San José State University
Aerospace Engineering Department
AE 171 A – Aircraft Design I

Fall 2022

Course and Contact Information

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Office Hours:	W-TR 3:00 – 4:15 & by appointment
Class Days/Time:	F 8:30-11:15
Classroom:	E403 when in person, online otherwise
Prerequisites:	Must be “senior” in good academic standing. AE20, AE162, AE165, Engr100W Completion of core GE
Co-requisites:	AE164, AE168, Engr.195A.

Course Description

This is the first course in a two-semester sequence, in which students work in teams to complete the conceptual and preliminary design of an aircraft. Students are challenged to consider the relationship of aerospace engineering to the broader community. Meets GE areas S and V when course is taken in combination with: AE 171B, ENGR 195A and ENGR 195B.

Course Goals

1. To offer an opportunity for going beyond a paper product (design report) into actual manufacturing and flight-testing of model airplanes.
2. To develop students' creative abilities in solving open-ended, airplane design problems.
3. To develop an appreciation of the interrelationships between aerodynamics, propulsion, structures, flight mechanics, stability & control, manufacturing, maintenance, and cost in an integrated airplane design.
4. To develop students' engineering judgment as well as their confidence in making and accepting responsibility for design decisions.
5. To develop students' oral and written communication skills, necessary to describe the assumptions, methods, and results of engineering analysis, synthesis, and decision making associated with airplane design.
6. To make students aware of the importance of teamwork in the design of an airplane and provide them with an opportunity to develop team and leadership skills.
7. To make students aware of their professional and ethical responsibilities as practicing engineers.
8. Discuss the role of identity, equality, social actions, and culture in aerospace engineering practice. (Integration of Area S and Engineering.)

Course Learning Objectives

Upon successful completion of this course, students will be able to:

GE Area S–LO1: *Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.*
BSAE LO–G: *Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.*
BSAE LO–H: *Recognition of the need for and ability to engage in life-long learning.*

- Engr195A **Reflection Paper 3**: Discuss and provide examples of how at least one of your identities (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability and/or age, among others) is shaped, or has been shaped, by cultural and societal influences within contexts of equality and inequality and how this impacts you as an engineer. Please integrate course material (concepts, theories, discussions, and lectures). Please cite at least one course reading and one appropriate source from outside class.
- AE171A – ***Essay 1*** (minimum 250 words): *Consider your identity as a future Aerospace Engineer. How is your identity shaped by cultural and societal influences within contexts of equality and inequality?*

GE Area S–LO2: *Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.*
BSAE LO–G: *Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.*
BSAE LO–H: *Recognition of the need for, and ability to engage in life-long learning.*

- Engr195A **Reflection Paper 2**: Consider technological innovations and developments in your field. Describe how one such innovation has either increased or decreased social justice and inequality in the U.S. Finally, discuss whether and/or how this will influence constructive and deconstructive interactions between people from different cultural, racial, and ethnic groups within the U.S. Please integrate course material (concepts, theories, discussions, lectures, readings). Please cite at least one course reading and one appropriate source from outside class.
- AE171A – ***Essay 2*** (minimum 500 words): *Describe how airplanes in general and your project in particular, fit into the historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S. and the world. Include at least two citations, not including course readings or lecture.*

GE Area S–LO3: *Describe social actions, which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).*
BSAE LO–G: *Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.*
BSAE LO–H: *Recognition of the need for, and ability to engage in life-long learning.*

- Engr195A **Refection Paper 1**: Discuss how your current or past projects have or will contribute to social and/or environmental action in the United States. Looking forward, can you predict any other possible unintended environmental and/or social consequences from your work as an engineer? Please integrate course material (concepts, theories, discussions, and lectures). Please cite at least one course reading and one appropriate source from outside class.
- AE171A – ***Essay 3*** (minimum 500 words): *Describe a historical example of how airplanes have increased (or hindered) social justice in the U.S. and the world. Include at least two citations, not including course readings or lecture.*

GE Area S–LO4: *Recognize and appreciate constructive interactions between people from different cultural,* racial, and ethnic groups within the U.S.
BSAE LO–D: *Ability to collaborate with people from different cultures, abilities, backgrounds, and disciplines to complete aerospace engineering projects.*
BSAE LO–H: *Recognition of the need for, and ability to engage in life-long learning.*

