COURSE OVERVIEW DE0734
Reservoir Simulation
(E-Learning Module)

Course Title
Reservoir Simulation (E-Learning Module)

Course Reference
DE0734

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)

Course Description

This E-Learning course is designed to provide participants with a basic overview of reservoir simulation. It covers the principles of reservoir engineering to numerical modeling; the results for single well, pattern and full-field models; the preparation of fluid and rock property data in the manner required for simulation studies; the identification and elimination of causes of numerical problems; the matched model to predict future performance under a variety of assumptions; the milestones for the engineering approach and the importance of the engineering and mathematical approaches; the single-phase fluid flow equations in multidimensional domain including its properties; and the properties of porous media and reservoir discretization.

During this course, participants will learn the basic engineering concepts and multidimensional flow in cartesian coordinates; the derivation of the one dimensional and multidimensional flow equation in cartesian coordinates including the approximation of time integrals; the flow equations using CVFD terminology, engineering notation, natural ordering scheme and block ordering scheme; the simulation with a block-centered grid, reservoir discretization and flow equation for boundary gridblocks; the treatment of boundary conditions, specified pressure gradient boundary condition, flow rate boundary condition and no-flow boundary condition; and the specified boundary pressure condition, boundary block pressure and calculation of transmissibilities.

Course Objectives

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

- Apply and gain a basic knowledge on reservoir simulation
- Apply the principles of reservoir engineering to numerical modeling
- Set up, run, and analyze the results for single well, pattern and full-field models
- Prepare fluid and rock property data in the manner required for simulation studies
- Identify and eliminate causes of numerical problems
- Perform a history match and use the matched model to predict future performance under a variety of assumptions
- Identify the milestones for the engineering approach and the importance of the engineering and mathematical approaches
- Review single-phase fluid flow equations in multidimensional domain including its properties
- Recognize the properties of porous media and carryout reservoir discretization
- Describe the basic engineering concepts and multidimensional flow in cartesian coordinates
- Discuss the derivation of the one dimensional and multidimensional flow equation in cartesian coordinates as well as the approximation of time integrals
- Explain the flow equations in multidimensions using engineering notation including the multidimensional flow in radial-cylindrical coordinates and approximation of time integrals
- Describe flow equations using CVFD terminology, engineering notation, natural ordering scheme and block ordering scheme
- Carryout simulation with a block-centered grid, reservoir discretization and flow equation for boundary gridblocks
- Employ treatment of boundary conditions as well as determine specified pressure gradient boundary condition, flow rate boundary condition and no-flow boundary condition
- Identify specified boundary pressure condition and boundary block pressure as well as calculate transmissibilities

Who Should Attend

This course provides a basic overview of reservoir simulation for experienced reservoir engineers. Participants shall have a basic knowledge of reservoir simulation, stochastic modelling, upscaling and some experience in the use of commercial reservoir simulators.

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.

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 Fee

As per proposal

Course Contents

- Introduction
- Background
- Milestones for the Engineering Approach
- Importance of the Engineering and Mathematical Approaches
- Single-Phase Fluid Flow Equations in Multidimensional Domain
- Properties of Single-Phase Fluid
- Properties of Porous Media
- Reservoir Discretization
- Basic Engineering Concepts
- Multidimensional Flow in Cartesian Coordinates
- Derivation of The One-Dimensional Flow Equation In Cartesian Coordinates
- Approximation of Time Integrals
- Flow Equations in Multidimensions Using Engineering Notation
- Multidimensional Flow in Radial-Cylindrical Coordinates
- Derivation of The Multidimensional Flow Equation In Radial-Cylindrical Coordinates
- Approximation of Time Integrals
- Summary
- Exercises

