Western University – Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 3344B - STRUCTURAL DYNAMICS I – Course Outline 2025/26

Students are introduced to concepts of structural dynamics and the response of civil engineering structures to time-varying loads, including those due to wind and earthquakes. This requires the extension of the structural theory to include the effects of the mass and damping and to evaluate the action of various deterministic and random dynamic loads. The importance of dynamic loads in the design of dynamically sensitive civil engineering structures, such as tall buildings, towers and chimneys, and long-span bridges is examined and their treatment in the National Building Code of Canada is reviewed. Topics include:

- Equation of motion of single-degree-of-freedom systems;
- Free and forced vibrations;
- Response spectra;
- Numerical evaluation of dynamic response;
- Generalised single-degree-of-freedom systems;
- Rayleigh's method;

Prerequisites:
CEE 2221A/B

Corequisites:
CEE 3340A/B

Antirequisites:
None

Note: It is the **student's responsibility** to ensure that all Prerequisite and/or Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also **students' responsibility** to ensure that they have not taken any course listed as an Antirequisite. The student maybe 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:

2 lecture hours per week:
Lecture materials are posted online before the lectures. Students should review the online lectures in the week they are posted, and be prepared to discuss and apply the concepts presented during the weekly lecture sessions. Review of lecture material and attendance at lecture sessions should take approximately 5 hours per week.

2 tutorial hours per week:
A 2-hour tutorial session will be delivered each week during the scheduled tutorial hours. During tutorial sessions, students will work on weekly assignments and receive assistance from the course instructor and teaching assistants. A tutorial assignment must be submitted by the end of the tutorial session.

Instructor:
[redacted]

Contact policy:

- Contact the course instructor via email (above)
- Weekly Office hours are held either via Zoom or in-person.

Textbook:

Prepared class notes should be brought to each class.

Chopra, A.K., Dynamics of Structures, Theory and Applications to Earthquake Engineering, Prentice Hall, (3rd edition) 2006. (Purchase is recommended). (Previous editions may be acceptable)

Other References:

Tedesco, J.W., McDougal, W. G., and Ross, C.A. "Structural Dynamics", Addison-Wesley

Humar, J. L. "Dynamics of structures", Balkema, 2005.

Clough, Penzien, *"Dynamics of Structures"*, McGraw-Hill, 1993

M. Paz, *"Structural Dynamics"*, Van Nostrand Reinhold Co., 1985.

Hurty, Rubinstein, *"Dynamics of Structures"*, Prentice-Hall, 1964

Biggs, *"Introduction to Structural Dynamics"*, McGraw-Hill, 1964

Units:

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

Specific Learning Objectives [GA Indicator – **bold** denotes evaluated indicator]**:**

KB1. Demonstrate competence in mathematics
KB3. Demonstrate competence in engineering fundamentals appropriate to the engineering discipline
KB4. Demonstrate competence in specialized engineering knowledge
PA2. Demonstrate ability to formulate a strategy to solve an engineering problem
ET3. Demonstrates ability to create/develop/adapt appropriate engineering tools

1. Equation of motion of single-degree-of-freedom systems. At the end of this section, the student should be able to:
   a) Understand the concept of damping, mass stiffness, and motion, and their relation [**KB1, KB3**]
   b) Idealise the motion and derive a mathematical description of motion [**KB1, KB3**]

2. Free and forced vibrations of single-degree-of-freedom. At the end of this section, the student should be able to apply knowledge of mathematics, science, and engineering to:
   a) Solve the differential equation of motion, and describe free vibration [**KB1, KB3**]
   b) Find natural frequency, and resonant response [**KB4**]
   c) Differentiate between the responses of undamped and damped vibration
   d) Calculate response to harmonic and periodic excitations, transmissibility [**KB4**]

e) Understand human response to vibrations
f) Calculate response to arbitrary, step and pulse excitations using Duhamel's integral

3. Numerical evaluation of dynamic response. At the end of this section, the student should recognize the need of using numerical methods in the dynamics of structures. The student should able to compute the dynamic response by implementing the following in the spreadsheet
a) Method based on interpolation of excitation
b) Central difference method [**ET3**]
c) Newmark's method, Wilson's method [**KB4, ET3**]

4. Response spectra.
a) Understand the response spectrum concept [**KB4**]
b) Identify the relations between deformation, pseudo-velocity and pseudo-acceleration spectra
c) Recognise the difference between design and response spectra [**KB4**]
d) Design simple structures using response spectra [**KB4, PA2, ET3**]

5. Generalised single-degree-of-freedom systems and Rayleigh's method
a) Understand the representation of motion in generalised coordinate [**KB4, PA2**]
b) Idealise and draw the shape function
c) Derive and solve the equation of motion for continuous beam subject to lateral force, and support motion [**KB4, PA2**]
d) Derive and solve the equation of motion lumped mass system [**KB4, PA2**]
e) Calculate frequencies using Rayleigh's method [**KB4**]

Instructors may expand or revise material presented in the course as appropriate

General Learning Objectives

E=Evaluate, T=Teach, I=Introduce; [Introductory (I), Developing (D), or Advanced (A) level]

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

Evaluation:

The final course mark will be determined as follows:

Weekly problems	35%
Quiz	15%
Participation	5%
Final Examination	45%
Total	100%

Note:

(a) **Students must pass the final examination to pass this course**. Students who do not satisfy this requirement will be assigned the aggregated 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 assignment or test marks from previous years. Previously completed assignments cannot be resubmitted.

1. Quiz and Examination:

A one-hour quiz is to be held during a tutorial session. The quiz is tentatively scheduled for [redacted]. A three-hour final **in-person exam** will be held during the examination period on all work covered during the course. Both the quiz and the final examination will be a **CLOSED-BOOK EXAM.**

2. Weekly Assignments:

Weekly problems are assigned during the tutorial session and the due day will be specified. They will be marked and returned. Extensions are to be negotiated with the course instructors, not the teaching assistants.

3. 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.
3. No makeup quiz will be offered. If a student misses the quiz for a valid reason, their final exam score will account for 60% of the overall course grade.

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 has 10 assignments. Academic consideration will not be granted for missed assignments. If students miss any assignments, they will receive a grade of zero on each missed assignment.
5. The assignment deadlines will be given during the tutorial sessions. For each assignment, students are expected to submit the assignment by the deadline listed. 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.
6. 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. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
4. 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 assistant, 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

Course Breakdown

Engineering Science = 50%
Engineering Design =50%