# PTE 411x Fall 2016 Introduction to Transport Processes in Porous Media

Instructor: Jincai Chang, Ph. D., <u>jincaich@usc.edu</u>, 213-740-7459 Class Hours: Wednesdays, 3:30 – 6:10 pm, OHE 136 Office Hours: Wednesdays 10:00 am – 12:00 noon, HED 314 TA: Atefeh Jahandideh, atefeh.jahandideh@usc.edu TA Office Hours: TBA

## **Course Description and Objectives:**

This course is intended for non-petroleum majors to understand concepts of oil and gas production, and to learn basic skills in modeling subsurface flow of oil, water and gas. The course starts with the introduction of oil and gas origination and the production process. Rock and fluid properties and their measurement methods will then be examined in detail. Finally, modeling and calculation methods of oil and gas flow will be explored.

## Course Outline:

1. Aug 24: Introduction. Origination of oil and gas, porosity, rock and formation compressibility

2. Aug 31: Pressure, Darcy's Law, permeability, measurement, gravity effect, average permeability for heterogeneous media, parallel and series flows.

3. Sep 7: Underground fluids, saturation, introduction of relative permeability, multiple phase flow calculation,

4. Sep 14: Properties of oil, water and gas. PVT calculation, viscosity, compressibility of liquid and gas, ideal and real gas equations, Z-factor, gas in place calculation

5. Sep 21: Interfacial tension and rock wettability, the effect wettability on fluid flow, wettability measurement method

6. Sep 28: Capillary pressure, definition and measurement method, basic equations, capillary pressure in heterogeneous rocks, importance of capillary pressure in oil and gas production

#### 7. Oct 5: Midterm exam

8. Oct 12: Relative permeability, definitions, measurement methods, empirical equations for 2phase relative permeability curves, applications

9. Oct 19: Fluid flow and pressure drop in a radial reservoir, oil, water and gas production calculation, GOR, WOR, WGR and CGR definitions and calculations

10. Oct 26: Diffusivity equation and boundary conditions, transient and steady state and pseudo steady flows

11. Nov 2: Two phase flow (oil and water) in a linear reservoir, Buckley-Leverett solution method

12. Nov 9: Two phase miscible flow, characteristics, application in oil and gas production

13. Nov 16: Phase behavior of a pure component and multiple component of hydrocarbon mixture, classifications of oil and gas reservoirs

14. Nov 23: Thanksgiving Week, no class

15. Nov 30: Phase behavior of reservoir fluids, fluid types, surface processing, and final sales products

16. Dec 7: (Review and summary)

17. Dec 12: Final exam, 2-4 pm

## Final Grade Calculation:

Homework 20%, Midterm Exam 35%, Final Exam 40%, Attendance & Class Participation 5%

100-95.1%	95.0 - 90.1%	90-85.1%	85-80.1%	80-75.1%	75-70.1%	70-65.1%	65 - 60.1%	60-0%
Α	A-	B+	В	B-	C+	С	C-	F

Homework will be assigned at the end of each lecture, and the assignment is due at the beginning of the next lecture. Completing homework on time is an important part of the learning process. Students can have group studies and discussions outside of class. However, each student must complete his or her homework and project assignments independently. All homework and project will be graded and the results will be tabulated and used in determining the final grade.

#### Other requirements for this course:

- 1. It is important to attend all lectures. Please check the class schedule and arrange your work and travel plans accordingly.
- 2. The midterm and final exam dates cannot be changed. Missing one exam will likely result in a failing grade.
- 3. DEN students can type their homework with a word processor, or scan handwritten pages with an optical scanner. Convert the typed or scanned homework to a PDF file and submit the PDF file electronically to the DEN office before the deadline. Photos of homework are *not* acceptable because they are often hard to read.
- 4. On-campus students are encouraged to submit their typed or handwritten homework in PDF format. A dropbox will be created for each homework on the Desire2Learn website. Students must upload the homework before the due time. Do *not* send pdf files through emails. Students who have difficulty converting homework to PDF files may submit homework on paper (8.5 by 11 inches), single-sided only.
- 5. Computer codes must be submitted in electronic form if requested.
- 6. All homework assignments must be submitted on time. If an assignment is turned in late, 10% credit will be deducted for each day late. If a student has an emergency and cannot turn in homework on time, please contact the instructor in advance for late homework submission. Keep in mind that chronic late homework submissions can result in a failing grade.
- 7. Microsoft Excel will be used extensively for homework assignments.
- 8. Light computer programming is required to complete some of the homework assignments. You can use MS Excel or other programming languages such as Matlab and C/C++.

#### Books and References:

- 1. Dandekar, A.Y., Petroleum Reservoir Rock and Fluid Properties, CRC Press, 2013
- 2. SPE papers to be assigned