Savitribai Phule Pune University, Pune
M.Sc. Petroleum Technology
Course Structure

Subject Name	Year	Semester	Course Type	**Course Code**	**Course Title**	**Credits**
Petroleum Technology	1	1	Core Compulsory Theory Paper	PTUT111	Fundamentals of Petroleum Geology	4
				PTUT112	Sedimentology	4
				PTUT113	Structural Geology in Petroleum Exploration	4
			Choice Based Optional Paper	PTDT114	Stratigraphy and Micropalaeontology	2
				PTDP114	Practical's related to PTDT114	2
			Core Compulsory Practical Paper	PTUP115	Practical's related to PTUT111,PTUT112,PTUT113	4
	1	2	Core Compulsory Theory Paper	PTUT121	Petroleum Geochemistry	4
				PTUT122	Depositional System Analysis and Petroliferous Basins of India	4
				PTUT123	Petroleum Exploration Techniques	4
			Choice Based Optional Paper	PTDT124	Environmental management and Economics	3.5
				PTDP124	Practical's related to PTDP124	0.5
			Core Compulsory Practical Paper	PTUP125	Practical's related to PTUT121,PTUT122,PTUT123	4
	2	3	Core Compulsory Theory Paper	PTUT231	Reservoir Dynamics	4
				PTUT232	Formation Evaluation -I	4
				PTUT233	Drilling and Well Completion	4
			Choice Based Optional Paper	PTDT234	Directional Drilling, Non-conventional Resources and Safety	3
				PTDP234	Practical's related to PTDT234	1
			Core Compulsory Practical Paper	PTUP235	Practical's related toPTUT231,PTUT232,PTUT233	4
	2	4	Core Compulsory Theory Paper	PTUT241	Reservoir Performance	4
				PTUT242	Formation Evaluation II	4
				PTUT243	Production Operations	4
			Choice Based Optional Paper	PTDT244	Mud logging and Mud Engineering	3
				PTDP244	Practical's related to PTDT244	1
			Core Compulsory Practical Paper	PTUP245	Practical's related to PTUT241,PTUT242,PTUT243	2
				PTUP246	Project Work	2

Savitribai Phule Pune University, Pune
M.Sc. Petroleum Technology
Revised syllabus w.e.f. June 2020

SEMESTER: III (20 Credits)

PTUT231: Reservoir Dynamics (4 Credits)

Unit 1.

Reservoir Geological Description: Characterisation and properties, sedimentary processes and environments related to reservoir development.

Reservoir Conditions:

Reservoir pressure: Reservoir pressure measurement, gradient, sources, anomalous pressure conditions. Reservoir temperature: temperature measurement, geothermal gradient, sources of heat energy. Phenomenon of interface amongst reservoir fluids: surface tension, interfacial tension, adhesion tension, formation of emulsion, wet ability, capillary pressure, and influence of these properties on oil and gas displacement in reservoir. Viscosities of water, natural gas and oil.Fluid compressibility under reservoir conditions.

Reservoir static and dynamic modelling

Drive Mechanisms: Natural sources of energy and their characteristics.

a) Dissolved gas drive b) Gas cap drive c) Water drive d) Gravitational segregation
e) Combination drive.

Unit 2:

Types of Petroleum Reservoirs:

a) Saturated and under saturated reservoirs b) Volumetric and non-volumetric reservoirs c) Finite and infinite reservoirs d) Gas reservoirs: perfect gas law, specific gravity of gases, real gases, gas volume factor, densities and gradients. e) Gas condensate reservoirs: characteristics. f) Under saturated oil reservoirs: solubility of gas, formation volume factor, compressibility of reservoir fluids**.**

Mechanics of Fluid Flow In Porous Media : Classification of reservoir fluid flow system, Darcy's law, linear flow of incompressible fluid – steady state, radial flow of incompressible fluid – steady state, Poiseuille's law for capillary flow – unsteady state, radial flow of compressible fluid (diffusivity equation and its applications.)

Unit 3:

Influence of Reservoir Conditions on Producing Characteristics of an Oil Well

a) Pressure conditions around a flowing well. b) Effect of following on pressure conditions in reservoir: Permeability and thickness of formation, rate of production, gas and water coning, WOR, GOR, casing and channel leak, stratified formation, gas and water production trends in reservoir.

PVT Studies: Obtaining the data and evaluation**.**

Unit 4:

Estimation of Hydrocarbon Reserves:

Gas reservoirs, calculating gas in place by volumetric method, unit recovery, recovery factor under water drive and Material Balance Equation (MBE). b) Under saturated oil reservoirs: calculation of initial oil in place by volumetric method and estimation of oil recoveries (unit recovery and recovery factor), Material Balance Equation. c) Oil reservoirs under simultaneous drives (dissolved gas drive, gas cap drive and water drive.) d) Generalized material balance equation, its uses and limitations. Selection of PVT data, for Material Balance Equation**.**

Recent trends in reservoir dynamics: CHDT, Probe Analysis etc.

