**COURSE DETAILS**

**Course Code:** G11RE  
**Full Course Title:** Reservoir Engineering  
**SCQF Level:** 11  
**SCAF Credits:** 15  
**Available as Elective:** No

**DELIVERY LEVEL**

<table>
<thead>
<tr>
<th>Undergraduate:</th>
<th>Postgraduate Taught:</th>
<th>Postgraduate Research:</th>
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<td>No</td>
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**COURSE AIMS**

The overall aim of this course is to allow the student to:

- Understand the rock and fluid properties of a hydrocarbon reservoir  
- Describe the nature of the fluid flow and pressure distribution in a reservoir  
- Understand the effects of production/injection on recovery of reserves

**LEARNING OUTCOMES – SUBJECT MASTERY**

On completion of the course, the student should be able to:

- understand and appreciate the nature of the reservoir and fluids contained  
- calculate the reserves and show the variability in the calculations  
- calculate the steady-state permeability of a reservoir rock  
- understand and calculate the saturation profile in a layered reservoir  
- understand and calculate the unsteady state fluid pressure changes in a reservoir (for the wells and for the aquifer)  
- describe the drive mechanisms, effect on production and the use of material balance as a reservoir tool  
- calculate natural water influx into a reservoir and the immiscible displacement of one fluid by another

**LEARNING OUTCOMES – PERSONAL ABILITIES**

In this course, students will be explicitly encouraged to:

- be aware of the importance of time management  
- develop their personal skills, including an awareness of both traditional and internet-based information sources  
- develop their skills in problem solving  
- use IT as appropriate  
- apply theoretical knowledge to practical problems  
- provide constructive feedback to teaching staff
G11RE Reservoir Engineering

SYLLABUS

- **Introduction to reservoir engineering:** Understand the location, formation, fluid content of a hydrocarbon reservoir; understand the definitions of reserves; be aware of the role of reservoir engineering in exploration and development.
- **Reservoir pressure and temperature:** Formation fluid density and pressure gradient in the reservoir; location of water/oil/gas contacts; use of contacts and pressure gradients to delineate reservoir units; measurement of fluid gradients.
- **Reservoir fluids composition:** Understanding composition of hydrocarbon fluids; classification systems based on density; simple models of fluid behaviour.
- **Phase behaviour of hydrocarbon systems:** Define: system, components, phases, equilibrium, intensive and extensive properties; understand relationship between pressure and temperature and phase for single and multi-component systems; define the expected phase changes in a reservoir fluid as it is produced to surface.
- **Behaviour of gasses:** Define equation of state wrt a reservoir gas; modify pv=nrt to account for compressibility factor z (pv=znt); use of pseudo critical values to account for gas mixtures; calculation of gas volumes and gas formation factor; use of equations of state in volume calculations.
- **Properties of reservoir liquids:** Definition of black oil and compositional models of reservoir fluid; use of flash and differential liberation to obtain black oil parameters; definition of Bo, Rs, Bg; define gas formation volume factor for a gas condensate; calculation of reservoir fluid viscosity.
- **Fundamental properties of reservoir rocks:** Definition of porosity and permeability; use of Darcy's Law to calculate permeability of single phase; definition of interfacial tension; use of capillary pressure to determine saturation changes in reservoir; definition of effective and relative permeability; use of drainage/immobility curves to characterise reservoir relative permeability; understanding pore doublet model in relation to recovery factors in reservoir fluid systems.
- **Fluid flow in porous media:** Understand the diffusivity equation in relation to slightly compressible systems; show the main flow regimes that can occur in a reservoir; calculate the steady state, unsteady state and pseudo steady state pressures in a reservoir; apply unsteady state relations to calculate pressure within a reservoir; understand the application of unsteady state techniques to well testing.
- **Drive mechanisms:** understand the relative compressibilities in a reservoir system; indicate the dominate drive mechanisms for water, gas cap and solution gas drive systems; understand the effects of the drive mechanisms on production through time.
- **Vapour-liquid equilibria:** Define equilibrium ratio. Derive equations for vapour-liquid equilibrium calculations for real systems and explain the application of the equations; Derive and explain the use of equations to determine the dew point pressure and bubble point pressure of a fluid mixture; Describe in general terms the impact of separator conditions the gas-oil ratio and oil formation volume factor.
- **PVT analysis:** Describe the scope of PVT analysis; describe the main apparatus used in the experiments; Determine the bubble point pressure from a set of P vs. V relative volume test data; Calculate oil formation volume factors above the bubble point; Determine the total formation volume factors above and below the bubble point; Determine the oil formation volume factors and gas-oil ratios for pressures below the bubble point pressure.
- **Material balance:** Present a material balance (MB) equation for a dry gas reservoir with and without water drive; Demonstrate the linear form of the MB equation for a gas reservoir with water drive and comment on its application; Be able to derive the material balance equation including gas cap expansion, water influx and core and water compressibility; Given the equation be able to identify the component parts of the MB equation, e.g. gas cap expansion etc.; Comment briefly on the assumptions, significance , use, data and limitations of the MB equation.
- **Natural water influx:** Calculate the total water influx resulting from a known aquifer volume in terms of total aquifer compressibility and pressure drop over the aquifer; Sketch and describe the Schiltius steady state model and the Van Everdingen and Hurst Unsteady State Model for Water; Sketch the progressive pressure profile for a constant boundary pressure; Explain how a constant boundary pressure profile solution can be used for declining pressure aquifer/ reservoir pressure; Calculate given prerequisite equations the water influx as a function of time for a declining pressure profile.
- **Immiscible flow:** Describe briefly the various benefits of water injection; Present a simple equation for the fractional flow of water in terms of water and oil flow rate; Comment briefly on the impact of; angle of dip, capillary pressure, and velocity on the fractional flow; Plot a set of relative permeabilities and identify end-point relative permeabilities; Define mobility ratio and present an equation for it and calculate its value given relative permeability data; Generate a fractional flow curve given relative permeability and viscosity data for injected.
and displaced fluids; Derive the Buckley-Leverett Frontal Advance Equation; Show the shape of the fractional flow curve and its associated derivative curve and the progressive saturation displacement profile

COURSE RELATIONSHIPS
N/A

LOCATION AND ASSESSMENT METHODS

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