PET E 295 Fundamental Reservoir Engineering

Winter 2025 - January 06 to April 09

Class time: Monday, Wednesday, Friday 10:00-10:50 Location: NRE 2-127

Instructor:

Shanshan Yao, PhD, she/her/hers

shansha3@ualberta.ca
Donadeo Innovation Centre For Engineering 7-324
Office Hours: By appointment

Course Description:

*3.8 (fi) (either term, 3-0-3/2) Rock properties (porosity, permeability): definition, measurement and models. Rock-fluid interaction (wettability, relative permeability, interfacial tension, capillary pressure): definition, measurement and models. Single and multiphase flow through porous media Darcy equation and diffusivity equation: Derivation and solution for different coordinates and boundary conditions.

Prerequisites: PET E 275. PET E 295 cannot be taken for credit if credit has already been obtained in PET E 373

Course synchronous and asynchronous content delivery schedule:

All lectures and labs will be offered in person.

Land Acknowledgment:

The University of Alberta respectfully acknowledges that we are located on Treaty 6 territory, a traditional gathering place for diverse Indigenous peoples including the Cree, Blackfoot, Métis, Nakota Sioux, Iroquois, Dene, Ojibway/ Saulteaux/Anishinaabe, Inuit, and many others whose histories, languages, and cultures continue to influence our vibrant community.

TA Information:

Nima Shojaei, nshojaei@ualberta.ca
Xin Yang, xy26@ualberta.ca
Smit Modi, smitmano@ualberta.ca

Lab Sections:

Section	Day	Time	Location
LAB H21	Tuesday	14:00 - 16:50	NRE 2-052
LAB H31	Wednesday	14:00 - 16:50	NRE 2-052
LAB H41	Thursday	14:00 - 16:50	NRE 2-052
LAB H51	Friday	14:00 - 16:50	NRE 2-052

Course Objectives & General Content:

At the end of the course, students will be familiar with techniques of estimating oil and gas reserves and recovery, techniques for determination of formation properties and analysis of fluid flow through reservoir rock.
The course will provide necessary engineering background in performing reservoir evaluation.

Learning Outcomes:

By the end of this course, students should be able to:

1. Determine reservoir petrophysical properties by analyzing laboratory data.
2. Determine various formation properties and understand their relevance for oil recovery.
3. Estimate oil and gas reserves.
4. Formulate concepts of incompressible, slightly compressible, and compressible fluid flow in porous media.
5. Formulate concepts and use analytical solutions for wellbore flowing pressure of a reservoir in steady-state, transient and pseudo steady-state flow conditions.
6. Explain and identify different reservoir drive (oil and gas production) mechanisms by analyzing production data.
7. Calculate oil and gas production by using reservoir properties and appropriate material balance methods for different types of reservoirs.
8. Recognize the oil and gas production behavior of the wells in naturally fractured reservoirs and the wells stimulated with hydraulic fractures.
9. Calculate the rate of water influx into petroleum reservoirs by analyzing production data and reservoir properties.

Marking Scheme:

Activity	(A)Synchronous	Due/Scheduled	Weight
Lecture participation and in-class quizzes	Synchronous		5%
Homework Assignments		Due one week after they are announced	15%
Laboratory Activity		Scheduled	5%
Lab Reports		Due two weeks after they are announced	20%
Midterm Exam			20%
Final Exam			35%

The Faculty recommended grade point average for a 200 level course is 2.8.Instructors have the leeway to deviate from this average and can assign grades based on their own scheme. All grades are approved by the department chair (or delegate). The office of the Dean has final oversight on all grades.

Term Work

All term work solutions will be posted no later than the last day of classes. All term work will be returned to students by the final day of classes, with the exception of major term work due in the last week of classes. The latter will be returned by the day of the final examination or the last day of the examination period if there is no final examination in the course as per university policy; instructors will make accommodations to return these term work. It is the responsibility of the student to pick up all their term work at the specified time and place. Any unreturned term work, shall be retained and then shredded six months after the deadline for reappraisal and grade appeals. Final examinations will be kept for one year as required by university guidelines and the Government of Alberta's Freedom of Information and Protection of Privacy Act.

Calculator Policy

There is no calculator policy in this course; students are free to use the calculator they wish for all assessments.

Expectations for AI use

In this course, we commit to AI use guided by ethical and transparent principles. While students are allowed to use advanced automated tools (such as ChatGPT or Dall-E 2) for certain written assignments, it is crucial to adhere to the following guidelines:
Seek prior approval from the instructor for AI use in specific assignments.
When allowed, clearly attribute and cite any AI-generated content in your work, including prompts and AI outputs as part of your academic record. Include an additional reflection component in your assessments, discussing how AI tools contributed to your learning process.
IMPORTANT: Please note that AI use is strictly prohibited in assessments and assignments not approved by the instructor. Failure to abide by this guideline may be considered an act of cheating and a violation as outlined in the relevant sections of University of Alberta (November 2022) Code of Student Behaviour .

