COURSE OVERVIEW DE0727
Fundamentals of Reservoir Engineering
(E-Learning Module)

Course Title
Fundamentals of Reservoir Engineering (E-Learning Module)

Course Reference
DE0727

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

3.0 CEUs (30 PDHs) AWARD

Course Description

This E-Learning course is designed to provide participants with a detailed and up-to-date overview of the fundamentals of reservoir engineering. It covers the reservoir hydrocarbon distribution and fractals on the small and big scale; the bulk volume of water and the free water volume level; the structure and electrical properties of water and buoyancy forces in reservoir fluids; the water saturation, bulk volume of water and height data; the fractal water saturation and height function; the fractal function to identify the hydrocarbon to water contact and for depth control; the comparison of log and core BVW functions; the capillary pressure formula, upscaling water and irreducible water saturation; and the reservoir fluid properties.

During this course, participants will learn the characteristics of reservoir rocks and the four major components of sandstone; the coring assembly, core bit, whole core analysis and plugs or sidewall cores; the fundamentals of reservoir fluids phase behavior; the classification of reservoirs and reservoir fluids; the basic concepts of origin, accumulation and recovery of hydrocarbons; the elements of petroleum reservoir; the fluid content of the reservoir; the classification of hydrocarbon reservoir and reservoir fluids; and the pressure-temperature diagram, types of crude oil and steady-state and pseudo steady state flow.

Course Objectives

Upon the successful completion of this course, participants will be able to:-

- Apply and gain a fundamental knowledge on reservoir engineering
- Discuss the reservoir hydrocarbon distribution and fractals on the small and big scale
- Verify fractal as well as determine the bulk volume of water and the free water volume level
- Identify the structure and electrical properties of water, buoyancy forces in reservoir fluids and forces acting on reservoir fluids
- Differentiate water saturation and bulk volume of water versus height data as well as fractal water saturation versus height function
- Use the fractal function to identify the hydrocarbon to water contact and for depth control
- Compare log and core BVW functions as well as bulk volume of water versus height data
- Recognize capillary pressure formula, upscaling water and irreducible water saturation including reservoir fluid properties
- Identify the characteristics of reservoir rocks and the four major components of sandstone
- Describe coring assembly and core bit, whole core analysis and plugs or sidewall cores
- Discuss the fundamentals of reservoir fluids phase behavior and classification of reservoirs and reservoir fluids
- Explain basic concepts of origin, accumulation and recovery of hydrocarbons and the elements of petroleum reservoir fluid content of the reservoir
- Identify the classification of hydrocarbon reservoir and reservoir fluids
- Review pressure-temperature diagram, types of crude oil and steady-state and pseudo steady state flow

Who Should Attend

This course provides an overview of all significant aspects and considerations of fundamentals of reservoir engineering for those who are involved in analysis, characterization, simulation, integration, statistics and naturally fractured for reservoir. This includes engineers, geologists, geophysicists, managers, government officials, field operation staffs and other technical staff.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Fee

As per proposal

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Contents

- Reservoir Hydrocarbon Distribution
- Why we Need a Reservoir Model
- What are Fractals?
- Fractals on the Small Scale
- Fractals on the Big Scale
- Fractals on the Really Big Scale
- What are Fractals?
- Why Fractals are Useful
- How to Verify if Something is Fractal
- Coastline Fractals
- Fractals in Reservoir Rocks
- The Bulk Volume of Water (BVW)
- The Free Water Level (FWL)
- Hydrocarbon Water Contact
- The Reservoir Model Needs a SW vs. Height Function
- What a Good Saturation Height Function Requires
- The Structure and Electrical Properties of Water
- Buoyancy Forces in Reservoir Fluids
- Forces Acting on Reservoir Fluids
- Fractals Describe the Rock Pore Network

- Water Saturation vs. Height Data
- Classical Water Saturation vs. Height Curves
- Problems with Classical SWH Functions
- Bulk Volume of Water vs. Height Data
- BVW is Independent of Rock Properties
- Net Reservoir Cut-off
- What the Fractal Function tells us about Net Reservoir
- Net Reservoir Cut-off
- Net Reservoir Example
- The Fractal Water Saturation vs. Height Function
- The Fractal Function is Easily Calculated
- SW vs. Height Modelling
- SW vs. Height Modelling Results
- Core Water Saturations
- The Differential Reservoir Model
- Picking the Free Water Level
- Using the Fractal Function to Identify the Hydrocarbon to Water Contact
- Using the Fractal Function for Depth Control
- Log and Core Data from 11 North Sea Fields Compared
- Case Study Results
- Comparison between Log and Core BVW Functions
- Conclusions – Fractals and Hydrocarbon Volumes
- Bulk Volume of Water vs. Height Data
- What's Benoit B. Mandelbrot Middle Name?
- Capillary Pressure holds the Water up
- Capillary Pressure Formula
- Capillary Pressure and Pore Size
- Gravity pulls the Water Down
- Upscaling Water Saturations
- Irreducible Water Saturation (Swirr)
- Uncertainty Modelling
- Reservoir Fluids
- Introduction
- Reservoir Fluid Properties?

