



Department of Petroleum Technology

Ph.D. Course Work (Petroleum Engineering) (Applicable for the scholars admitted from the AY: 2024-25)

The credit requirement for the Ph.D. course work is a minimum of 12 credits including the courses on ‘Research Methodology’ and ‘Research and Publication Ethics’ for 2 credits each. The candidate must complete two domain-specific courses of 3 credits each, recommended by the respective Department Research Committee (DRC). These courses can be completed through MOOCs.

The candidate must present two research seminars before the completion of course work, typically within the first year. The first research seminar shall be before the end of first semester on introduction to the proposed research work, and the second seminar shall be before the end of the second semester or after the completion of course work on the research proposal, as per the format provided. Each research seminar will have one credit weightage. The course structure is presented in Table 1 and list of domain-specific courses is presented in Table 2.

Table 1: Course Structure

S.No.	Course Code	Name of the Course	Credit (s)
1	246UC001	Research Seminar -I	1
2	246UC002	Research Seminar -II	1
3	246UC003	Research Methodology	2
4	246UC004	Research and Publication Ethics	2
5	-	Domain Specific Course -I	3
6	-	Domain Specific Course -II	3
Total			12

Table 2: List of Domain-Specific Courses

S.No.	Course Code	Name of the Course
1	246PT001	Advanced Petroleum Geology
2	246PT002	Production Engineering
3	246PT003	Reservoir Engineering-I
4	246PT004	Production Technology-I
5	246PT005	Petroleum Sedimentology
6	246PT006	Reservoir Engineering-II
7	246PT007	Petroleum Economics & Environmental Management
8	246PT008	Drilling Fluids
9	246PT009	Drilling Technology
10	246PT010	Production Technology-II
11	246PT011	Oil and Gas Economics and Risk Management
12	246PT012	Enhanced Oil Recovery Techniques
13	246PT013	Drilling Engineering Hydraulics
14	246PT014	Exploration and Formation Evaluation of Oil and Gas Reservoirs
15	246PT015	Offshore Drilling and Production Practices
16	246PT016	Surface Facility for Oil and Gas Handling
17	246PT017	Reservoir Simulation
18	246PT018	Artificial Lift Technology for Oil and Gas Production
19	246PT019	Production Chemicals & Oil Field Chemistry
20	246PT020	Flow Assurance

Research Methodology

Course Code: 246UC003

UNIT -I:

Research Design

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys. Case studies.

UNIT-II:

Data Collection and Sources

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT-III:

Data Analysis and Reporting

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT-IV:

Intellectual Property Rights

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT-V: Patents

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

Text Books:

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, Sage Publications, 4th Edition, 2015.
2. Intellectual Property: A Very Short Introduction, Siva Vaidhyanathan, Oxford University Press, 2017.
3. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets" Deborah E. Bouchoux, Cengage India, 4th Edition, 2013.

Reference Books:

1. Research methodology: an introduction for science & engineering students, Stuart Melville and Wayne Goddard, Juta Academic, 2nd Edition, 2014.
2. Research design: Qualitative, quantitative, and mixed methods approaches, Creswell, J.W. and Creswell, J.D., Sage publications, 2017.
3. Intellectual Property in New Technological Age, Robert P. Merges, Peter S. Menell, Mark A. Lemley, Clause 8 Publishing; Volume I: Perspectives, Trade Secrets & Patents; 2023.

Web Links:

1. <https://archive.nptel.ac.in/courses/121/106/121106007/#>
2. https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview

Research and Publication Ethics

Course Code: 246UC004

Unit-I: Philosophy & Ethics

Introduction to Philosophy: Definition, Nature & Scope, Concept, Branches

Ethics: Definition, Moral Philosophy, Nature of Moral Judgements & Reactions

Unit-II: Scientific Conducts

Ethics with respect to Science and Research, Intellectual Honesty & Research Integrity

Scientific Misconducts: Falsification, Fabrication & Plagiarism

Redundant Publications: Duplicate & Overlapping Publication, Salami Slicing, Selective Reporting & Misrepresentation of Data

Unit-III: Publication Ethics

Publication Ethics: Definition, Introduction and Importance

Best Practices/ Standard Setting Initiatives and Guidelines: COPE, WAVE, etc., Conflicts of Interest

Publication Misconduct: Definition, Concept, Problems that lead to unethical behaviour and vice-versa, types, Violation of Publication Ethics, Authorship and Contributorship, Identification of Publication Misconduct, Complaints and Appeals, Predatory Publishers and Journals

Unit-IV: Open Access Publishing

Open Access publications and Initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-achieving policies, Software tool to identify predatory publications developed by SPPU, Journal Finder/ Journal Suggestion tools viz. JANE, ELSEVIER, SPINGER, Journal suggester etc.

Unit-V: Publication

Misconduct Group

Discussions:

Subject-specific Ethical issues, FFP, Authorship, Conflicts of Interest, Complaints and Appeals: Examples and fraud from India and Abroad

Software tools:

Use of Plagiarism software like Turnitin, Urkund and other open source software tools

Database and Research Metrics:

Database:

Indexing database, Citation database: web of science, Scopus etc.

Impact factor of journal as per journal citation report, SNIP, SJR, IPP, cite score

Metrics: h-index, g-index, i-10 index, AL metrics etc.

Text Books:

1. Philosophy in Science, Bird A, Routledge, 2006.
2. A Short History of Ethics, MacIntyre, London, 1967.

Reference Book:

1. Ethics in Science, Education and Governance, Indian National Science Academy, 2019.

Weblinks:

1. www.niehs.nih.gov/research/resources/bioethics/whatis
2. https://onlinecourses.swayam2.ac.in/nou22_ge73/preview

Advanced Petroleum Geology

Course Code: 246PT001

UNIT -I:

Origin, types and composition of Petroleum. Unconventional hydrocarbons, Depositional environment and its impact on reservoir characteristics

UNIT-II:

Measurement of statistical grain size parameters and their influence on textures of reservoir rocks

UNIT-III:

Provenance study and their role in characterization of reservoir rock. Heavy minerals.

