

ASEN 5051: Fundamentals of Fluid Dynamics MCEN 5021: Introduction to Fluid Dynamics

University of Colorado Boulder

Fall Semester 2020

Syllabus

Time: Mon., Wed. & Fri. 2:20pm-3:10pm

Physical Classroom: AERO 111

Virtual Classroom/Office:

Instructor: Assistant Professor John Farnsworth

Office: AERO 365

Phone: (303)735-7287

Email: john.farnsworth@colorado.edu

Office Hours: Tues. 12:00pm-1:00pm

Teaching Assistant: Joseph Straccia

Email: joseph.straccia@colorado.edu

Office Hours: Fri. 12:00pm-1:00pm

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: 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.

Objective: To establish a fundamental understanding of fluid mechanics with a specific emphasis on incompressible flows.

Description: A rigorous introduction to the fundamentals of fluid dynamics. The course provides a solid foundation for students intending to study fluids at the advanced level, but is sufficiently broad that it serves as a valuable survey for many other students. Topics: Cartesian tensors, kinematics of fluid flows, conservation laws, vorticity dynamics, theory and application of irrotational flows, topics in geophysical fluid dynamics, dynamic similarity and nondimensional parameters, viscous flows, and boundary layers. Intended for students in all engineering majors.

Prerequisites: This class requires undergraduate courses in fluid mechanics, thermodynamics, and ordinary and partial differential equations. It attacks the subject at a graduate mathematics

level with extensive use of indicial notation and vector calculus. Students will find the course material much easier to digest by reviewing these topics before the start of class as only a rapid review of the background material will be given.

Required Text:

Fluid Mechanics, Kundu and Cohen (and Dowling). Academic Press, 4th Edition (6th Edition), 2008 (2016). [CU Library Online Access](#)

Note: There preferred edition of the textbook is the 4th edition, however any edition of this text should suffice for the course. The CU library provides full online access to each of the editions of the text. The link posted above 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 off-campus, or may be asked to log in with your campus credentials to access the text.

Supplemental Material:

1. *Incompressible Flow*, Panton, Wiley, 4th Edition, 2013. [CU Library Online Access](#)
2. *An Album of Fluid Motion*, Van Dyke, Parabolic Press, 1982.
3. *National Committee for Fluid Mechanics Films (NCFMF)*, Shapiro.
<http://web.mit.edu/hml/ncfmf.html>
4. *Vectors, Tensors and the Basic Equations of Fluid Mechanics*, Aris, Dover, 1989.
[CU Library Online Access](#)

Topics:

1. Basic Fluid Concepts
2. Scalars, Vectors, and Tensors
3. Basic Kinematic Concepts
4. Conservation Laws
5. Potential Flows
6. Vorticity Dynamics
7. Waves in Fluids
8. Laminar Flows
9. Boundary Layers
10. Stability and Transition to Turbulence
11. Turbulent Flows

Class Format: The class meets three times a week for fifty minutes of formal lecture and discussion. If students are unable to participate in-person, students are encouraged to participate in lectures virtually in a synchronous format using the Zoom web-link above. 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 will take place in a virtual format using the Zoom web-link provided above, same as that used for lectures.

Grading:

- 15% Homework Assignments
- 20% Concept Quizzes
- 30% Mid-Term Exams
- 35% Final Exam

Grades are posted to the class website on Canvas.

Reading: Readings are assigned frequently 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, they should either raise them during the lecture or contact the professor via email who will address the question during lecture.

Homework Policy: Homework problems are assigned weekly on Wednesdays so that students can implement and practice the theory and concepts discussed in class through traditional engineering problem solving. Students will have one week to complete the assignment and will submit a scanned copy to the course website on Canvas or Gradescope. Students should make an effort to turn in assignments that are organized, professional looking, and legible.

