

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

**CEE 4480B – Wind Engineering – Course Outline Winter 2018**

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)

**Contact Hours:**

2 lecture hours/week; 2 tutorial hours/week; (recommended additional personal study - 3 hours).

Attendance at the tutorial/laboratory session is **mandatory**

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

**Corequisites:**

**Antirequisite:**

**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.

**Instructor:**

Dr Craig Miller, P.Eng., IGAB 3N50, email: [cmiller@eng.uwo.ca](mailto:cmiller@eng.uwo.ca). Administrative Support: SEB 3005

**Textbook:**

There is no specific textbook for this course.

Prepared class notes should be brought to each class, and may be downloaded from the course OWL site at <http://owl.uwo.ca/>

**Other References:**

*Wind Loading of Structures*, Third Edition, by John Holmes, CRC Press, 2015.

*Wind Effects on Structures: Fundamentals and Application to Design*, Third Edition, by Emil Simiu and Robert H. Scanlan, John Wiley, 1996.

*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:**

SI units will be used in lectures 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

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

## Evaluation:

The final course mark will be determined as follows:

Assignments:	20%
Group projects:	20%
Final exam:	60%
Total:	<u>100%</u>

- Note:
- (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.
  - (c) Should any of the assignments or exams conflict with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than two weeks before the scheduled test. For further information on accommodations for religious holidays see [http://www.uwo.ca/univsec/handbook/appeals/accommodation\\_religious.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_religious.pdf)

### 1. Quizzes and Examinations:

The final examination will be **CLOSED BOOK**, approved handheld non-programmable calculators are allowed, but NO other external sources of information, including books, notes or crib sheets, are permitted. Please consult the list of acceptable calculators for closed book exams posted on the bulletin board across from the Department of Civil and Environmental Engineering Office to be sure your calculator is on it! **Part marks may not be awarded for some of the problems on the final exam.**

### 2. Assignments

Assignments will due at either at the start or the end of the tutorial period, as directed by the course instructor. Late assignments will receive a grade 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 a wind tunnel test exploring some of the factors affecting the pressure distribution on the sides and top of a surface-mounted cube, while the second will examine aspects of the design pressures acting on a low-rise building and how these vary by wind direction. Both hard and electronic copies of the resulting group project reports must be submitted by the specified due date. Reports that are found to be plagiarized will be given a mark of zero. Late submissions will be penalized.

### 4. Use of English

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the 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.

**Plagiarism Checking:**

The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

**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:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf)

**Attendance:**

Any student who, in the opinion of the instructor, is absent too frequently from 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.

**Accessibility:**

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**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. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. 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: <http://www.uwo.ca/univsec/board/code.pdf>

**Sickness and Other Problems:**

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:

[http://www.uwo.ca/univsec/handbook/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf)

**Notice:**

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

**Consultation:**

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

**Course Breakdown:**

25% Natural Science; 75% Engineering Science.

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

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

**A. GENERAL REGULATIONS & PROCEDURES**

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

**B. TERM TESTS**

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.
3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

**C. FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
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, 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 sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**N.B. It is the student's responsibility to check the date, time and location of the Special Examination.**

**D. LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
  - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
  - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

## E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

## F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

## G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

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

## H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

**Calendar References:** Check these regulations in your 2017 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness: <http://westerncalendar.uwo.ca/2017/pg117.html>

Academic Accommodations for Students with Disabilities: <http://westerncalendar.uwo.ca/2017/pg118.html>

Academic Accommodations for Religious or Holy Days: <http://westerncalendar.uwo.ca/2017/pg119.html>

Course Withdrawals: <http://westerncalendar.uwo.ca/2017/pg157.html>

Examinations: <http://westerncalendar.uwo.ca/2017/pg129.html>

Scheduling of Term Assignments: <http://westerncalendar.uwo.ca/2017/pg135.html>

Scholastic Offences: <http://www.westerncalendar.uwo.ca/2017/pg111.html>

Student Medical Certificate: [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)

Engineering Academic Regulations: <http://www.westerncalendar.uwo.ca/2017/pg1442.html>

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

### **Drop Deadlines:**

First term half course (i.e. "A" or "F"):	November 5, 2017
Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2017
Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

### **Contact Information:**

Undergraduate Services Office:	SEB 2097	Telephone: (519) 661-2130	E-mail: <a href="mailto:engugrad@uwo.ca">engugrad@uwo.ca</a>
Dept. of Chemical and Biochemical Engineering & Green Process Engineering:	TEB 477	Telephone: (519) 661-2131	E-mail: <a href="mailto:cbeugrad@uwo.ca">cbeugrad@uwo.ca</a>
Dept. of Civil and Environmental Engineering:	SEB 3005	Telephone: (519) 661-2139	E-mail: <a href="mailto:civil@uwo.ca">civil@uwo.ca</a>
Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering:	TEB 279	Telephone: (519) 661-3758	E-mail: <a href="mailto:eceugrad@uwo.ca">eceugrad@uwo.ca</a>
Dept. of Mechanical and Materials Engineering:	SEB 3002	Telephone: (519) 661-4122	E-mail: <a href="mailto:mmeundergraduate@uwo.ca">mmeundergraduate@uwo.ca</a>