Syllabus

Post Name	:	**Senior Officer (Drilling)** **(Bachelor degree in Mechanical Engineering)**
Post Code	:	**DR (04)**

Section 1: Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors. Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial 63 derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

Section 2: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 3: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and airconditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric 64 chart, basic psychrometric processes. Turbo machinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Section 4: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.
Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multipoint cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Syllabus for recruitment of various posts in OIL

Post Name	:	**Senior Officer (Geology)**
Post Code	:	**GL (01)**

Part A: Common Section

Earth and Planetary system-size, shape, internal structure and composition of the earth; concept of isostasy; elements of seismology- body and surface waves, propagation of body waves in the earth's interior; Gravitational field of the Earth; geomagnetism and paleomagnetism; continental drift; plate tectonics- relationship with earthquakes, volcanism and mountain building; continental and oceanic crust-composition, structure and thickness.

Weathering and soil formation; landforms created by river, wind, glacier ocean and volcanoes. Basic structural geology – stress, strain and material response; brittle and ductile deformation; nomenclature and classification of folds and faults. Crystallography – basic crystal symmetry and concept of point groups. Mineralogy – silicate crystal structure and determinative mineralogy of common rock forming minerals. Petrology- mineralogy and classification of common igneous, sedimentary and metamorphic rocks. Geological time scale- geochronology and absolute time. Stratigraphic principles; major stratigraphic divisions of India. Geological and geographical distribution of mineral, coal and petroleum resources of India.

Introduction of remote sensing. Engineering properties of rocks and soils. Ground water geology.

Principles and applications of gravity, magnetic, electrical, electromagnetic, seismic and radiometric methods of prospecting for oil, mineral and ground water; introductory well logging.

Part B (Section -1) : Geology

Geomorphic processes and agents; development and evolution of landforms; slope and drainage; process in deep oceanic and near-shore regions; quantitative and applied geomorphology.

Mechanism of rock deformation; primary and secondary structures; geometry and genesis of folds, faults, joints and unconformities; cleavage, schistosity and lineation; methods of projection; tectonites and their significance; shear zones; superposed folding; basement-cover relationship.

Crystallography – symmetry, forms and twining; crystal chemistry; optical mineralogy, classification of minerals, diagnostic physical and optical properties of rock- forming minerals.

Cosmic abundance of elements; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements in crust and mantle; elements of geochemical thermodynamics; is otope geochemistry; geochemistry of waters including solution equilibria and water-rock interaction.

Igneous rocks- classification, forms and textures; magmatic differentiation; binary and ternary phase diagrams; major and trace elements as monitors of partial melting and magma evolutionary processes. Sedimentary rocks- texture and structure; sedimentary processes and environments, sedimentary facies, provencance and basin analysis. Metamorphic rocks – structure and textures.

Physico-chemical conditions of metamorphism and concept of metamorphic facies, grade and baric types; metamorphism of politic, mafic and impure carbonate rocks; role of fluids in metamorphism; metamorphic P-T-t paths and their tectonic significance. Association of igneous, sedimentary and metamorphic rocks with tectonic setting. Igneous and metamorphic provinces and important sedimentary basins of India.

Morphology, classification and geological significance of important invertebrates, verebrates, plant fossils and microfossils.

Principles of Stratigraphy and concepts of correlation – lithostratigraphy, biostratigraphy and chronostratigraphy. Indian stratigraphy – Precambrian and Phanerozoic. Overview of Himalayan Geology.

Ore-Mineralogy and optical properties of ore minerals; ore forming processes vis-à-vis ore-rock association (magmatic, hydrothermal, sedimentary, supergene and metamorphogenic ores); fluid inclusions as an ore genetic tool. Coal and petroleum geology; marine mineral resources. Prospecting and exploration of economic mineral deposits-sampling, ore reserve estimation, geostatistics, mining methods. Ore dress and mineral economics. Origin and distribution of mineral, fossil and nuclear fuel deposits in India.

Engineering properties of rocks and soils; rocks as construction materials; role of geology in the construction of engineering structures including dams, tunnels and excavation sites; natural hazards. Ground water geology — exploration, well hydraulics and water quality. Basic principles of remote sensing — energy sources and radiation principles, atmospheric absorption, interaction of energy with earth's surface, aerial-photo interpretation, multispectral remote sensing in visible, infrared, thermal IR and microwave regions, digital processing of satellite images. GIS — basic concepts, raster and vector mode operations.

Syllabus

Post Name	:	**Senior Officer (Geophysics)**
Post Code	:	**GP (02)**

Part A: Common Section

Earth and Planetary system-size, shape, internal structure and composition of the earth; concept of isostasy; elements of seismology- body and surface waves, propagation of body waves in the earth's interior; Gravitational field of the Earth; geomagnetism and paleomagnetism; continental drift; plate tectonics- relationship with earthquakes, volcanism and mountain building; continental and oceanic crust-composition, structure and thickness.

Weathering and soil formation; landforms created by river, wind, glacier ocean and volcanoes. Basic structural geology – stress, strain and material response; brittle and ductile deformation; nomenclature and classification of folds and faults. Crystallography – basic crystal symmetry and concept of point groups. Mineralogy – silicate crystal structure and determinative mineralogy of common rock forming minerals. Petrology-mineralogy and classification of common igneous, sedimentary and metamorphic rocks. Geological time scale- geochronology and absolute time. Stratigraphic principles; major stratigraphic divisions of India. Geological and geographical distribution of mineral, coal and petroleum resources of India.

Introduction of remote sensing. Engineering properties of rocks and soils. Ground water geology.

Principles and applications of gravity, magnetic, electrical, electromagnetic, seismic and radiometric methods of prospecting for oil, mineral and ground water; introductory well logging.

Part B (Section-2): Geophysics

The earth as a planet; different motions of the earth; gravity field of the earth, Clairaut's theorem, size and shape of earth; geomagnetic field, paleomagnetism; Geothermics and heat flow; seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties of the earth; earthquakes-causes and measurements, magnitude and intensity, focal mechanisms, earthquake quantification, source characteristics, seismotectonics and seismic hazards; digital seismographs,

Scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems in Cartesian, cylindrical and spherical polar

coordinates; Green's theorem; Image theory; integral equations in potential theory; Eikonal equation and Ray theory.

Absolute and relative gravity measurements; Gravimeters, Land, airborne, shipborne and bore-hole gravity surveys; various corrections for gravity data reduction — free air, Bouguer and isostatic anomalies; density estimates of rocks; regional and residual gravity separation; principle of equivalent stratum; data enhancement techniques, upward and downward continuation; derivative maps, wavelength filtering; preparation and analysis of gravity maps; gravity anomalies and their interpretation — anomalies due to geometrical and irregular shaped bodies, depth rules, calculation of mass.— Elements of Earth's magnetic field, units of measurement, magnetic susceptibility of rocks and measurements, magnetometers, Land, airborne and marine magnetic surveys, Various corrections applied to magnetic data, IGRF, Reduction to Pole transformation, Poisson's relation of gravity and magnetic potential field, preparation of magnetic maps, upward and downward continuation, magnetic anomalies-geometrical shaped bodies, depth estimates, Image processing concepts in processing of magnetic anomaly maps; Interpretation of processed magnetic anomaly data. Applications of gravity and magnetic methods for mineral and oil exploration.

Conduction of electricity through rocks, electrical conductivities of metals, non- metals, rock forming minerals and different rocks, concepts of D.C. resistivity measurement, various electrode configurations for resistivity sounding and profiling, application of filter theory, Type-curves over multi-layered structures, Dar-Zarrouck parameters, reduction of layers, coefficient of anisotropy, interpretation of resistivity field data, equivalence and suppression, self-potential and its origin, field measurement, Induced polarization, time and frequency domain IP measurements; interpretation and applications of IP, ground-water exploration, mineral exploration, environmental and engineering applications.