UNIT-IV:

Distribution of Oil & gas fields in NE India. Future exploration targets in NE India

UNIT-V:

Collection of data before, during and after drilling a well. Geological mapping- measurement of dip & strike and thickness of beds.

Text Books:

1. Elements of Petroleum Geology, Richard C Shelly, Academic Press, An Imprint of Elsevier. ISBN: , 9780126363708
2. Reservoir Seismology , Mamdough, R. Gadallah, Pennwell Books, Pennwell Publishing Company, Tusa, Oklahoma. ISBN: 0-87814-411-0

Reference Books:

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip. ISBN: 978-2710806998
2. Exploration Geophysics: An Introduction, M.Gadallah, R.Fisher, Springer Publications. ISBN: 978-3-540-85160-8

Web Links:

1. <https://www.britannica.com/science/petroleum/Unconventional-oil>
2. <https://www.slideshare.net/slideshow/grain-sizepptx/109406202>
3. <https://eng.geus.dk/products-services-facilities/analyses/provenance-analysis>
4. https://www.fipi.org.in/assets/pdf/post-pdf/Report_6-7_February_2020_NE.pdf
5. <https://openpress.usask.ca/geolmanual/chapter/overview-of-strike-dip-and-structural-cross-sections/>

Production Engineering

Course Code: 246PT002

UNIT -I:

Recovery of Petroleum:

Primary recovery mechanism, Definitions of secondary recovery, improved oil recovery and its classification, Recovery factor, hydrostatic pressure of liquid columns, types of fluid flow into the reservoir.

UNIT-II:

Enhanced Oil Recovery

Chemical flooding by surfactant, alkali and polymer, Micellar polymer flooding,

UNIT-III:

Fluid Flow

Fluid flow through porous medium: multi-phase flow with respect to EOR-theory and application.

UNIT-IV:

Rheological Study of Reservoir Fluids

UNIT-V:

Reservoir Simulation & Modelling

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2019 ISBN: 9780750682701
2. Petroleum Production Systems, M.J. Economides, A. Daniel Hill & C.E. Economides, Prentice Hall. ISBN: 9780137031580

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.

Web Links:

1. https://petrowiki.spe.org/PEH:Oil_Reservoir_Primary_Drive_Mechanisms
2. <https://www.japex.co.jp/en/technology/research/eor/>
3. https://www.researchgate.net/publication/234150794_Multiphase_Fluid_Flow_Through_Porous_Media
4. <https://nordicrheologysociety.org/Content/Transactions/2012/2%20Roenningsen%20Rheology%20of%20Petroleum%20fluids.pdf>
5. <https://www.spe-aberdeen.org/wp-content/uploads/2018/06/Devex-2018-Introduction-to-Reservoir-Simulation.pdf>

Reservoir Engineering-I

Course Code: 246PT003

UNIT -I:

Fluid flow in reservoirs: Darcy's law; Classification of reservoir flow systems; Steady-state flow equations for the flow of incompressible, compressible, and slightly compressible fluids.

UNIT-II:

Solutions to the radial diffusivity equation: Unsteady-state flow and derivation of radial diffusivity equation CTR solutions to diffusivity equations; Pseudo steady-state flow equations; Principle of superposition, Transient well testing.

UNIT-III:

Reservoir Drive Mechanisms: Primary recovery mechanisms and their effects on the performances of oil reservoirs.

UNIT-IV:

Principles of Waterflooding– conventional and hybrid methods.

UNIT-V:

Reserve Estimation: Resource & reserve concept, Different reserve Estimation Techniques: Volumetric, MBE, decline curve analysis.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P.Dake, Elsevier science ISBN: 9780080568980
2. Applied Petroleum Reservoir Engineering, Third Edition, B.C Craft and M.Hawkins, Revised By Ronald E.Terry & J.Brandon Rorgers, Prentice Hall, New York. ISBN: 9780133155617

Reference Books:

1. Reservoir Engineering Handbook, Tarek Ahmed, 4th Edition, Gulf Professional Publishing. ISBN: 9781856178037
2. Basic Reservoir Engineering, Rene Cosse, Editions, Technip ISBN: 9782710806301

Web Links:

1. <https://byjus.com/physics/darcys-law/>
2. <https://www.scribd.com/document/342880137/1-Derivation-of-the-Diffusivity-Equation>
3. https://petrowiki.spe.org/PEH:Oil_Reservoir_Primary_Drive_Mechanisms
4. <https://www.intechopen.com/chapters/68009>
5. http://wiki.aapg.org/Reserves_estimation

Production Technology-I

Course Code: 246PT004

UNIT -I:

Self flowing & Artificial lift methods:

Self-flowing mechanisms, artificial lift-types, Gas lift, SRP, ESP, Jet Pump

UNIT-II:

Improved Oil Recovery:

Secondary recovery-water flooding & gas injection, Enhanced Oil Recovery-types & selection mechanisms

UNIT-III:

Flow assurance:

Sick well, problem well types & solutions-water & gas cut, scale formation, high viscosity oil, limited production rate, etc.

UNIT-IV:

IV Well Perforation

Introduction, Well Perforating Methods, Perforating Gun Types, Shaped Charge, Type, Size, Depth and Orientation of perforation holes, Shot Density, Standoff, Explosives in perforation, Explosive Train.

UNIT-V:

Well Stimulation Techniques

Importance of Well Stimulation, Acid Solutions for Acidizing, Acid Additives, Matrix Acidizing, Fracture Acidizing, Hydraulic Fracturing, Wave Technology, Microbial Stimulation.

