

CARLETON UNIVERSITY
Department of Civil and Environmental Engineering
CIVE 3203 - Introduction to Structural Analysis (Fall 2021)

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Office Hours: TBA

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Web: Carleton Brightspace

Some course materials, announcements, etc. may be posted on the course web page in Brightspace. It is highly recommended that students visit this page as often as possible for the latest updates.

Textbooks:

(1) Structural Analysis, 10th Edition, R.C. Hibbeler.

(2) An Introduction to Structural Analysis for Civil Engineers, J. Erochko.[Online]

www.learnaboutstructures.com

Tentative Lecture Schedule

Week 1-2: Introduction to structural analysis; classification of structures; general description of plane frame; joints; supports; stability; determinacy; forces; equilibrium. Axial force, shear force and bending moment diagrams in beams and frames.

Week 3: Plane trusses; stability; determinacy; analysis of statically determinate trusses.

Week 4: Basic concepts and assumptions for structural analysis; work and energy; generalized forces and displacements; principles of virtual work: principle of virtual displacement; principle of virtual force.

Week 5: Influence lines.

Week 6: Deflections using energy method in beams, frames and trusses.

Week 7-9: Analysis of statically indeterminate structures by the force method (method of consistent deformation) – frames and trusses.

Week 10-13: Introduction to stiffness method of analysis; slope deflection method; Introduction to matrix methods (e.g. 1 DOF systems, trusses).

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:

Mid-term Exam (25%): All topics covered until the end of the week before the exam will be included. Missing mid-term exam will automatically result in a mark of zero for that component unless acceptable documentation is presented to justify your absence within three days of the date of the mid-term exam. The instructor will decide what documentations are acceptable. You must obtain approval prior to the mid-term exam if you cannot write the mid-term exam at the scheduled time (except in cases of unexpected emergencies). If unsure of what would be proper documentation for the given circumstances, please consult with your instructor. If you miss the mid-term exam and present acceptable documentations, there will be only one make-up mid-term exam, time and place to be announced. *Tentative* Schedule: November 5; the mid-term exam will be conducted during your PA session.

Assignments (10%): Maximum 4 assignments.

Final Exam (65%): Maximum 3 hours. Date and time determined by the university. A minimum mark of 30% in term-work (mid-term + assignments), 30% in the final exam, and 50% of the total mark (mid-term + assignments + final exam) is required to pass this course.

Notes:

- * Use of e-Proctoring system: This course has timed written assessments, which may consist of tests, midterms and/or final examinations. The Carleton University e-Proctoring system may be used in your assessments, and requires the use of webcams, microphones, and smart phones.
- * The course will be delivered in synchronous mode via web conferencing tools at scheduled times.
- * The instructor may modify the outline during the term as the course progresses.
- * Attendance to all mid-term exam and PA/Labs are mandatory.
- * The final exam is for evaluation purposes only, and the paper will not be returned or made available to students by the instructors after it is marked.
- * All grade appeals in this course must be made within seven days of the posting or return of the graded component. Appeals are to be addressed to the marking TA first.
- * All electronic distractions must be off during lectures, PAs and exams.
- * 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 behaviours 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.

* Students will be assigned a grade of Failure if they failed to achieve a mark of less than 30% on the term work, regardless of the mark on the final exam.

* **Copyright on Materials:** The materials created for this course are intended for personal use and may not be reproduced, redistributed, or posted on any website without prior written permission from the author(s).

* **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 (<http://www.carleton.ca/pmc>) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working, and living environment where sexual violence will not be tolerated, and survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, please visit: <http://www.carleton.ca/sexual-violence-support>.

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. 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 information, please consult: <http://students.carleton.ca/course-outline>.

