PET E 364 Drilling Engineering

Fall 2024 - September 03 to December 09

Class time: Monday, Wednesday, Friday 11:00-11:50 Location: GSB 5-53

Instructor:

Huazhou Li/Shanshan Yao, PhD, P.Eng

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Donadeo Innovation Centre For Engineering 6-273
Office Hours: Booking via Email

Course Description:

*4.3 (fi) (either term, 3-1S-3/2) Rotary drilling systems, elements of rock mechanics, properties and field testing procedures of drilling fluids, drilling fluids hydraulics, drill bit hydraulics and mechanics, well control, factors affecting rate of penetration, drill string mechanics, fundamentals of directional drilling.

Prerequisites: CH E 312 or equivalent and CIV E 270

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:

Course TA: Vishnu Jayaprakash (jayapra1@ualberta.ca)

Lab TAs:
Facheng Gong (facheng@ualberta.ca)
Changxu Wu (changxu@ualberta.ca)

Lab Sections:

Section	Day	Time	Location
LAB D31	Wednesday	14:00 - 16:50	NRE 2-052
LAB D51	Friday	14:00 - 16:50	NRE 2-052

Seminar Sections:

Section	Day	Time	Location
SEM E41	Thursday	13:00 - 13:50	GSB 5-53

Course Objectives & General Content:

Course objectives: To develop understanding of basic elements of oil and gas well drilling engineering design specifically; To carry out engineering designs related to the sizing and selection of the elements of a rotary drilling system (elements of drilling rig), drilling hydraulics optimization, drill bit mechanics, drillstring design, well planning and cost control, directional and horizontal well planning and field implementations.

Course content: Rotary drilling systems (elements of drilling rig), elements of rock mechanics, properties and field testing procedures of drilling fluids, drilling fluids hydraulics, drill bit hydraulics and mechanics, well control, factors affecting rate of penetration, drill string mechanics, fundamentals of directional drilling.

Learning Outcomes:

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

1. Recognize major components of drilling machinery, how they work and what are the design criteria for their selection and operation.
2. Evaluate accumulated work done by the drilling lines (i.e. ton-mile calculation) and conduct proper slip and cut program to ensure drilling lines are kept in good working conditions at all times during well drilling operations.
3. Develop a well control procedure for safely circulating the gas kick out of the well using Drillers and Engineers methods and determine the kill mud weight, safe circulating drillpipe pressure and drillpipe pressure schedule to be used while circulating the gas kick out of the well.
4. Determine the optimum outer diameter, unit weight and length of drill collars as part of the bottom hole assembly design required for trouble free drilling at given drilling operational conditions.
5. Determine, as part of the design efforts for minimizing drilling cost, appropriate bit selection for initial and subsequent bit runs based on off-set well data, the minimum cost/ft criteria, performance of various drilling bits, and well formation.
6. Determine optimum drill string composition by considering safe operation conditions, minimum overall drill string weight and the cost.
7. Determine drilling fluid rheological properties (such as plastic viscosity, yield point, gel strength) using lab measurements conducted by using API field testing procedures of drilling fluid properties.
8. Determine, as part of an individual open-ended project, required pressure, volumetric flow rate and horsepower capacity of mud pumps used for drilling fluid circulation.
9. Design, as part of an individual open-ended project, a bit hydraulics program to maximize the drilling rate in a vertical well.
10. Design, as part of a group project, optimum well locations and wellbore trajectory for an off-shore field development drilling campaign plan using directional wells.

Marking Scheme:

Activity	(A)Synchronous	Due/Scheduled	Weight
Attendance			5%
Assignments (4)	Asynchronous		10%
Lab reports	Asynchronous	Reports are due two weeks after the lab session, by 4:00 P.M.	15%
Design Project - I	Asynchronous	October 22 @11.55 pm	15%
Design Project - II	Asynchronous	December 9 @11.55 pm	15%
Midterm Exam	Synchronous	Oct 17 1-3 PM	10%
Final Exam	Synchronous	Dec 19 1-4 PM	30%

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.

Calculator Policy

Only approved non-programmable calculators are permitted in examinations. Any calculator taken into an examination must have a sticker identifying it as an acceptable 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.

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 (Recommended):

"Fundamentals of Drilling Engineering," Mitchell, R.F., Miska, S.,
SPE Textbook Series, Vol.12, 2011 (Access via UofA Library).

"Applied Drilling Engineering", Bourgoyne et al. SPE Textbook Series, 1986.

Website:

eClass

Previous Examples of Evaluative Materials:

A previous midterm exam example will be provided.