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2019 ISBN: 9780750682701
2. Petroleum Production Systems, M.J. Economides, A.Daniel Hill &C.E.Economides, Prentice Hall. ISBN: 9780137031580

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books. ISBN: 9780878140312

Web Links:

1. <https://www.learntodrill.com/post/artificial-lift-system-functions>
2. <https://www.intechopen.com/chapters/70319>
3. <https://www.scribd.com/presentation/312562253/2-1-Sick-Well-Analysis>

4. <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-perforating>

Petroleum Sedimentology

Course Code: 246PT005

UNIT -I:

Classification of sedimentary rocks. Sandstone diagenesis and its impact on reservoir characteristics

UNIT-II:

Types of organic matters in sediments. Role of time and temperature in maturation of sediments (TTI)

UNIT-III:

Hydrocarbon Source Rock analysis: TOC, whole rock analysis and kerogen analysis

UNIT-IV:

Well logging and their application in reservoir studies.

UNIT-V:

Structure contour map, isopach map, iso facies map and its application. Application of Scanning Electron Microscope (SEM) in reservoir studies.

Text Books:

1. Petroleum Engineering Handbook: Volume I, edited by Larry W. Lake, Richard J. Heald, and William J. Meyer, Society of Petroleum Engineers, 2006, ISBN: 9781555631024.
2. Sedimentology and Sedimentary Basins: From Turbulence to Tectonics, Mike R. Leeder, Cambridge University Press, 2nd Edition

Reference Books:

1. The Petroleum System: From Source to Trap, **edited** by M. A. K. Moore and D. E. Schenk, Cambridge University Press, 1998, ISBN: 9780521625859.
2. "Petroleum Geochemistry and Exploration" edited by P. R. T. Williams and J. M. L. McKillop

Web Links:

1. https://www.degruyter.com/document/doi/10.1515/geo-2019-0004/html?srsId=AfmBOoqczR4RbENSIEEisREBX-2B_daS5QqGSHDMHoriMuzSSDIEbD-u
2. <https://pubs.geoscienceworld.org/aapg/aapgbull/article/64/6/916/37275/Time-and-Temperature-in-Petroleum-Formation>
3. <https://www.appt-int.com/glossary/toc-and-rock-eval>
4. http://wiki.aapg.org/Well_log_analysis_for_reservoir_characterization

Reservoir Engineering-II

Course Code: 246PT006

UNIT -I:

Reservoir Rock and Fluid Properties: Phase behaviour and phase diagrams; Fluid composition and fluid types classification; Natural gas properties; Crude oil properties; Formation water properties; Porosity; Permeability; Fluid saturations; Wettability; Surface forces and Capillary pressure; Rock Compressibility.

UNIT-II:

Routine and special core analysis: Core preparation; Routine core analysis for the determination of porosity and permeability of reservoir cores; Special core analysis like IOR/EOR studies, wettability determination, and reservoir condition core floods.

UNIT-III:

Laboratory analysis of reservoir fluids.

UNIT-IV:

Reservoir engineering aspects of enhanced oil recovery methods: Fractional flow equation; Buckley-Leverett frontal advance equation; Oil recovery mechanisms; Concepts of enhanced oil recovery methods.

UNIT-V:

Immiscible displacement process: Fractional flow and fractional displacement process in linear reservoir, Buckley and Leverett treatment Reservoir, Decline curve analysis. Gas, gas-condensate and oil reserves: Identification from fluid composition, Performance of volumetric reservoir, Production characteristics.

Text Books:

1. Applied Petroleum Reservoir Engineering, B. C. Craft and M. Hawkins, Revised by Ronald E. Terry & J. Brandon Rogers, Prentice Hall, Third Edition, 2014, ISBN: 9780133372682.
2. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).

Reference Books:

1. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006, ISBN: 9780120887789.
2. Petroleum Reservoir Engineering, James W. Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw-Hill, 1960, ISBN: 9780070342963.

Web Links:

1. <https://www.slideshare.net/slideshow/reservoir-rock-fluid/46167244>
2. <https://www.slideshare.net/slideshow/routine-core-analysis-and-special-core-analysis-142124816/142124816>
3. <http://sb.uta.cl/ebooks/Reservoir%20Engineering%20Handbook/3-s2.0->

- [B9781856178037500110-main.pdf](#)
4. https://www.researchgate.net/publication/343400229_In_Reservoir_Engineering_Method_Buckley-Leverett_method_in_water_Flooding_approach_prepared_by_Mahdi_Mohsen
 5. <https://perminc.com/resources/fundamentals-of-fluid-flow-in-porous-media/chapter-4-immiscible-displacement/buckley-leverett-theory/>

Petroleum Economics & Environmental Management

Course Code: 246PT007

UNIT -I:

Application of petroleum engineering principles and economics to the evaluation of oil and gas projects, evaluation principles, time value of money concepts, investment measures, cost estimation, price and production forecasting, risk and uncertainty, project selection and capital budgeting inflation, escalation, operating costs, depreciation, cost recovery.

UNIT-II:

Petroleum exploration and production contracts. Sharing of the economic rent, portfolio management. Value creation, corporate finance & return on capital, economic appraisal methods for oil field development, reservoir model costs and calculations.

UNIT-III:

Case studies: Economic study of an oil field development project, petrochemical plant project, natural gas break-even price, natural gas liquefaction cost, LNG transport cost, investment profitability study for a gas pipeline.

UNIT-IV:

Principles and concept pertaining to the environment (a) Physical, chemical and biological factors governing the environment (b) Climate, ecosystem, food chains (c) Air, water, land and noise pollution and its abatement (d) Soil erosion, conservation and watershed management (e) Preservation of natural environment and control of degradation by artificial means, vegetation and its management, global warming and ozone depletion. Environmental issues considered during exploration, refining and marketing of crude oil and its product. Oil spill prevention and control.

UNIT-V:

Treatment of produced oil field water and refinery waste water. Pollution by hydrocarbon processing industries and their control. Environmental management strategies. Safety in oil industries

Text Books:

1. **Industrial Economics – An Introductory Textbook**, R. R. Barthwal, 2nd Edition, New Age International Publisher, Year Unknown, ISBN: 9788122421690.
2. **Managerial Economics**, D.N. Divedi, 6th Revised Edition, Vikas Publishing House Private Ltd, Year Unknown, ISBN: 9789325977235.

