Instructor: Bora Pulatsu  
Department of Civil and Environmental Engineering  
Office: 2037 Minto Centre  
Email: bora.pulatsu@carleton.ca  
Office Hours: Friday 2:30 pm – 5:30 pm

Course Info:  
Meeting Times and Location: 2:35 – 5:25 pm M Tory Building 340  
Lab Sessions: Fridays: 2:35 pm – 5:25 pm AT 102  
Reference Books:  
[B2] An Introduction to Structural Analysis for Civil Engineers, by J. Erochko [free online website].  
Course Webpage: The course materials will be available on Brightspacehttps://brightspace.carleton.ca/. Please follow the course web page for announcements, posted lectures, etc.

Class Description:  
This course introduces principles of structural analysis for engineering structures. Learning structural analysis will provide you with important problem-solving concepts and skills that are applicable to the topic of structural engineering. To develop the skills required for this course you have to practice and participate in lectures, laboratory sessions, and other course elements. The course consists of concepts and assumptions for structural analysis: framed structures; joints; supports; compatibility and equilibrium; stability and determinacy; generalized forces and displacements. Principle of Virtual Work: unknown force calculations; influence lines. Complementary Virtual Work: displacement calculations, indeterminate analysis.  
Prerequisites: CIVE2200, MATH 1004

Tentative Lecture Schedule:  
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<tr>
<th>WEEK</th>
<th>LECTURE DATE</th>
<th>TOPIC</th>
<th>LAB SESSION</th>
<th>TEXTBOOK CHAPTER</th>
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<tr>
<td>1</td>
<td>Sept. 13</td>
<td>Introduction to Structural Analysis</td>
<td>Lab 1</td>
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<td>2</td>
<td>Sept. 20</td>
<td>Analysis of Statically Determinate Structures</td>
<td>Lab 1</td>
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<td>3</td>
<td>Sept. 27</td>
<td>Internal Forces and Shear/Bending Moment Diagrams 1</td>
<td>Lab 2</td>
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<td>4</td>
<td>Oct. 4*</td>
<td>Internal Forces and Shear/Bending Moment Diagrams 2</td>
<td>Lab 2</td>
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<td></td>
<td>Oct.</td>
<td>Topic</td>
<td>Lab</td>
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<tr>
<td>5</td>
<td>Oct. 11</td>
<td>Virtual Work Method</td>
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<td>6</td>
<td>Oct. 18</td>
<td>Deflections and Moment-Area Method</td>
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<td>7</td>
<td>Oct. 25</td>
<td><strong>Reading Week</strong></td>
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<td>8</td>
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<td>Conjugate Beam Method</td>
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<td>Influence Lines 1</td>
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<td>10</td>
<td>Nov. 15</td>
<td>Influence Lines 2</td>
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<td>11</td>
<td>Nov. 22</td>
<td>Castigliano’s Theorem</td>
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<td>12</td>
<td>Nov. 29</td>
<td>Force Method</td>
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<td>13</td>
<td>Dec.  6</td>
<td>Slope-Deflection Method</td>
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</table>

**Course Objectives:**
This course is designed to help the student:

- Understand the important structural analysis concepts of elasticity, equilibrium, and compatibility.
- Understand and perform structural analysis using the methods of equilibrium.
- Understand and perform structural analysis using the methods of work and energy.
- Understand and evaluate the concepts of structural stability and determinacy.
- Understand and perform analysis of structures subject to live and moving loads using influence lines.
- Determine structural displacements due to applied forces, temperature changes, member distortions and support movements using virtual work and energy methods.
- Understand and perform the analysis of statically indeterminate structures using a flexibility (force, compatibility) method.
- Understand and perform the analysis of statically indeterminate structures using a stiffness (displacement, equilibrium) method.

