CIV_ENV 495
Computational Geotechnics
Spring Quarter 2018

Instructors	Prof. James P. Hambleton Office: Tech A122 Office hours: Monday, 2:00-3:00; By appointment Email: jphambleton@northwestern.edu Dr. Zhenhao Shi Office: Tech AG32 Office hours: By appointment Email: zhenhao.shi@northwestern.edu
Class Times	Monday and Wednesday, 10:00-11:50am
Location	Technological Institute L168
Class Website	Northwestern Course Management System (Canvas) http://www.it.northwestern.edu/education/login.html
Required Textbook	None
Suggested Reading	Potts, D.M., and Zdravković, L. (1999). *Finite Element Analysis in Geotechnical Engineering: Theory*. Thomas Telford, London. Potts, D.M., and Zdravković, L. (2001). *Finite Element Analysis in Geotechnical Engineering: Application*. Thomas Telford, London. Fish, J., and Belytschko, T. (2007). *A First Course in Finite Elements*. Wiley, New York.
Prerequisites	Familiarity with elementary mechanics and fundamental concepts in geotechnical engineering

---

Course Objectives

The overall learning aims of this course are (1) to understand the fundamentals of the finite element method for geotechnical analysis and (2) to be competent in the use of a finite element code as applied to geotechnical problems. It is intended to provide an essential skillset to those entering the practice of geotechnical engineering, and to build a foundation for future study and inquiry to those who are engaged primarily in research. Specific learning objectives are as follows:

- Understand the theory, assumptions, and approximations of finite element method as it is used in geotechnical engineering and geomechanics
- Understand critical aspects of commonly encountered problems in geotechnical engineering
- Apply a commercial finite element code for geotechnical analysis
- Critically analyze numerical results, being mindful of the possibilities and limitations of the finite element method for solving problems in geotechnical engineering and geomechanics

Course Outline

Week 1		
Lecture 1	Tue, 4/3	Introduction; Continua versus discontinua; Stress, strain, and equilibrium; Numerical simulation
Lecture 2	Wed, 4/4	Linear elasticity; Finite element method
Week 2		
Lecture 3	Mon, 4/9	Boundary conditions; well-posed boundary value problems; plane strain; plane stress; axisymmetric problems; Analytical solutions; Finite element approximation
Tutorial 1	Wed, 4/11	Tutorial with commercial code; **Description of potential projects due**
Week 3		
Lecture 4	Mon, 4/16	Material non-linearity; Consistent tangent stiffness matrix; Return mapping
Lecture 5	Wed, 4/18	Contact and contact formulations
Week 4		
Lecture 6	Mon, 4/23	Solution techniques; Convergence and stability
Lecture 7	Wed, 4/25	Seepage; Coupled analysis; Consolidation
Week 5		
Lecture 8	Mon, 4/30	Effective stress analysis; Undrained conditions
Presentations	Wed, 5/2	**Project proposal presentations**
Week 6		
Lecture 9	Mon, 5/7	Dimensional analysis; Parameter identification; Model fitting
Lecture 10	Wed, 5/9	Initial stresses; Structural elements
Week 7		
Lecture 11	Mon, 5/14	Selected Applications: Soil-structure interaction
Midterm	Wed, 5/16	**Midterm exam**
Week 8		
Lecture 12	Mon, 5/21	Selected Applications: Staged construction
Guest Lecture	Wed, 5/23	Guest lecture by Prof. David Muir Wood
Week 9		
Lecture 13	Mon, 5/28*	Selected Applications: Slope stability; Strength reduction
Lecture 14	Wed, 5/30	Advanced topics (e.g., creep, installation effects, dynamic effects)
Week 10		
Presentations	Mon, 6/4	Advanced topics
Symposium	Wed, 6/6	USNC/TAM 2018 Mini-symposia

Final Project Presentations will be scheduled during exam week.

* As May 28 is Memorial Day, this class will be rescheduled.

Course Assessment

Grades are determined based on the following assessment items, weighted as indicated:

- 5% Description of 3 potential projects (research projects or case studies)
- 15% Homework
- 10% Project proposal presentation
- 25% Midterm
- 25% Final report
- 15% Final presentation
- 5% Attendance and question formulations for USNC/TAM 2018 mini-symposia