Reference Books:

1. Petroleum Engineering Handbook. Bradely, H.B. Society of Petroleum Engineers. Richardson. Texas.
2. The Encyclopedia Americana, International Edition Volume 9, Grolier Incorporated.

Web Links:

1. https://petrowiki.spe.org/PEH:Petroleum_Economics
2. https://dghindia.gov.in/assets/downloads/56cee2dfb848d4_MPSC_NELP-IV.pdf
3. https://journals.ut.ac.ir/article_53519_749a3af7ecbd9babefd0fd39dc3e2055.pdf
4. <https://vardhaman.org/wp-content/uploads/2021/03/ENVIRONMENTAL-SCIENCE-1.pdf>
5. <https://www.intechopen.com/chapters/86156>

Drilling Fluids

Course Code: 246PT008

UNIT -I:

Introduction to Drilling Fluids

Functions of Drilling Fluids, Composition of Drilling Fluids, Properties of Drilling Fluids, Drilling Fluid Selection, Mud Handling Equipment, Clay Mineralogy and the Chemistry of Drilling Fluids.

UNIT-II:

Drilling Fluid Components

Viscosifiers, Weighing materials, Chemical additives, Emulsifiers, Lost circulation materials, Fluid loss reducers, Special additives

UNIT-III:

The Rheology of Drilling Fluids

Laminar Flow Regime, Turbulent Flow Regime, Influence of Temperature and Pressure on the Rheology of Drilling Fluids, Rheological Properties Required for Optimum Performance, The Importance of Hole Stability.

UNIT-IV:

The Filtration Properties of Drilling Fluids

Static Filtration, The Filter Cake, Dynamic Filtration, Filtration in the Borehole

UNIT-V:

Additives

Oil-base and Saline mud system. Additives used to control drilling fluid system

Text Books:

1. Drilling Fluids Processing Handbook, J.J. Azar and D. Robello Samuel, Elsevier, Year Unknown, ISBN: 9781856176760.
2. Drilling Fluids: Rheology, Chemistry, and Technology, J. S. McKee and L. L. Schulte, Gulf Professional Publishing, Year Unknown, ISBN: 9780884151325.

Reference Books:

1. Drilling Fluids Processing Handbook, J.J. Azar and D. Robello Samuel, Elsevier, 2007, ISBN: 9781856176760.
2. Drilling Fluids: Rheology, Chemistry, and Technology, J. S. McKee and L. L. Schulte, Gulf Professional Publishing, 1997, ISBN: 9780884151325.

Web Links:

1. <https://www.slideshare.net/sehamjalal/drilling-fluids>
2. <https://www.slb.com/products-and-services/innovating-in-oil-and-gas/well-construction/drilling-fluids/drilling-fluid-additives>
3. <https://www.intechopen.com/chapters/83531>
4. <https://onepetro.org/JPT/article/6/02/30/162394/Filtration-From-Mud-During-Drilling>
5. <https://www.oil-drilling-fluids.com/oil-based-mud-system>

Drilling Technology

Course Code: 246PT009

UNIT-I:

Introduction: Objective, scope and outcome of the course.

UNIT-II:

Down Hole Motors: Positive displacement motors and Turbo-drills – motor description, Power calculation and applications

UNIT-III: Horizontal Well Drilling: Horizontal well objectives and selection, Different profiles, Drilling techniques.

Down the Hole Well Surveying: Well surveying objectives, Surveying methods, Surveying Analysis.

UNIT-IV: Measurements While Drilling: Objectives of MWD/ LWD, MWD tools, Telemetry system and data interpretation.

UNIT-V: Special Methods of Drilling: Aerated drilling, Under-Balanced drilling, Overbalanced drilling, HPHT Drilling, Plasma drilling, Top drive drilling, Re-entry drilling, Jet Drilling, Extended reach drilling, Multilateral drilling, Slim hole drilling, coil tubing drilling.

Textbooks:

1. Drilling Engineering, J.J. Azar and C. Robert Montgomery, Elsevier, 2007, ISBN: 9781856176760.
2. Horizontal Directional Drilling: Principles and Practices, Gary W. Smith, ASCE Press, 2011, ISBN: 9780784411145.

Reference Books:

1. Drilling Fluids Processing Handbook, J.J. Azar and D. Robello Samuel, Elsevier, 2007, ISBN: 9781856176760.
2. "Drilling Technology" by B. C. K. Chapman and C. R. (Ron) Flemming

Web links:

1. <https://www.studocu.com/in/document/engineering-college-ajmer/computer-science/unit-1-coa-notes/90280617>
2. <https://www.scribd.com/doc/184101346/Directional-Drilling>
3. <https://www.slideshare.net/slideshow/horizontal-drilling/42205228>
4. <https://www.slideshare.net/slideshow/mwd-projectgroup-new/50422273>
5. <https://www.api.org/oil-and-natural-gas/wells-to-consumer/exploration-and-production/natural-gas/advanced-drilling>

Production Technology-II

Course Code: 246PT010

UNIT-I:

Oil Recovery Methods:

Self-flowing & Artificial lift methods, Secondary recovery-water flooding & gas injection, Enhanced Oil Recovery-types & selection mechanisms

UNIT-II:

Well completion:

Well completion, completions-Gas Lift, SRP, ESP, Jet Pump, Multi-zone completion, well activation.

UNIT-III:

Performance Evaluation:

Drawdown and Productivity Index (PI), Specific Productivity Index (SPI), Inflow performance relationship (IPR), vertical lift performance-flow regime in vertical two-phase flow, stable and unstable flowing conditions, choke performance, Nodal analysis

UNIT-IV:

Sick well analysis:

Sick well, limited production rate, water production problems in oil wells, mechanical failures, problem well analysis checklist.

UNIT-V:

Work Over and Well Simulation :

Work Over- Workover Rigs: Types & selection, Workover & Completion Fluids. Well Stimulation - Type & description of stimulation techniques, Design of matrix acidization and acid fracturing. Design of hydraulic fracturing

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2019 ISBN: 9780750682701
2. Petroleum Production Systems, M.J. Economides, A.Daniel Hill &C.E.Economides, Prentice Hall. ISBN: 9780137031580

Reference Books:

1. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books. ISBN: 9780878140312
2. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.

