Syllabus

Course Information

Title: Aircraft Design
Number: AERO 4312

CRN: 17029
Term: Fall 2023
Instructor: John Bird
Office: Engineering Building A-115
Instructor email: jjbird@utep.edu
Instructor phone: 915.747.8406
Office Hours:\

Course Description

The design of aircraft follows a distinct process but one that varies widely with vehicle application and requirements This course introduces the broad aircraft design process including sub-system interactions, then leads students through specific design tasks. These tasks include sizing of structures and control surfaces, wing loading and structural supports, aircraft configuration, weight distribution, and human considerations.

What this course is: An exploration of the complex and interdisciplinary world of aircraft design. An opportunity to practice it, a way to sythesize prior work across disciplines of aerospace engineering and see how they interact and depend on one another to produce functional aircraft.

What this course is not: A recap of material from supporting disciplines (e.g. aerodynamics, structures). I am expecting that you will go back to course materials and textbooks as needed to refresh yourself (we can also discuss some of this in class but I won't be delivering specific lectures). We take as a starting point in aircraft design that you can analyse a beam or interpret what the lift coefficient is. You'll find that most of aircraft design can actually be accomplished with very simple methods. Yes, aircraft design in industry does use very powerful tools, but this often happens much later in the design process than you'd expect, once the "core" of a design is complete. Most of the heart of aircraft design can be done with pen and paper, excel sheets, or simple self-written programs.

What to expect: A lot of independent reading for background. Short lectures and a lot of collaborative work in class on case studies, examples, and projects.

Course Objectives

At the conclusion of this course you will be able to:

- formulate requirements and relate them to the mission of an aircraft
- analyse aircraft configurations to identify one suitable to requirements
- determine how big an aircraft should be

- size the lifting surfaces, structure, control systems, and propulsion together
- iteratively refine the design to ensure that there are no “show stoppers”
- communicate design decisions and seek informed feedback on design elements
- perform trade studies to evaluate design decisions

Course Prerequisites

- AERO 3312 – Aerodynamics 1
- AERO 3323 – Aerospace Structures 1
- MECH 3352 – Engineering Analysis

Meeting Times:

Class will meet from 12:00 to 1:20 pm Monday and Wednesday in room 313 in Hudspeth Hall.

Office Hours:
tbd or by appointment

I’ll set office hours within the first week or two of the semester. I strongly encourage you to come by with any questions or concerns you have. This time is yours. I’ll have my office door open and may be working on something (probably coursework) but PLEASE INTERRUPT ME during these times. This time is yours to do anything I can which helps you learn. If I’m doing something else during office hours, it is only to avoid twiddling my thumbs while waiting for someone to stop by. There is nothing too small or too irrelevant to talk about, it is far better to come in early with a small question to get a good foundation.

Course Communication

Email is the best way to contact me. I will attempt to respond within 24-48 hours, please include the course title or number in your email subject.

Course Resources

Required Materials

Fundamentals of Aircraft and Airship Design: Volume 1 – Aircraft Design, Leland Nicolai and Grand Carichner

Homework will not be assigned from this book, however it provides a concise description of

the aircraft design process and some “first look” equations and thoughts in a number of areas. We will focus the class on running through exercises in designing aircraft with supporting lectures as appropriate. It is essential that you read through an aircraft design book independently in order to be prepared for these exercises. Other resources you may find helpful include:

Aircraft Design: a Conceptual Approach, Dan Raymer General Aviation Aircraft Design: Applied Methods and Procedures, Snorri Gudmundsson Designing Unmanned Aircraft Systems: A Comprehensive Approach, Jay Gundlach

I’ve included relevant chapters from each of these books under topics in the schedule. I don’t expect you to read every word of every chapter, or every book (though I strongly recommend it, your brain is plastic, fill it up with useful tidbits). I do expect you to go through the chapters, identify the pieces that seem most relevant (simple subsonic, classic aircraft stuff is a good foundation for everything). I’d like nothing more than to stop during lecture or examples to explain something that isn’t clear, but I’m going to rely on you to go find those things.

