AE 271 – Advanced Aircraft Design
Fall 2017

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Class Days / Time TR 18:00 – 19:15
Final Project Presentations 14 December 2017, 5:15 pm
Classroom Engr.164
Prerequisite Graduate standing in AE or instructor consent
Credit 3 units
GWAR This course satisfies the Graduation Writing Assessment Requirement (GWAR)

Textbook Roskam, J. (1985). Airplane design, Part 1: Preliminary sizing of airplanes. Roskam Aviation and Engineering Corporation Rt4, Box 274, Ottawa, Kansas 66067, USA.

Required Reading

Riboldi, C.E.D. & Gualdoni, F. (2016). An integrated approach to the preliminary weight sizing of small electric aircraft. *Aerospace Science and Technology,* 58, 134–149.

Other References

Bradley, M.K. & Droney, C.K. (2012, May). Subsonic ultra green aircraft research phase II: N+4 advanced concept development. *NASA/CR-2012-217556*.

Bradley, M.K. & Droney, C.K. (2015, April). Subsonic ultra-green aircraft research phase II: Hybrid electric design exploration. *NASA/CR–2015-218704*/Volume II.

Bradley, M.K., Allen, T.J. & Droney, C.K. (2014, April). Subsonic ultra-green aircraft research phase II: Truss braced wing aeroelastic test report. *NASA/CR–2015-218704*/Volume III.

Raymer, D. (2012). *Aircraft design: A conceptual approach*. AIAA Education Series, Reston, VA 2012 ISBN 978-1-60086-911-2

Torenbeek, E. (1982). *Synthesis of subsonic airplane design*. Springer. Also available as e-book. ISBN 978-94-017-3202-4

AE 271 – Advanced Aircraft Design

Description This is a project course in which students complete the preliminary design of an airplane of their choice. The design process involves defining the mission requirements, weight sizing, performance sizing, fuselage design, wing, high-lift system and lateral controls design, landing gear design, weight and balance, stability and control, drag polars, final drawings. In their final report students will also discuss any environmental, economic and safety considerations for their airplane.

Goals

1. To provide graduate level experience in airplane design.
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.

Learning Objectives Each student completing AE271 will be able to:

1. Describe the pros and cons of unconventional aircraft configurations such as canards, 3-surface, swept-forward wings, flying wings, tailless, V/STOL, stealth, etc.
2. Perform weight and performance sizing of a gas-powered or electric airplane, including pertinent Title 14 of the U.S. Code of Federal Regulations (14 CFR Parts 23/25) and European standards (EASA CS23/25)
3. Design the fuselage, the wing, the empennage, and the landing gear of an airplane.
4. Perform weight and balance analysis of an airplane.
5. Perform a stability and control analysis of an airplane.
6. Compute the drag polars of an airplane.
7. Construct the V-n diagram of an airplane.

Grading

Design reports*	= 60%
1st oral progress report & oral exam	= 20%
Final oral presentation & examination	= 20%

850 points	< A-, A, A+
700 points	< B-, B, B+
650 points	< C

Reports Reports will be graded for **English** (grammar, spelling, punctuation, etc.) as well as for **technical content**. Please see general guidelines for professional reports below. **Written reports not meeting minimum writing proficiency standards will be returned without a grade.** Revised reports may be re-submitted (once each) with a ***penalty of 20 points*** in the scale of 1 to 100.
If your report is returned for English please seek help from the **SJSU Writing Center** <http://www.sjsu.edu/writingcenter/tutoring/index.html>

Approximate Weekly Schedule

Week	Lecture Topic(s)
25 August	Aircraft design overview.
29 August	Mission requirements. Figures of merit. Weight sizing,
06 September	Weight sensitivities, trade studies.
12 September	Performance sizing.
19 September	Configuration design – conventional configurations.
26 September	Configuration design – unconventional configurations.

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03 October	***1st Briefing (10 min) – Mission, configuration, weight sizing, Performance sizing.***
10 October	***1st Briefing (cont'd) – Mission, configuration, weight sizing, Performance sizing.***
17 October	Fuselage, wing & empennage design.
24 October	Landing gear design. Weight & balance.
31 October	Longitudinal stability & control.
07 November	Lateral stability & control.
14 November	Directional stability & control.
21 November	Green Aviation (No Class On 24 November - Thanksgiving)
28 November	Possibilities for green aviation
05 December	**6 & 8 December – Final Design Briefings**
19 December	***Final Exam & Final Design Review: 14:45 – 17:00***

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GENERAL COMMENTS ON PROFESSIONAL REPORT WRITING

Each report must meet minimum standards of professionalism. Unprofessional reports will be **severely downgraded even if** the technical content is correct. The following items explain some of the features of a professional report.

