ME408 – Aircraft Performance and Design

Fall 2023 Course Syllabus

1) Instructor Information

Jim Geiger
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Office Hours: Tu – Thu, 3:30 to 6:00
Office: Building EMC, Room 202A, 730 Commonwealth Avenue.

You can e-mail me and I will generally respond within 24 hours, if possible. If the e-mail involves specific technical questions about your team projects, then ***PLEASE INCLUDE ALL TEAM MEMBERS ON E-MAIL DISTRIBUTION!!***

2) Course Objectives

a) Expose students to the **key elements** of conceptual, fixed-wing aircraft design: Requirements, Sizing, Performance, Wing-Fuselage-Empennage Design, Enhanced Lift, Structural Design, Stability & Control and Cost Estimation.

b) Demonstrate the fundamental, **iterative nature** of design through complete aircraft design projects that run parallel to the course material.

c) Students learn to design **multiple types** of fixed wing aircraft and gain appreciation for what drives the three basic types: Commercial Transport, General Aviation and Military.

d) Establish a foundation for the **fundamental principles** of aircraft design, especially for Aero-Concentrators who, on successful completion of ME408, may select an aircraft design related project for Senior Design I (ME 460) and Senior Design II (ME461).

3) References

a) Required Texts

Primary Text Book; “Design of Aircraft”, Corke, Thomas C., Prentice Hall, 2003

Reference Text Book; “Theory of Wing Sections”, Abbott, Ira Herbert and von Doenhoff, Albert Edward, Dover Publications, 1949

Other Resources: Jane’s All the Worlds Aircraft in four (4) separate volumes.
Jane’s All the Worlds Aircraft-Dev & Prod
Jane’s All the Worlds Aircraft-In Service
Jane’s All the Worlds Aircraft-Unmanned
Jane’s All the Worlds Aircraft -Aero Engines

Jane’s volumes are available at the BU Library and ARE required for each team to consult.

b) Other Texts

“Aircraft Design”, Sadraey, Mohammad H., Wiley, 2013

“Aircraft Design: A Conceptual Approach”, 6th Edition, Daniel P. Raymer, AIAA, 2018

“Aircraft Engine Design”, Mattingly, Jack D., Heiser, William H., Daley, Daniel H., AIAA Education Series, 1987 … (Chapters 2 and 3 only).

4) Attendance

Lectures: Attendance and participation are highly recommended. This is a team-oriented course, so missing class will affect your team as well as yourself. Students are also encouraged to bring their texts and laptops to class, as we will often be doing exercises in class.

Mentoring Sessions: Attendance and participation are highly recommended. Attendance for these sessions has proven to be beneficial, if the teams are prepared for the session. There are four (4) mentoring sessions scheduled in the class before the team design reviews. These sessions allow for each team to meet with the instructor for ~15 min one-on-one and to ask specific questions about their designs.

Presentations: Attendance and participation are mandatory. There are four (4) design review / presentations during the semester that will constitute your entire grade. See the next Section 5) Grades for details.

5) Grades

The individual course letter grades for this course will be based on the BU point system.

Points	Letter Grade	Honor Points
95+	A	4.0
90-94.99	A-	3.7
85-89.99	B+	3.3
80-84.99	B	3.0
75-79.99	B-	2.7
70-74.99	C+	2.3
65-69.99	C	2.0
60-64.99	C-	1.7
55-59.99	D	1.0
<55	F	0.0

There is no final exam, tests or graded homework for this course. Your grade will be determined via team design reviews. Points will be awarded to each team based on a sequence of four (4) Design Reviews. Each review will involve a team presentation to the class according to the schedule shown below. Presentation and content and dates are subject to change, if need be. All students on a given team will receive the same points, unless a student misses a presentation, in which case that student will receive 75% of the team's points for that presentation. There are seven (7) bonus points up for grabs in five (5) separate opportunities for each team to claim as indicated below. Only the team with the best design review will win the bonus point(s).

Course Item	Content	Max Points	*Bonus Points	Presentation Date
Paper Airplane Design			1	Thu, 9/7/2023
Conceptual Design Review (CDR)	Mission Analysis Design Point Selection Competitive Assessment	25	1	Thu, 9/28/2023
Preliminary Design Review #1 (PDR1)	Main Wing Design Fuselage Design Landing Gear Design Empennage Design Competitive Assessment	25	1	Tue, 10/24/23
Preliminary Design Review #2 (PDR2)	Propulsion System Design Takeoff & Landing Analysis Enhanced Lift (Flaps) Design Competitive Assessment	25	1	Tue, 11/14/2023
Final Preliminary Design Review (PDR3)	Structural Analysis Static Stability & Control Cost Estimate Competitive Assessment Final Preliminary Design	25	2	Tue, 12/12/2023

6) Team Projects

a) Projects

There are eleven (11) team projects offered to the students to work through out the semester. Each project is a complete, aircraft design project that runs parallel to the course lecture material. Students will join a team and work one (1) of these projects during the semester. Student teams will work the project together and make four (4) presentations (design reviews) to the entire class during the semester.

The eleven (11) projects offered for Fall 2023 are;

Military
-Air Cargo Freighter
-Long Range Strike Bomber
-Multirole Fighter
-Maritime Patrol Aircraft

Commercial
-Twin Jet Airliner
-New Midsize Airliner
-Trans Oceanic Business Jet

General Aviation
-Agricultural Sprayer / Aerial Firefighter
-Aerobatic Sport-plane
-Civil Utility Aircraft
-Single Engine Piston

Each team will be expected to work the entire design project throughout the Semester.

