Syllabus for 3 years Diploma in Petroleum Engineering

A. Fundamentals of Mechanical Engineering

1. Laws of thermodynamics: Analysis of various thermodynamics processes, P-V and T-S diagrams , Analysis of air standard cycles - Carnot cycle, Joules cycle, Otto cycle and Diesel cycle
2. Engines : Classification of I C Engine, Performance of internal combustion engines
3. Properties of fluids: Classification -Ideal fluid , Newtonian, Non-Newtonian fluids
4. Fluid dynamics: One dimensional equation of motion -Bernoulli‟s equation ,Application of Bernoulli‟s equation, Venturimeter, Orifice meter ,Nozzle ; Flow through pipes - Darcy – Weisbach‟s equation, Head loss in Pipes, Pipes in series/ Parallel
5. Classification of pumps: Basic construction and application of different types of pumps - Centrifugal pump, Axial pumps, Gear pump, Vane pump ,Reciprocation pump and Screw pump; Classification, basic construction and applications of different types of compressor - Centrifugal Compressor, Axial Compressor, Rotary Vane type Compressor and Screw pump Compressor
6. Turbines: Gas, Steam and Hydraulic turbines

B. Chemistry of Hydrocarbons :

1. Origin and formation of Petroleum: Reserves and deposits of Hydrocarbon in India;Indian Petroleum Industry; Composition of crude Oils, ultimate and chemical composition; Hydrocarbons in petroleum, Asphltenes and Resins; classification of petroleum, evaluation of crude oil; Bench mark crudes.
2. Characterization of crude oils: TBP and ASTM distillation; Classification by chemical composition; Correlation Index. Density, API gravity, Viscosity, UOP characterization factor, etc. ;Physical & Thermal properties of petroleum; ASTM, TBP, EFV distillation curves.
3. Properties of crude oil: Properties of crude oil octane no. etc ; Pre-treatment, Electric desalting; Atmospheric and vacuum distillation; Petroleum products and their quality control tests.
4. Value addition of petrochemicals: From feedstock to consumer end products; Chemical reactions of hydrocarbons - Decomposition (Thermal & Catalytic); Halogenations; Isomerisation; Hydrogenation; Alkylation; Nitration; Sulfonation, etc. with chemistry and reaction mechanism.
5. Gaseous fuels: Natural gas; Synthetic gases, their composition & properties; Producer gas, Water gas, Coal Gas, LPG, CNG, and Hydrogen as fuel.

C. Basic Petroleum Geology

1. Mineralogy and Petrology: General properties of minerals and their classification , Properties of common rock forming minerals and clay minerals; Petrology: Texture, Structures, classifications and descriptions of Igneous and metamorphic rocks.
2. Sedimentology:
   Mode of formation of sedimentary rock - Texture and its types, grain size, grain shape, sorting & composition; Mechanically and chemically formed Structures; Classification of sedimentary rocks and their characteristics; Descriptions of sedimentary rocks.
   Characteristic of sedimentary rock - Detailed study of clastic, carbonate rocks, evaporites, coal and oil shales; Sedimentary Environments:- Concept of sedimentary environments; Environmental parameters and their control; Classification of environments. Continental Environments: Fluvial, lacustrine, Paluda, Eolian & Glacial;Transitional to Shallow Marine Environments: Deltas, Beaches and Barrier Islands, Clastic shelf, carbonate shelves and

platforms; Deep Marine: Pelagic & Turbidites;Concept of tectonics and sedimentation; Role of environmental analysis in petroleum exploration.

