

GEL 380 – Hydrogeology

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Classes: Tuesday/Thursday, 11:00-11:50 AM, 306 Brooks
Laboratory: Friday 9AM -12 PM, 306 Brooks
Office Hours: Monday-Thursday 9-10:15 AM or by appointment

Description: This course is an introduction to the study of groundwater: groundwater flow, well hydraulics, groundwater quality and pollution, and resource exploration, evaluation, and management.

Course Objectives: Following successful completion of this course, you will be able to:

- Relate soil and site characteristics to the distribution of groundwater
- Discuss and quantitatively model how and why groundwater moves
- Apply quantitative skills for evaluating groundwater resources and problems
- Evaluate groundwater supplies in terms of both quantity and quality

Assigned Text: C.W. Fetter, Applied Hydrogeology, 4th ed., Prentice Hall, New Jersey, 598 pg., 2001.
ISBN 0-13-088239-9

A copy of the text is available in the library for 2 hour durations via course reserves.

Suggested supplies: pencils, a good eraser, a scientific calculator, and a folder or notebook for handouts

Prerequisites: GEL 101 or 105, and GEL 102; or GEL 100 or 130; MTH 106 or higher; junior standing.
This course is algebra intensive thus, although not a prerequisite, MTH 107 is highly recommended.

Attendance: Our class time will be a mix of lectures, worksheets, and group work. It is your responsibility to attend scheduled class meetings and to read all assigned readings. I give out handouts containing the important figures from class but I do not provide notes. If you are absent for any reason, it is your responsibility to get class notes from a classmate and access the handouts from the Blackboard site.

If you must miss a laboratory or exam, notify me *by email* as far in advance as possible to determine the appropriate alternative. Make-up exams and labs will be given at my discretion (which means I may choose not to allow a make-up in accordance with university policies). In the event of an emergency, please contact me as soon as feasible to determine an appropriate strategy to keep you on track with your learning.

Laboratory: The laboratory section meets on Fridays from 9:00 AM – 12 PM. The meeting location, and necessary tools or attire will be announced ahead of time. The labs will be a mix of field, classroom, and computer activities. Please be prompt. Some weeks require preparation (reading, data selection, calculations, materials) so that you can complete the lab in a timely manner. Laboratories will be handed in

project style at the conclusion of each unit, please coordinate with your group members to be sure you complete and save each lab to hand in as a unit.

Assignments: We will have homework in two forms. We have labs every Friday morning. During the lab we will work on field and modeling skills in case study style problems. Sometimes additional practice problems will accompany the lab and often you will need to continue work on the lab outside of class. Your team will also complete a capstone project to present during the final exam period in December that is included in the lab grade. I encourage you to work on your assignments early in the week so that you have time to ask questions and do not have to scramble at the last minute. You have also received a packet of practice problems with their due dates. These are problems we will be reviewing in class every day. You will get credit for completing the practice problems by bringing them to class on the due date. We will review the solution, discuss complications, and you will get credit for every problem you complete **regardless of correctness.**

I DO NOT accept late assignments unless previously arranged (see attendance above) but I will drop your lowest lab assignment and excuse you from two practice problems. You may work with classmates on labs and assignments. However, **you must submit your own, individually prepared, assignments unless instructed to submit a team effort.** Show as much of your work as possible to achieve maximum credit. Please be neat and circle your calculation answers. Give yourself time to work through the problems and come ask questions in office hours.

Exams: This class has 3 cumulative exams. The exams cover the content of the lectures, readings, practice problems, and laboratory exercises. There are no quizzes.

Grading: Your final grade will consist of:

60% Exams

10% Practice problems

30% Labs and projects

Academic dishonesty: All work is expected to be in compliance with the Policy on Academic Integrity which states that “In the academic community the high value placed on truth implies a corresponding intolerance of scholastic dishonesty. Written or other work which students submit must be the product of their own efforts and must be consistent with appropriate standards of professional ethics. Academic dishonesty, which includes cheating, plagiarism and other forms of dishonest or unethical behavior, is prohibited.” The complete policy may be found at: <http://academicsenate.cmich.edu/noncurric.htm>.

Class Communication: I respond to class related emails within 24 hours. I also sometimes post announcements on Blackboard. Please feel free to stop by Brooks 321 or Brooks 303 when you have questions, even if it isn't office hours. If I am busy I'll make an appointment with you for another time.

Students with Disabilities:

“Central Michigan University provides students with disabilities reasonable accommodations to participate in educational programs, activities, or services. Students with disabilities who require accommodation to participate in class activities or meet course requirements should contact the instructor as soon as possible so that arrangements can be made. Students with disabilities requiring accommodation to participate in class activities or meet course requirements must first register with

the Office of Student Disability Services (120 Park Library; telephone 774-3018; TDD 774-2586).
Reasonable accommodations will be determined on a case by case basis.”