Electronic Resources

Modern engineering practice draws heavily on electronic resources broadly available including technical papers, content from online courses, technical forums, blog posts, and wikipedia. Recognizing this, you are encourged to make *careful* use of these resources. They can be valuable references but their quality and notation can vary. Ultimately you will be tasked with developing solutions to novel problems in your careers so it is critical that an understanding of the theory of a solution is developed rather than simply stringing together code snippets from stackoverflow. There are no restrictions on the resources you makes use of, but resources must be clearly documented, including a way for me to access a resource, a description of what was obtained from each resource, and how it was used. Note that you are still responsible for your solution being correct and working.

Course Structure and Sequence

The course will be structured around conceptual and early preliminary design of a small uncrewed aircraft. Initial lectures to present the broad discipline and approach to aircraft design will be provided but there is an art to aircraft design which must be learned by doing. To this end, much of the class will be spent “working” on exercises and on a design project which will thread through the course.

The course can be thought of as divided into roughly three sections (progressing roughly but not strictly chronologically):

Preliminaries

In the first part of the course we will cover conceptual models to aircraft design. Approaches to the design process or loop will be discussed. We will discuss what “sizing” is, and contemplate how to squeeze jello. The interdisciplinary nature of aircraft design will be explored, and we will perform some simple sizing exercises. We will try to visit an aircraft museum together to look at some airplanes and their design features.

Requirements, Exercises, and Trade Studies

We will carry out a series of design exercises. This will include defining requirements of a design, big picture questions (configuration selection), and detailed calculations to assist in making design decisions (we call these “trade studies”). We will also discuss concepts of sensitivity and technical risk. This section of the course will conclude with a conceptual design report.

Design Project

Finally, you will work in groups to carry out an independent design project. Given a mission and partial list of requirements you will identify requirements, perform a configuration study, and initial sizing. You will deliver a conceptual design review and then begin refining your design. The semester will conclude with a design report and presentation.

Assignments and Evaluation

Progress in this course will be evaluated through a sequence of exercises, design reports, and presentations.

Exercises

Many class periods will be occupied by design exercises. Each exercise will have a recommendation and rationale as its output, with analysis or reasoning as the supporting evidence. You will be provided a design recommendation template to complete for exercises, as well as a self-assessment (plus peer assessments on group exercises). One objective is for you to not only know and understand the material, but to have an understanding of how well you know and understand it. You will complete the self assessment so that you can later compare it to feedback I provide, helping you to calibrate yourself.

Aircraft Design Feature

Every day someone will conduct a short (3 min) presentation on an aircraft design feature. This is intended as a light-hearted (but technically rigorous) opportunity to share something interesting about aircraft design and think deeply about it. Almost every feature of an aircraft is that way for a reason, you will find a specific feature of an airplane and:

- Give us context on this feature
- Explain why you think it is the way it is
- Explain how you think it supports the mission of the aircraft

Project

You will also complete a group aircraft design exercise. This will result in a conceptual design review presentation and a design report to be completed in mid October.

At the conclusion of the semester you will turn in a final project report documenting the state of your design.

Grade Expectations

Rubrics for evaluation of course assignments will be constructed so that a “C” level grade indicates a satisfactory solution to the assigned problem but without demonstrating an understanding of the theoretical background for the problem and its solution. A “B” level grade will indicate both solution of the assigned problem and an understanding of its theoretical properties. “A” level grades will indicate that in addition to “C” and “B” level mastery that you understand the limitations of the solution developed.

Grade Assignment

Grade assignment will be guided by self evaluation, peer evaluation, and instructor input.