3. Structural Geology : Deformation mechanism of folds and faults;Nomenclature, Classification and recognition, joints; Unconformity, salt domes, plate tectonics and basin formation and Effects of folds, faults and fractures on strata and their importance in Exploration activities
4. Stratigraphy : Earth‟s history in rock record - Introduction of stratigraphic principles – lithostratigraphy, cyclostratigraphy, chronostratigraphy, event stratigraphy; Indian Geological time-scale; Introduction to paleontology, fossils & microfossils and their mode of preservation, significance of microfossils in petroleum exploration; Broad stratigraphic subdivisions and associated rock types of important coal basins and oil basins of India; Geology of prospective basins of India
5. Petroleum Geochemistry : Introduction to Petroleum Geochemistry; Theories of origin of petroleum; Biomass composition; Sedimentary organic matter; Transformation of sedimentary organic matter into kerogen; Transformation of kerogen into oil and gas; Migration of oil and gas: mechanism, pattern and barriers; Reservoir rocks and cap rocks. Entrapment of oil- types and mechanism; Accumulation of oil and gas; Composition and classification of petroleum; Laboratory analysis equipment and methods; Biomarkers; Stable isotopes; Source rock characterisation and evaluation in terms of quantity, quality and maturation of organic matter ; Analytical techniques; Oil to oil and oil to source correlation; Gas to gas and gas to source correlation.

D. Drilling Technology

Overview of drilling: Drilling plan- GTO -Types of drilling, Rotary bit technology- Drilling string basics. Drilling fluid properties- Drilling fluid hydraulics calculations- Bit HydraulicsOptimization- Swab & Surge-pressures- Mud hydraulics analysis report- Lost circulation. Disposing of the drilling fluids waste and drill cuttings waste.

Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation- Mud logging methods - Measurement while drilling & logging while drilling; data Direct measurements of pore pressure -Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient HPHT well design.

Wellbore stability–Determination of the magnitude and direction of the in situ stress, Determination of rock properties, Failure criteria – Stress distribution around a wellbore Procedure for determining safe mud weights to prevent hole collapse, Preventing borehole instability Gas behavior in a well – Kick tolerance, How to calculate kick tolerance – Influence of FG on kick tolerance – Kick tolerance while drilling – Kick tolerance graph – Modifying the calculate kick tolerance – Use of kick tolerance to calculate wellbore pressures.

Casing: Functions of casing – Types of casing – Casing properties Casing specifications – Casing connections – Factors influencing casing design – Collapse criterion – Burst criterion – Combination strings – Tension criterion Compression loads – Biaxial effects – Triaxial analysis – Triaxial load capacity diagram, Casing seat selection method. Cementation: Introduction cement slurries-Typical field calculations- Cementing nomenclature Cement additives – Cementation of liners.

Directional drilling: Applications- Well planning- Down-hole motors- Deflection tools and techniques- Face orientation- Direction control with rotary assemblies- Navigation drilling

systems;.Horizontal wells–Well profile design considerations – Torque and drag – Horizontal borehole stability – Extended reach well design – Multilateral wells.

Stuck pipe, well control: Kicks- Kick control- Pressure control theory- BOP-Special kick problems and procedures to free the pipes and Fishing operations. Types of fishing tools, Case studies of blow out control.

E. Drilling Fluids & Cementing Technology :

1. Overview of Drilling Fluids: Clay chemistry and its application to drilling fluids, Types of clays and Hydration, Flocculation, Aggregation and Dispersion
2. Classification, Types and applications of drilling fluids: Water based, Oil based, Emulsion based and Polymer based; Surfactant based, Foam based and Aerated drilling fluids
3. Drilling Fluid Characteristics: Basic functions, properties; Maintenance and treatments of drilling fluids
4. Calculations: Drilling fluid calculations
5. Rotary Drilling Hydraulics : Rheology of drilling fluids , Pressure loss calculations and Rig hydraulics and Mud logging
6. Cementing, Cements & cement slurry: Objectives of cementing; Oil well cements; Classification of cement ; Slurry design, Slurry additives, Factors influencing cement slurry design and Cementing equipments
7. Cementing Methods: Primary cementing, Stage cementing, Liner cementing; Plugging, Squeeze Cementing techniques in practice; Deep well cementing and Characteristics of good quality cementation.