Web links:

1. <https://www.e-education.psu.edu/png301/node/642>
2. <https://kh.aquaenergyexpo.com/wp-content/uploads/2023/01/Well-Completion-Program-.pdf>
3. <https://www.slideshare.net/slideshow/nodal-analysis-introduction-to-inflow-and->

- [outflow-performance-next/69360790](#)
4. <https://www.scribd.com/document/370793281/Sick-Well-Analysis>
 5. <https://onepetro.org/books/book/34/chapter/10919135/Well-Completions>

Oil and Gas Economics and Risk Management

Course Code: 246PT011

UNIT-I

Introduction:

The development of Oil & Gas Industry, Structure of Oil & Gas Industry, India Hydrocarbon vision 2025; Petroleum Resource classification, Analysis of resource management.

UNIT-II

Natural Gas:

Introduction, Natural Gas Measurements; Demand, Supply & Storage of natural gas: Gas production, Source of demand in India, The supply system, Gas Sales Pattern in India, Gas Pipeline Regulations in India, Gas Trading, Gas Pricing.

UNIT-III

International & National Institutions of Oil & Gas:

API, OPEC, OECD, OADB, DGH, PNGRB, CHT, PII, PPAC, PCRA.

UNIT-IV

Petroleum Contracts:

NELP - Role & Background, Types of Contracts and fiscal components, Production sharing contracts in India, Crude Oil trading and pricing, CBM Contracts.

UNIT-V

Trade Practices & Taxation:

Norms on various trade practices, Elements of Petroleum Development Policy, Financial and taxation issues; Risk Management: source of risk, managing risks by risk reduction, diversification, and uncertainty and decision analysis by decision tree.

Text books:

1. Mark Cook., Petroleum Economics and Risk Analysis: A Practical Guide to E&P Investment Decision-Making (Volume 71) (Developments in Petroleum Science, Volume 71) Paperback – Import, 29 January 2021. ISBN: 0128211903.
2. Gerardo Portela Da Ponte., Risk Management in the Oil and Gas Industry Offshore and Onshore Concepts and Case Studies 1st Edition - June 9, 2021. ISBN: 9780128235331.

Reference books:

1. K. A. Alal and Mohamed A - Petroleum and Gas Field development.
2. Satter Abdus; Integrated Petroleum Reservoir Management.

Web links:

1. <https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Oil%20and%20Gas%20Industry.pdf>
2. <https://www.slideshare.net/slideshow/natural-gas-in-india/14819696>
3. <https://guides.loc.gov/oil-and-gas-industry/organizations>
4. https://ibm.gov.in/writereaddata/files/17125771166613da5c80e71Petroleum_and_Natural_Gas_2022.pdf
5. <https://www.elibrary.imf.org/view/book/9780415781381/ch007.xml>

Enhanced Oil Recovery Techniques

Course Code: 246PT012

UNIT-I

Principles and Mechanism:

Screening criteria, Macroscopic displacement of fluids: Areal sweep efficiency. Vertical sweep efficiency Displacement efficiency, mobility ratio, well spacing.

UNIT-II

Water flooding in reservoir:

Equation of motion. Continuity, solution methods, Pattern flooding, recovery etc., permeability heterogeneity.

UNIT-III

Chemical flooding: Polymer flood;

mobility control in-situ permeability modification, foam flooding; WAG process. Surfactant flooding, miscellar/polymer flooding, micro emulsion phase behavior, wettability modification, Alkaline flooding.

UNIT-IV

Miscible displacement processes:

miscibility condition, high pressure gas injection, enriched gas injection, LPG flooding, carbon dioxide flooding, alcohol flooding.

UNIT-V

Thermal Recovery processes:

Hot water flooding, steam flooding, cyclic steam injection, in-situ combustion, air requirement; combustion front monitoring, microbial oil recovery.

Text books:

1. Bradley H B, Petroleum Engineering Handbook, third edition, SPE.
2. Enhanced Oil Recovery; Teknica; Teknica Petroleum Services Ltd.; Calagry, Alberta.

Reference books:

1. Larry Lake; Russell T. Johns; William R. Rossen; Gary A. Pope., Fundamentals of Enhanced Oil Recovery, 2014, ISBN: 978-1-61399-885-4
2. Enhanced Oil Recovery, D.W. Green and G.P. Willhite, Society of Petroleum Engineers (SPE), 2003, 556 pp, ISBN: 9781555631031.

Web links:

1. <https://perminc.com/resources/fundamentals-of-fluid-flow-in-porous-media/chapter-4-immiscible-displacement/vertical-volumetric-sweep-efficiencies/>
2. <https://wiki.aapg.org/Waterflooding>
3. <https://guides.loc.gov/oil-and-gas-industry/organizations>
4. <https://perminc.com/resources/fundamentals-of-fluid-flow-in-porous-media/chapter-5-miscible-displacement/>
5. <https://www.slideshare.net/slideshow/eor-thermal-steam-injectionpdf/256197042>

Drilling Engineering Hydraulics

Course Code: 246PT013

UNIT-I

Types of drilling fluid, components of drilling fluid system: bentonite types and hydration characteristics

UNIT-II

Fluid-loss characteristics and characteristics of Filter cake

UNIT-III

Oil-base and Saline mud system. Additives used to control drilling fluid system

UNIT-IV

Oil-well cements; composition, cement slurry components

UNIT-V

Cement-slurry preparation and down hole displacement processes and system

Text books:

1. Adams, Neal J. Drilling Engineering: A Complete Well Planning Approach. Pennwell Books Publishing Company, 2004. ISBN: 978-1593700193.
2. Baker Hughes. Drilling Engineering Workbook. Baker Hughes, 2015. ISBN: 978-0989541907.
3. Wake, Larry W. Handbook of Petroleum Engineering Volume II: Drilling Engineering. Society of Petroleum Engineers, 2000. ISBN: 978-1-55563-126-0.

