

CEE 4491A – Structural Dynamics II – Course Outline 2025/26

This course provides an introduction to the calculation of dynamic effects for multi-degree of freedom structures, including the response of such structures to random, time-varying loads due to wind and earthquakes. Code approaches to the calculation of these loads, and how these are implemented in the National Building Code of Canada (NBCC) are also reviewed. The general objectives of the course are for the student to become able to:

- calculate the mass and stiffness matrices for multi-degree of freedom structures, before determining the corresponding natural frequencies and mode shapes using eigenvalues and eigenvectors respectively;
- apply the principles of modal analysis to describe the response of multi-degree of freedom structures to both free and forced undamped and damped vibration;
- determine the response of multi-degree of freedom structures to ground motion using either recorded ground motion time histories, or response spectrum concepts;
- calculate the dynamic response of a structure to earthquake loads using an appropriate method from the NBCC; and
- calculate the dynamic response of a simple single-degree of freedom structure to wind loads using either direct methods or the NBCC approach.

Land Acknowledgment:

Western University recognizes that its campus is situated on First Nations territory. The Great Lakes woodland region of Turtle Island has been home to many Nations over centuries and at different times, including the Anishinaabek, Haudenosaunee, Lunaapéewak and Huron-Wendat peoples. The three local First Nations communities in closest proximity to Western are:

- Chippewas of the Thames First Nation;
- Oneida Nation of the Thames; and
- Munsee-Delaware Nation.

For some time, the Dish with One Spoon Covenant Wampum served as an agreement between the Haudenosaunee and Anishinaabek for sharing hunting territory, thus ensuring the viability of this land into the future. After contact, Treaty making between the Anishinaabek and Britain took place. In the London area, there are several Treaties including the Treaty 6 London Township, Treaty 7 Sombra Township and Treaty 21 Longwoods.

Today, London and the region are home to a diverse Indigenous population including First Nations, Métis and Inuit people. By recognizing Indigenous peoples' historic and present relationships to the land and London, Ontario, Western makes explicit Indigenous peoples' ongoing presence and their rights to self-determination. Please visit: <https://indigenous.uwo.ca/>

Calendar Copy:

Students are introduced to the analysis of multi-degree-of-freedom system under dynamic loading, including those due to wind and earthquakes. Topics include: the effects of the mass and damping; random dynamic loads; the design of dynamically sensitive structured, and fatigue.

Prerequisites:

CEE 3344A/B

Antirequisites:

The former CEE 4490

Corequisites:

None

Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the student's responsibility to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours:

3 lecture hours/week.

Lectures will be delivered in-person, and are organized by major learning topics. Depending on the material to be covered each major learning topic may take a number of weeks to complete.

2 tutorial hours/week.

A 2-hour tutorial session will be delivered each week during the scheduled tutorial hours. Graded individual or team assignments will be given each week and must be submitted by the start of the following week's tutorial session, unless otherwise indicated by the course instructor.

Instructor:

Dr. Craig Miller, P.Eng.; SEB 2084

E-mail: cmiller@eng.uwo.ca

Office hours: by appointment

Textbook:

None

Other References:

Several of the team and individual assignments given during the course will require the use of MATLAB, which can be installed on personal computing devices under the terms of the university's MATLAB site license. Details on how to install this software will be given on the OWL Brightspace course site.

Dynamics of Structures, Fifth Edition, by Anil K. Chopra, Prentice Hall, 2017.

Units:

Both SI and FPS unit systems may be used in lectures, laboratories, tutorials and examinations.

Specific Learning Objectives:

1. Introduction [KB3]
 - a) Understand and review the basic principles governing the response of single degree of freedom systems, including the effects of stiffness, damping, and forced vibration
2. Free Vibration of Multi-degree of Freedom Systems [KB4, PA3]
 - a) Derive the mass and stiffness matrices for multi-degree of freedom (MDOF) structures
 - b) Solve the resulting equations of motion for free vibration to calculate the corresponding natural frequencies and mode shapes using eigenvalues and eigenvectors respectively
3. Forced Vibration of Multi-degree of Freedom Systems [KB4, PA3]
 - a) Calculate the generalized mass, stiffness, and force matrices for MDOF structures undergoing harmonic forced vibration
 - b) Solve for the response of MDOF structures undergoing harmonic undamped or damped forced vibration using modal analysis and the principle of superposition
4. Ground Motion and the Response of Multi-degree of Freedom Systems [KB4, PA3, ET3]
 - a) Understand the effects of earthquakes, and the factors that affect ground motion that are relevant to the response of MDOF structures
 - b) Understand when to use the dynamic and quasi-static approaches presented in the NBCC
 - c) Determine the response of SDOF structures to ground motion using the NBCC quasi-static approach
 - d) Determine the response of MDOF structures to ground motion using recorded ground motion time histories and numerical methods [ET3]
 - e) Determine the response of MDOF structures to ground motion using response spectrum concepts for either specific events or the NBCC design response spectrum approach
5. Dynamic Approaches to Wind Loads [KB4, PA3]
 - a) Describe the underlying theory behind the dynamic approach to wind loads, and importance of the resonant response in the calculation of wind loads on several classes of structure, including tall buildings and long-span bridges
 - b) Calculate the dynamic response of a simple single-degree of freedom structure to wind loads using either direct methods or the NBCC approach.

