INTRODUCTION TO GROUNDWATER HYDROLOGY
SPRING 2008
SPEA E411 Section 26208

Time: MW 1:00 - 2:15 p.m.; room BH 233

Instructor: Gusyev Maksym

Office hours: MW 2:30 - 4:00 p.m. and R 2:30 - 3:30; room SPEA 426
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Secretary: Jennifer Mitchner, SPEA 341, phone 855-7980

Course Text:

R. C. Heath (1983). "Basic Ground-water Hydrology", U.S. Geological Survey, Water-Supply Paper 2220,
Download a copy from IU website "Oncourse" or
from the web-site *http://pubs.usgs.gov/wsp/wsp2220/*
Additional materials will be uploaded on the IU website "Oncourse" during the semester.

Reserve Materials:

Four books are placed on reserve at SPEA Library:
C.W. Fetter (1993). "Applied Hydrogeology", 3rd Edition, MacMillan.
Freeze R.A. and J.A. Cherry (1979). "Groundwater", Prentice Hall.
H.M. Haitjema (1995). "Analytic Element Modeling for Groundwater flow", Academic Press.
H. Bouwer (1978). "Groundwater Hydrology", McGraw Hill.

Course Objectives

The student will be familiarized with the basics of groundwater hydrology, groundwater and surface water interactions, and groundwater contamination and remediation. Towards the end of the course the student is expected to be able to comprehend technical reports dealing with aquifer testing, groundwater hydrology, and aquifer restoration.

Course Contents

Topics include: Darcy's law, well hydraulics, pumping tests, wetland hydrology, groundwater models, contaminant transport, aquifer restoration, drinking water production, US EPA's wellhead protection program, flow in fractured rock, groundwater management, water law, computer modeling methods, etc. Although some basic groundwater flow equations will be presented and used, the emphasis in the course will be on concepts and their practical implementation. Slight modifications of syllabus might be applied during the course.

Course Format and Policy

The course is offered in the form of formal lectures. Where appropriate computer demonstration will be given to illustrate groundwater flow concepts. During the first ten weeks of the course there will be weekly homework assignments to reinforce concepts presented in class. Halfway the course students will work on a project of their own choice which will culminate in a report at the end of the course. Students are allowed to interact with each other while working on homework or the project, however, the material that are handed in must be the student's individual work. Cheating, plagiarism, or other form of academic dishonesty are not tolerated and will result in an academic sanction. The sanction may be a lower or failing grade on the assignment, requiring the student to repeat the assignment or requiring the student to perform additional work, or failing the course.

Course Performance

Assignments and examinations will include: elementary calculations and essay questions regarding concepts discussed in class. The course package and texts on Oncourse should be regarded as reference material.

Grade distribution:

Homework Assignments:	10%
Midterm Examination:	30 %
Individual Project:	30%
Final Exam:	30%

Important Dates:

Midterm Examination:	2/13
Project proposal due:	2/27
Project report due:	4/16
Final Examination:	5/2

COURSE OUTLINE PER WEEK

1. INTRODUCTION

- **Lecture 1/7:** Course Overview and introduction.
- **Lecture 1/9:** Basic terminology.
- **Readings:** Heath 1-12, 16-18 p.; **optional:** Fetter: 4.7, 4.9, 4.11; Freeze&Cherry: 2.7-2.8.

2. BASIC CONCEPTS

- **Lecture 1/14:** Basic concepts and equations.
- **Lecture 1/16:** Two-dimensional flow (Dupuit-Forchheimer), uniform flow, radial flow toward a well.
- **Readings:** Heath 12-14, 25-29 p; **optional:** Haitjema: 5-13 p. sect. 2.1.1-2.1.4, 21-24 p. sect. 3.1.1-3.1.2., 46-49 p. sect. 3.1.8 (posted on Oncourse).

3. REGIONAL FLOW

- **Lecture 1/21:** Martin Luther King Jr. Day (No Class).
  Lecture 1/23: Equipotentials and streamlines, a flownet, superposition, the method of images.
- **Readings:** Heath 20-24 p.; **optional:** Haitjema: 64-69 p. sect. 3.1.13-3.1.15; Fetter: 5.11.

