Western University
Faculty of Engineering
Department of Civil & Environmental Engineering

CEE 9693b – Bluff Body Aerodynamics

COURSE OUTLINE – Winter 2025

DESCRIPTION

This is a graduate course focusing on the fluid mechanics aspects of bluff body aerodynamics. While the theoretical, experimental, and computational aspects of the aerodynamics around streamlined bodies are highly developed, flows around bluff bodies have remained more elusive to both theory and computation. As a result, the wind tunnel method is still the primary method for determining wind loads. This is largely because of the role of turbulence, high Reynolds numbers, and the complex flow fields that arise in applications such as wind loads on structures. The purpose of the course is to aid the student in understanding the role of the various factors which impact the aerodynamic buffeting loads on bluff bodies in the wind, as well as to familiarize the student on the use of the data analysis methods used to understand bluff body flows. By the end of the course, the student should understand and implement the requirements of the wind tunnel method to determine design wind loads on buildings.

The course will use a variety of styles to present the topics including traditional lectures, the use of experimental data from a variety of sources, and group discussions pertaining to the review of scientific papers and the student's own analysis of provided data. In order for group discussions to be effective, the student must be committed to completing assigned readings prior to class. Students will also be expected to participate in the classes directly. Assignments will be based around analysis of archived experimental data, together with review of published literature as related to the analysis of the data. Students will make brief presentations of their findings for all assignments, to the class.

ENROLLMENT RESTRICTIONS

Enrollment in this course is restricted to graduate students in Civil & Environmental Engineering and Mechanical & Materials Engineering, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

INSTRUCTOR CONTACT INFORMATION

Course instructor: Gregory Kopp
Email address: gakopp@uwo.ca
Office: ACEB 4476
Office hours: contact instructor

COURSE FORMAT

In-person.
Note that there are no classes during Reading Week.

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	Aerodynamic forces	• Lectures • Additional reading material	Weeks 1-2
2	Turbulence & analysis of time-varying signals	• Lectures • Practice problems • Assignment	Weeks 2-4
3	Turbulent shear flows (boundary layers, shear layers, wakes)	• Lectures • Additional reading material • Assignment	Weeks 4-6
4	Flow separation and reattachment	• Lectures • Additional reading material • Assignment	Weeks 7-8
5	Effects of turbulence on the flow around bluff bodies	• Lectures • Additional reading material	Weeks 8-9
6	Quasi-steady theory	• Lectures • Additional reading material • Assignment	Week 10
7	The wind tunnel method	• Lectures • Additional reading material • Assignment	Weeks 11-12

SPECIFC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	30%	• Assignments • Review of scientific literature	• Understanding of advanced concepts and theories • Awareness of important current problems in the field of study • Understanding of computational and/or empirical methodologies to solve related problems
Research & scholarship	10%	• Assignments • Review of scientific literature	• Ability to conduct critical evaluation of current advancements in the field of specialization • Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment
Application of knowledge	30%	• Assignments	• Ability to apply knowledge in a rational way to analyze a particular problem

			• Ability to use coherent approach to design a particular engineering system using existing design tools
Professional capacity / autonomy	5%	• Assignments • Discussions in class	• Awareness of academic integrity • Ability to implement established procedures and practices in the coursework • Defends own ideas and conclusions • Integrates reflection into his/her learning process
Communication skills	20%	• Assignments • Review of scientific literature • Discussions in class	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	5%	• Review of scientific literature	• Awareness of the need of assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitation due to complexity of practical problems

By the end of the course, the student should:

1. Be able to calculate aerodynamic coefficients and related statistical parameters from temporally- and/or spatially-varying wind tunnel aerodynamic data;
2. Have a basic understanding of similarity concepts and their importance in determining wind loads and scaling of wind tunnel experiments;
3. Be able to describe the role of turbulence intensity and turbulence scales and sketch the flow patterns around bluff bodies of various geometries;
4. Be able to utilize the quasi-steady theory in determining wind loads on buildings and other structures and describe its limitations;
5. Have a basic understanding and be able to discuss current research issues pertaining to bluff body aerodynamics;
6. Be able to design a wind tunnel test of a scale-model that meets the requirements of ASCE 49-21.

ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (5)	Topics 1, 2, 3, 4, 5, 6, 7	Every 2 weeks (approximate)	75%
Assignment Presentations (5)	All topics	In-class on assignment due date	15%
Participation in class activities	Weekly presentations and discussion	In-class	10%

Activities in which collaboration is permitted:

- In-person discussions

Activities in which students must work alone (collaboration is not permitted):

- Assignments and literature reviews

REQUIRED TEXTBOOK

There is no text book required for this course. Various papers in the literature will be studied. Some will be discussed in class, although students will be expected to do significant reading for these assignments. Prepared class notes will be made available through the course OWL site at http://owl.uwo.ca/, along with other useful reference material and data for assignments.

OPTIONAL COURSE READINGS

There are several excellent books which address only partial aspects of the course materials including: (i) Turbulent Flows, by Stephen Pope, Cambridge University Press, (ii) Physical Fluid Dynamics, by D.J. Tritton, Oxford University Press, (iii) Wind Effects on Structures, by Emil Simiu and Robert Scanlan, Wiley, (iv) Wind Loading of Structures, by John Holmes, Spon Press.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in 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).

STATEMENT ON THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

The use of AI in the preparation of the projects and assignments must be acknowledged in the submission. Please refer to Western University's published Provisional Guidance for the Use of Generative AI in Graduate Studies.

CONDUCT

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS SERVICES

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. Information on how to schedule an appointment with the counsellor is available at: https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/Student-Wellness-Counselling.html.

Students who are in emotional/mental distress should refer to Mental Health@Western: http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website: https://www.uwo.ca/health/student_support/survivor_support/get-help.html. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:

https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html

ACCESSIBLE EDUCATION WESTERN (AEW)

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.