## Modules for
**Joint MSc Degree in Petroleum Projects and Offshore Technology**
**NUS – IFP School**

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OT5901 Reservoir Fluid Characterization (2 MCs)

Instructor:
• Prof Lau Hon Chung

Module Description
This subject will provide concepts in the area of Reservoir Fluid Characterization. Topics covered will include: components of petroleum fluids, phase behaviour, equations of state, the five reservoir fluids, properties of dry gas, properties of wet gas, properties of black oil, and fluid sampling.

Learning Outcome
The subject will provide understanding of the concepts of petroleum fluids in oil and gas reservoirs. Students will learn the basics of different petroleum fluids, and gain an insight into how fluid systems affect oil and gas production in petroleum reservoirs.

Topics
1. Components of Naturally Occurring Petroleum Fluids
   • Organic chemistry, alkanes, alkenes, aromatics, Nonhydrocarbon components, resins and asphaltenes, Classification of crude oils

2. Phase Behaviour
   • Pure substances, Two component mixtures, Multicomponent mixtures

3. Equation of State
   • Ideal gas, Mixtures of ideal gases, Behaviour of real gases

4. The Five Reservoir Fluids
   • Black oil, Volatile oil, Retrograde gas, Wet gas, Dry gas

5. Properties of Dry Gases
   • Standard conditions, Dry gas, Heating value, Joule-Thomson effect

6. Properties of Wet Gases
   • Recombination of surface fluids, Formation volume factor of wet gas, Retrograde gas

7. Properties of Black Oil
   • Black oil reservoir, Fluid properties of production-pressure history, Volatile oil, Retrograde gas

8. Sampling of Petroleum Fluids
   • Sampling, Sample handling and transfer, PVT report
OT5902 Petroleum Geoscience & Drilling (4 MCs)

Instructor:
- Prof (Practice) Arthur Cheng Chuen Hon / Associate Prof Loh Wai Lam

Module Description
The formation, distribution and preservation or destruction of oil and natural gas resources are governed by geologic histories of basins. Good understanding of geological principles and aspects of petroleum geoscience, therefore founds the basis for successful exploration, development and production in the petroleum industry.

This course aims to provide students with a knowledge-base to understand the:
1. fundamental principles of geology and its use for sedimentary basins studies.
2. nature and origin of petroleum and the methods for characterizing and evaluating hydrocarbon basins and prospects
3. direct experience of studying sedimentary rocks in an oilfield.

This module also serves as an introduction to oil & gas drilling and completion process. Starting from a typical Drill Rig and its major systems, to the process of drilling onshore and offshore, to casing & cementing, through to well completion.

Learning Outcome
At the end of the course students should be have the knowledge and abilities
1. To identify and characterise rocks on hand specimens and on field
2. To be able to identify and evaluate a petroleum system in a sedimentary basin.
3. To be able to collect information from the field and integrate them with other information to evaluate the petroleum potential of an area
4. Basic understanding of how the seismic data is acquired and processed to obtain an image of the subsurface.
5. The physics behind the tools used in downhole measurements of properties of the subsurface.
6. The rock physics models used in the interpretation of the data acquired.
7. Integration of the above 3 points for the characterization of the subsurface reservoir.

The student will also understand and acquire the knowledge drilling and completion technology and also the functions of the equipment used in drill rigs and drilling processes, and the different types of completions used in typical oil & gas wells.

Topics

Geology Mapping
1. Principles of Geology:
   a) Evolution and history of earth, minerals and rocks, Wilson & rock cycle, plate tectonics, principles of stratigraphy
2. Petroleum System:
   a) Origin and occurrence of Petroleum, sedimentary basins and petroleum System components
3. **Exploration Tools:**
   a) Exploration methods, Gravity & Magnetics, seismic methods, Geological interpretation and subsurface mapping, petroleum plays and prospect identification.

