# AME 481

Department of Aerospace and Mechanical Engineering
University of Southern California

Course Syllabus

Spring 2024 (version 3/4/2024)

# AME 481
# Aircraft Design
*Units: 4*


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| **Instructor**: | Marty K. Bradley, Ph.D |
| **Email**: | mkbradle@usc.edu |
| **Office Hours**: | THH 118, Mondays 6:20pm–7:20pm |
| **Virtual Office Hours**: | Tuesdays 4:00pm–5:00pm |
| **Join URL**: | https://usc.zoom.us/j/94413403803 |
| **Passcode**: | VM3ZHVaHB7 |

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|---|---|
| **Instructor**: | David S. Lazzara, Ph.D |
| **Email**: | lazzara@usc.edu |
| **Office Hours**: | THH 118, Mondays 6:20pm–7:20pm |
| **Virtual Office Hours**: | Thursdays 4:00pm–5:00pm |
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|---|---|
| **Instructor**: | Hubert Wong |
| **Email**: | hubertwo@usc.edu |
| **Virtual Office Hours**: | Fridays 10:00am–12:00pm |
| **Join URL**: | https://usc.zoom.us/j/98867188022 |
| **Passcode**: | AME481 |

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|---|---|
| **Grader**: | Jash Panchal |
| **Email**: | jpanchal@usc.edu) |


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| **Lecture Room**: | THH 118 |
| **Lecture Time**: | Mondays 3:30pm–6:20pm |

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| **Lab Room**: | SAL 127 |
| **Lab Time**: | Wednesdays 5:00pm–7:50pm |

## Course Description

This course provides a comprehensive overview of principles and analysis related to aircraft design. Various topics are presented to summarize an organized approach to aircraft design problems with a multidisciplinary emphasis. Lectures provide a summary of design principles, aircraft components, specifications, design best-practices, conventional and unconventional vehicles, and information on quantifying aircraft performance at the system and sub-system level. Lab sections will provide practical implementation of lecture material, including in-depth instruction on exercising various analysis and design tools for aerodynamics, structures, configuration layout, CAD and many other topics. Both lectures and labs will enable students to analyze and design existing or new aircraft configurations via a variety of weekly homework assignments and a design project at the end of the semester.

# Assignments

Homework assignments will be assigned most weeks throughout the semester in lecture and will be due by the start of lab the following week. Lab assignments will be assigned in most labs and will either be due at the end of the lab section or before the start of the next lab section. Assignments should be submitted electronically in PDF format via the Blackboard class website.

The homework, lab, and project assignments are designed for students to practice and demonstrate important skills pertaining to aircraft design. Students will be expected to apply the resources and material taught in lecture, lab and prior engineering course-work when completing assignments for this course.

Most homework assignments are related to the aircraft design project by working you through the procesess you will need to follow to complete a task in the project. Some homework assigments will not be directly related to the aircraft design project, but nevertheless will provide practice and demonstrate other important skills or information. For the student's convenience, some lectures, labs, and homework material may reference the sections of the project they support.

An airline customer network study will be conducted early in the semester and will determine the aircraft design missions for the aircraft design project later in the semester. Students will make group presentations.

An aircraft design project will be assigned approximately halfway through the semester. Students will submit their own formal project report at the end of the semester. These will also be submitted electronically in PDF format to the Blackboard website. See the project definition document for further information.

# Course Grading

The grading scale for AME 481 is summarized as follows:

| **Assignment** | **Weighting** |
|---|---|
| Total Homework | 30% |
| Total Lab Assignments | 20% |
| Network Study Results Presentation | 5% |
| PDR Presentation | 10% |
| Final Project Report | 35% |
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| Total | 100% |

Each homework assignment is weighted equally in the final grade. Late assignments will not be accepted, except for verified medical reasons.

# Grade Definitions

The USC Office of Academic Records and Registrar provides the following grade definitions used in this course (see Grading and Correction of Grades Handbook):

| Grade | Definition |
|---|---|
| A | Work of **excellent** quality |
| B | Work of **good** quality |
| C | Work of **fair** quality |
| D minus | Work of **minimal** passing quality |
| F | Work that does not meet **minimal** standards for passing the course |

# Course Schedule

| Week | Date | Lecture | Material | Homework |
|---|---|---|---|---|
| 1 | Jan. 8 | 1 | Course Introduction, Configuration Layout, Interiors, Fuselage, Cockpit, Landing Gear Design | 1 |
| 2 | Jan. 15 | – | No Class | |
| 3 | Jan. 22 | 2 | Mass Properties & Economics | 2 |
| 4 | Jan. 29 | 3 | Aerodynamic Performance | 3 |
| 5 | Feb. 5 | 4 | High-Speed Aerodynamics | 4 |
| 6 | Feb. 12 | 5 | Propulsion | 5 |
| 7 | Feb. 19 | – | No Class | |
| 8 | Feb. 26 | 6 | Structures | 6 |
| 9 | Mar. 4 | 7 | Project Phase B Start, High-Lift Aerodynamics, Mission Performance | – |
| 10 | Mar. 11 | – | No Class | |
| 11 | Mar. 18 | 8 | Stability & Control | – |
| 12 | Mar. 25 | 9 | Design Principles | – |
| 13 | Apr. 1 | 10 | Design Optimization & Trade Studies | – |
| 14 | Apr. 8 | 11 | Safety, Systems, Sustainable Aviation I | – |
| 15 | Apr. 15 | 12 | Guest Lecture (Safety and AI), Sustainable Aviation II | – |
| 16 | Apr. 22 | 13 | Electric Aircraft Design, Wrap Up, and Project Question Session | – |
| 17 | May 3 | | Project Due (4 pm) | |