Basic concept of EM induction in the earth, Skin-depth, elliptic polarization, in phase and quadrature components, Various EM methods, measurements in different source-receiver configurations,. Earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, electromagnetic profiling, Time domain EM method, EM scale modeling, processing of EM data and interpretation. Geological applications including groundwater, mineral and hydrocarbon exploration.

Seismic methods of prospecting; Elastic properties of earth materials; Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity — depth models, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition, processing and interpretation; CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, Digital seismic data processing, seismic deconvolution and migration methods, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP, AVO. Reservoir geophysics.

Geophysical signal processing, sampling theorem, aliasing, Nyquist frequency, Fourier series, periodic waveform, Fourier and Hilbert transform, Z-transform and wavelet transform; power spectrum, delta function, auto correlation, cross correlation, convolution, deconvolution, principles of digital filters, windows, poles and zeros.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging, micro-logs. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods of groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration.

Basic concepts of forward and inverse problems, Ill-posedness of inverse problems, condition number, non-uniqueness and stability of solutions; L1, L2 and Lp norms, overdetermined, underdetermined and mixed determined inverse problems, quasi-linear and non-linear methods including Tikhonov's regularization method, Singular Value Decomposion, Backus-Gilbert, simulated annealing, genetic algorithms and artificial neural network.

Geodynamics, Physical & Structural Geology, Mineralogy, Petrology:

Plate tectonics & formation of rocks in plate tectonic settings. Physical and Structural Geology, introduction to geology, scope and sub disciplines, weathering agents, landslides and volcanic activity, representation of altitude, Dip and strike, outcrops, outlier and inlier, folds, faults, unconformities, joints and their classification, criteria of their recognition, clinometer compass and its use. Mineral – its definition and mode of occurrence, physical properties of minerals like form, colour, lustre, streak, cleavage,fracture,hardness and specific gravity, physical characters and chemical composition of the following rock forming minerals, quartz, orthoclase, Microcline, Plagioclase, Nepheline, Muscovite, Biotite, Augite, Hornblende, Olivine, Garnet, Epidote, Calcite and Beryl, Graphite, Tourmalilne, Talc, Kaolinite, Kyanite and Corundum. Petrology - Rock- its definition, classification and distinguishing characteristics of Igneous, Sedimentary and Metamorphic rocks forms of Igneous rocks, elementary ideas regarding formation, texture and structure of Igneous, Sedimentary and Metamorphic rocks, brief petrographic description and occurrences of the following rocks: Granite, Syenite, Gabbro, Rhyolite, Dolerite, Basalt, Conglomerate, Breccia, Sandstone, Limestone, Shale, Gneiss, Schist, Quartzite and Marble,

Stratigraphy, Economic & Petroleum Geology:

Principles of Stratigraphy, elements of stratigraphic classification; geological time scale. Basic concepts of sequence Stratigraphy and seismic stratigraphy. Geophysical methods of stratigraphic correlation. Physical and structural divisions of Indian subcontinent and their characteristics. Definition of ore, ore mineral and gangue, Classification of ore deposits, Chemical composition, diagnostic characters, usages and distribution in India of

the following metallic and nonmetallic minerals: Haematite, magnetite, pyrolusite, psilomalane, chromite, ilmenite, wolframite, cassiterite, chalcopyrite, boronite, galena, sphelerite, pyrite, bauxite sulphur, graphite, gypsum, fluorite, barite, magnesite, dolomite, apatite, calcite, kyanite, sillimanite, beryl, muscovite, kaolinite, halite and talc. Origin of petroleum; source rocks; reservoir rocks; reservoir pore spaces; reservoir traps. Migration and accumulation of oil and gas. Geological modelling in petroleum exploration, Brief geological account of oil and gas fields in India: Assam, Gujarat, Tamil Nadu and Bombay Offshore.

Remote Sensing, GIS and Surveying:

Basic principles of Remote sensing-energy sources and radiation principles, atmospheric absorption, interaction of energy with earth's surface, aerial photo interpretation, multi-spectral remote sensing in visible, infra-red, thermal IR and microwave regions, digital processing of satellite images. GIS- basic concepts, raster and vector mode operations. Surveying- Linear Measurement, measurement of Elevation, measurement of direction, traversing, triangulation, trilateration, plane tabling, adjustment computations, project surveying.

Meteorology:

Composition and structure of atmosphere. Evaporation, condensation , fog, cloud, precipitation & thunderstorm, tornado. Solar and terrestrial radiation, laws of radiation, greenhouse effect, heat balance of earth & atmosphere.

GeoHydrology:

Hydrology cycle, origin of groundwater, subsurface distribution of water, springs. Hydrology Properties of Water Bearing Materials: Porosity, void radio, permeability, transmissivity, storativity, diffusivity, laboratory methods of determination of permeability. Movement of groundwater and aquifer performance tests, Darcy's law and its range of validity, theory of groundwater flow under steady and unsteady conditions, determination of permeability, transmissivity and storativity by discharging methods. Precipitation, evaporation, evapo transpiration, seepage, infiltration and runoff

Numerical methods and computer programming:

Solution of algebraic and transcendental equations, bisection and Newton Raphson methods, solution of simultaneous linear equations, matrix inversion method, interpolation, Newton and Lagrange formula, numerical differentiation, numerical integration, Simpson, trapezoidal and Gaussian quadrature methods, least square curve fitting, straight line and polynomial fits, numerical solution of ordinary differential equation, Euler and Runga-Kutta methods, finite difference methods.

Computer Programming: Low level and high level languages, overview of compilers, interpreters and operating systems, problem solving on a computer, algorithms and flow

charts integer and floating point arithmetic, FORTRAN preliminaries, constants, variables, data types and expressions, built in functions, executable and non-executable statements assignment, control and input /output statements, subroutines and functions, operations with files.

Physical Oceanography & Marine Geophysics

Physical properties of Sea Water: Chlorinity, salinity, thermal properties, density, pressure, optical properties, transmission of sound, water masses, T-S diagram, variation of salinity, heat budget of the ocean, Bowen ratio. Salinity measurements, Nansen bottle, light in sea, measurement of SST, reversing thermometers, Bathy thermograph, current meters. Ocean Currents: Hydrodynamic equations of motion, inertia currents, geostrophic currents in homogeneous and stratified ocean; relative and slope currents, thermohaline currents, drift current in homogeneous water, Ekman theory, the major surface current systems of the ocean, upwelling and sinking with special reference to Indian ocean and their effects. Wave velocity, group velocity, theory of surface gravity waves, short and long waves, generation and growth of wind waves, long waves in canals, standing waves in closed basins, seiches, swell, breakers and surf, internal waves, storm surges, tsunami. Tides: Tide generating forces, principal harmonic components, theories of tides, description and types of tides, prediction of tides, tidal gauges. Air Sea Interaction: Structure of the boundary layer, exchange coefficients and profiles, transfer of heat and water vapour. Ocean and Seas: classification, growth and decline of ocean basins, turbidity currents, submarine sedimentation and stratigraphy, physiography and divisions of the sea floor, continental shelves, slopes, aprons and abyssal planes, occurrence of mineral deposits and hydrocarbon in offshore.

Principles of GPR method.