4. **Field Mapping**
   a) Lithological mapping
   b) Structural mapping
   c) Sequence stratigraphy
   d) Fluvial & coastal sedimentary processes
   e) Oil seeps
   f) Limestones
   g) Mud volcanism
   h) The Miri Petroleum Museum

**Geophysics for Petroleum Engineers**

1. **Seismic Acquisition:**
   a) Different types of Sources
   b) Different types of Receivers
   c) Survey geometry

2. **Seismic Processing:**
   a) Preprocessing
   b) CMP
   c) Imaging

3. **Downhole Measurements:**
   a) physics of downhole measurement
   b) logging tools
   c) Logging While Drilling

4. **Rock physics**
   a) rock physics models: bounds
   b) fluid substitution
   c) stress effects

**Drilling and Completion Process**

1. Types of Drilling
2. Drilling Rigs & Equipment
3. Drilling Process
4. Casing & Cementing
5. Directional Drilling
6. Managed Pressure Drilling
7. Well Completion
OT5903 From Reservoir to Wellhead (4 MCs)

Instructor:
- Dr. I. Rey-Fabret / C. Castillo – IFP School

Module Description
This module introduces the fundamentals of subsurface production including reservoir studies and well performance considerations for the production forecast and optimization.

Learning Outcome
1. define the concepts of fluid flow in porous media and the different production mechanisms
2. discuss the information that is gained from petrophysics, fluids and PVT studies
3. evaluate the Oil in Place and be able to distinguish between Oil in place and Reserves
4. describe the different production mechanisms, including natural production and EOR methods
5. estimate if the well is flowing naturally and describe the different well activation systems and their applications
6. integrate the economic aspects in the development project of an O&G field

Topics
1. Petrophysics
   a) Introduction to Porosity, saturations, permeability
   b) Basic measurement methods
   c) Fluids and PVT studies

2. Fluid flow in porous media
   a) Multiphase flow in porous media, fluid flow near the well bore (skin, wellbore storage, non Darcian effects)
   b) Gas flow
   c) Dynamic reservoir simulation

3. Production mechanisms
   a) Natural production
   b) Secondary recovery - IOR
   c) EOR

4. OOIP - GIIP
   a) Original Oil/Gas in Place
   b) Uncertainties
   c) Reserves calculations

5. Material balance
   a) General form of the MB equation
   b) Uses and limitations of the method

6. Field development Plan
   a) Reservoir model
   b) Development plan
   c) Reserve calculation
   d) Associated Uncertainties
7. **Well performance**
   a) Inflow Performance relationship
   b) Outflow
   c) Well deliverability

8. **Artificial lift**
   a) Gas lift
   b) Pumps
   c) Comparison of the different kinds of artificial lift systems and their applications
OT5904 Petroleum Process (5 MCs)

**Instructor:**
- J. Guillet-Lhermite / Dr. I. Rey-Fabret – IFP School

**Module Description**
This module introduces the fundamentals of process engineering, including principles of oil, gas and water treatment, design and modelling of the process.

HSE concerns are explained and taken into consideration in the design.

**Learning Outcome**
1. Understand, select and design the main processing steps for wellhead effluent.
2. Build a process simulation on ®HYSYS from a PFD
3. Size the main static & rotating equipment
4. Conduct basic safety engineering on a plant design
5. Consider new energy options for process optimization

**Topics**

1. **Well Effluent Processing**
   a) Need for field processing of oil - Quality requirements (oil, gas and water) and functional analysis
   b) Crude oil treatment including separation, stabilization, dehydration, desalting and H2S removal.
   c) Injection water requirement and main corresponding treatments (seawater focus)
   d) Production water & sand management (including disposal and re-injection treatments)
   e) Natural gas processing including separation, dehydration, sweetening and NGL extraction
   f) LPG and condensate fractionation

2. **Process Engineering & Equipment Design**
   a) Thermodynamic & process simulation using HYSYS™
   b) Static equipment sizing (separators, piping, valves, heat exchangers...)
   c) Rotating equipment sizing and specification (compressors, expanders and pumps)

3. **Safety Engineering**
   a) HAZOP methodology for process safety review
   b) Safety engineering : Relief valve, HIPPS, Flare and vent network design
   c) Tutorial : Relief valve sizing using HYSYS® safety engineering module and FLARESIM®

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OT5905 Petroleum Fluid Valorisation (3 MCs)

Instructor:
• Part A: E. Tocque / Part B: Olivier Massol – IFP School

Module Description
This module focuses on the monetization of petroleum resources. It covers the technological challenges and the economics of resource monetization.

