1THE UNIVERSITY OF COLORADO BOULDER

ASEN 3111: Aerodynamics
Spring 2020

SYLLABUS

Instructors: Professor Kenneth Jansen (Lecture Instructor)
E-Mail Address: jansenke@colorado.edu
Office Hours Location: AERO 363
Office Hours Times: Wednesday 12:50-2:00,
TBD

Professor Brian Argrow (Lab Instructor)
E-mail Address: Brian.Argrow@colorado.edu
Office Hours Location: AERO 224N
Office Hours Times: Monday 8:30 am -9:30 am,
Tuesday 4:30 pm -5:30 pm

Lecture Location: AERO 120
Lecture Time: Monday/Wednesday, 9:30 am – 10:45 am

Lab Location: AERO N100
Lab Time: Tuesday, 8:30 am – 10:20 pm / Tuesday, 2:30 pm – 4:20 pm

Teaching Assistants: Sara Swenson (Lab Lead)
E-mail Address: sara.swenson@colorado.edu
Office Hours Location: AERO TBD
Office Hours Time: Monday 11:00-12:00, Wednesday 5:00-6:00

John Patterson (Lecture Lead)
E-mail Address: john.patterson@colorado.edu
Office Hours Location: AERO TBD
Office Hours Time: Monday 1:00 Friday 4:00

Teaching Fellows: Shannon Chott (Primary Homework Grader and 10:30 am Lab Assist)
E-mail Address: shannon.chott@colorado.edu

Thomas Kisylia (Primary Lab Grader and 1:30 pm Lab Assist)
E-mail Address: thomas.kisylia@colorado.edu

Lead Lab Assistant: Rowan Gonder (Lead and Coordinator of Wind Tunnel Lab Assistants)
E-mail Address: rowan.gonder@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
    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 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 (both computational and experimental). There will be a total of four computational modeling assignments, one experimental wind tunnel lab, and one CFD (Computational Fluid Dynamics) 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 Exams (3 x 12%)
24% Final Exam
5% Reading Quizzes
5% Lab Quizzes
Group Effort:
10% Homework
20% Computational Assignments and Labs

Of the 20% allotted for computational assignments and labs, 8% will be allotted for computational assignments (2% for each computational assignment), 6% will be allotted for the experimental lab, and 6% will be allotted for the CFD 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, 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".

Reading Quiz Policy:

There will be 4-6 random reading quizzes in lecture throughout the semester. These will be worth 10 points each. 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 4-6 random lab quizzes in lab throughout the semester. These will be worth 10 points each. The lab quizzes will cover material associated with the laboratory exercises (both the computational assignments, the experimental lab, and the CFD lab) as well as material presented or discussed in 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 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, February 5, 2020: Fundamentals and Potential Flow
Examination 2, March 9, 2020: Incompressible Flow About Airfoils and Finite Wings
Examination 3, April 22, 2020: Compressible Flow and Shock Waves

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 midterm material.

Final Exam Policy:

There will be a comprehensive final examination on Tuesday, May 5, 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 13, 2019***.

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.

Experimental Wind Tunnel Lab Policy:

There will be one experimental lab: "Examination of the Wake Behind Aerodynamic Bodies". The experimental lab is more complex than hands-on homework and requires special equipment such as the educational wind tunnel in the PILOT Lab.

You will work in groups to collect the data, but will submit an individual report. Collaboration is permitted on the experimental laboratory work. You may discuss the means and methods for collecting and analyzing the data and even compare answers, but you are not free to copy someone else's work. ***Copying material from any resource (including post-processing or analysis code) and submitting it as one's own is considered plagiarism and is an Honor Code violation.***

Your experimental lab report should be completed using a word processor or desktop publishing package such as Microsoft Word or LaTeX. In your report you should include an acknowledgement section, and identify all of the group members who collaborated in the data collection and credit any other individuals whom you worked with in the data analysis. ***Your report 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 experimental lab report write-up and submission will be given in class.

Computational Fluid Dynamics Lab Policy:

There will be one computational fluid dynamics lab: "Computational Fluid Dynamics (CFD) Simulation of Aerodynamic Bodies." In this lab you will simulate aerodynamics of a simple wing section using a commercial CFD software package (i.e. a "virtual wind tunnel").

You will carry-out the simulations individually, and will also submit an individual report detailing your work and findings. Collaboration is permitted on the CFD laboratory work. You may discuss the means and methods for simulating the flow and analyzing the data and even compare answers, but you are not free to copy someone else's work. ***Copying material from any resource (including using someone else's CFD results) and submitting it as one's own is considered plagiarism and is an Honor Code violation.***

Your CFD lab report should be completed using a word processor or desktop publishing package such as Microsoft Word or LaTeX. In your report you should include an acknowledgement section,

and credit any other individuals whom you worked with in the CFD simulation or data analysis. ***Your report 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 computational fluid dynamics 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 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 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:

Students and faculty each have responsibility for maintaining an appropriate learning environment. 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. Class rosters are provided to the instructor with the student's legal name. Faculty will honor your request to address you by an alternate name or gender pronoun. Please advise faculty of this preference early in the semester so that they may make appropriate changes to their records. For more information, see the policies on classroom behavior and the Student Code of Conduct.

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: Brian Argrow, John Evans, John Farnsworth, and Kenneth Jansen
Date: January 13, 2020