Reference books:

1. Gatlin, C. Petroleum Engineering: Drilling and Well Completions. Prentice Hall, 1984. ISBN: 978-0130253366.
2. Azar, J. J., and Robello Samuel, G. Drilling Engineering. PennWell, 2007. ISBN: 978-1593700780.
3. Gulf Publishing Company. Drilling Mud and Cement Slurry Rheology Manual. Gulf Publishing Company, 1992. ISBN: 978-0886981745.
4. Smith, P.K. Cementing. Society of Petroleum Engineers (SPE) Publications, 2nd Edition, 1976. ISBN: 978-0891813089

Web links:

1. <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-drilling-fluids>
2. <https://www.witpress.com/Secure/elibrary/papers/MPF07/MPF07017FU1.pdf>
3. <https://www.oil-drilling-fluids.com/oil-based-mud-additives-obm>
4. <https://www.bricknbolt.com/blogs-and-articles/construction-guide/oil-well-cement>
5. <https://www.slideshare.net/slideshow/cementation-46169143/46169143>

Exploration and Formation Evaluation of Oil and Gas Reservoirs

Course Code: 246PT014

UNIT-I

Gravity, introduction to Geophysical Methods:

the Role of Non-Seismic Methods in the E& P Business, Gravity Surveying, Determination of Contour Map anomalies, Calculation of Gravity Responses, Determination of Gravity Resolution of Bodies, anticlines and Faults,

UNIT-II:

Depth Estimation Methods:

Half- Width, Gradient-Amplitude, Exercises on Paper and Using Computer Software Magnetics and Electrical Methods, introduction to Magnetic and Electrical Methods, Gravity and Magnetic Signatures, (Poisson's), Relationship Between Gravity and Magnetic Responses,

UNIT-III:

Electrical Measurement Methods:

Calculations of Resistivity Profiles, Effective Resistivity, Exercises on Paper and Using Computer Software Electrical and Electro-Magnetic (EM) Methods, EM: Diffusion Or Wave-Propagation? Land EM: TEM Surveying,

UNIT-IV

Production Logging:

Well Logging for Metallic and Non-Metallic Minerals: Radioactive and Nonradioactive Evaporates, Coal, Sulphur. Borehole Geophysics for Groundwater Exploration., Effective Pay Thickness of an aquifer.

UNIT-V:

Porosity, Permeability, Resistivity, Water and Hydrocarbon Saturations, and Movable Oil. Subsurface Correlation of formations and interpretation of Field Data.

Text Books:

1. Kearey, P., Brooks, M., & Hill, I. An Introduction to Geophysical Exploration. John Wiley & Sons, 2013. ISBN: 978-1405182191.
2. Telford, William Murray, Geldart, Lloyd P., & Sheriff, Robert E. Applied Geophysics, Vol. 1. Cambridge University Press, 1990. ISBN: 978-0521423658..

Reference Books:

1. Helander, D.P. Fundamentals of Formation Evaluation. Society of Petroleum Engineers, 1987. ISBN: 978-1555630439.'
2. Dewan, J.T. Essentials of Modern Open-Hole Log Interpretation. PennWell Books, 1983. ISBN: 978-0878142466.

Web links:

1. <https://www.nexttraining.net/course/non-seismic-geophysical-methods/1138>
2. <https://www.intechopen.com/chapters/45989>
3. <https://library.nexteinstein.org/wp-content/uploads/2022/04/felix2007-8.pdf>
4. <https://iie.edu.in/wp-content/uploads/2024/08/20210303103833742.pdf>

Offshore Drilling and Production Practices

Course Code: 246PT015

UNIT-I:

Ocean Environment for installation, Operation and Survival Condition; Exploratory, Production, Storage and Transportation, Platform installation and Positioning, Subsea Preparation.

UNIT-II:

Deep-Water Platforms:

FPSO, Semisubmersible, TLP and Spar with Case Studies including Transportation by Tankers and Pipelines. Difference Between onshore Drilling and offshore Drilling.

UNIT-III:

Unconventional and Conventional Resources and Environmental Effects, Digital Oil Field, Oil Processing Facilities and Gas Processing Facilities: Upstream Well Planning, Risers for Shallow and Deep-Water Platforms,

UNIT-IV:

Corrosion inhibition in Pipelines, Case Studies on offshore Drilling Worldwide, Oil Spill and Safety Measures. anchors: Pile, Suction, torpedo, Dead Weight, Mushroom Etc. Calm, SPM, Mooring Dolphins and Booms, Selection Criteria, Moorings with and Without Buoys, Mooring alternatives

UNIT-V:

Dynamic Positioning Systems (DPS), Remotely Operated Vehicles (ROV) and Its Types. Viv in offshore Pipelines, Umbilical's and Risers, and Its Mitigation Measures.

Text Books:

1. Chakrabarti, Subrata K. Handbook of Offshore Engineering, Volume 1 and 2. Elsevier, 2005. ISBN: 978-0080442906.
2. Tsinker, Gregory. Marine Structure Engineering: Specialized Applications. Springer, 1995. ISBN: 978-3540588767.

Reference Books:

1. Speight, James G. Handbook of Offshore Oil and Gas Operations. Elsevier, 2011. ISBN: 978-1856177668.
2. Sukumar, Laik. Offshore Petroleum Drilling and Production. CRC Press, 2018. ISBN: 978-0367334682..

Web links:

1. <https://doe.iitm.ac.in/OECourses/PE/PE5050.pdf>
2. <https://blog.armoda.com/types-of-offshore-drilling-platforms>
3. <https://new.abb.com/oil-and-gas/production-book/facilities-processes>
4. https://archive.physionet.org/physiotools/deid/dict/sno_edited.txt
5. <http://www.shipseducation.com/info/offshore/dynamic-position-5.html>

Surface Facility for Oil and Gas Handling

Course Code: 246PT016

UNIT-I:

Two and Three Phase Separators, Emulsion Treatment theory and Practice, Emulsifiers & Demulsifiers, Coalescence, Coalescing Media, Electrostatic Coalescers. Natural Gas Dehydration,

UNIT-II:

Glycol Process:

Effect of Variables, Natural Gas Sweetening: Effect of Variables. Evaporative Emissions, Storage Tanks, Strategic Storage.

