PET E 375 Applied Reservoir Engineering

Fall 2024 - September 03 to December 09

Class time: Monday, Wednesday, Friday 9:00-9:50 Location: NRE 1-143

Instructor:

Juliana Leung, PhD, P.Eng, she/her

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Donadeo Innovation Centre for Engineering 6-285
Office Hours: TBA or by appointment

Course Description:

*3.8 (fi) (either term, 3-3S/2-0) Reserves estimation. Analysis and prediction of reservoir performance by use of material balance. Primary recovery performance for water influx and solution gas drive reservoirs. Decline curve analysis. Basics of well test analysis. Pressure drawdown and buildup tests. Average reservoir pressure estimation. Drill stem testing and gas well testing.

Prerequisites: PET E 295 or PET E 373. PET E 375 cannot be taken for credit if credit has already been obtained in PET E 475

Course synchronous and asynchronous content delivery schedule:

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:

Ziming Xu (he/him/his) - ziming4@ualberta.ca

Seminar Sections:

Section	Day	Time	Location
SEM E11	Monday	14:00 - 16:50	NRE 2-003

Course Objectives & General Content:

Students will learn how reservoir engineering concepts are applied in the practical exploration and development of subsurface flow reservoir systems for various geo-energy applications:

1. Provide quantitative estimation of resource volumes;

2. Assess and appraise reservoir quality;
3. Evaluate and predict reservoir performance.

It is important to prepare yourself for this course through a review of the prerequisite material. Students who do not have the required prerequisites at the time of taking this course should not expect supplementary tutoring from the instructor.

The course is based on materials from the required text, lectures, and supplemental readings. Students are responsible for textbook and lecture materials, although not all parts of the text will be covered in class, and not all lectures will be drawn exclusively from the text. The best way to study for this course is to complement the lecture materials with the textbook readings. Class notes, videos, assignments, announcements, and other relevant materials will be posted on eClass.

Note: This course is 3.80 units, so you may expect a higher workload for this course.

Learning Outcomes:

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

1. Estimate volume in-place and reserves using geologic and production data.
2. Formulate Monte Carlo simulation to perform probabilistic volumetric calculations.
3. Propose, as part of the team open-ended design assignments, field exploration activities and data collection programs considering uncertainties in the in-place volumes.
4. Apply pressure transient theories to analyze common well tests.
5. Perform decline analysis calculations to forecast production.
6. Build, as part of the team open-ended design assignment, a model of the subsurface conditions from a diverse set of data sources, considering, interpreting and reconciling any discrepancies and uncertainties in the data.
7. Construct tank-based material balance models to predict recovery performance under different drive mechanisms.
8. Assess, as part of the team open-ended design assignment, different field development scenarios and determine the relevant operational parameters using the tank-based material balance models and economic calculations.
9. Construct, as part of the individual open-ended seminar exercises, numerical simulation models to study the effects of reservoir heterogeneities and propose development strategies (e.g., well placement and operational parameters).

Marking Scheme:

Activity	(A)Synchronous	Due/Scheduled	Weight
Group Design Assignments (3)			35%
Midterm			25%

Final Exam		As scheduled by Office of the Registrar	40%

The Faculty recommended grade point average for a 300 level course is 3.0. 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.

Additional Notes

Midterm and final exam will be open book.

Calculator Policy

Approved programmable or approved non-programmable calculators are permitted in examinations. Any calculator taken into an examination must have a sticker identifying it as an acceptable programmable calculator (green sticker) or non-programmable calculator (gold sticker). Students can purchase calculators at the University Bookstore with the stickers already affixed. Calculators purchased elsewhere can be brought to the Student Services where the appropriate sticker will be affixed to the calculator.

Text and References (Recommended):

T.H. Ahmed (2010). Reservoir Engineering Handbook (4th ed.). Gulf Professional Publishing. [strongly recommended]
L.P. Dake (1978). Fundamentals of Reservoir Engineering. Elsevier.
L.P. Dake (2001). The Practice of Reservoir Engineering (revised edition). Elsevier B.C. Craft & M.W. Hawkins (1991). Applied Petroleum Reservoir Engineering. Prentice Hall.
B.F. Towler (2002). Fundamental Principles of Reservoir Engineering. SPE Textbook Series vol. 8.
J. Lee (1982). Well Testing. SPE Textbook Series vol. 1.
J. Lee, J.B. Rollings & J.P. Spivey (2003). Pressure Transient Testing. SPE Textbook Series vol. 9.
R.C. Earlougher Jr. (1977). Advances in Well Test Analysis. SPE Monograph vol. 5.
C.S. Matthews & D.G. Russell (1967). Pressure Buildup and Flow Tests in Wells. SPE Monograph vol. 1.

Website:

eClass

Previous Examples of Evaluative Materials:

Practice problem sets are posted.

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!