F. Reservoir Engineering

1. Introduction: Introduction to reservoir engineering; Characteristics of crude oil and natural gas; Classification of crude and its physicochemical properties
2. Reservoir Rock Properties: Porosity and permeability determination; Combination of permeability in parallel & series beds; Porosity permeability relationship; Fluid saturation determination and significance; Effective and relative permeability; Wettability, capillary pressure characteristics, measurements and uses; Coring and Core Analysis
3. Reservoir Fluids: Phase behavior of hydrocarbon system, ideal & non ideal system and Equilibrium ratios; Reservoir fluid sampling; PVT properties determination; Different correlations and laboratory measurements, data reduction, evaluation and application.
4. Flow of Fluids through Porous Media: Darcy's law; Single and multiphase flow ;Linear, radial & spherical flow; Steady state & unsteady state flow; GOR, WOR equations
5. Reservoir Pressure , Drives and estimation : Reservoir Pressure Measurements: Techniques of pressure measurement; Reservoir Drives :Reservoir drive mechanics and recovery factors; Reserve estimation: resource & reserve concept; Different reserve estimation techniques: Volumetric, MBE, decline curve analysis; Latest SPE/ WPC/ IS classification
6. Multi phase flow: Relative permeability-fractional flow; Well performance – inflow performance, tubing performance

G. Fundamentals of Well Logging Techniques

1. Introduction to Well Logging : Methods of gathering formation evaluation data - Mud logging, Coring, MWD; Open hole logging; Cased hole logging ; Modern logging techniques
2. Rock Properties :
   Methods of analysis and application of results - The genesis of Reservoir Rocks, Fluid Distribution in the Reservoir; Relative Permeability, Measurement of Porosity ; Measurements of Permeability, Measurements of Saturation
   Basic concepts of Log Analysis -Lithology, Porosity, Water Saturation, Hydrocarbon Type; Pay counting; Permeability

Reserve Estimation - Oil and Gas-In-Place Estimates; Reserve estimates, Factors; Formation Volume Factors, Reservoir Volumes

3. Open hole Logging Measurements : The SP Log, The Gamma Ray Log; Resistivity Measurements; Induction Logging, Latero log, Micro resistivity Log, Dielectric Logs, Sonic (Acoustic)Logging and Elastic
4. Analysis Of Logs And Cores: Compatibly Scaled Overlays, Cross plots, Histograms; Quick look Algorithm, Porosity Estimation From Neutron; Cross Plots: Density Logs, Sonic Logs Using Various Cross plot And Overlay Techniques; Lithology Identification From Various Cross plots And Other Types Of Plots
5. Water Saturation and Archie Equation: Rw Determination Using SP Log, Ratio Techniques, Crossplots; F Overlay Techniques and from chemical analysis; Water Saturation: Basic Archie‟s Equation, Saturation Exponent-n And Formation Factor-m For Clean Formation.

H. PETROLEUM PRODUCTION OPERATION

Well equipments. Well completion techniques. Well production problems and mitigation. Well servicing & Workover operations - Productive formation testing and bottom hole sampling. Operations to solve formation damage related problems and well services for mechanical problems of a wellbore. Removal of scale, hydrate, paraffin and sand during workover. Operations on killed wells. Squeeze cementation. Water and gas shut off jobs. Liquid unloading in gas wells. Fishing tools and jobs during production.

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. Primary, Secondary, Tertiary well control operational procedures, well control methods well control kill sheet, kick pressure analysis, Special conditions and problems, BOP control unit, Accumulator calculations, BOP stack testing's, Snubbing, Stripping.

I. Petroleum Transportation and storage System

1. **Transportation of petroleum & petroleum products** : Basics of Pipeline construction, operation and protection.
2. **Pump and compressor stations** : Instrumentation and Control; Metering and measurements of oil and gas.
3. **Traffic management** : Fire and safety rules. Indian and Global supply scenario of petroleum and petroleum products, Product quality control.
4. Bulk distribution and handling-domestic, commercial and industrial. Storage of petroleum products in fixed installations. Standards and regulations.
5. Role of International oil companies and OPEC pricing mechanism. Administered and market determined pricing mechanism in India. Conservation of petroleum & its products. Spot and other market control mechanism

J. Pipeline Engineering

1. **Introduction to Piping Engineering Fundamentals**: Scope of piping in projects, Plant piping systems and transportation, Difference between codes and standards, ASME / API Codes and Standards. Principles for piping design, Major piping standards, Pipe designators -NPS, IPS, NB, Pipe wall thickness and Schedule, Pipe weights, Lengths, grades, Ends, Joining methods, Methods of manufacture, Pipe ratings, Pipe symbols.

