

THE UNIVERSITY OF COLORADO BOULDER

ASEN 3111: Aerodynamics Fall 2020

SYLLABUS

Instructors: Professor Kenneth Jansen (Lecture Instructor)
E-Mail Address: kenneth.jansen@colorado.edu
Office Hours Location: Zoom
Office Hours Times: Tuesday 3:00–4:00 pm, Thursday, 6:00–7:00 pm

Professor John Evans (Lab Instructor)
E-mail Address: john.a.evans@colorado.edu
Office Hours Location: Zoom
Office Hours Times: Tuesday, 8:30–9:30 am, Friday 4:00–5:00 pm

Lecture Location: Zoom
Lecture Time: Monday/Wednesday, 11:40 am–12:55 pm

Lab Location: AERO 141 / AERO N240 / AERO N250 / Zoom
Lab Time: Friday, 10:40 am–12:30 pm / Friday, 1:40–3:30 pm

Teaching Assistants: Jeffrey Hadley (Lab Lead)
E-mail Address: Jeffrey.Hadley@colorado.edu
Office Hours Location: Zoom
Office Hours Time: Tuesday 6:00–7:00 pm, Thursday 5:00–5:45 pm

Teaching Fellows: TBD
E-mail Address: TBD

TBD
E-mail Address: TBD

Lead Lab Assistant: TBD
E-mail Address: TBD

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

Prerequisites:

Prerequisites include APPM 2350, ASEN 2002, and ASEN 2004 with a minimum grade of C in each class. This course is restricted to Aerospace Engineering majors only.

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, lab assignments, schedules, and supplemental documents will be posted to this site throughout the semester. Please check back to see what has been posted.

Course Format:

The course will follow a blend of traditional lectures and laboratory exercises. There will be four computational modeling assignments and a semester-long design lab. Homework will be assigned every Wednesday to be due the next Wednesday at the start of class. There will be three midterm exams throughout the semester and a final examination. Student assessment will be based on homework assignments, computational assignments, lab reports, midterm exams, and the final exam.

Grading:

Course grades will be assigned based on the following percentages:

Individual Effort:

36% Midterm Quizzes (6 x 6%)

24% Final Exam

5% Reading Quizzes

10% Lab Quizzes (4 x 2.5%)

Group Effort:

5% Homework

10% Computational Assignments (4 x 2.5%)

10% Design Lab

Grades will be posted to the course website on Canvas. Group Effort only contributes to the final grade if the total Individual Effort grade is C or better.

Letter Grading Scheme:

Letter grades will be assigned as follows:

Letter Grade	Percent Grade	4.00 Scale
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 examination will be curved, while the homework, quizzes, computational assignments, and labs 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.

Homework Policy:

Homework will be assigned every Wednesday during lecture to be due the next Wednesday at the start of lecture. ***Homework assignments are due at the start of lecture on the due date.*** There is a ten-minute grace period (9:30 am – 9:40 am) during which the homework may be submitted. If you must miss class for an excused absence, you may submit your homework early. If you know in advance that you must miss a homework due date, send your instructor an e-mail to make arrangements. Late assignments will not be accepted under any circumstance. However, the lowest homework grade will be dropped.

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.*** 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 solutions must 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. These problem-solving steps are critical for developing problem formulation skills. Always submit work with a professional appearance. Neatness, clarity, and completeness will factor into your homework grade.

Each homework assignment will be worth 10 points. Assignments will only be graded for "completeness". Solutions will be posted for self-assessment of "correctness".

Reading Quiz Policy:

There will be 4-6 random reading quizzes in lecture throughout the semester. The reading quizzes will cover material assigned in readings that should be completed prior to the start of the lecture as well as material discussed in prior lecture periods. There will be no make-up reading quizzes. However, the lowest reading quiz grade will be dropped.

Lab Quiz Policy:

There will be 4 lab quizzes throughout the semester, one following each computational assignment. The lab quizzes will cover material associated with the computational assignments as well as material presented or discussed within the lab. There will be no make-up lab quizzes. However, the lowest lab quiz grade will be dropped.

Homework Submission Policy:

All homework must be submitted to canvas as scans of 8.5 x 11-inch paper. You may use ruled notebook paper, but blank paper or engineering paper is much preferred. Use only the front side of engineering paper as scans can bleed through material written on the other side. Take care to set contrast for readability. This is good practice for your exams which will need to be submitted the same way.. Your name (i.e., Last Name, First Name), assignment number, and due date should be visible on the outside in the upper portion of each page. Written work must be neat and readable with adequate spacing and margins. You are responsible for legibility – no re-evaluation will be granted. Very messy work will be returned to you ungraded and a score of zero recorded. Final answers must be indicated with an arrow, underline, or box. Multiple answers will be counted incorrect when only one is required.

