Course Outline

Numerical Methods in Geotechnical Engineering

CIVE 5800 (Winter 2023)

Department of Civil and Environmental Engineering
Carleton University

Instructor: Mehdi Pouragha	**Lectures:** Mon 11:35-2:25 pm
MC 2034, Mehdi.Pouragha@Carleton.ca	**Location:** SA 409

Topics

- Introduction and Mathematical and Mechanics Preliminaries
  Vector and matrix calculus, Gradient, Divergence, and Jacobian, Newton-Raphson Method
- Introduction to computational coding in MATLAB
- Time integration, Computational elastoplasticity
  Explicit vs. Implicit methods, Return mapping, Yield functions, 1D and 2D formulation
- Finite Difference Method
  Harmonic oscillator, 2D diffusion problems
- Initial Value Problems
  Vibrating String, Stability of the numerical solution
- Introduction to Finite Element Methods (1D)
  Local vs global stiffness, Stiffness matrix assembly, Shape functions

Textbook

The course does not follow a specific textbook. The books below can be used as additional resources.

- Simo, J. C., & Hughes, T. J. (2006). *Computational Inelasticity* (Vol. 7). Springer Science & Business Media.
  Vector and matrix calculus, Gradient, Divergence, and Jacobian, Newton-Raphson Method
- Langtangen, H. P., & Linge, S. (2017). *Finite difference computing with PDEs: a modern software approach*. Springer Nature.
- Fish, J., & Belytschko, T. (2007). *A first course in finite elements* (Vol. 1). New York: John Wiley & Sons.

Evaluation

- The assessment is based on <u>three</u> individual assignments given during the semester. Based on their preference, the students can complete the assignments using either MATLAB or Python.
- Weights: First assignment 30%, Second assignment 35%, Third assignment 35%.
- A minimum of 50% in <u>each</u> assignment is required to obtain a passing grade.

Required Knowledge (IMPORTANT**)**

This course requires a working knowledge of: vector and matrix algebra, basics of elastic and plastic strains, basics of material models, and basics of differential equation (simple ODEs and PDEs). Basic skills of computer coding and computational algorithms are also required.

Course Delivery

All lectures will be in-person, except for lecture 2 (Jan 16th) which will be asynchronous online to allow for a better software training.

Copyright of Materials

The materials created for this course (including the course outline and any slides, computer codes, project, assignments, exams and solutions) are intended for personal use and should not be reproduced, redistributed, or posted on any website without prior written permission from the instructor.

Student Accommodation

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (`www.carleton.ca/pmc`) for the deadline to request accommodations for the formally-scheduled exam (if applicable).