**Learning Outcomes:**
This course requires the student to demonstrate competence in the following areas:

1. Draw complete free body diagrams involving the applied loads and reactions for planar beam, frame and truss structures.
2. Understand the concepts of boundary conditions, constraints and compatibility, and the implications for forces and displacements in structures.
3. Determine the reactions acting on planar, statically determinate, beam, frame and truss structures using equilibrium methods.
4. Determine the reactions acting on planar, statically determinate, beam and frame structures using the method of virtual work (virtual displacement).
5. Understand the effect of distributed loads acting on sloping frame members, and to understand the different load specifications and their implications.
6. Understand the concept of equilibrium as applied to portions of structures.
7. Draw complete free body diagrams of portions of planar beam, frame and truss structures.
8. Understand the relationships between external forces and internal shear forces, bending moments and normal forces in planar beam and frame structures.
9. Draw clear and accurate shear force, bending moment and normal force diagrams for planar beam and frame structures.
10. Use knowledge of loads and member end forces to determine the external reactions acting on planar beam and frame structures.
11. Use shear force and bending moment diagrams to determine loads and reactions acting on planar beam and frame structures.
12. Perform equilibrium checks to partially evaluate the correctness of a structural analysis.
13. To be able to classify a planar truss as either simple, compound or complex.
14. Determine all of the member forces for statically determinate trusses using the method of joints and the method of sections.
15. Formulate statically determinate truss analysis problems in matrix form and solve the resulting sets of equations.
16. Draw influence lines for statically determinate, planar, beam, frame and truss structures.
17. Use influence lines to determine extreme structural responses for planar structures subjected to moving and live loads.
18. Understand the concept of statical determinacy and stability and be able to evaluate a planar structure for stability and determinacy.
19. Determine displacements due to loads, temperature changes and member distortions in planar trusses using the method of virtual work.
20. Determine displacements due to loads in planar beam and frame problems using direct energy methods.
21. Determine displacements due to loads, member distortions, temperature changes and support movements in planar beam, frame and compound frame-truss problems using the method of virtual work.
22. Determine the reactions acting on statically indeterminate, planar beam, frame and truss structures using a flexibility (force) method.
23. Determine all of the internal member end forces acting on statically indeterminate, planar beam and frame structures using the method of slope-deflection (a stiffness, or displacement method).
24. Determine the reactions in a statically indeterminate beam or frame structure from the loads and member end forces.

**Marking Scheme:**
Assignments (15%)
Midterm (35%)
Final Exam (50%)
**Assignments**

There will be a total of 4 assignments posted and due on the following dates:

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<tr>
<th>Assignments</th>
<th>Posted Date</th>
<th>Due Date (at 4:00 pm)</th>
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<td>Assignment 1</td>
<td>Sept. 28</td>
<td>Oct. 12</td>
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<td>Assignment 2</td>
<td>Oct. 12</td>
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<td>Assignment 3</td>
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<td>Assignment 4</td>
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Submission of the assignments will be done in person through the submission of physical assignments copies in the assignment box located in front of the Department of Civil & Environmental Engineering (Mackenzie Building, 3rd floor, 4th module). **While it is permitted (and recommended) to discuss and work through the assignments with colleagues to enhance your personal understanding, it is crucial that assignments are completed individually.** Attempting assignments individually is the only way to have an opportunity to test your understanding and practice for the midterm and the final exam.

**Midterm Exam**

The midterm exam is scheduled to take place on Friday, November 4th from 2:35 pm – 5:25 pm. The midterm exam location is the same room as the laboratory room, Azrieli Theatre 102 (AT 102).

**Final Exam**

The final exam has not yet been scheduled. You will be notified of the date, time and location through the university once SES makes the exam schedule available.

**Notes:**

* The instructor may modify the outline during the term as the course progresses.
* Academic integrity is essential to the pursuit of learning and scholarship in a university. As a result, the University treats cases of cheating and plagiarism very seriously. Carleton University’s Policy on Academic Integrity (http://www.carleton.ca/registrar/academic-integrity) outlines the behaviors that constitute academic dishonesty and the processes for addressing academic offences. It is your responsibility to be familiar with these policies. Any students who do not act with academic integrity will face severe consequences including immediate referral to Associate Dean of Student Affairs.
* **Copyright on Materials:** The materials created for this course are intended for personal use and cannot be reproduced, redistributed, or posted on any website.
* Graduate Attributes: The Canadian Engineering Accreditation Board (CEAB) requires the faculty to collect data on graduate attributes and use that data to improve our program. The aggregate data is used for accreditation purposes and to guide program improvements only, and have no impact on individual student progression or evaluation. Data is collected in many courses across the faculty.
* Academic Accommodation: Students with diverse learning styles and needs are welcome in this course. You may need special arrangements to meet your academic obligations during the term. For an
accommodation request, the processes are as follows. For more information, please consult: http://students.carleton.ca/course-outline

Pregnancy Obligation: Please contact the instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please consult: http://students.carleton.ca/course-outline.

Religious Obligation: Please contact the instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please consult: http://students.carleton.ca/course-outline.

**Accommodations for Students with Disabilities:**
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).