MECH 3620 – Aircraft Design

Spring 2023/24

Course Description and Syllabus

1 General information

The teaching teams and their contact information are provided below:

Role	**Name**	Contact information
Course instructor	Prof. Rhea Liem	Room 2562, `rpliem@ust.hk`
Teaching assistant	Mr. Aobo Yang	Room 6111, `ayangae@connect.ust.hk`
Teaching assistant	Mr. Christian Reyner	Room 6111, `creyner@connect.ust.hk`

The office hours are by appointment only. The class schedule is provided below:

Class type	**Day and time**	**Venue**
Lecture	Tuesday, 16:30 – 17:50	Room 2406
Lecture	Thursday, 16:30 – 17:50	Room 2406
Tutorial	Tuesday, 18:00 – 18:50	Room 2406

The course is a **project-based** course, where all students will work on a group design project that (heavily) involves programming.

2 Course Objectives

1. Understand the overall aircraft design process, following the typical industry practice
2. Understand the basic concepts of design thinking and systems engineering in a complex and multidisciplinary system such as aircraft
3. Understand the interrelations between the different disciplines (e.g., aerodynamics, structures, stability, propulsion, etc) in an aircraft system
4. Go through a simple conceptual design stage of an aircraft through a course project
5. Learn how to use programming and computing tools to help solve real-world engineering problems
6. Practice scientific communication skills (in English), both in written reports and in oral presentation
7. Exercise good teamwork to achieve the course project's design objectives

3 Textbooks and Reference Materials

Class notes (slides in PDF format and Pluto notebooks) will be provided and uploaded to Canvas per topic.

Several **textbooks** that are available at the HKUST library:

1. Daniel P. Raymer. Aircraft Design: A Conceptual Approach. AIAA, 5th edition, 2012.
2. Lloyd R. Jenkinson, Paul Simpkin, and Darren Rhodes. Civil Jet Aircraft Design. Arnold, 1999.
3. Leland M. Nicolai and Grant E. Carichner. Fundamentals of Aircraft and Airship Design, Vol I-Aircraft Design. AIAA, Reston, VA, 2010.
4. Egbert Torenbeek. Advanced Aircraft Design: Conceptual Design, Analysis and Optimization of Subsonic Civil Airplanes. Wiley, West Sussex, UK, 2013.
5. Snorri Gudmundsson. General Aviation Aircraft Design: Applied Methods and Procedures. 1st edition. Butterworth-Heinemann, 2014.

4 Class Schedule

The provisional schedules for the lectures and tutorials are given in Tables 1 and 2, respectively. These schedules are subject to change, and the notifications would be made via Canvas. Depending on students' interest, aircraft design case studies and guest lectures (if possible) might be inserted to the schedule.

Lecture	Date	Topic	Assignment
1	February 1	Course introduction	
2	February 6	Aircraft design overview	
3	February 8	Preliminary weight estimation	
–	February 13	The fourth day of Lunar New Year	
4	February 15	Preliminary weight estimation	Project group finalization
5	February 20	Preliminary sizing	Term paper topic due
6	February 22	Preliminary sizing	
7	February 27	Configuration selection	Quiz 1 out
8	February 29	Configuration selection	Quiz 1 due
9	March 5	Design of cockpit and fuselage layout	
10	March 7	Preliminary wing design	
11	March 12	Preliminary wing design	
12	March 14	Preliminary weight and balance	
13	March 19	**Midterm project review**	Quiz 2 out
14	March 21	**Midterm project review**	Quiz 2 due
15	March 26	Landing gear sizing and disposition	
–	March 28	Midterm break	
–	April 2	Midterm break	
–	April 4	Ching Ming Festival	
16	April 9	Stability analysis	Individual term paper due
17	April 11	Empennage design	
18	April 16	Structural load and consideration	
19	April 18	Structural load and consideration	
20	April 23	Propulsion system	Quiz 3 out
21	April 25	Aerodynamic and sizing refinements	Quiz 3 due
22	April 30	Aerodynamic and sizing refinements + Cost analysis	
23	May 2	Aircraft design review and optimization	
24	May 7	**Final project presentation**	
25	May 9	**Final project presentation**	
–	May 16		Final report due

Table 1: Provisional lecture schedule for MECH 3620, Spring 2023/24 session.

