CIVE 4201A Finite Element Methods in Civil Engineering – Course Syllabus

1 Key Mentoring and Support Personnel

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Office Hours: Monday 0900-1130

Teaching Assistant: To be determined
Office: To be determined
E-mail: To be determined
Office Hours: To be determined

2 Course Description and Requirements

2.1 Schedule
See Course Search - Carleton University for current information on the location, date and time for classes and PA sessions.

2.2 Course Description
Please refer to CIVE 4201 for the calendar course description.

2.3 Overview and Learning Outcomes

This course introduces the finite element methods (FEM) for applications in civil engineering. Upon successful completion of this course, the student will be able to:

- acquire knowledge on the theory and application of Finite Element Methods (FEM) in Civil Engineering for the analysis of linear, elastic systems,
- develop modelling skills for the idealization and formulation of Civil Engineering problems using FEM,
- apply FE modelling procedures to solve practical Civil Engineering problems, and develop critical thinking skills to assess the quality of the numerical predictions (i.e., understand the benefits, constraints, and limitations of the FEM),
- develop other technical skills (e.g., software programming) and personal attributes (e.g., work effectively within a team environment), and
- understand the relationship between numerical simulations and professional engineering practice (e.g., competence, supporting design and decision making, public safety).

1 Students should limit e-mail correspondence to either the scheduling of meetings or providing information (e.g., absence from course work). The TA or instructor will not address questions on course content by e-mail correspondence.
2.4 Lecture Progression

The general topics addressed during this course:

Introduction
- Introduction to numerical and finite element methods

Modelling Concepts for Linear Elastic Finite Element Analysis (FEA)
- Element type, order, and performance (topology and convergence studies)
- Materials, loads and boundary conditions
- Analysis and interpretation of results, and highlighting common errors
- Static analysis, steady state thermal stress analysis and structural dynamics

Structural Analysis
- Matrix or stiffness methods
- Common elements including bar (1D), truss (2D plane, 3D space), beams and frames

Plane Continuum Analysis
- Plane stress and plane strain analysis
- Discontinuities and stress concentrations

Geotechnical Engineering
- Solving geotechnical problems using finite element methods
- Modelling considerations and applications to engineering problems

Special Topics
- Introduction to sources of nonlinearity, modelling considerations and applications
- Reflective symmetry and axisymmetric problems
- Overview of special elements

The planned lecture progression is summarized in the following table, which may be adjusted during the term in response to unforeseen events or constraints. Prior to each lecture, students are expected to review the assigned materials, review class notes, and be prepared for active participation in the class discussions. The lectures will highlight key theoretical concepts and illustrate the application of FEM through worked examples. The online course material complements the lectures and facilitates learning.
### Course Syllabus Fall 2023

#### Lec # | Week of | Lecture Topic [PA Session]
--- | --- | ---
1 | 11/09 | Introduction to numerical and finite element methods
2 | 18/09 | Foundational mathematical concepts [PA1]
3 | 25/09 | FEM procedures for the 1D bar and truss element
4 | 02/10 | Extension of FEM procedures for the 2D and 3D truss element [PA2]
5 | 09/10 | FEM procedures for beam (structural) elements
6 | 16/10 | FEM procedures for thermal stress analysis [PA3]

**Fall Term Break: October 23-27, 2023**

7 | 30/10 | FEM procedures for the 2D plane stress & plane strain elements
8 | 06/11 | FEM in structural dynamics [PA4]
9 | 13/11 | FEM applications in structural dynamics
10 | 20/11 | FEM in geotechnical engineering [PA5]
11 | 27/11 | FE applications in geotechnical engineering
12 | 04/12 | Special topics in FEM [PA6]

**Fall Term Ends December 8, 2023**

### 2.5 Course Evaluation

<table>
<thead>
<tr>
<th>Assessment Element</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>5 assignments (aligned with the first 5 PA sessions).</td>
<td>40%</td>
</tr>
<tr>
<td>Comprehension Activities</td>
<td>5 in-class assessments (open book &amp; notes quiz) held during the PA session weeks.</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Closed book with formula sheet provided. 3-hour exam.</td>
<td>50%</td>
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### 2.6 Course Resources

The course textbook is “A First Course in the Finite Element Method”, Enhanced Edition, SI Version by D.L. Logan (ISBN-10: 0357676432; ISBN-13: 9780357676431). Course notes, where needed, will provide supplemental content and illustrative examples. The MATLAB programming language will also be used to achieve learning goals in the application of the FEM.
The FE modelling software package Abaqus™ will be used to develop numerical modeling procedures, simulate the civil engineering problem, and generate the numerical predictions. The Abaqus student version and other resources (e.g., installation instructions, tutorials and workshops, links for study resources) can be obtained through https://academy.3ds.com/en/software/abaqus-student-edition. Create an account with Simulia, download and install this program onto your computer for use in the course. Learning will be imparted through lectures, PA sessions and assignments.

Other online resources available through the Carleton University library include:


Other supplementary resources are posted on the course website and the following communications focused resources are identified:

- Michael Alley, Website, Penn State, Writing as an Engineering or Scientist
- Michael Alley, Website, Penn State, Assertion-Evidence

2.7 Self-declaration form and deferred term work

Students who claim illness, injury, or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases. This must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult Section 4.4 of the University Calendar.
2.8 Academic dates
Students should be aware of the academic dates (e.g., last day for academic withdrawal) posted on the Registrar's office web site.

