SYLLABUS

CE 493M SPTP GROUNDWATER ENGINEERING (CRN 18337)

CE 524 GROUNDWATER ENGINEERING (CRN 15115)

January 2010

CATALOG DESCRIPTION

Groundwater Engineering 3 HR PR: CE 321 or consent. Introduction to the nature, hydrology, mechanics, technology, and quality of groundwater. Well solutions in confined, leaky, and unconfined aquifers. Modeling concepts and public-domain computer programs.

EXPECTED LEARNING OUTCOMES

Upon successful completion of this course students will:

1. Understand the nature of groundwater and its role in the water cycle.
2. Understand Darcy's law and the groundwater flow equation.
3. Understand the basic concepts and techniques of groundwater modeling and be able to use public-domain software such as MODFLOW.
4. Be familiar with the technology of water wells and groundwater monitoring.
5. Be able to solve direct and inverse well problems in confined, leaky, and unconfined aquifers.
6. Understand the nature of groundwater contaminant transport including the phenomena of diffusion, dispersion, and advection.

REQUIRED BACKGROUND

Prerequisite: CE 321 Fluid Mechanics for Civil Engineers or equivalent

You should review the following topics if necessary: piezometric and total head, the continuity equation, the mechanical energy equation, partial differentiation, integration, curve fitting with log-log paper, computer usage, spreadsheets.

TEXTBOOK: C. W. Fetter, 2001. *Applied Hydrogeology*, Fourth Edition, Prentice Hall. (must have CD)

REFERENCES:

H. Bouwer, 1978. *Groundwater Hydrology*, McGraw-Hill.

D. Deming, 2002. *Introduction to Hydrogeology*, McGraw-Hill.

P. A. Domenico and F. W. Schwartz, 1998. *Physical and Chemical Hydrogeology*, 2nd edition, Wiley.

F. G. Driscoll, 1986. *Groundwater and Wells*, Second Edition, Johnson Filtration Systems, Inc., St. Paul, Minnesota 55112.

C. R. Fitts, 2002. *Groundwater Science*, Academic Press.

R. A. Freeze and J. A. Cherry, 1979. *Groundwater*, Prentice Hall.

J. F. Hermance, 1999. *A Mathematical Primer on Groundwater Flow*, Prentice Hall.

D. B. McWhorter and D. K. Sunada, 1977. *Ground-Water Hydrology and Hydraulics*, Water Resources Publications, Highlands Ranch, Colorado.

G. F. Pinder and M. A. Celia, 2006. *Subsurface Hydrology*, Wiley-Interscience.

F. W. Schwartz and H. Zhang, 2003. *Fundamentals of Groundwater*, Wiley.

D. K. Todd and L. W. Mays, 2005. *Groundwater Hydrology*, Third Edition, Wiley.

R. C. Ward and M. Robinson, 1990. *Principles of Hydrology*, 3rd Edition, McGraw-Hill (UK).

D. D. Gray, 2000. *A First Course in Fluid Mechanics for Civil Engineers*, Water Resources Publications, Highlands Ranch, Colorado.

INSTRUCTOR: Dr. Donald D. Gray, P.E.
Room 641a ESB (corner office)
phone: 293-9933
email: dgray@wvu.edu

CLASS HOURS: MWF 12:00 to 12:50 pm, Room 249A ESB

OFFICE HOURS: To be arranged.

ATTENDANCE

Attendance is strongly recommended, but will not be recorded. Poor attendance will reduce your class participation grade.

GRADING:

Component	**CE 491M**		**CE 524**
Class participation	10 %		10 %
Homework	20 %		10 %
3 tests	50 %		40 %
Exam	20 %		20 %
Term project	none		20 %
Total	100 %		100 %

Letter grades will be assigned on the basis of the final point totals. The following ranges may be lowered at the discretion of the instructor, but the minimums will not be raised.

[90,100] = A
[80, 90) = B
[70, 80) = C
[60, 70) = D
[0, 60) = F

Grades will be assigned **without regard** for the grade's effect on a student's ability to qualify for a Promise Scholarship or other financial aid.

