandal, Ajay, and Keka Ojha. Enhanced Oil Recovery: Mechanisms, Technologies and Feasibility Analyses. CRC Press, 2023.
2. Sagir, Muhammad, et al. Surfactants for enhanced oil recovery applications. Cham: Springer, 2020.
3. Samsuri, Ariffin, ed. Enhanced oil recovery processes: New technologies. BoD–Books on Demand, 2019.
4. Mitra, Niladri Kumar. Principles of Artificial Lift. Vol. 1. Allied Publishers, 2012..
5. Shah, Dinesh Ochhavlal, ed. Improved oil recovery by surfactant and polymer flooding. Elsevier, 2012.
6. Green, Don W., and G. Paul Willhite. Enhanced oil recovery. Vol. 6. Richardson, TX: Henry L. Doherty Memorial Fund of AIME, Society of Petroleum Engineers, 1998.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VIII	PET 656	PETROCHEMICALS	2+1

Objective:

To enable the students to understand the product of petrochemicals

Learning Outcomes:

After studying this course, the learners will be able to:

- *Organization, hydrogenation poly mediation most important in fertilizers, pvc, other petrochemical products used in different areas (refinery fertilizer manifesting student achieve best knowledge).*

Contents

Introduction. Advance petrochemical processes and industries. Study of the industries in the light of the following operation, oxidization, hydrogenation, polymerization, pyrolysis, hydroformylation Maintain, diazotization. Production of various petrochemical raw materials. Manufacture and purification of synthetic gases. Production of important products e.g. fertilizers, polymers.

Labs:

- Determination of industrial aromatic hydrocarbon distillation of BTX (Benzene, Toluene & Xylene) by ASTM D-850.
- Analysis of Purity of DEA (Di ethanol Amine) By color Titration Method (UOP-824).
- Analysis of Purity of Mono ethanolamine (MEA) by color Titration Method (UOP-825).
- Analysis of purity of Caustic soda (NaOH) in given sample of sodium hydroxide by Titration.
- Analysis of coke formatting properties in synthetic oil by ASTM D-189 Method.
- Analysis of paint pigments is a given sample of paints.
- Deposit Analysis of given sample by Gravimetric Procedure.

Books Recommended:

1. Speight, James G. Hydro treating and Hydro cracking Processes in Refining Technology. CRC Press, 2023.
2. Da Silva, Marcio Wagner. Crude Oil Refining: A Simplified Approach. CRC Press, 2022

3. Johnson, James A., David W. Ablin, and Gregory A. Ernst. Efficient Petrochemical Processes: Technology, Design and Operation. John Wiley & Sons, 2019.
4. Johnson, James A., David W. Ablin, and Gregory A. Ernst. Efficient Petrochemical Processes: Technology, Design and Operation. John Wiley & Sons, 2019.
5. Patel, Vivek, ed. Advances in Petrochemicals. BoD–Books on Demand, 2015.
6. M. S., Manfred J. Mirbach, and Hassan A. Tayim, eds. Catalysis in petrochemical processes. Springer Science & Business Media, 2012.
7. Matar, Sami, and Lewis F. Hatch. Chemistry of petrochemical processes. Elsevier, 2001.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VIII	PET 658	GEOSTATISTICS & BASIC MODELING	2+1

Objective:

Knowledge about geo statistics reservoir characterization.

Learning Outcomes:

After studying this course, the learners will be able to, Student aver data analysis basic elements of reservoir characterization multiple simulation seniors.

Contents

Introduction. Origin of Geostatistics. Role of Geostatistics in Reservoir Characterization. Measurement Systems. Samples and sample Populations. Probability and Uncertainty. Random Variables and Probability Distributions. Data Analysis. Univariate Data Analysis. Multivariate Data Analysis. Normal-Score Transform. Geostatistics: into the domain of the spatially correlated variable. Properties of the RV and Random Functions. Stationarity. Structural analysis. Support effect and data integration. Kriging and cokriging. Static-data integration. Static and Dynamic-Data integration. Conditional Simulation and Uncertainty Estimation.