Learning Outcome
1. Fundamentals of refining technology.
2. Fundamentals of LNG technology including liquefaction process, LNG transport and regasification.
3. Fundamentals of commodity markets and trading with applications to crude oil, petroleum products and natural gas markets.
4. The economics of natural gas.

Topics
Part A: Technology

1. Fundamentals of refining
   a) Petroleum products characterization
      • Understanding a crude oil assay: main characteristics measured by standard test
      • Principal components of petroleum products; general hydrocarbon classification and main impurities (sulfur, nitrogen, metals and asphaltenes, etc.).
      • Quality requirements imposed on petroleum products in view of their utilization:
   b) Refining processes outlook
      • Crude oil fractionation (atmospheric and vacuum distillation)
      • Catalytic reforming and isomerization
      • Hydro refining processes
      • Conversion units (including thermal cracking and catalytic cracking)
      • Case study: Manufacturing flow sheet from crude oil assay (Up to date refining schemes including the production of petrochemical intermediate products)

2. LNG technologies
   a) Thermodynamics of LNG and refrigeration cycles
   b) LNG liquefaction plant review including gas pre-treatment & liquefaction process
   c) LNG transport, storage and regasification technology
Part B: Economics

1. **Fundamentals of commodity trading with applications to crude oil, petroleum products and natural gas**
   a) Introduction to markets (OTC products, physical vs. cash settlement) and futures (contango and backwardation)
   b) Physical Markets
      Introduction to futures markets (contracts, clearing house, order book)
   c) Shipping & Physical Trading
   d) An introduction to hedging strategies and energy markets risk management

2. **Natural Gas Economics**
   a) Introduction: industry & market outlooks and contemporary challenges
   d) The monetization of natural gas reserves: a mean-variance portfolio approach
   e) The economics of gas pipelines
   f) The economics of LNG projects
   g) Downstream issues: storage, flexibility, distribution
   h) Contracts: structure & economics
   i) International trade issues
   j) Industrial organization: market structure, liberalization, industry restructuring and market designs
   k) Policy challenges.

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OT5906 Offshore Field Architecture and Subsea System (3 MCs)

Instructor:
- Associate Prof Loh Wai Lam

Module Description
This module introduces concepts of subsea systems engineering and associated offshore field architecture. The module considers key decision criteria and options available for both shallow and deep-water field developments and covers aspects of subsea equipment design, control and well intervention systems.

Learning Outcome
The student will have an understanding of key aspects of subsea field architecture and development and will be able to recognise and appreciate issues that arise in subsea production systems and will be able to apply engineering concepts to these issues in the development and optimisation of subsea assets.

Topics
1. Introduction to subsea systems
2. Field architecture concepts
3. Aspects of hydrographic, geophysical and geotechnical survey applied to subsea architecture
4. Field optimisation
5. Subsea Equipment
6. Subsea Control & communication systems
7. Subsea construction, hook-up & commissioning
8. Production start-up
9. Life of asset management
10. Inspection, repair & maintenance operations
11. Subsea well intervention

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OT5907 Design of Offshore Structures (3 MCs)

Instructor:
• Principal Instructor: Prof Leung Chun Fai

Module Description
This module is concerned with the design of offshore structures and elements including fixed and floating offshore structures, like semi-submersibles, FPSOs, spar platforms, floating jack-up structures and elements such as reinforced (hull) plating and mooring turntables. Topsides design principles, key hydrodynamic effects and environmental loading will be highlighted. Important concepts such as the design process, construction and installations requirements and interactions among platform elements are introduced. Also covered are the methods of analysis and criteria in design such as stability, wave loading and motion in waves, (dynamic) positioning, mooring system components, structural strength and fatigue, and design safety assessment codes.