Syllabus

Post Name	:	**Senior Officer (Production) (Master degree in Petroleum Engineering /Technology)**
Post Code	:	**PD (05)**

1) OIL & GAS PROPERTY EVALUATION, ECONOMICS & RISK ANALYSIS

- Introduction: Structure of oil industry, financial aspects of the oil industry, world oil supply and demand.
- Principles, Methods and Techniques for Oil and Gas Property Evaluation, Project Parameters: Time value of money in capital investment, Depreciation, depletion and amortization of oil projects, Financial measures and profitability analysis, Break-even and sensitivity analysis, Optimization Techniques.
- Applications and Project Evaluation of Oil Fields: Economic evaluation of exploration and drilling operations, Estimation of oil reserves and evaluation of an oil property, Economic evaluation of production operation.
- Downstream Oil Activities: Economic evaluation: Oil transportation, Crude oil processing, Distribution and Marketing,
- Taxation: Severance and Ad Valorem taxes, Federal income taxation of oil and gas transactions, Value added taxation .
- Uncertainty and Risk Analysis: source of risk, managing risks by risk reduction, diversification, and uncertainty investment and decision analysis by decision tree. Risk management in energy markets including the identification of risk and the use of 'futures' and 'options' markets.
- Environment and pollution control: Regulation and control of pollution and environmental modelling, monitoring and database management

2) FLUID FLOW THROUGH POROUS MEDIA

- The Porous Medium: The Physical Medium, Relevant Physical Phenomena, Pore Scale vs. Continuum Scale, Fluid and Porous Matrix Properties
- Mathematical Models of Porous Media: Network Models, Statistical Descriptors, Fractal Models, Effective Medium, Mixture Theories, Double Porosity Model
- Single Phase Flow in a Porous Medium: Darcy's law.
- Balance Principles: Mass, Momentum and Energy Conservation, Equations of Motion,
- Constitutive Theory : Constitutive equations for mass and heat transfer and Mechanical response for solid phase
- Boundary Value Problems: Well-Posed Problems, Common Boundary Conditions, Common Solution Procedures
- Immiscible Multiphase Flow : Surface Chemistry, Thermodynamics of Interface, Interfacial Tension, Capillary Pressure, Simultaneous Flow of Two Fluids

- Surface Phenomena : Adsorption, Wetting, Thin Films, Transport through Membranes
- Miscible Displacements and Dispersion

3) OIL AND GAS FIELD DEVELOPMENT AND PLANNING

- Brief overview on field development, Difference between oil and gas field development,
- The Field Life Cycle: Gaining Access, Exploration Phase, Appraisal Phase, Development Phase, Production Phase, Decommissioning.
- Petroleum Agreements & Bidding: Invitations to bid, Motivations and form of bid, Block Award, Fiscal System, Farm-in & Farm-out, Unitisation and Equity determination. NELP & OALP, PSC.
- Reservoir Description: Data Gathering, Data Interpretation
- Field Appraisal: Importance of Appraisal, Identifying and quantifying sources of Uncertainty, Cost benefit calculations for Appraisal.
- Reservoir Dynamic Behaviour: Fluid Flow studies, PVT data, Drive Mechanisms. Gas Reservoirs: Gas sales profiles; Influence of Contracts; movement of GWC during production, Pressure response, Fluid displacement in the Reservoir, Estimation of Reserves, Reservoir Simulation, Estimating the Recovery Factor, Estimating the Production Profile.
- Well Dynamic Behaviour in Vertical and Horizontal Wells: Estimating the number of Development Wells, Fluid flow near the wellbore.
- Importance of Surface Facilities in Field Development
- Project & Contract Management: Phasing & Organisation, Planning & Control, Cost Estimation & Budgets, Types of Contracts.
- Petroleum Economics: Basic principles of Development Economics, Project Cash flow, Revenue & expenditure items, CAPEX-OPEX, Sensitivity Analysis,
- Managing the Producing Field: Subsurface, surface facilities, Internal & External factors.

4) ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS

- **Section A : Advanced Numerical Methods:**

Solution of tridiagonal system, Evaluation of double and triple integrals by numerical method and its application, solution of non-linear simultaneous equations numerical solution of integral equations, Advanced method of interpolation, Numerical solution of simultaneous first order ordinary differential equations and higher order O.D.E. Initial and Boundary value problems, Numerical solution of partial differential equations: Laplace and Poisson equation, Heat conduction and waved equations,

- **Section-B : Applied Statistics**

Review of binomial, Poisson, normal and log normal probability distributions. Interval

estimates. Tests of significance for mean, variance (One an dtwo population case-Z,t,X^2 and F tests), tests for correlation and regression coefficients, Non-parametric tests: sign test, Mann-Whiteney Wilcoxon U-test. Run test and test of randomness. One way & two way analysis of variance, Time series analysis, reliability an dlife testing experiments in engineering problems.

5) PETROLEUM ENVIRONMENT, HEALTH AND SAFETY PRACTICES

- Introduction to Health, Safety and Environmental Management
- HSE Terms and Definitions, Importance of HSE Management, HSE performance.
- HSE Regulations and regulatory agencies for Oil and Gas Industry
- Environmental issues and Management
- Air pollution- Stack emissions, Flaring and fugitive release
- Water pollution and wastewater management, Produced water management
- Oil spill Management
- Waste management: Drilling waste, Rock cutting, oily sludge, etc.,
- Environmental Management, monitoring and Impact Assessment.
- Occupational Health and Safety Management
- Risk assessment and management: (Qualitative and quantitative)

6) MULTILATERAL AND HORIZONTAL WELL TECHNOLOGY

- Introduction & objectives of horizontal wells, ERD, Laterals etc.
- Geological aspects, & development of oil & gas field using horizontal wells.
- Drilling of horizontal, multilateral and ERD wells.
- Completion of horizontal, multilateral and ERD wells.
- Reservoir engineering concepts of horizontal wells.
- Well logging methods in horizontal wells.
- Well test analysis of horizontal wells.
- Well performance & productivity of horizontal Wells.
- Water & Gas coning in horizontal wells.
- Application of horizontal wells in gas reservoirs & in recovery of heavy oils.

7) WELL SERVICING

- **WELL COMPLETION:**
- Design of Perforations
- Perforating process; Perforation Guns and firing head.
- Perforating/ well activation mechanism: Underbalanced and overbalanced perforations.
- Pressure control equipment (Well Head Lubricator Assembly); Type, size and orientation of perforation holes;
- Optimum Perforation Practices; Down-hole Equipment- Packers – their types, Tubing, Flow couplings, expansion joints, Sliding Sleeves / Side Pocket Mandrels &

Blast Joints etc.

- Smart / Intelligent Wells, Well Completion Design.
- Well Sickness, diagnosis and mitigation: Type of well sickness, Symptoms of sick wells, Testing of sick wells, Identification and Diagnosis of Well Problems, Planning of Workover Jobs; Minor & Major (Capital Repair) jobs; Water & Gas Shut-off jobs; Squeeze Cementing; Water and Gas Coning; Sand Control & its Techniques; Fishing operation, Coil Tubing Unit, Snubbing unit.
- Well Stimulation Techniques: Acidizing of O & G Wells; Hydraulic Fracturing; Acid fracturing, Heat treatment, Down-hole Heaters. In-situ Combustion.

8) ADVANCED WELL COMPLETION PRACTICES

- Basics of Reservoir Completion: Inflow Performance Relationship, Perforating, Hydraulic Fracturing, Acid Fracturing
- Sand Control: Rock Strength, Sand control Prediction, Sand production mitigation, Sand control screens, Gravel Packing, Chemical sand consolidation.
- Life of Well Operations: Types and methods of Intervening, Impact on Completion Design.
- Tubing well performance, Multiphase flow & tubing performance, Flow predictions, Temperature prediction and Control, Packer fluids, Production & Injection well sizing.
- Material Selection: Down hole Corrosion, Metallurgy Selection, Corrosion Inhibition, Seals, Control Lines and encapsulation, Coatings and liners
- Tubing Stress Analysis: Stress, Strain and Grades, Axial Loads, Burst ,Collapse, Triaxial Analysis, Safety and design Factors, Load Cases, Tubing Connections
- Completion Equipment: On-land and subsea Christmas trees; Subsurface safety Valves, Packers, Expansion devices and anchor latches, Landing nipples, locks and sleeves, Mandrels and gauges, Capillary lines and cable clamps, Loss control and reservoir isolation valves, Crossovers, Flow couplings, Modules,
- Well Completion Techniques: Deep water Completions. HPHT Completions, Completions with down hole flow control, Multilateral Completions, Dual Completions, Multipurpose Completions, Underbalanced completions, Coiled tubing and insert completions, Completions for Heavy oil and steam injection, Completions for Coal Bed Methane.
- Installation of Completion systems: Wellbore Clean-out and mud displacement, Completion fluids and filtration, Well clean-up and flow initiation.