2.9 Graduate Attributes
The Canadian Engineering Accreditation Board (CEAB) defines design as “...an ability to design solutions for complex, open ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations...”.
As part of the CEAB accreditation process we will measure and assess graduate attributes (i.e., technical, professional and personal attributes) we seek to develop and refine throughout your undergraduate engineering program. The graduate attributes are evaluated using defined rubrics that are focused on teaching and learning outcomes. The graduate attribute assessment does not influence your grade assessment as defined in the course syllabus. The graduate attributes are measured and analyzed as part of the Civil and Environmental Engineering program improvement.

The Canadian Engineering Accreditation Board (CEAB) requires graduates of undergraduate engineering programs to possess 12 graduate attributes (GAs). Courses in all four years of our programs evaluate students' progress towards acquiring these GAs. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. In this course, GAs are not measured.

3 Academic Integrity and Plagiarism
The Carleton University Academic Integrity Policy addresses the expected behaviour of students with respect to academic integrity, which is essential to the university environment. This policy reflects the values we hold to be important in the pursuit of engagement, learning, and scholarship. Violations of this policy can have a range of repercussions and outcomes (e.g., resubmission of work, change in grade, withdrawal from course(s), suspension).

Consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures. Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or expulsion.
One of the main objectives of the Academic Integrity Policy is to ensure that **the work you submit is your own**. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source. Examples of violations of the policy include, but are not limited to:

- any submission prepared in whole or in part, by someone else,
- using another’s data or research findings without appropriate acknowledgement,
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own, and
- failing to acknowledge sources of information by not including proper citations when using another’s work and/or failing to use quotations marks.

### 4 Copyright

All course materials (e.g., course outline, posted resources, lectures slides, notes, videos assignments, quizzes, exams and corresponding solutions) are provided under copyright for personal use (academic study) only. Reproduction, distribution, or transmittal of course materials by any means, without explicit documentation expressing allowance from the copyright holder is a violation of copyright law. This action is an academic offence of the Academic Integrity Policy of Carleton University and Code of Conduct (Category 2 Offence). If you have any questions about fair dealing and your rights to use work for educational purposes, please contact copyright@carleton.ca.

### 5 Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University’s educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca. We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone’s personal beliefs, choices, and opinions.
6 Academic Accommodations

Carleton University is committed to providing access to the educational experience that promotes academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

You may need special arrangements to meet your academic obligations during the term. Please view the link for academic accommodation requests with respect to:

- Academic accommodations for students with disabilities
- Accommodation for student activities
- Addressing human rights concerns
- Pregnancy obligations
- Religious obligations
- Survivors of sexual violence

7 Engineering Academic Advising

The Engineering Academic Support Service assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation. The Department of Civil and Environmental engineering (CEE) also has Academic Advisors that you may need to contact.

8 Student Mental Health and Wellness

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator helps students connect with mental health and wellness resources.

If you need to talk to someone from the Department of Civil and Environmental engineering (CEE) for more information and support with connecting you to resources, please reach out to one of our Administrators or Academic Advisors.

The following list provides additional on-campus and off-campus resources:
1. **Carleton’s Health and Counselling Services**: To book an appointment contact the main clinic by calling (613) 520-6674. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away.

2. **Emergencies and Crisis and Emergency Numbers**

3. **Good2Talk (1-866-925-5454)**: Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, additions, and well-being to post-secondary students in Ontario, 24/7/365.

4. **Empower Me**: Undergraduate students have access to free counselling services in the community through Empower Me, either in person, by telephone, video-counselling, or e-counselling. This free service is accessible 24/7, 365 days per year. Call **1-844-741-6389 (toll free)** to make an appointment with a counsellor in the community.

5. **The Walk-In Counselling Clinic (off-campus community resource)**: The walk-in Counselling Clinic have offices in various locations across Ottawa and the greater Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic offers services in many languages and is free and confidential.

6. **Distress Centre of Ottawa and Region**: Available 10am-11pm, 7 days/week, 365 days/year. **Distress Line**: 613-238-3311, **Crisis Line**: 613-722-6914 or 1-866-996-0991, **Text**: 343-306-5550.

7. **Distress and Crisis Ontario**, Available for chat 2:00PM– 2:00AM EST.

8. **BounceBack Ontario** (Toll-Free: 1-866-345-0224) is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness.

9 **General Carleton University Policies**

This section summarizes other key university and course policies. As a student you must be aware of and follow the regulations of Carleton University for academic behaviour and understand your rights and responsibilities for non-academic behaviour.

9.1 **Academic petition and appeal of grade**

For extenuating circumstances that affect your ability to meet your academic obligations, you have the option to submit a petition.
Before initiating the **Appeal of Grade** process, seek resolution through communication with (1) the assigned Teaching Assistant (TA), and, if the issue remains unresolved, (2) the Primary Evaluator based on Table 3 § Course Evaluation.

### 9.2 Additional student resources

**From Intention to Action** – Supports undergraduate and graduate students in the often-stressful university experience. We help students to better manage stress and improve their academic performance, by navigating the personal stressors that can often get in the way of school.

**International Students** – offers services and programs that contribute to positive international experiences for all Carleton students.

**Peer Assisted Study Sessions** – offers free, course-specific study sessions known as Peer Assisted Study Sessions (PASS). PASS is a learning enhancement program that is attached to historically challenging courses. PASS is a peer-to-peer program which provides a welcoming and supportive environment where students work through course content and learn transferable study skills that they can apply to other courses.

**Student Experience Office** – facilitate student-centered learning that enhances the university experience by offering transition support, leadership opportunities, and experiential learning resources to enhance university experience.

**Writing Service** – offers equitable access to writing support services for the Carleton community.