- Flow Equations Using CVFD Terminology
- Introduction
- Flow Equations Using CVFD Terminology And Engineering Notation
- Introduction
- Flow Equations Using CVFD Terminology
- Flow Equations Using CVFD Terminology and Engineering Notation
- Flow Equations Using CVFD Terminology and The Natural Ordering Scheme
- Flow Equations in Radial-Cylindrical Coordinates Using CVFD Terminology
- Flow Equations Using CVFD Terminology in any Block Ordering Scheme
- Summary
- Exercises
- Simulation with a Block-Centered Grid
- Reservoir Discretization
- Flow Equation for Boundary Gridblocks
- Treatment of Boundary Conditions
- Specified Pressure Gradient Boundary Condition
- Specified Flow Rate Boundary Condition
- No-Flow Boundary Condition
- Specified Boundary Pressure Condition
- Specified Boundary Block Pressure
- Calculation of Transmissibilities
- Symmetry and Its Use in Solving Practical Problems
- Flow Equation for Boundary Gridpoints
- Specified Boundary Gridpoint Pressure
- Symmetry and Its Use in Solving Practical Problems
- Summary
- Exercises
- Well Representation in Simulators
- Single-Block Wells
- Treatment of Wells In 1D Radial Flow
- Treatment of Wells In 2D Areal Flow
- Multiblock Wells
- Vertical Effects (Flow Within Wellbore)
- Wellblock Contribution to Well Rate

- Estimation of The Wellblock Geometric Factor
- Estimation of Well Rate And FBHP
- Practical Considerations Dealing with Modeling Well Operating Conditions
- Single-Phase Flow Equation for Various Fluids
- Pressure Dependence of Fluid and Rock Properties
- Rock Porosity
- General Single-Phase Flow Equation in Multi Dimensions
- Incompressible Fluid Flow Equation
- Slightly Compressible Fluid Flow Equation
- Formulations of the Slightly Compressible Fluid Flow Equation
- Advancing the Pressure Solution in Time
- Material Balance Check for a Slightly Compressible Fluid Flow Problem
- Compressible Fluid Flow Equation
- Formulations of Compressible Fluid Flow Equation
- Advancing the Pressure Solution in Time
- Material Balance Check for a Compressible Fluid Flow Problem
- Linearization of Flow Equations
- Nonlinearity of Flow Equations for Various Fluids
- Linearity of The Incompressible Fluid Flow Equation
- Nonlinearity of The Slightly Compressible Fluid Flow Equation
- Nonlinearity of The Compressible Fluid Flow Equation
- Linearization of Nonlinear Terms
- Linearization of Transmissibilities
- Linearization of fp in Space
- Linearization of fp in Time
- Linearization of Well Production Rates
- Well Production Rate Linearization in the Mathematical Approach
- Well Production Rate Linearization in the Engineering Approach
- Linearization of Fictitious Well Rates
- Linearization of Coefficients In Accumulation Term
- Linearized Flow Equations in Time
- Explicit Method
- Simple-Iteration Method
- Explicit Transmissibility Method

- Simple Iteration on Transmissibility Method
- Newton's Iteration (Fully Implicit) Method
- Methods of Solution of Linear Equations
- Direct Solution Methods
- 1D Rectangular or Radial Flow Problems (Thomas' Algorithm)
- 1D Tangential Flow Problem (Tang's Algorithm)
- 2D and 3D Flow Problems (Sparse Matrices)
- Iterative Solution Methods
- Point Iterative Methods
- Point Jacobi Method
- Point Gauss-Seidel Method
- Point SOR Method
- Line and Block SOR Methods
- Line SOR Method
- Alternating-Direction-Implicit Procedure
- Advanced Iterative Methods
- Introduction to Modeling Multiphase Flow in Petroleum Reservoirs
- Reservoir Engineering Concepts in Multiphase Flow
- Fluid Properties
- Relative Permeability
- Capillary Pressure
- Darcy's Law in Multiphase Flow
- Multiphase Flow Models
- Flow Equations for OillWater Flow Model
- Flow Equations for OillGas Flow Model
- Flow Equations for Black-Oil Model
- Solution of Multiphase Flow Equations
- Expansion of Accumulation Terms
- Well Rate Terms
- Production Terms
- Treatment of Boundary Conditions
- Specified Pressure Gradient Boundary Condition
- Specified Flow Rate Boundary Condition
- No-flow Boundary Condition

- Specified Boundary Pressure Condition
- Treatment of Nonlinearities
- Solution Methods
- IMPES Method
- SS Method
- Material Balance Checks
- Advancing Solution in Time
- User's Manual for Single-Phase Simulator
- Data File Preparation
- Format Procedure
- Description of Variables Used in Preparing a Data File
- Instructions to Run Simulator
- Enter Names of Input and Output Files
- Limitations Imposed on the Compiled Version
- Example of a Prepared Data File