

# THE UNIVERSITY OF COLORADO BOULDER

## ASEN 3711: Aerodynamics Fall 2023

### SYLLABUS

**Instructors:** Professor Robyn Macdonald  
E-Mail Address: [robyn.macdonald@colorado.edu](mailto:robyn.macdonald@colorado.edu)  
Office Hours Times/Location: Friday, 4 – 5 PM (AERO 359)

**Lecture Time/Location:** AERO 120      Monday/Wednesday/Friday, 1:55 – 2:45 PM

**Teaching Assistant:** Jaylon McGhee  
E-Mail Address: [jaylon.mcgee@colorado.edu](mailto:jaylon.mcgee@colorado.edu)  
Office Hours Times/Location: Wednesday, 5 – 6 PM (AERO 303)  
Tuesday, 5:30 – 7:00 PM (AERO N111)  
Thursday 5:30 – 7:00 PM (AERO N111)

**Teaching Fellows:** Avery Gillespie  
E-Mail Address: [avery.gillespie-1@colorado.edu](mailto:avery.gillespie-1@colorado.edu)  
Office Hours Times/Location: Monday, 5 – 6 PM (AERO 303)  
  
Nathan Varghese  
E-Mail Address: [nathan.varghese@colorado.edu](mailto:nathan.varghese@colorado.edu)

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

### Course Objectives:

The primary course objective is to develop a fundamental understanding of the origins and magnitude of aerodynamic forces and moments, primarily on aircraft where they provide the lift and balance needed to fly, and to develop methodologies for modeling and prediction of such forces and moments. A secondary course objective is to develop a fundamental understanding of gas dynamics in nozzles with application to aircraft and rocket propulsion.

### Learning Goals:

Establish a level of competency in the following topics such that you may use this expertise in the design of operational aircraft.

## **1. Fundamentals**

- a. Vector Calculus
- b. Fluid Mechanics
- c. Aerodynamics
- d. Gas Dynamics

## **2. Origins of Lift**

- a. Airfoils and Circulation
- b. Subsonic Wings
- c. Wing Sweep
- d. Supersonic Wings

## **3. Origins of Drag**

- a. Skin Friction Drag
- b. Form Drag
- c. Induced Drag
- d. Transonic Compressibility Drag
- e. Supersonic Wave Drag

## **4. Modeling and Prediction of Lift and Drag**

- a. Potential Flow Theory
- b. Incompressible Thin Airfoil Theory
- c. Compressible Thin Airfoil Theory
- d. Panel Methods
- e. Prandtl Lifting Line Theory

### **Textbook, References, and Material:**

Fundamentals of Aerodynamics, J.D. Anderson, Fifth or Sixth Edition

### **Course Website and E-Mail List:**

There will be a class website on Canvas. All relevant documents, schedules, and supplemental documents will be posted to this site throughout the semester. Please check back to see what has been posted. All course announcements outside of lecture will be sent as Canvas announcements, so it is the student's responsibility to make sure their Canvas settings are appropriately configured to receive these announcements.

Students should only e-mail the teaching team if they have a pressing logistical or health issue. The teaching team will aim to respond to e-mails within one business day. All questions on assignments, quizzes, exams, and course content should be asked during lecture or office hours.

### **Course Format:**

The course will follow a traditional lecture format. Homework will be assigned every Friday to be due the next Friday at the start of class. There will be three midterm exams throughout the semester and a final exam. Student assessment will be based on homework assignments, concept quizzes, in class activities, midterm exams, and the final exam.

**Grading:**

Course grades will be assigned based on the following percentages:

45% Midterm Exams (3 x 15%)  
25% Final Exam  
10% Homework  
10% Concept Quizzes  
10% In Class Activities

Grades will be posted to the course website on Canvas.

**Letter Grading Scheme:**

Letter grades will be assigned as follows:

<b>Letter Grade</b>	<b>Percent Grade</b>	<b>4.00 Scale</b>
A	93.00 – 100.00	4.00
A-	90.00 – 92.99	3.67
B+	87.00 – 89.99	3.33
B	83.00 – 86.99	3.00
B-	80.00 – 82.99	2.67
C+	77.00 – 79.99	2.33
C	73.00 – 76.99	2.00
C-	70.00 – 72.99	1.67
D	60.00 – 69.99	1.00
F	Below 60.00	0.00

All three midterm exams as well as the final exam will be curved, while the homework, quizzes, and in class activities will not be curved.