Reference Books

1. Reservoir Engineering Clerk
2 Geology of Petroleum I.A. Leverson
3 Petroleum Reservoir Engineering Craft and Hawkins
4 Petroleum Geology F.K. North
5 Petroleum Reservoir Engineering Amyx, Bass, Whitting
6 Oil Reservoir Engineering Sylvain J. Pirson

PTUT232: Formation Evaluation –I (4 Credits)

UNIT 1:

PetrophysicsAnd Formation Evaluation: Introduction, Conditions Allowing the Accumulation of Hydrocarbons in a Reservoir, Calculating Hydrocarbon Volumes in a Reservoir, Uncertainties.

Reservoir Fluids: Introduction, Fluid Distribution, Aqueous Fluids, Phase Behaviour of Hydrocarbon Systems, PVT Properties of Hydrocarbon Fluids.

Permeability: Theory, Controls on Permeability and the Range of Permeability Values in Nature, Permeability Determination, Relative Permeability, Well Productivity, Porosity-Permeability Relationships, Permeability Relationships.

Fluid Saturation And Capillary Pressure: Fluid Saturations, Fluid-Fluid Interactions (Surface Tension), Fluid-Solid Interactions (Wettability), Capillary Pressure (Derivation of the Capillary Pressure Equation, Capillary Force, Reservoir Scenarios) Implications of Capillary Pressure in Reservoirs (Capillary Rise and Reservoir Fluid Pressures, Displacement Pressure) The Measurement of Capillary Pressure Curves for Rocks (Porous Plate, Centrifuge, Mercury Porosimetry) Capillary Pressure Data Correction, Fluid Distributions in Reservoirs,

Wireline Logging: What is a Wireline Log, Running a Wireline Log, The Presentation of Log Data, Tools (Common open-hole tools and their uses).

The Borehole Environment: Introduction, Overburden Pressures, Fluid Pressures, Effective Pressure, Drilling Muds, Invasion (Introduction, Invasion with Water-Based Drilling Muds, Invasion with Oil-Based Drilling Muds, Fluid Segregation), Logging Tool Characteristics (Depth of Investigation, Vertical (Bed) Resolution, Investigation Geometry, Logging Speed.)

UNIT 2

Temperature Logs: Introduction, Theory, Borehole Temperature Measurement, Borehole Temperature Corrections, Uses of Temperature Logs.

Caliper Logs: Introduction, Log Presentation, Simple Caliper Interpretation, Uses of Caliper Logs.

Radioactivity Logging: Introduction, Radioactivity Theory, Scattering and Attenuation.

Total Gamma Ray Log: Introduction, Principles, Calibration, Log Presentation, Depth of Investigation, Logging Speed, Vertical Resolution, Borehole Quality, Mud Type, Uses of the Total Gamma Ray Log (Determination of Lithology, Determination of Shale Content, Depth Matching, Cased Hole Correlations, Recognition of Radioactive Mineral Deposits, Recognition of Non-Radioactive Mineral Deposits, Radio-isotope Tracer Operations, Facies and Depositional Environment Analysis)

The Spectral Gamma Ray Log: Introduction, Principles, Calibration, Log Presentation, Depth of Investigation, Logging Speed, Vertical Resolution, Borehole Quality, Mud Type, Uses of the Spectral Gamma Ray Log:- Determination of Lithology (Discriminating between Sands, Shales and Accessory Minerals, Clay-Bearing Sandstones, Arkose sandstones, Micaceous sandstones, Graywackes, Greensands, Heavy mineral-bearing sandstones, Carbonate Formations, Evaporites,), Unconformity Detection, Inter-well Correlation, Recognition of Igneous Rocks, Diagenesis, Sedimentology, Estimation of Uranium Potential,

Cation Exchange Capacity, Radioactive Scaling, Hydrocarbon Potential, Fracture Detection, Fracture Detection, Phosphate Detection.

The Spontaneous Potential Log: Introduction, Principles (Electrochemical Components-The diffusion potential / the liquid-junction potential, the membrane potential / the shale potential. Electrokinetic Components-The mudcake potential, the shale wall potential. The Combined Spontaneous Potential Effect, Measurement Tools, Log Presentation, Vertical Resolution and Bed Resolution, The Amplitude of the SP Deflection, Uses of the Spontaneous Potential Log (Permeable Beds, Correlation and Facies, Mineral Recognition, Calculation of Rw, Calculation of Shale Volume.

