Semester IV

Reservoir Engineering-II

1.1 Course Number: PE206
1.2 Contact Hours: 3-1-0 Credits:11
1.3 Semester-offered: 2nd Year –Even
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Chinmoy Jit Sarma, Dr. Satyajit Chowdhury, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

2. Objective:

i) To help the students understand the fundamentals and relevance of reservoir engineering in the broader context of Oil/Gas Field Exploitation, and have in-depth knowledge of vital aspects of elements of reservoir engineering in particular
ii) To enable students to understand fluid properties existing in hydrocarbon reservoir and apply laws of fluid flow through porous media and their applicability under various field conditions.
iii) To empower students with the resource analysis expertise through extensive evaluation of hydrocarbon reservoir with respect to reserve estimations, recovery factors and ensure a positive economic gain.
iv) To enable students to emulate and simulate the reservoir parameters and use the same in futuristic R&D of their respective research areas and concerns in and around fluid mechanics such as energy, health etc. across multidisciplinary domains.
v) To equip students with multidisciplinary approach of problem-solving professional way by using commercial software packages, data analysis and presentation, numerical simulations etc.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction**	Overview of applied reservoir engineering and reservoir management.	5
2	**Performance analysis**	Performance prediction of depletion drive, gas cap drive, water drive and combination drive.	5
3	**Water influx**	Water influx: steady and unsteady state models.	5
4	**Water and gas injection**	Reservoir pressure maintenance techniques, their advantages and limitations.	4
5	**Theory of fluid-fluid displacement**	Immiscible Displacement processes: Theory & practices-Buckley Leverette treatment of fractional flow and frontal advance equations, water flood performance.	6

6	**Enhanced Oil Recovery**	Introduction, Improved Oil Recovery: Conventional IOR and EOR, Primary and IOR chart; Primary recovery, Pressure declines after primary recovery, Secondary recovery, Factors causing High residual oil Saturation, EOR/Tertiary Recovery, Viscous fingering, Economic value of different EOR techniques, Chemical EOR, Miscible EOR, Thermal EOR, Microbial EOR	7
7	**Well Testing**	Role of oil well tests, oil well test types- periodic production test, productivity test (bean study), pressure transient tests; indicator diagram study: procedure and parameters obtained, Buildup test and drawdown test, gas well test, type curve, Drill stem testing, wireline formation tests, multiple well tests- interference well test and pulse test, Injectivity and fall off tests	6
Total			**38**

4. Readings

4.1 Textbooks:

1. Tarek Ahmed, "Reservoir Engineering Handbook", Gulf Professional Publishing, 4th ed, (2010).
2. NnaemekaEzekwe, "Petroleum Reservoir Engineering Practice", Pearson Education, Inc, (2010).

4.2 Reference Books:

1. Benjamin Cole Craft, Murray Free Hawkins, and Ronald E. Terry, "Applied Petroleum Reservoir Engineering" by Prentice Hall, (1991).
2. LP Dake, "Fundamentals of Reservoir Engineering" shell learning and development, (1998).
3. Tarek Ahmed, Paul D. McKinney, "Advanced Reservoir Engineering" Gulf Professional Publishing, 4th ed, (2005).
4. BF Towler, "Fundamental Principles of Reservoir Engineering", SPE, (2002).
5. Heriot Watt, "Reservoir Engineering Handbook".
6. Abhijit Y. Dandekar, "Petroleum Reservoir Rock and Fluid Properties", CRC Press, (2013).

5. Outcome of the Course:

1) Gain the knowledge of reservoir properties of rocks
2) Calculate the properties of reservoir fluid.
3) Gain insight into vapor – liquid, liquid – solid phase equilibrium during oil & gas production.
4) Understand the phenomenon of multiphase flow system in porous media and Equations for the calculation of required parameters applied in Reservoir Engineering.
5) Understand and explain different drive mechanisms and recovery factor of a Reservoir.
6) Calculate reserves of oil and gas by volumetric and material balance and acquire the Basics knowledge of Reservoir Modeling Software's

Basics of Petroleum Refinery

1.1 Course Number: PE207
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester- offered: 2nd Year –Even
1.4 Prerequisite: Diploma level Chemistry and Unit Operations I
1.5 Syllabus Committee Members: Dr. Chinmoy Jit Sarma, Dr. Satyajit Chowdhury, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