- Engr195A **Reflection Paper 1**: Consider technological innovations and developments in your field. Describe how one such innovation has either increased or decreased social justice and inequality in the U.S. Finally, discuss whether and/or how this will influence constructive and deconstructive interactions between people from different cultural, racial, and ethnic groups within the U.S. Please integrate course material (concepts, theories, discussions, lectures, readings). Please cite at least one course reading and one appropriate source from outside class.
  AE171A – ***Essay 4*** (minimum 500 words): *Consider a negative side effect of airplanes: noise. Read the four references pertaining to aircraft noise (Swift, 2010; Morrison et al, 1998; FAA; ICAO) and research the procedures regarding airplane noise in your own town or region. What civic organizations promote the reduction of airplane noise in your community? Either visit one of these groups' websites or visit the group in person and describe the interactions between this group and the larger community. Your paper must cite all your sources, including the ones listed below.*

  <u>Articles:</u>
  - Swift, H. (2010, July). A review of the literature related to potential health effects of aircraft noise. Partner Project 19 Final Report. Partnership for Air Transportation Noise and Emissions Reduction: an FAA / NASA / Transport Canada – sponsored Center-of-Excellence.

- Morrison, S.A., Watson, T. & Winston, C. (1998, September). Fundamental Flaws of
- Social Regulation: The Case of Airplane Noise. AEI-Brookings Joint Center, Available: http://www.brookings.edu/research/papers/1998/09/airplane-winston
- FAA Advisory Circulars, Noise Standards: Aircraft Type and Airworthiness Certification, Available: http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list/parentTopicID/112
- ICAO, Environmental Protection, Aircraft Noise, Available: http://www.icao.int/environmental-protection/Pages/noise.aspx

BSAE LO–C: *Ability to perform conceptual and preliminary design of aircraft or spacecraft to meet a set of mission requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.*

1. Define an appropriate set of mission requirements and sketch the mission profile of an airplane.
2. Define, calculate, and evaluate measures of merit (MOM) for an airplane.
3. Perform a literature search and collect data to show the need for a particular airplane. ***(BSAE LO–H:*** *Recognition of the need for, and ability to engage in life-long learning.)*
4. Identify the critical mission requirements of an airplane.
5. Evaluate the configuration of airplanes and describe the connection between configuration choices (ex. high wing, tandem landing gear) and mission requirements.
6. Describe the pros and cons of the various conventional aircraft configurations.
7. Describe the pros and cons of unconventional aircraft configurations such as canards, 3-surface, swept-forward wings, flying wings, tailless, V/STOL, stealth, etc.
8. Select an appropriate configuration for an airplane with a specified mission.
9. Estimate the takeoff weight of an airplane based on the mission requirements using the weight fraction method.
10. Calculate the takeoff weight sensitivities of an airplane to changes of critical parameters such as L/D, sfc, etc.
11. Perform trade studies between range and payload.
12. Construct a matching graph based on specific performance constraints (stall speed, cruise speed, takeoff and landing distance, maneuverability requirements) and use it to predict the required thrust/power and wing area of an airplane.
13. Prepare CAD drawings of the cockpit and the fuselage of an airplane based on specific payload requirements.
14. Design the wing, high-lift system, and lateral controls of an airplane.
15. Design the empennage and the directional controls of an airplane.
16. Design the landing gear of an airplane using tip-over and ground clearance criteria and (for retractable landing gear) show the retraction feasibility with appropriate drawings.
17. Perform a weight and balance analysis for an airplane and draw the c.g. excursion diagram.
18. Perform static longitudinal and directional stability analysis for an airplane and draw the corresponding x – plots.
19. Perform a critical evaluation of the landing gear design, the empennage, the weight and balance, and the stability and control analysis to ensure that an airplane is not prone to tip-over problems, too much c.g. travel, too much or too little stability and / or a minimum control speed problem.
20. Estimate the drag polars of an airplane for the takeoff, cruise (low and high speed), and landing configurations.

BSAE LO–D: *Ability to collaborate with people from different cultures, abilities, backgrounds, and disciplines to complete aerospace engineering projects.*

21. Work harmoniously and effectively in a team to solve engineering problems related to the design of an airplane and to communicate the results in technical reports and oral briefings.
22. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
23. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.