The instructor may expand or revise material presented in the course as appropriate.

General Learning Objectives:

E=Evaluate, T=Teach, I=Introduce; (I) = Introduction, (D) = Developing, (A) = Advanced level

Knowledge Base	T (A)	Engineering Tools	T (A)	Impact on Society	
Problem Analysis	T (A)	Team Work		Ethics and Equity	
Investigation		Communication		Economics and Project Management	
Design		Professionalism		Life-Long Learning	

Accreditation Units:

Engineering Science: 75%, Math: 25%

Evaluation:

The final course grade will be determined as follows:

Assignments:	25%
Midterm exam:	15%
Final exam:	60%
Total:	100%

- Notes: (a) **Students must pass the final examination to pass this course.** Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less.
- (b) **Students who have failed this course previously must repeat all components of the course.** No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted.

1. Quizzes and Examinations:

A three-hour written final examination will be held during the regular December examination period.

2. Midterm Exam

A one-hour midterm exam will be held during the first hour of the tutorial on October 14. The exam will cover material from the first five weeks of class and will be closed book. A formula sheet will be provided as part of the exam. **Academic consideration will not be given for this assessment without appropriate documentation.**

3. Weekly Assignments:

Group or individual assignments will be given on a weekly basis. Assignments to be submitted electronically prior to the due date using Gradescope accessed through the OWL Brightspace course site. Extensions are to be negotiated with the course instructor, not the teaching assistants.

4. Participation:

Participation will be assessed based on class attendance, participation in lectures and tutorials and completion of short in-class assessments.

I. Missed/Late Accommodation Policy:

1. Students missing a test/assignment/lab or examination you will report the absence by submitting Academic Consideration Request form through [STUDENT ABSENCE PORTAL](#).
2. Documentation must be provided as soon as possible.

II. Exam Accommodation:

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#). PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. Late Assignments:

1. Students must advise the course instructor if they are having difficulty completing an assignment on time (prior to the due date of the assignment).

2. Students should be prepared to submit the Academic Consideration Request Form and provide documentation if requested to do so by the course instructor (see reverse side for information on documentation).
3. If granted an extension, a revised due date should be established with the course instructor. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. This course employs flexible deadlines for weekly assignments. For each assignment, students are expected to submit the assignment by the deadline listed in the assignment. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a late penalty of 10% per day will be subtracted from the assessed grade. As flexible deadlines are used in this course, requests for academic consideration will not be granted. If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.
5. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

IV. Medical Accommodation:

1. Requests for Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Requests for academic consideration must include the following components:
 - a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
 - b. Medical note
 - c. Indication of the course(s) and assessment(s) affected by the request
 - d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline. Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Engineering.

V. Religious Accommodation:

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity:

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit [Academic Integrity Western Engineering](#) for more information

VII. Academic Offences:

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.

[Scholastic Discipline for Undergraduate Students](#) & [Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know](#)

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy:

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

X. Accessibility:

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable

access to services and facilities. To help provide the best experience to all members of the campus community, please visit the [Accessibility Western University](#) for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit [Academic Support & Engagement -Academic Accommodation](#).

XI. Inclusivity, Diversity, and Respect:

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the [Office of Equity, Diversity and Inclusion](#).

XII. Health and Well-Being:

- [Health & Wellness Services – Students](#) - Offers appointment-based medical clinic for all registered part-time and full-time students.
- [Mental Health Support](#) - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- [Crisis Support](#) - For immediate assistance, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click [here](#).
- [Gender-Based Violence and Survivor Support](#) - Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts:

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	519-661-2139	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links:

- [WESTERN ACADEMIC CALENDAR](#)
- [ACADEMIC RIGHTS AND RESPONSIBILITIES](#)