Colorado State University
Department of Civil and Environmental Engineering
Fall 2013
CE 631 - Computational Methods in Subsurface Systems (3-0-0)

Course Objectives: this course will introduce students to the main numerical techniques currently used for modeling groundwater flow and transport of contaminants in the subsurface. The major topics of this course include but are not limited to: numerical methods for the solution of system of linear and non linear equations; finite difference and finite element techniques for the solution of the ordinary and partial differential equations that govern groundwater processes. Students will learn to write their own mathematical models as well as use popular subsurface numerical models and other codes provided by the instructor. It is suggested that students have some basic knowledge in computer programming languages.

Prerequisites: CIVE 423 or CIVE 531. The course may be taken concurrently with CIVE 531.

Class Schedule and Location: Tuesday-Thursday, 12:30-1:45 pm; 107B Wagar Building.

Instructor: Domenico Baú, PhD, Assistant Professor, Department of Civil and Environmental Engineering, Room B206 Engineering Building; E-mail: domenico.bau@colostate.edu; Phone: 491-6060.

Office hours: Tue.-Thu., 2:00-3:00 pm, or by appointment (Room B206 Engineering Building; phone: 491-6060, email: domenico.bau@colostate.edu).

Class website: http://ramct.colostate.edu

Course Material
The class will be primarily taught using notes, handouts, and journal articles provided by the instructor. Additional recommended/reference books will be placed on reserve at the library for consultation.

Reference Books
- Rushton, K.R. (2003). Groundwater Hydrology: Conceptual and Computational Models. John Wiley and Sons Ltd., ISBN-13: 9780470850046.
- Anderson, M.P., and W.W. Woessner (1992) Applied Groundwater Modeling: Simulation of Flow and Advective Transport, Academic Press, ISBN-13: 9780120594856.
- Peter S. Huyakorn, George F. Pinder (1983), Computational Methods in Subsurface Flow, Elsevier Science & Technology Books, ISBN-13: 9780123634801.
- Press W.H., S.A. Teukolsky, W.T. Vetterling, B.P. Flannery (2007). Numerical Recipes: The Art of Scientific Computing, Third Edition , Cambridge University Press, ISBN-10: 0521880688.

Grading breakdown

- Homework/Projects 80%
- Final Exam 20%

Course Outline

	Topics	**Description**
1.	*Systems of linear and non-linear equations*	• Direct and Iterative Methods • Gradient and Picard Methods.
2.	*Numerical Derivation*	• Forward, Central, Backward Differences.
3.	*Ordinary differential equations*	• Euler, Runge-Kutta Methods • Stability, Accuracy, and Error Propagation.
4.	*Partial Differential Equations for Subsurface Flow and Solute Transport*	• Subsurface Flow in Saturated and Variably Saturated Porous Media: - Finite-Difference Methods: Spatial-Temporal Solutions. - Finite-Element Methods; Basis Functions; Spatial-Temporal Solutions. - Numerical Models: MODFLOW, SAT2D. • Solute Transport in Porous Media: - Advection; Diffusion; Dispersion; Biodegradation/Decay; Local Equilibrium Linear/Non-linear Sorption. - Finite-Element Methods - Finite-Difference Methods - Numerical models: TRAN2D, MT3D.