Midterm Exam Policy:

There will be six midterm examinations:

Midterm Quiz 1, September 9, 2020: Fundamentals

Midterm Quiz 2, September 28, 2020: Potential Flow

Midterm Quiz 3, October 12, 2020: Incompressible Flow About Airfoils

Midterm Quiz 4, October 26, 2020: Incompressible Flow About Finite Wings

Midterm Quiz 5, November 9, 2020: Compressible Flow and Shock Waves

Midterm Quiz 6, November 30, 2020: Nozzles and Linearized Compressible Potential Flow

The midterm examinations will cover all material in the course including lecture, discussions, assignments, and laboratory exercises.

The midterm examinations will be closed book except for a crib sheet, and collaboration on the midterm examinations 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 examinations. If you are unable to attend a particular midterm

examination due to an excused absence, your midterm examination grade will be replaced by your final examination grade associated with the missed midterm material.

The course is broken into 6 topics that are assessed through 6 in class quizzes. These same 6 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 to replace a lower topic score on the final, you must score at least a 70% on that topic of the final exam. Thus, failing a topic on the final will result in that topic's 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 examination on Sunday, December 13, 2020 from 1:30 pm to 4:00 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 examination will cover all material in the course including lecture, discussions, assignments, and laboratory exercises.

The final examination will be closed book except for three crib sheets, and collaboration on the final 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.

If you have an "A" midterm examination average grade going into the final examination, you may elect to not take the final examination. In this case, your midterm examination average grade would replace your final examination grade. *Students qualifying for this option will be notified by no later than the final exam reading day, Friday, December 11, 2020.*

Computational Assignments Policy:

There will be four computational modeling assignments throughout the semester. These are:

- CA 1:** Introduction to Numerical Integration and Computation of Lift/Drag
- CA 2:** Computing Lifting Flow over Thin Airfoils via Superposition
- CA 3:** Computing Lifting Flow over Thick Airfoils via the Vortex Panel Method
- CA 4:** Computing Lifting Flow over Finite Wings via Prandtl Lifting Line Theory

To complete these assignments, students must have access to a computer, basic programming skills, and familiarity with some programming languages and/or environments similar to what is covered in introductory computing courses. The minimum requirement is some proficiency with MATLAB. If you are not familiar with MATLAB, it is your responsibility to become so. You have access to

the Co-PILOT computers during regular class lab times and during periods for which no other class is using them.

Collaboration is permitted on the computational assignments. 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 work. ***Copying material from any resource (including code from another student or online) and submitting it as one's own is considered plagiarism and is an Honor Code violation.***

For each computational assignment, code must be submitted, including a "driver" MATLAB script producing all requested figures. Code must be written individually. If you have collaborated with others while designing your code, be sure to credit them in a comment section at the top of your "driver" MATLAB script. ***Codes should be submitted via the course website by 11:59 PM on the due date. Code will not be accepted after the given due date.***

Further guidelines for the code submission will be given in class.

Design Lab Policy:

There will be a semester-long design lab where you will estimate the range and endurance of an unmanned aerial vehicle using theory, modeling, and simulation. There will be three deliverables associated with this design lab. The first deliverable will involve estimating range and endurance using provided computational fluid dynamics data. The second deliverable will involve estimating range and endurance using thin airfoil theory and Prandtl lifting line theory. Finally, the third deliverable will involve estimating range and endurance using the modeling tools developed in the four computational assignments.

You will submit an individual report detailing your work and findings for each design lab deliverable. Collaboration is permitted on the design lab deliverables. You may discuss means and methods for estimating range and endurance and even compare answers, but you are not free to copy someone else's work. ***Copying material from any resource (including using code from another student or online) and submitting it as one's own is considered plagiarism and is an Honor Code violation.***

Your design lab reports should be completed using a word processor or desktop publishing package such as Microsoft Word or LaTeX. In your reports you should include an acknowledgement section, and credit any other individuals whom you worked with. ***Your reports should be submitted via the course website by 11:59 PM on the due date. Reports will not be accepted after this date.***

Further guidelines for the design lab report write-up and submission will be given in class.

Reading Assignments Policy:

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

Attendance Policy:

Attendance is expected at all scheduled lecture and laboratory periods. Expect new material to be presented in both the lecture and laboratory periods. Exams will cover all the material in the course, including lecture, discussions, homework, and laboratory exercises.

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 design and conduct experiments (O6)
- Ability to appreciate ethical, economic, historical, and technical context (O1, O2)

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 or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website.

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. For each class, check with your faculty member in advance so that you are aware of their specific requirements for accommodating religious observances. See the [campus policy regarding religious observances](#) for full details.

Classroom and On-Campus 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](#).

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

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including dating or domestic violence), stalking, 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, discrimination, harassment, and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

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 who are 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](#).

Prepared by (through iteration with) : Brian Argrow, John Evans, John Farnsworth, and Kenneth Jansen