2. **Pipe Fittings and Flanges** – ASME Standards, Selection, Application, Drawing Symbols and Dimensioning. :Types of fittings, Pipe bends branch connections, Reducers , Offset calculation, Stub ends and types, Application of Stub Ends, Fabricated branch connections, Welding minimums for Stub In, Branch reinforcements, Types of flange and Couplings, Dimensioning, Minimum pipe requirements, Screwed and Socket weld fittings – Drawing representations, Dimensioning exercises.
3. **Piping Material Specification, Pipe Supports, Pipe Racks and Utility Stations** : Piping material Specifications (PMS), PMS creation requirements, Piping specifications, Material selection, P-T ratings, Valve data, PMS Application, Piping supports, Anchors, Pipe guides, Limit stops, Pipe shoe, Shoe guides / Hold down guides, support, Rigid hangers, Manifold Supports, Pipe rack design, Pipe arrangements, Control station and Utility station on pipe racks.
4. **Process Flow Diagrams and Piping Drawings** : Block and process flow diagrams, Utility flow diagram, Piping & Instrumentation diagram, Line Numbering, Line Designation table/ Line list creation, Print reading exercise, Flow Diagram versus Piping drawings, Symbols and abbreviations, Equipment vendor data, Instrument types and symbols – flow, temperature pressure and level, Instrument hook-up drawings, Plot plan and Equipment layout.
5. **Pressure Design of Process Piping Systems – ASME B 31. 3**: (Scope of ASME B 31.3, B31.4 & B 31.8, Code interpretation – ASME B 31.3 ASME B 31.3 Fluid service categories, Design pressure and temperature for piping systems, Pressure design of straight pipe under internal pressure. – wall thickness calculations, Maximum design pressure for piping systems, Maximum allowable operating pressure for pipelines, Piping material Selection per ASME Code, ASME piping materials for fluid service categories.
6. **Miscellaneous Topics.** : Steam piping, Corrosion and protection, Thermal insulation, costing, Pipe color coding, Fabrication and installation, Valves, its types and selection, Introduction to Subsea piping. Pipe Stress Analysis: objectives and definition of stress analysis. Critical line list, Information required for stress analysis, Piping loads, Introduction to Pipe stress analysis software CAESAR II Flexibility Analysis: Concept of thermal expansion, minimum leg required to absorb thermal Expansion, Stress monographs for pump and Vessel piping, Types of expansion loops.

K. Petroleum Refining and Petrochemicals

1. Introduction: Origin, exploration and production of Petroleum; Types of crudes, composition, characteristics, Products Pattern, Indigenous and imported crudes; Crude heating, primary distillation principles; Separation of cuts, gaps / overlaps, stripping; Vacuum distillation; Types of trays, drawoffs, intermediate product, quality control
2. Solvant Treatment and Extraction : Lube oil and wax processing; Solvent extraction, dewaxing desilting; Deasphalting, clay contacting – Principles, Operating parameters and Feed and product equalities and yields;
   Types and functions of secondary processing; Cracking, thermal cracking and visbreaking, different feed stocks, products, yields and qualities
3. Catalytic cracking and reforming : Fluid catalytic feed stocks and product yields and qualities, Catalyst and operating parameters; Steam Reforming, Hydrogen, Synthesis gas ; Cracking of gaseous and liquid feed stocks, olefins, Diolofins, Acetylene and Aromatics and their separation
4. Unit Processes : Alkylation, oxidation, dehydrogenation; Nitration, chlorination, sulphonation and isomerisation
5. Polymerisation : Models and Techniquies,Production of polyethylene, PVC, Polypropylene, SAN, ABS, SBR; Polyacrylonitrile, Polycarbonates, Polyurethanes, Nylon, PET

