PET E 630-A2 (58865)
Advanced Reservoir Engineering
Fall 2025
Monday, Wednesday, Friday 13:00 – 13:50

Professor: Shanshan Yao, shansha3@ualberta.ca

Office: ICE 7-324, 780-257-2188

TA: Xin Yang, xy26@ualberta.ca

Textbook/Lecture Notes:

1- Fluid Flow through Permeable Media, Dr. Gary Pope (not published and will be uploaded to Canvas).
2- Well Testing Lecture Notes, Per Arne Slotte and Carl Fredrik Berg (published online and will be uploaded to Canvas)
3- Advanced Petrophysics, Dr. Ekwere J. Peters (University of Alberta Library)

Prerequisites: Fundamentals of petrophysics and transport phenomena.

Goals: This course will cover the basics concepts of reservoir engineering with applications to the oil and gas production. The governing equations for flow in porous media will be derived and solved for several typical cases of basic reservoir engineering. Concepts such as transient, steady state, pseudo-steady state single-phase flows, fractured reservoirs, multiphase flow in porous media, and immiscible and miscible displacement will be reviewed. The fluid flow theories taught in this course will be used for practical applications such as well testing, well planning, tracer, and water flooding.

Grading:

- Attendance ~5%
- Group Project 1 (Limit on the number of group members: 3 to 4) ~20 %
- Individual Project 2 ~15 %
- Final exam (TBD) ~30 %
- Homework problems (5 Assignments) ~30 %

No late submission past the due date is accepted.

Ethics Policy for Homework and Individual Project: Verbal discussion of problems among students is acceptable for assignments after you have done significant individual effort and the discussion is brief and neither student copies material. All assignments turned in under your name must be your own.

Course Outline:

1. Introduction (**Week 1 to Week 2)**
    - Appling Darcy equation to describe the fluid flow in different media
2. Steady-state single phase flow (**Week 2 to Week 4)**
    - Deriving different forms of diffusivity equation
    - Line source and sink
    - Pathlines and streamlines
3. Transient single-phase flow (**Week 5 to Week 7)**
    - Deriving radial diffusivity equation for oil and gas
    - Solving radial diffusivity equation with line sources and sinks
    - Superposition in space
    - Superposition in time and buildup tests
4. Transient single-phase flow in fractured reservoirs (**Week 8 to Week 10, Week 11 Reading Week)**
    - Application of dual porosity models for evaluating fractured reservoirs
    - Deriving and solving linear diffusivity equation representing hydrocarbon flow in stimulated tight reservoirs
    - Production data analysis of fractured horizontal wells
5. Multi-phase flow in porous media (**Week 12 to Week 14)**
    - Capillary pressure and relative permeability
    - Mass balance for two-phase flow in porous media
    - Linear waterflood: Buckley-Leverett solution
    - Techniques for measuring and modelling two-phase relative permeability
    - Empirical models to predict three-phase relative permeability
6. Miscible flow (**Week 14 to Week 15)**
    - Deriving and solving convection diffusion equation
    - Dispersion and mixing

Useful References:

- *Enhanced oil recovery, Lake* (1989)
- *Waterflooding*, Willhite (1986)
- *Basic Applied Reservoir Simulation,* Ertekin, Abou-Kassem, King (2001)
- *Integrated Flow Modeling,* Fanchi *(2001)*
- *Principles of Applied Reservoir Simulation*, Fanchi (2001)
- *Reservoir Engineering Handbook*, Ahmed (2000)
- *The Practice of Reservoir Engineering*, Dake (1994)
- *Well Test Analysis*, Raghavan (1993)
- *Applied Petroleum Reservoir Engineering*, Craft and Hawkins (rev. Terry) (1991)
- *Natural Gas Engineering,* Katz and Lee (1990)
- *Reservoir Simulation*, Mattax and Dalton (1990).
- *The Properties of Petroleum Fluids*, McCain (1990)
- *Fundamentals of Reservoir Engineering*, Dake (1978)
- *Advances in Well Test Analysis*, Earlougher (1977)
- *Pressure Buildup and Flow Tests in Wells*, Matthews and Russell (1967)
- *Flow of Fluids through Porous Materials,* Collins (1961)
- *Petroleum Reservoir Engineering*, Amyx, Bass, and Whiting (1960)