Code No: 07A62104 **R07** **Set No. 2**

**III B.Tech II Semester Examinations,December 2010**
**FLIGHT VEHICLE DESIGN**
**Aeronautical Engineering**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) Discuss the 2-D and 3-D drag coefficients with special reference to Oswald's efficiency factor.
   (b) Discuss the effect of aspect ratio on $C_{L\alpha}$, the lift coefficient slope of a wing. [8+8]

2. Describe in detail, the various forces and moments acting on an aircraft. [16]

3. Explain with the help of neat sketches,
   (a) Water lines
   (b) Butt - plane cuts
   (c) Flat wrap
   (d) Conic shape parameter [16]

4. A jet aircraft is designed for a loiter of half an hours at a distance of 5,000 km. The crew, passengers and payload together weigh 40,000 kg. The aircraft cruises at Mach 0.8 at an altitude of 10 km, where the speed of sound can be taken to be 299 m/s. The maximum value of (L/D) is 16. The aircraft should, at the end of the loiter, be able to climb again and proceed to another airport 400 km away for landing. Calculate the mission fuel weight fraction of the aircraft if the specific fuel consumption 0.015 grams per Newton per second. Assume and state explicitly, the values assumed for take-off segment weight ratio, climb segment weight ratio and landing segment weight ratio. [16]

5. Explain the major differences in the designs of the fuselages of a military cargo plane and a passenger plane. Justify your answer. Draw neat sketches. [16]

6. The gross weight of an airplane consists of crew weight, payload weight, weight of the fuel and the empty weight of the airplane. The normal mission profile of an aircraft is described as: Take-off (0-1) Climb (1-2) Cruise (2-3) Loiter (3-4) Landing (4-5). Mission segment weight fraction for the airplane is given as: $W_1/W_0 = 0.97$, $W_2/W_1 = 0.985$, $W_4/W_3 = 1$ (assuming power-off landing approach), and $W_5/W_4 = 0.995$. Use the data: Range of the aircraft in cruise, R = 2500 km, trim speed $V_\infty = 100$ m/sec, and specific fuel consumption, $c = 2.02 \times 10^{-7}$, $(L/D)_{max} = 14$.
   Determine the followings:
   (a) Mission segment weight fraction in the cruise condition using Breguet range equation.

(b) Given that an allowance of 6% has to be made for the trapped fuel, compute the fuel weight - gross weight ratio of the airplane.

(c) Given that the crew consists of a pilot (weight 70 kg), and payload consists of 5 passengers (weight 70 kg each) and their baggage (weight 20 kg each), obtain an estimate of the gross weight of the airplane. [16]

7. Explain the various phases of the design of an aircraft. Explain why going back and forth in the design is inevitable. Are there ways of minimizing the cycles? Explain clearly. [16]

8. Draw the three views and neatly label the various components of a high subsonic aircraft having swept back wing plan form. Estimate the performance and stability characteristics of this aircraft and compare them wit a similar aircraft having a rectangular wing configuration. [16]

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Code No: 07A62104 **R07** **Set No. 4**

**III B.Tech II Semester Examinations,December 2010**
**FLIGHT VEHICLE DESIGN**
**Aeronautical Engineering**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) Discuss the various designs for the wing tips and their advantages and disadvantages.
   (b) What is a winglet? If you have no limit on the span of the wing, would prefer an end plate, winglet or neither? Explain. [8+8]

2. Write short notes, with neat sketches, on
   (a) Airfoil leading edge sharpness parameter
   (b) Wing strake (leading edge extension)
   (c) Leakage drag
   (d) Wind milling engine drag [4+4+4+4]

3. An airplane has following pitch moment characteristics:
   $C_{mCG} = 0.25$, $\alpha$ - 0.185. Distance of the airplane center-of-gravity measured from the wing leading edge at the mean aerodynamic chord in terms of chord length percentage is given to be 0.15. Determine the followings:
   (a) Static stability margin of the airplane in terms of the percentage of the mean aerodynamic chord of the wing, and
   (b) Neutral point location. [16]

4. (a) List the various types of military airplanes.
   (b) Describe their roles and typical mission profiles.
   (c) Describe how one may design a multiple role aircraft? [4+6+6]

5. Explain the major differences in the designs of the fuselages of a bomber and a passenger plane. Justify your answer. Draw neat sketches. [16]

6. Define 'Flat wrap'. What are the advantages of 'Flat wrap' in the fabrication of an aircraft? Explain how a fuselage is designed such that the outer surface is 'flat wrapped'. Can the whole fuselage be flat wrapped? Explain in detail, with the help of neat sketches. [16]

7. Explain clearly.
   (a) What is meant by technology availability in the context of aircraft design.
   (b) How overly optimism affects the design of aircraft.

