

ME408 – Aircraft Performance and Design

Course Outline

1) Instructor Information

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2) Course Objectives

- a) Establish ME408 as a senior level, undergraduate aerospace engineering course that introduces the student to fixed wing aircraft conceptual design.
- b) Expose students to the key elements of conceptual aircraft design: Requirements, Sizing, Performance, Configuration Design, Stability & Control and Cost Estimation.
- c) Demonstrate the fundamental, iterative nature of design through complete aircraft design projects that run parallel to the course material
- d) Make use of Project Teams to promote teamwork and gain experience with presenting results to a large group.
- e) 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

3) References

Main Text Book: “Design of Aircraft”, Corke, Thomas C., Prentice Hall, 2003

Reference: “Aircraft Performance and Design”, Anderson, J., McGraw-Hill

Reference: Jane’s All the Worlds Aircraft

4) ME408 Syllabus and *Schedule

				Pre-Class	Team		Homework
Week	Class	Date	Day	Reading	Presentations	Lecture Topic	Problems
1	1	9/4/2012	Tu	None	None	Intro, Syllabus, Class Projects	None
1	2	9/6/2012	Thu	Chapter 1	None	Chapter 1-Introduction, Team Charter	None
2	3	9/11/2012	Tu	Chapter 2	Team Charter	Chapter 2 - Preliminary Estimate of Takeoff Weight	2.3 and 2.5
2	4	9/13/2012	Thu	Chapter 2	None	Chapter 2 - Preliminary Estimate of Takeoff Weight	None
3	5	9/18/2012	Tu	Chapter 3	Preliminary Estimate of Takeoff Weight	Chapter 3 - Wing Loading Selection	3.9 and 3.10
3	6	9/20/2012	Thu	Chapter 3	None	Chapter 3 - Wing Loading Selection	None
4	7	9/25/2012	Tu	Chapter 4	Wing Loading Selection	Chapter 4 - Main Wing Design	4.6 and 4.7
4	8	9/27/2012	Thu	Chapter 4	None	Chapter 4 - Main Wing Design	None
5	9	10/2/2012	Tu	Chapters 1-4	Main Wing Design	None, Review Chapters 1 through 4	None
5	10	10/4/2012	Thu	None	None	EXAM 1 - Chapters 1 through 4	None
6	11	10/9/2012	Tu	None	None	NO CLASS, Holiday	None
6	12	10/11/2012	Thu	Chapter 5	None	Chapter 5 - Fuselage Design	5.1, 5.5 and 5.7
7	13	10/16/2012	Tu	Chapter 6	Fuselage Design	Chapter 6 - Horizontal and Vertical Tail Design	6.1, 6.2 and 6.9
7	14	10/18/2012	Thu	Chapter 6	None	Chapter 6 - Horizontal and Vertical Tail Design	None
8	15	10/23/2012	Tu	Chapter 7	Horizontal and Vertical Tail Design	Chapter 7 - Engine Selection	7.2, 7.5 and 7.11
8	16	10/25/2012	Thu	Chapter 7	None	Chapter 7 - Engine Selection	None
9	17	10/30/2012	Tu	Chapter 8	Engine Selection	Chapter 8 - Take-Off and Landing	8.1, 8.4 and 8.5
9	18	11/1/2012	Thu	Chapter 8	None	Chapter 8 - Take-Off and Landing	None
10	19	11/6/2012	Tu	Chapter 9	Takeoff and Landing	Chapter 9 - Enhanced Lift Design	9.1, 9.10 and 9.11
10	20	11/8/2012	Thu	Chapter 9	None	Chapter 9 - Enhanced Lift Design	None
11	21	11/13/2012	Tu	Chapters 5-9	Enhanced Lift Design	None, Review Chapters 5 through 9	None
11	22	11/15/2012	Thu	None	None	EXAM 2 - Chapters 5 through 9	None
12	23	11/20/2012	Tu	Chapter 11	None	Chapter 10 - V-n Diagrams (only)	TBD
12	24	11/22/2012	Thu	None	None	NO CLASS, Holiday	None
13	25	11/27/2012	Tu	Chapter 11	None	Chapter 11 - Static Stability and Control	None
13	26	11/29/2012	Thu	Chapter 11	None	Chapter 11 - Static Stability and Control	None
14	27	12/4/2012	Tu	Chapter 12 & 13	Static Stability and Control	Chapter 12 - Cost Estimate and Chapter 13 Design Summary	TBD
14	28	12/6/2012	Thu	Chapter 12 & 13	None	Chapter 12 - Cost Estimate and Chapter 13 Design Summary	None
15	29	12/11/2012	Tu	None	Final Project Presentations	None	None
15	30	12/13/2012	Thu	None	Final Project Presentations	None	None

Note:

*Subject to change. Professor will be absent for week 5 and will miss the Tue (10/2) and Thu (10/4) classes.