9) DRILLING SYSTEM DESIGN

- Drilling Rig Selection and Design: Environmental loading and stability of rig. Design of Block
- and Tackle System, Design of Draw works Drum,Top drive drilling.
- Casing Design: Conventional and conditional Casing Design Practices, Deep well strings, Design practices for high inclined, Horizontal and Slanted wells. Liner design and setting,

- Casing Buckling and Well Head Loads: Casing landing practices, Buckling criteria and Calculation of well head loads.
- Casing while drilling.
- Drill String Design.
- Drilling fluid selection method for critical exploratory wells and development drilling.
- Mud Hydraulics Design: Rheology of drilling fluids and compatibility to borehole conditions, Hydraulic horse power and Rig horse power calculations. Jet impact force, Hydraulics design in High inclines wells. Bit Hydraulics, Bottom drive hydraulics design.
- Rotary System Design: Design and performance of Kelly drive, Bottom Drive and Top Drive Systems.
- Special Methods of Drilling: Aerated drilling, Under-balanced drilling, Overbalanced drilling, HPHT Drilling, Variable pressure regime, Plasma drilling, Electrical Drilling, Re-entry drilling, Jet Drilling, Drilling automation. Smart wells Design, Managed Pressure Drilling
- Drilling Economics.
- Computer Application in Drilling

10) WELL INTERVENTION, WORKOVER AND STIMULATION TECHNIQUES

- Work-over operations. Work over fluids, fluid loss and formation damage. Scraping, well circulation, Water and gas Shut-off, Squeeze cementing. Handling water and gas coning.
- Production packers, Packers calculation, Well activation. Repair of wells, Paraffin and scale removal. Planning and evaluation of workover jobs. Corrosion, Bacteria & Scale control.
- Well treatment; acidzing oil & gas wells. Hydro-perforation. Hydraulic fracturing. Stimulation designing, Proppants and their placement. Thermal stimulation techniques. Surface equipment for Stimulation and Gravel Pack jobs. Down-hole heaters. Horizontal well related development on the subject.
- Sand-control, Screens, Gravel packs: Design and installation.
- Well Intervention: Slickline/ Wireline operations, Coil Tubing Operation

11) WELL PERFORMANCE & ARTIFICIAL LIFT TECHNIQUES

- Flowing well concept, Inflow performance, Vertical lift performance, Choke Bean performance,
- Multi-phase flows in horizontal and vertical pipes.
- Total production system Analysis: Nodal analysis.
- Introduction to different Artificial lift techniques: SRP, Continuous gas lift, Intermittent gas lift: Plunger lift, Chamber lift, Electrical submersible pumping, hydraulic pumping, Jet pumping etc,
- Selection procedure, planning, design; and analysis of artificial lift system.
- Well installation, maintenance and trouble shooting in artificial lift method.

12) INTEGRATED RESERVOIR MANAGEMENT

- Introduction: Scope and Objectives
- Reservoir management concepts: Definition and history, fundamentals of reservoir management, synergy and team; integration of geosciences and engineering, integration of exploration and development technology
- Reservoir management process: Setting goals, developing plans and economics, surveillance and monitoring, evaluation
- Data acquisition, analysis and management: Classification of data, acquisition, analysis and application, validation, storing and retrieval
- Reservoir model: Role of reservoir model in reservoir management, integration of G & G and reservoir model
- Reservoir performance analysis and prediction: Naturally producing mechanism, reserves and role of various forecasting tools- volumetric method, MBE, Decline curve and mathematical simulation
- Matured field reservoir Management.
- Reservoir Management economics: evaluation, risk and uncertainties
- Reservoir management plans: strategy for newly developed field and Secondary and EOR operated field.

13) ENERGY MANAGEMENT & POLICY

- Markets for oil, gas, coal, electricity and renewable energy resources and alternate fuels. Legal and policy aspects of supply and trading in energy. Regulations of energy industries, Industry privatization. International context of liberalization of energy markets. Land acquisition policy, Carbon credit, Modeling techniques for supply and demand, market structure, transportation models, game theory, futures markets, environmental issues, energy policy, energy regulation, input/output models, linear and nonlinear programming models, energy conservation, and dynamic optimization. Development of appropriate models and their application to current issues in energy markets. Energy audit.

14) PETROLEUM ENGINEERING PRACTICALS

- Practicals related to the design & selection of drilling fluids, Petro-physical properties of rocks, Well testing, formation evaluation and testing of Petroleum products.

15) OIL AND GAS MARKETING AND RESOURCE MANAGEMENT

- Introduction: The structure and development of Oil & Gas Industry, India Hydrocarbon vision 2025.
- Petroleum Resource classification, Analysis of resource management.
- Natural Gas: What is Natural Gas, Measuring Natural Gas, Pipeline quality natural Gas
- Demand, Supply & Storage of natural gas: Gas production, Source of demand in

India, The supply system, Pipeline Operations & Network, Storage of Natural Gas, Liquefied Natural gas Plant & Operations, Gas Sales Pattern in India, Gas Pipeline Regulations in India, Gas Trading, Gas Pricing

- Coal Bed Methane: Introduction, Present status of Coal Bed Methane, CBM Storage and sales, CBM Pricing in India
- Crude Oil: Crude oil/ specification, Measuring/ Custody transfer of Crude Oil, Crude Oil Transportation, Crude Oil Production in India, Crude Oil refineries, Products from Crude Oil
- International & National Institutions of Oil & Gas: API,OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA
- Petroleum Contracts: NELP - Role & Background , Types of Contracts and fiscal components, Production sharing contracts in India, Crude Oil trading and pricing, CBM Contracts
- Strategic Reserves concepts.

16) PETROLEUM RESERVOIR MODELING AND SIMULATION

- Introduction & Overview:
- Modeling Concepts: The concept of Gridblocks & Timesteps, Static and Dynamic Modeling. Mobility Weighting, Grid Orientation effects, Explicit & Implicit functions, Solution methods.
- Designing the reservoir model, Checklist for model design, Selection of the number of dimensions,
- Pseudo-relative permeability & Capillary pressure functions, VE pseudo functions, Windowed models, Naturally fractured reservoirs, Representation of reservoir fluids, Representation of reservoir rock, Well models.
- Selecting reservoir rock and fluid properties data: Data for model construction, Selection and assignment of data Fluid properties, Establishing Initial pressure and saturation distribution.
- Selecting Grid & Time-step sizes: Selection of gridblock size example grids, Selection of time-steps, Numerical dispersion, Grid orientation, Cost considerations.
- Selecting the Numerical solution method.: Terminology, Formulating the equations, Material Balance & pressure equations, Formulating options, Matrix Equations, Solution methods, Selecting the Equation-solving technique.
- Well Management: Designing & Controlling Production Parameters.
- History Matching: Validity of the Reservoir Model, Strategy & Plans, Adjustment of parameters, Pressures, Pressure gradients, GOR-WOR behavior Automatic History Matching.
- Forecasting Future Performance: Planning prediction cases, Preparation of input data, smooth transition from history to predictions, Review & Analysis of predicted performance, Evaluating & Monitoring predicted performance.

17) COALBED METHANE, GAS HYDRATES AND SHALE GAS/ OIL

A: COALBED METHANE:

- Introduction & present status of coalbed methane- Global and Indian Scenario
- Formation and properties of coalbed methane: Generation of coalbed methane gas & its properties, properties of coal as reservoir rock & Reserve Estimation.
- Thermodynamics of coalbed methane: isotherm studies
- Overview of Drilling and Production systems of coalbed methane wells.
- Hydro-fracturing of coal seams
- Treating and disposing produced water.
- Testing of coalbed methane wells.