Project Management

24. Develop a milestone schedule (timeline) for an engineering project and follow it.

BSAE LO–F: *Understanding of professional and ethical responsibility.*

25. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.

BSAE LO–E: *Ability to communicate effectively through technical reports, memos, and oral presentations as well as in small group settings.*

26. Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).
27. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.

Relationship of CLOs to BSAE Student Learning Outcomes

	BSAE Student Learning Outcomes								
	A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***
Course Learning Outcomes									
1 – 20	B		C					C	C
21 – 24				C	C			C	
25						C		C	
26 – 27					C				
32 – 34							C	C	
GE Area S – LO1							C	C	
GE Area S – LO2							C	C	
GE Area S – LO3							C	C	
GE Area S – LO4				C				C	

NB: The letters inside the table indicate the highest level of skill achieved by the LOs on the left-hand side. "B" corresponds to levels 3 or 4 in Bloom's Taxonomy; "C" corresponds to levels 5 or 6 in Bloom's Taxonomy.

Text s

Roskam, J (1989). *Airplane Design, Parts I-VIII*, Roskam Aviation and Engineering Corporation, Rt. 4, Box 274, Ottawa, Kansas 66067, USA
Daniel P. Raymer, Aircraft Design: A Conceptual Approach. AIAA Education Series. ISBN 0-930403-51-7

Other Required Reading

FAA Advisory Circulars, Noise Standards: Aircraft Type and Airworthiness Certification, available at <http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list/parentTopicID/112>

Hoover, K. & Fowler, W.T. *Studies in Ethics, Safety, and Liability for Engineers – The Crash of American Airlines Flight 191*, The University of Texas at Austin, available at < http://www.tsgc.utexas.edu/archive/general/ethics/aacrash.html>

Hoover, K. & Fowler, W.T. & Stearman, R.O. *Studies in Ethics, Safety, and Liability for Engineers – The V-Tail Bonanza*, The University of Texas at Austin, available at < http://www.tsgc.utexas.edu/archive/general/ethics/vtail.html>

ICAO, Environmental Protection, Aircraft Noise, available at <http://www.icao.int/environmental-protection/Pages/noise.aspx>

Morrison, S.A., Watson, T. & Winston, C. (1998, September). Fundamental Flaws of Social Regulation: The Case of Airplane Noise. AEI-Brookings Joint Center, available at <http://www.brookings.edu/research/papers/1998/09/airplane-winston>

Swift, H. (2010, July). A review of the literature related to potential health effects of aircraft noise. Partner Project 19 Final Report. Partnership for Air Transportation Noise and Emissions Reduction: an FAA / NASA / Transport Canada – sponsored Center-of-Excellence.

Course Requirements and Assignments

Course assignments consist of several design reports, design quizzes, technical discussions, a written test, and collaboration with the AE20 and AE30 students.

Final Examination / Evaluation

The Team "Critical Design Review" oral examination will take place in lieu of a final exam.

Grading

The course grade is determined as follows:

- 60% based on team performance (design reports and presentations); individual scores are determined by peer evaluations (see Teamwork section at the end of this document).
- 22% based on individual technical performance (written tests and participation in technical discussions)
- 18% based on additional assignments:
    - GE Area S / BSAE LO–H: Reflection papers 1, 2, 3, and 4.
    - Design questions and graded ethics discussion
    - BSAE LO–F: Case studies on safety, ethics, and liability issues: Review of case studies for the Beech V-Tail Bonanza empennage and the American Airlines 191 accident.
    - BSAE LO–G: Reflection papers 1, 2, and 3.
    - **NB-1: Even if you score 100% on the technical (design) part of the course, you will NOT receive a passing grade UNLESS you also average 70% or higher on all assignments within each of the following categories:**
        1. Assignments that address BSAE LO–F
        2. Assignments that address BSAE LO–G
        3. Assignments that address BSAE LO–H
        4. Assignments that address GE Area S

- **NB-2: Your papers will suffer a significant point reduction and/or may be returned ungraded if they are deficient in one or more of the following areas:**
  - ***Grammar and spelling are not at an acceptable level for an advanced GE course / capstone, senior design experience.***
  - References are not included or are not cited in the text.
  - References listed do not follow APA or AIAA rules.
  - Fewer than 3 journal or peer reviewed articles are used / cited in your paper.
  - Supporting materials are too old (older than 5 years)
  - Turnitin.com plagiarism check was positive (except in the "References" section)
  - Assignment was submitted late.