Text and References (Mandatory):

Reservoir Engineering Handbook, Ahmed, Tarek H., 4th ed., Elsevier, 2010

Website:

Canvas

Previous Examples of Evaluative Materials:

Sample exams are uploaded on Canvas.

Lab Information:

Lab Topic	Date
Lab 1: Porosity Determination by Mercury Injection and Boyle's Law Porosimeter	
Lab 2: Klinkenberg Permeability pages	
Lab 3: Darcy's Law Permeability	
Lab 4: Transverse Permeability	

Did you know that the University of Alberta has various low-to-no-cost services to help students succeed? Visit http://www.deanofstudents.ualberta.ca/ for information about the academic, wellness, and various other support services available to U of A students. It's never too early or too late to seek help!

Course Contents & Tentative Schedule

1. Review of Rock Properties (10 sessions)
    - Porosity
    - Saturation
    - Permeability (Assignment #1)
    - Wettability, Interfacial Tension, Capillarity (Assignment #2)
    - Rock Compressibility
    - Relative Permeability
2. Fundamentals of Reservoir Fluid Flow (13 sessions)
    - Steady-state flow of incompressible, slightly compressible, and compressible fluid flow (Assignment #3)
    - Transient flow of oil and gas in porous media (Assignment #4)
    - Pseudo steady-state flow of oil and gas in porous media (Assignment #5)
    - Skin effect
3. Fractured Reservoirs (2 sessions)
    - Flow of oil and gas in naturally fractured reservoirs
    - Flow of oil and gas associated with hydraulically fractured wells (Assignment #6)
4. Water Influx (2 sessions)
    - Pot aquifer model, Schilthuis's steady-state model, the van Everdingen-Hurst model
5. Oil Recovery Mechanisms and Material Balance Equation (7 sessions)
    - Reservoir recovery mechanisms
    - General form of the Material Balance Equation
    - Drive Indices
    - Material Balance as straight-line equation (Assignment #7)

University and faculty policies

Respect and professionalism

The Faculty of Engineering is committed to fostering and protecting an equitable, inclusive, and respectful work and study environment in line with University of Alberta policies and professional engineering industry standards.

The faculty prepares students to uphold industry standards to become a Professional Engineer (P.Eng). Therefore, respect, professionalism, and accountability must be upheld within the Faculty of Engineering and the University of Alberta.

Academic integrity and student conduct

The University of Alberta is committed to the highest standards of academic integrity and honesty, as well as maintaining a learning environment that fosters the safety, security, and the inherent dignity of each member of the community, ensuring students conduct themselves accordingly. Students are expected to be familiar with the standards of academic honesty and appropriate student conduct, and to uphold the policies of the University in this respect.

Students are particularly urged to familiarize themselves with the provisions of the Student Academic Integrity Policy and the Student Conduct Policy, and avoid any behaviour that could

potentially result in suspicions of academic misconduct (e.g., cheating, plagiarism, misrepresentation of facts, participation in an offence) and non-academic misconduct (e.g., discrimination, harassment, physical assault). Academic and non-academic misconduct are taken very seriously and can result in suspension or expulsion from the University.

All students are expected to consult the Academic Integrity website for clarification on the various academic offences. All forms of academic dishonesty are unacceptable at the University. Unfamiliarity of the rules, procrastination or personal pressures are not acceptable excuses for committing an offence. Listen to your instructor, be a good person, ask for help when you need it, and do your own work -- this will lead you toward a path to success. Any academic integrity concern in this course will be reported to the College of Natural and Applied Sciences. Suspected cases of non-academic misconduct will be reported to the Dean of Students. The College, the Faculty, and the Dean of Students are committed to student rights and responsibilities, and adhere to due process and administrative fairness, as outlined in the Student Academic Integrity Policy and the Student Conduct Policy. Please refer to the policy websites for details on inappropriate behaviours and possible sanctions.

The College of Natural and Applied Sciences (CNAS) has created an Academic Integrity for CNAS Students eClass site. Students can self-enroll and review the various resources provided, including the importance of academic integrity, examples of academic misconduct & possible sanctions, and the academic misconduct & appeal process. Students can also complete assessments to test their knowledge and earn a completion certificate.

"Integrity is doing the right thing, even when no one is watching." -- C.S. Lewis

The Faculty of Engineering expects an environment free of harassment, discrimination, and bullying. We encourage you to talk to the Office of Safe Disclosure and Human Rights about experiences, questions, or concerns. Additional resources and support for students are attached below.

Engineering students studying in the province of Alberta must also follow the Code of Ethics set by the Association of Professional Engineers and Geoscientists of Alberta (APEGA).

Course outline policies, course requirements, evaluation and grading information can be found in the University Calendar.

Safety during learning activities

In all Faculty of Engineering courses, labs, seminars or other learning activities, safety is of paramount importance. In some cases, laboratory work in a program requires high standards for risk management to keep potential hazards safely under control.

