Applied Groundwater Modeling

ISC 5236, 3 Credits

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Lectures: 12:30-1:45 PM, Monday and Wednesday, DSC 152

Labs: 12:30-1:45 PM when needed, DSC 152

Office Hours: 2:30-3:30 PM, Monday and Wednesday, or by appointment

Recommended Textbook:

Software Manuals:
MODFLOW Manual:
Available at http://water.usgs.gov/nrp/gwsoftware/modflow2005/modflow2005.html

UCODE Manual:
Available at http://typhoon.mines.edu/freeware/ucode/

PEST Manual:
Available at http://www.sspa.com/pest/

Recommended Materials:

Anderson, M.P and W.W. Woessner (1992), Applied Groundwater Modeling: Simulation of Flow and Advective Transport, Academic Press, Inc, San Diego.

Hill, M.C. and Tiedeman, C.R. (2007), Effective Methods and Guidelines for Groundwater Model Calibration, Including Analysis of Data, Sensitivities, Predictions, and Uncertainty, John Wiley and Sons.

Hill, M.C. (1998), Methods and Guidelines for Effective Model Calibration, U.S. Geologic Survey, Water-Resources Investigator Report, 98-4005, Denver, Colorado. Available on line at http://wwwbrr.cr.usgs.gov/projects/GW_ModUncert/mchill/pubs/method/index.shtml

Prerequisites: Background of groundwater hydrology and basic experience of numerical calculation and computer modeling

Descriptions: This course introduces theory and practice of groundwater modeling, with emphasis on model construction, simulation, and calibration using state-of-the-art modeling tools. Students learn basic concepts and governing equations of fluid flow in porous media, computational algorithms of solving the equations, and mathemtical methods of inverse modeing. Essential statistics of evaluating quality of model simulations will be introduced. Examples of synethtic cases and realw-world applications will be used for computer labs and course projects.

Paper Review: Five journal articles will be given for review during the course, and review of each article will be due two weeks later. The reading assignments will count 5% toward the final grade in the course.

Labs: There will be a computer lab about every two weeks. An assignment will be given in each lab and due about a week later. While small groups are encouraged on the lab to complete assignments, each student must write and submit his/her own report for each lab. Late labs report will not be accepted without a valid excuse or preauthorized agreement with the instructor. The labs and other assignment will count 40% toward the final grade in the course.

Exams: There will be one mid-term exam. The exam will count 20% toward the final grade in the course. There will be no final exam, but a final project.

Final Project: There will be a final project that will involve the application of subroutines presented in the course to a real world application. You may choose your own project topic and talk with the instructor for his help. Small groups consisting of two or three students are allowed to complete the assignment and write a final group report. The final project will count 30% toward the final grade in the course.

Participation: Students are expected to arrive on time and attend all lectures and labs. Neither make-up lectures nor make-up exams will be given except as specified below. In addition, students are expected to actively engage in discussions in both the lectures and labs. Questions in class and office hour are encouraged. Attendance and class participation will count 5% toward the final grade in the course.

Software: Students will need access to a personal computer and a variety of software packages outside of the scheduled lab period to complete the lab assignments and final project. Students should plan on using a memory stick, CD, or other storage device to transport files to and from labs and other computers.

Grading Policy: Final grades will be assigned according to the following schedule. A plus/minus system may be employed at the instructors discretion. The instructor may also elect to employ a curve that favors the students.

Grade	Semester average
A- to A	90 to 100
B- to B+	80 to 89
C- to C+	70 to 79
D- to D+	60 to 69
F	Below 60

Final grades will be computed as follows:
Midterm 20%, Final Project 30%, Labs and Assignments 40%, Paper Review 5%, and Attendance 5%

Syllabus Change: The syllabus is tentative and course schedule of topics, labs, and reading assignments may be subject to change depending on course progress. Date of midterm and final project due date are fixed, except under very unusual circumstances. Students will be provided with an updated syllabus if significant changes are necessary.

Accommodations for Students with Disabilities: Reasonable accommodations for students with disabilities may be arranged by contacting the instructor of this course on an individual basis. Those requiring accommodations due to disabilities should 1) register with and provide documentation to the Student Disability Resource Center (SDRC) and 2) bring a letter to the instructor from SDRC indicating the need for academic accommodations. This should be done within the first week of class. This syllabus can be made available in an alternate format upon request. For more information about services available to FSU students with disabilities, contact the

Student Disability Resource Center
Dean of Students Department
08 Kellum Hall
Florida State University
Tallahassee, FL 32306-4400
(850) 644-9566 (voice)
(850) 644-8504 (TDD)
SDRC@admin.fsu.edu
http://www.fsu.edu/~staffair/dean/StudentDisability/

Academic Honor Code: Students are required to observe the University's Academic Honor Code, as it is published in the Bulletin and the Student Handbook. Any case of academic dishonesty will be delt with extremely severely.

Week	Lecture Topics	Reading
1	Introduction of groundwater modeling.	Class handout
	Governing equations of groundwater systems.	Class handout
2	Boundary and initial conditions.	Class handout
	Finite difference method: General description.	Class handout
3	Computer Lab 1: Simple modeling with EXCEL.	Lab handout
	Finite difference method of MODFLOW.	Chapters 2 and 3
4	Description of modeling processes.	Chapter 3
	Temporal and spatial discretization.	Chapters 2, 4 and 8
5	Modeling inputs and outputs.	Chapters 2, 4 and 8
	Numerical solver of groundwater modeling.	Chapters 5 and 8
6	Modeling internal functions.	Chapters 6 and 8
	Modeling external stress.	Chapters 6 and 8
7	Computer Lab 2: MODFLOW modeling.	MODFLOW manual
	Computer Lab 3: MODFLOW modeling.	MODFLOW manual
8	Course Overview.	
	Mid-term Exam.	
9	Review of mid-term exam.	
	Inverse modeling: Overview.	Course handout
10	Inverse modeling: Least-square method I.	Course handout
	Inverse modeling: Least-square method II.	Course handout
11	Inverse modeling: Bayesian method I.	Course handout
	Inverse modeling: Bayesian method II.	Course handout
12	Parameter estimation uncertainty.	Course handout
	Groundwater model calibration using PEST.	PEST manual
13	Computer Lab 4: PEST calibration	PEST manual
	Groundwater model calibration using UCODE.	UCODE manual
14	Computer Lab 5: UCODE calibration	UCODE manual
	Assignment of final project	