

ASEN 2004 – Spring 2021

Introduction to Aerospace Vehicle Design and Performance

Recitation: Tu/Th 8:30 – 9:45 am

Lab: M/W 8:30 – 10:20 am (Section 011)
M/W 10:40 am – 12:30 pm (Section 012)
M/W 12:50 – 2:40 pm (Section 013)

Instructors: Prof. John Mah (Aircraft)
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Class Website: <https://canvas.colorado.edu/courses/69951>

Slack:

Quiz / Lab Submission Site: Gradescope, <https://www.gradescope.com/courses/221063>

Class Email List: Through Canvas.

Texts: Anderson, **Introduction to Flight**, 8th ed. 2016 (hardcopy or electronic version)
Sellers, **Understanding Space: An Introduction to Astronautics**, 3rd (2005) or 4th (2014) ed. (only select chapters required: 1, 4, 5, 6, 7, 12, 13, and 14.)

Prerequisites: ASEN 2002, ASEN 2012, APPM 2350 or equivalent.

Corequisites: APPM 2360 or equivalent.

Required Equipment

- A way to turn written work into a PDF. This could be a tablet computer on which you write electronically, or a scanner smartphone app (such as CamScanner or Scannable) to scan in handwritten work on paper.
- A computer microphone or a phone would be very beneficial to participate in group work.

Course Objectives: To introduce the theory and methods for design and performance analysis of aircraft and spacecraft. Aircraft topics include wing design, propulsion, aircraft performance, and stability and control.

Spacecraft topics include mission design, rocket performance, orbital mechanics and spacecraft subsystems. Emphasis is placed on introducing systems engineering aspects of design and analysis for aerospace vehicles.

Major Course Topics

Aircraft

1. Elements of airplane design
2. Performance of airfoils and wings
3. Elements of airplane performance
4. Preliminary airplane stability and control
5. Preliminary airplane propulsion

Spacecraft

1. Elements of space mission design
2. Launch requirements and rocket performance
3. Introduction to astrodynamics
4. Overview of spacecraft subsystems
5. Introduction to spacecraft systems engineering

Grading Guidelines

Group work:	2 Aircraft Labs	20% (10% each)
	2 Spacecraft Labs	20% (10% each)

Individual:	6 Quizzes (3 aircraft, 3 spacecraft)	60% (10% each)
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100%

- Group work only counts towards final grade if the total individual grade is C or better.
- Please verify all your scores and grades on Canvas and Gradescope within 2 weeks after they are posted; requests to change a score need to be made within this period. All regrade requests should be submitted to Gradescope using the “regrade request” functionality.
- We reserve the right to make minor changes to this distribution of weights based on variations in assignments.

Course Delivery

Guidelines use the following definitions:

- In-Person (Synchronous): activity in person on campus on scheduled days and times.
- Hybrid (Synchronous): rotating in-person schedule.
- Remote (Synchronous): activity via Zoom or other real-time platform on scheduled days and times; students will need to participate in activity or complete assignment at a specified time.
- Online (Asynchronous): activity via lecture capture or Canvas online; students can participate when it is convenient for them within a specified time window.

Class	Class Delivery	Notes
Lecture	Online (Asynchronous)	Online videos posted to Canvas every Friday for the following week's 1-2 topics. Recommend watching the day of or before the scheduled topic.
Recitation	Remote (Synchronous)	Offered over Zoom during lecture times. Attendance is encouraged, but not required with a few exceptions noted on the schedule. Recitations will be recorded and posted to Canvas after they occur synchronously.
Quizzes	Remote (Synchronous)	Quizzes occur during scheduled lecture time and will be submitted via Gradescope. Attendance is required.
Final Exam (Optional)	Remote (Synchronous)	The final exam will occur during the university-scheduled time and will be submitted via Gradescope. Attendance is required.
Office Hours	Remote (Synchronous)	Offered over Zoom.
Lab	Remote (Synchronous)	Offered over Zoom and will occur during scheduled lab time. Attendance is required on Mondays and encouraged, but not required, on Wednesdays with a few exceptions noted on the schedule. You also need to work with your assigned lab team outside of lab hours to complete assignments.
Testing (Optional)	Hybrid (Synchronous)	During the last 2 weeks of labs, teams will have the opportunity to build their glider and rocket and sign up for a time to test them at the Aerospace Building.

