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

CEE 4480b – Wind Engineering – Course Outline Winter 2021

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.

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. (0.5 course)

Prerequisites:
CEE 2224 and SS 2141A/B, or their equivalents

Antirequisites:
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;
Depending on the exact situation prevailing for the Winter term, lectures will either be delivered simultaneously in-person and synchronously using Zoom as per the lecture schedule on the Office of the Registrar’s website, or asynchronously through pre-recorded videos posted to the course OWL site at the start of each week. In the case of in-person/synchronous lectures delivered using Zoom, these will also be
recorded and posted to the course OWL site for students to review in their own time. Attendance/review of lecture material and self-study should take approximately five hours per week.

2 tutorial hours/week.
A 2-hour tutorial session will be delivered synchronously through Zoom each week during the scheduled tutorial hours. Tutorials are not mandatory but students seeking assistance with weekly assignments or clarification on lecture material are strongly encouraged to attend. The link to the Zoom meeting will be posted to the course OWL site.

**Instructor:**
Dr Craig Miller, P.Eng., ACEB 4480, email: cmiller@eng.uwo.ca.

Administrative Assistant: Sandra McKay (smckay@uwo.ca)

**Textbook:**
There is no specific textbook for this course.

Prepared class notes, organized by topic, will be posted to the course OWL site prior to the start of that topic.

**Other References:**


*Advanced Structural Wind Engineering*, edited by Yukio Tamura and Ahsan Kareem, Springer, 2013 (advanced text, available online through Western Libraries - see course OWL site for details on how to access).

Links to other useful background material may be posted to the course OWL site.

**Computing:**
Students will be required to use portable computers during tutorials. Some assignments will require the use of additional software available through site licences held by the University of Western Ontario, and in particular the use of the numerical computing environment software MATLAB.

**Units:**
Both SI and FPS unit systems may be used in lectures, tutorials and examinations.

**Specific Learning Objectives:**
1. Introduction
   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
   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)
   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
   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
   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
   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
   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; (I) = Introduction, (D) = Developing, (A) = Advanced Level

<table>
<thead>
<tr>
<th>Knowledge Base</th>
<th>Engineering Tools</th>
<th>Impact on Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(A)</td>
<td>T(A)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Analysis</th>
<th>Team Work</th>
<th>Ethics and Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(A)</td>
<td>T(A)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Communication</th>
<th>Economics and Project Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(A)</td>
<td>Communication</td>
<td>Economics and Project Management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design</th>
<th>Professionalism</th>
<th>Life-Long Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professionalism</td>
<td>Life-Long Learning</td>
</tr>
</tbody>
</table>

Evaluation:

The final course mark will be determined as follows:

- Assignments: 20%
- Group projects: 20%
- Final assessment: 60%
- Total: 100%

Note: 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 online final assessment will be held during the regular examination period. The assessment will be delivered through the course OWL site, but will not require a continuous internet connection for the duration of the assessment. There is no requirement to pass the final assessment in order to pass the course.

2. Weekly Assignments:

Assignments will be given on a weekly basis. Assignments are to be submitted prior to the due date using Gradescope accessed through the course OWL site. Late assignments will be assessed a penalty of 10% per day, to a maximum of 4 days, after which they 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 examining aspects of the pressure distribution on the sides and top of a low-rise building based on wind tunnel tests, while the second will examine aspects of the design pressures acting on a low-rise building and how these vary by wind direction. Group reports for both projects are to be submitted prior to the due date using Gradescope accessed through the course OWL site. Late reports will be assessed a penalty of 10% per day, to a maximum of 4 days, after which they will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants.

4. Use of English:

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 with the exception of 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.
**Cheating:**
University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.
For more information on scholastic offenses, please see: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

**Attendance:**
Any student who, in the opinion of the instructor, has not engaged sufficiently in class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

**Accommodation:**
Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: Academic Accommodation for Students with Disabilities

**Academic Consideration for Student Absence:**
Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student’s final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student’s final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are not met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For Western University policy on Consideration for Student Absence, see Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs and for the Student Medical Certificate (SMC), see: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.
**Religious Accommodation:**
Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the [Western Multicultural Calendar](https://www.uwo.ca/univsec/pdf/board/code.pdf).

**Use of Recordings:**
All of the remote learning sessions for this course will be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals under special circumstances. Please contact the instructor if you have any concerns related to session recordings. Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

**Conduct:**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Please turn off your cell phone before coming to a class, tutorial, quiz or exam. On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: [https://www.uwo.ca/univsec/pdf/board/code.pdf](https://www.uwo.ca/univsec/pdf/board/code.pdf)

**Contingency plan for an in-person class pivoting to 100% online learning:**
In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor.

**Notice:**
Students are responsible for regularly checking their email, course website ([https://owl.uwo.ca/portal](https://owl.uwo.ca/portal)) and notices posted outside the Civil and Environmental Engineering Department Office.

**Consultation:**
Students are encouraged to discuss problems with their teaching assistant and/or the Instructor in tutorial sessions. Office hours will be arranged for the students to meet with the Instructor and teaching assistants. Other individual consultation can be arranged by appointment with the instructor.

**Course Breakdown:**
25% Natural Science; 75% Engineering Science.
AUs: Total 36; Natural Science 9; Engineering Science 27.

The attached document “INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED” is part of this course outline.