THE UNIVERSITY OF COLORADO BOULDER

ASEN 6037 / MCEN 7221: Turbulent Flows / Turbulence
Spring 2026

SYLLABUS

Instructor: Associate Professor John Evans
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Web Page: Canvas (canvas.colorado.edu)

Course Objective:

To establish a fundamental understanding of the mathematics and physics of turbulent flows and to introduce the concepts and analytical tools needed in developing turbulence models and turbulence simulation methods.

Prerequisites:

This class requires a graduate course in fluid mechanics such as ASEN 5051 / MCEN 5021. Topics covered should include kinematics of fluid flows, conservation laws, vorticity dynamics, theory and application of irrotational flows, dynamic similarity, viscous flows, and boundary layers. A working knowledge of vector calculus, Cartesian tensors, and Fourier transforms is also required.

Required Textbook:

Turbulent Flows, Pope, Cambridge University Press, 2000.

Reference and Supplemental Textbooks:

Fluid Mechanics, Kundu, Cohen, and Dowling, Academic Press, Sixth Edition, 2016.

Turbulence: An Introduction for Scientists and Engineers, Davidson, Oxford Press, Second Edition, 2015.

Statistical Theory and Modeling for Turbulent Flows, Durbin and Pettersson Reif, Wiley, Third Edition, 2001.

A First Course in Turbulence, Tennekes and Lumley, MIT Press, 1972.

Turbulence: The Legacy of A.N. Kolmogorov, Frisch, Cambridge Press, 1995.

Topics:

1. **Turbulence Theory**
    a. Statistical Description of Turbulence
    b. Mean Flow Equations
    c. Free Shear Flows
    d. Wall-Bounded Flows
    e. The Scales of Turbulent Motion

2. **Turbulence Modeling and Simulation**
    a. Direct Numerical Simulation (DNS)
    b. Reynolds Averaged Navier-Stokes (RANS) Models
        i. Turbulent Viscosity Models
        ii. Reynolds Stress Transport Models
    c. Large Eddy Simulation (LES)

Class Format:

The class meets twice a week for an hour and fifteen minutes of formal lecture and discussion.

Grading:

30% Homework Assignments
30% Midterm Exam
15% Literature Review Project
25% Final Project

Grades will be posted to the class website on Canvas.

Reading Assignments:

Reading assignments are assigned frequently through the course website and are to be completed before lecture. The lecture should help to clarify and supplement what students have read. If a student has any questions on the reading material, the student should contact the instructor by Slack or e-mail who will address the question during lecture.

Homework Policy:

There will be six homework assignments throughout the semester. Homework assignments are to be turned in through the course website by the start of class on their due date. Students should make an effort to turn in assignments that are organized, professional looking, and legible.

Each homework assignment will consist of a number of problems and be worth 100 points, of which 50 points will be assigned for "completeness" and 50 points will be assigned for "correctness". All problems associated with an assignment will count toward the "completeness" score. Only one problem associated with an assignment will count toward the "correctness" score. Homework

solutions will be made available for each assignment so students can "self-grade" their performance on problems only graded on the basis of "completion".

Collaboration is permitted on homework. This means students may discuss the means and methods for solving problems and even compare answers, but students are not free to copy someone's assignment. The work that a student turns in must be his or her own – copying is not allowed for any assignment and will not be tolerated. Students who are caught copying (or providing his or her assignment to another) will receive an "F" for the course and reported to the Dean's office for further punitive action.

Examination Policy:

The midterm examination will cover all "Turbulence Theory" material in the course including lecture, discussions, and homework. The midterm examination will be take-home and open-book.

Collaboration on the midterm examination will not be tolerated. Students who are caught in these activities will receive an "F" for the course and reported to the Dean's office for further punitive action. Students are free to ask the instructor any clarification questions.

Literature Review Project:

A literature review project will be assigned during the fourth week of the semester. For this project, students will review a highly-cited journal article on either turbulence theory or turbulence modeling and simulation. The deliverable of the project will consist of a review paper which summarizes the main results of the article, reflects on the impact of the article, and identifies what new questions the article raises.