Units

0. Introduction to “applied” reservoir engineering
1. Resources estimation
    - Volumetric methods (Ch. 4)
    - Monte Carlo technique for uncertainty analysis
    - Reserves and resources definitions
    - Exploration plan design
2. Reservoir characterization (Ch. 6)
    - Basic concepts of well testing
    - Fundamentals of pressure transient analysis
    - Pressure drawdown and build-up tests
    - Derivative plots and type curve analysis
    - Well test design
    - Well test applications
3. Reservoir performance analysis and prediction
    - Decline analysis (Ch. 16)
    - Material balance concepts (Ch. 11)
    - Tank models for different drive mechanisms (Ch. 12)
    - Water influx models (Ch. 10)
    - Development plan design

Remarks

- The numbers inside the brackets correspond to the relevant chapters in Ahmed (2010).
- There are three units. For each unit, there will be a group design assignment. An additional set of practice problems is also posted, but it will not be collected for grading.
- There will be one midterm and one comprehensive final exam (i.e., covering all three units).
- Both SI and imperial systems will be used in this course.
- Use of various data analysis and scripting tools will be introduced.

Design Assignments

Unless stated otherwise, all assigned work must be electronically submitted to eClass by 5 pm on the due date.

Late submissions will have 10% of the total marks deducted for each day or partial day (including weekend days) beyond the due time. There will be no make-up assignments and their weights cannot be shifted to the final (as per the Faculty of Engineering's regulations).

Midterm and Final Exam

All tests and exams will be open-book. They will be administered in person.

There will be a 75-minute midterm, and it will take place during one of the seminar sessions. If a test is missed due to a valid reason (e.g., severe illness), its weight will be shifted to that of the final exam.

The final exam will be comprehensive and take place as scheduled by The Office of the Registrar. A student who misses the final exam should apply to the Faculty of Engineering for a deferred exam.

General Expectations

Disputed grades must be discussed with the instructor within five (5) business days of their return to students.

Please include PET E 375 in the subject line. Emails will be responded to within one (1) business day. Please use your ualberta email address to avoid being filtered as spam. You are expected to check your ualberta email account and course website (on eClass) regularly, at least once daily.

Although asynchronous materials (e.g., slides and notes) will be posted, participation in all lectures is strongly encouraged. These are excellent opportunities to interact with your classmates and engage in group discussions.

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

All students are expected to follow the University of Alberta's Student Code of Behaviour and Student Conduct Policy. The faculty 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 Code of Behaviour 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)

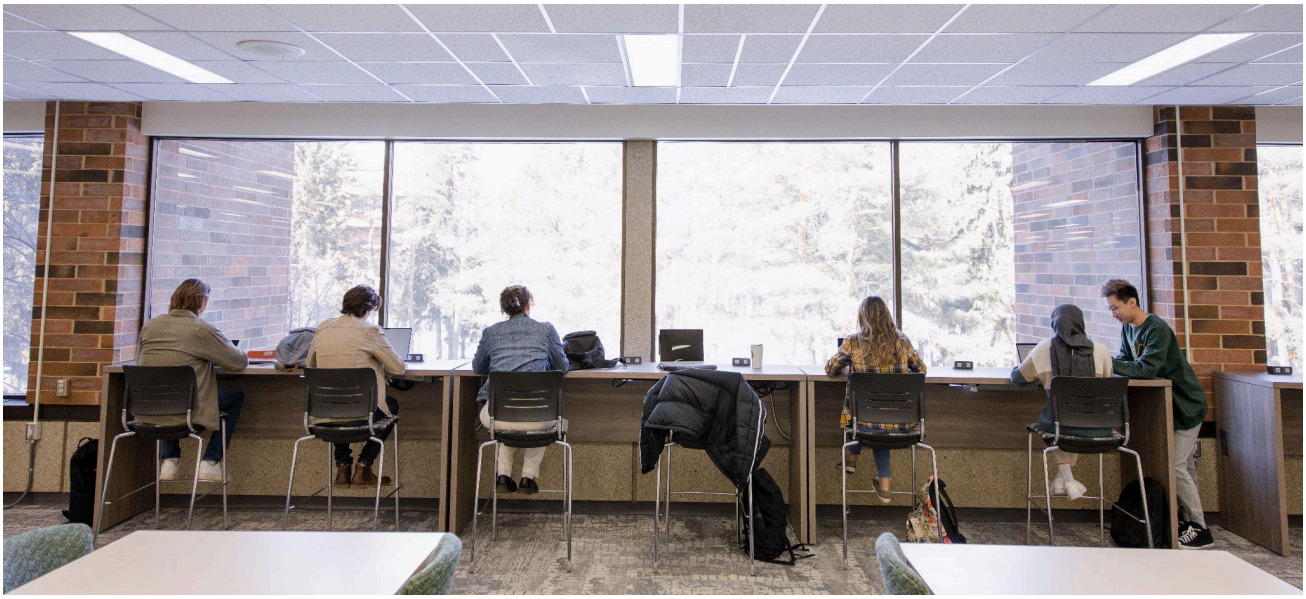
The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy. Visit uab.ca/OSDHR to learn more.

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.

UNIVERSITY OF ALBERTA

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.