MECH3620 - Aircraft Design

Course Code: MECH 3620
Course Title: Aircraft Design

Required Course Or Elective Course:
Required Course

Terms Offered (Credits): Spring, 3 credits

Faculty In Charge: Rhea Liem

Pre/Co-Requisites:
Pre-requisites: MECH3640 & MECH3650
Co-requisites: MECH3660 & MECH3670

Course Structure: Lecture – 3 hours per week; Tutorial – 1 hour per week

Textbook/Required Material:

Course Description:
The main objective of this course is to introduce students to the overall aircraft design process, following the typical industry practice. This process typically starts with specifying the mission requirements, based on the market research analysis. The process is then followed by preliminary sizing and weight estimation. Upon designing the overall configuration and fuselage layout, the students can then perform more detailed analyses such as: wing design, controls, stability, landing gear, propulsion, and structural consideration. The students will also learn to perform basic cost analyses for aircraft.

Due to the complexity of the aircraft system, the aircraft design is typically performed iteratively. This is mainly due to the interdisciplinary coupling within the system, i.e., how changing one parameter will affect the others. The students thus need to be exposed to the different disciplines involved in designing aircraft (e.g., aerodynamic, structures, propulsion, control, stability, avionics, etc) and understand the relationship between them. Students would know how to perform the basic analyses of the aircraft performance and interpret the results. Communication skill is another important aspect of the project, both in maintaining a solid teamwork between the team members and in presenting the work (oral and written).

In addition to the technical aspects of designing aircraft, the students will first be introduced to the overall design processes, overview of past and current aircraft designs and configurations (including case study discussion), as well as regulations that need to be taken into account before the design process takes place. An aircraft design platform has been developed to assist students in completing design project and to help students become more familiar with programming and modern design tools.

Course Topics:
1. Overview of aircraft designs, configurations, and regulations
2. Overview of aircraft design processes
3. Preliminary weight estimation
4. Preliminary sizing, drag polar, wing loading (W/S) and thrust-to-weight ratio (T/W)
5. Configuration design, fuselage layout
6. Wing design, high-lift devices, controls, empennage
7. Weights, center of gravity (CG), stability
8. Landing gear design and disposition
Course Objectives:
(correlated program objectives)

1. This course trains engineers to meet those challenges, and prepares them for careers in civil and military aviation (PO-1, PO-2, PO-3, PO-4, PO-5)
2. It aims is to provide a comprehensive overview of aircraft performance, structures, aerodynamics and advanced systems, and how they are interrelated. (PO-1, PO-3, PO-5)
3. A holistic teaching approach will be used to explore how the individual elements of an aircraft can be designed and integrated using up-to-date techniques. (PO-1, PO-2, PO-3, PO-4, PO-5)
4. Students will learn to understand how to select specific systems, such as the engines, and how this selection will affect the aircraft as a whole (PO-1, PO-3, PO-4, PO-5)

Course Outcomes:
(correlated course objectives and program outcomes)

On successful completion of this course, students are expected to be able to:

A. Students will develop an understanding of aircraft design methodology through lectures, and then apply that understanding to a real-life case study involving a complete aircraft through team-based projects (POC-1,3,5,6,8) (CO-1, CO-2, CO-3, CO-4)
B. Management, communication, team work and research skills; solve problems as part of a team and assume leadership duties (POC-1,3,5,6,7,8,12) (CO-1)
C. Understand and implement the design and development process for aerospace vehicles (POC-1,3,4,5,6,11) (CO-2, CO-3, CO-4)
D. Perform open-ended iterative tasks related to aircraft and engine designs (POC-1,3,4,5,6) (CO-1, CO-2, CO-3, CO-4)
E. Integrate a variety of systems and sub-systems within aircraft to demonstrate design feasibility (POC-1,3,4,5,6) (CO-2, CO-3, CO-4)
F. Prioritize design requirements/trade-offs and organize project schedules/deadlines; use formal structured design methods to develop aircraft that meet or exceed customer expectations (POC-1,3,5,6,9,10) (CO-1, CO-4)

Assessment Tools:
(correlated course outcomes)

Written Assignment and Quizzes (25%) A,C,E
Project Report (30%) A,B,C,D,E,F
Presentation (20%) B, C
Individual term paper (25%) A, E
Programme objectives:

P-O1 Be able to communicate and perform as an effective engineering professional in both individual and team-based project environments;
P-O2 Have an international outlook with clear perspectives on the Pearl River Delta and Greater China;
P-O3 Be able to research, design, develop, test, evaluate and implement engineering solutions to problems that are of complexity encountered in professional practice and leadership;
P-O4 Clearly consider the ethical implications and societal impacts of engineering solutions; and
P-O5 Continuously improve through lifelong learning.

Programme outcomes (POC):

POC-1 Ability to identify and formulate problems in multidisciplinary environment with an understanding of engineering issues and constraints
POC-2 Ability to design and conduct experiments as well as analyze and interpret data
POC-3 Ability to apply knowledge of mathematics, science, and engineering for problem solving in aerospace engineering and related sectors or for further education in a research career
POC-4 Ability to develop specification and to design system, component, or process to meet needs
POC-5 Ability to understand the design, operation, and maintenance of aircraft components and systems
POC-6 Ability to use modern engineering tools, techniques, and skills in engineering practice
POC-7 Ability to communicate effectively
POC-8 Ability to function in multi-disciplinary teams and provide leadership
POC-9 Broadly educated with an understanding of the impact of engineering solutions on issues such as economics, business, politics, environment, health and safety, sustainability, and societal context
POC-10 Clear understanding of professional and ethical responsibilities
POC-11 Recognition of the need for life-long learning and continuing education
POC-12 International outlook with knowledge of contemporary issues