

# ASEN 6011: Experimental Fluid Mechanics

University of Colorado Boulder

Fall Semester 2023

## Syllabus

**Time:** Mon. & Wed. 10:00 AM - 11:15 AM

**Physical Classroom:** AERO 114

**Physical Laboratory Space:** WIND

**Virtual Office:**

**Instructor:** Professor John Farnsworth

Physical Office: AERO 365

Office Phone: (303)735-7287

Email: [john.farnsworth@colorado.edu](mailto:john.farnsworth@colorado.edu)

Office Hours: Mon. 2:00-3:00 PM & Wed. 3:00-4:00 PM

**Website:** Canvas (<https://canvas.colorado.edu>)

**Slack Workspace:** To help better facilitate online communication this semester we will also be using the following Slack Workspace: [Exp. Fluid Mech. \(ASEN 6011\)](#). Please note that you are not required to use this and all course wide notifications will still be sent out also via notifications through the course webpage, but we believe this application will help improve communication and collaboration within the course.

To join the Slack Workspace for the first time please register with your ...@colorado.edu email address using the following link: <https://join.slack.com/t/expfluidmechasen6011/signup>.

**Objective:** To establish a fundamental understanding of the theory and practice of performing experimental measurements in fluid mechanics.

**Description:** This course presents an intermediate level introduction into the theory and practice of performing experimental measurements in fluid mechanics. The fundamental principles and definitions associated with instrumentation, measurement procedures, data analysis, and uncertainty quantification will be discussed. A specific focus will be placed on the application of a variety of measurement techniques in low-speed aerodynamic environments. A selection of measurement techniques will be extensively studied and applied including: classical pressure and temperature measurements, thermal (hot-wire) anemometry, laser doppler anemometry, particle image velocimetry, surface and field flow visualization techniques, schlieren and shadowgraph photography techniques.

**Prerequisites:** Undergraduate level courses dedicated to the fundamentals of fluid mechanics, thermodynamics, and aerodynamics are recommended for this course. A basic background in optics, simple electronics, system dynamics, and signal processing will also be beneficial.

**Required Text:**

S. Tavoularis, *Measurements in Fluid Mechanics*. Cambridge University Press, 2005.

*Note: There is no official online access to this text through the CU Library.*

**Secondary Texts:**

1. C. Tropea, A. Yarin, J.F. Foss, *Springer Handbook of Experimental Fluid Mechanics*. Springer, 2007. [CU Library Online Access](#)
2. H. W. Coleman, W. G. Steele, *Experimentation, Validation, and Uncertainty Analysis for Engineers*. Wiley, 4th Ed., 2018. [CU Library Online Access](#)

*Note: The CU library provides full online access both of these texts.*

**Supplemental References:**

*Note: The CU library provides full online access to many of these texts. The links posted below should take you to the library search page from which you can access the texts. To access you may have to be on the campus network, logged into the campus VPN from on-campus, or may be asked to log in with your campus credentials to access the text.*

1. Experimental Fluid Mechanics Book Series, Springer. (Approximately 15 books each focused on a specific set of techniques, all can be downloaded on campus.) [Online Access](#)
2. M. Raffel, C. Willert, S. Wereley, J. Kompenhans, *Particle Image Velocimetry*. Springer, 3rd Ed., 2018. [CU Library Online Access](#)
3. R. J. Adrian, J. Westerweel, *Particle Image Velocimetry*. Cambridge Univ. Press, 2010.
4. G. S. Settles, *Schlieren and Shadowgraph Techniques*. Springer, 2001. [CU Library Online Access](#)
5. R. J. Goldstein, *Fluid Mechanics Measurements*. Taylor & Francis, 2nd Ed., 1996. [CU Library Online Access](#)
6. E. Rathakrishnan, *Instrumentation, Measurements, and Experiments in Fluids*. CRC Press, 2007. [CU Library Online Access](#)
7. J. R. Taylor, *An Introduction to Error Analysis*. University Science Books, 2nd Ed., 1997. [CU Library Online Access](#)
8. J. B. Barlow, W. H. Rae, A. Pope, *Low-Speed Wind Tunnel Testing*. Wiley, 3rd Ed. 1999.