Resistivity Theory: Introduction, Basic Definitions and Ohm's Law, Resistivity of Rocks (Uninvaded Formations, Invaded Zones), Temperature and Pressure (Calculating Formation Temperature, The Effect of Salt Composition, The Variation of Formation Fluid Resistivity with Temperature, The Variation of Drilling Mud Resistivity with Temperature, The Variation of Mud cake and Mud Filtrate Resistivity with Temperature), Formation Factor (Archie's First Law), Partial Water Saturation (Archie's Second Law), Combining Archie's Laws, The Effect of Errors in Resistivity Calculations, The Hingle Plot, The Pickett Plot, Saturation of Moveable Hydrocarbons.

Electrical Logging: Introduction, Principle, Uses of Electrical Logs, Typical Responses of an Electrical Tool, Old Electrical Logs, Modern Resistivity Logs (Later logs)- The Basic Later logs, The Dual Laterolog, The Spherically Focused Log. Micro-Resistivity Logs- The Micro log, The Microlaterolog, The Proximity Log, The Micro Spherically Focussed Log. Induction Logs- Introduction, Principle, Tools (The 6FF40 Induction-Electrical Survey Log, The 6FF28 Induction-Electrical Survey Log, The Dual Induction-Laterolog, The Induction Spherically Focussed Log, Array Induction Tools) Comparing Later logs and Induction Logs, Bed Resolution, Investigation Depth, Log Presentation, Uses of Electrical Logs (Recognition of Hydrocarbon Zones, Calculation of Water Saturation, Calculation of Water Saturation, Correlation, Lithology Recognition. Other Applications- Compaction of shales, overpressure zones, Source rocks.

UNIT-3

Electromagnetic Propagation & Dielectric logs: Principles, Tools, Log representation, Depth of investigation, Vertical Resolution, Qualitative & Quantitative interpretations and Applications.

Dip meter Log: Principles, properties measured instruments and application.

Direct Measurements of Subsurface formation

Core Logging: Conventional coring method, cleaning, marking and packing,transportation and storage of cores. Properties studied from cores, Preparation ofcore log.

Specialized Coring Techniques: Purpose and Coring Process of (Tricore, Rubber Sleeve Coring, Wire-line Core Barrel, Oriented Cores, Pressure Cores), Rock sampling (side wall coring- Process, Tool,Considerations during Gun Set-Up,Analysis,Sidewall Core Extraction,Examination and Description, Advantages & disadvantages. Mechanical Sidewall Coring Tool (MSCT): Advantages & applications

Fluid Sampling Methods:Fluid sampling and Pressure measurements: Formation tester, Formation interval tester, Repeat Formation tester, Fluid sampler applications.

MDT: Principles, measurements and applications.

RITE board verification, safety prior to running logs, particular sequence of logs and why it is run in this sequence, fishing tools, details of main and repeat passes and its importance, casing check, stuck tool and its solutions. TLC (Tough Logging Conditions)

Reference books:

1)Encyclopedia of Well Logging (Robert Desbrandes)
2) Fundamentals of Well Log InterpretationO' Serra

3) Geologic Well Log Analysis (Sylvain J. Pirson)
4) Geological Interpretation of Well Log (M.H. Rider)
5) Fundamentals of Quantitative Log Interpretation (Schlumberger)
6) The Drill Stem (API Manual)
7) Hand book of well log Analysis for oil and gasformation evaluationSylvian J.Pirson
8) Basic well log analysis D. Krygowski, G. B.Asquith, & C. R. Gibson
9) Fundamentals of Electric Log Interpretation M.R. Wyllie
10) Basic well log analysis for geologist G.B. Asoutts and Gibson
11) Handbook of sub-surface geology A.C. Moore
12) Cased Hole and production log evaluation James. J. Smolen
13) Well logging and formation Evaluation Tony Darling
14) Practical Formation Evaluation Ransom Robert
15) The Log Analysis Hand book E. R. Crain

PTUT 233 Drilling and Well Completion (4 Credits)

Unit 1:

Introduction to Well Planning: Well planning objectives, Classification of well types, planning costs, Overview of the planning process.

Formation Integrity Test, Leak off test (Calculation of formation strength and Equivalent mud weight (EMW), Formation Strength (Fracture Pressure/Gradient)

Rotary Drilling: Drilling Team; Drilling Rigs: Onshore (Land rigs: Fixed & Portable rigs); Offshore: Mobile (Jack–Up, Semi-Submersible, Submersible, Drill – Ships); Fixed: Platform Rigs, Major Rig Components.

Rig Systems: Power, Circulatory, Rotary, and Well-Control; Pipe handling equipments, Drill String Design. Drilling Cost Analysis.

Drilling Operations: Spudding-in, Drilling ahead, making a connection, tripping operations, monitoring the drilling process (Depth, ROP, WOB, WHO etc).