Homework assignments are provided as a learning tool to help students internalize the theories and methods discussed in class and are not used as detailed assessment of the learning. As a result, homework assignments will be graded for completion, in other words a student will receive full credit if they attempt each problem and display sufficient work along the way to each solution. Detailed problem solutions will be provided by the instructor and teaching assistant including basic grading rubrics. This will allow students to individually evaluate their work and assess their equivalent numerical grade, would the assignment have been graded for full credit. The process of critically evaluating ones own work, represents an additional learning opportunity, as it will force each student to dissect their work and understand any miss-steps they may have made.

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.

Twelve homework assignments are tentatively planned throughout the fifteen week semester. The lowest two homework assignment grades will be dropped from the overall homework average to provide students some flexibility and recovery throughout the course. Students are asked to complete their homework assignments on standard plain white or engineering paper, however this is not a requirement. That said students should keep individual problems separated on different pages. In other words, page breaks should be inserted between problems to simplify the uploading to the website and identification of individual problems.

Concept Quizzes: Short, timed quizzes which cover basic concepts, will be administered throughout the semester online using the course website on Canvas. The quizzes are meant to review

a students basic knowledge in fluid dynamics and for students to practice basic concepts progressively through the course. As a result these quizzes are used both as an assessment and a learning tool. Additionally, regular quizzes will be used to help keep students current with the course material and readings. Minimal mathematical problem solving will be required for the quizzes. The quizzes are closed to all notes and collaboration is not permitted.

Six concept quizzes are tentatively planned throughout the fifteen week semester. The lowest (one) grade will be dropped from the overall quiz average to provide students some flexibility and recovery throughout the course.

Exam Policy: The midterm and final examinations will cover all material in the course including lecture, discussions, homework, and quizzes. The final examination will be cumulative.

Collaboration on exams will not be tolerated. For the exams a one-sided (two-sided) 8.5 in. × 11 in. crib sheet is allowed for the midterm (final) exams. No calculators or other electronic devices are permitted. Students who are caught in violation of these policies will receive an “F” for the course and reported to the Dean’s office for further punitive action. Additionally students should be aware of the university’s final exam policies which can be found on the registrar’s website at <http://www.colorado.edu/policies/final-examination-policy>.

All exams will be administered remotely and will tentatively take place at the days and times provided below. If a student has a conflict with the day/time of the exam they are required to notify the instructor in writing via email at least two weeks prior to the exam to coordinate an alternate exam time. Please note that students must have a sufficient excuse to justify an adjustment to the exam schedule. Additionally, all students will be asked to log into the Zoom channel during the exam period for administration of the exam and for addressing any clarifying questions that may arise. Students will be responsible for completing the exam problems on their own paper and scanning the exam and submitting it to the course webpage on Canvas or Gradescope. Students are asked to specifically use standard plain white or engineering paper, however this is not a requirement. That said students should keep individual problems separated on different pages. In other words, page breaks should be inserted between problems to simplify the uploading to the website and identification of individual problems.

Midterm Exam 1: 2:20pm - 3:10pm Wednesday September 30, 2020

Midterm Exam 2: 2:20pm - 3:10pm Wednesday November 11, 2020

Final Exam: 1:30pm - 4:00pm Thursday December 10, 2020

Classroom Behavior: Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail 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 policies on [classroom behavior](#) and the [Student Code of Conduct](#).

Requirements for COVID-19: As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming on to campus each day, all students are required to complete a [Daily Health Form](#). In this class, you may be reminded of the responsibility to complete the [Daily Health Form](#) and given time during class to complete it.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick or quarantined, please notify the instructor of your absence from in-person activities and continue in a completely remote mode until you are able and allowed 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, however you are welcome to share information you feel necessary to protect the health and safety of others in the course.

Accommodation for Disabilities: 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.

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 policy may include: plagiarism, 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 the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation: The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#). Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

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 instructors know of any such conflicts within the first two weeks of the semester so that we can work with you to make reasonable arrangements.

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

Prepared By (Date): John A. N. Farnsworth (September 4, 2020)