B: NATURAL GAS HYDRATES:

- Introduction & present status of gas hydrates
- Formation, accumulation and properties of gas hydrates
- Thermodynamics, kinetics and phase behaviour of gas hydrates
- Drilling and production systems of gas hydrate wells
- Prevention & control of gas hydrates
- Gas extraction from gas hydrates. Uses and application of gas hydrates.

C: SHALE GAS/ OIL:

- Global Scenario of shale gas/ Oil production.
- Nature, origin and distribution of Shale Gas/ Oil.
- Characterization of Shale for Production of Shale Gas/ Oil.
- Extraction methods of Shale gas/ Oil: development of current practices.
- Location and size of production areas: estimated reserves and economics.
- Environmental issues in shale gas exploration.
- Markets and Globus impact on energy scenario.
- Economic factor of shale Gas/ oil production

18) OIL & GAS PROCESSING PLANT DESIGN

- Oil desalting: Operation, variables, Heater treater design.
- Crude & Condensate Stabilization : LTX Stabilization.
- Oil & Gas Treatment : Oil desalter, emulsion treatment theory and practice, Emulsifiers & Demulsifiers, Gravity Separation, coalescence, coalescing media, electrostatic coalescers.
- Treating Equipment : pressure vessels - Vertical, horizontal, Electrostatic. Process heat duty, Sensible heat of natural gas, Water, Heat transfer from fire-tube. Heat exchangers- types, fluid placement, sizing, number of tubes.
- Natural Gas Dehydration : (a) Glycol Process : operation, effect of variables, dew point depression, stage calculation.
- NTU - graphical and analytical methods, Absorber sizing. Lean oil absorption. (b) Solid-bed process : design & operation, effect of process variables, Regeneration and cooling calculations. Hydrocarbon recovery. (c) Hydrate formation & inhibition.
- Natural Gas Sweetening : Acid gases, Toxicity, Pipeline specification. Solid-bed Process : Design, operation & effect of variables. Adsorbent selection. Multistage

Separation, Hengsteback's Flash calculation, stabilizer design. Amine and other absorptive process details.

19) DEEP WATER TECHNOLOGY

- Introduction : Definition, Global deep water reserves & development activity. Technological advances.
- Dynamics of Offshore Structure : Analysis of Waves and fluid induced forces on offshore structures, Current and wind forces, soil mechanics of seabed & structures.
- Deep water Exploration & Drilling : Seismic/Seabed Survey, constraints in deep water survey like geo-hazards, gas hydrate etc., deep water Drilling with emphasis on the additional inputs to normal offshore Drilling operation.
- Deep water Production System : Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating Production Systems like FPSOs, FPSSs, TLPs, Spar Platform and FSOs.
- Deep water applications of Subsea Technology : Subsea completion, X-mas tree, control systems, Manifolds, Templates, ROVs, deep-water installation vessels with DP system and associated problems.
- Deep water Pipelines & umbilical : Issues in deep water Pipeline Design, Rigid and Flexible flow lines, Pipe-in-pipe, deep-water Risers and their configurations, Pipeline installation methods, Umbilical – functions, configurations and installation, Flow assurance strategies.
- Emerging deep water Technologies : Autonomous Underwater Vehicles (AUVs) Seismic- while-drilling, Dual-activity-drilling, Innovative Floating Production Concepts, Subsea processing, subsea separation (VASPS, SUBSIS, Twister) and any new innovations.
- Problems and Mitigation in Deepwater Drilling: Specialized consideration, specific planning requirement, specialized equipment and deep water complication.

20) CARBON CAPTURE AND SEQUESTRATION

- Introduction: Scope, Objectives and Necessity of CCS
- The contribution of fossil fuels emission to Climate change and global warming. Concept of Carbon Credit and carbon footprint.
- Carbon capture techniques: Carbon-di-oxide emission, Scrubbing of CO_2 , Carbon dioxide re- cycling
- Carbon dioxide sequestration: Underground storage, Potential for Geologic Storage, Application in Oil and gas industry, Carbon di oxide flooding projects, Methane recovery projects.
- Strategy for implementing CCS technology:
- Modeling of Cost and Performance of CCS Plants.
- Role and function of IPCC

21) ADVANCED PETROLEUM FORMATION EVALUATION

- Introduction to Formation Evaluation

- Direct Methods: Coring & Core Analysis, mud logging .
- Wire-line Logging Devices: Electrical, Radioactive, Acoustic Logging devices.
- Cased Hole Log Analysis Monitoring: Objectives of Cased Hole Logging Environment. CBL/VDL and Casing Inspection Logs. Perforating.
- Production Logging & Reservoir Performance Monitoring: Flow Velocity Tools. Fluid Density Measurements. Pressure Measurements & Temperature Measurement Techniques
- Recent Development: Flow View Measurements. Modular Formation Dynamics Tester. Water Flow log services. Formation Subsidence Monitor Tool. Digital Entry Fluid Imaging Tools. Ultrasonic Imaging Tools
- Interpretation Methods: Standard Log Interpretation Methods. MID Plot Method. Cross- plotting Methods.

Syllabus

Post Name	:	**Senior Officer (Production)** **(Bachelor degree in Mechanical Engineering)**
Post Code	:	**PD (05)**

Section 1: Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors. Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial 63 derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

Section 2: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes;

testing of materials with universal testing machine; testing of hardness and impact strength.
Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 3: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and airconditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbo machinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Section 4: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.
Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multipoint cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Syllabus

Post Name	:	**Senior Officer (Reservoir)** **(Bachelor's degree in Petroleum Engineering)**
Post Code	:	**RE (03)**

Petroleum Engineering

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Taylor series, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Complex number, polar form of complex number, triangle inequality.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.

Petroleum Exploration: Classification and description of some common rocks with special reference to elastic and nonelastic reservoir rocks. Origin, migration and accumulation of Petroleum. Petroleum exploration methods.

Oil and Gas Well Drilling Technology: Well planning. Drilling method. Drilling rigs Rig operating systems. Drilling fluids function and properties. Drilling fluid maintenance equipment. Oil & gas well cementing operations. Drill bit types and their applications. Drill string & Casing string function, operations, selection & design. Drilling problems, their control & remedies. Directional drilling tools. Directional survey. Application of horizontal, multilateral, extended reach, slim wells.

Reservoir Engineering: Petrophysical properties of reservoir rocks. Coring and core analysis. Reservoir fluid properties. Phase behavior of hydrocarbon system. Flow of fluids

through porous media. Water and gas coning. Reservoir pressure measurements. Reservoir drives, drive mechanics and recovery factors. Reserve estimation & techniques.

Petroleum Production Operations: Well equipments. Well completion techniques. Well production problems and mitigation. Well servicing & Workover operations. Workover & completion fluids. Formation damage. Well stimulation techniques. Artificial lift techniques. Field processing of oil & gas. Storage and transportation of petroleum and petroleum products. Metering and measurements oil & gas. Production system analysis & optimization. Production testing. Multiphase flow in tubing and flow-lines. Nodal system analysis. Pressure vessels, storage tanks, shell and tube heat exchangers, pumps and compressors, LNG value chain.

Offshore Drilling and Production Practices: Offshore oil and gas operations & ocean environment. Offshore fixed platforms, Offshore mobile units, Station keeping methods like mooring & dynamic positioning system. Offshore drilling from fixed platform, jack-up, ships and semi submersibles. Use of conductors and risers. Offshore well completion. Deep water applications of subsea technology. Offshore production: Oil processing platforms, water injection platforms, storage, SPM and SBM transportation and utilities. Deep water drilling rig. Deep water production system. Emerging deep water technologies.