2. Objective:

Petroleum sector plays the most vital role for keeping the wheels of economic development rolling and chemical engineers mainly run the petroleum industry. Knowing the sources of crude petroleum, extraction of the crude petroleum, its refining to the useful Petro-products and efficient transport to the end users through network are important tasks to the petroleum or chemical engineers. This course intends to form the foundation of the chemical engineers on all the above-mentioned basic fields of petroleum from extraction to the safe end use where refining is the most challenging. The course puts major thrust on all the techniques/processes of petroleum refining encompassing selection of the mass/heat transfer devices, their operation and basic design. The course also covers the feed stocks of petrochemical industries and manufacture important petrochemicals.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topic	Sub-Topics	Lectures
1	**Introduction to Petroleum Industry**	Overview of Indian petroleum industry, Crude oil: Origin, Composition, Characteristics; Exploration Methods, Search for crude oil, Scientific methods for petroleum survey, Introduction to rigs.	6
2	**Quality Control of Petroleum Products**	Classification of laboratory tests: Distillation, Vapour pressure, Flash and Fire points, Octane number, Performance number, Cetane number, Aniline point, Viscosity index, Calorific value, Smoke point, Char value, Viscosity, Viscosity index, Penetration test, Cloud and Pour points, Drop point of grease, Melting and Settling points of wax, Softening point of Bitumen, Induction period of gasoline, Thermal stability of jet fuels, gum content, Total Sulphur, Acidity and Alkalinity, Copper Strip Corrosion Test, Silver-Strip Corrosion Test for ATF, Ash, Carbon Residue (Conradson method, Ramsbottom method), Colour, Density and Specific gravity.	6
3	**Petroleum Products**	Composition, Properties & Specification of LPG, Naphthas, Motor spirit, Kerosine, Aviation Turbine Fuels, Diesel Fuels, Fuel Oils.	6
4	**Crude Oil Distillation, Thermal and Catalytic Conversion**	Desalting of crude oils, Atmospheric distillation of crude oil, Vacuum distillation of atmospheric residue. Products of fractional distillation of crude oil and their boiling ranges. Thermal Cracking Reactions, Thermal Cracking, Visbreaking (Conventional Visbreaking and Soaker	10

	Process	Visbreaking), Coking (Delayed Coking, Fluid Coking, Flexicoking), Fluid catalytic cracking; Comparison between thermal and Catalytic cracking, Hydrocracking, Hydrotreating, Reforming, Isomerization, Alkylation: Hydrofluoric acid process, Sulphuric acid process; Polymerization.	
5	**Introduction of Petrochemical Industry**	Definition, History, Raw materials for petrochemicals, Characteristics of petrochemical Industry, Major petrochemical producers in India, different petrochemical products and their uses.	6
6	**Safety in Hydrocarbon Industry**	Introduction, Crude oil Pretreating, Distillation, Thermal Cracking, FCC (Fluidized Catalytic cracking), Hydro Cracking, Catalytic Reforming, Hydro Desulfurization, Hydrogen sulfide safety, Isomerization, Polymerization Alkylation, Sweetening and Treating process	6
TOTAL			**40**

4. Readings:

4.1 Textbooks:

1. W.L. Nelson, Petroleum Refinery Engineering, McGraw Hill, New York.
2. B.K. B Rao, Modern *Petroleum Refining* Processes, Oxford & IBH *Publishing.*

4.2 Reference Books:

1. B.K. B Rao, A Text on Petrochemicals, Khanna Publishers.
2. S. Maity, Introduction to Petrochemicals, Oxford and IBH Publishing.

5. Outcome of the Course:

On completion of this course, students will be able to

1) Understand the worldwide scenario of petroleum refinery, growth prospects, origin of crude oil, their characteristics and future trends.
2) Demonstrate the comprehensive understanding of classification, properties and uses of various refinery products.
3) Develop the knowledge of different refining operations like pretreatment of crude oil, atmospheric and vacuum distillation, cracking operations.
4) Study of different advance processing techniques like hydro cracking, Vis breaking, isomerization, polymerization along with process flow sheet and descriptions.
5) Identify and suggest safe practices in operations of refineries and petrochemical complexes.

Drilling Engineering-II

1.1 Course Number: PE208
1.2 Contact Hours: 3-1-0 Credits:11
1.3 Semester-offered: 2nd Year –Even
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Chinmoy Jit Sarma, Dr. Satyajit Chowdhury, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