Refer to Power point file, "ME408 Fall 2023 Design Projects, v1" on Learn for details on each team project.

b) Teams

Members
Each student will be placed on a team based on project selections made by the students. The first class of ME 408 is primarily a review of the eleven (11) projects offered to give students some context about each project. The first assignment is to review the design projects and submit to the Instructor (jgeiger@bu.edu) your top four (4) choices. All efforts will be made to form teams with each student's top choices.

Trades
Each team will have the option of one (1) "trade" during the semester. The trade option is voluntary, not required and intended to give teams the option of improving upon team chemistry, in the event that

personalities are getting in the way of team progress and morale. The trade must be one-for-one and both teams involved in the trade must be in full concurrence that the trade is approved. If a trade cannot be worked out to the satisfaction of all concerned, then the team seeking a trade must find a way to "soldier on" with the current team members as is. If and when the details of a proposed trade have been determined, then both teams should consult with the instructor to finalize the trade.

Team Presentations

Each Team will present the status of their designs to the class on four (4) occasions during the semester (see section 5 above for details). Each presentation will be graded. Details of the expected content for each presentation will be given during the semester prior to each presentation.

Team Participation

Each member of the team will receive the same grade for a given presentation, unless as noted above a student misses a design review/presentation, in which case that student will receive 75% of the team's points. NOTE: This fact that all team members receive the same grade is the reason why each team member needs to contribute to the team in a fair manner. Teams that struggle in ME 408 almost ALWAYS have a team member participation issue as a root cause to their problems.

Mid-Term Peer Evaluations

Each team member will have a chance to anonymously rate his or her team mates on overall contribution to the team. If the evaluations show clear evidence that a team member is not contributing to the team in a fair and equitable way, based on the other team members input, then a meeting with the Instructor will be arranged and a plan outlined to improve performance. If the behavior persists throughout the semester, then the final grade of the underperforming student(s) will be modified, downward, to reflect the injurious behavior of the student on the overall team chemistry.

SCROLL TO SEE CLASS CALENDAR

7) ME408 Class Calendar, Fall 2023

Note that all dates are tentative. We will stick to this schedule as close as possible, but may need to adjust the dates and/or course material if situations arise that call for it.

ME408 - Aircraft Performance and Design				
Fall 2023 Class Schedule				
Version 1, 9/5/2023				
Course Text: "Design of Aircraft", Corke, Thomas C., 2003 Pearson Education Inc.				
			Corke	
Class	**Date**	**Day**	**Chapter**	**Lecture or Design Review Topic**
1	9/5/2023	Tue	1	Course Introduction, Syllabus, Team Project Descriptions, Competitive Assessment
2	9/7/2023	Thu		Team Exercise - Paper Airplane Design and Test (INITIAL).
3	9/12/2023	Tue	2	Mission Analysis - Mission Profile, Aircraft Aerodynamics, Propulsion, Weights
4	9/14/2023	Thu	2	Mission Analysis - Mission Profile, Aircraft Aerodynamics, Propulsion, Weights
5	9/19/2023	Tue	3	Design Point Selection - Matching Chart
6	9/21/2023	Thu	3	Design Point Selection - Matching Chart
7	9/26/2023	Tue		Mentoring Session ~20 min with each team.
8	9/28/2023	Thu		**Team Presentations - Conceptual Design Review (CDR)**
9	10/3/2023	Tue	4	Main Wing Design - Airfoil selection, 3D wing parameters, Max Lift Coefficient, Drag Calculations
10	10/5/2023	Thu	5	Fuselage Design - Volume Calculations, Drag Calculations, Landing Gear Design, Armament Design
	10/10/2023	Tue		NO CLASS (Holiday, Substitute Monday Schedule)
11	10/12/2023	Thu	5	Fuselage Design - Volume Calculations, Drag Calculations, Landing Gear Design, Armament Design
12	10/17/2023	Tue	6	Empennage Design - Sizing, Shape and Placement (stall control and spin control)
13	10/19/2023	Thu		Mentoring Session ~20 min with each team.
14	10/24/2023	Tue		**Team Presentations - Preliminary Design Review #1 (PDR1)**
15	10/26/2023	Thu	7	Propulsion System Design - Engine Scaling, Propeller Design, Hybrid Electric and All Electric Propulsion
16	10/31/2023	Tue	7	Propulsion System Design - Engine Scaling, Propeller Design, Hybrid Electric and All Electric Propulsion
17	11/2/2023	Thu	8 & 9	Enhanced Lift - Takeoff and Landing Performance, Flap Design
18	11/7/2023	Tue	8 & 9	Enhanced Lift - Takeoff and Landing Performance, Flap Design
19	11/9/2023	Thu		Mentoring Session ~20 min with each team.
20	11/14/2023	Tue		**Team Presentations - Preliminary Design Review #2 (PDR2)**
21	11/16/2023	Thu	10	Structural Design and Material Selection - Design Load Factor, Shear and Bending Moment Diagrams, Materials
22	11/21/2023	Tue	11	Static Stability and Control - Refined Weight Estimate, Static Margin, Stability Coefficients
	11/23/2023	Thu		NO CLASS (Holiday)
23	11/28/2023	Tue	11, 12, 13	Static Stability and Control AND Cost Estimate, Design Summary and Trade Study
24	11/30/2023	Thu	11, 12, 13	Static Stability and Control AND Cost Estimate, Design Summary and Trade Study
25	12/5/2023	Tue		Team Exercise - Paper Airplane Design and Test (FINAL)
26	12/7/2023	Thu		Mentoring Session ~20 min with each team.
27	**12/12/2023**	**Tue**		**Team Presentations - Preliminary Design Review #4 (PDR4)**
	12/14/2023	Thu		NO CLASS (No Final Exam)