Petroleum Formation Evaluation: Evaluation of petrophysical of sub-surface formations: Principles applications, advantages and disadvantages of SP, resistivity, radioactive, acoustic logs and types of tools used. Evaluation of CBL/VDL, USIT, SFT, RFT. Production logging tools, principles, limitations and applications. Special type of logging tools. Casing inspection tools (principles, applications and limitations), Formations micro scanner (FMS), NMR logging principles. Standard log interpretation methods. Cross-plotting methods.

Oil and Gas Well Testing: Diffusivity equation, derivation & solutions. Radius of investigation. Principle of superposition. Horner's approximation. Drill Stem Testing. Pressure Transient Tests:

Drawdown and build up-test analysis. Wellbore effects. Multilayer reservoirs. Injection well testing. Multiple well testing. Interference testing, Pulse testing, well-test analysis by use of type curves. Gas well testing.

Health Safety and Environment in Petroleum Industry: Health hazards in Petroleum Industry: Toxicity, Physiological, Asphyxiation, respiratory and skin effect of petroleum hydrocarbons, sour gases. Safety System: Manual & automatic shutdown system, blow down systems. Gas detection system. Fire detection and suppression systems. Personal protection system & measures. HSE Policies. Disaster & crisis management in Petroleum Industry. Environment: Environment concepts, impact on eco-system, air, water and soil. The impact of drilling & production operations on environment, Environmental transport of petroleum wastes. Offshore environmental studies. Offshore oil spill and oil spill control. Waste treatment methods.

Enhanced Oil Recovery Techniques: Basic principles and mechanism of EOR, Screening of EOR process. Concept of pattern flooding, recovery efficiency, permeability heterogeneity. Macroscopic and microscopic displacement efficiency. EOR methods: Chemical flooding, Miscible flooding. Thermal recoveries (steam stimulation, hot water & steam flooding, in-situ combustion), Microbial EOR.

Latest trends in Petroleum Engineering: Coal bed methane, shale gas, oil shale, gas hydrate, and heavy oil.

PETROLEUM ECONOMICS:

Production Forecast and Reserves Estimation Methods, Oil and Gas Prices: International Market and Geopolitics, Cash Flow Analysis and Economic Parameters, Risk and Uncertainty Analysis, Financial Analysis and Accounting, Petroleum Fiscal System.

Syllabus

Post Name	:	**Senior Officer (Reservoir) (Master degree in Petroleum Engineering /Technology)**
Post Code	:	**RE 03**

1) OIL & GAS PROPERTY EVALUATION, ECONOMICS & RISK ANALYSIS

- Introduction: Structure of oil industry, financial aspects of the oil industry, world oil supply and demand.
- Principles, Methods and Techniques for Oil and Gas Property Evaluation, Project Parameters: Time value of money in capital investment, Depreciation, depletion and amortization of oil projects, Financial measures and profitability analysis, Break-even and sensitivity analysis, Optimization Techniques.
- Applications and Project Evaluation of Oil Fields: Economic evaluation of exploration and drilling operations, Estimation of oil reserves and evaluation of an oil property, Economic evaluation of production operation.
- Downstream Oil Activities: Economic evaluation: Oil transportation, Crude oil processing, Distribution and Marketing,
- Taxation: Severance and Ad Valorem taxes, Federal income taxation of oil and gas transactions, Value added taxation .
- Uncertainty and Risk Analysis: source of risk, managing risks by risk reduction, diversification, and uncertainty investment and decision analysis by decision tree. Risk management in energy markets including the identification of risk and the use of 'futures' and 'options' markets.
- Environment and pollution control: Regulation and control of pollution and environmental modelling, monitoring and database management

2) FLUID FLOW THROUGH POROUS MEDIA

- The Porous Medium: The Physical Medium, Relevant Physical Phenomena, Pore Scale vs. Continuum Scale, Fluid and Porous Matrix Properties
- Mathematical Models of Porous Media: Network Models, Statistical Descriptors, Fractal Models, Effective Medium, Mixture Theories, Double Porosity Model
- Single Phase Flow in a Porous Medium: Darcy's law.
- Balance Principles: Mass, Momentum and Energy Conservation, Equations of Motion,
- Constitutive Theory : Constitutive equations for mass and heat transfer and Mechanical response for solid phase
- Boundary Value Problems: Well-Posed Problems, Common Boundary Conditions, Common Solution Procedures
- Immiscible Multiphase Flow : Surface Chemistry, Thermodynamics of Interface, Interfacial Tension, Capillary Pressure, Simultaneous Flow of Two Fluids
- Surface Phenomena : Adsorption, Wetting, Thin Films, Transport through

Membranes

- Miscible Displacements and Dispersion

3) OIL AND GAS FIELD DEVELOPMENT AND PLANNING

- Brief overview on field development, Difference between oil and gas field development,
- The Field Life Cycle: Gaining Access, Exploration Phase, Appraisal Phase, Development Phase, Production Phase, Decommissioning.
- Petroleum Agreements & Bidding: Invitations to bid, Motivations and form of bid, Block Award, Fiscal System, Farm-in & Farm-out, Unitisation and Equity determination. NELP & OALP, PSC.
- Reservoir Description: Data Gathering, Data Interpretation
- Field Appraisal: Importance of Appraisal, Identifying and quantifying sources of Uncertainty, Cost benefit calculations for Appraisal.
- Reservoir Dynamic Behaviour: Fluid Flow studies, PVT data, Drive Mechanisms. Gas Reservoirs: Gas sales profiles; Influence of Contracts; movement of GWC during production, Pressure response, Fluid displacement in the Reservoir, Estimation of Reserves, Reservoir Simulation, Estimating the Recovery Factor, Estimating the Production Profile.
- Well Dynamic Behaviour in Vertical and Horizontal Wells: Estimating the number of Development Wells, Fluid flow near the wellbore.
- Importance of Surface Facilities in Field Development
- Project & Contract Management: Phasing & Organisation, Planning & Control, Cost Estimation & Budgets, Types of Contracts.
- Petroleum Economics: Basic principles of Development Economics, Project Cash flow, Revenue & expenditure items, CAPEX-OPEX, Sensitivity Analysis,
- Managing the Producing Field: Subsurface, surface facilities, Internal & External factors.

4) ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS

- **Section A : Advanced Numerical Methods:**

Solution of tridiagonal system, Evaluation of double and triple integrals by numerical method and its application, solution of non-linear simultaneous equations numerical solution of integral equations, Advanced method of interpolation, Numerical solution of simultaneous first order ordinary differential equations and higher order O.D.E. Initial and Boundary value problems, Numerical solution of partial differential equations: Laplace and Poisson equation, Heat conduction and waved equations,

- **Section-B : Applied Statistics**

Review of binomial, Poisson, normal and log normal probability distributions. Interval estimates. Tests of significance for mean, variance (One an dtwo population case-Z,t,X^2 and F tests), tests for correlation and regression coefficients, Non-parametric tests: sign test, Mann-Whiteney Wilcoxon U-test. Run test and test of randomness.

One way & two way analysis of variance, Time series analysis, reliability an dlife testing experiments in engineering problems.

5) PETROLEUM ENVIRONMENT, HEALTH AND SAFETY PRACTICES

- Introduction to Health, Safety and Environmental Management
- HSE Terms and Definitions, Importance of HSE Management, HSE performance.
- HSE Regulations and regulatory agencies for Oil and Gas Industry
- Environmental issues and Management
- Air pollution- Stack emissions, Flaring and fugitive release
- Water pollution and wastewater management, Produced water management
- Oil spill Management
- Waste management: Drilling waste, Rock cutting, oily sludge, etc.,
- Environmental Management, monitoring and Impact Assessment.
- Occupational Health and Safety Management
- Risk assessment and management: (Qualitative and quantitative)

6) MULTILATERAL AND HORIZONTAL WELL TECHNOLOGY

- Introduction & objectives of horizontal wells, ERD, Laterals etc.
- Geological aspects, & development of oil & gas field using horizontal wells.
- Drilling of horizontal, multilateral and ERD wells.
- Completion of horizontal, multilateral and ERD wells.
- Reservoir engineering concepts of horizontal wells.
- Well logging methods in horizontal wells.
- Well test analysis of horizontal wells.
- Well performance & productivity of horizontal Wells.
- Water & Gas coning in horizontal wells.
- Application of horizontal wells in gas reservoirs & in recovery of heavy oils.