- Reservoir Rocks
- Characteristics of Reservoir Rocks
- Source of data: Coring
- Rock Matrix and Pore Space
- Four Major Components of Sandstone
- Four Components of Sandstone
- Coring Assembly and Core Bit
- Coring
- Whole Core
- Sidewall Sampling Gun
- Sidewall Coring Tool
- Whole Core Analysis vs. Plugs or Sidewall Cores
- Coring
- Information from Cores
- Fundamentals of Reservoir Fluids Phase behavior
- Classification of Reservoirs and Reservoir Fluids
- Pressure-Temperature Diagram
- Petroleum Geology
- How is Petroleum Formed
- What is a Trap?
- Where Petroleum is found?
- Basic Concepts of Origin, Accumulation and Recovery of Hydrocarbons
- Elements of Petroleum Reservoir Fluid Content of the Reservoir
- Porosity and Effective Porosity
- Porosity
- Absolute Porosity
- Effective Porosity
- Quiz
- Permeability and Darcy's Law
- Permeability
- Quiz
- Linear flow model
- Saturation
- Residual oil saturation, Sor

- Movable Oil Saturation, Som
- Critical Gas Saturation, Sgc
- Critical Water Saturation, Swc
- Capillary Pressure and Its Curve
- Capillary Pressure
- Transition Zone
- Water Oil Contact
- Gas Oil Contact
- Wettability and Distribution of Reservoir Fluids
- Wettability
- Properties of Natural Gas
- PVT Behaviour
- Classification of Hydrocarbon Reservoir
- Classification of Reservoirs and Reservoir Fluids
- Pressure-Temperature Diagram
- Types of Crude Oil
- Gas Reservoirs
- Retrograde Gas-Condensate Reservoir
- Quiz
- Wet-Gas Reservoir
- Quiz
- Dry-Gas Reservoir
- Steady-State and Pseudo Steady-state Flow
- The Area of Concern in this Lecture
- Types of Fluids
- Flow Regimes
- Reservoir Geometry
- Linear Flow
- Spherical and Hemispherical Flow
- Number of Flowing Fluids in the Reservoir
- Horizontal Wells
- Method I
- Method II
- Quiz

- Quiz
- Natural Flow Recovery
- Quiz
- Mechanical Recovery (Rod System)
- Formation Damage Control
- Skin Factor
- Life Cycle of Oil & Gas Wells
- Quiz
- Introduction
- Well Types
- Life Segments of Oil & Gas Wells
- Quiz
- Planning
- Drilling
- Land or Onshore Rig
- Off shore RIG: 1- Jack-up Rigs
- Off shore RIG: 2- Submersible Rigs
- Off shore RIG: 3- Semi-submersible Rigs
- Off shore RIG: 4- Platform Rigs
- Off shore RIG: 5- Drill Ships
- Drilling: Rig Crew
- Drilling: Rigging up
- Drilling Operations
- Drilling Operations: A- Oil Based Mud
- Drilling Operations: A- Water Based Mud
- Drilling Operations: What's the meaning of kick
- Well Casing
- Well Casing: 1- Conductor Casing
- Well Casing: 2- Surface Casing
- Well Casing: 3- Intermediate Casing
- Well Casing: 4- Production Casing
- Well Casing: 5- Liner Casing
- Completion
- Completion Design Criteria

- Objectives of Completion
- Classifications of Completion
- Classifications of Completion: 1- Open Hole Completion
- Classifications of Completion: 2- Cased Perforated Completion
- Classifications of Completion: 4- Multiple Zone Completion
- Completion Components
- Completion Components: 1- Well Head
- Casing Head
- Tubing Head
- Christ-mass Tree
- Completion Components: 2- Safety Control Sub-Surface Safety Valve
- Completion Components: 3- Side Pocket Mandrel
- Completion Components: 4- Sliding Sleeves
- Completion Components: 5- Landing Nipples
- Completion Components: 6- Packers
- Completion Components: 7- Perforated Joint
- Production
- Well Intervention
- Well Stimulation
- Well & Reservoir Management WRM:
- Abandonment
- Drilling
- Definition of Reserves and Volume Estimation Methods
- Reservoir
- Reservoir Rock
- Reservoir Engineering
- The Primary Functions of a Reservoir Engineer
- Goal of Reservoir Engineering
- Calculation of Hydrocarbon Volumes
- The Stock Tank Oil Initially in Place
- Reservoir Engineering Application
- Resources
- General Definition of Resources
- Key Elements of Resources

