THE UNIVERSITY OF COLORADO BOULDER

ASEN 3111: Aerodynamics
Spring 2021

SYLLABUS

Instructors:	Professor John Evans (Lecture Instructor) E-Mail Address: john.a.evans@colorado.edu Office Hours Location: Zoom Office Hours Times: Tuesday 3:00–4:00 pm, Thursday 2:00–3:00 pm Professor John Farnsworth (Lab Instructor) E-mail Address: john.farnsworth@colorado.edu Office Hours Location: Zoom Office Hours Times: Friday 3:30–4:30 pm, Monday 9:00–10:00 am
Lecture Location: **Lecture Time:**	Zoom Tuesday/Thursday, 11:40 am–12:55 pm
Lab Location: **Lab Time:**	AERO 141/N100/111/120 / Zoom Friday 8:30–10:20 am / Monday 3:00–4:50 pm
Teaching Assistants:	Joseph Straccia E-mail Address: joseph.straccia@colorado.edu Office Hours Location: Zoom Office Hours Time: Monday 1:00–3:00 pm
Teaching Fellows:	David Perkins E-mail Address: david.perkins@colorado.edu Aidan Kirby E-mail Address: aidan.kirby@colorado.edu Shray Chauhan E-mail Address: shray.chauhan@colorado.edu Tristan Liu E-mail Address: tristan.liu@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

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. Homework will be assigned every Tuesday to be due the next Tuesday at the start of class. There will be four computational assignments and an end-of-semester design lab. There will be weekly concept quizzes and a lab quiz following each computational assignment. There will be three midterm exams throughout the semester and a final exam. Student assessment will be based on homework assignments, computational assignments, the design lab, concept quizzes, lab quizzes, midterm exams, and the final exam.

Grading:

Course grades will be assigned based on the following percentages:

Individual Effort:
- 36% Midterm Exams (3 x 12%)
- 24% Final Exam
- 10% Lab Quizzes (4 x 2.5%)

Group Effort:
- 5% Homework
- 5% Concept Quizzes
- 20% Computational Assignments and Design Lab (5 x 4%)

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 exam will be curved, while the homework, concept quizzes, lab quizzes, computational assignments, and design lab 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 Tuesday during lecture to be due the next Tuesday at the start of lecture. All homework submissions must be uploaded to Canvas as PDF files before they are due. ***Homework assignments are due at the start of lecture on the due date.***

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". Late assignments will not be accepted under any circumstance, but 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.*** 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 March 23, 2021. 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.

Lab Quiz Policy:

There will be four 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. The lab quizzes will be closed book, and there will be no make-up lab quizzes. However, the lowest lab quiz grade will be dropped.

Midterm Exam Policy:

There will be three midterm exams:

> **Exam 1, February 16, 2021:** Fundamentals and Potential Flow
> **Exam 2, March 16, 2021:** Incompressible Flow About Airfoils and Finite Wings
> **Exam 3, April 20, 2021:** Compressible Flow and Shock Waves

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

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 Wednesday, May 5, 2021 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, discussions, assignments, and laboratory exercises.

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" midterm exam average grade 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, April 30, 2021***.

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.

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.*** Students who are caught copying material will receive a zero "Computational Assignments and Design Lab" grade for the class.

For each computational assignment, a zip file containing your code must be submitted, including a "driver" or "main" 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" or "main" MATLAB script. ***Codes should be submitted via the course website by 11:59 PM on the due date (typically a Thursday). 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 an end-of-semester design lab where you will estimate the range and endurance of an unmanned aerial vehicle using the computational tools developed with the computational assignments throughout the semester. You will submit a write-up detailing your work for this design lab directly to Canvas as a PDF file.

Collaboration is permitted on the design lab. 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.*** Students who are caught copying material will receive a zero "Computational Assignments and Design Lab" grade for the class.

Your write-up should be completed using a word processor or desktop publishing package such as Microsoft Word or LaTeX. In your write-up you should include an acknowledgement section where you credit any other individuals whom you worked with. ***Your write-up should be submitted via the course website by 11:59 PM on the due date (Thursday April 29, 2021). Write-ups will not be accepted after this date.***

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

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 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. All lectures and lab introductions will be recorded and posted on Canvas.

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 effective (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, see Temporary Medical Conditions 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 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.

All students who are new to campus must complete the COVID-19 Student Health and Expectations Course. Before coming to campus each day, all students are required to complete the Buff Pass.

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. Such students will be able to attend the lab and lecture remotely in this class. If you are sick or quarantined, please inform the instructor if you need proper accommodations.

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 graduate 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.

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.

Prepared by: John Evans and John Farnsworth (January 14, 2021)