CIV_ENV 495
Computational Geotechnics
Spring Quarter 2018

Instructors
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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


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.

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* 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