- Total Petroleum Initially-In-Place (TPIIP)
- Discovered vs Undiscovered PIIP
- Discovered Resources
- Undiscovered
- Reserves
- General Overview of Reserves
- Definition of Reserves
- Condition for to be Called Reserves
- Reserves Estimation
- Reserves Category
- Further Classification
- Levels of Certainty in Reported Reserves
- Reserve Estimation – Recovery Factor
- Worldwide End-of-Year Proved Oil Reserves
- Proven Oil Reserves Distribution
- Relation Between Resources and Reserves
- Risks Related to Resources
- Chance of Commerciality
- Chance of Discovery
- Resources Classification Framework
- Current Resources
- General Requirements for Classification of Reservoirs
- Procedure for Reserve Estimation
- Volumetric Method
- Material Balance
- Production Decline Analysis
- Future Drilling and Planned Enhanced Recovery Projects
- Validation of Reserves Estimates
- Darcy's Law and Fundamentals of Fluid Flow in Porous Media
- Finite Element Method
- Contents
- Introduction
- Fundamental Concepts
- Derivation of Basics Differential Equations

- Darcy's Law
- Two-dimensional Fluid Flow
- Fluid Flow in Pipes and Around Solid Bodies
- One-Dimensional Finite Element Formulation for Fluid Flow Through Porous Media
- Step 1: Select Element Type
- Step 2: Choose a Potential Function
- Step3: Define the Gradient/Potential and
- Step 4: Derive the Element Stiffness Matrix and Equations
- Step 5: Assemble the Element Equations to Obtain the Global Equations and Introduce
- Boundary Conditions
- Step 6Solve for the Nodal Potentials
- Step 7: Solve for the Element Velocities and Volumetric Flow Rates
- Problem
- Solution
- The Flow Rates and Velocities at nodes are:
- Finite Element Formulation of a Two-Dimensional Fluid Flow
- Step 1: Element Type
- Step2: The Potential Function
- Step: 3: Define the Gradient/Potential and Velocity/Gradient Relationships
- Step 4: Derive the Element Stiffness Matrix and Equations
- Step 5 Assemble the Element Equations to Obtain the Global Equations and Introduce Boundary Conditions
- Step 6 Solve for the Nodal Potentials
- Step 7 Solve for the Element Velocities and Volumetric Flow Rates
- Example
- Nodal Analysis Introduction to Inflow
- Nodal Analysis Concept
- Graphical Solution of The Problem
- Exercise: Illustration of Nodal Analysis Concept
- Graphical Solution of The Problem
- Why 'Nodal'?
- Pressure Losses in Well System
- Nodal Analysis

- Well Outflow Performance
- Reservoir Inflow Performance
- Types of Outflow Systems
- Wellbore Flow Performance (OUTFLOW)
- Quiz
- Single Phase Flow Basic Concepts
- Fundamentals of Fluid Flow in Pipes
- Friction Losses Calculation
- Quiz
- Quiz
- Friction Factor Calculation (Single Phase Flow)
- Moody Diagram for Friction Factor Calculation
- Exercise
- Oil Reservoir Phase Envelop
- Multiphase Flow
- Gravity Term
- Friction Term
- Acceleration Term
- Basic Concepts
- No-Slip Liquid Holdup (Input Liquid Content), λ
- Superficial Gas Velocity, VSG
- Vertical Flow Parameters
- Two-Phase Vertical Flow
- Vertical Flow Patterns
- Horizontal Flow Patterns
- 2-Phase – Gas-Liq) Flow Regimes
- Flow Regime (Ros)
- Correlations
- Procedure for Pressure Traverse Calculation
- Outflow Calculation (Node at the Bottomhole)
- Well Performance Software
- Effect of The Tubing Size (Node Selected at the Bottomhole)
- Tubing Size in Depleting Reservoir
- Effect of Gas Injection Rate

- Gas Lift Performance Curve
- Inflow Performance Curve
- System Graph
- System Graph – Wellhead Node
- Nodal Analysis: Uses
- Nodal Analysis
- The Inflow Performance Relationship
- Effect of Skin in IPR
- Effect of Pressure Depletion in IPR
- The Outflow Performance Relationship Dependent On
- Effect of Tubing Size in Outflow
- Immiscible Displacement Concepts
- Recovery / Frontal Displacement
- Flooding Patterns
- Fractional Flow Equation
- Recovery/Frontal Displacement
- Recovery Efficiency
- Overall Recovery Efficiency
- Displacement Efficiency
- Areal Sweep Efficiency
- Vertical Sweep Efficiency
- Volumetric Sweep Efficiency
- Reservoir Heterogeneity
- Vertical Heterogeneity
- Areal Heterogeneity
- Vertical vs. Areal Heterogeneity
- Displacement Efficiency
- Displacement Efficiency Definition
- Displacement Efficiency Expression
- Displacement Efficiency Calculation
- Frontal Displacement
- Average Water Saturation in the Swept Area
- Frontal Displacement Theory
- Fractional Flow Equation

- Flash Back: Fluid Potential in Tilted Reservoir
- Fluid Density Under Reservoir Condition vs. Specific Gravity
- Linear Displacement in a Tilted System
- Fractional Flow Equation
- Fractional Flow Expression
- Fractional Flow Expression for Water
- Fractional Flow Parameters
- Fractional Flow Expression General
- Gas Fractional Flow
- Fractional Flow: Neglecting Pc
- Fractional Flow Range
- Fractional Flow Curves a Function of Saturations
- Effects of Displacement Efficiency
- Relation between FO & FWss