**Grading:** The following presents the planned grading structure for the course. Be aware, that this is subject to change, however the class will be thoroughly notified and polled for agreement.

50% Homework Assignments (approximately 7 during first half of semester)

50% Lab Assignments (approximately 3 during second half of semester)

-Grades are posted to the class website (Canvas).

**Class Format:** The class meets in-person twice a week for an hour and fifteen minutes of formal lecture and discussion. All lectures will be recorded and posted on the course website for asynchronous viewing after the scheduled lecture period, and all students actively enrolled in the course will have access to the lecture videos. All office hours and other one-on-one meetings associated with this course can take place either in-person or virtually using the Zoom web-link provided above.

Select class meetings will be held in the Experimental Aerodynamics Laboratory which is within in the WIND building on the CU Boulder East Campus. During these class periods hands-on experimental laboratory experiments will be conducted. These experimental demonstrations will be separately recorded (independent of the classroom captured lectures) by the instructor and posted to the course website for asynchronous viewing by all students enrolled in the course.

**Homework Assignments:** Approximately seven sets of homework problems will be assigned during the first half of the semester so that students can implement and practice the theory and concepts discussed in class through traditional engineering problem solving. Students will have approximately one week to complete the assignment and will submit a scanned copy to Gradescope through the course website. Students should make an effort to turn in assignments that are organized, professional looking, and legible.

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 assignments from other students/sources. The work that a student turns in must be their own – copying is not allowed for any assignment and will not be tolerated. Students who are caught copying (or providing their assignment to another) will receive an “F” for the course and reported to the Dean’s office for further punitive action.

**Laboratory Assignments:** Approximately three laboratory assignments are planned to provide a practical experience with the the measurement techniques and the their data analysis. Due to the limitations on in-person participation, in-person attendance of the experimental demonstrations while strongly encourages, is not required. Video recordings of the laboratory demonstrations will be captured by the instructor and posted independently (i.e. separate from the classroom lecture recordings) to the course website for asynchronous viewing by all of the students enrolled in the course. Data sets, with clear directions will be posted to the course website to allow all individuals to participate. Students will submit individual laboratory reports. These reports will be limited to a four page single spaced document with a minimum 1 in margin and 10 pt font. This page limit is inclusive of all discussion, figures, and references. The lab reports will be uploaded as a pdf document to the drop-box folder on the course 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, political affiliation, or political philosophy. For more information, see the [classroom behavior policy](#), the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

**Requirements for Infectious Diseases:** Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the [further guidance of the Public Health Office](#). For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

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

[Disability Services](#) determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation, please notify the instructor as soon as possible so that appropriate accommodations can be made. If you are sick or require isolation please notify the instructor of your absence from in-person activities and continue in a completely remote mode, as you are able, until you are allowed or able to return to campus. Please note that for health privacy reasons you are not required to disclose to the instructor the nature of your illness or condition, however you are welcome to share information you feel necessary to protect the health and safety of others within the course. Also see [Temporary Medical Conditions](#) on the Disability Services website.

**Preferred Student Names and Pronouns:** CU Boulder recognizes that students’ legal information doesn’t always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors’ class rosters. In the absence of such updates, the name that appears on the class roster is the student’s legal name.

**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.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: [honor@colorado.edu](mailto:honor@colorado.edu), 303-492-5550. Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

**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 sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, protected-class discrimination and harassment, and related retaliation by or against members of our community on and off campus.

Visit [OIEC](#) for more information about university policies, [reporting options](#), and support resources. If you believe you may have been subjected to misconduct, [email OIEC](#) or call 303-492-2127.

Faculty and graduate instructors are required to inform OIEC when they learn of any issues related to these policies regardless of when or where they occurred. This ensures that individuals impacted receive information about their rights, support resources, and resolution options. Visit the [Don't Ignore It](#) page to learn more about reporting and support options.

**Religious Holidays:** Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must let the instructor know of any such conflicts within the first two weeks of the semester so that they can work with you to make reasonable arrangements.

See the [campus policy regarding religious observances](#) for full details.

**Last revised on:** August 30, 2023