

CE 473/573 Groundwater

Fall 2009

Course information

- Instructor:** Prof. Chris Rehmann
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- Office:** 482B Town Engineering Building
294-1203
- Goals:** To apply fundamental principles governing movement of water and contaminants in groundwater systems to solve problems of groundwater resource evaluation and groundwater contamination, to develop thinking skills, to communicate effectively and function on teams
- Prerequisites:** Elementary fluid mechanics and water resources engineering, calculus

Tentative outline:

1. Basics of groundwater
 - 1.1. Physical properties of aquifers
 - 1.1.1. Porous media
 - 1.1.2. Darcy's law
 - 1.1.3. Aquifers and groundwater geology
 - 1.2. Framework for groundwater flow
 - 1.2.1. Conservation of mass
 - 1.2.2. Equations of groundwater flow
 - 1.2.3. Confined and unconfined aquifers
2. Groundwater flow
 - 2.1. Streamlines, equipotentials, and flow nets
 - 2.2. Elementary solutions for confined and unconfined flow
 - 2.3. Wells
 - 2.3.1. Steady flow
 - 2.3.2. Unsteady flow & pump tests
 - 2.4. Superposition
3. Groundwater contamination
 - 3.1. Sources of contamination
 - 3.2. Physical, chemical, and biological processes
 - 3.3. Transport equations
 - 3.4. Behavior of non-reactive and reactive contaminants
4. Groundwater modeling
 - 4.1. Introduction to finite-difference models
 - 4.2. Models of groundwater flow
 - 4.3. Models of contaminant transport
 - 4.4. Available models

Recommended textbooks

Fetter, C.W., *Applied Hydrogeology*, Prentice-Hall.
Freeze, R.A. and Cherry, J.A., *Groundwater*, Prentice-Hall.
Strack, O.D.L, *Groundwater Mechanics*, Prentice-Hall.

Requirements and policies:

For CE 573, the grade will be based on homework (15%), two midterm exams (15 and 20%), a project (20%), and a final exam (30%). For CE 473, the grade will be based on homework (20%), two midterm exams (20 and 25%), and a final exam (35%); if undergraduates complete a project, then their grades will be computed from the highest possible combination. The midterm exams will be Friday October 2 (subject to change) and Friday November 6. Optional exercises will be given to reinforce lecture material; as incentive, individuals or teams may submit the exercises for extra credit (~5%). The homework will be done in teams of three or four students that the instructor will assign; students may form 'meta-teams', or teams of teams, to discuss homework. Your team will have the following responsibilities in completing homework:

1. Designate a coordinator, recorder, and one or two checkers for each homework. Rotate these roles for every homework.
2. Agree on meeting times and the individual work to be done before the meetings.
3. Do the required individual preparation.
4. Meet and work. The **coordinator** keeps everyone on task and makes sure everyone is involved. The **recorder** prepares the final solution, and the **checkers** check the solution and ensure that everyone understands the solution and strategy.
5. Submit the assignment and review the returned homework.

Late homework without a valid excuse given in advance of the deadline will be penalized 40%. Homework that fails to rotate the recorder will be penalized 25%. To facilitate group work and promote individual accountability, students will periodically rate everyone's effort (not academic ability), and the ratings will be factored into the individual grades. Students will also be asked to comment on group functioning throughout the term. The groups will be reshuffled if a majority of students would like to.

The projects will allow you to explore a topic in groundwater (unrelated to your thesis) in more depth. Students will work individually on projects. The project may include theoretical analysis, literature review, laboratory experiments, computer modeling, or any other idea you may have. All projects will include a written component, whose length will vary based on the approach you choose. Project topics will be due on September 18; an outline will be due on October 2; a list of references will be due on October 16; a preliminary draft will be due November 20; and the final project will be due on December 11. The first three steps will each be worth 5% of the final project grade.

For students with a disability

If you have a disability and require accommodations, please contact the instructor early in the semester so that your learning needs may be appropriately met. You will need to provide documentation of your disability to the Disability Resources office, located on the main floor of the Student Services Building, Room 1076, 515-294-7220.