

McMaster University  
Department of Mechanical Engineering  
Course Outline:  
**MechEng 709 Turbulence and Turbulence Modelling**  
TERM 2 (January-April 2024)

**Instructor:** Dr. Stephen Tullis [stullis@mcmaster.ca](mailto:stullis@mcmaster.ca) JHE 304 ext 26792

**Content:**

The course introduces the phenomenological features in turbulent flows and the methods used to analyze these flows. This will include developing the Reynolds average equations, investigating the vortex dynamics in these flows, applying the governing equations to different flows both free shear and wall-bounded. Turbulence models for both RANS and LES are examined in detail.

**Lectures:** TBD Either two 1.5hr lectures or one 3hr lecture per week

Lecture Notes will be posted on Avenue to Learn

**References:** Matthieu and Scott, An Introduction to Turbulent Flow  
Davidson, Turbulence  
Pope, Turbulent Flows  
White, Viscous Fluid Flow

**Grading Scheme:**

Assignments	35%
Exam	30%
Project (paper and presentation)	35%

**Course Content:**

1. Introduction
2. Nature & characteristics of turbulent flows
3. Reynolds-averaged Navier-Stokes equations
4. Homogeneous isotropic turbulence
5. Free shear flows
6. Wall bounded flows
7. Turbulent boundary layers
8. Reynolds-averaged Navier-Stokes turbulence modelling
9. Large Eddy Simulation (LES)
10. Direct Numerical Simulation (DNS)
11. Additional topics - including buoyancy and particle transport

**Assignments:** Several (~4) problem sets are planned for this course. The purpose of these assignments is to provide students with an opportunity to work out fundamental and applied

problems related to the course material. A mix of exam-like questions and more mini-project analyses.

**Project:** A literature review project is undertaken on a specific topic in a current active area of turbulent flows or modelling. The topic cannot be directly related to the student's main research area - it is expected that the student discuss potential project topics with the instructor. An outline and progress report are due roughly 4 and 8 weeks into the term, respectively (for comment, but are not graded). Each student presents their paper to the class on the final day of classes.

## **Policy Statements**

### **Academic Integrity (Ethics and Dishonesty)**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. Academic dishonesty includes, but not limited to: plagiarism, improper collaboration in group work and copying or using unauthorized aids in tests and examinations.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at <https://secretariat.mcmaster.ca/app/uploads/Academic-Integrity-Policy-1-1.pdf>

### **Conduct Expectations**

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

### **Academic Accommodation of Students with Disabilities**

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext.28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

### **Academic Accommodation for Religious, Indigenous or Spiritual Observances (RISO)**

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

## **Copyright and Recording**

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, *including lectures* by University instructors. The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student only for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

## **Extreme Circumstances**

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, **global pandemics**, etc.). If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.