7) WELL SERVICING

- **WELL COMPLETION:**
- Design of Perforations
- Perforating process; Perforation Guns and firing head.
- Perforating/ well activation mechanism: Underbalanced and overbalanced perforations.
- Pressure control equipment (Well Head Lubricator Assembly); Type, size and orientation of perforation holes;
- Optimum Perforation Practices; Down-hole Equipment- Packers – their types, Tubing, Flow couplings, expansion joints, Sliding Sleeves / Side Pocket Mandrels & Blast Joints etc.
- Smart / Intelligent Wells, Well Completion Design.
- Well Sickness, diagnosis and mitigation: Type of well sickness, Symptoms of sick

wells, Testing of sick wells, Identification and Diagnosis of Well Problems, Planning of Workover Jobs; Minor & Major (Capital Repair) jobs; Water & Gas Shut-off jobs; Squeeze Cementing; Water and Gas Coning; Sand Control & its Techniques; Fishing operation, Coil Tubing Unit, Snubbing unit.

- Well Stimulation Techniques: Acidizing of O & G Wells; Hydraulic Fracturing; Acid fracturing, Heat treatment, Down-hole Heaters. In-situ Combustion.

8) ADVANCED WELL COMPLETION PRACTICES

- Basics of Reservoir Completion: Inflow Performance Relationship, Perforating, Hydraulic Fracturing, Acid Fracturing
- Sand Control: Rock Strength, Sand control Prediction, Sand production mitigation, Sand control screens, Gravel Packing, Chemical sand consolidation.
- Life of Well Operations: Types and methods of Intervening, Impact on Completion Design.
- Tubing well performance, Multiphase flow & tubing performance, Flow predictions, Temperature prediction and Control, Packer fluids, Production & Injection well sizing.
- Material Selection: Down hole Corrosion, Metallurgy Selection, Corrosion Inhibition, Seals, Control Lines and encapsulation, Coatings and liners
- Tubing Stress Analysis: Stress, Strain and Grades, Axial Loads, Burst ,Collapse, Triaxial Analysis, Safety and design Factors, Load Cases, Tubing Connections
- Completion Equipment: On-land and subsea Christmas trees; Subsurface safety Valves, Packers, Expansion devices and anchor latches, Landing nipples, locks and sleeves, Mandrels and gauges, Capillary lines and cable clamps, Loss control and reservoir isolation valves, Crossovers, Flow couplings, Modules,
- Well Completion Techniques: Deep water Completions. HPHT Completions, Completions with down hole flow control, Multilateral Completions, Dual Completions, Multipurpose Completions, Underbalanced completions, Coiled tubing and insert completions, Completions for Heavy oil and steam injection, Completions for Coal Bed Methane.
- Installation of Completion systems: Wellbore Clean-out and mud displacement, Completion fluids and filtration, Well clean-up and flow initiation.

9) DRILLING SYSTEM DESIGN

- Drilling Rig Selection and Design: Environmental loading and stability of rig. Design of Block
- and Tackle System, Design of Draw works Drum,Top drive drilling.
- Casing Design: Conventional and conditional Casing Design Practices, Deep well strings, Design practices for high inclined, Horizontal and Slanted wells. Liner design and setting,
- Casing Buckling and Well Head Loads: Casing landing practices, Buckling criteria and Calculation of well head loads.
- Casing while drilling.

- Drill String Design.
- Drilling fluid selection method for critical exploratory wells and development drilling.
- Mud Hydraulics Design: Rheology of drilling fluids and compatibility to borehole conditions, Hydraulic horse power and Rig horse power calculations. Jet impact force, Hydraulics design in High inclines wells. Bit Hydraulics, Bottom drive hydraulics design.
- Rotary System Design: Design and performance of Kelly drive, Bottom Drive and Top Drive Systems.
- Special Methods of Drilling: Aerated drilling, Under-balanced drilling, Overbalanced drilling, HPHT Drilling, Variable pressure regime, Plasma drilling, Electrical Drilling, Re-entry drilling, Jet Drilling, Drilling automation. Smart wells Design, Managed Pressure Drilling
- Drilling Economics.
- Computer Application in Drilling

10) WELL INTERVENTION, WORKOVER AND STIMULATION TECHNIQUES

- Work-over operations. Work over fluids, fluid loss and formation damage. Scraping, well circulation, Water and gas Shut-off, Squeeze cementing. Handling water and gas coning.
- Production packers, Packers calculation, Well activation. Repair of wells, Paraffin and scale removal. Planning and evaluation of workover jobs. Corrosion, Bacteria & Scale control.
- Well treatment; acidzing oil & gas wells. Hydro-perforation. Hydraulic fracturing. Stimulation designing, Proppants and their placement. Thermal stimulation techniques. Surface equipment for Stimulation and Gravel Pack jobs. Down-hole heaters. Horizontal well related development on the subject.
- Sand-control, Screens, Gravel packs: Design and installation.
- Well Intervention: Slickline/ Wireline operations, Coil Tubing Operation

11) WELL PERFORMANCE & ARTIFICIAL LIFT TECHNIQUES

- Flowing well concept, Inflow performance, Vertical lift performance, Choke Bean performance,
- Multi-phase flows in horizontal and vertical pipes.
- Total production system Analysis: Nodal analysis.
- Introduction to different Artificial lift techniques: SRP, Continuous gas lift, Intermittent gas lift: Plunger lift, Chamber lift, Electrical submersible pumping, hydraulic pumping, Jet pumping etc,
- Selection procedure, planning, design; and analysis of artificial lift system.
- Well installation, maintenance and trouble shooting in artificial lift method.

12) INTEGRATED RESERVOIR MANAGEMENT

- Introduction: Scope and Objectives

- Reservoir management concepts: Definition and history, fundamentals of reservoir management, synergy and team; integration of geosciences and engineering, integration of exploration and development technology
- Reservoir management process: Setting goals, developing plans and economics, surveillance and monitoring, evaluation
- Data acquisition, analysis and management: Classification of data, acquisition, analysis and application, validation, storing and retrieval
- Reservoir model: Role of reservoir model in reservoir management, integration of G & G and reservoir model
- Reservoir performance analysis and prediction: Naturally producing mechanism, reserves and role of various forecasting tools- volumetric method, MBE, Decline curve and mathematical simulation
- Matured field reservoir Management.
- Reservoir Management economics: evaluation, risk and uncertainties
- Reservoir management plans: strategy for newly developed field and Secondary and EOR operated field.

13) ENERGY MANAGEMENT & POLICY

- Markets for oil, gas, coal, electricity and renewable energy resources and alternate fuels. Legal and policy aspects of supply and trading in energy. Regulations of energy industries, Industry privatization. International context of liberalization of energy markets. Land acquisition policy, Carbon credit, Modeling techniques for supply and demand, market structure, transportation models, game theory, futures markets, environmental issues, energy policy, energy regulation, input/output models, linear and nonlinear programming models, energy conservation, and dynamic optimization. Development of appropriate models and their application to current issues in energy markets. Energy audit.

14) PETROLEUM ENGINEERING PRACTICALS

- Practicals related to the design & selection of drilling fluids, Petro-physical properties of rocks, Well testing, formation evaluation and testing of Petroleum products.