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 OUTLINE

CHAPTER 1 INTRODUCTION TO ROTARY DRILLING SYSTEMS

1.1 Rotary Drilling Rigs (Week-1)

1.2 Power System (Week-1)

1.3 Hoisting System (Weeks-1 and2)

Assignment-1

1.4 Circulating System (Week-3)

1.5 Rotary System (Week-3)

1.6 Well Control System (Week-3)

1.7 Well Monitoring System (Week-3)

Assignment-2

CHAPTER 2 DRILLING HYDRAULICS DESIGN

2.1 Rheological Models (Week–4)

2.2 Flow Through Pipes, Annuli, and Bit Jets (Week–5)

2.3 Optimization of Drilling Hydraulics (Week-6)

Special Lecture - Fundamentals of Cement Design and Field Applications (TBA)

Midterm Exam (1-3 PM October 24th)

Design Project I (Due on October 27nd @ 11.55 pm)

CHAPTER 3 DIRECTIONAL AND HORIZONTAL WELL TRAJECTORY DESIGN

3.1 Introduction (Week-7)

3.2 2-D Trajectory Design (Week-7)

3.3 3-D Trajectory Design(Week-7-8)

3.4 Deviation Control and Trajectory Correction (Week-8)

Design Project II (Due on December 9th @ 11.55 pm)

CHAPTER 4 WELL CONTROL OPERATIONS

4.1 Causes, Identification and Verification of a Kick (Week-9)

4.2 Kick Circulation Methods (Week-9)

4.3 Design Calculations for Well Control Operations (Week-10)

Assignment-3

November 2nd, 9.00-12.00: UBD/MPD Workshop (Virtual Lecture/Training Sessionby Mona Trick, PENG)

Nov 12th, 2:30-6:30 PM: Technical Talk by Dr. Franklin M. (Lynn) Orr, Jr., a Distinguished Stanford Professor and former Under Secretary for Science and Energy of the U.S. Department of Energy

Fall Term Break (Week-11)

CHAPTER 5 DRILLSTRING DESIGN

5.1 Introduction (Week-12)

5.2 Drill Collars, Drill Pipes and Tool Joints (Week-12)

5.3 Drillstring Design (Week-12)

CHAPTER 6 DRILLING BIT FUNDAMENTALS AND DRILLING PERFORMANCE EVALUATIONS

6.1 Types of Drilling Bits (Week-13)

6.2 Drilling Bit Selection and Evaluation (Week-13)

6.3 Dull bit evaluation (Week-13)

6.4 Factors controlling drilling rate (Week-14)

6.5 Drilling performance evaluation- MSE Concept (Week 14)

Assignment-4

Final Exam (1-4 PM, Dec 19)

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)

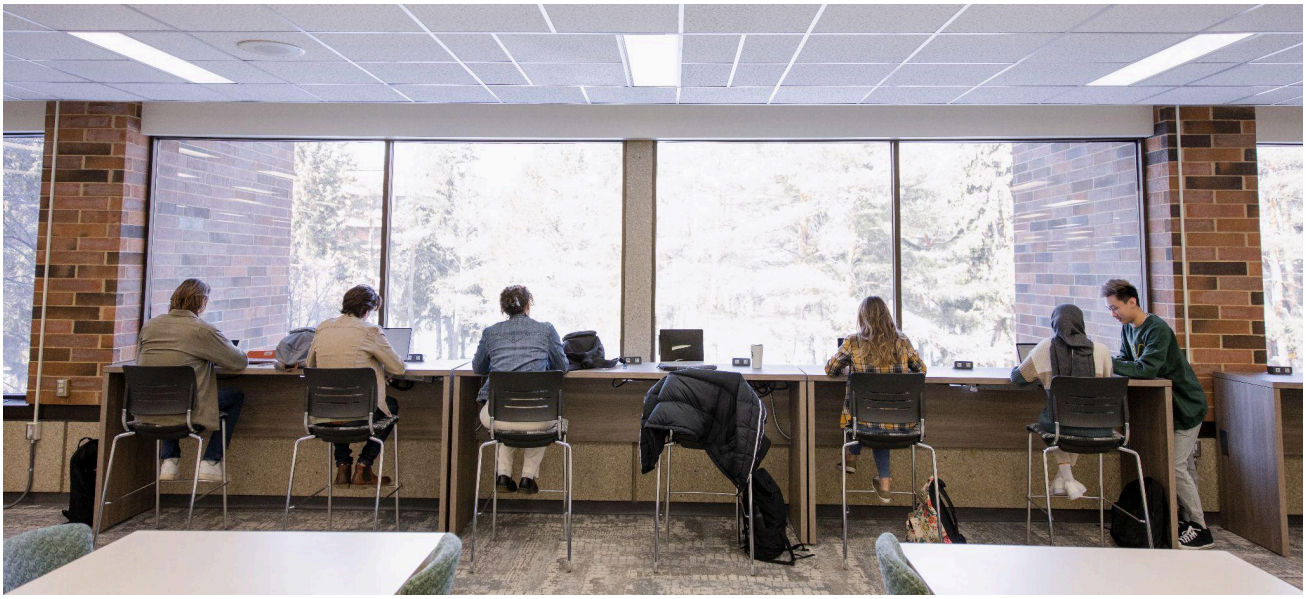
The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy. Visit uab.ca/OSDHR to learn more.

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.