4. GROUNDWATER AND SURFACE WATER

- **Lecture 1/28:** Boundary conditions: areal recharge, streams, lakes, losing and gaining streams, streamflow, baseflow, etc.
- **Lecture 1/30:** Toth's concepts of regional flow versus Dupuit-Forchheimer flow. (*Prof. Haitjema*)
- **Readings:** Heath 14 - 15 p.; **optional:** Haitjema: 79 - 82 p. sect. 3.2.1; Fetter: 8.2.

5. GROUNDWATER FLOW MODELING

- **Lecture 2/4:** Modeling concepts and types of groundwater flow models. (*Prof. Haitjema*)
- **Lecture 2/6:** Model demonstration and regional flow simulations.
- **Readings:** Haitjema: 249-259 p. sect 5.3.1-5.3.3 (posted on Oncourse); Fetter: 14.2-14.7.

6. MIDTERM EXAMINATION

- **Lecture 2/11:** Review.
- **MIDTERM EXAMINATION 2/13:** in class, open book, multiple choice and (brief) essay questions.

7. CONTAMINANT TRANSPORT

- **Lecture 2/18:** Mechanism of contaminant transport: diffusion, advection, and dispersion.
- **Lecture 2/20:** Modeling contaminant transport.
- **Readings:** no required readings; **optional:** Fetter: 11.6.1-11.6.6; Freeze & Cherry: 9.2.

8. GROUNDWATER CONTAMINATION

- **Lecture 2/25:** Types and source of groundwater contamination.
- **Lecture 2/27:** *Guest speaker:* Dr. Banaszak (Keramida Environmental, Inc.). PROJECT PROPOSAL DUE.
- **Readings:** Heath: 66–69 p.; **optional:** Haitjema: 57-59 p. sect 3.1.11; Fetter: sect. 11.7; Freeze & Cherry: sect. 8.13.

9. AQUIFER RESTORATION

- **Lecture 3/3:** Investigating aquifer contamination.
- **Lecture 3/5:** Remediating aquifer contamination.
- **Readings:** no required readings; **optional:** Fetter: sect. 11.8.1 – 11.8.3, sect 11.9.

10. GROUNDWATER MANAGEMENT

- **Lecture 3/17:** Principles of groundwater management.
- **Lecture 3/19:** *Guest speaker:* Dr. Kelson (WHPA, Inc.) .
- **Readings:** Heath**:** 70 – 71, 74 – 75 p.; **optional:** Fetter 12.3-12.11; Freeze & Cherry: sect. 8.1, 8.10-8.12.

11. DRINKING WATER PRODUCTION

- **Lecture 3/24:** Source Water Assessment Planning and Welhead Protection.
- **Lecture 3/26:** *Guest speaker:* Prof. Haitjema
- **Readings:** Heath: 64 – 65, 76 – 79 p.; **optional:** Haitjema: 96-97 p. 3.2.7 – 3.2.8; Bouwer: Chapter 10.

12. WATER LAW

- **Lecture 3/31:** Policy and Implementation.
- **Lecture 4/2:** *Guest speaker:* Prof. Fischman (Law School)
- **Readings:** no required readings; **optional:** Bouwer: Chapter 12.

13. WETLAND HYDROLOGY

- **Lecture 4/7:** Wetland hydrology.
- **Lecture 4/9:** *Guest speaker:* Dr. Sherry-Mitchell Bruker
- **Readings:** no required readings; **optional:** posted on Oncourse.

14. WELL CONSTRUCTION AND PUMPING TESTS

- **Lecture 4/14:** Aquifer test (single well, well with observation wells).
- **Lecture 4/16:** Drilling methods, types of wells, well logging. --PROJECT REPORT DUE.
- **Readings:** Heath: 30 – 43, 44 – 45; 48 – 63, 72 – 73, 80 p.

15. COURSE WRAP UP

- **Lecture 4/21:** Carst Hydrology.
- **Lecture 4/23:** Review.
- **Readings:** no required readings.

16. FINAL EXAMINATION

- **5/2 at 2:45 – 4:45 p.m.** Final Examination (room BH 233, open book)