1. All reports must be prepared with a **word processor**.
2. Organize reports using a **decimal numbering system**. The chapters, Sections, Sub-Sections should be indicated as follows:

   4. TITLE OF CHAPTER
   4.1 TITLE OF SECTION
   4.1.1 Title of Sub-Section
   4.1.1.1 Title of sub-sub-section
3. Many reports require **calculations**. At least one "hand" calculation **must** be performed and documented for each case in a separate sub-section. These hand-calculations do not have to be typed but should be clearly written and well organized. **If they are lengthy (i.e. more than 2 pages)**, they should be placed in a separate appendix but the results should be discussed in the main body of the report.
4. **All** pages must be numbered. Start the introduction at page 1. Pages in the main body of the report are numbered: 1, 2, 3, etc. Preliminary pages such as Table of Contents, List of Symbols etc. are numbered sequentially : i, ii, iii, iv, etc.
5. A minimum **margin** of **one inch** must be observed on all pages including graphs, figures, tables, computer print-outs, etc.
6. The report must be written in good **English.** All words must be properly spelled. You are expected to proofread your reports before handing them in.
7. Avoid using sentences longer than 2 lines. If you do not, your report will have a high "**Fog Index**" (i.e. it will be difficult to read).
8. **Do not** use I, You, We, They, etc. in a technical report. Also, **do not** treat an airplane or airplane components as persons, i.e., DO NOT write: *the airplane's landing gear is of the retractable type.* Instead, write: *the landing gear of the Cessna 182 is of the retractable type* or, even better, *the airplane has a retractable landing gear.*
9. **Do not use** the words: **'in order to ...'**. Remember, the words 'in order' are nearly always out of order!
10. Make use of the technique called **"bulletizing"**.
    Instead of: *in this chapter, the results of calculations of wing-loading, maximum lift coefficients, thrust-to weight ratio, lift-to-drag ratio and cruise lift coefficients are presented.*
    Write: *In this chapter the following characteristics of the Spartan Jet are presented:*
    - *Wing Loading*
    - *Maximum Lift Coefficients*
    - *Thrust-to-Weight Ratio*
    - *Lift-to-Drag Ratio*
    - *Cruise Lift Coefficient*
11. Make sure that no **symbols** are **omitted** from your equations. Again, it is important to proofread your reports before handing them in!
12. All **equations** must be numbered and numbered sequentially. Within a chapter use a decimal numbering system. For example:

$$X = Y + Z \qquad (4.17)$$

13. All **references** must be numbered sequentially as they appear in your report. See examples below (1 is a book, 2 is a technical report, 3 is a journal article, 4 is a conference paper, 5 is an internet reference). In your report refer to each of them with a number in a bracket. For example: *The vortex increases the lift of the flat plate [2]* or *Mourtos [2] found that the existence of the vortex increased the lift on the flat plate at any given angle-of-attack.*

1. Nickel, K., Wohlfahrt, M., *Tailless Aircraft in Theory and Practice*, AIAA Education Series, 1994.
2. Mourtos, N.J., Couillaud, S., Carter, D., Hange, C., Wardwell, D., Margason, R.J., Flow Visualization Studies of Jet VTOL models during Hover in Ground Effect, *NASA TM 108860*, Jan. 1995.

3. Mourtos, N.J., Flow past a Flat Plate with a Vortex / Sink Combination, *ASME Journal of Applied Mechanics*, Jun. 1996.
4. Papadopoulos, P., Subrahmanyam, P., Airbreathing Engine Analysis and Simulation Tool for Space Vehicle Design, *Proc., AIAA/CIRA 13th International Space Planes and Hypersonics Systems and Technologies Conf.,* Centro Italiano Ricerche Aerospaziali (CIRA), Capua, Italy, 16-20 May 2005.
5. UAV, Wikipedia, URL: <http://en.wikipedia.org/wiki/Unmanned_aerial_vehicle>, retrieved Dec. 5, 2007.

14. All **figures** and **graphs** must be **numbered** and numbered sequentially. They must also have descriptive **titles**. Titles must appear **below** the figure. All **axes** must have scale and descriptive **labels** including **units** whenever appropriate. **Curves** must also have descriptive **labels**. All lettering must be at least 3 mm high to be legible! For example:

