

## Model Question Paper

### Sixth Semester BE Degree Examination

### Aircraft Design

**Time: 3 Hours (180 Minutes)**

**Max. Marks: 100**

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.*

| Module - 1        |    |  | M | L  | C   |
|-------------------|----|--|---|----|-----|
| Q1                | a. | What is the initial phase of an aircraft design? Describe in detail about the design philosophy of an aircraft and explain with the help of diagram  | 6 | L2 | CO2 |
|                   | b. | An aircraft has the following estimated data. The take-off weight is 15,000 kg. The empty weight fraction is 0.55, and the fuel fraction is 0.20. The aircraft cruises at a speed of 70 m/s. The air density is 1.225 kg/m <sup>3</sup> . The airfoil chord length is 1.5m, and the air viscosity is 1.8 × 10 <sup>-5</sup> Pa-s. The wing area is 20m <sup>2</sup> , and the lift produced at cruise is 30,000 N. Find the Following: i) Calculate the empty weight and fuel weight of the aircraft using the given weight fractions. | 8 | L3 | CO1 |
|                   | c. | Explain the mission profiles with a neat sketch and also explain mission segment weight fractions for a simple cruise.   | 6 | L2 | CO2 |
| <b>OR</b>         |    |  |   |    |     |
| Q2                | a. | Describe in detail about the airfoil geometry with required diagrams.  | 6 | L2 | CO2 |
|                   | b. | An aircraft has cruise range of 1500NM and SFC, C = 0.5 1/hr. Cruise velocity of jet aircraft is 570ft/s with L/D as 13.2. Aircraft is supposed to do loiter of 2 hrs. Then what should be the gross weight of aircraft? Given, empty weight fraction of 0.55, crew and payload of 6500kg with 0.98 as mission segment fuel fraction for climb, take-off and landing.  | 8 | L3 | CO1 |
|                   | c. | Explain in detail about preliminary design process of aircraft design, with help of neat diagram.  | 6 | L2 | CO2 |
| <b>Module- 2</b>  |    |  |   |    |     |
| Q3                | a. | Mention the different types of tail configurations and wing configurations are available? Explain their effects with neat sketches   | 6 | L2 | CO2 |
|                   | b. | Derive the relationship between the thrust-to-weight ratio (T/W) and wing loading (W/S) of an aircraft in a climb gradient G and justify the same.   | 8 | L3 | CO3 |
|                   | c. | Explain tail geometry for some general-aviation aircraft with tail aspect ratio and taper ratio  | 6 | L2 | CO2 |
| <b>OR</b>         |    |  |   |    |     |
| Q4                | a. | What are the different types of wings? Explain how any one particular type of wing suits a particular mission.   | 6 | L2 | CO2 |
|                   | b. | For steady coordinated turn in a general aviation aircraft, derive pitch rate 'q' as<br>$q = \frac{g(n-1/n)}{v}$   | 8 | L3 | CO3 |
|                   | c. | List the factors involved deciding the location of the wing with respect to the fuselage. Explain in detail.   | 6 | L2 | CO2 |
| <b>Module - 3</b> |    |  |   |    |     |

|                   |    |  |    |    |     |
|-------------------|----|--|----|----|-----|
| Q5                | a. | What are the importance of sizing? Explain in detail about refined sizing method with help of neat sketch  | 6  | L2 | CO2 |
|                   | b. | Construct the longitudinal control line for a conic fuselage section using the method of conic fuselage development with a neat labeled diagram.   | 8  | L3 | CO3 |
|                   | c. | Describe lofting and brief the procedure consider in the flat wrap lofting, with an example  | 6  | L2 | CO2 |
| <b>OR</b>         |    |  |    |    |     |
| Q6                | a. | Write a short note on wrap fuselage lofting. Describe a method for verifying the same.   | 6  | L2 | CO2 |
|                   | b. | List the type of loads that are acting on the aircraft and also outline the critical aspects of the loads with the help of V-N diagram.  | 8  | L3 | CO2 |
|                   | c. | List and discuss the special considerations in configuring the layout.   | 6  | L2 | CO2 |
| <b>Module - 4</b> |    |  |    |    |     |
| Q7                | a. | Discuss in brief the methodology and considerations for the selection of propulsion system for a fighter aircraft.   | 05 | L2 | CO2 |
|                   | b. | A transport aircraft encounters a strong vertical gust at cruising altitude, as a design engineer analyze the gust loads acting on the wings. Using the relevant equations determine the variation of gust load with airspeed and justify the analysis with a graph.   | 10 | L3 | CO4 |
|                   | c. | What are the propulsion selection factors for design of propulsion system layout?  | 05 | L2 | CO2 |
| <b>OR</b>         |    |  |    |    |     |
| Q8                | a. | Explain the different types of structural loads which comes on the aircraft with neat sketch.  | 05 | L2 | CO2 |
|                   | b. | An aircraft weighing 2, 50,000 N has a wing area of 80 m <sup>2</sup> and its drag equation is $C_D = 0.016 + 0.04 C_L^2$ . Calculate (i) minimum thrust required ( $T_{min}$ ) (ii) minimum power required ( $P_{min}$ ) for straight and level flight and the corresponding true air speeds ( $V_{md}$ & $V_{mp}$ ) at sea level and at an altitude where $(\sigma)^{1/2} = 0.58$ . Assume sea level air density to be 1.226 kg/m <sup>3</sup> . | 10 | L3 | CO4 |
|                   | c. | Describe the performance of the turbo prop engine with suitable graph.   | 05 | L2 | CO2 |
| <b>Module - 5</b> |    |  |    |    |     |
| Q9                | a. | Explain the landing gear arrangements for multi-wheel main landing gear with a neat sketch.  | 6  | L2 | CO5 |
|                   | b. | Explain the concept of Auxiliary power systems in aircraft design with example   | 8  | L2 | CO5 |
|                   | c. | Explain the impact of hydraulic Flight-control system on the aircraft conceptual design.   | 6  | L2 | CO5 |
| <b>OR</b>         |    |  |    |    |     |
| Q10               | a. | Describe the Electrical & Avionic Systems of the aircraft in performance of control and navigation.  | 6  | L2 | CO5 |
|                   | b. | Explain the anti-icing and deicing system in the aircraft using pneumatic design concept.  | 8  | L2 | CO5 |
|                   | c. | With neat sketch, Explain the three commonly used landing gear arrangements.   | 6  | L2 | CO5 |

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