UNIT-III:

Mechanism of Heat Transfer, Process Heat Duty, Sensible Heat of Natural Gas, Water, Heat Transfer from a Fire-Tube, Heat Exchangers- Types, Sizing, Number of Tubes.

UNIT-IV:

Pressure Vessel Design, Wall Thickness and Stress, Corrosion allowance. Pressure Relief and Safety System, Valves, Fittings and Piping's. Material Considerations. Natural Gas Handling Compressors- Reciprocating, Centrifugal and Other Types. Surge Control, Process Parameters, Compressor Selection Calculations. Pumps on the Surface Facilities, Selections

UNIT-V:

Prime Movers:

Internal Combustion Engines, Fuel, Gas Turbine Engines, Construction and Mechanism of the Engines, Pollutions

Text Books:

1. Stewart, Maurice, & Arnold, Ken. Surface Production Operations (Vol I & II). Gulf Professional Publishing, 2007. ISBN: 978-0884158831.
2. Stewart, Maurice. Surface Production Operations (Vol III & IV). Gulf Professional Publishing, 2018. ISBN: 978-0128046971.

Reference Books:

1. Lyons, William C., & Plisga, Gary J. Standard Handbook of Petroleum and Natural Gas Engineering. Gulf Professional Publishing, 2005. ISBN: 978-0750676807.
2. Lyons, William C., & Plisga, Gary J. Standard Handbook of Petroleum and Natural Gas Engineering. Gulf Professional Publishing, 2004. ISBN: 978-0750677851.
3. Lake, Larry W. Petroleum Engineering Handbook, Vol-III. Society of Petroleum Engineers (SPE), 2007. ISBN: 978-1555631313.
4. Szilas, A. P. Production and Transportation of Oil and Gas, Part B. Elsevier, 1986. ISBN: 978-0444425123.

Web links:

1. <https://www.scribd.com/document/476025917/EMULSIONS-ELECTROSTATIC-SEPARATORS>
2. <https://www.ijres.org/papers/Volume-10/Issue-3/Ser-6/J10034550.pdf>

3. <https://archive.nptel.ac.in/content/storage2/courses/103103027/pdf/mod1.pdf>
4. <https://f.nordiskemedier.dk/2km5j4ndxxlw6h6a.pdf>

Reservoir Simulation

Course Code: 246PT017

UNIT-I:

Derivation of Partial Differential Equations Governing Single and Multi-Phase Fluid

UNIT-II:

Flow Through Petroleum Reservoirs; Conceptual, Mathematical and Numerical Modelling Principles;

UNIT-III:

Introduction to Elliptic, Parabolic and Hyperbolic Partial Differential Equations; introduction to Finite Difference Techniques

UNIT-IV:

Introducing Numerical Modelling Concepts on thermal/Microbial Enhanced Oil Recovery Techniques.

UNIT-V:

Fluid Flow Through Fractured/Shale-Gas/Coal-Bed-Methane Reservoirs Using Dual- Porosity approach

Text Books:

1. Chen, Zhangxin. Reservoir Simulation: Mathematical Techniques in Oil Recovery. Society for Industrial and Applied Mathematics (SIAM), 2008. ISBN: 978-0898716716..
2. Abou-Kassem, J. H., Farouq Ali, S. M., & Islam, M. R. Petroleum Reservoir Simulation: A Basic Approach. Gulf Publishing Company, 2006. ISBN: 978-0884159609.
3. Fanchi, John R. Principles of Applied Reservoir Simulation. Gulf Professional Publishing, 2005. ISBN: 978-0884159166.

Reference Books:

1. Mattax, C.C., & KYTE, R.L. Reservoir Simulation. Monograph Series, Society of Petroleum Engineers (SPE), Richardson, TX, 1990. ISBN: 978-1555631320.
2. Ertekin, T., Abou-Kassem, J. H., & King, G. W. Basic Applied Reservoir Simulation. SPE Textbook Series, Vol. 7, Society of Petroleum Engineers (SPE), 2001. ISBN: 978-1555630804.
3. Mattax, C.C., & Dalton, R.L. Reservoir Simulation. SPE Monograph Series, Society of Petroleum Engineers (SPE), 1990. ISBN: 978-1555631314.

Web links:

1. <https://www.eng.auburn.edu/~tplacek/courses/fluidsreview-1.pdf>
2. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/reservoir-modeling>
3. <https://egyankosh.ac.in/bitstream/123456789/12560/1/Unit-11.pdf>
4. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9660592/>
5. <https://etd.lib.metu.edu.tr/upload/12615510/index.pdf>

Artificial Lift Technology for Oil and Gas Production

Course Code: 246PT018

Unit-I

Introduction:

Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

Unit-II

Sucker Rod lift:

Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.

Unit-III

Gas lift:

Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve continuous and intermittent gas lift advantages and limitations.

Unit-IV

Electrical submersible pumps, Progressive cavity pumping: Electrical submersible pumps (ESP)-principle-hydraulic piston pumping-ESP design-ESP advantages and limitations. Progressive cavity pumping: Plunger lift-working principle-design-plunger lift models progressive cavity pumping (PCP) advantages and limitations.

Unit -V

Hydraulic Jet pumping: Hydraulic Jet pumping-selection of jet pump-advantages and disadvantages. Selection of artificial lift method: artificial lift method selection-gas lift vs pump assisted lift installation and replacement of artificial lift-maintenance of artificial lift.

Textbooks:

1. Guo, Boyun, Lyons, William C., & Ghalambor, Ali. Petroleum Production Engineering: A Computer-Assisted Approach. Elsevier Science & Technology Books, 2007. ISBN: 978-1856175374.
2. Clegg, Joe Dunn, & Lake, Larry W. Petroleum Engineering Handbook – Production Operations Engineering, Volume 4. Society of Petroleum Engineers (SPE), 2006. ISBN: 978-1555631413.