Tutorial	Date	Topic
1	February 6	Course project briefing + Introduction to `Julia` programming and `GitHub`
–	February 13	The fourth day of Lunar New Year
2	February 20	Preliminary weight estimation
3	February 27	Drag polar and matching chart
4	March 5	Introduction to `AeroFuse` platform + programming tutorials
5	March 12	Preliminary wing design
6	March 19	**Midterm project review**
7	March 26	Preliminary weight and balance
–	April 2	Midterm break
8	April 9	Project consultation
9	April 16	Project consultation
10	April 23	Structural analysis + propulsion system
11	April 30	Project consultation
12	May 7	**Final project presentation**

Table 2: Provisional tutorial schedule for MECH 3620, Spring 2023/24 session.

5 Course assessments and weights

The course assessment methods are presented in Table 3 along with their descriptions, grading criteria, and grade-weightings.

Assessment		Weighting
Group design project Students work in groups of 4–5 students on a preliminary aircraft design project. Peer assessment will be included in the final grading. *Grading criteria: theoretical understanding, implementation of solution methods, programming, organization of the project, teamwork, communication skills (oral and written).* Midterm project review Final report and presentation	 10% 40%	50%
Independent self-study Individual term paper on a free (student-selected) topic pertaining to aircraft design and/or the airline industry. *Grading criteria: literature review, technical discussion, original thoughts, quality of final submission, communication skills.*		30%
Individual assignment Quiz 1 – Aircraft Design and Preliminary Sizing Quiz 2 – Configuration Layout and Preliminary Wing Design Quiz 3 – Aircraft stability, structures, and propulsion system	 5% 5% 5%	15%
Class participation *Grading criteria: in-class interactions, questions asked and answered, class attendance, punctuality, and in-class behavior.*		5%
TOTAL		100%

Table 3: Course assessments and weights for MECH 3620, Spring 2023/24 session.

A brief description of course assignments is given below:

Independent self study Students are encouraged to pick a topic related to aircraft design and/or airline industry and perform an independent study beyond what is taught in class. The submission will be in the form of a term paper (5 to 10 pages long).

The grading criteria are summarized in Table 4. The important dates are listed in Table 5.

Group design project Working in a group of around 4 to 5 students, students will work on a conceptual aircraft design. The group project description and detailed instruction will be given in class, and the document will be posted on Canvas in due time. The scheduled tasks are summarized in Table 6.

Students will use the in-house **Multidisciplinary Aircraft Design Education (MADE)** framework, called `AeroFuse`. The platform is developed using `Julia` programming language with Pluto notebook as interface. A thorough tutorial will be provided once the semester

Criterion	Weighting
Background and motivation *(why you find the topic interesting/important)*	15%
Technical contents *(e.g., analyses of the effects on aircraft design/operations)*	40%
Personal thoughts, opinions, and analyses	20%
Technical writing quality *(i.e., the structure of the presentation)*	15%
References *(at least eight conference/journal articles)* *Students need to present relevant and important facts and figures, and cite journal articles/books/other references properly.*	10%
TOTAL	**100**%

Table 4: Grading scheme for the independent self-study assignment.

Date	Task
February 20, 2024	Submit a paragraph or two describing your proposed topic and the scope of your submission
February 25, 2024	Topic approval due
April 9, 2024	Final submission due

Table 5: Independent self-study (individual term paper) schedule.

starts. To be better prepared for the course (especially the term project), students are referred to the following important references:

1. `Julia` programming language: `https://julialang.org/`
2. Pluto notebook: `https://plutojl.org/`
3. `AeroFuse` documentation: `https://hkust-octad-lab.github.io/AeroFuse.jl/stable/`
4. `AeroFuse` platform repository: `https://github.com/HKUST-OCTAD-LAB/AeroFuse.jl`

Students are highly encouraged to check them out before the start of the course.

Each student will also need to submit *peer assessment*, *statement of contribution*, and *self-reflection on learning experience*. A template will be provided for this individual submission. Failing to submit peer assessments will incur a 10% penalty of the student's project grade.

Individual take-home quizzes There will be three quizzes in total.

1. Quiz 1 – Aircraft Design and Preliminary Sizing (February 27–29, 2024)
2. Quiz 2 – Configuration Layout and Preliminary Wing Design (March 19–21, 2024)
3. Quiz 3 – Aircraft stability, structures, and propulsion system (April 23–25, 2024)

Class participation This includes enthusiasm, questions asked, questions answered, class attendance, punctuality, and in-class behavior.

Date	**Task**
February 15, 2024	Finalize group formations (on Canvas → People → "Design project groups" tab)
March 19 & 21, 2024 (3 sessions)	Midterm project review
May 7 & 9, 2024 (3 sessions)	Final project presentations
May 16, 2024	Final deadline for project report submission (in PDF/Pluto notebook format only)

Table 6: Group design project schedule.

✈ ✈ ✈ ENJOY THE COURSE! ✈ ✈ ✈