Anyone found to be unable to function safely in the class, lab, seminar or other learning activity may be asked to leave or be removed for their and the safety of other participants and instructors in alignment with the Student Academic Integrity Policy and Student Conduct Policy. As members, or prospective members, of the engineering profession, it is your responsibility to identify and inform the proper authorities of unsafe work.

Audio and video recording

Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan.

Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Only those items specifically authorized by the instructor may be brought into the exam facility. Students must not bring any unauthorized electronic device into an examination room, including cell phones or other devices.

Student services and support

Health & Wellness Support

Counselling and Clinical Services

Free, short-term, appointment-based counselling and psychiatric services. Also offers drop-in workshops. Book an initial consultation. Visit uab.ca/CCS to learn more.

Wellness Supports Social Workers

Free one-on-one support for students in the areas of housing, finances, academics, personal wellness, life skill development, family dynamics, system navigation, and any area of life where there is a desire to invite change. Visit uab.ca/wellness to learn more.

Sexual Assault Centre

Free, anonymous, and confidential drop-in counselling. Visit uab.ca/UASAC to learn more.

The Office of Safe Disclosure & Human Rights (OSDHR)

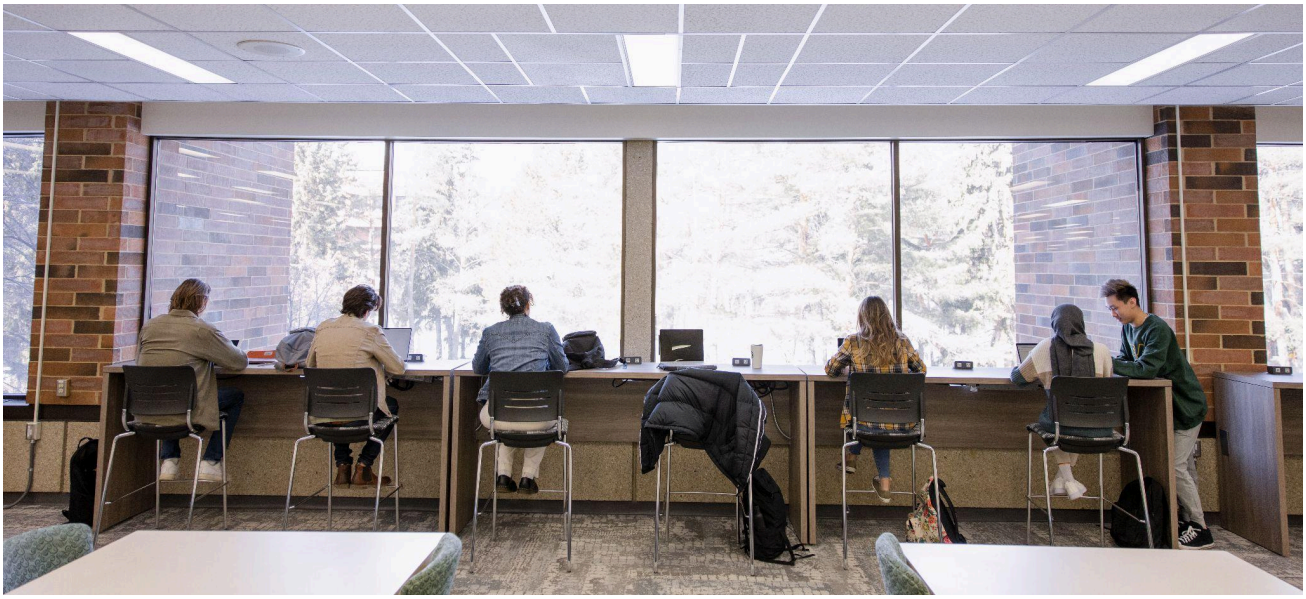
The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy. Visit uab.ca/OSDHR to learn more.

HIAR (Helping Individuals at Risk)

If you're worried about someone, contact HIAR, who can help assess risk and connect individuals to support. Learn more at uab.ca/HIAR.

Immediate External Supports

Health Link Alberta: 811
Suicide Crisis Helpline: 988



Academic support

Academic Success Centre
Access to a variety of services to maximize your academic success. Learn more at uab.ca/ASC.

Accessibility Resources
Connects students with disabilities to accommodations. Learn more at uab.ca/Access under accommodations + accessibility.

Decima Robinson Support Centre
Academic support for 100- or 200-level introductory calculus, linear algebra and statistics courses. Visit uab.ca/DSC to learn more.

Engineering Student Success Centre
The Faculty of Engineering provides drop-in tutoring for first-year courses. Visit uab.ca/ESSC to learn more.

Office of the Student Ombuds
Call for complex problems and conflict mediation. Learn more at uab.ca/ombuds.

Financial support

Student Service Centre

For awards and other funding support. Learn more at uab.ca/ask.

Campus Food Bank

The Campus Food Bank Society is an independent charity supporting University of Alberta students, faculty, staff, and alumni for up to five years. For additional information visit their website at campusfoodbank.com.