2. **Objective:**

i) To help the students understand the risks in well construction.
ii) To enable students to understand the well design procedure.
iii) To enable students to understand the types of directional drilling techniques.
iv) To empower students with the expertise of understanding different procedures of well control.
v) To equip students with necessary engineering skills such as solving engineering problems in a professional way.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Straight hole drilling**	Causes of hole deviation, mechanical factors, crooked-hole tendency, Bottom hole assembly: Slick BHA, Pendulum BHA, packed hole BHA; stabilizers and reamers	12
2	**Directional hole drilling**	Well geometry, types, directional BHAs, surveying tools, Well path deflection & correction. deflection tools- bent-sub, whipstock, jet bit downhole motors – turbine and positive displacement mud motor, dog leg severity, Horizontal well	14
3	**Basics of well control**	Introduction to Well Control, Overburden stress, hydrostatic pressure, fracture pressure, fracture gradient – leak off test, casing seat selection, Causes of Kicks, Kick Warning Signs and Kick Indicators, Prevention of kick, Well Control Methods	11
4	**Well control and well killing methods**	Well Control Equipment: Blowout Preventers (BOPs) and its types, Choke Manifolds and Chokes, BOP Control Systems, well killing procedure, kill mud, killing methods: wait and wait method, driller's method.	10
Total			**47**

4. Readings

4.1 Suggested Books:

1. Directional and Horizontal Drilling, J.A. Short, PennWell Publishing
2. Oil well Drilling Engineering, H Rabia, Gulf Publishing
3. Blowout and Well Control Handbook, Robert D. Grace, Gulf Professional Publishing
4. Advanced Drilling Engineering, G. Robello Samuel, Xiushan Liu; Gulf Publishing
5. Drilling Engineering Workbook, Baker Hughes INTEQ
6. Drilling Operation Practices Manual, Institute of Drilling Technology, ONGC
7. Drilling Engineering, Heriot Watt University

5. Outcome of the Course:

On completion of this course, the students will be able to

1) Understanding of different drilling rig components and drilling systems.
2) Evaluate the different types of muds, drilling systems and Bits and Drill String.
3) Evaluate the application of Casing and Cementing Operation.
4) Analyze the importance of Directional Drilling and designing of any drilling process before operating it.
5) Examine the various methods of well control and different well control Equipment's.
6) Examine the various instruments that come under well completion and methods of Drilling fluids disposal methods.

Production Engineering-II

1.1 Course Number: PE209
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Even
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Chinmoy Jit Sarma, Dr. Satyajit Chowdhury, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

2. Objective:

The objective of this course is to help participants gain an understanding of oil & gas surface installation systems. The course introduces the various separation processes utilized in separating three phases of recovered crude. i.e., oil, water and gas. It also introduces about the different treatment techniques employed in the treatment of crude oil and also of produced water before being injected/discharged into the well/environment.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction**	Surface Operation: Separator and storage, Typical flowsheet in a production facility, Common flow sheet symbols, well to sales flow, Stage Separation, Process controls, Safety symbols, Group Gathering Station (GGS)	6
2	**Two Phase liquid & gas separation**	Introduction, Factors affecting separation, Separators: components, types, operating problems.	6
3	**Oil & water separation**	Introduction, three phase separation, water washing, oil pad, separator types: Horizontal and vertical separators: Weir design and bucket and weir design	6
4	**Crude Oil Treating System**	Emulsion: Emulsifiers and de-emulsifiers, De-emulsification & Dehydration process, Types of Treating equipment: vertical, horizontal and electrostatic treaters.	6
5	**Storage**	Introduction, Categories of storage tank system: Onshore: Above ground and underground system, and offshore storages, Tank maintenance and Tank Gauging.	6
6	**Produced Water treating system**	Theory, Treatment types and equipment: Primary, Secondary and tertiary systems.	6
Total			**36**

4. Readings

4.1 Reference Books:

1. Surface Production Operations, Volume 1, Ken Arnold & Maurice Stewart, Gulf Publishing, Houston, Texas, USA
2. Petroleum Production Engineering, Boyun Guo, William C. Lyons & Ali Ghalambor, Elsevier Science & Technology Books
3. Introduction to Petroleum Production: Volume 3: Well site facilities, Water Handling, Storage, Instrumentation and Control System, D. R. Skinner, Gulf Publishing Company

5. Outcome of the Course:

The students will be able to:

1) Get to know about the surface equipments installations at oil and gas locations
2) Understand various operations involved in separation of crude oil, gas and water phases
3) Get acquainted to crude oil and water treating systems

Health, Safety and Environment Management

1.1 Course Number: PE210
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 2nd Year – Even
1.4 Prerequisite: NA
1.5 Syllabus Committee Members: Dr. Satyajit Chowdhury, Dr. Chinmoy Jit Sarma, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