If you cannot meet a component of the course delivery system, please notify both instructors. If you seek an all-online, asynchronous experience (not able to meet weekly scheduled lectures or labs even remotely), please reach out to Profs. Mah and Johnson as soon as possible.

Online Learning Protocol

The Zoom meeting environment is a professional one—this includes expectations for your conduct, attire, and environment. Please refer to the “AES Lab and Groupwork Protocol” document for more details. Here are some highlights:

- 1) Please use your preferred full name when you join the Zoom session. Do not use any usernames or “nicknames” that don’t represent your real name.
- 2) Please mute yourself when you are not talking to avoid distracting the rest of the class.
- 3) If you feel comfortable turning your camera on during office hours and lab, you are encouraged to do so. However, students will not be required to show video of themselves during any part of the class. If you choose to have your camera turned off, we would appreciate you putting a picture of yourself as your Zoom profile picture to help us connect your face to your name!
- 4) You will be able to fully participate in the class without having a webcam. You will be able to ask questions during recitation, office hours, and lab through voice (by using the “Raise Hand” feature in Zoom) or through chat.
- 5) This course is a professional space. If you are not in an office-like setting, we recommend that you use a virtual background if your computer allows. Also please wear attire that you would wear to class if we were meeting in person.
- 6) Be engaged and responsive during the meeting. Don’t be afraid to speak or use chat, especially if the meeting is small. Your feedback and engagement are essential to the communication that takes place in a meeting.

Quiz Times and Policies

Instead of exams, students will take 6 quizzes Remotely throughout the semester. Each quiz will consist of a few conceptual questions and at least one work-out problem. Each quiz will open at 9:00 am MST/MDT and will close at 9:45 am MST/MDT. The quiz will be available on Gradescope, and you will have 30 minutes to complete the quiz and then an additional 15 minutes to scan and submit your handwritten work to Gradescope. You will not be given credit for a work-out problem if you submit the final answer without work. If you have the wrong final answer, this work will be used to give you partial credit.

- Aircraft Quizzes
 - Quiz 1: Thursday, Jan. 28
 - Quiz 2: Tuesday, Feb. 16
 - Quiz 3: Tuesday, March 2
- Spacecraft Quizzes
 - Quiz 4: Thursday, March 18
 - Quiz 5: Thursday, April 8
 - Quiz 6: Tuesday, April 20

As students may use the final exam to replace up to 3 quizzes, no make-up quizzes will be granted.

Final Exam

The final exam is optional: students are not required to take the final exam and the final exam will not be counted towards your grade on its own. The final exam will be used to replace up to 3 quiz grades. The final exam will consist of 6 questions, each one covering material from a different quiz. You will choose

up to 3 questions to answer. If your score on a given final exam question is higher than your score for the corresponding quiz, your quiz score will be replaced with your score on that final exam question. If your score on a given final exam question is lower than your score for that quiz, your quiz score will remain unchanged.

The final exam will take place during the university-scheduled final exam time, which is:

- Optional Final Exam: Saturday, May 1, 7:30 – 9:15 pm MDT

Homework: One homework assignment will be assigned for each quiz. These assignments are to provide you practice application problems to prepare you for the quizzes but homework will not be graded.

Lecture: The primary mode of lecture will be pre-recorded videos provided by your instructors via a link through Canvas. These videos are an Online, asynchronous component of the course delivery in addition to your reading and homework activity.

Recitations: “Recitation” meetings will occur during the course’s established meeting time – Tuesdays and Thursdays from 8:30 – 9:45 am. In the meetings the instructor will present example application problems, give students time to work through these problems, discuss the process for solving the problem, and then conclude with open office hours. These recitations are a Remote, synchronous component of the course delivery. Students are strongly encouraged to participate in recitations, but synchronous attendance is not required. All recitations will be recorded and posted to Canvas after they are conducted.