L. 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.

M. Unconventional Hydrocarbon resources

1. 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.
2. Shale Gas/ Oil Reservoir : 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.
3. Coal Bed Methane : Formation and properties of coal bed methane. Thermodynamics of coal bed methane. Exploration and Evaluation of CBM. Hydro-fracturing of coal seam. Production installation and surface facilities. Well operations and production equipment.
4. 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.
5. Coal and Gas conversion to Oil : Introduction, classification and principles, pyrolysis, theoretical aspect of processes involved in conversion. Technological development of direct conversion and indirect processes and sustainability of conversions.
6. Environment and Economic Considerations : Environmental considerations of unconventional oil and gas. Treating and disposing produced water, Economics of development

N. Natural Gas Engineering :

1. **Properties and Measurement of Natural Gas**: Introduction to Natural Gas, origin of natural gas, other sources of gaseous fluids. Phase behavior fundamentals, qualitative and quantitative phase behavior, vapor liquid equilibrium. Equation of state, critical pressure and temperature determination. Gas compressibility, viscosity and thermal conductivity, formation volume factor.
2. **Gas Reservoir Performance and Gas flow measurement**: Fundamentals of gas flow in conduits, fundamentals of fluid flow in porous media, inflow performance curves, outflow performance. Gas flow measurement, fundamentals, Methods of measurements, Orifice meters equation, turbine meters, Selection, Recording charts, Uncertainties in flow.
3. **Flow of Gas in Production Tubing** : Introduction, gas flow fundamentals, vertical and inclined single phase flow of gas, calculating flow and static bottom hole pressure, gas flow through restrictions. Temperatures profiling in flowing gas systems.
4. **Natural Gas Processing** : Gas liquid separations, dehydration processes, absorption and adsorption by gas permeation. Desulfurization processes, solid bed sweetening process, physical and chemical absorption processes, Acid gas removal. Integrating natural gas processing
5. **Gas Compression** : Introduction, types of compressors, Selection, Thermodynamics of compressors, Design fundamentals for reciprocating, centrifugal and rotary compressors (single and multistage), Use of Mollier diagrams. Unit VI: Gas Gathering and Transport: Gas gathering system, steady state flow in simple pipeline system, steady state and non steady state flow in pipelines, solution for transient flow, Pipeline economics. Installation, operation and trouble shooting of natural gas pipelines.

O. Unit Operation for Petroleum Industry

1. **Conduction** : Introduction to unit operation and its application in petroleum engineering. Heat

Transfer and its application, Modes of heat transfer one dimensional and two dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

2. **Convection** Convective heat transfer, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, Fouling factor. Heat transfer with and without phase change conditions.
3. **Heat Exchange equipment:** Introduction to double pipe, shell and tube exchangers, condensers, extended surface equipments,
   Evaporation: Evaporation- Type of evaporators and their applications single and multiple effect evaporators, operation of forward– backward and mixed feed operations,
4. **Mass transfer and its application:** Analogies in transfer process, basic concept of diffusion and interphase mass transfer. Mass transfer theory film theory Penetration and surface renewal theory,
   Distillation : distillation, Rectification, reflux ratio, calculation of numbers of plates by McCabe Thiele method, optimum reflux ratio, Basic introduction to absorption, liquid liquid extraction, leaching
5. **Drying**: Equilibrium mechanism theory of drying, drying rate curve, Introduction to filtration Sedimentation and settling.

P. HSE & Hazards 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.

Q. Fundamentals of Instrumentation Engineering :

Principles of measurements and classification of process instruments; Measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration; Electrical and thermal conductivity; Humidity of gases.

Note: The above syllabus is indicative and the questions in the test may include similar other topics pertaining to the level and content of essential qualification.