| Week | Date | Lab | Material |
|---|---|---|---|
| 1 | Jan.10 | 1 | Lab Introduction + Jetsizer Tutorial and Mission Sizer |
| 2 | Jan. 17 | 2 | DBF Critical Design Review |
| 3 | Jan. 24 | 3 | Aircraft Operations |
| 4 | Jan. 31 | 4 | Aerodynamic Performance / High Speed Aero |
| 5 | Feb. 7 | 5 | Phase A Project Kickoff |
| 6 | Feb. 14 | 6 | Propulsion |
| 7 | Feb. 21 | - | Preparation for SRR next week |
| 8 | Feb. 28 | 7 | Group Presentations: Network Analysis System Requirements Review (SRR) |
| 9 | Mar. 6 | 8 | Finite Element Modeling |
| 10 | Mar. 13 | – | No Class |
| 11 | Mar. 20 | 9 | High-Lift System Design |
| 12 | Mar. 27 | 10 | Stability & Control |
| 13 | Apr. 3 | 11 | Preliminary Design Review (PDR) Group Presentations |
| 14 | Apr. 10 | 12 | Design Optimization and Trade Studies |
| 15 | Apr. 17 | 13 | Unique Trade Studies |
| 16 | Apr. 24 | 14 | Final Project Question Session |

Lab Assignments will be started during lab and completed outside the lab if necessary.

Students that have previously approved "Time Conflict Forms" for the AME-481 Lab will have to give priority to lab sessions. Most AME-481 Labs will have live interactive projects and there will be live Group Presentations on Feb 28th and April 3rd.

| Week | Date | Time | Deliverable |
|---|---|---|---|
| 8 | Feb. 28 | 4:45 PM | Network Study System Requirements Review (SRR) Group Presentation Slides |
| 13 | Apr. 3 | 4:45 PM | Preliminary Design Review (PDR) Slides |
| 17 | May 3 | 4:00 PM | Individual Project Report |

# Learning Outcomes

Students will develop and document a comprehensive aircraft design that includes consideration of:

- Proper verbal and written communications including making presentations, writing, drawing, and graphing
- Phases of an aircraft program (requirements development, conceptual design, preliminary design, production, operations, end of life)

- Customer requirements development and validation
- Aircraft design tools
- Mission performance and vehicle sizing
- Aircraft configuration layouts
- Aerodynamic design and optimization
- Aircraft propulsion
- Mass properties
- Aircraft systems
- Structural design
- Stability and Control
- Aircraft and airline economics
- Trade studies and optimization
- Safety and ethical issues
- Environmental impact and sustainability
- Alternative aircraft fuels, propulsion, and configurations
- Current developments, future technologies, and the need for lifetime learning.

Upon completion, the student will be able to:

- Configure an aircraft to meet specified design requirements;
- Design an airfoil;
- Model elements of the aircraft design in software;
- Analyze overall aircraft performance; and
- Prepare and present a series of design briefings similar to those done in industry.

Relation of the Course to ABET Program Outcomes: This course contributes primarily to ABET General Student Outcomes: (1), (2), (3), (4), and (7).

- (1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- (2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

- (3) An ability to communicate effectively with a range of audiences
- (4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- (7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

# Academic Integrity

Each student is responsible for completing and submitting their own work on assignments. Students are encouraged to discuss the assignments, but must ensure there is no plagiarism involved when creating and submitting their own work. Plagiarized assignments will receive no credit; students will only receive credit for their own work. Before submitting any assignment in AME 481, please ask the instructor to clarify any questions regarding what constitutes plagiarism if ambiguity exists. The following is a non-exhaustive list of examples that will be considered plagiarism:

- Copying codes/scripts programmed by someone else and submitting it without proper reference to the original author.
- Submitting copies of another student's completed assignment, in whole or in part, as one's own.
- Submitting plots or images not generated by the student and without proper reference to the original author.
- Submitting tables of text and/or data not generated by the student and without proper reference to the original author.
- Submitting text not generated by the student and without proper reference to the original author.

In order to minimize the likelihood of committing plagiarism, students shall do the following on AME 481 assignments:

- Program their own code and scripts.
- Create their own plots and images; reference the source of images they did not generate themselves.
- Write their own mathematical derivations.
- Write their own text in response to assignment questions.
- Write their own tables of text and/or data.

- Report data and results as generated by the codes/scripts the student programmed themselves.

AME 481 students suspected of plagiarism will be reported to the USC Student Judicial Affairs and Community Standards (SJACS) office for academic integrity violations. The official USC statement on academic integrity is the following (copied verbatim from `http://www.usc.edu/schools/GraduateSchool/academic_conduct.html`):

## Statement on Academic Conduct and Support Systems

**Plagiarism** - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, *Behavior Violating University Standards and Appropriate Sanctions*, accessible here: `http://studentaffairs.usc.edu/scampus/`. Other forms of academic dishonesty are equally unacceptable. See the university policies on scientific misconduct: `http://policy.usc.edu/scientific-misconduct`.

**Discrimination, sexual assault, and harassment** are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* `http://equity.usc.edu/` or to the *Department of Public Safety* via either of these forms: `http://dps.usc.edu/contact/report/` or `http://web-app.usc.edu/web/dps/silentWitness/`. *The Center for Women and Men* `http://engemannshc.usc.edu/cwm/` provides 24/7 confidential support, and the sexual assault resource center webpage `http://sarc.usc.edu/` describes reporting options and other resources.

**Help with scholarly writing** is provided by a number of USC's schools. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* `http://ali.usc.edu`, which sponsors courses and workshops specifically for international graduate students.

**Help arranging accommodation for students with disabilities** is provided by the *Office of Disability Services and Programs* `http://dsp.usc.edu`

**Emergency information** will be posted at `http://emergency.usc.edu`. If an officially declared emergency makes travel to campus infeasible, this website will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.