THE UNIVERSITY OF COLORADO BOULDER

ASEN 3111: Aerodynamics
Fall 2017

SYLLABUS

Material is preliminary and subject to change

Instructors: Assistant Professor John Evans
Office: ECAE 159
E-Mail Address: john.a.evans@colorado.edu
Office Hours: Tuesday/Thursday, 9:30 am – 10:30 am

Additional Availability: Second half of labs in breakout room

Lecture Location: GOLD A2B70
Lecture Time: Tuesday/Thursday, 8:00 am – 9:15 am

Lab Location: ITLL 2B10
Lab Time: Friday, 8:00 am – 9:50 am / 10:00 am – 11:50 am / 1:00 pm – 2:50 pm

Teaching Assistants: Charles Goble
E-mail Address: Charles.Goble@colorado.edu
Office: ECAE 124
Office Hours: Monday, 2:30 pm – 4:30 pm

Corwin Sheahan
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Office Hours: Wednesday, 2:00 pm – 4:00 pm

Bryce Huber
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Course Assistant: David Emmert
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Lab Assistant: Alexander Walker
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Web Page: Desire2Learn (learn.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
    f. Computational Fluid Dynamics

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 at Desire2Learn. 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 computational and experimental labs. There will be a total of five computational labs and two experimental labs. Homework will be assigned every Tuesday to be due the next Tuesday at the start of class. There will be three midterm exams throughout the semester and a final examination. Finally, there will be a project involving CFD (Computational Fluid Dynamics) software. Student assessment will be based on homework assignments, programs and lab reports, midterm exams, the final exam, and the project.

Grading:

Course grades will be assigned based on the following percentages:

Individual Effort:
- 36% Midterm Exams (3 x 12%)
- 24% Final Exam

Group Effort:
- 10% Homework and Quizzes
- 30% Labs and Projects

Of the 30% allotted for Labs and Projects, 16% will be allotted for computational labs (3% for Lab 1, 1% for Lab 2, 3% for Lab 3, 5% for Lab 4, and 4% for Lab 5), 8% will be allotted for experimental labs (4% for each lab), and 6% will be allotted for the CFD project.

Grades will be posted to the course website on Desire2Learn. 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, labs, and projects 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. *Homework assignments are due at the start of lecture on the due date*. There is a ten-minute grace period (8:00 am – 8:10 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.

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, of which 5 points will be assigned for "completeness" and 5 points will be assigned for "correctness". All problems associated with an assignment will count toward the "completeness" score, and credit for a given problem will be awarded only if a student selects a solution method, applies it, and obtains an answer. If a student does not execute all three of these steps, he or she will not receive "completeness" credit for the given problem. Only one problem associated with an assignment will count toward the "correctness" score. 3 of the 5 "correctness" points will be associated with correctness of solution

methodology, while 2 of the 5 "correctness" points will be associated with correctness of the final answer. There will generally be no partial credit associated with "correctness".

There will also be 4-6 random reading quizzes throughout the semester. These will be worth 10 points each and will count toward a student's overall homework grade.

Homework Submission Policy:

All homework must be on 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. Do not submit assignments on spiral notebook paper with ripped edges. Multiple pages must be stapled in the upper-left corner. 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 three midterm examinations:

> *Examination 1, September 28, 2017:* Fundamentals and Potential Flow
> *Examination 2, October 26, 2017:* Incompressible Flow About Airfoils and Finite Wings
> *Examination 3, December 7, 2017:* Compressible Flow and Shock Waves

The midterm examinations will cover all material in the course including lecture, discussions, assignments, and computational and experimental labs.

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.

Final Exam Policy:

There will be a comprehensive final examination. The final examination will cover all material in the course including lecture, discussions, assignments, and computational and experimental labs.

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.

Final Project Policy:

A CFD-based (Computational Fluid Dynamics) project will be assigned toward the end of the semester. You may work on the final project in groups. In this project, you will simulate aerodynamics of a real-life engineering system using CFD software (a "virtual wind tunnel").

Computational Lab Policy:

There will be five computational labs throughout the semester. These are:

Lab 1: Introduction to Numerical Integration and Computation of Lift/Drag
Lab 2: Introduction to Numerical Solution of Potential Flow using the PDETool
Lab 3: Computing Lifting Flow over Thin Airfoils via Superposition
Lab 4: Computing Lifting Flow over Thick Airfoils via the Vortex Panel Method
Lab 5: Computing Lifting Flow over Finite Wings via Prandtl Lifting Line Theory

To complete these labs, 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 ITLL Lab Plaza computers during regular class lab times and during periods for which no other class is using them. There are also a number of computers in the student group-study rooms and in the main building of the Engineering Center.

Collaboration is permitted on the computational labs. 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 solutions manuals) and submitting it as one's own is considered plagiarism and is an Honor Code violation.*

Computational lab reports must be written individually. If you have collaborated with others while writing your code, be sure to credit them in the Acknowledgements section. Computational lab reports should be submitted via the course website by 8:00 AM on the due date. Reports will not be accepted after the given due date.

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

Experimental Lab Policy:

There will be two experimental labs throughout the semester. These are:

Lab 1: Examination of the Wake Behind Aerodynamic Bodies
Lab 2: Study of Aerodynamic Forces and Moments About Finite Wings

Experimental laboratory exercises are more complex than hands-on homework and require special equipment such as a wind tunnel. You will work in teams and submit group reports for each experimental lab. Experimental lab reports should be completed using a word processor or desktop publishing package such as Microsoft Word. All group member names should appear on the cover page (one report per group) and should be submitted via the course website by 8:00 AM on the due date. Reports will not be accepted after this date. Each group member will also be required to submit a confidential peer evaluation of his or her group members, and a portion of each student's grade will be based on these peer evaluations.

Safety is the number one priority for the experimental laboratory. You are required to attend the safety lecture presented by the ASEN 2000 Laboratory Coordinator during the first week of the semester. The ITLL also has a mandatory orientation. Anyone violating rules of safe conduct may receive a zero for the laboratory exercise and may be restricted from the ITLL. Those endangering themselves, others, or laboratory equipment by their unsafe conduct will not maintain their access privileges. Food and drink are not allowed in the ITLL laboratory plazas. This includes bottled water.

Further guidelines for the experimental 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 computational and experimental labs.

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 included 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 (www.colorado.edu/disabilityservices/students). 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 and discuss your needs with your professor.

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 campus policy regarding religious observances for full details.

Classroom and On-Campus Behavior:

Students and faculty each have responsibility for maintaining an appropriate learning environment, not only while in class, but *also while working outside of class such as in labs and study areas*. 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 differences of race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy. Class rosters are provided to the instructor with the student's legal name. We will gladly honor your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester so that we may make appropriate changes to our records. For more information, see the policies on classroom behavior and the student code.

Discrimination and Harassment:

The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning,

working, and living environment. CU Boulder will not tolerate, both in-class and outside of class, acts of sexual misconduct, discrimination, harassment, or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking, or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment, or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment, or related retaliation can be found at the OIEC website.

Honor Code:

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the academic integrity policy. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible of violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at http://honorcode.colorado.edu.

Prepared by: John Evans Date: August 21, 2017