UNIVERSITY OF CALIFORNIA
Department of Mechanical and Aeronautical Engineering

Professor Harvey Fall 2025

MAE 298
Advanced Aircraft Design

Course goals

With aircraft design advancing at unprecedented speeds, this course prepares students to lead in this transformative era of aviation. This graduate course provides an overview of cutting-edge techniques shaping modern aircraft, guided by industry-relevant expertise, current research, and insights from guest lectures by leading experts. By the end of the course, students will work in groups to deliver a comprehensive research paper and presentation, showcasing innovative solutions to advance aviation technologies.

Learning objectives

Upon completion of this course, you will demonstrate your ability to:

- Understand, analyze, and balance trade-offs within aircraft design.
- Optimize an existing aircraft subsystem to meet customer needs leveraging modern tools and workflows.
- Integrate subsystems into a complete functional system.
- Work effectively in a multi-disciplinary team.
- Communicate the technical considerations in your design to a broad audience.
- Document and present technical content in industry-relevant formats.
- Incorporate regulatory, certification, and safety constraints into a conceptual design.

Expectations

- We are here to learn, and everyone brings a growth mindset to class.
- We recognize that engineering is not a purely objective discipline, and our own biases can and will affect our work.
- We commit to understanding our own biases and work to promote inclusivity and equity within our classroom and engineering as a whole.
- We will not tolerate any forms of discrimination.
- We will follow the UC Davis Code of Academic Conduct.

Instructor

Prof. Christina Harvey (*she/her/hers*)
Contact: harvey@ucdavis.edu
Office hours: Thursdays 12:00-1:00PM PST; Bainer Hall Room 2048
About me: I lead the Biologically Inspired Research and Design (BIRD) lab where we study how animals fly with the goal of identifying the most beneficial attributes that can advance aircraft design. For more information refer to my lab website: https://birdlab.notion.site

Land acknowledgement

We should take a moment to acknowledge the land on which we are gathered. For thousands of years, this land has been the home of Patwin people. Today, there are three federally recognized Patwin tribes: Cachil DeHe Band of Wintun Indians of the Colusa Indian Community, Kletsel Dehe Wintun Nation, and Yocha Dehe Wintun Nation.

The Patwin people have remained committed to the stewardship of this land over many centuries. It has been cherished and protected, as elders have instructed the young through generations. We are honored and grateful to be here today on their traditional lands.

Class location and time

Tuesdays and Thursdays; Wellman Hall 201

Lectures 10:00 – 11:50AM PST

- Lectures will be recorded and posted to Canvas within one week of the class.
- Please bring your phones or computers. In class activities may require online participation.
- Note: this is a flipped classroom requiring online completion of assigned reading, assignments, and quizzes prior to class attendance.

Course outline

1. From then to now: A history of aircraft design (Week 1-2)
    a. A brief history of aircraft design
    b. Modern aircraft design and future trends
    c. Communication principles: Reports, Presentations, and more
2. Optimization in Aircraft Design (Week 2-3)
    a. Basics of Design Optimization
    b. Basics of Multiobjective Design Optimization – Intro to NASA's OpenMDAO
    c. Introduction to Aviary - *Guest Workshop: NASA Glenn Aviary Team*
3. Subsystems in Aircraft Design (Week 4-7)
    a. Subsystem: Mass *(Mass/Weight, CG, and cost estimation methods)*
    b. Subsystem: Geometry *(Conventional and novel geometry methods)*
    c. Subsystem: Aerodynamics (*From experiments to CFD*)
    d. Subsystem: Propulsion/Energy (*Conventional, electric, and beyond*)
    e. Subsystem: Mission Analysis *(Trajectory planning, flight phases)*
4. Systems Integration (Week 8-10)
    a. Sustainability in Aviation *(alternative fuels, electric, integration, BLI)*
    b. Life cycle analysis *(subsystems integration, safety, maintenance, reliability)*
    c. Risk analysis *(trees and industry standards)*
    d. Regulations and certification *(standards compliance, certification challenges)*
    e. Bio-informed aircraft design (*birds, bats, pterosaurs, insects*)

Textbooks

No mandatory textbook.

Alternative resources

Airplane Design (Parts I through VIII) – *J. Roskam*
Airplane Design: A Conceptual Design – *Daniel P. Raymer*
Engineering Design Optimization – *J.R.R.A. Martins and A. Ning*
Intro to the Design of Fixed-Wing Micro Air Vehicles – *T. Mueller et al.*
An Introduction to Flapping Wing Aerodynamics – *W. Shyy, H. Aono, C. Kang, H. Liu*

Grading structure

Group assignments	
Aircraft program preview	5%
Proposal	20%
Final presentation	20%
Final report	25%
Individual assignments	
Peer evaluations	10%
In-class engagement	10%
Online engagement	10%
Bonus points	
Catch my mistakes	2%

Bonus points: If you find a mistake in the slides or assignments, please email Christina directly to claim your points. 0.5% per mistake up to 2% total.

Late policies

There is a strict no late policy for the in-class and online engagement components.

All other late assignments will lose 15% per day for the first two (2) days. After that, late submissions will not be accepted and will be given 0%. If the final report is not completed and submitted, an incomplete grade for the full class ("I") will be given.

If exceptional circumstances arise, contact Christina directly as far in advance of the deadline as possible.

Mental health

Many studies have found increased rates of depression, anxiety and stress among university students when compared to the general public. Your mental health directly affects your academic performance and quality of life. Therefore, your mental health is just as valuable as the skills that you will learn in this class. Our department and I are committed to advancing your well-being. UC Davis has many resources (https://mentalhealth. ucdavis.edu) including confidential counselling services available through the Student Health and Counseling Services (https://shcs.ucdavis.edu) and a 24/7 confidential, urgent phone line through the Center for Advocacy, Resources & Education (https://care. ucdavis.edu, 530-752-3299).

Student accommodations

It is important to me that everyone in this class is provided with an equitable learning environment. At UC Davis the Student Disability Center (https://sdc.ucdavis.edu) is your go-to support office. After

meeting with their staff to determine the necessary accommodations, they will write an official Letter of Accommodation.

Other resources

- Center for Chicanx and Latinx Academic Student Success (https://cclass.ucdavis.edu)
- Native American Academic Student Success Center (https://naassc.ucdavis.edu)
- A broad collection of UC Davis' many support resources are linked on my lab website.