HOW THE COURSE WILL BE CONDUCTED

The textbook is the best available in groundwater engineering. Although it is imperfect, you should consider it to be the primary source of content for this course. You should expect to read most of the textbook several times during the semester. To maximize your learning, read the relevant sections before they are covered in class.

As a general policy, I will assign a set of homework problems each week. These will be due on the following Wednesday. I will devote the first 5 minutes of each previous Monday's class to questions related to the assignment. I will also assign a journal article for you to read each week for discussion on Friday. More details are given below.

ACCOMMODATIONS

If you have a disability and anticipate needing any type of accommodation in order to participate fully in this class, please advise the instructor, and make appropriate arrangements with the Office of Disability Services (293-6700).

CLASSROOM BEHAVIOR

Do: Turn off you cell phone or pager at the start of class.

Do: Behave in a professional manner. Be on time, stay awake, pay attention, take notes. When I assign in-class work, use a loose sheet that you can hand in (be sure your name and the date are on the page). You may eat or drink if you need to.

Do not: Sleep, read the paper, text, use electronic media, study for other classes, or talk to neighbors except when assigned to do so.

I understand that you may occasionally be late due to unavoidable circumstances. If you are late, you will probably find that the doors are closed, but not locked. Enter, close the door behind you, and take your seat. If the door is locked, knock loudly.

CLASS PARTICIPATION

This grade depends on the questions you ask, your response to the instructor's questions, and the extent to which you engage in classroom discussions. One key element of the participation grade will be based on discussion of assigned journal papers. I intend to assign a journal paper each week for discussion on Friday. I expect you to write notes on the paper as a basis of your in-class discussion. I will collect these notes and grade them. Your participation in these discussions and the quality and extent of your notes will be a significant factor in your class participation grade.

There may be in-class quizzes.

HOMEWORK

Homework is a key component of this course. To pass you must be able to solve problems, and the only way to learn how to solve problems is through extensive practice. For maximum learning, work as many problems as your schedule permits.

Typically, problems sets will be assigned about every week and will be due at the start of class. Late problems will not be accepted. Written reports on certain topics may be required.

Work should be presented in a neat and orderly fashion. Start each problem with "Given" and "Find". Draw labeled figures, define variables, state assumptions, and use words freely to make clear what you are doing and why you are doing it. This is essential in order to receive partial credit. Be especially careful about units. Box your answers.

Write neatly using a dark pencil or pen on one side of the page. Write large enough for an old person to read your writing without squinting. Staple your sheets together. Do not fold them. Always be sure your name and the date is on everything you hand in. Illegible or messy work is unprofessional and will not be graded.

Some homeworks will require computer usage. You may have to write spreadsheets using Excel (or equivalent software). The ability to program in high level procedural languages such as Fortran 90/95/2000/2005 is desirable, but is not required. Some homeworks will require the use of public domain (free) computer programs.

In all assignments, you must abide by the policy on plagiarism in Section III.B.1.a of the WVU Code of Student Rights and Responsibilities of Students. (http://www.arc.wvu.edu/rightsa.html) Be sure you understand this policy.

TESTS AND EXAM DATES

Test 1: F, Feb. 12
Test 2: F, March 26
Test 3: F, April 23
Comprehensive Exam: W, May 5, 3-5 PM.

Make-up tests will be allowed only in plausible cases of illness or emergency.

GROUNDWATER ENGINEERING TENTATIVE TOPICAL OUTLINE

week	chapter	topics
1	1, 2	inventory, water cycle, rainfall-runoff, hydrographs, base flow
2	3, 6	porosity, soil properties, capillary fringe, aquifers
3	4, 6	unsaturated flow, specific yield
4	4	1-D Darcy's law, hydraulic conductivity, limitations
5	4	3-D flow, tensor conductivity
6	4, 6	storativity, groundwater flow equation, unconfined flow
7	4, 7	boundary conditions, regional flow solutions
8	13	Groundwater models
9	13	MODFLOW
10	10	contaminant transport
11	5	well solutions, well tests
12	5	well solutions, linearity and superposition
13	5	slug tests, well technology
14	11	Groundwater development and management
15	-	Project reports