**Remarks on Grading:**

Our grading scheme is not designed to reward or punish. It is designed to indicate your level of competency compared to the standard that we set. Do you meet the minimum level of competency? Do you exceed the minimum? Are you below the minimum? The answers to these questions should be indicated by your final grade.

The final grade indicates your readiness to continue to the next level of courses. Meeting the minimum requirements indicates that you are prepared to continue at least at the minimum level required for the next in the sequence of courses. Exceeding the minimum means you are ready to enter the next course and that you have mastery of material beyond the minimum, that is, you show some level of proficiency.

**Regrading:**

All regrade requests must be made within two weeks of receiving the grade for an assessment. This policy applies to homework, exams, and quizzes.

## Homework Policy:

Homework will be assigned every Friday during lecture to be due the next Friday at the start of lecture. **Homework assignments are due on Canvas at the start of lecture (1:55 PM) on the due date.** If you must miss class for an excused absence, you may submit your homework early. Late assignments will not be accepted under any circumstance. However, the lowest homework grade will be dropped. Each homework assignment will be worth 10 points. Homework submissions will be graded for “completeness”, and solutions will be posted for self-assessment of “correctness”.

Collaboration is permitted on homework. You may discuss the means and methods for formulating and solving problems and even compare answers, but you are not free to copy someone else’s assignment. ***Copying material from any resource (including solutions manuals) and submitting it as one’s own is considered plagiarism and is an Honor Code violation.*** Students who are caught copying material, from either the solution manual or peer assignments, will receive a zero “Homework” grade for the class. Remember, the less you think about the problems yourself, the less you actually learn, and the more difficult it will be to succeed on exams.

Homework is meant both as a mechanism for students to learn and apply course material as well as practice solving problems for the midterm exams and final exam. As such, students should approach the homework assignments as if they were graded for “correctness”. Students should strive to demonstrate an understanding of the principles involved by including diagrams, using correct notation and terminology, explaining the approach, showing the key steps to obtaining the solution, and outlining the answer with proper units. Students should also submit work with a professional appearance.

## Concept Quiz Policy:

There will be a concept quiz each week of the semester except for the first and last week of class, midterm exam weeks, and the week of November 20, 2023. These concept quizzes will be administered as Canvas quizzes, and each quiz will be assigned on a Monday and due on the Friday of the same week at 11:59 PM. Students will have fifteen minutes to complete each quiz, and students will be able to take the concept quizzes as many times as they like before they are due. The concept quizzes will cover material assigned in readings during the week they are assigned, and they are intended to help students identify, practice, and comprehend important concepts. The concept quizzes will be closed-book, and there will be no make-up concept quizzes. However, the lowest concept quiz grade will be dropped.

## In Class Activities Policy:

There will be a periodic in class activities (such as iClicker questions, short worked out problems, and short paper quizzes) during the lecture. These activities are intended to provide practice in applying concepts discussed in lecture, reinforce conceptual understanding, and develop problem solving skills. There will be no make-up in class activities for missed lectures. However, up to 10% of points missed through in class activities will be dropped.

## **Midterm Exam Policy:**

There will be three midterm exams:

**Exam 1, October 6, 2023:** Fundamentals and Potential Flow

**Exam 2, October 30, 2023:** Incompressible Flow About Airfoils and Finite Wings

**Exam 3, December 4, 2023:** Compressible Flow and Shock Waves

The midterm exams will cover all material in the course including lectures, readings, and assignments.

Each midterm exam will consist of two parts. The first part will be fully closed book and will test understanding of concepts. The second part will be closed book except for a crib sheet and will involve derivation and problem solving. Collaboration on the midterm exams 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.

There will be no makeup midterm exams. If you are unable to attend a particular midterm exam due to an excused absence, your midterm examination grade will be replaced by your final exam grade associated with the missed midterm material.

