Syllabus

Hydrogeologic Modeling: GLY-5826

Meeting time: M, W, F 11:00-11:50
Meeting location: PCA 167
Course Level: Graduate 5826 Sections: 1

Course Catalogue Description

Techniques used in modeling groundwater flow and solute transport in geologic systems. Case studies of significant aquifers. Prerequisites: GLY 5827, MAP 2302, or Permission of the instructor. (S, SS)

Instructor:	Dr. Michael Sukop
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Office/Lab Hours:	T, Th 2:30 to 4:30, as available, and by appointment

Objectives

The objectives of this course are to provide introductions to the theory and implementation of hydrogeological modeling techniques. Students will develop fundamental skills and knowledge to enable them to construct basic models and effectively critique modeling efforts. Students will be able to derive and solve finite difference expressions for 2-dimensional ground water flow. Students will understand the significance of and be able to specify and implement constant head and no-flow boundary conditions and various initial conditions in simple models. Students will have a basic understanding of geostatistics and will know how to operate MODFLOW.

Outline

1. Review
    a. Math
        i. Calculus
            1. Slopes
            2. Derivatives
            3. Partial derivatives
    b. Tools
        i. Excel ‘tricks’
        ii. Matlab
            1. surface plots
            2. contouring
            3. gradient function
            4. quiver plots
            5. streamlines
    c. Ground Water
        i. Flux and Darcy’s Law
        ii. Total, pressure, and elevation heads

iii. Potential diagrams
iv. Average pore water velocity

2. 1-D Flow
    a. Derivation of governing PDE (Poisson and Laplace Equations)
        i. Boundary conditions
        ii. Boundary value problems
    b. Analytical solution
    c. Finite difference solution
    d. Excel model
3. 2-D Flow
    a. Derivation of PDE
    b. FD solution
    c. Excel model
    d. Contours
    e. Flowlines/Streamtubes
4. Matrix solutions
5. Geostatistics and conditional simulation
    a. Overview
    b. SGeMS
6. Transient Flows
    a. Storage coefficient/Storativity
    b. Initial conditions
7. Multilayer models
    a. Leakance
8. MODFLOW and FloPy
9. Heterogeneous aquifers
    a. Streamline refraction
10. Inverse Methods
    a. PEST/Groundwater Vistas
11. Finite Element Methods
    a. MicroFEM
    b. SUTRA
12. Fractured Media
13. Analytic Element models

Assignment Dates

Weekly assignments will be handed out weekly and will be due the following week.

Performance Measures, Grading/Attendance Standards

Attendance: Participation in classroom instruction and computer exercises is critical to successful completion of this course. More than 3 unexcused absences will result in one letter grade reduction.

Homework: Homework assignments will be given weekly and will generally consist of short reports on specific exercises usually including modeling and comparison with analytical solutions. English, spelling, units, significant figures, quality of graphics, accuracy of analysis, and quality of evaluation will all be considered in grading the homework. You are encouraged to work together to develop your understanding, but you must complete all assignments yourself; copying the work of others (including from the Internet) is unacceptable and will result in a grade of F for the course. Late homework will be reduced 25% for each late day. These assignments will account for 1/2 of your grade.

Quizzes: 1/8 of grade. 10-minute quizzes will be administered weekly or as appropriate following completion of the homework assignments. The sum of all quiz grades will be weighted to account for 1/8 of your overall course grade.

Examinations: 1/8 of grade each. One mid-term and one final examination will focus on concepts, theory, derivations, and practical computations associated with hydrogeologic modeling. Examinations will be primarily based on lecture, homework, and quiz material.

Projects/Presentations: An in-class presentation and report on a final project consisting of a ground water modeling effort will constitute 1/8 of your grade. Your presentation and report will be graded on content and professional quality. You will submit a one page description of your project concept after the midterm. Individual and group projects are possible, but equal effort (and a regular full presentation and report) is expected from all group project participants. Presentations and report due dates will be at the end of the semester.

Text

None

Bibliography

Fitts, Charles, 2012. Groundwater Science (Second Edition), Elsevier
ISBN: 978-0-12-384705-8
http://www.sciencedirect.com/science/book/9780123847058

Wang and Anderson, 1982. Introduction to Groundwater Modeling. W. H. Freeman and Company, San Francisco. 237 pp.

Anderson and Woessner, Applied Groundwater Modeling: Simulation of Flow and Advective Transport, Academic Press, 1992.

Mary P. Anderson, William W. Woessner, Randall J. Hunt, 2015, Applied Groundwater Modeling: Simulation of Flow and Advective Transport, Elsevier Science & Technology Books, 630 pages

Bakker, M., Post, V., Langevin, C. D., Hughes, J. D., White, J. T., Starn, J. J. and Fienen, M. N., 2016, Scripting MODFLOW model development using Python and FloPy: Groundwater, doi: http://dx.doi.org/10.1111/gwat.12413

Bennett, Gordon D., 1976. INTRODUCTION TO GROUND-WATER HYDRAULICS, U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter B2. Available online at http://water.usgs.gov/pubs/twri/twri3-b2/html/pdf.html

Hutchinson, C.B. 1984. Ground-water models as a management tool in Florida, Water-resources investigations report; 84-4016, U.S. Geological Survey, Tallahassee, Fla. 26 pp.