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

CEE 4480B – Wind Engineering – Course Outline 2024/25

This course provides an introduction to wind effects on structures, including both quasi-static and dynamic approaches to the prediction of wind loads on structures, and how these are implemented using both the National Building Code of Canada (NBCC) and ASCE 7-16. The general objectives of the course are for the student to become able to:

- assess the wind climate and predict design wind speeds using extreme value theory from historical wind speed records;
- describe the mean and turbulent wind structure of the atmospheric boundary layer over different terrain;
- describe the aerodynamic forces acting on bluff bodies and the factors that affect them;
- calculate the wind loads acting on a structure using either quasi-static or dynamic approaches, and to select an appropriate method to use given a particular class of structure;
- assess the impact of internal pressures on external wind loads; and
- apply the quasi-static approach as implemented in both the NBCC and ASCE 7-16 to a simple structure.

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, Treatymaking 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:

An introduction to wind effects on structures. Topics covered include wind climate, the atmospheric boundary layer and its description, bluff body aerodynamics and aeroelastic effects, quasi-static and dynamic approaches to wind loads on structures, internal pressures, and code approaches to wind loads on structures.

Prerequisites:

CEE 2224, Statistical Sciences 2141A/B, or their equivalents

Antirequisites:

None

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:

2 lecture hours/week;
Lectures are organized by major learning topic, and will be delivered in-person. Depending on the material to be covered each major learning topic may take several weeks to complete.

2 tutorial hours/week; (recommended additional personal study - 3 hours).
A 2-hour tutorial session will be delivered each week during the scheduled tutorial hours. Graded individual assignments will be completed most weeks and must be submitted online by the start of the following week's tutorial session. Two group projects will also be given through the course of the term, the first of which will require attendance at a wind tunnel test in the Boundary Layer Wind Tunnel Laboratory.

Instructor:

Dr. Craig Miller, P.Eng.; SEB 2084
E-mail: cmiller@eng.uwo.ca
Office hours: by appointment

Textbook:

None

Other References:

There are a number of wind engineering textbooks that can be referred to for further information and which are available online through Western Libraries, including;

- *Wind Loading of Structures*, Third Edition, by John Holmes, CRC Press, 2015,
- *Wind Effects on Structures: Fundamentals and Application to Design*, Fourth Edition, by Emil Simiu and DongHun Yeo, John Wiley, 2019, and
- *Advanced Structural Wind Engineering*, edited by Yukio Tamura and Ahsan Kareem, Springer, 2013 (this is a more advanced text, but still covers the fundamentals).

Links to access all of the above textbooks directly while logged into the uwo.ca domain may be found on the OWL Brightspace course site.

Units:

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

Specific Learning Objectives:

1. Introduction [KB4]

a) Recognize the various components of the Davenport wind loading chain, and quantify their individual contributions to the wind loads acting on a structure

2. Wind Climate [KB4]

a) Describe the features of the general atmospheric circulation
b) Differentiate between the different types of wind storms likely to be of interest to a designer, including extra-tropical and tropical cyclones, thunderstorms, and tornadoes
c) Derive a wind rose for a specific site using historical wind speed records
d) Calculate the design wind speed for a given return period from historical wind speed records using extreme value theory

3. Atmospheric Boundary Layer (ABL) [KB4]

a) Calculate gradient and geostrophic wind speeds from atmospheric pressure distributions
b) Derive the theoretical mean velocity distribution within the ABL
c) Compare the theoretical and 'power law' velocity distributions
d) Quantify the turbulent structure of the ABL in space and time using empirical data for different terrain
e) Calculate boundary layer growth due to abrupt changes in terrain and how this impacts design wind speeds for a specific site
f) Determine the relationship between gust and mean wind speeds - gust factor approach
g) Discuss the qualitative differences in wind structure for different storms i.e. thunderstorms, hurricanes and tornadoes

4. Bluff Body Aerodynamics [KB4, I3, ITW2]

a) Describe the basic flow pattern about simple structural shapes, such as flat plates and rectangular bodies, in both uniform and boundary layer flows
b) Identify and quantify the factors that affect the flow patterns and resulting forces acting on simple structural shapes
c) Quantify the effects of turbulence on the mean and fluctuating forces acting on simple shapes, and how these effects are captured through of an aerodynamic admittance function
d) Recognize the impact of other aeroelastic phenomena, such as vortex shedding, galloping and flutter, and the conditions under which these effects may be significant

5. Quasi-static and Dynamic Approaches to Wind Loads [KB4]

a) Derive the quasi-static loading equation, and recognize the conditions under which this approach can be used to calculate the wind loads on a simple structure
b) 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
c) Calculate the response of a simple single-degree of freedom structure using the dynamic approach to wind loads

6. Internal pressures [KB4]

a) Recognize the impact of internal pressures on the net wind loads acting on a structure, and determine the particular combinations of positive and negative external and internal pressures that lead to the worst case load effects

7. Codification of Wind Loads using either the NBCC or ASCE 7-16 [KB4, I3, ET2, ITW2]

a) Calculate external design pressures using either the NBCC or ASCE 7-16 simple procedures including exposure, gust and pressure factors
b) Calculate internal design pressures using either the NBCC or ASCE 7-16 provisions

c) Calculate design wind loads and structural load effects for low-rise buildings
d) Calculate peak wind pressures for cladding/envelope design
e) Recognize the structure types where explicit dynamic analyses are required for wind load effects using either the NBCC or ASCE 7-16

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

General Learning Objectives:

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

Knowledge Base	T (A)	Engineering Tools	T(A)	Impact on Society	
Problem Analysis		Team Work	T(A)	Ethics and Equity	
Investigation	T (A)	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:

Individual Assignments	20%
Group Projects	20%
Final Examination	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. Examinations:
   A three-hour written final examination will be held during the regular examination period.

2. Individual Assignments:
   Six individual assignments will be given on a semi-weekly basis. Assignments are to be submitted electronically prior to the due date using Gradescope accessed through the OWL Brightspace course site. Assignments may be submitted up to 72 hours late without penalty, assignments submitted after this time will not be graded and will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants.

3. Group Projects:
   Two group projects will be given as part of the course. The first of these will involve comparing the measured full-scale pressure coefficients on the Silsoe Cube with those measured using a 1:50 scale model of the cube in a boundary layer wind tunnel. The second project will examine the calculation of design pressures for a low-rise building, and compare how these vary in reality with the approach used in modern wind loading codes. Group reports for both projects are to be submitted prior to the

due date using Gradescope accessed through the OWL Brightspace course site. Reports may be submitted up to 72 hours late without penalty, reports submitted after this time will not be graded and will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants.

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 has 10 assignments with only 8/10 assignments counted towards your final grade. Academic consideration will not be granted for missed assignments. If students miss 2/10 assignments, the remaining 8 assignments will be used in the calculation of the final grade. If students miss more than 2 assignments, they will receive a grade of zero on each missed assignment.
5. This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. 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 XX% 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.
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. 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 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