(c) How utter pessimism affects the design of aircraft.

(d) Which path you would choose between b and c above, and why? [4+4+4+4]

8. (a) Describe Vectored thrust using a neat sketch.

(b) Derive the expression for thrust vector angle for maximum instantaneous turn rate.

[8+8]

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Code No: 07A62104 **R07** **Set No. 1**

**III B.Tech II Semester Examinations,December 2010**
**FLIGHT VEHICLE DESIGN**
**Aeronautical Engineering**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. Describe how the existing aircraft may be classified into different types. Give examples for each and discuss why you classify them that way. [16]
2. Define the following terms with respect to wing and explain how these terms affect the aerodynamic design of a civil jet aircraft.
   (a) Lift / Drag ratio
   (b) Centre of gravity
   (c) Canard wing configuration
   (d) Supersonic area rule of Whitcomb [4+4+4+4]
3. Explain the term 'Longitudinal Control Line'. How do you generate the outer profile of the fuselage of an aircraft using longitudinal control lines. Explain in detail with neat sketches. [16]
4. (a) Derive the wing loading W/S, for a jet aircraft for loitre as a function of dynamic pressure and parasite drag coefficient.
   (b) An aircraft turns at the rate of 3 degrees per second in a level flight at 100 km/hour. What is the normal load factor ('g' loading) on the aircraft? [8+8]
5. Detail out the considerations in the design of a passenger airplane with a cruise velocity of 600 km / hour, crew of 6 and 150 passengers, with 50 kg baggage each. Draw neat sketches and graphs in support of your answer. [16]
6. What are the major constructional details of the aircraft which the conceptual sketch should indicate? Elaborate. [16]
7. (a) Describe Vectored thrust using a neat sketch.
   (b) Derive the expression for thrust vector angle for a sustained turn. [8+8]
8. (a) How does a tail-less aircraft ensure its longitudinal stability?
   (b) What is the design for directional stability of such an aircraft?
   (c) An aircraft with "T" tail is more susceptible to 'pitch up' problem. Justify or contradict. [5+5+6]

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Code No: 07A62104 **R07** **Set No. 3**

**III B.Tech II Semester Examinations,December 2010**
**FLIGHT VEHICLE DESIGN**
**Aeronautical Engineering**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. Describe with good sketches, all wing and tail control surfaces of an airplane. [16]
2. Given following data for the wing: span, b = 20 m, taper ratio, $\lambda = 0.7$, and tip chord length, $c_t = 0.5$ m. Determine the followings:
   (a) The mean aerodynamic chord length
   (b) The mean aerodynamic chord location along the span of the wing
   (c) Aspect ratio of the wing
   (d) Lift curve slope of the wing. [16]
3. (a) Explain why sweep is given to the wingof i) low speed airplane, ii) high subsonic airplane and iii) supersonic airplane.
   (b) Explain why dihedral is given to the wing.
   (c) When both sweep and dihedral are given to the wing, how do you apportion them? [8+4+4]
4. A surveillance propeller driver aircraft is designed for a loiter of three hours at a distance of 2,000 km from the base. The crew weighs 400 kg and payload weighs 4600 kg. The aircraft cruises at Mach 0.6 at an altitude of 10 km, where the speed of sound can be taken to be 300 m/s. The maximum value of (L/D) is 16. Calculate the mission fuel weight fraction of the aircraft if the specific fuel consumption of 0.015 grams per Newton per second. [16]
5. Explain, in detail, the factors affecting the structural arrangements of a wing. [16]
6. Draw the specifications for a supersonic airliner for two hundred (200) passengers with two pilots and six cabin attendants cruising at Mach 2.0 with a range of 10,000 km and two hour endurance. Make use of sketches and graphs to illustrate your answer. [16]
7. Explain in detail,
   (a) Supersonic area rule of Whitcomb,
   (b) Sears - Haack volume distribution,
   (c) Explain how the area rule can be applied in the case of
      i. a fighte aircraft,
      ii. a wide bodied passenger aircraft. [4+4+4+4]

8. (a) Describe Vectored thrust using a neat sketch.
   (b) Derive the expression for thrust vector angle for a sustained turn.
   (c) Derive the expression for the load factor, 'n', in terms of Lift, Thrust and Weight of the aircraft for sustained turn. [4+6+6]

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