15) OIL AND GAS MARKETING AND RESOURCE MANAGEMENT

- Introduction: The structure and development of Oil & Gas Industry, India Hydrocarbon vision 2025.
- Petroleum Resource classification, Analysis of resource management.
- Natural Gas: What is Natural Gas, Measuring Natural Gas, Pipeline quality natural Gas
- Demand, Supply & Storage of natural gas: Gas production, Source of demand in India, The supply system, Pipeline Operations & Network, Storage of Natural Gas, Liquefied Natural gas Plant & Operations, Gas Sales Pattern in India, Gas Pipeline Regulations in India, Gas Trading, Gas Pricing

- Coal Bed Methane: Introduction, Present status of Coal Bed Methane, CBM Storage and sales, CBM Pricing in India
- Crude Oil: Crude oil/ specification, Measuring/ Custody transfer of Crude Oil, Crude Oil Transportation, Crude Oil Production in India, Crude Oil refineries, Products from Crude Oil
- International & National Institutions of Oil & Gas: API,OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA
- Petroleum Contracts: NELP - Role & Background , Types of Contracts and fiscal components, Production sharing contracts in India, Crude Oil trading and pricing, CBM Contracts
- Strategic Reserves concepts.

16) PETROLEUM RESERVOIR MODELING AND SIMULATION

- Introduction & Overview:
- Modeling Concepts: The concept of Gridblocks & Timesteps, Static and Dynamic Modeling. Mobility Weighting, Grid Orientation effects, Explicit & Implicit functions, Solution methods.
- Designing the reservoir model, Checklist for model design, Selection of the number of dimensions,
- Pseudo-relative permeability & Capillary pressure functions, VE pseudo functions, Windowed models, Naturally fractured reservoirs, Representation of reservoir fluids, Representation of reservoir rock, Well models.
- Selecting reservoir rock and fluid properties data: Data for model construction, Selection and assignment of data Fluid properties, Establishing Initial pressure and saturation distribution.
- Selecting Grid & Time-step sizes: Selection of gridblock size example grids, Selection of time-steps, Numerical dispersion, Grid orientation, Cost considerations.
- Selecting the Numerical solution method.: Terminology, Formulating the equations, Material Balance & pressure equations, Formulating options, Matrix Equations, Solution methods, Selecting the Equation-solving technique.
- Well Management: Designing & Controlling Production Parameters.
- History Matching: Validity of the Reservoir Model, Strategy & Plans, Adjustment of parameters, Pressures, Pressure gradients, GOR-WOR behavior Automatic History Matching.
- Forecasting Future Performance: Planning prediction cases, Preparation of input data, smooth transition from history to predictions, Review & Analysis of predicted performance, Evaluating & Monitoring predicted performance.

17) COALBED METHANE, GAS HYDRATES AND SHALE GAS/ OIL

A: COALBED METHANE:

- Introduction & present status of coalbed methane- Global and Indian Scenario

- Formation and properties of coalbed methane: Generation of coalbed methane gas & its properties, properties of coal as reservoir rock & Reserve Estimation.
- Thermodynamics of coalbed methane: isotherm studies
- Overview of Drilling and Production systems of coalbed methane wells.
- Hydro-fracturing of coal seams
- Treating and disposing produced water.
- Testing of coalbed methane wells.

B: NATURAL GAS HYDRATES:

- Introduction & present status of gas hydrates
- Formation, accumulation and properties of gas hydrates
- Thermodynamics, kinetics and phase behaviour of gas hydrates
- Drilling and production systems of gas hydrate wells
- Prevention & control of gas hydrates
- Gas extraction from gas hydrates. Uses and application of gas hydrates.

C: SHALE GAS/ OIL:

- Global Scenario of shale gas/ Oil production.
- Nature, origin and distribution of Shale Gas/ Oil.
- Characterization of Shale for Production of Shale Gas/ Oil.
- Extraction methods of Shale gas/ Oil: development of current practices.
- Location and size of production areas: estimated reserves and economics.
- Environmental issues in shale gas exploration.
- Markets and Globus impact on energy scenario.
- Economic factor of shale Gas/ oil production

18) OIL & GAS PROCESSING PLANT DESIGN

- Oil desalting: Operation, variables, Heater treater design.
- Crude & Condensate Stabilization : LTX Stabilization.
- Oil & Gas Treatment : Oil desalter, emulsion treatment theory and practice, Emulsifiers & Demulsifiers, Gravity Separation, coalescence, coalescing media, electrostatic coalescers.
- Treating Equipment : pressure vessels - Vertical, horizontal, Electrostatic. Process heat duty, Sensible heat of natural gas, Water, Heat transfer from fire-tube. Heat exchangers- types, fluid placement, sizing, number of tubes.
- Natural Gas Dehydration : (a) Glycol Process : operation, effect of variables, dew point depression, stage calculation.
- NTU - graphical and analytical methods, Absorber sizing. Lean oil absorption. (b) Solid-bed process : design & operation, effect of process variables, Regeneration and cooling calculations. Hydrocarbon recovery. (c) Hydrate formation & inhibition.
- Natural Gas Sweetening : Acid gases, Toxicity, Pipeline specification. Solid-bed Process : Design, operation & effect of variables. Adsorbent selection. Multistage Separation, Hengsteback's Flash calculation, stabilizer design. Amine and other absorptive process details.

19) DEEP WATER TECHNOLOGY

- Introduction : Definition, Global deep water reserves & development activity. Technological advances.
- Dynamics of Offshore Structure : Analysis of Waves and fluid induced forces on offshore structures, Current and wind forces, soil mechanics of seabed & structures.
- Deep water Exploration & Drilling : Seismic/Seabed Survey, constraints in deep water survey like geo-hazards, gas hydrate etc., deep water Drilling with emphasis on the additional inputs to normal offshore Drilling operation.
- Deep water Production System : Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating Production Systems like FPSOs, FPSSs, TLPs, Spar Platform and FSOs.
- Deep water applications of Subsea Technology : Subsea completion, X-mas tree, control systems, Manifolds, Templates, ROVs, deep-water installation vessels with DP system and associated problems.
- Deep water Pipelines & umbilical : Issues in deep water Pipeline Design, Rigid and Flexible flow lines, Pipe-in-pipe, deep-water Risers and their configurations, Pipeline installation methods, Umbilical – functions, configurations and installation, Flow assurance strategies.
- Emerging deep water Technologies : Autonomous Underwater Vehicles (AUVs) Seismic- while-drilling, Dual-activity-drilling, Innovative Floating Production Concepts, Subsea processing, subsea separation (VASPS, SUBSIS, Twister) and any new innovations.
- Problems and Mitigation in Deepwater Drilling: Specialized consideration, specific planning requirement, specialized equipment and deep water complication.

20) CARBON CAPTURE AND SEQUESTRATION

- Introduction: Scope, Objectives and Necessity of CCS
- The contribution of fossil fuels emission to Climate change and global warming. Concept of Carbon Credit and carbon footprint.
- Carbon capture techniques: Carbon-di-oxide emission, Scrubbing of CO_2 , Carbon dioxide re- cycling
- Carbon dioxide sequestration: Underground storage, Potential for Geologic Storage, Application in Oil and gas industry, Carbon di oxide flooding projects, Methane recovery projects.
- Strategy for implementing CCS technology:
- Modeling of Cost and Performance of CCS Plants.
- Role and function of IPCC

21) ADVANCED PETROLEUM FORMATION EVALUATION

- Introduction to Formation Evaluation
- Direct Methods: Coring & Core Analysis, mud logging .
- Wire-line Logging Devices: Electrical, Radioactive, Acoustic Logging devices.

- Cased Hole Log Analysis Monitoring: Objectives of Cased Hole Logging Environment. CBL/VDL and Casing Inspection Logs. Perforating.
- Production Logging & Reservoir Performance Monitoring: Flow Velocity Tools. Fluid Density Measurements. Pressure Measurements & Temperature Measurement Techniques
- Recent Development: Flow View Measurements. Modular Formation Dynamics Tester. Water Flow log services. Formation Subsidence Monitor Tool. Digital Entry Fluid Imaging Tools. Ultrasonic Imaging Tools
- Interpretation Methods: Standard Log Interpretation Methods. MID Plot Method. Cross- plotting Methods.