MECH 3620 – Aircraft Design

Spring 2022/23

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. Mingzhi Shihua (James)	Room 6111, `mshihua@connect.ust.hk`
Teaching assistant	Mr. Aobo Yang	Room 6111, `ayangae@connect.ust.hk`
Research assistant	Mr. Arjit Seth	Room 6112, `ajseth@ust.hk`

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

Class type	**Day and time**	**Venue**
Lecture	Tuesday, 09:00 – 10:20	Room 2503
Lecture	Thursday, 09:00 – 10:20	Room 2503
Tutorial	Tuesday, 14:00 – 14:50	Room 4504

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 (tentative) 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
1	Feb 7	Course introduction
2	Feb 9	Aircraft design overview
3	Feb 14	Preliminary weight estimation
4	Feb 16	Preliminary weight estimation
5	Feb 21	Preliminary sizing
6	Feb 23	Preliminary sizing
7	Feb 28	Configuration selection
8	March 2	Configuration selection
9	March 7	Design of cockpit and fuselage layout
10	March 9	Preliminary wing design
11	March 14	Preliminary wing design
12	March 16	Preliminary weight and balance
13	March 21	Stability analysis
14	March 23	Empennage design
15	March 28	Landing gear sizing and disposition
16	March 30	Structural loads and consideration
17	April 4	Structural loads and consideration
–	April 6	Mid Term Break
–	April 11	Mid Term Break
18	April 13	Propulsion system
19	April 18	Aerodynamic and sizing refinements
20	April 20	Aerodynamic and sizing refinements
21	April 25	Cost analysis
22	April 27	Aircraft design review and optimization
23	May 2	**Final project presentation**
24	May 4	**Final project presentation**
25	May 9	**Final project presentation**

Table 1: Lecture schedule for MECH 3620, Spring 2022/23 session (tentative).

Tutorial	Date	Topic
–	Feb 7	No tutorial
1	Feb 14	Course project briefing + introduction to Julia programming
2	Feb 21	Preliminary weight estimation
3	Feb 28	Drag polar and matching chart
4	March 7	Introduction to `AeroFuse` platform + programming tutorials
5	March 14	Preliminary wing design
6	March 21	Preliminary wing design
7	March 28	Preliminary weight and balance
8	April 4	Structural analysis
–	April 11	Mid Term Break
9	April 18	Propulsion system
10	April 25	Project consultation
–	May 2	No tutorial
–	May 9	No tutorial

Table 2: Tutorial schedule for MECH 3620, Spring 2022/23 session (tentative).

5 Course assessments and weights

The course assessment methods are presented in the table below 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).* **OPTION 1** Midterm report 15% Final report and presentation 35% *You will get the chance to check whether you are on the right direction or not. Your final grade will NOT depend only on your final results.* **OPTION 2** Final report and presentation 50% *You might save a bit of time, but if you do something wrong or off-course, we might not have the chance to let you know.*	50%
Independent self-study **OPTION 1**: term paper **OPTION 2**: video production *Grading criteria: literature review, technical discussion, original thoughts, quality of final submission, communication skills.*	25%
Individual assignment Coding assignment 10% Quiz 1 5% Quiz 2 5%	20%
Class participation *Grading criteria: in-class interactions, questions asked and answered, class attendance, punctuality, and in-class behavior.*	5%
TOTAL	100%

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. Students can choose between the following two formats for the submission:

- Term paper: 5 to 10 pages long
- Video: 5 to 10 minutes long

The same grading criteria apply for both types of submissions. For video, you can submit a list of references separately or show it at the end of the video. These criteria are summarized

in Table 3. The important dates are listed in Table 4.

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/video quality *(i.e., the structure of the presentation)*	15%
References *(at least six 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 3: Grading scheme for the independent self-study assignment.

Date	Task
February 21, 2023	Submit a paragraph or two describing your proposed topic and the scope of your submission
February 26, 2023	Topic approval due
April 4, 2023	Final submission due

Table 4: Independent self-study schedule.

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 5.

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 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.

Individual mini assignments One coding assignment and two quizzes (times TBC).

Date	Task
February 14, 2023	Finalize group formations (on Canvas → People → "Design project groups" tab)
March 28, 2023	Midterm report (OPTIONAL)
May 2, 4, 9, 2023	Final project presentations
May 18, 2023	Final deadline for project report submission (in PDF/Pluto notebook format only)

Table 5: Group design project schedule.

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

✈ ✈ ✈ ENJOY THE COURSE! ✈ ✈ ✈