Learning Outcome
1. Apply field development criteria for offshore platform concept selection
2. Explain constraints of platform construction and installation requirements
3. Apply analysis methods for platform hull, mooring and risers design
4. Manage design interface requirements for offshore platforms
5. Contribute to safety and risk management on projects

Topics
1. Environmental Considerations
   a) Waves Description
   b) Wind Characterization
   c) Current Characterization
   d) Tides Characterization
   e) Metocean Studies

2. Hydrodynamics of Offshore Structures
   a) Wave Modelling
   b) Hydrodynamic Loading

3. Introduction to Naval Architecture
   a) Stability of Floating Structures
   b) Stationkeeping

4. Fixed & Floating Structures
   a) Types of Fixed & Floating Structures
   b) Load Case Definition
   c) Design Principles
   d) Facilities Arrangement

5. Moorings
   a) Moorings System
   b) Connectors
   c) Design

6. Foundation System
   a) Seabed Characterization
   b) Shallow Foundations
   c) Deep Foundations
OT5908 Subsea Umbilicals, Risers and Flowlines Design (3 MCs)

Instructor:

Module Description
Subsea Umbilicals, Risers and Flowlines (SURF) are the conduits that connect Subsea Systems and Offshore Structures, to allow the export of petroleum fluid from the offshore wells to onshore refineries. SURF also serves as a conduit for communication and control of the different systems offshore.

The module covers the design of Subsea Umbilicals, Risers and Flowlines (SURF). The syllabus include Flow Assurance, Pipeline Definition and Detailed Design of Pipeline System. It will also include an introduction to Flexibles & Risers, and Umbilicals.

Learning Outcome

The students are expected to

1. Understand how single- and multiphase pipelines need to be operated to avoid flow assurance problems, and how this affects design requirements.
2. Design and specify a pipeline system from conceptual to detailed design
3. Latest technology of flexibles, risers and umbilicals

Topics

1. Flow Assurance
   a) Hydraulic Friction
   b) Non-Newtonian Fluids
   c) Single Phase Flow
   d) Two- & Three-Phase Flow
   e) Gas Flow Simulation
   f) Multiphase Flow Simulation
   g) Slug Catchers
   h) Operational Envelops, Flowing Heating, Chemical Injection Systems

2. Pipeline Definition
   a) Route Selection
   b) Material Selection
   c) Coating Specification
   d) Concrete Weight Coating
   e) Cathodic Protection
   f) Pigging & Repair

3. Detailed Design
   a) Hoop & Longitudinal Stress
   b) On-Bottom Stability
   c) Vortex-Induced Vibration
   d) Pipeline Crossings
   e) Seabed Scouring
   f) Accidental Loads
4. **Flexibles & Risers**  
   a) Unbonded vs Bonded  
   b) Structure & Components  
   c) Mechanical Properties  

5. **Umbilicals**  
   a) Functional Requirement  
   b) Structure & Components  
   c) End Terminations  
   d) Monitoring & Testing
OT5909 From Construction to Decommissioning (2 MCs)

Instructor:
- Prof Choo Yoo Sang / Prof (Practice) Michael Si

Module Description
This module will provide the students the understanding of key technical and operational parameters that drive the offshore construction, commissioning and de-commissioning operations, and the impact on the intrinsic design of a fixed, floating or subsea asset. After completion of the module, the students will be able to select appropriate marine spread and methodology for the offshore construction of a fixed, floating or subsea asset.

Learning Outcome
The students will gain knowledge on the methods for loadout, transportation and installation of offshore structures and pipelines. They will also learn how to engineer for the installation phase to ensure asset integrity. In addition, they will gain know-how on CAPEX and OPEX considerations for construction, installation and decommissioning.

Topics
1. Offshore Structures
   a) Loadout, Transportation, Launching, Upending of Sub-Structure
   b) Installation of Topsides
   c) Installation of Foundation / Mooring Lines / Tendons / Subsea Structures

2. Pipelines, Umbilicals & Risers
   a) Storage, Transport & Handling
   b) Installation Engineering
   c) Rigid Lay (S/J-Lay)
   d) Reel Lay
   e) Bundle-Tow
   f) Tie-In & Pre-Commissioning

3. Pre-Commissioning & Commissioning
   a) Mechanical Completion & Punchlist
   b) Hook-Up & Commissioning of Systems
   c) Ready for Start-Up

4. Decommissioning
   a) Topsides
   b) Sub-Structure
   c) Subsea Structures
   d) Wells
OT5910 Special Topics on Energy (2 MCs)

Instructor:
• J.P. Deflandre – IFP School

Module Description
This module completes the portfolio of hydrocarbon resources –i.e. outside the domain of conventional oil and gas accumulations in reservoirs. Main differences are highlighted and production technics described.