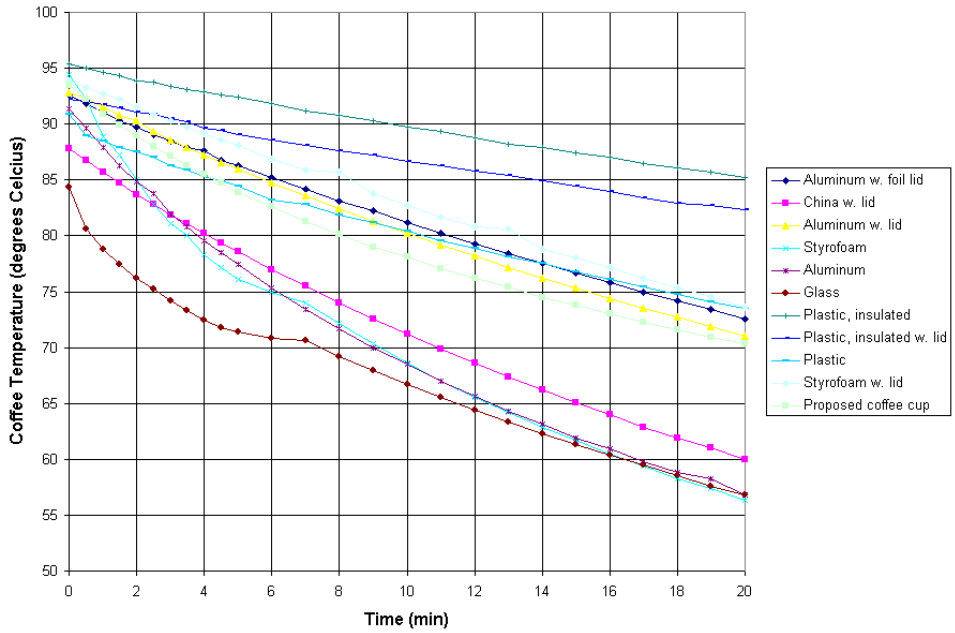

Figure 3.1 – Coffee temperature decline in various cups.

15. All **tables** must be **numbered** and numbered sequentially. They must also have descriptive **titles**. Titles must appear **above** the table. Again, all lettering must be at least 3 mm high to be legible!

Table 5.1 - The heaviest ten airplanes. MTOW = Maximum take-off weight, MLW = Maximum landing weight, TOR = Take-off run (SL, ISA+15°, MTOW), LR = Landing run (SL, ISA+15°, MLW)

Type	MTOW [tons]	MLW [tons]	TOR [m]	LR [m]
Antonov An-225	640			
Airbus A380-800F	590	427		
Boeing 747-8I	439.985	306.175		
Antonov An-124	405			
Airbus A340-500	368	240	3050	2010
Boeing 777-300ER	351.535	251.29		
MD-11	273.314	195.04	3115	2118
Ilyushin IL-96M	270	175		
Boeing 787-9	244.94			
L-1011-500	231.54	166.92	2636	

16. When presenting **aerodynamic data** in a table, graph or figure it is mandatory that you include the following information:
    - Reference geometries: S, c and b in ft (or inches) and m (or cm).
    - Moment center information in fractions of the m.g.c.
    - Airplane weight consistent with the presentation of the data.
    - Airplane configuration information, such as:
        - Clean
        - Flaps down, gear up
        - Flaps down, gear down
        - Thrust or power setting
        - Speed brake deployment
        - Flight condition
        - C.g. location in fractions of m.g.c.
17. Remember: **tables, graphs** and **figures** are much easier to understand than **prose** so use them as much as possible.
18. Do not put **lengthy derivations** in the main body of the report. Put such material in an appendix (or appendices) and **summarize** the result in the main part of the report.
19. **Plagiarism** will result in **total loss of credit for the entire report**! If you decide to use material, which was not generated by you, clearly identify the source of such material. Give credit where credit is due!
20. A **list of symbols** must be included in your report. This list must define all symbols used anywhere in the report (including figures, appendices, etc.). Do not include symbols which are not used in your report! Do not copy a list of symbols from another reference! The list of symbols must be presented in the following manner:

Symbol	**Definition**	**Units (SI)**
W	Weight	lbs (N)
Greek Symbols		
α	Angle of attack	deg or rad
Subscripts		
$( )_{TO}$	Takeoff	-------
Acronyms		
APU	Auxiliary Power Unit	-------

21. Never make an **unsubstantiated claim**! Example: if you claim that you have optimized airplane weight, you are expected to prove it. If you cannot, do not make the claim!
22. **Avoid** the use of **superlatives, (**e.g. *this is the best airplane ever designed* or *the wing area selected is the smallest possible for this type of airplane*).
23. If you **extrapolate** data or if you extrapolate existing technology, discuss the consequences to your design of not being able to achieve the extrapolated characteristics.
24. Include **units** (both systems) with all your results.
25. Appendices must be sequenced using capital letters and must have specific titles. For example:
    Appendix A - Hand Calculations
    Appendix B - Design Parameters of Comparable Aircraft