Labs:

- Study basic elements of reservoir characterization.
- Design integrated 3D reservoir model.
- Design modeling scale.
- Find out the concept of regrinding and upscaling.
- Carry out multiple simulations and scenarios.

Books Recommended:

1. Regina and Leo S. Hsu. Post GIS in action. Simon and Schuster, 2021.
2. Krainski, Elias, et al. Advanced spatial modeling with stochastic partial differential equations using R and INLA. Chapman and Hall/CRC, 2018.
3. Azevedo, Leonardo, and Amílcar Soares. Geostatistical methods for reservoir geophysics. Berlin: Springer, 2017.
4. Abernathy, David. Using geodata and geolocation in the social sciences: Mapping our connected world. Sage, 2016.
5. Sen, Zekai. Spatial modeling principles in earth sciences. Vol. 10. Berlin/Heidelberg, Germany: Springer International Publishing, 2016.
6. Cressie, Noel. Statistics for spatial data. John Wiley & Sons, 2015.
7. Agterberg, Frits. Geomathematics: theoretical foundations, applications and future developments. Vol. 18. Springer, 2014.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VIII	PET 660	UNCONVENTIONAL HYDROCARBON RESOURCES	2+1

Objective:

To enable the students to understand unconventional hydrocarbon reservoirs.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Discuss the fundamentals of different types of unconventional hydrocarbon resources.*
- *Understand the economics, social, political and environmental issues related to the development of unconventional reservoirs. Calculate the reserves of unconventional reservoirs.*
- *Understand basic measurement techniques for characterization of unconventional resources.*

Contents

Introduction to Unconventional energy resources. Systematic approaches to resource assessment.

Importance in unconventional reservoirs.

Low-permeability (Tight) Sands.

Occurrences, resources, reservoir characteristics. Drilling and completion methods. Facilities, reservoir management, limitations on development present activity. Coalbed Gas: Occurrences, resources, reservoir characteristics. Drilling and completion methods. Facilities, reservoir management, limitations on development present activity.

Coalbed gas

Occurrences, resources, reservoir characteristics. Drilling and completion methods. Facilities, reservoir management, limitations on development present activity Water and environmental issues.

Shale Reservoirs (Gas and Oil)

Occurrences, resources, reservoir characteristics. Drilling and completion methods. Facilities, reservoir management, limitations on development present activity. Water and environmental issues.

Heavy Oil:

Occurrences, resources, reservoir characteristics. Drilling and completion methods. Facilities, reservoir management, limitations on development present activity. Environmental issues.

Gas Hydrates:

Occurrences, resources, reservoir characteristics. i) Recovery methods. ii) Limitations on development, present activity.iii) Environmental issues: Gas Storage: Types and locations of gas storage reservoirs I) Technical issues and terminology ii) Gas storage volumes and economics.

Labs:

- Differentiate between Darcy and Non-darcy flow by interpretation of the given Special core analysis of a Tight Gas Sand Reservoir.
- Using the non-darcy flow behavior of Labs-1 identify and define the Early Region (ER), Middle Region (MR), and Late Region (LR) on the basis of Threshold Pressure Gradient (TPG) of a Tight Gas Sand Reservoir.
- Perform Material Balance method of a given data of Tight Gas Reservoir using MBAL software of IPM.
- Perform Decline Curve Analysis of a given production history data of a Tight Gas Reservoir using DCA and MBAL software of IPM.
- Build three-dimensional heavy oil reservoir numerical simulation model on ECLIPSE software. Run the sensitivities by varying the density of oil and compare the results.
- Design heat injection wells in the model of Labs-5 in ECLIPSE software. Inject the heat into the wellbore through; 1) Electric and 2) Steam. Simulate the heat dissipation mechanism and compare the recovery factor of this heavy oil.
- Build a three-dimensional Oil share reservoir numerical simulation model on CMG software. Design the injection and production wells for in-situ conversion of kerogen.

