ASEN 4138 Aircraft Design Syllabus

Spring 2026

Administration Information

Lectures	Mon/Wed 12:50 pm – 1:40 pm (Aero 111)
Labs	Section 011 Thursday 11:05 am – 12:55 pm - Section 011 (Aero N100 Co-Pilot)
	Section 012 Thursday 1:10 pm – 3:00 pm - Section 012 (Aero N100 Co-Pilot)
Instructor	John Mah
Teaching Assistants	Jonathan Morris Nathan Evans
Pre-Reqs	ASEN 3128
Required Materials	Textbook: • Raymer, Daniel P., *Aircraft Design: A Conceptual Approach*, 6th Edition, AIAA Education Series, Reston, Virginia, 2018. Computer System: • Windows or MacOS system (preferably in laptop form) Software: • Open Vehicle Sketch Pad (OpenVSP). Download at www.OpenVSP.org • MATLAB • MS Excel
Canvas Page	https://canvas.colorado.edu/courses/
Digication Course	Digication will be utilized for all course submissions

Course Description

At a fundamental level, this course examines the principles of conceptual aircraft design to meet mission and performance specifications through the application of a structure aircraft design methodology and synthesis of knowledge across multiple aerospace disciplines. The aerospace discipline knowledge most utilized are aerodynamics, stability and control, propulsion, and aerospace structures; however, many other disciplines both within aerospace and outside aerospace are often critical as part of a successful aircraft design. While most students may never lead a new aircraft design in their careers, exposure to the aircraft design discipline will enhance the student's ability to understand interdependencies across aerospace disciplines and improve their ability to work within large aerospace project teams regardless of if they ever become a lead designer or configurator themselves.

Course Macro Objectives

1) Learn the fundamentals of the aircraft design process through the creation of an original conceptual aircraft design to meet student-defined performance and mission requirements. The design process will require the synthesis of multi-disciplinary aerospace knowledge within the framework of a structured aircraft design methodology.
2) Develop professional aerospace engineering mindset & attributes through:
   a) Demonstrating the ability to interpret and plan toward the achievement of goal-oriented performance expectations.
   b) Demonstrating the ability to collaborate and integrate feedback, critiques, and diverse perspectives towards achieving team/organizational goals.
   c) Demonstrate the ability to think both critically and creatively.
   d) Demonstrate curiosity and development of self-knowledge through the joy of exploratory learning.

Specific Topic Areas Covered: All of the following topics will be covered through the conceptual design level of aircraft design. Application of knowledge in these areas will be sufficient to conclude conceptual design and start preliminary design by the end of the course.

1. Aircraft design process & methodologies
2. Exploration and analysis of prior aircraft design
3. Development of aircraft requirements and mission profiles
4. Initial parametric sizing & analysis of design space (weight estimation and master constraint equation analysis)
5. Initial conceptual configuration and sketching
6. Refined wing design and sizing
7. Refined control surface design and sizing
8. Initial propulsion system selection, integration, and sizing
9. Initial internal layout analysis (subsystem integration)
10. Initial landing gear analysis
11. Technology Readiness Levels
12. Performance of design trade studies

Student Evaluations

There will be three evaluation periods with defined tasks and expectations aligned with phases of the conceptual design process. Each evaluation period will end with a defined deliverable (digital design portfolio update) which will encompass a portion of the student's evaluation grade along with an assessment of the student's professional performance over the entire evaluation period.

Evaluation Period	% of Phase Grade based on Professionalism	% of Phase Grade based on Engineering	Overall Grade Weight
Phase 1 (Closes with Dash 1 Update)	20%	80%	25%
Phase 2 (Closes with Dash 2 Update)	20%	80%	35%
Phase 3 (Closes with Dash 3 Update + Presentation)	20%	80%	40%

Final grade will be the weighted average of your performance over the three evaluation periods. The three evaluation periods will be slightly weighted more toward the back end of the course to allow for students to adapt to this evaluation method and reward growth and the student's ability to take in critiques and improve.

Evaluations in project-based design course are always difficult because by nature, there is no "one right answer" to a complex design problem. Additionally, our desire to allow students design freedom in exploring a design problem that interests them further complicates assessment. As such, for each phase, student evaluations will be broken down into the following criteria:

1) **Engineering Task Evaluation:** Did you accomplish all the required tasks during a given phase deliverable? This is an objective criterion based on the provided engineering phase objectives.
2) **Engineering Quality Evaluation:** Adds or subtracts from the baseline engineering task score to account for quality of engineering work for the phase deliverable. This is both an objective and subjective measure. During each phase, some more specifics in terms of quality measures will be provided, but on the subjective side in takes into account the following expectations:
    a. Sound and consistent application of fundamental aerospace concepts in design.
    b. Adherence to structured design processes.
    c. Clear understanding and appropriate application of methodologies (models) used in analysis.
    d. Logical, structured, and planned trade studies.
    e. Sound engineering judgment in making design decisions and application of simplifying assumptions.
    f. Demonstrate agility and initiative in overcoming engineering challenges.
    g. Communicates clearly in written, visual, and verbal technical communication.
3) **Professionalism Evaluation:** This is a combination of your ability to communicate effectively through your digital portfolio and poster session as well as your individual

actions in class, labs, and within your team (if a part of one). This evaluation considers the following:

a. Structure, format, spelling, grammar, and clarity of written work inf digital portfolio.
b. Technical specificity and presentation of technical data in submitted work.
c. Verbal presentation and professionalism during poster session.
d. Individual preparedness and on-time to work sessions and effectively utilize in-person sessions to advance your project.
e. Effectively communicate status of your work and engage in group discussions and collaboration. Be open to various feedback from instructional team and peers.
f. Demonstrate self-initiative, agility, and creativity.
g. Be accountable to the course and teammates and take ownership of your work.

The following is the correlation table of each of these criteria:

Engineering Task Evaluation	Engr Task Point Baseline	Quality of Engineering Evaluation	Quality of Engineering Point Adjustment	Professionalism Evaluation	Professionalism Point Correlation
Exceeds Standard & Expectations	90	Outstanding	9 to10	Exceeds Standards & Expectations	10
Meets Standards & Expectations	80	Above Average	6 to 8	Meets Standards & Expectations	8 to 9
Approaching Standards & Expectations (1-2 Missing Elements)	70	Average	0 to 5	Approaching Standards & Expectations	6 to 7
Does Not Meet Standards & Expectations (> 2 missing elements)	<60	Below Average	-5 to -1	Does Not Meet Standards & Expectations	< 6
		Poor	-10 to -6		

Phase Grade will then be calculated with the following formula:

$$Phase\ Grade\ Total\ Pts = \left(\frac{Engr\ Task\ Pt + Engr\ Qual\ Pts}{100}\right) * 80 + \left(\frac{Prof\ Eval\ Pts}{10}\right) * 20$$

Final Grade is calculated by utilizing the phase grade totals and the phase weights:

$$Final\ Grade\ Pts = \left(\frac{Phase\ 1\ Total\ Pts}{100}\right) * 25 + \left(\frac{Phase\ 2\ Total\ Pts}{100}\right) * 35 + \left(\frac{Phase\ 3\ Total\ Pts}{100}\right) * 40$$

The letter grade will be assigned based on the final grade percentage (out of 100 weighted points) on the following grade scale:

Letter Grade	Range
A	100% to 93%
A-	< 93% to 90%
B+	< 90% to 87%
B	< 87% to 83%
B-	< 83% to 80%
C+	< 80% to 77%
C	< 77% to 73%
C-	< 73% to 70%
D+	< 70% to 67%
D	< 67% to 63%
D-	< 63% to 60%
F	< 60% to 0%

Individual vs Team Effort

There is no standard team size in this course; however, the maximum student team is capped at 3 students. The reasoning for this is to enable students to pursue a design which interests them individually if desired. As such, there is no defined "individual work" as collaboration across ALL students is expected and encouraged even if you are working on an individual design. The goal of this course is to encourage exploration and learning. Evaluations will address both team performance and individual behaviors within design teams and the course even if you are doing an individual design project.

How to Perform Well in this Course

Good Actions / Behaviors	Bad Actions / Behaviors
Show strong grasp of aerospace engineering fundamental in work.	**Consistently plagued by fundamental conceptual errors in prior knowledge *with the unwillingness to acknowledge, revisit and correct*.**
Show initiative, the ability to self-learn, and a curiosity of mind.	**Do minimal work to "check the box" on a process.** Do not seek out new knowledge outside of lecture/class/textbook. Show limited curiosity and desire to explore research or literature to learn new things. Not putting in the work or time to contribute.
Show structured and logical approach (planning & organization of thought). Methodology is planned out before execution, and results are clearly captured for analysis.	**Don't adhere to the aircraft design process.** Relying too much on random "guess and check". Chaotic, illogical approach to design and analysis. Failing to capture iterative analysis data. Version control issues with design.
Show good engineering judgment and agility of mind when addressing uncertainty.	**Using given engineering models without regard to applicability or addressing implications (not adapting models where appropriate).** Making design choices without clear rationale. Failing to discuss / address impact of assumptions on validity of design. Not seeking new knowledge to address obstacles or problems.
Show consistent willingness to collaborate, communicate, and work with instructor, TA, and fellow students (Engage in discussions, be open to inputs, actively seek feedback, and effectively communicate your work).	**Not showing up for team interactions (lectures, labs, outside of class meetings).** Not engaging in discussion in lecture/labs. Waiting until the end of course to communicate problems or issues that occurred earlier in semester. Becoming defensive when critiqued rather than looking at how to learn and improve from them.
Effort and attitude matter! Designing an aircraft requires a lot of work but should be fun and rewarding. If you're not having fun, let's talk!	

