THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Numerical Methods in Geotechnical Engineering

CIVILEN 5581

Credit Hours:
3.00 - 3.00

Course Levels:
Undergraduate (1000-5000 level)
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Introduction to Geomechanical Numerical modeling of soils and development of Soil-Structure Interaction (SSI) solutions using the Finite Difference and Element Methods, and to the constitutive modeling of soils based on elasticity and plasticity deformation theories. Multiple numerical techniques that are widely used in Geotechnical engineering and Soil-Structure Interaction problems.

Prerequisites and Co-requisites:
Prereq: 3540; and 5561 or 5571; or permission of instructor.

Course Goals / Objectives:
- Be able to identify for a specific project the advantages and disadvantages of different numerical techniques, and discuss the advantages and disadvantages of each technique.
- Use numerical methods in stage-by-stage analyses for earth structures such as levees and dams, to estimate, seepage, pore pressures, displacements, and factors of safety.
- Create numerical models for soil-structure interaction problems and compute solutions including various foundation systems (e.g., footings, driven piles, drilled shafts, and mat foundations)
- and retaining wall elements (e.g., soldier piles, tiebacks, soil nails, and anchors).

Course Topics:

- 1. Introduction, and historical perspective: a. Need for numerical models. b. Early deformation and strength studies
- c. Formulation of equations of general equilibrium and theory of elasticity d. Plasticity theory and the contributions to soil mechanics
- 2. Introduction to Linear Elasticity, tensors and the Finite Difference Method. Introduction to FLAC. 3. Finite Difference solutions for Terzaghi’s consolidation theory and confined fluid flow (Laplace equation).
- 4. Strength Reduction Method and solutions using FLAC/Slope for bearing capacity, slope stability and earth pressures. 5. Introduction to the Finite Element Method:
- Development of Finite Element Solutions: Different type of elements, appropriate shape functions, 4 and 9 node quadrilateral elements.Choosing an element type and a guidelines for mesh generation.
- 7. Non-Linear Elasticity: a. Simple deformation models. b. Duncan and Chang’s hyperbolic model. c. Problems with non-linear elasticity
- 8. Introduction to the deformation theory of Plasticity 9. Potential formulation for nonlinear elasticity. 10. Nonassociated Plasticity models and instability of numerical solutions.
- 11. Bifurcation theories, shear band formation, and numerical instability (including static liquefaction). 12. Solving seismic problems:

Designation:
Elective