2. Objective:

i) To create the awareness among students regarding importance of safety in industries.
ii) To introduce the definitions, concepts, methodologies used in management of occupational safety in industries.
iii) Students will be able to recognize and evaluate occupational safety and health hazards in the workplace, and to determine appropriate hazard controls following the hierarchy of controls.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Safety - Need for safety- HSE policy Definitions**	Health, Safety, Accident, Near Miss, Lost Time Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement- Causes of Accident- Safety education & training – Importance, Various training methods, Effectiveness of training.	5
2	**FIRE**	Definition of Fire, Fire Triangle, Tetrahedron of Fire, Classification of fires, Types of Extinguishing Media, Principles of Fire Extinguishing Methods Cooling, Starvation, Smothering, Retarding Chain Reaction, Stages of Fire, various Products of combustion, ignition sources.	5
3	**Active & passive fire protection system**	Overview of suppression and extinguishment, Suppression agents, Portable Fire Extinguishers-Classifications of portable fire extinguishers. Water based suppression system, Foam based Suppression system, Carbon Dioxide based Suppression system, Dry & Wet Chemical based Suppression system. Overview of Fire Fighting Equipments.	8
4	**Hazard**	Classification of Hazards-Risk Control Hierarchy- Risk Assessment- HIRA- Process Safety Management-Elements of PSM. Job Safety Analysis- Plant Inspection- Safety Audit-Near Miss Reporting – Accident investigation.	6

5	**Work permit system**	Objectives, hot work and cold work permits. Entry to Confined space- Confined Space permits. Working at height & Scaffolding hazards. Electrical hazards- Electrical Permit-LOTO. Personal Protective equipments.	6
6	**Occupational Health monitoring system. Environmental impacts of various industrial operations**	EIA. Case studies of various major Industrial accidents. OISD 105, OISD 115, 116, OISD 117, OISD-166.	6
Total			**36**

4. Readings

4.1 Textbooks:

1. Sesha, P., Manual of Fire Safety
2. A. *Maurice* Jones, Fire Protection System- Third Edition,2021
3. RK Jain and Sunil S Rao- Industrial Safety, Health and environment Management system.

4.2 Reference Books:

1. Petroleum act,1934 & Petroleum Rules, 2002, PESO
2. OISD-115 (Oil Industry Safety Directorate), (2002). Guidelines on Fire Fighting Equipment and Appliances in Petroleum Industry. <http://www.oisd.nic.in/oisd-std-115>.
3. OISD-116 (Oil Industry Safety Directorate), (2017). Fire Protection Facilities for Petroleum Refineries and Oil/Gas Processing Plants. <http://www.oisd.nic.in/oisd-std-116>.
4. OISD-117 (Oil Industry Safety Directorate), (2017). Fire Protection Facilities for Petroleum Depots, Terminals, Pipeline Installations & Lube oil installations. <http://www.oisd.nic.in/oisd-std-117>.
5. OISD-105 (Oil Industry Safety Directorate), Work Permit System.

5. Outcome of the Course:

On completion of this course, students will be able to-

1) Demonstrate the knowledge and understanding of basic terms in safety management.
2) Understand safety organizational requirements for effective safety management.
3) Evaluate the workplace hazards and apply controls measures using hierarchy of control.

Drilling Fluid and Cementation Laboratory

1.1 Course Number: PE204L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 2nd Year–Even
1.4 Prerequisite: Fundamentals of Drilling Engineering and Fluid Mechanics
1.5 Syllabus Committee Members: Dr. Satyajit Chowdhury, Dr. Chinmoy Jit Sarma, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

List of Experiments:

1. Formulation of polymer and bentonite-based drilling fluid
2. Measuring density and specific gravity of drilling fluid.
3. Determining rheology of drilling fluid (Viscosity, Gel strength, and Yield point) at low and high temperatures
4. Determination of fluid loss of a given drilling fluid using API filter press at LPLT condition.
5. Measurement of oil, water, solid and clay content of a drilling fluid.
6. Determining setting point and consistency of cement slurry.
7. Measurement of pH, salinity, and conductivity of mud
8. Measurement of viscosity of drilling fluid using Marsh Funnel Viscometer
9. Measurement of sand content in mud using sand content kit.

Reservoir Engineering Laboratory

1.1 Course Number: PE202L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 2nd Year–Even
1.4 Prerequisite: Fundamentals of Reservoir and Enhanced oil Recovery processes.
1.5 Syllabus Committee Members: Dr. Satyajit Chowdhury, Dr. Chinmoy Jit Sarma, Dr. Sekhar Gogoi & Dr. Srawanti Medhi

List of Experiments:

1. Determination of effective porosity by Saturation method.
2. Measurement of surface tension & interfacial tension with a Tensiometer.
3. Determination of wettability by Amott cell
4. Measurement of absolute permeability using liquid permeameter.
5. Measurement of absolute permeability using Air permeameter
6. Cutting, plugging, trimming/end facing of core samples.
7. Core cleaning using Soxhlet apparatus.
8. Determination of capillary pressure of a core sample
9. Determination of resistivity of a core sample