5) Team Projects

a) Students will form teams of four (4) to six (6) team members. The max # of teams for the class will be five (5).

b) Each team will be charged with completing a conceptual design of a fixed wing aircraft during the course. Teams will select their respective designs from one of the following nine (9) categories:

- 1) General Aviation - 2 to 9 passenger (Normal Category, FAR Part 23)
- 2) General Aviation - 2 to 9 passenger (Utility Category, FAR Part 23)
- 3) General Aviation - 10 to 19 Passenger (Commuter Category, FAR Part 23)
- 4) Commercial Transport - 20 to 100 passenger turboprop (Transport Category, FAR Part 25)
- 5) Commercial Transport - 100 to 250 passenger narrow body turbofan (Transport Category, FAR Part 25)
- 6) Commercial Transport - 250+ passenger wide-body turbofan (Transport Category, FAR Part 25)
- 7) Military - Attack/Fighter/Interdiction (MIL-STD-3013A)
- 8) Military - Bombers (MIL-STD-3013A)
- 9) Military - Cargo/Transport/Refueling (MIL-STD-3013A)

Each of the nine (9) categories will be discussed in the first week of class. In addition, each team must select at least two (2) competitor aircraft, but preferably more than two, from the same category as their design. Throughout the course teams will use their chosen competitor aircraft as a basis for performance comparison and for assumptions for unknown parameters.

c) Each week, at the start of the Tuesday class, teams will have 5 to 10 minutes (max) to present the status of their designs and to field at most one challenge question from one of the teams. Challenge questions are not required, but teams have the right to issue one (1) challenge question per week if they so choose. Presentation format is free style. A team member is allowed up to two (2) unexcused absences from the Tuesday presentations, after which the absent team member will not receive full credit for the teams' presentation. The presentations will be graded. See the Grades Section for more on how the weekly presentations will be graded.

d) A final presentation at the end of the course will summarize each of the team's designs, including the final design choices for configuration and the final performance relative to requirements and the competition. Each team will have 30 to 45 min (max) to present their final designs. Each team must offer at least one (1) challenge question for the final projects. The best design of the class will be chosen. See the Grades Section for more on how the final presentation will be graded and the best design chosen.

e) Peer Evaluations will be conducted at mid-term and again at the end of the class. 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 evidence that a team member is not contributing to the team, based on the other team members input, then the grades of that team member will be adjusted.

6) Grades

The individual course grades for this course will be based on a point system.

<u>Points</u>	<u>Letter Grade</u>	<u>Honor Points</u>
95+	A	4.0
90-94	A-	3.7
85-89	B+	3.3
80-84	B	3.0
75-79	B-	2.7
70-74	C+	2.3
65-69	C	2.0
60-64	C-	1.7
55-59	D	1.0
<55	F	0.0

Points will be awarded on the following basis:

<u>Course Item</u>	<u># of Opportunities</u>	<u>Max Possible Points/Oppty.</u>	<u>Max Possible Points</u>
Weekly Presentations	10	3	30
Mid-Term Exams	2	15	30
Final Presentations	1	40	40
BONUS-Best Design	1	5	5

Weekly Presentations - Points for the weekly presentations will be awarded based on the following four (4) elements:

- 1) Solution Approach and Correctness (1 Point) – Teams will describe the solution approach taken and summarize the final solution in a free format, electronic document.
- 2) Investigation of Alternative Concepts (1 Point) – Teams will describe which alternative concepts were studied and clearly describe the rationale in the concept(s) that they have retained as well as those that have been ruled out.
- 3) Overall Presentation Effectiveness (1 point) – Teams will be judged on the overall effectiveness of their presentations. The presentations should concisely summarize the week's task and the team's solution, convey the work that was done and any remaining issues/concerns that they may have with their design, and allow for time to field a challenge question from the any team in attendance. A strict time limit of 10 min max will be enforced, so it is recommended to limit the main body of the presentations to 3 or 4 pages max. Other supporting work can be included in an Appendix. The document must be delivered to the Blackboard website by 4PM each Tuesday.
- 4) Challenge Question (+/- 1 Point) - If a team receives a challenge question they will have until the next scheduled class to respond via e-mail by stating the challenge and either defending their design or agreeing with the posed challenge, in either case giving due technical substantiation to their position.

The challenged team will receive 1 point if their response is received on time and judged to be accurate (by the Professor and/or GTF), and the challenging team will not receive any points. If the response is judged to be inaccurate, then the challenged team will lose a point and the challenging team will gain a point. However, the challenged team can also choose not to respond to a challenge, whereby they would lose a point and the challenging team will gain a point.

Although there are 4 areas to gain points, the most points a team can obtain for any one week will be 3.

Mid Term Exams – Two (2) mid-term exams are planned. Open book.

Final Presentations – Teams will present their final designs to the class. Challenge questions are conducted similarly to the weekly presentations, but for the final project presentations it is mandatory for each team to pose a challenge question. Each team will receive at most one challenge question. The challenged team will be required to verbally address the challenge at that moment. Format is free style. The content must address each of the ~12 main topics covered in the course. A recommendation is to include 1 slide per topic (Wo, Wo/S, Wing, etc.) followed by a 3 view drawing to scale, a final performance chart vs. the competition showing the original design requirements, the competitions level of performance and the team's final design level of performance. Finally, each team will be expected to make a final recommendation on the launch of their design and why. The grading of the final projects is worth a maximum possible 40 points and each team's score will be determined by the Professor. The score will depend on the following elements:

Overall Presentation	5 Points
Alternative Concept Investigation and Down-select process	15 Points
Performance relative to Requirements and Competition	15 Points
Query response	5 Points

Best in Class Design – The best design in the class will be awarded by the Professor. The team with the best design will gain 5 Bonus points for each of the team members, pending peer evaluations. The best design will have the following characteristics:

- Team completed all steps of the design process
- Performed the necessary iterations, when necessary
- Investigated the right balance of alternative concepts (not too few, not too many)
- Down-selected to the “best” concept in a data driven, team oriented approach
- Compares favorably to the competition and has multiple areas of market advantage
- Meets most or all of the Customer Requirements
- Team able to respond effectively and professionally to all challenges

