CEE 457
GROUNDWATER

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Fall 2024
TuTh 12:30–13:50

COURSE DESCRIPTION

This is an introductory course emphasizing the fundamental principles governing the movement of water and contaminants in groundwater systems. Topics include the physical properties of groundwater and aquifers, principles and fundamental equations of porous media flow and mass transport, well hydraulics and pumping test analysis, the role of groundwater in the hydrologic cycle, groundwater quality, and contaminant transport.

This course is not design or practice-oriented, however, we will apply fundamental principles of fluid mechanics, hydrogeology, mass transport, and mathematics to address some simplified engineering design problems.

WEBSITES:

Illinois Canvas: https://canvas.illinois.edu/courses/49660
Lecture Videos: https://mediaspace.illinois.edu/

USE OF ILLINOIS CANVAS

Illinois Canvas is the online learning management system and main portal for the class. There is a detailed schedule, lecture notes, supplemental material, homework assignments and solutions, practice exam questions and solutions, etc.

OFFICE HOURS

Thursdays, 2-3 pm

TEXT

Available pdf files for viewing, download and printing on the Canvas site:

(1) CEE 457 Course Notes. This is a collection of background reading material from texts and reports, plus more in-depth notes compiled by Prof A. Valocchi who had taught this course at UIUC for the past 10+ years. The pdf file is bookmarked to material for each section of the syllabus.

(2) CEE 457 Lecture Slides: You may want to take notes or add information directly onto the slides presented in lecture. Some of you may want to use paper copies of the ppt slides. In that case, do not print more than one topic in advance since slides will be updated throughout the semester.

SUPPLEMENTAL REFERENCES

Freeze, R.A. and J.A Cherry, Groundwater, Prentice-Hall, Englewood Cliffs, N.J., 1979. ;

(available for free download)

Fetter, C.W., Applied Hydrogeology, 4th ed. Prentice Hall, 2001.

Domenico, P.A. and F.W. Schwartz, Physical and Chemical Hydrogeology, 2nd Edition, John Wiley & Sons, New York, 1998.

McWhorter, D. and D.K. Sunada, Groundwater Hydrology and Hydraulics, Water Resources Publications, Littelton, Colorado, 1977.

Anderson, M.P., W. W. Woessner and R.J. Hunt, Applied Groundwater Modeling, Elsevier, 2nd ed., Elsevier, 2015.

PREREQUISITES

- Introductory Fluid Mechanics (e.g. TAM 335)
- Basic Engineering Mathematics and Differential Equations
- Introductory Hydrology (e.g. CEE 350)

SOME OTHER USEFUL TEXTS AND REFERENCE BOOKS

Bear, Jacob, Hydraulics of Groundwater, McGraw-Hill, New York, 1979.

Bouwer, Herman, Groundwater Hydrology, McGraw-Hill, New York, 1978.

Charbeneau, R.J., Groundwater Hydraulics and Pollutant Transport, Prentice Hall, 2000.

de Marsily, G., Quantitative Hydrogeology, Academic Press, 1986.

Fetter, C.W., Contaminant Hydrogeology, 2nd ed., Prentice Hall, 1999.

Hillel, D., Introduction to Soil Physics, Academic Press, New York, 1982.

Johnson Div., UOP Inc., Ground Water and Wells, 2nd ed., F. Driscoll, ed., St. Paul, Minn., 1986.

Kresic, N., Groundwater Resources: Sustainability, Management, and Restoration, McGraw Hill, New York, 2009.

Mariño, M.A. and J.N. Luthin, Seepage and Groundwater, Elsevier, Amsterdam, 1982.

Pinder, G. and M. Celia, Subsurface Hydrology, Wiley, 2006.

Schwartz, F.W. and H. Zhang, Fundamentals of Ground Water, John Wiley, 2003.

Strack, O.D.L., Groundwater Mechanics, Prentice Hall, 1989.

Todd, D.K., Groundwater Hydrology, 2nd ed., Wiley, New York, 1980.

SCHEDULE OF TOPICS AND LECTURES (subject to change)

F&C = Freeze & Cherry
D&S = Domenico & Schwartz
F = Fetter
M & S = McWhorter & Sunada