Office Hours: Students can ask questions about concepts, example problems given in the lecture videos, and homework assignments Remotely via Zoom during office hours that will be held throughout the week. Students are strongly encouraged to participate in office hours, even if they don’t have specific questions about the material or the homework. The course Slack workspace may also be used for any questions at any time and will be moderated by the instructional team.

Evaluated Outcomes

The Department of Aerospace Engineering Sciences has adopted a policy of assigning grades according to evaluated outcomes (Ox) in each course. Each assignment designed and graded to assess some combination of several or a few of the following outcomes:

- O1** Professional context and expectations (ethics, economics, etc.)
- O2** Historical perspective and vision
- O3** Multidisciplinary, system perspective
- O4** Written, oral, graphical communication ability
- O5** Knowledge of key scientific/engineering concepts
- O6** Ability to define and conduct experiments, use instrumentation
- O7** Ability to learn independently, find information
- O8** Ability to work in teams
- O9** Ability to design systems
- O10** Ability to formulate and solve problems
- O11** Ability to use and program computers

Evaluation of these outcomes allows an assessment of your performance and provides a major portion of the process we 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 Co., Lockheed Martin Corp. and Ball Aerospace Corp. 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 designed and graded to assess some combination of these outcomes.

Important Notes:

1. All questions regarding course content (material, homework, quizzes, lab assignments) should be posted to the course Slack workspace or asked over Zoom during lab, recitation, or office hours. Slack posts regarding quizzes or lab assignments that are received 24 hours or less before the deadlines will not be responded to. All other questions, concerns, or issues not regarding course content should be e-mailed to the instructor. E-mails and Slack posts will be responded to during business hours, i.e. Monday through Friday, 8:00 am – 5:00 pm MST/MDT.
2. All homework questions must be posted to the course Slack workspace. If we receive an email with a homework question, we will direct you to the course Slack workspace board.
3. We reserve the right to make changes to the weekly course schedule based on occurring events that require different dispositions. We will give sufficient advance notice through announcements in class and posting on the web. Changes to this syllabus and assignments-table may be announced at any time during class periods. We will post the current syllabus and assignments-table on the web. Both are dated in the footnote.
4. Canvas will be used to send out announcements, to provide comments to you daily on class activities, and to provide general information about course assignments.
5. Rationale for course assignments and evaluations
 - Reading assignments are to be completed before viewing the lecture video. The lectures will help clarify and supplement your reading and to prepare you for homework assignments, quizzes, laboratory work, and exams.
 - Homework reinforces the mental processes that help you to become proficient in a subject. In addition to the assigned homework, we encourage you to work additional problems for practice and make summary notes for yourself. Before beginning any homework assignment, you should read the relevant text sections and work through the examples in the text.
 - Experimental laboratory exercises are more complex than the homework and require special equipment (such as the static test stand). You will work in teams to collect and analyze the data, as well as deliver the experimental laboratory assessment.
 - Quizzes provide a gauge to determine what you have learned individually.
 - Design projects help you to learn how to synthesize the basic concepts, methods, and tools presented in the course curriculum by combining theory and practice. The team-oriented lab approach will give you experience in the benefits and challenges of working and cooperating in groups, as is typical in this industry.

6. Homework:

- All homework questions must be submitted to the course Slack workspace under the appropriate homework assignment/question. No homework questions should be emailed to the instructional team—all questions should be asked at office hours or posted on Slack. The instructional team will not respond to posts that are posted within 24 hours of a quiz.
- Collaboration is permitted on homework. However, we strongly recommend to first work on your own on the homework before comparing your results with your homework team members. If collaborating on the homework, we recommend you discuss the means and methods for formulating and solving problems and compare answers, but that you do not just look at someone's solution or copy someone's work. Remember, the less you think about the problems yourself, the less you actually learn, and the more difficult it will be to succeed on quizzes.
- Homework solutions will be posted before each quiz.