University Policies:

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 Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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. Understanding the course's syllabus is a vital part of adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from Student Conduct & Conflict Resolution and will be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

ACCOMMODATION FOR DISABILITIES, TEMPORARY MEDICAL CONDITIONS, AND MEDICAL ISOLATION

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.

If you have a temporary illness, injury or required medical isolation for which you require adjustment, **please contact the instructor of the course as soon as possible to coordinate how to mitigate impacts to your course accomplishment.**

Accommodation for Religious Obligations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, **you are expected to review the course schedule, identify any religious conflicts, and contact the instructor to coordinate any mitigation strategies within the first two weeks of the semester.** See the campus policy regarding religious observances for full details.

PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have your preferred name (rather than your legal name) and/or your preferred pronouns appear on your instructors' class rosters and in Canvas, visit the Registrar's website for instructions on how to change your personal information in university systems.

CLASSROOM BEHAVIOR

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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, marital status, political affiliation, or political philosophy.

Additional classroom behavior information

- Student Classroom and Course-Related Behavior Policy.
- Student Code of Conduct.
- Office of Institutional Equity and Compliance.
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Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email OIEC@colorado.edu. Information about university policies, reporting options, and OIEC support resources including confidential services can be found on the OIEC website.

Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure the person impacted receives outreach from OIEC about resolution options and support resources. To learn more about reporting and support a variety of concerns, visit the Don't Ignore It page.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS), located in C4C, or call (303) 492-2277, 24/7.

PROFESSIONAL ATTRIBUTES REFERENCE

The following is excerpted from one of the guiding papers on the inclusion of design curriculum in aerospace undergraduate education and source of inspiration in the development of this course's objectives.

Source: John McMasters and Lee Matsch. "Desired attributes of an engineering graduate - An industry perspective," AIAA 1996-2241. *Advanced Measurement and Ground Testing Conference*. June 1996.

CAREER DEVELOPMENT ELEMENTS

	FUNCTION	TECHNICAL COMPETENCE	LEARNING & CURIOSITY	PRACTICE	INTEGRITY	OWNERSHIP
LEADER (25 YEARS OUT)	Leader - Industry - Technical - Research - Academic - Society Highly Valued	Breadth & Depth Catalyst for change Driver of new technologies Definer of new tools Enabler of communications	Causes discovery Causes synergy Non-engineering field knowledge	Reduces complex issues to manageable tasks Discerns & innovates the most valuable initiatives Eliminates problems	Honest Gives credit Assumes responsibility	Stimulates organization-wide pride in work Enables break-throughs Instills loyalty
ESTABLISHED POSITION (10 YEARS OUT)	Marketing & sales Product engineer Technical specialist Project engineer Educator Interdisciplinary engineer	Depth Solves analytical problems Project specific applications Specific tools expertise Expert in communications	Personal contributions Deep and broad investigations Serendipitous discoveries	Understands what is possible Successfully drive to pragmatic results Anticipates problems & opportunities	Ditto	Team builder Sustained contributor Loyalty that builds integrity
ENTRY LEVEL (BS DEGREED)	Design engineer Analyst Test engineer Field engineer Process engineer Mfg. engineer Grad student	Breadth Classical physical laws Design applications Tool competence Communication skills evident	Extracurricular activities Exposure to diversity "Street smart" Self initiated discovery	Makes sound assumptions Can get linearized results to real problems Not intimidated by engineering problems	Ditto	Takes pride in work Takes on responsibility to contribute Loyalty

DESIRED ATTRIBUTES OF AN ENGINEERING GRADUATE

- A good grasp of engineering science fundamentals.
  - Mathematics (including statistics)
  - Physical and life sciences
  - Information technology
- A good understanding of the design and manufacturing process (i.e., understand engineering).
- A basic understanding of the *context* in which engineering is practiced.
  - Economics and business practice
  - History
  - The environment
  - Customer and societal needs
- Possesses a multi-disciplinary, *system* perspective
- Good communication skills.
  - Written
  - Verbal
  - Graphic
  - Listening
- High ethical standards.
- An ability to think both critically and creatively - independently and cooperatively.
- Flexibility--An ability and the self-confidence to adapt to rapid/major change.
- Curiosity and a desire to learn - for life.
- A profound understanding of the importance of team work.

Note: This is a list of basic, durable *attributes* into which can be mapped specific *skills* reflecting the diversity of the overall engineering environment in which we in professional practice operate. In specifying desired attributes (i.e. desired outcomes of the *educational process*), we avoid specifying *how* a given university goes about meeting industry needs. Curriculum development is viewed as a university task to be done in cooperation with their "customers", and in recognition of their own local resources and constraints. Industry, as an important customer, must be an active partner in this process.