Rotary Drilling Bits: Types of Bits: Roller cone Bits, Design Factors (Journal ample, Cone offset, Teeth Bearing (Anti-friction, friction), Bearing Lubrication. Fixed cutter Bits (PDC, TSP, Diamond Bits, Drag Bits).Criteria for Bit Selection.

Types of sensors Used on the Rig : Pit level sensor (Acoustic), Hookload Sensor(wheat-stone bridge), Depth Optical Encoder , Pressure Transducer Sensor

Unit 2:

Rig Hydraulics: Introduction, Pressure Losses, Surface Connection losses, Pipe, Annular losses, and Pressure drop across bit, Optimization of Bit hydraulics, Surface pressure, Hydraulic Criteria, Nozzle selection, Optimum Flow rate.

Mud chemistry & Engineering: Principle, Types of drilling mud, functions, applications, mud chemicals and properties etc.

Vertical well Drilling: Causes of Hole deviation (Mechanical factors, Formation characteristics) Bottom Hole Assembly (Slick, Pendulum, Packed); Measurement of hole verticality.

Complications In the Course of Drilling: Formation Pressures – concept, causes and effects; Abnormal pressure conditions, Pipe sticking (Differential, Mechanical, Key – seating) Causes and Preventive measures, Lost circulation – Definition, Location of lost circulation zeros, Effect of lost circulation, curing of lost circulation, Lost circulation material; Fishing Operations (Situations requiring fishing Job. FishingTools)

Pressure Control: Types of Blow-Out Preventers (BOP), Causes of Kicks & Blowouts, Indications of well kick & short in procedure, Classic pressure control procedures (Drillers method, Wait & Weight method)

Unit 3:

Well Completion Practices:

A) Casing: Casing policy & design; Functions of Casing, Types of casing (Structural/Drive pipe, Conductor Casing, Surface casing, Intermediate or protective casing, production casing liners& their types. Casing Accessories, Strength properties (Yield strength, collapse strength, burst strength), Setting depth design procedures.

B) Cementation: Principles & practices; Introduction, Manufacture & Composition of Cements, General properties of oil well cements (Viscosity, thickening time, Density, Yield, Fluid loss, Free water, compressive Strength) Cement Additives (Density Control, Accelerators, Retarders, Fluid-loss additives, Friction reducers, Lost circulation material, special cement). Job planning & execution. Primary &Secondary cementing Methods-Cement Evaluation (Temperature log, radioactive tracers, Acoustic Logging Tools), deciding number of stages, block cementation vs.blind squeeze.

C) Well Completion Design: Controlling factors, Reservoir considerations, Mechanical Considerations, Method of Completion,

Types of Completions: Open hole, Cased hole& perforated completions; Liner Completion, Tubing less Completions, Casing with suspended tubing completions. Conventional Tubular Configurations – Single & Multiple Zone Completions, Unconventional Tubular Configurations, Sizing Production Tubulars.Completion Intervals identification. Types of tubular strings, Types of Tubing - packer completions: (Single string & Single packer, Commingled; Advantages & Disadvantages of the different types ofcompletions; Packers: Functions & Types, Packer fluids; Perforations: Types, design, Methods, evaluation of perforator performance; perforation clusters, Practical Considerations. Completion Fluids.Sub surface Control Equipments: Surface safety and catastrophe systems, bottohole chokes and regulators, subsurface injection safety valves.

Reference Books:

1) Applied Drilling Engineering
2)Drilling Practices; Presented Richard S. Corden.(Tulsa Publications)Robert D. Grace, JeraldL. Shursen, RichardS.Cardon
3) Oil well Drilling Engineering (Principles &Practices)H. Rabia
4)Drilling Engineering (Pennwell) Neal J. Addams
5) Oil Well Drilling Technology (McCray and Cole)
6) Fundamentals of Drilling Technology andEconomicsJ.L. Kennedy
7) Drilling Technology Vol. I & II J.A. 'Jim' Short
8) Well Design, Drilling and Production Craft, Holden, andGraves
9)Petroleum Engineering- Drilling and CompletionWell(Carl Gatlin)
10)Practical Well Planning and Drilling Manual Steve (Devereax)

PTDT234: Directional Drilling, Non-conventional Resources andSafety (3 Credits)

Unit 1:

Directional Drilling: Directional Drilling technique, Objective and applications. Directional drilling terminologies, Types of directional wells (Long radius, Medium radius & Short radius). Well planning. Deflection methods/techniques (Jetting, PDM motors, Turbines, Whipstock, RSS), Directional drilling tools

Directional Drilling BHA and related calculations: Directional BHA designing, Hydraulics, Torque and drag analysis, Directional bit selection.

Unit 2:

Directional drilling surveying: Directional Drilling Coordinate Systems (UTM Coordinate system), Latitude, Longitude, Easting, Northing, Various survey calculation methods,

Surveying tools, Mud pulse telemetries, Survey tool calibrations, Logging while drilling (LWD).