Please note that some labs will take place outdoors in Veit’s Woods, which features a wood chip path, although we will need to traverse a steep hill to access the river and well sites. We may also have an off campus field trip. I am happy to work with anyone to determine the best way to participate.

Classroom Civility: the *Code of Student Rights, Responsibilities, and Disciplinary Procedure* states that “A student shall not obstruct, disrupt or interfere, or attempt to disrupt or interfere with another student’s right to study, learn, participate, or a teacher’s right to teach during a class.” In a nutshell this means that you should come to class prepared to learn. Please respect me and your classmates by bringing your class materials, arriving on time, turning phones to silent, dressing appropriately for scheduled activities, and refraining from distracting behaviors.

Tentative schedule. Changes will be announced in class.

Date	Week	Section	Topic	Reading
28-Aug	1	GW and the Hydrologic Cycle	Hydrologic Balance	Skim Chapter 1, 2.1-2.8, 11.1-11.3
4-Sep	2		Hydrologic Balance	2.9-2.10, 2.11-2.13.1
11-Sep	3		Porous Media	3.1-3.5, 3.9-3.10
18-Sep	4		Basics of Flow	3.6-3.8, 3.11-3.12
25-Sep	5		Basics of Flow	3.11-3.12
2-Oct	6		Aquifers of the US	8.1-8.7, 8.10.0
9-Oct	7	Modeling GW Flow	Intro to modeling	4.1-4.8
16-Oct	8		Flow Nets	4.9-4.12, 7.1-pg. 278
23-Oct	9		1-D models	4.13--4.14
30-Oct	10		Flow to Wells/well tests	5.1-5.4.1, 5.5-5.5.3.3
6-Nov	11		Superposition/layers	5.5.6-5.5.6.2, 5.6.4-5.10
13-Nov	12	Water quality and Contamination	Water quality parameters	10.1-10.3, 10.6-10.7
20-Nov	13		1-D AD eqn.	catch-up
27-Nov	14		Remediation Methods	10.8-10.10
4-Dec	15		Capstone projects	start studying
13-Dec	16	Comprehensive	Final Exam Period, 12/13, 10 AM - 12 PM	

Lecture and Practice Problem Schedule

Week	Tuesday Lecture	Practice Problem	Thursday Lecture	Practice Problem
1	Intro - units	1.1 Units and math review	Components	1.2 Basic hydro balance
2	Measuring/calculating components	2.1 Residence time	Measuring/calculating components	2.2 Hydro balance pre-calc
3	Porosity, permeability	3.1 Soil texture	Storage parameters and water table changes	3.2 Specific yield
4	Anisotropy	4.1 Anisotropic hydraulic conductivity	Groundwater velocity and discharge	4.2 Darcy columns
5	Head within aquifers	5.1 Piezometric mapping	Flow direction in aquifers	5.2 Gradient calculation
6	Exam 1 (can take early if needed)	none	Capstone Project Instructions	6.2 Aquifer cards
7	Applying Darcy beyond columns	7.1 1-D Darcy calc	1-D Darcy	7.2 Flow/discharge
8	Flow nets	8.1 Hydro boundaries in flow nets	Drawing a flow net	8.2 Flow net cross section
9	The three 1-D eqns.	9.1 Variations on Darcy	Practice with the three 1-D eqn.	9.2 Application of Darcy
10	Radial flow (Theim)	10.1 Steady state radial drawdown	Theiss	10.2 Transient radial drawdown
11	Superposition and non-idealities	11.1 Superposition flow nets/calcs	Slug tests	11.2 Slug example
12	Sources of Pollutants	12.1 Superfund site info	1-D AD eqn.	12.2 Superfund site remediation
13	Exam II covering Ch 4 and 5	13.1 Calc A-D Components	Thanksgiving	none
14	1-D A-D	14.1 A-D application	1-D A-D	none
15	Capstone project worksession		Capstone project worksession	
16			Project Presentations and SOS	

Week	Lab Schedule	Lab Due Dates
1	No Lab- Have a safe holiday weekend	
2	1a Viet's set-up	
3	1b Excel set-up, soils prep	
4	2a lab soils	1 Hydro balance lab
5	3a Cross sections	2 Soils lab
6	3b Isopach maps	
7	3c Piezometric surfaces	
8	Field Trip	3 Aquifer Characterization lab
9	4a Radial flow - Viet's Wells	
10	4b Well test analysis	
11	4c Wells with boundaries	
12	5a Cape Cod site analysis	4 Well Analysis lab
13	Eat some turkey and chill out!	
14	5b 1D AD in Excel	5 Contaminant Transport lab
15	Exam III - Comprehensive	Take home final due Friday, 5 PM NO EXCEPTIONS!!!
16	None	None

Additional important dates:

Exam I: Oct. 2nd
 Field Trip: Oct. 19th

Exam II: Nov. 20th Exam III: Dec. 7th 5 PM
 Project Presentation: Dec 13th 10-12