7. Quizzes:

- Makeup quizzes will not be granted for any reason. The final exam will be used for replacing up to 3 quiz grades per the policy stated above.
- Expect new material to be presented in both the lecture/recitation and laboratory periods. Quizzes and exams can cover all material in the course including lectures, recitation problems, homework, and laboratory work.
- Collaboration on quizzes or exams, using another student's work as your own, or allowing another student to use your work as their own is considered academic misconduct and will not be tolerated. If you are caught in any of these activities, you will be reported to the Honor Council.
- Regrade requests must be submitted to the professors within 2 weeks of the grade posting to Canvas. Regrade requests should be submitted through Gradescope using the "regrade request" functionality. Regrade requests should not be e-mailed to a member of the instructional team. Regrade requests are only considered if you believe there was an error in the grading of your quiz per the written rubric. Regrade requests are not to argue against the grading rubric, as we carefully design this for each quiz.

8. Labs:

- Lab meetings will be conducted Remotely. Therefore, ALL students are required to join live during their scheduled lab sessions on Mondays. Students are encouraged, but not required, to join live during their scheduled lab sessions on Wednesday (with a few required Wednesday lab meetings, which are noted on the course schedule). This will ensure that students have an opportunity to hear the lab introductions, work in small groups on the lab assignments, ask questions about the lab assignments, take short lab quizzes, and participate in debriefs at the conclusion of each assignment. Lab meetings will NOT be recorded. The course schedule will provide a summary of lab topics, duration of the lab, and lab deliverables.
- In addition to these Remote meetings, students will work in groups on lab assignments outside of class time in a Remote, In-person, or Online fashion with synchronous or asynchronous group meetings at the discretion of and organization by the lab group. Resources and tools to help facilitate group efforts will be provided on the course Canvas page. Group formation will

be defined prior to the lab introduction and will attempt to account for an individual's situation such as time-zone differences or access to high-speed internet for synchronous activities.

- Students can ask questions about lab assignments Remotely via Zoom during the normal scheduled lab dates and times, or during office hours.
- Many assignments will require access to a computer and basic programming skills. Computer programming skills are a prerequisite for this class, e.g. GEEN 1300 or CSCI 1300. We will not teach computer programming, although we will make an effort to formulate the assignments to emphasize proper computing skills. In this department we primarily use the programming language MATLAB. You can download a free MATLAB license for your personal computer from CU at <https://oit.colorado.edu/software-hardware/software-downloads-and-licensing/matlab>. You can also use MATLAB Online for this course at <https://matlab.mathworks.com/>.
- Lab documents will be provided in advance of the labs, which provide a detailed description of various steps and milestones in each lab. You are required to carefully study the lab documents before the beginning of each lab section. These lab documents will also include guidelines for the individual and group work that needs to be submitted for each lab.
- Experimental lab reports should be completed using digital word processing program (Word, LaTeX, PDF, etc). All group member names with relevant assignment information must appear on the cover page. Bottom line - submit all work with a professional appearance. *Neatness, clarity, and completeness really do count in the work world!*
- Students are encouraged to submit lab questions to the course Slack workspace under the appropriate channel. As with the homework, you may discuss the means and methods for formulating and solving problems but you cannot compare answers on Slack nor post your exact work or computer code.

9. Grading

- Minor adjustments may be made in the determination of final letter grades and with grade cut lines, but there is no “curving” in this course.
- To receive a course grade of C or better (which is required to fulfill the prerequisite for junior-year courses), students must receive a C or better in the individual coursework portion of the class. Stated differently, the students who receive an individual grade of C- or lower will not receive any group grades.

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.

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](#).

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 and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick and will miss a quiz or lab, please e-mail both Dr. Wingate and Dr. Johnson with “2001” at the beginning of your e-mail title (e.g. “2001: Missing Lab on Monday”). You are not required to state the nature of your illness. If you will miss meetings for other sophomore courses (2002 and/or 2012), it would be helpful to e-mail all of your 2000-level instructors together so that we all know of your absence.

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.