- 10% based on your collaboration with and mentoring of AE20 and AE30 students. In particular, you are expected to:
  - Explain your design project to AE20 / AE30 student teams assigned to you.
  - Assign simple CAD and programming tasks related to your project to each AE20 / AE30 team.
  - Be available to meet with AE20 / AE30 student teams assigned to you and provide mentoring to them as needed.

Determination of Grades

Grade	Minimum Score
A+	950
A	900
A-	850
B+	800
B	750
B-	700
C+	675
C	650
F	649 or lower

AE171A – Aircraft Design I – Fall 2022
Approximate Weekly Schedule

Week	Topics, Readings, Assignments, Deadlines
1 – 8/19	Teamwork. Introduction to Aircraft Design. Class Expectations. Team formation.
2 – 8/26	Mission Requirements and General Design. Discussion on Cultural Shaping of our Identity as Engineers in the Context of Equality and Inequality. Review Weight Sizing and Sensitivities.
3 – 9/2	Performance sizing
4 – 9/9	Complete performance sizing. Configuration design. Design of the fuselage, cockpit. Powerplant integration and other initial considerations.
5 – 9/16	Wing and empennage configuration. Weight and Balance Analysis.
6 – 9/23	Project review. **Mission Spec and Comparative Study Report due (9/24)**
7 – 9/30	Longitudinal Stability Analysis. Project societal impact discussion.
8 – 10/6	Landing Gear Positioning. Project Review. **Essay #4 (GE Area S) due (10/7).**
9 – 10/14	Landing Gear Design. **Weight and Performance Sizing Report due (10/15)**
10 – 10/21	Catch up week. **Essay #2 (GE Area S) due (10/22).**
11 – 10/28	Review of Initial Ethics Case in Aircraft Design. Wing Devices. **Configuration Design Report and Schematics due (10/29).**
12 – 11/4	Wing Devices. **Essay #3 (GE Area S) due (11/4).**
13 – 11/11	Misc topics. **Test (take home format, 100% individual effort).**
14 – 11/18	Catch up week. Project Review. **Essay #1 (GE Area S) due (11/19)** **Weight and Balance Report due (11/23)**. **Online Ethics Discussion Closed (11/29)**
15 – 12/2	**Critical Design Review (Presentation, see rubric in Canvas). Basic Stability and Control Report Due (12/3).**
16 – 12/9	Project Review. **Online Discussions Closed**

Teamwork

- You are **required** to work in teams for a number of assignments. Please make yourself available to meet and work with your teammates outside of class.

- Instructor has final say in the formation of all teams. The instructor may form the teams if required.

- At the end of each requested assignment every Team member must submit their self and peer evaluation electronically. If you disagree with the scores you receive from your peers, you may provide an explanation to your instructor in writing and request an individual exam on the assignment. To get full credit on a team assignment, your teammates must grade you above 85% in all areas of peer review (see team member report card). Otherwise, your score for the assignment will be your team's score multiplied by the average peer review score.

- If your name appears on a team paper, you are expected to be capable of explaining whatever answers, solutions, conclusions, or derivations are on the paper. The instructor may request that any student provide specific answers on behalf of the group to ensure compliance.

- Senior Design Teams must develop and oversee a project for AE20/30 students to complete over the course of the semester. At a minimum, a statement of work, rolling action item list, and overall project schedule must be prepared and reviewed over weekly meetings with participation of all Team members. The Senior Design Team would then evaluate the contributions of their assigned Support Team. Members of the Support Teams, to be formed with the assistance of AE 20/30 Instructors or Coordinator, will complete their projects as part of their coursework and will provide feedback for the evaluation of the Senior Team's performance.

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/

AE Department Policies http://www.sjsu.edu/ae/programs/policies/

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on my faculty web page at http://www.sjsu.edu/people/firstname.lastname and/or on Canvas Leaning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system through MySJSU at http://my.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.