CHE 514: Fundamentals of Petroleum Production – COURSE INFORMATION

Instructor: Prof. M. Ioannidis, PhD, PEng, FEC
E-mail: mioannid@uwaterloo.ca

Course Outline: Fundamentals of surface chemistry, capillary pressure and wettability. Petrophysics: measurement and interpretation of electrical, capillary and flow properties of reservoir rock. Hydrostatic pressure regimes and estimation of oil and gas reserves. Darcy's law and modelling of steady-state and transient incompressible and compressible single-phase flow through porous media. Thermodynamics of petroleum fluids. Material balance for oil and gas reservoirs: subsurface withdrawal and primary production mechanisms. Oil well testing. Two-phase flow in oil reservoirs: relative permeability, Buckley-Leverett theory of linear water flooding and sweep efficiency. Introduction to enhanced oil recovery.

Textbook:
(i) "Fundamentals of Reservoir Engineering", L.P. Dake, 1978, Elsevier.
(ii) "Reservoir Engineering Handbook", T.H. Ahmed, 2019, Gulf Professional Publishing (available online through the Library).

Grading:

Home Assignments (4)	28%
Case Study	40%
Quiz	10%
Presentation	20%
Discussions	2%

Course Plan

	Learning Module	Assessment
Week 1	Module 0: Introduction to Petroleum Engineering	
Week 2	Module 1: Capillarity	
Week 3	Module 2: Petrophysical Properties	
Week 4	Module 3: Basic Concepts in Reservoir Engineering	**HA#1**
Week 5	Module 4: PVT Analysis for Oil	
Week 6	**Reading Week**	
Week 7	Module 5: Material Balance applied to Oil Reservoirs	**HA #2**
Week 8	Module 6: Description of Fluid Flow in Oil Reservoirs	
Week 9	Module 7: Fundamentals of Oilwell Testing	**HA #3**
Week 10	**Presentation Checkpoint**	
Week 11	Module 8: Multiphase Flow of Immiscible Fluids in Oil Reservoirs	
Week 12		**HA#4**
Week 13	**Case Study & Presentation Wrap-Up**	**Quiz**

Course Objectives: This elective course is an introduction to the discipline of Petroleum Engineering. At the conclusion of this course,

- You are familiar with petroleum reservoir terminology, vocabulary and literature
- You understand fundamental concepts of fluid flow and capillary phenomena in porous media relevant to petroleum production
- You are able to interpret reservoir engineering data with specific focus on core analysis, estimation of hydrocarbon reserves, identification of primary production mechanisms, oil well testing, and modeling of secondary recovery by water flooding.

Learning Modules: Each module comes with a single-page "roadmap" articulating the module's key learning objectives and what you need to do to achieve them.

Assignments: Assignments are of equal value (7% of the final course grade each). Each assignment consists of a solution to a set of problems (this is Part I of the assignment and is worth 50% of the assignment's grade if it is submitted on time and 0% otherwise) and a reflection on the problems and their solution (this is Part II of the assignment and is worth 50% of the assignment's grade if Part I is submitted on time and 25% otherwise). This scheme allows you to earn points for problems that you were not able or did not have time to do at all, but you have to try Part I and submit your best work on time. Make sure that what you submit is legible – I will not grade what I have difficulty reading.

When grading Part I, great emphasis will be placed on the way you approach the solution to a problem. I will be looking for the following:

- Statement of a rationale for the choice of solution method (why is what you're doing the right thing to do?)
- Symbol definition and unit consistency
- Clear exposition of intermediate steps in calculations and derivations
- Clear statement and justification of any assumptions made to obtain a solution (what you are assuming, why you need to assume it, and why is it OK to assume it)

Of course, obtaining the correct answer is highly desirable, but will not be the only criterion for grading assignments. The solutions to Part I will be available immediately after Part I is due.

When grading Part II, I will be expecting you to genuinely reflect on your approach after having seen the solution provided. What was right and what wrong in your solution and why? How serious was the error? Did you have a misunderstanding that is now cleared up? Is the misunderstanding still there? For problems that you were not able (or didn't have time) to solve, can you articulate in your own words the strategy that the posted solution followed? Does it make sense to you?

Quiz: The quiz is a summative test of your understanding of fundamental concepts and is not calculation heavy. The quiz will test the entire course content.

Case Study: This is a term-long individual project that integrates knowledge from all modules to demonstrate competencies in well-log interpretation, reserves estimation, reservoir fluid characterization, primary production and oil well testing. Details are provided on Learn.

Presentation: In this term-long individual project, you will prepare and deliver a presentation on a reservoir engineering topic chosen from a list provided. Details and grading rubric are provided on Learn.

Discussions: Discussions take place on the Learn discussion forum, where I expect Q&A to take place on different topics (sometimes prompted by me, mostly initiated by you). The intent is to unpack "sticky" points through open dialogue and collective thinking. Small reward based on genuine participation.

Class time: There will be two 1 ½-hour in-person meetings each week (Monday and Wednesday at 1:30 am EDT). The meetings will be streamed online and recorded. During this time I will go over the presentations, answer your questions about the content, discuss solution approaches to assignment problems, do practice questions, and help you complete the case study.

Office Hours: There will be one 45-min office hour online (not recorded).

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check *https://uwaterloo.ca/academic-integrity/* for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.