Reference Books:

1. Economides, M. J., Hill, A. Daniel, & Economides, C. E. Petroleum Production Systems. Prentice-Hall, N.J., 1994. ISBN: 978-0136559785..
2. Brown, K.E. The Technology of Artificial Lift Methods, Volume 1-4. PennWell Books, Tulsa, Oklahoma, 1977. ISBN: 978-0878140737.
3. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.

Web links:

1. <https://bhagwantuniversity.ac.in/wp-content/uploads/2016/01/ARTIFICIAL-LIFT-METHODS.pptx>
2. <https://www.slb.com/products-and-services/innovating-in-oil-and-gas/completions/artificial-lift/sucker-rod-pumps>
3. <https://www.pumpsandsystems.com/electrical-submersible-progressing-cavity-pump-systems>
4. <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-esp>
5. <https://www.learntodrill.com/post/artificial-lift-system-functions>

Production Chemicals & Oil Field Chemistry

Course Code: 246PT019

UNIT-I

Introduction

Role of specialty of production chemicals- Functions, selection and types of drilling mud- Classifications and compositions of drilling mud- Dispersed non-inhibited systems- Chemicals: additives, thickener- Drilling fluid disposal, characterization of drilling fluids- Fluid loss additives- Clay stabilization: types and swelling impedes- Mechanisms causing instability, inhibitors of swelling- Chemicals in detail

UNIT-II

Oilfield Metallurgy

Dispersant: low molecular weight dispersant, synthetic, alternative and co-polymers- Natural modified polymers, dispersant for “S”- Reservoir: Bacteria control, mechanisms of growth, Detection of bacteria, mathematical model- Treatments with biocides, non-biocide control- Various biocides- Bacterial corrosion- Water shutoff

UNIT- III

Corrosion in the Oil Field

Production: Corrosion inhibitors: classification and fields of application- Scale removal treatment, application techniques, amides- Nitrogen based- Poly amine derivatives- Imidazoline corrosion inhibitor, azoles- Carbonyl compounds- Scale inhibitors- Gelling agents

UNIT – IV

Oil Field Chemicals

Oil spill- Chemicals in detail- EOR- Polymers- Chemicals in detail- Hydraulic fracturing fluids, Types and characterization- Oil based system- Foam based system, clay stabilization, fluid loss additives, drilling muds, bit lubricants, bacteria control, corrosion inhibitors, scale inhibitors, gelling agents.

UNIT- V

Polymer Material

Introduction Polymers and Additives for Cements Corrosion, Asset Integrity Management and Monitoring Standards and Testing. Nanomaterials and Nano-composites, Elastomers and Thermosets for downhole applications Pipes.

Text Books:

1. Borchardt, J.K., & Yen, T.F. Oil-Field Chemistry, Enhanced Recovery and Production Stimulation. 1st Edition, 1988. ISBN: 978-0878144285.
2. DiStasio, J. I. Chemicals for Oil Field Operations. 1st Edition, 1981. ISBN: 978-0878143387.

Reference Books:

1. L.J. Zitha, “Well Treatments and Water Shut-off by Polymer Gels”, 2000.
2. L.L. Schramm, “Surfactants Fundamentals and Applications in the Oil Industry”- 2000.

Web links:

1. <https://onepetro.org/books/book/74/chapter/14367196/Drilling-Fluids>
2. <https://oilindustry.ir/Upload/782RE-002-Petroleum%20Engineer's%20Guide%20to%20Oil%20Field%20Chemicals%20and%20Fluids.pdf>
3. <https://patents.google.com/patent/CN112771207A/en>
4. <https://www.sciencedirect.com/book/9780123838445/petroleum-engineers-guide-to-oil-field-chemicals-and-fluids>

Flow Assurance

Course Code: 246PT020

UNIT-I

Introduction to flow assurance; Pipe friction; Friction in Non-circular pipes; Friction loss in components.

UNIT-II

Non-Newtonian Fluid & Friction; Transient flow; Transient flow; Simplified liquid flow solution; Heat Transfer Fundamentals; U-Value; Steady State / Transient Heat Transfer; Thermal management strategy and Insulation; Simulation Results & Program Testing.

UNIT-III

Composition & properties of Hydrocarbons; Emulsion, Phase Behavior, Hydrocarbon Flow; Single, two, three & four phase regimes; conservation equations; 2 & 3 fluid models; friction, deposition & entrainment, solving two-phase three fluid equations; gas & Liquid slug including boiling & condensation.

UNIT-IV:

Hydraulics Two Phase Liquid-Liquid Flow; Two Phase Liquid-Gas Flow, Two Phase Liquid-Solid Flow; Three Phase Gas-Liquid-Liquid Flow; Three phase Gas-Liquid-Solid Flow

UNIT-V:

Hydrates, Wax & Asphaltenes Physics & Phase Behavior; Hydrate Prevention; Hydrate Remediation; Hydrate Control Design Philosophies; Recovery of Thermodynamic Hydrate Inhibitors. Wax; Wax Management; Wax remediation; Asphaltenes; Asphaltene control design philosophies

Text Books:

1. Bai, Yong & Bai, Qiang. Subsea Engineering Handbook. Gulf Professional Publishing, 2005. ISBN: 978-0750678537
2. “Pipe Flow-1 Single Phase Flow Assurance” – Over Bratland (e-Book)
3. “Pipe Flow-2 Multi Phase Flow Assurance” – Over Bratland (e-Book)

Reference book:

1. Sloan, Dendy, et al. Natural Gas Hydrates in Flow Assurance. Gulf Professional Publishing, 2008. ISBN: 978-0750681599.

Web links:

1. <https://drbratland.com/PipeFlow1/index.html>
2. <https://www.thermopedia.com/pt/content/985/>
3. <https://patents.google.com/patent/CN112771207A/en>
4. <https://files.engineering.com/download.aspx?folder=7579835a-8d24-405b-aa44-ddb87c07e1ba&file=PipeFlow2Multi-phaseFlowAssurance.pdf>