Field aspects of Directional Drilling: Directional Drilling problems, stuck pipe conditions and remedies, Mud considerations in Directional wells, sidetracking techniques, Directional drilling parameters (WOB, Hook load, RPM, TRQ, SPP, Off bottom & On bottom torque, Differential pressure, Up weight, Down weight and rotary weight), Advantages and disadvantages/comparison of PDM and RSS. Hole cleaning challenges and practices in directional/horizontal wells. Case studies.

Unit 3:

Non-Conventional Energy Resources –

Shale Gas - Introduction to shale gas & basin centered gas, tight reservoirs, Shale gas geology, important occurrences in India, petrophysical properties, Development of shale gas, design of hydro fracturing job, horizontal wells, production profiles,

Coal-bed Methane - Formation and properties of coal bed methane, Thermo-dynamics of coal bed methane, Exploration and Evaluation of CBM. Hydro-fracturing of coal seam.Production installation and surface facilities.

Gas Hydrates - Introduction & present status of gas hydrates. Formation and properties of gas hydrates, Thermodynamics of gas hydrates. Recovery methods. Prevention & control of gas hydrates, Gas hydrates accumulation in porous medium. Gas extraction from gas hydrates. Introduction, classification and principles, pyrolysis, theoretical aspect of processes involved in conversion.Technological development of direct conversion and indirect processes and sustainability of conversions.

Non-Conventional Oil - Continuous Accumulation System, Introduction, geology of Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales, their origin and occurrence worldwide, resources, reservoir characteristics, new production technologies.

Safety & Environment Hazards – JRA / JSA, PTW, Isolation details, HUET, TBT, PJSM, permissions for jobs, use of OBM and its safety concerns, MSDS & COSHH, Fire and H_2S drills, desert conditions, driving on sites etc. Toxicity, Physiological, Asphyxiation, respiratory and skin effect of Petroleum Hydrocarbons (including mixtures), sour gases (e.g. Hydrogen sulphide and carbon monoxide etc) with their thresh-hold limits. Hazards analysis, developing a safe process, failure mode analysis, safety analysis (API-14C) safety analysis function evaluation chart (synergic approach). Manual & automatic shutdown system, blow down systems. Gas detection system.Fire detection and suppression systems.Personal protection systems & measures. HSE Policies, standards & specifications. Disaster & crisis management.

Reference Books:

1) Oil well Drilling Engineering (Principles &Practices)H. Rabia
2) Oil Well Drilling Technology (McCray and Cole)
3)Petroleum Engineering- Drilling and CompletionWell(Carl Gatlin)
4)Practical Well Planning and Drilling Manual Steve (Devereax)

PTDP244 Practicals related to PTDT234 (1 Credit)

1)Dog leg Severity
2)Orientation of the Deflected Tools.
3)Determination Tool face angle

PTUP235Practicals related toPTUT231, PTUT232, PTUT233 (4 Credits)

PTUT231: Reservoir Dynamics

1 Fluid flow of Reservoirs.

2 Calculation of net volume of reservoir
3 Calculation of Formation volume factor from surface data.
4 Behavior of gases at reservoirs.
5 Calculation of formation volume factor from charts.
6 Diffusivity equation and its practical applications.
7 The perfect Gas Law.
8 Estimation of hydrocarbon Reserves.
9 Specific gravity of reservoir fluids & gases.
10 Applications of Computer in Reservoir Studies.

PTUT232 Formation Evaluation – I
1 Principles of Wire-line logging Borehole Environment Examples of Log Scales Logging Header
2 Caliper Log:-Behavior of Caliper log, its interpretation & applications
3 Temperature Log:- a) Behavior of Temperature log, its interpretation &applications
b) Estimation of Formation Temperature
4 Self Potential Log: - a) Examples of SP deflection from the Shale Baseline. b) Qualitative analysis of SP Log. c) Quantitative analysis of SP Log (Raw& Shale Volume Calculations)
5 Resistivity Log: - a) Basics of Resistivity. b) Illustrations of SP and Resistivity patterns. c) Example of DIL through Water bearing zone. d) Example of DLL through Water bearing zone. e) Example of DIL through HC bearing zone. f) Example of DLL through HC bearing zone. g) Calculation of Rt using Tornado Chart using DIL & DLL
6 Interpretations of a) GR, Caliper& Resistivity Logs. b) SP, Caliper&Resistivity Logs.
c) GR, Caliper& Induction Logs. d) Calculations of Shale Volume using Gamma Ray Log
7 Use of Computers in Formation Evaluation.

