MEG602: Multiphase Flow in Sub-surface Porous Media

Program and Course Code	Mechanical Engineering Program MEG602
Course Title	Multiphase Flow in Sub-surface Porous Media
Credit Hours	3
Instructors	Dr. Mohamed Sassi
Contact Information	Email: msassi@masdar.ac.ae Tel. 02 810 9148
Office Hours	Two hours for every hour of class, TBA in beginning of semester
Bulletin Course Description	The course is focused on the achievement of a clear and rigorous understanding of the fundamental properties, concepts and theories which are of importance in treating storage and multiphase fluid flow in sub-surface porous media, with or without heat transfer, mass transfer, and/or chemical reactions.
Pre-requisites	MEG501, MEG507, MEG510, or equivalents
Co-requisites	None
Course Objectives (Student Learning Outcomes of the Course)	After completing this course, students will be able to: • Describe the physical nature and derive properties of porous media • Describe flow dynamics in porous media • Derive Darcy's Law • Derive and manipulate equations governing saturated and unsaturated flows in porous media • Quantitatively describe chemical mass transport in permeable porous media • Quantitatively describe heat transfer in porous media • Solve problems with chemical reactions and transport phenomena in porous media

Relationship of course objectives to IDDP program outcomes	
Program Outcome	Demonstrate appropriate depth and breadth of knowledge that is at the frontier of their disciplines (thermal fluids)
Program Outcome	Understand and value diverse approaches to solving critical problems in research and to creating new knowledge judged by international standards
Program Outcome	Work effectively in a multidisciplinary collaborative environment using highly developed cognitive and creative expert skills and intellectual independence
Program Outcome	Communicate effectively, in written and oral forms, their research results and/or critique highly complex and diverse matters to diverse audiences

Week	**Course Topics and Contents**
1, 2	• Physical nature and properties of fluid phases and porous media
3, 4	• Mass conservation equations in porous media
5, 6	• Derivation of Darcy's Law and flow equations
7, 8	• Equations governing saturated and unsaturated flows in porous media
	• Midterm Exam

9, 10	• Multiphase fluids flow and transport phenomena in porous Media
11, 12	• Chemical reactions with transport phenomena in porous media
12, 14	• Numerical simulations of multiphase flow in porous media
15	**Final Exam**

Out-of-class assignments	
Homework	Several analytical and numerical simulation homework assignments will be given during the semester
Course Project	A theoretical and numerical simulation project assigned towards the end of the semester and due the last week of classes

Course Grading	
Homework	20 %
Midterm Exam	20 %
Computer project	30 %
Final Exam	30 %
Total	100 %

Class/Laboratory schedule and Methodology	
Class	The class meets 14 weeks, 2 lectures per week, 75 minutes each.
Laboratory	Experimental laboratory demonstrations will be used to emphasize certain concepts. Computer laboratory will be used for software applications in multiphase flow in porous media
Teaching and learning methodologies	A combination of white board use, Power-point slide presentation, and interactive class discussions to encourage student participation and enhance the learning.

Course Materials	
Textbook(s)	Fluid Flow in Porous Media, by Zoltan Heinemann, 2003. Essentials of Multiphase Flow in Porous Media, William G. Gray, John Wiley & Sons, 2008.
Recommended Readings	Dynamics of Fluids in Porous Media, by Jacob Bear, 1972. Flow and Reactions in Permeable Rocks, by Owen Phillips, 1991.
Instructional material and resources	A course website will be set at the beginning of the semester where all course necessary material will be posted including course notes, homework assignments and solutions, available computational software tools and manuals.