Multiphase Flows in Porous Media - Course Syllabus

Course Number: ErSE 305

Course Title: Multiphase Flows in Porous Media

Academic Semester:	Spring	**Academic Year:**	2015/ 2016
Semester Start Date:	Jan, 24, 2016	**Semester End Date:**	May, 19, 2016

Class Schedule: 9:00-10:30am Sundays and Tuesdays

Classroom Number:

Instructor(s) Name(s): Shuyu Sun
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Teaching Assistant name:
Email:

Office Location: Building 1, Room 4417
Office Hours: 4:00-5:30pm Mondays

COURSE DESCRIPTION FROM PROGRAM GUIDE

Thermodynamics of pressure, volume, temperature and composition relationships in water, oil or nonaqueous phase liquids and gas mixtures. Modeling compositional and thermal fluids, including streamline flow, fractional flow and both immiscible and miscible flow.

COMPREHENSIVE COURSE DESCRIPTION

Course Description:

Understanding and modeling of multiphase flow in geological formation is required for making decisions associated with the management of petroleum reservoir. This course will cover the basic theory and numerical computation of multiphase flow in porous media. In the class, we present not only the models that describe phenomena of multiphase flow in porous media, but also to emphasize the theoretical foundation and the various assumptions that simplify the complex reality to the extent that it can be described by rather simple and solvable models. We will pay particular attention to the following two models: 1) incompressible two-phase immiscible flow and 2) compressible compositional multiphase flow. To make this course an introductory one accessible to students without any previous porous media flow knowledge, we will also go over subsurface single-phase flow in the beginning of this course.

We will first provide basic physical laws governing flow and transport in porous media, and then we discuss rock and fluid properties. Then derivation of mathematical models for multiphase flow in subsurface porous media will be covered. Since the equations governing a mathematical model of a reservoir cannot be solved by analytical methods in general, we will focus on numerical solution approaches. Finite difference methods, especially the mass-conservative block-centered finite difference scheme, will be formulated and discussed in details for the pressure equation and the saturation equation (for immiscible flow) or the species transport equation (for compositional flow). If time allows, toward the end of the semester we will gently and briefly touch upon a number of important finite volume and finite element approaches for the numerical modeling of groundwater flow and species transport. Implementation of numerical simulators, especially of block-centered finite difference oil-water two-phase flow simulators, is one focus of this course. Students will have opportunities to earn hands-on experiences of developing their own numerical reservoir simulators using the programming language of R.

GOALS AND OBJECTIVES

Goals and Objectives: The aim of this course is to introduce the basic theory and computational techniques for modeling multiphase flow in subsurface porous media, especially as applied to petroleum reservoir simulation. At the end of the course students will be able to construct conceptual and mathematical models that represent simplified scenarios of petroleum reservoir, and students are expected to be able to implement the mathematical models into numerical simulators using a high-level programming language such as R.

REQUIRED KNOWLEDGE

Basic numerical PDE course and basic programming skills in R, or consent of instructor

REFERENCE TEXTS

Text:

1) Reservoir Simulation: Mathematical Techniques in Oil Recovery (CBMS-NSF Regional Conference Series in Applied Mathematics), by Zhangxin Chen. Published by Society for Industrial and Applied Mathematics. 1 edition (October 31, 2007). ISBN: 978-0898716405.

2) Principles of Applied Reservoir Simulation, by John R. Fanchi. Published by Gulf Professional Publishing. Third Edition (December 22, 2005). ISBN: 978-0750679336.

Additional Recommended References:

1) Computational Methods for Multiphase Flows in Porous Media (Computational Science and Engineering), by Zhangxin Chen. Published by Society for Industrial and Applied Mathematics. 1st edition (March 30, 2006). ISBN: 978-0898716061.

2) Thermodynamics of Hydrocarbon Reservoirs, by Abbas Firoozabadi. Published by McGraw-Hill Professional. 1st edition (January 1, 1999). ISBN: 978-0070220713

METHOD OF EVALUATION

Percentages %	Graded content
10% **30%** **20%** **40%**	**Grading Policy:** **Your final grade will be determined as follows** • **Attendance and participation** • **Homework and in-class quizzes** • **Mid-term paper presentation** • **Semester final project (including presentation and project report)**

COURSE REQUIREMENTS

Assignments

Homework and in-class quizzes
Mid-term paper presentation
Semester final project

Course Policies

Attendance: Regular and punctual attendance is necessary for each student to maximize his/her understanding of the material. Students are expected to wait 15 minutes before leaving if the instructor is not present at the scheduled start time of the class. Excused absences include official university business and personal emergencies (medical, legal, death in the family, etc). It is the student's responsibility to contact the instructor prior to the absence (when possible) and provide the documentation required for excused absences. It is the student's responsibility to make up any deficiency resulting from class absence in a timely manner, including getting class notes (from other students) and assignments. Please carefully read the university attendance policy for additional specifics. Students who have more than 5 unexcused absences are subject to being dropped from the course.

Additional Information

Academic Integrity: As members of the KAUST community, we have a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a KAUST degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.

NOTE
The instructor reserves the right to make changes to this syllabus as necessary.