Topic	Lecture Hours	F&C	D&S	M&S	F
I. Introduction	1	Ch 1	Ch 1	Ch 1	Ch.1
II. Physical Properties of GW & Aquifers	8				
A. Porous Media		2.5	2.1	p. 15-20	3.1, 3.2
B. Fluid Statics and Dynamics in Porous Media		2.1, 2.2, 2.3	3.1, 3.2, 3.3, 3.4	3.1	4.1-4.7; 3.4-3.9
C. Aquifer Heterogeneity & Anisotropy		- 2.4	- 3.2	- 3.2	3.11 -
D. Vertically Averaged Darcy's Law		2.10	-	-	Ch 8
E. Aquifers & GW Geology		2.7, Ch 4	2.2 - 2.6	-	Ch 7
F. Unsaturated Flow		2.6	3.5; 16.3	p. 20-28	3.3, 3.10
G. Storage Properties of Porous Media		2.9; 2.10	4.2	2.2; p. 28-33	-
III. Governing Equations for Groundwater Flow	3				
A. Introduction		2.11; App. II	4.1; 6.4	3.3	4.7, 4.8
B. Mass Conservation Equation for Saturated Porous Media					
C. Modeling Concepts					
D. Unsaturated Porous Media					
E. Confined Aquifer Flow				3.5	
F. Unconfined Aquifer Flow		5.5		3.4	
IV. Steady State Groundwater Hydraulics	7				
A. Streamlines & Equipotential Lines				4.1	4.10
B. Solutions for Confined Aquifer Flow				4.2, 4.5	4.13
C. Solutions for Unconfined Aquifer Flow		5.5		4.6	4.14
D. Superposition of Elementary Solutions		5.1	4.3	4.3 4.4	4.11,4.12
E. Overview of Flow Nets					
V. Groundwater Quality & Contamination	10				
A. Introduction		9.1, 9.5, Chap. 3; Chap. 7	16.1, Chs 11 & 12		10.1, 10.2, 10.7
B. Physical Transport Processes		2.13; 9.2	10.1 - 10.4		10.6
C. Solute Transport Equation		p. 392-394; App. 10	Ch. 13		
D. Solutions for Non-Reactive Contaminants		9.2, p. 388-401	Ch. 17		
E. Solutions for Reactive Contaminants		9.2, p. 402-408 9.3	Ch. 17 Ch. 18		
F. Overview of Parameter Estimation					

	Lecture Hours	F&C	D&S	M&S	F
VI. Unsteady Groundwater Hydraulics	8				
A. Response of Confined Aquifers to Pumping		8.1, 8.3	5.1	5.1	5.1-5.4
B. Response of Unconfined Aquifers to Pumping		8.3, p. 324-27		5.1, p. 185-88	5.4
C. Superposition of Elementary Solutions		8.3, p. 327-31	5.4	5.1, p. 190-94, 5.3	3.12, 3.13
D. Pumping Tests and Estimation of Hydraulic Parameters		8.4, 8.5, 8.6, 8.7	5.2, 5.3	5.2	5.5-5.10
E. One-Dimensional Flow		-	-	5.4, 5.5	-
F. Cell Balance Models & Intro to Numerical Models		8.8, 5.3	6.2	6.1	Ch.13
VII. GW & the Hydrologic Cycle	4				
A. Regional GW Flow		6.1; 6.3	7.1; 7.2		Ch 7
B. Fluctuation in GW Levels		6.8	4.4	2.3	-
C. Hydrologic Budgets		6.2	1.4	2.4	11.1-11.3
D. Yield of GW Basins		8.10	6.1		11.5, 11.9,11.10
E. Artificial Recharge		8.11	6.1		11.7
F. Infiltration & GW Recharge		6.4; 2.6	1.4		6.7
G. GW & Streamflow		6.5, 6.6	1.4		
Exams & Review	4				

COURSE GRADING POLICY

Class Participation Exercises ~ **10%**
Homework Assignments **~ 25%**
Three Exams (including Final) **~ 65% (Dates to be announced later)**

Examinations are open-book written examinations.

The summary course grade will be based upon a curve. In past years, students with the average numerical grade earned a letter grade of about B to B-.

HOMEWORK

There will be approximately 6 assignments. The assignments serve as critical learning tools, so it is very important for each student to understand how to do every assignment. **You are allowed to work as a team on homework.** A team cannot include more than 3 people and should turn in only **one** solution to the homework. A team homework solution should have a cover sheet bearing **both the electronic signature and clearly printed name** of each team member. I will assume that all team members signing the cover sheet agree that each person listed did a fair share of the work. All team members receive the same grade.

Normally you will have 7-10 days to complete each assignment. Late homework without a valid excuse given in advance of the deadline will be penalized 50%. Clearly note your answers to each homework problem (e.g., underline or put a box around the answer). Partial credit will be given based upon the judgment of the grader. I recommend that you make copies of corrected homework solutions for your personal use during the take-home exams.

Note that team effort on **examinations** is strictly prohibited. Examination solutions must represent the effort of individuals only. Examinations are open-note/open-book. By participating in this class, you agree to abide by campus and department academic integrity codes.

CEE HONOR CODE

To foster and promote integrity among students, the CEE Honor Code was developed with input from several CEE undergraduate organizations, the CEE Graduate Student Advisory Committee, and the CEE Graduate Affairs Committee. You (the student) commit to honor the code each time you sign an exam, and implicitly whenever you sign homework or turn in other class assignments.

The CEE Honor Code pledge is the following:

I pledge to uphold the highest levels of professional and personal integrity in all of my actions, including 1) never assisting or receiving unfair assistance during exams, 2) never assisting or receiving assistance on class assignments beyond that specified by an instructor, and 3) always fully contributing to group activities that are part of a course activity.

Emergency Response Recommendations

Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/.

I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/.

IMPORTANT INFORMATION AND STATEMENTS FOR ALL COURSES

See Syllabus Folder on Course Canvas Site

- Grainger College of Engineering Anti-Racism and Inclusivity Statement
- Sexual Misconduct Reporting Obligation
- Academic Integrity

- Religious Observances
- Disability-Related Accommodations
- Family Educational Rights and Privacy Act (FERPA)