- Generate a fluid model of the components used in the Labs-7. Lumped the different hydrocarbon components by mixing rule using WINPROP module of CMG software.
- Generate the chemical reactions of kerogen conversion into oil and gas in the model in Labs-7. Introduce the heat into the wellbore through 1) Electric and 2) Steam and run the simulation by using STAR simulator of CMG software.

Books Recommended:

1. Dwivedi, Deepak, Amit Ranjan, and Jitendra S. Sangwai, eds. Functional Materials for the Oil and Gas Industry: Characterization and Applications. CRC Press, 2023.
2. Eshiet, Kenneth Imo-Imo Israel. Exploitation of Unconventional Oil and Gas Resources: Hydraulic Fracturing and Other Recovery and Assessment Techniques. Intech Open, 2019.
3. Cai, Jianchao, et al., eds. Flow and Transport Properties of Unconventional Reservoirs 2018.
4. Suárez-Ruiz, Isabel, and João Graciano Mendonça Filho, eds. The Role of Organic Petrology in the Exploration of Conventional and Unconventional Hydrocarbon Systems. Vol. 1. Bentham Science Publishers, 2017.
5. Ahmed, Usman, and D. Nathan Meehan, eds. Unconventional oil and gas resources: exploitation and development. CRC Press, 2016.
6. Lake, Larry W., et al. Fundamentals of enhanced oil recovery. Vol. 1. Richardson, TX: Society of Petroleum Engineers, 2014.

Year	Semester	Course No.	Course Title	Credit Hours
IV	VIII	PET 662	ADVANCED DRILLING & OFFSHORE TECHNOLOGY	2+1

Objective:

To learn the advance drilling operations.

Learning Outcomes:

After studying this course, the learners will be able to: -

- *Describe the fundamental concepts of drilling engineering. Explain the functions of various components of drilling system.*
- *Identify, compute, analyze and solve drilling problems.*
- *Formulate the pressure requirement at every stage of the drilling operation from the pump to the bit and back to the surface based on rheological models and drilling hydraulics procedures and the API recommended practices.*

Contents

Introduction Advanced drilling methods and drilling technologies. Drill string mechanics. Mechanized drilling operations. Drilling problems and their solutions in modern drilling operations. Coiled tubing drilling technology. Casing drilling technology and casing fatigue. Expandable tubular and their applications. Drilling HPHT wells. Drilling fluids for HPHT environment. Wellbore hydraulics. Drill bit optimization and selection. Non-conventional drilling methods. High-performance drilling concepts. Drilling through gas hydrates. Aspects of wellbore construction and wellbore integrity. Proper selection of drilling technologies and methods for your business. Offshore platforms and mobile vessels. Offshore drilling from fixed and floating drilling structures Offshore rigs and equipment's, wellheads, casing program, offshore blowout prevention equipment, the drilling riser, riser tensioning, drilling hydraulics, motion compensation, formation testing, shallow water flow, dual gradient drilling, subsea mud-lift drilling. Horizontal drilling in offshore environment; torque and drag, hydrates and potential problems in deep-water drilling.

Labs:

- Field visits to drilling sites.
- Case studies.

Books Recommended:

1. Tolouei-Rad, Majid, ed. *Drilling Technology*. BoD–Books on Demand, 2021
2. Ponton, Rebecca. *Breaking the Gas Ceiling: Offshore Oil and Gas Industry*. Modern History Press, 2019.
3. Chandrasekaran, Srinivasan. *Dynamic Analysis and Design of offshore structures*. Vol. 761. New Delhi: Springer India, 2015.
4. Fang, Huacan, and Menglan Duan. *Offshore operation facilities: Equipment and Procedures*. Gulf professional publishing, 2014.
5. Aadnoy, Bernt, et al. *Advanced drilling and well technology*. Richardson, Texas: SPE, 2009.
6. Chakrabarti, Subrata. *Handbook of Offshore Engineering (2-volume set)*. Elsevier, 2005
7. Bourgoyne, Adam T., et al. *Applied drilling engineering*. Vol. 2. Richardson: Society of Petroleum Engineers, 1986.