PTUT 233 Drilling and Well Completion
1 Rig power system.
2 Pump stroke calculations.
3 Drill collar weights.
4 Mud weight – computation.
5 Mud calculations.
6 Pressure Loss calculations
7 Cementation.
8 Pull required to stuck pipe.
9Life of a well.
10 Applications of Computer in Drilling Operations

SEMESTER IV **(20 credits)**

PTUT241Reservoir Performance (4 Credits)
Unit 1:
A) Introduction: Activities in reservoir engineering, role of reservoir engineers, physical principles of reservoir engineering**.**
B) Pressure Buildup and Flow Tests In wells: Uses of pressure information in petroleum engineering, types of pressure information, pressure build-up analysis (Horner's method), pressure drawdown analysis, multiple rate flow test analysis, drill stem test pressure analysis, pulse testing, importance of pressure analysismethods, injection well testing.
Unit 2: A) Reservoir Performance: Permeability curves, reservoir limit tests (RLT), permeability and rate of production from reservoir parameters, productivity tests.

B) Pressure Transient Analysis: Diffusivity equation and its solution, indicator diagram, IPR, Pseudo-pressure analysis, Flowing-well performance.

Unit 3:

A) Development of Oil and Gas Fields: Theoretical fundamentals of development: Objective, criteria for rational development, parameters for development plan, stages of development**.**

B) Enhanced Oil Recovery: Significance, secondary recovery of crude oil, initial production of oil, pressure maintenance, water flooding, and immiscible gas injection. Tertiary recovery of crude oil (miscible and thermal techniques), oil recovery by nuclear explosion, future of enhanced oil recovery.

Unit 4:

A) Reservoir Simulation: Introduction, incentives for reservoir simulation; modeling concepts: Designing a reservoir model: Tank model, one-dimensional models, 2D aerial models, 2-D cross sectional and radial models, multi-layer models, 3 D models, representation of reservoir fluids and reservoir rocks, well models – coupling between well and reservoir. Selection of data, selecting grid and time step sizes.

B) Forecasting future performance: History matching, simulating special processes, Trends in oil field management.

Reference Books:

1)Reservoir Engineering(Clerk)
2)Geology of Petroleum(I.A. Leverson)
3) Petroleum Geology(F.K. North)
4)Petroleum Reservoir Engineering(Amyx, Bass, Whitting)
5) Oil Reservoir Engineering (Sylvain J. Pirson)
6) Hydrocarbon Reservoir and well performance(T. E. W. Nind)
7) Enhanced Oil Recovery(L W Lake)
8) Reservoir simulation Calvin Mattax& R.L.Dalton
9) Numerical Reservoir Simulation(BrijNandan et al.),
10) Enhanced Oil Recovery(Editor M. M. Schumacher)
11) Pressure Transient Analysis J. P. Anand et al.,
12) Worldwide Practical Petroleum Reservoir Engineering methods Slider H. C

PTUT242 Formation Evaluation II (4 Credits)

Principles, tools used (Vertical resolution VS and depth of investigation DOI), scale and representation of logs with their units, calibration and qualitative and quantitative applications of the following logging methods:

Unit 1:

Density Log: (Pair Production, Compton Scattering, Photo-electric effect), Absorption equation, Depth of investigation, Vertical resolution, relation between the electronic density and bulk-density, Environmental effects, Geological factors (Rock composition, rock texture, sedimentary. Structure, temperature, pressure, depositional environment-sequential evolution); Applications.

Litho–Density Log: Photo-electric interaction, definition of the photoelectric absorption index, ρe of a composite material, Geological factors affecting measurements, Environmental effects on measurement; (Mineralogical composition of the formation, fracture detection, sedimentological studies)

Neutron Log: Measurement of the apparent hydrogen index, Neutron logs and sources, Calibration and logging units, Tools, Depth of investigation, Vertical resolution,

Measurement point, Factors influencing Measurement, Interpretation, Environmental effects, Geological factors affecting the hydrogen index.

Unit 2:

Thermal Decay Time Log: Neutron Capture and diffusion, Measurement of the neutron population and Capture cross-section, Measure points, Factors influencing the ρe measurement (The matrix ρma, Porosity, Fluids, Shales, Acidization). Environmental effects, Geological factors affecting the ρemeasurement.Porosity and gas indication (porosity, gas indication from the count rates).

Acoustics / Sonic Log:

Acoustic Log: Fundamentals (Acoustic signals, period T, frequency f, Wavelength λ, Acoustic waves, Compressional or longitudinal waves, Transverse or Shear waves, Sound wave velocities, Sound wave propagation, Reflection and refraction of waves, Acoustic impedance, Reflection Coefficient, Wave interference.)Measurement of sonic attenuation and amplitude:-Cement Bond Log and Variable Density Log.

Sonic Log: Principle of the Sonic Log, Earlier Tools, and Borehole compensated tool, Measure point, depth of investigation, vertical resolution and units.Factorsinfluencing measurement (the matrix, porosity and fluids, temperature and pressure, texture). Interpretation. Environmental and other effects (Transit time stretching, Cycle skipping, Kicks to smaller Δt, The borehole, Invasion, Radial cracking effects).Travel time integration. Sonic log rescaling.Determination of Elasticity parameters using logs.

