

AIRCRAFT PRELIMINARY DESIGN

ENAS 411

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : IV
Part : I

Course Objectives:

The objective of this course is to provide students with a fundamental understanding of aircraft configurations, layouts, power plants, propellers, and aerodynamic loads. It aims to develop knowledge of basic aircraft maneuvers, including gliding, takeoff and landing, and to introduce the design features and specifications of specialized aircraft.

1 Introduction (4 hours)

- 1.1 Engineering design
- 1.2 Aircraft design process
- 1.3 Aircraft conceptual design synthesis process
- 1.4 Aircraft configuration: Conventional and Alternative configuration
- 1.5 Creativity and configuration design
- 1.6 Design considerations

2 Design Estimations (12 hours)

- 2.1 Types of weights and weight estimations
- 2.2 Lift, drag and mass estimation
- 2.3 Performance estimation
- 2.4 Conceptual design
- 2.5 Refinement and analysis concept
- 2.6 Landing gear
- 2.7 Center of Gravity(CG), trim and CG travel

3 Power Plant Types and Characteristics (8 hours)

- 3.1 Power plant placements
- 3.2 Types of power plants
- 3.3 Typical engine parameters
- 3.4 Flight regimes of power plants
- 3.5 Power plant performance representation
- 3.6 Typical aircraft installed thrust power

4 Preliminary Design

(16 hours)

- 4.1 Fuselages layout
- 4.2 Function of fuselage
- 4.3 Primary considerations and overall layout
- 4.4 Local layout aspects
- 4.5 Crew and payload
- 4.6 Fuselage layout procedure
- 4.7 Airfoil design
- 4.8 Planform shape and geometry
- 4.9 High lift devices
- 4.10 Crew station: Function and design
- 4.11 Fuel tanks

5 Optimization

(5 hours)

- 5.1 Cost and optimization
- 5.2 Parametric analysis and optimization
- 5.3 Optimizing wing location and control surfaces
- 5.4 Empennage considerations
- 5.5 Aerodynamic optimization
- 5.6 Handling qualities

Tutorial

(15 hours)

- 1. Determination of the weight of the aircraft and its different parts.
- 2. Estimation of the center of gravity travel diagram and balance limits.
- 3. Calculation of the fuel consumption during different phases of flight.
- 4. Determination of the wing and empennage placement on the aircraft.
- 5. Estimation of the control surface sizing and required deflections.

Practical

(22.5 hours)

- 1. Execution of a team-based conceptual design of an aircraft for a specified mission profile, building upon flight dynamics principles.
- 2. Evaluation of aircraft handling qualities through standardized performance and stability test routines.
- 3. Construction of the center of gravity travel diagram to track balance variations across operating weights.
- 4. Preparation and presentation of a poster for the Preliminary Design Review (PDR).

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	6
2	12	14
3	8	12
4	16	18
5	5	10
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Fielding, J. P. (1999). Introduction to aircraft design. Cambridge University Press.
2. Raymer, D. P. (2018). Aircraft design: A conceptual approach (Latest ed.). American Institute of Aeronautics and Astronautics.
3. Roskam, J. (1985). Airplane design (Parts I–VIII). DAR Corporation.
4. Sadraey, M. H. (2012). Aircraft design: A systems engineering approach. John Wiley & Sons.
5. Stinton, D. (2001). The design of the aeroplane (Latest ed.). Wiley-Blackwell.