Nominal Weights

Deliverable	**Weight**
Exercises	0.15
Design Feature	0.1
Conceptual Design Review	0.15
Conceptual Design Report	0.2

Deliverable	Weight
End of Semester Review	0.2
End of Semester Design Report	0.2

Preliminary Schedule

Day	Topic	Nicolai	Raymer	Gudmundsson
2023-08-28	What is aircraft design? The design process	Ch 1	Ch 1	Ch 1
2023-08-30	Requirements, disciplines, sizing, sensitivity, weight exercise	Ch 1	Ch 2	
2023-09-04	no class			
2023-09-06	Configuration	Ch 7, 8	Ch 3, 4	Ch 4
2023-09-11	Wing sizing	Ch 4, 5, 6, 10	Ch 5, 6	Ch 3, 8, 9
2023-09-13	Weight estimation	Ch 5, 6, 19, 20	Ch 5, 6, 15	Ch 6
2023-09-18	Structures	Ch 19	Ch 14	Ch 5
2023-09-20	Performance estimation	Ch 3, 4, 5, 6, 10, 14, 17	Ch 17	Ch 16-23
2023-09-25	Stability and Control	Ch 11, 21, 22, 23	Ch 16	Ch 24, 25
2023-09-27	Trade Studies	Ch 25	Ch 19	

Day	Topic	Nicolai	Raymer	Gudmundsson
2023-10-02	Project Kickoff			
2023-10-04	Requirements definition			
2023-10-09	Configuration study			
2023-10-11	Configuration study			
2023-10-16	Configuration study			
2023-10-18	Configuration study			
2023-10-23	Conceptual Design Review			
2023-10-25	Conceptual Design Report Due			
2023-10-30	Trade study: wing planform			
2023-11-01				
2023-11-06	Trade study: structure and materials			
2023-11-08				
2023-11-13	Trade study: propulsion			
2023-11-15				
2023-11-20	Trade study: airfoil			
2023-11-22				
2023-11-27	Trade study: controls			
2023-11-29				

Day	Topic	Nicolai	Raymer	Gudmundsson
2023-12-04				
2023-12-06				

Course Policies

Technology Requirements

While aircraft design can be accomplished without the use of computers, it is much easier when they are used. An essential element of aircraft design is its iterative and exploratory nature. Careful use of computers enables the designer to rapidly try out ideas. Computers and “design software” are not oracles however. You should prinicpally use tools you build yourself (you know what they do!) from excel, matlab, python, or another tool you are comfortable with. You may find yourself using more powerful analysis tools for certain tasks, but these should be used cautiously as they often have steep learning curves, they take time to set up good input cases for, and interpretation of the results can be lengthy. This can make them difficult to use well in initial design, you should go to them when you already have a pretty good idea what the answer is and are looking to retire technical risk or to buy margin.

Reports should be submitted as pdf files.

Course Attendance Policy

There will be no formal attendance taken, but you are expected to be engaged in the class discussions.

Late Work Policy

Assignments may be accepted at my discretion provided that you contact me more than 24 hours in advance and receive an extension. Absent an emergency or prior extension, work that is simply not turned in on time will not be accepted after the deadline. If you have an emergency get in touch as soon as practical and we’ll work something out.

Accommodations Policy

The University is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries

of University programs, services and activities with documented disabilities in order to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship on the University. Students requesting an accommodation based on a disability must register with the UTEP Center for Accommodations and Support Services (CASS). Contact the Center for Accommodations and Support Services at 915-747-5148, or email them at cass@utep.edu, or apply for accommodations online via the CASS portal.

COVID 19 Precautions

You are expected to adhere to university guidance on COVID 19 precautions available at: https://www.utep.edu/resuming-campus-operations/ Guidance and policy with respect to COVID may change throughout the semester.

If you have tested positive for COVID 19 or have reason to suspect you may have COVID 19 (e.g. because of symptoms or close contact with an individual who has COVID 19) you are expected to stay home as directed by https://www.cdc.gov/coronavirus/2019-ncov/your-health/quarantine-isolation.html. Contact me and we will arrange appropriate accomodations.

Students who are considered high risk according to CDC guidelines and/or those who live with individuals who are considered high risk may contact Center for Accommodations and Support Services (CASS) to discuss temporary accommodations for on-campus courses and activities.

Academic Integrity

Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as one's own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline.

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