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.s

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](#).

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 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.

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, excused absences for labs on religious holidays need to be communicated to the instructor via email 2 weeks ahead of the expected absence. See the [campus policy regarding religious observances](#) for full details.

Spring Pause

The week of March 22-26 will be used in this class as a spring pause to provide us all with a safe and supportive way to promote health, wellness and learning without leaving campus. During this week, we will not have any quizzes or assignments due, but we will still have a lab meeting on Monday, March 22 and a possible recitation (and associated lecture video) on Tuesday, March 23. We will not have lab on Wednesday, March 24 nor lecture on Thursday, March 25 (a Wellness Day). We wish we could take a regular spring break, but public health concerns prevent us from doing so. It is still important for students to behave responsibly during this pause—you should not use the week to travel or engage in risky behavior that could result in an outbreak on campus after we all return.

Week		Monday Lab	Tuesday Lecture		Wednesday Lab	Thursday Lecture		Friday
			Topic	Reading		Topic	Reading	Deliverable
1	1/14 - 1/15	No lab	No lecture		No lab	LSN 1 - Course Overview & Finite Wings (3-D Wings)	<i>Introduction to Flight</i> 5.13-5.16	Aero Lab Overview, Team Selection & Aircraft Design Methodology
2	1/18 - 1/22	No lab (MLK Day)	LSN 2 - Aircraft Aerodynamics Whole Aircraft Drag / EOM	6.1-6.2	Aero lab work day	LSN 3 - Thrust, Power, Drag Curves	6.3-6.8	
3	1/25 - 1/29	Aero Lab Work Day	LSN 4 - Range and Endurance	6.9, 6.12 - 6.14	Aero lab work day	QUIZ #1 - LSN 1-4 9:00 - 9:45 am		Aero Lab Milestone 1 Due (Fri, 29 Jan 5:00 pm)
4	2/1 - 2/5	Discussion of Milestone 1 Results Kickoff to Aero Lab Milestone 2: New Glider Design	LSN 5 - Climbs and Ceilings	6.8, 6.10-6.11	Aero lab work day (Individual Conceptual Designs)	LSN 6 - Takeoff, Landings	6.15 - 6.16	
5	2/8 - 2/12	Aero Lab Work Day	LSN 7 - Turn Performance	6.17	Aero lab work day	LSN 8 - Energy & Master Constraint Equation	6.18	Aero Lab Milestone 2: Individual Concept Design Due (Fri, 12 Feb 5:00 pm)
6	2/15 - 2/19	Discussion of Final Glider Design Presentation Video Kickoff to Aero Lab Milestone 3: Optional Glider Build Discussion and Material Checkout #1	QUIZ #2 - LSN 5-8 9:00 - 9:45 am		No lab (Wellness Day)	LSN 9 - Longitudinal Static Stability Pt 1	7.1 - 7.6	
7	2/22 - 2/26	Aero Lab Work Day	LSN 10 - Longitudinal Static Stability Pt 2	7.7 - 7.11	Aero lab work day	LSN 11 - Lateral Static Stability	7.17 - 7.18	Aero Lab Milestone 2: Final Design Presentation Slides & Videos Due (Fri, 26 Feb 5:00 pm)
8.1	3/1 - 3/5	Aero Lab Milestone 3: Optional Glider Build Material Checkout #2	QUIZ #3 - LSN 9-11 9:00 - 9:45 am		Macroethics Discussions	LSN 12 - Intro to Spaceflight, History, Elements of a Space Mission	<i>Understanding Space</i> 1, 2.2	
9	3/8 - 3/12	Introduction, team assignments, test equipment demos, Checklists	LSN 13 - The Space Environment & Space Coordinate System	3	Checklists work day	LSN 14 - Rocket Equation	14.1	Space Lab Checklists Due (Fri, 12 March 5:00 pm)
10	3/15 - 3/19	Static test stand data	LSN 15 - Rockets	14.1 - 14.2	Static test stand report work day	QUIZ #4 - LSN 12-15 9:00 - 9:45 am		

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