Micrologs: Principles, Tools, Interpretations and Applications.

Unit 3:

Nuclear Magnetic Resonance Log: Introduction, Principle, Tool, method of measurement, signal processing Geological and Environmental factors influencing measurement, Interpretation, Applications.

Image Logs: Tool Design, Scale, representation and applications of Resistivity
Imaging, Acoustic Imaging, Density Imaging, and Azimuthal Gamma Imaging

Unit 4:

Crossplots and Overlays: Porosity Overlays: Selection of Logs for Overlays, Gas detection from overlays.

Two-porosity Lithology Cross plots :- Introduction, The Acoustic-Density Cross plots, Effect of Secondary porosity, Effect of Gas and Shale, Mineral Identification – Evaporites, Sulphur, Coal, Metallic ores, Oil Shale.

The Density-Sidewall Neutron Cross plot: – Use, Effect of Gas and Shale**.**

Gas Saturation Cross plots- Use, Effect of Shale and Invasion Effects.

Shale Cross plot: Introduction, Density-Neutron Cross plots.

Interpretations: Determination of porosity and lithology: Using lithology-porosity charts (M-N cross plot & MID cross plot)

Determination of: Absolute permeability & Relative permeability

Reference books:

1)Encyclopedia of Well Logging(Robert Desbrandes)
2)Fundamentals of Well Log InterpretationO' Serra
3)Geologic Well Log Analysis(Sylvain J. Pirson)
4)Geological Interpretation of Well Log(M.H. Rider)
5)Fundamentals of Quantitative Log Interpretation (Schlumberger)
6) The Drill Stem (API Manual)
7) Hand book of well log Analysis for oil and gasformation evaluationSylvian J.Pirson
8) Basic well log analysis D. Krygowski, G. B.Asquith, & C. R. Gibson
9) Fundamentals of Electric Log Interpretation M.R. Wyllie
10) Basic well log analysis for geologist G.B. Asoutts andGibson

11)Handbook of sub-surface geology A.C. Moore
12)Cased Hole and production log evaluation James. J. Smolen
13) Well logging and formation Evaluation Tony Darling
14) Practical Formation Evaluation Ransom Robert
15) The Log Analysis Hand book E. R. Crain

PTUT243 Production Operations (4 Credits)

Unit 1:

Geological Consideration in Producing Operations: Introduction, Geologic factors affecting reservoir properties in sandstone and carbonate reservoirs.

Reservoir considerations in well completions: Fluid flow and pressure distribution around well bore and effects of reservoir considerations in well characteristics on well completion;

Problem Well Analysis: Problem wells, Problem Well Analysis Checklist.

Through-tubing Production Logging: Logging devices, Application of Through- Tubing Production Logging.

Unit 2:

Sand control: Definition; Mechanical methods of sand control, Practical considerations in gravel packing.

Formation Damage: Occurrence and significance; Basic effects of clays and water on damage, Reduced relative permeability; Increased fluid viscosity;

Surfactants for Well treatments: Characteristics; use and action of surfactants, well stimulation with surfactants.

Unit 3:

Acidizing: Acids used; Acid additivites, Carbonate and Sandstone Acidizing;

Hydraulic Fracturing: Introduction, mechanics of fracturing, propping the fracture, frac fluids, frac job design and performance;

Scale deposition: Causes, prediction and identification of scale, Scale removal and prevention;

Corrosion Control: Introduction, types of corrosion, corrosion control.

Unit 4:

Workover: Conventional Production Rigs, Non – conventional Workover Systems; Concentric Tubing Workovers; artificial lift.

Workover Planning: Reasons and applicability under different conditions; Workover Economics.

Completion and Workover Fluids: Selection criteria, clear water and oil fluids; water base and oil base muds; perforating and packer fluids; well killing.

Reference Books:

1)Well Design, Drilling and Production Craft, Holden, andGraves
2) Production Operation Vol.I& II Allen & Roberts
3) Introduction to Petroleum Production Vol. II & III D.R. Skinner
4) Polymer & Surfactant Flooding Shah
5) Technical Manual For Production OperationsIOGPT, ONGCL.(R. K. Mukerjee)

PTDT244Mud logging and Mud Engineering (3 credits)

Unit 1:

Objectives and duties of Mud Logger: Mud-logging unit, users, personnel and their duties. Use of Mud logging for safety, efficiency and formation evaluation, outputs from ML unit. Rig up and rig down.

Lag Time: Lag time and lag strokes, onshore and offshore differences, Lag time calculation and verification.