Learning Outcome
An understanding of topics such as:

1. renewable energies and their synergy with O&G production
2. unconventional resources
3. CO2 capture and storage

Topics
1. Portfolio of Unconventional Hydrocarbon Resources:
   a) Resources location, specificities, production methods

2. Unconventional Hydrocarbon Resources Production:
   a) source rock, tight formations, coal bed methane
   b) understanding of fracturing principle, fracture monitoring from microseismic monitoring and well positioning.
   c) Extra heavy oil, oil sand and oil shale

3. CO2 Capture and Storage:
   a) Introduction of global warming issues and the role of CCS.
   b) Capture routes
   c) Geological Storage requirements, site characterisation, performance assessment of the site, modelling workflow and monitoring plan versus site characteristics, site integrity issues. Illustration from field pilot cases.
   d) Environmental issues (and public acceptance)

4. Renewable Energies:
   a) Wind, solar, geothermal energies, ocean energies: energy grid
   b) Synergy with O&G production
   c) Environmental constraints
OT5911 Offshore Materials, Welding and Corrosion (2 MCs)

Instructor:
• Associate Prof Manoj Gupta

Module Description
This subject will provide students with fundamental understanding of materials, properties, corrosion, welding and inspection techniques.

Learning Outcome
1. Development of basic understanding of materials that are used in oil and gas industry
2. An understanding of the fundamental properties required for the qualification of materials.
3. Corrosion mechanisms that are common in industry.
4. Introduction to welding and inspection techniques.

Topics
1. An Introduction to Materials:
   Category of Materials, Processing-Microstructure-Properties-Performance Correlation, An Introduction to Microstructure, Common Materials used in Oil and Gas Sector

2. Materials Processing:
   Primary Processing, Secondary Processing

3. Strengthening Mechanisms:
   Basic Concepts, Work Hardening, Grain Size Strengthening, Solid Solution Strengthening, Precipitation Strengthening, Dispersion Strengthening, ANNEALING

4. Material Properties:
   Tensile Properties, Compressive Properties, Fatigue, Bending, Torsion, Wear

5. Corrosion of Materials:
   Corrosion Environments, Types of Corrosion, Prevention of Corrosion, Coatings.

6. Introduction to Welding

7. Introduction to Inspection Methods:
OT5912 Development of Offshore Upstream Projects (7 MCs)

Instructor:
- O. Massol / Rey-Fabret
- With NUS Lecturers

Module Description
Apply the whole knowledge acquired during the master during the final Project, based on a real case of offshore field development.

Learning Outcome
1. understand companies vs contractors and vendors contractual mechanisms
2. perform a risk analysis
3. understand projects performance criteria
4. gain good practice of the standard methods of investment analysis
5. be able to build their own model and use a model acquired by a company of upstream investment analysis taking into account fiscal aspects, inflation, and risk to make a decision related to the development of an offshore field

Topics
1. Project Contractual Mechanisms
   a) Introduction to contractual forms (turnkey, etc..) and contractual schemes (teaming, partnering, JV)
   b) the project life-cycle: RFI, Tendering, Negotiation, Contract Award, Execution of works
   c) Scope of work, Rights & Liabilities, Limits of responsibilities of the various parties.

2. Risk Analysis and Management
   a) HAZID, HAZOP
   b) Risk Assessment in details: How to build and use a risk register

3. Project Profitability Analysis
   a) Introducing: cash flow schedule / discount rate
   b) Criteria: net present value (NPV) / internal rate of return (IRR) / pay out time
   c) Fiscal impact: depreciation rate and profitability / after tax NPV, IRR
   d) Taking inflation into account: current money/constant money

4. Project Management
   a) Planning
   b) Project economics

5. Final Project, based on a real case of offshore field development
   a) Subsurface analysis, including field development economics
   b) Choice of the field architecture
   c) Engineering studies
   d) Project Planning
   e) Project costs, risk and profitability analysis
   f) Project HSE study
   g) Report and final presentation
OT5913 Professional Integration (Internship) (12 MCs)

Objective

To apply the overall knowledge acquired throughout the coursework period to work on real issue/s in an industrial environment.

Outcome

Students should be able to:

1. Apply their new knowledge on a real-life field development project
2. Manage a small-scale development project as a hand-on experience
3. Draw lessons learned from practice and relate them to their new knowledge
4. Understand the issues and challenges faced to enhance their learning experience