Final Project:

A group-based final project will be assigned before the spring break. For this project, students will either (i) conduct a statistical analysis of turbulence simulation data, (ii) conduct a statistical analysis of turbulence experimental data, (iii) conduct a comparison of turbulence modeling approaches using a standard turbulent benchmark problem, (iv) examine the efficacy of a turbulence modeling approach for several turbulent benchmark problems, or (v) pursue their own topic with the instructor's permission. The deliverable of the project will consist of a journal-style paper, the details of which will be discussed when the project is assigned.

Slack:

A Slack channel has been created to foster communication. Students will receive an e-mail invitation to join this channel. Students can use Slack to ask questions regarding lecture material, homework assignments, the midterm exam, the literature review project, and the final project. Slack is the instructor's preferred means of communication, and he will make every effort to respond to Slack messages within 24 hours.

Late Submission Policy:

Generally speaking, late submissions will not be accepted. However, please contact the instructor if you are unable to submit any of the homework assignments, the midterm exam, the literature review project, or the final project due to illness, technical issues, or other challenging extenuating circumstances. Reasonable accommodations will be made where appropriate provided you contact the instructor before the submission due date.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation:

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Classroom Behavior:

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy.

Additional classroom behavior information

- Student Classroom and Course-Related Behavior Policy.
- Student Code of Conduct.
- Office of Institutional Equity and Compliance.
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- Office of Institutional Equity and Compliance.

Preferred Student Names and Pronouns:

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have your preferred name (rather than your legal name) and/or your preferred pronouns appear on your instructors' class rosters and in Canvas, visit the Registrar's website for instructions on how to change your personal information in university systems.

Honor Code:

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud,

submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part of adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from Student Conduct & Conflict Resolution and will be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Acceptable Use of AI In This Class:

This course emphasizes independent technical reasoning, physical interpretation, and mathematical understanding of turbulent flows. Artificial intelligence (AI) tools (e.g., large language models, code assistants, or similar technologies) may be used in limited and clearly defined ways. Students are responsible for ensuring that all submitted work reflects their own understanding and original intellectual contributions.

Permitted Uses (with disclosure):

- **Idea iteration and clarification:** AI tools may be used to refine, rephrase, or clarify ideas that you have already developed (e.g. to check logical flow, improve clarity of explanations, or identify alternative ways of presenting an argument).
- **Conceptual review:** AI tools may be used to review definitions, remind you of mathematical identities, or summarize background material *after* you have engaged with the primary sources (e.g., lecture notes, Pope, or journal articles).
- **Code debugging and refactoring:** AI tools may be used to assist you in identifying syntax errors, improving code readability, or improving efficiency for code that you have already written yourself.

Prohibited Uses:

- **Idea generation:** AI tools may not be used to generate original solution strategies, physical interpretations, mathematical derivations, or modeling choices for homework problems, projects, or written work.
- **Solution generation:** AI tools may not be used to generate full or partial solutions to homework problems, derivations, proofs, or computational workflows *even if* you seed them with solution strategies you initially developed.
- **Code generation:** AI tools may not be used to write substantial portions of original code or define the overall structure of algorithms, numerical methods, or simulation setups.
- **Examinations:** The use of AI tools is *strictly prohibited* on the midterm examination.
- **Misrepresentation:** Submitting AI-generated text, figures, code, or analysis as your own work – whether modified or unmodified – constitutes academic misconduct.

Disclosure Requirement:

If AI tools are used in any permitted way, students must briefly disclose how they were used (e.g., "AI was used to help debug plotting syntax" or "AI was used to improve clarity of prose"). Failure to disclose permitted AI use will be treated as a violation of course policy and the CU Honor Code.

Words of Caution:

Recognize that AI-generated content is often prone to inaccuracies or biases. For instance, AI often hallucinates mathematical steps or produces physically inconsistent explanations, especially in turbulence theory. Moreover, generated code may be numerically incorrect or scientifically meaningless despite appearing polished.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation:

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email OIEC@colorado.edu. Information about university policies, reporting options, and OIEC support resources including confidential services can be found on the OIEC website.

Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure the person impacted receives outreach from OIEC about resolution options and support resources. To learn more about reporting and support a variety of concerns, visit the Don't Ignore It page.

Religious Holidays:

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. Please communicate the need for a religious accommodation in a timely manner. See the campus policy regarding religious observances for full details.

Prepared by: John Evans Date: January 6, 2026