

Essentials of Flow in Porous Media

GEO 391, Spring 2013

Class details

Class room: JGB 3.222
Class time: Tu/Th 11:00 to 12:30
Unique: 27775
Prerequisite: consent of instructor
Description: This class will cover the basic dynamic phenomena that occur in flow in porous media from a mathematical and numerical perspective. The emphasis is on non-linear dynamics of natural convection, viscous fingering, and two-phase flow. Through out the course mathematical analysis and analytic solutions are tightly integrated with numerical solution of the governing equations. Numerical solutions will be based on standard finite volume methods, but implementation will emphasize modularity by discretizing basic differential operators. At the end of the class the student should be able to solve most problems in porous media flow.

Instructor

Instructor: Dr. Marc Hesse
Office: EPS 3.152
Office hours: TBD
Email: mhesse@jsg.utexas.edu
html: <http://www.jsg.utexas.edu/hesse>

Assessment

Grading: The class will be graded based on regular homeworks. Collaboration: Homeworks can/should be discussed amongst students, but the solutions have to be written up individually.

Course materials

No textbook is required, but some relevant books on the topic are:

1. *Flow and reactions in permeable media*, Phillips
 2. *Multi-phase flow and transport processes in the subsurface*, Helmig
 3. *Finite volume methods for hyperbolic equations*, LeVeque
 4. *Essentials of multiphase flow and transport in porous media*, Pinder & Gray
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Syllabus

week	dates	lecture	topics	homework
1	15 Jan	1	Volume & Area Fractions and REV	HW 1
	17 Jan	2	Darcy's law and Huppert	
2	22 Jan	3	Balance equations & fluid mass balance	HW 2
	24 Jan	4	Transient pressure equation	
3	29 Jan	5	PDE classification & properties of Laplacian	HW 3
	31 Jan	6	Topography driven flow - scaling analysis	
4	5 Feb	7	Topography driven flow - analytical solution	HW 4
	7 Feb	8	Streamfunction & Toth solution	
5	12 Feb	9	1D discrete divergence and gradient	HW 5
	14 Feb	10	Handling constraints: Penalty and Lagrange multipliers	
6	19 Feb	-	cancelled	
	21 Feb	-	cancelled	
7	26 Feb	11	2D numerical implementation	
	28 Feb	-	cancelled	
8	5 Mar	12	Numerical solution topography driven flow	
	7 Mar	13	Iterative numerical methods for non-linear problems	
9		-	Spring break	
10	19 Mar	14	Numerical solution for gas flow	HW 6
	21 Mar	15	Transient groundwater flow finite aquifer	
11	26 Mar	16	Transient groundwater flow semi-infinite aquifer	
	28 Mar	17	Numerical solution of transient problems	
12	2 Apr	18	Self-similar solutions fo transient gas flow	HW 7
	4 Apr	19	Numerical solution of transient gas flow & Energy Balance	
13	9 Apr	20	Advection diffusion and Peclet number	HW 8
	11 Apr	21	Forced heat convection in regional groundwater flow	
14	16 Apr	-	cancelled	HW 9
	18 Apr	22	Natural/Free convection I	
15	23 Apr	23	Natural/Free convection II	
	25 Apr	24	Gravity currents I	
16	30 Apr	25	Gravity currents II & discussion	
	2 May	-	cancelled	