Course Description

1. Course Name: Numerical Methods and Reservoir Simulation
2. Course Code: PE408
3. Semester / Year: Academic year 2025/2026
4. Description Preparation Date:17/9/2025
5. Available Attendance Forms: classrooms and labs
6. Number of Credit Hours (96) / Number of Units (6) 48 Theoretical hours+48 lab hours=96 Hs
7. Course administrator's name (mention all, if more than one name) Name: Hasan Ali Azeez Email: Hasan.Ali@alayen.edu.iq
8. Course Objectives

Course Objectives	• **Understanding the derivation of partial differential equations that govern flow in porous media.** • **Acquiring skills to numerically solve partial differential equations related to porous media flow.**
9. Teaching and Learning Strategies	
Strategy	• Presentation • Interactive learning • Discussions • Brainstorming • Group Solving Problems • Problem-Based Learning • Self-learning

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1	2 lecture + 2 lab	A2, A3,B1,C1	Linear, Lagrange, Least Square Method (Linear & Polynomial Equations)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
2	2 lecture + 2 lab	A2, A3,B1,C1	Review of Matrix Properties, Determinants, Inverse of Matrix	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
3	2 lecture + 2 lab	A2, A3,B1,C1	Key Steps in Reservoir Simulation Study: Clear Objectives, Reservoir Characterization	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
4	2 lecture + 2 lab	A2, A3,B1,C1	Model Selection, Model Construction, Validation, Predictions	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
5	2 lecture + 2 lab	A2, A3,B1,C1	Types of Fluids, Flow Regimes, Flow Geometry, Number of Flowing Fluids	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
6	2 lecture + 2 lab	A2, A3,B1,C1	Basic Equations of Fluid Flow in Porous Media (Part 1)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
7	2 lecture + 2 lab	A2, A3,B1,C1	Basic Equations of Fluid Flow in Porous Media (Part 2)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning

8	2 lecture + 2 lab	**A2, A3,B1,C1**	Principles of Finite Difference Approximation (Finite Difference Scheme & Discretization)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
9	2 lecture + 2 lab	**A2, A3,B1,C1**	Principles of Finite Difference Approximation (Explicit Approximation)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
10	2 lecture + 2 lab	**A2, A3,B1,C1**	Principles of Finite Difference Approximation (Implicit Approximation)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
11	2 lecture + 2 lab	**A2, A3,B1,C1**	Methods of Solving Systems of Linear Equations (Part 1)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
12	2 lecture + 2 lab	**A2, A3,B1,C1**	Methods of Solving Systems of Linear Equations (Part 2)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
13	2 lecture + 2 lab	**A2, A3,B1,C1**	Methods of Solving Systems of Linear Equations (Part 3)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
14	2 lecture + 2 lab	**A2, A3,B1,C1**	Methods of Solving Systems of Linear Equations (Part 4)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
15	2 lecture + 2 lab	**A2, A3,B1,C1**	Simple 1D Linear Flow with Sources/Sinks (Part 1)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning

16	2 lecture + 2 lab	**A2, A3,B1,C1**	Simple 1D Linear Flow with Sources/Sinks (Part 2)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
17	2 lecture + 2 lab	**A2, A3,B1,C1**	Introduction to Types of Boundary Conditions and Grid Systems	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
18	2 lecture + 2 lab	**A2, A3,B1,C1**	Incorporation of Boundary Conditions in the System of Block-Centered Grid	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
19	2 lecture + 2 lab	**A2, A3,B1,C1**	Incorporation of Boundary Conditions in the System of Point-Centered Grid	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
20	2 lecture + 2 lab	**A2, A3,B1,C1**	Application of Finite Difference Approximation in 2D and 3D Systems (Part 1)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
21	2 lecture + 2 lab	**A2, A3,B1,C1**	Application of Finite Difference Approximation in 2D and 3D Systems (Part 2)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
22	2 lecture + 2 lab	**A2, A3,B1,C1**	Application of Finite Difference Approximation in 2D and 3D Systems (Part 3)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning
23	2 lecture + 2 lab	**A2, A3,B1,C1**	Well Modelling	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning

24	2 lecture + 2 lab	**A2, A3,B1,C1**	Introduction to the Numerical Simulation of Multi-Phase Flow through Porous Media (Part 1)	Theoretical lecture & computer lab applications	•Presentation •Interactive learning •Discussions •Brainstorming •Group Solving Problems •Problem-Based Learning •Self-learning

11. Course Evaluation

Quizzes 10%
Lab 30%
Monthly exams 20%
Final exam 40%

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	
Main references (sources)	1.Petroleum Reservoir Simulation A Basic Approach by Abou-Kassem J. H., Farouq Ali S. M. and Islam M. R. 2.Basic Applied Reservoir Simulation by Ertekin T., Abou-Kassem J.H. and King G. R 3.Petroleum Reservoir Simulation by Aziz K. and Settari A. 4. Heriot-Watt University. Reservoir Simulation. Edinburgh, Scotland: Heriot-Watt University (2016)
Recommended books and references (scientific journals, reports...)	
Electronic References, Websites	https://eng.alayen.edu.iq//colleges/e/42