Mud-logging Sensors: Data acquisition, Mud logging parameters, placement of sensors, principles of sensors as Depth, WHO, SPP, SPM, Torque, Flow out, Pit level, RPM, WHP, Mud resistivity, Mud weight, H2S, HC Gas acquisition. Maintenance and calibration of equipments.

Chart Interpretation and Monitoring: Instantaneous and lagged parameters, data presentation, monitoring drilling logging, interpretation of events from charts as tripping, circulation, drilling, kick, check of lag time, gas chart etc.

Unit 2:

Sample collection: Different type of samples and methods of collection.

Cutting Sample description: Type of samples, collection and packing of samples, Cutting description, fluorescence and cut.Calcimeter, flurometer.

Coring: Conventional and other coring methods, cleaning of core, marking and packing, transportation and storage of cores. Properties studied from cores, Preparation of core log.

Unit 3:

Master Log & Well Report: Scales of log, plotting of different parameters, interpretative lithology, abbreviations, Descriptions and remarks.

Hydrocarbon Gas: Physical properties of gas, terminology, coal gas, hydrates, porosity permeability and gas, terms for recorded as BG, TG, CG, peak gas, degasser, and gas-detection system, inferences from recorded gas, gas diagrams and ratios.

Subsurface Pressures: Hydrostatic pressure, normal and over pressure, overburden, causes of overpressure, detection of over pressure, pressure log, kick indicators.

Unit 4:

Mud Engineering: Fundamentals of Fluid flow (Fluid flow, viscosity), Types & Flow (Laminar, Turbulent). Criteria for the type of flow.Types of Fluids (Newtonian &Non-Newtonian), Viscometers.

Mud Engineering: Functions of Drilling Mud, Types of Drilling muds (Water-base &Oil base) & their Chemical Additives.

Mud Properties: Mud Weight, Rheological Properties, pH, Filtrate and filter cake.

Mud Contaminants: NaCl, Anhydrite, Gypsum, and Cement.

Conditioning equipment: Shale shaker, sand trap, degasser, de-sander and desilter.Under balanced Drilling: Equipment and process.

Reference Books:

1)Field Geologist Training Guide(Alun Whittaker)
2) Mud Logging Hand Book((Alun Whittaker)
3) Field Geologist's Training Guide (Prentice Hall.) Edited By AlunWhittaker

PTDP 244 Practicals related to PTDT244(1 Credit)

1 Calculation of Pressure gradient using mud weight.
2 Hydrostatic Pressure calculations using mud weight and depth.
3 Conversions: Pressure into mud weight, specific gravity to mud weight, specific gravity to pressure gradient.
4 Hydrostatic Pressure calculations- while pulling wet and dry pipe out of hole.
5 Surge and Swab pressures during tripping.
6 Lag Time Calculation
7 Pit Gain calculations.

Calculations related to Drilling Fluids:-

8 Increased mud density/ reduce mud density. Mud weight calculation
9 Problems related to Mixing of fluids different densities.
10 Oil based mud calculations.

11 Oil/Water ratio calculations.
12 Uses of Computer in Mud logging& Mud Engineering

PTUP245 Practicals related to PTUT241, PTUT242, PTUT243(4 Credit)

Practicals for PTUT241Reservoir Performance
1 Pressure buildup tests for oil reservoir
2 Productivity Index tests.
3 Calculation of Unit Recovery.
4 Material Balance Equation.
5 Pressure buildup tests for gas reservoirs.
6 Gas Deviation factor.
7 Productivity tests.
8 Estimation of feature behaviors of reservoir
9 Problems on Improved Oil Recovery (IOR)
10 Problems on Reservoir stimulation
11 Applications of Computers in Reservoir Studies.

PracticalsforPTUT242Formation Evaluation II

1 Porosity determination from sonic log
2 Determination of water saturation
3 Determination of spacing between transmitter & receiver of sonic log
4 Determination of porosity from sonic log and correlating porosity values using compaction correction
5 Determination of shale percentage and (F_ correction from neutron –density log
6 Cross plots and overlays
7 Determination of shale percentage &(F_ correction from neutron- density cross plot
8 Porosity estimation in hydrocarbon zones F (N)&_F (D)
9 Density- Side Wall Neutron log analysis
10 Determination of formation mineralogy
11 Interpretation of logs- GR, Calliper, F (N), F (D)
12 GR, Calliper& Sonic
13 Matrix identification using: a) RHOB & NPHI cross plot; b) Δt& NPHI cross plot
14 Interpretation of GR, Caliper, F (N), F (D) Log.
15 Uses of Computer in Formation Evaluation.

Practicals for PTUT243 Production Operations
1 Hydraulic Fracturing
2 Acidizing
3 Calculation of static injection pressure
4 Oil and Gas Separator design
5 Applications of Computers in Production Operations.
6 Skin due to Incomplete Perforations
7 Uses of Computer in Production Operations.