

University of Waterloo

Term and Year of Offering: Fall 2015

Course Number and Title: EARTH 359, Flow Through Porous Media

Lecture Times, Building and Room Number: M, W, F 10:30 to 11:20; RCH 207

Tutorial Time, Building and Room Number: F 1:30 to 2:20; RCH 204

Instructor's Name, Office Location, Office Hours, Contact: Nandita Basu, E2-2327, Office Hours By Appointment, nandita.basu@uwaterloo.ca; ext 37917

TA's Name, Office, Office Hours, Contact; Kimberly Van Meter, PHY 230, office hours F 2:30-3:30. For other times, please contact first for availability, kvanmeter@uwaterloo.ca

Course Description:

"Quantitative introduction to the physical principles that govern the flow of fluids through porous and fractured geologic materials. Physical properties of fluids and porous media will be presented and conservation, flux and state equations will be developed. Physics of flow of immiscible fluids, including air-water and oil-water combinations will be included."

Course Objectives: At the end of the course you should be able to:

- Explain the major physical processes that govern saturated and variably-saturated groundwater flow.
- Understand the origins and limitations of a number of the primary equations used by hydrogeologists;
- Be able to apply these equations to practical hydrogeological situations;

Textbook: There is no recommended text for this course, just course notes. The course notes, homeworks and other class materials will be distributed through the Desire2learn website for the course. The course notes provided might not all be covered, but exams will be based only on the material covered in the lectures. Learning objectives will be provided to help with exam prep.

Evaluation: The course grade will be based on a mid-term examination, homeworks, a class project and a final examination which will be held during the Official Examination Schedule. The breakdown is as follows:

Homeworks 30% (the number of homeworks varies each year, but averages between 4-6 assignments)

Class Project 10%

Mid-term Examination 25%

Final Examination 35%

Note: Student travel plans are not considered acceptable grounds for granting an alternative examination time. (see <http://www.registrar.uwaterloo.ca/exams/finalexams.html>).

The final exam schedule is usually posted about 5 or 6 weeks into the term, so students should start checking Quest near the end of October.

Penalties for Late Homework and Exam Submissions

Assignments and exams that are submitted after their due date are subject to a 50% reduction in their respective values if handed in within 24 hours of the due date. Each additional late day will be penalized at an additional reduction of 10% per day. Exceptions/adjustments can be made if the student provides sufficient justification. Deciding if the late

submission is justified is left to the judgment of the instructor, may require documentation (Doctor's note, etc.) and will be decided on a case-by-case basis.

Classroom Etiquette

Behavior that limits another student's ability to learn or that disrupts the instructor's ability to deliver material will not be permitted. You must be polite, professional, and attentive in class, and must not exhibit any disruptive behavior in or out of class. In the event of disruptions caused by students, the instructor reserves the right to discontinue lectures and/or prohibit the disruptive students from attending classes. The instructor may also choose to penalize class participation grades in such scenarios. Examples of disruptions are loud conversation, whispering during lectures, replying to instructor's questions or comments with the intention to gain undue attention or to disrupt class proceedings, disrespectful or threatening behavior, physical or verbal abuse, and showing disdainful or intolerant attitude. Use of electronic devices including cell phones, mobile devices, pagers, transmitters, computers, etc., is prohibited inside the classroom and during examinations. You may use a laptop computer or tablet for recording class notes provided the activity does not disturb your neighbors.

Academic Integrity, Grievance, Discipline, Appeals and Note for Students with Disabilities: see www.uwaterloo.ca/accountability/documents/courseoutlinestmts.pdf The text for this web site is listed below:

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 www.uwaterloo.ca/academicintegrity/ for more information.]

For this course students may consult with one another regarding homework assignments (e.g. determining approaches for solving a problem on an assignment). However, **it is required that each student will carry out the actual work required for each assignment themselves.** Put another way, it is acceptable to discuss how to do homework with classmates but anything being submitted by a student for a grade has to be their own work. Any questions about homework collaboration should be brought up directly to the course instructor.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. 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 [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for his/her 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, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

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 he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for Students with Disabilities: AccessAbility Services, located in Needles Hall, Room 1132, 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 the office at the beginning of each academic term.

Lecture Topics:

The course lecture plan given below is tentative and some changes may occur in the content and the order of lectures. Any changes in assignment due dates or test dates will be discussed and announced in class and also posted on the course webpage. However, the grading scheme will remain the same.

Week	Topics	Tentative Due Dates
1 (Sep 14 – 19)	Introduction and Logistics REV, Soil Properties Head & Potential	Assign 1 given
2 (Sep 21 – 26)	Flow equations Navier Stokes Flow in Tubes and Parallel Plates/Fracture Flow	Assign 1 due Assign 2 given
3 (Sep 28 – Oct 2)	Darcy's Equation in 3D, Specific Storage and Storativity	
4 (Oct 5 – Oct 9)	Equations of motions – Single Phase Flow	Assign 2 due
5 (Oct 12 – Oct 16)	Statistical Analysis of Porous Media Properties and Groundwater Heads	Assign 3 given
6 (Oct 19 – Oct 23)	Midterm Exam – date to be announced in Class	Project Given
7 (Oct 26 – Oct 30)	Immiscible Fluids and Capillarity	Assign 3 due Assign 4 given
8 (Nov 2 – Nov 6)	Fluid distribution Capillary pressure – saturation relationships	
9 (Nov 9 – Nov 13)	Multiphase flow equations Relative permeability	Assign 4 due Assign 5 given (?)
10 (Nov 16 – Nov 20)	Unsaturated flow – Richards' equation	
11 (Nov 23 – Nov 27)	Infiltration and Redistribution	
12 (Nov 30 – Dec 4)	Other miscellaneous topics	Project Due Assign 5 due

Important: You are required to thoroughly read and understand this document in its entirety. In case of any doubt, dispute or disagreement, the interpretations, opinion and decision of the course instructor will be final.