The course is broken into three topics that are assessed through three midterm exams. These same three topics will be tested on the final. Recognizing that testing is never an exact science, your final grade will be calculated from your best percentage of the two topic tests (one from midterm, one from final) according to the following policy. When the better performance on a given topic occurs on the final, the topic score from the final will always be chosen which allows the final to replace any (up to all) midterm scores. However, for a midterm topic score to replace a lower topic score on the final, a student must score at least a 70% on the topic score from the final (after accounting for any curve applied). Thus, failing a topic on the final will result in that topic score being used in the final exam score with the weighting described at the start of the Grading section above.

## **Final Exam Policy:**

***There will be a comprehensive final exam on Tuesday, December 19, 2023 from 4:30 pm to 7:00 pm.*** The date of the final exam is dictated by the University of Colorado Boulder registrar's office and can not be changed or modified. As a result the exam can not be offered early and no make-ups will be permitted. Students are advised to plan their end of semester schedules accordingly.

The final exam will cover all material in the course including lecture, readings, and assignments.

The final exam will consist of two parts. The first part will be fully closed book and will test understanding of concepts. The second part will be closed book except for four crib sheets and will involve derivation and problem solving. Collaboration on the final exam 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.

If a student has an “A” (93 and above) midterm exam grade for each midterm going into the final exam, the student may elect to not take the final exam. In this case, the student’s midterm exam

average grade will replace the student's final exam grade. ***Students qualifying for this option will be notified by no later than the final exam reading day, Friday, December 15, 2023.***

### **Reading Assignments Policy:**

There will be reading assignments associated with each lecture. These assignments may be found on the course schedule. These reading assignments are to be completed before the lecture. The lecture and discussions should help to clarify and supplement what you have read.

### **Attendance Policy:**

Students are highly encouraged to attend all scheduled lectures. Expect new material to be presented in the lecture. Exams will cover all the material in the course, including lecture and homework. All lectures will be recorded via Classroom Capture for asynchronous review (not live Zoom). In class activities will not be available to those who do not attend the lecture where they are given (see In Class Activities above).

### **Evaluated Outcomes:**

The Department of Aerospace Engineering Sciences has adopted a policy of assigning grades to "evaluated outcomes" in each course:

- O1:** Professional context and expectations
- O2:** Current and historical perspective
- O3:** Multidisciplinary systems perspective
- O4:** Written, oral, and graphical communication ability
- O5:** Knowledge of key scientific/engineering concepts
- O6:** Ability to define and conduct experiments and use experimentation
- O7:** Ability to lead independently and find information
- O8:** Ability to work in teams
- O9:** Ability to design
- O10:** Ability to formulate and solve problems
- O11:** Ability to use and program computers

Evaluation of these outcomes allows an assessment of your performances and provides a major portion of the process we, the Faculty, use for continuous assessment and improvement of the entire AES undergraduate curriculum. The model for these outcomes derives from several sources including the *Desired Attributes of an Engineer* as defined by The Boeing Company and "curriculum reviews" from major aerospace corporations including The Boeing Company, Lockheed Martin Corporation, and Ball Aerospace Corporation. These inputs were combined with the AES faculty vision of the desired attributes of an aerospace engineer and the requirements of the Accreditation Board for Engineering and Technology (ABET) to produce this list of evaluated outcomes. Each assignment is designed and graded to assess some combination of these outcomes.

For ASEN 3111, these outcomes are grouped according to:

- Knowledge of scientific and engineering principles (O5)
- Ability to formulate and solve problems (O7, O10)

- Ability to develop and use computer programs (O11)
- Ability to design with a multidisciplinary systems perspective (O3, O9)
- Ability to work in a team (O8)
- Ability to communicate effectively (O4)
- Ability to appreciate ethical, economic, historical, and technical context (O1, O2)

## **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 contact the professor to coordinate for necessary accommodations. 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 [protected-class](#) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, [reporting options](#), and support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive an outreach from OIEC about their options for addressing a concern and the support resources available. To learn more about reporting and support resources for a variety of issues, visit [Don't Ignore It](#).

## **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 contact the professor at least two weeks in advance of any religious obligations which will conflict with class activities.

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



## **Mental Health and Wellness**

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact [Counseling and Psychiatric Services \(CAPS\)](#) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through [Academic Live Care](#). The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

**Prepared by:** Robyn Macdonald (August 22, 2023), Updated August 28, 2023