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

III B.Tech II Semester Examinations,APRIL 2011
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. What are the performance data of the existing aircraft that can be used as guide lines for the conceptual design of an aircraft? Explain, considering four design parameters. Also, explain how you would use the data. [16]

2. Discuss airfoil aerodynamic characteristics of 6 digit NACA airfoils. Use good sketches. Discuss in particular $(C_l)_{max}$ versus t/c (thickness to chord ratio). [16]

3. Assume that the mid-section of the fuselage of an aircraft is circular. How does it end on either side? Draw neat sketches and justify the configurations. [16]

4. Write short notes on
   (a) Down wash
   (b) Up wash
   (c) c.g. (centre of gravity) location for a flying wing
   (d) c.g. (centre of gravity) location for a transport aircraft.
   [4+4+4+4]

5. Explain, in detail, the factors affecting the structural arrangements of a wing. [16]

6. Define the following terms and explain how these terms affect the aerodynamic design of a civil jet aircraft.
   (a) Tail plane incidence
   (b) Angle of attack of wing
   (c) Cross winds
   (d) Slenderness ratio of fuselage [4+4+4+4]

7. (a) Prove that $(L/D)_{loiter}$ for a Propeller aircraft is 0.866 $(L/D)_{max}$.
   (b) An observation Propeller aircraft is designed for a loiter of four hours at a distance of 500 km. The crew weight is 400 kg and payload weight is 1,000 kg. The aircraft cruises at Mach 0.6 at an altitude of 7 km, where the speed of sound can be taken to be 312 m/s. The maximum value of (L/D) is 16. Calculate the total take-off weight of the aircraft if the specific fuel consumption of 0.015 grams per Newton per second. Stop the calculations after iterations. Assume empty weight fraction relation $W_e/W_0 = 2.05\ W_0^{-0.18}$.
   [8+8]

8. 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]

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

III B.Tech II Semester Examinations,APRIL 2011
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) Explain why a cylindrical cross-section is normally preferred for the fuselage. What are the alternatives you suggest and why? Use neat sketches.
   (b) What are the considerations for deciding the length of the fuselage. [8+8]
2. (a) What are the factors involved in deciding the location of the wing with respect to the fuselage? Explain in detail.
   (b) What are the preferred locations for the wing for
      i. airliner with an aft - tail,
      ii. fighter aircraft with an aft - tail,
      iii. fighter aircraft with a non-lifting type of canard.

   Explain in detail, with neat sketches. [4+4+4+4]
3. Describe in detail, the various forces and moments acting on an aircraft. [16]
4. (a) Write the force equations for an aircraft in steady climb, with the help of a sketch.
   (b) From this, derive the expression for the vertical velocity component.
   (c) Express this equation in terms of T/W ratio and K (drag - due - to - lift factor) and wing loading W/S.
   (d) Derive the expression for velocity corresponding to best rate of climb for a jet aircraft. [4+4+4+4]
5. (a) Explain briefly, when a variable sweep wing is preferred over a fixed swept wing.
   (b) What are the disadvantages of a variable sweep wing?
   (c) define critical Mach number and drag divergence Mach number.
   (d) Explain the effect of sweep of the leading edge of a wing in supersonic flight,on its aerodynamic characteristics. [4+4+4+4]
6. Explain the usefulness of conceptual sketch as one of the first steps in the design of an aircraft. What are the data you have arrived at before this? Explain very clearly using neat sketches. [16]
7. Consider a thirty (30) passenger plane powered by piston-propellers. How does it compare with a turbo-prop powered passenger plane in its design features having similar specifications? Make use of sketches and plots to illustrate your answer. [16]

8. (a) Discuss the aerodynamic and structural designs of wing - fuselage junction.
   (b) Differentiate between determinate and indeterminate structures. Give practical examples of each. [16]

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

III B.Tech II Semester Examinations,APRIL 2011
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. Explain clearly, the sets of data required to be available before the beginning of preliminary design phase and the data that is expected to be ready at the end of this phase. [16]

2. Determine the center-of-gravity location of an airplane given the following data: W_{engine} = 400 kg, $W_{payload}$ = 500 kg, $W_{baggage}$ = 60 kg, X_{engine} = 20 m, $X_{payload}$ = 10 m, $X_{baggage}$ = 15 m. Xs are distances measured from the nose of the fuselage. [16]

3. Define the following terms 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) Area rule. [4+4+4+4]

4. (a) Discuss the advantages and disadvantages of pusher and tractor engine aircraft configurations.
   (b) A regional jet transport airplane has to be powered by 3 turbojet engines. Suggest all possible locations of the engines on the airplane with feasible explanations. [8+8]

5. Discuss the advantages and disadvantages of the following structural components/configurations of the airplane:
   (a) Canard
   (b) Wing sweep
   (c) Wing location on the fuselage
   (d) Wing taper
   (e) Wing dihedral angle. [16]

6. An antisubmarine turbo jet aircraft is designed for a loiter of three hours at a distance of 3,000 km from the base. The crew weighs 400 kg and payload weigh 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 omission fuel weight fraction of the aircraft if the specific fuel consumption is 0.015 grams per Newton per second. [16]

7. Write short notes on the following aspects of a control surface (elevator, aileron or rudder).
   (a) Aerodynamic balance
   (b) Mass balance
   (c) Taper control surface chord / Chord of wing or tail
   (d) Three surface configuration (canard, wing and empennage) [4+4+4+4]

8. Describe the parameters to be evaluated while verifying the preliminary design of an aircraft. [16]

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

III B.Tech II Semester Examinations,APRIL 2011
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. Write short notes, with neat sketches, on
   (a) Compression lift in supersonic flight,
   (b) Aerodynamic 'fixes' on wings and fuselage,
   (c) Isobars on wings
   (d) Determination of wetted area [4+4+4+4]
2. (a) Define fineness ratio of the fuselage.
   (b) While designing the fuselage of a passenger aircraft, what are the factors to be considered?
   (c) Explain how you go about deciding the fuselage shape and dimensions for 150 passenger aircraft.
   (d) Also, consider the equation $L = a\ W_0{}^C$, L and W_0 being the fuselage length and take-off weight of the aircraft, and a and C, constants, 0.287 and 0.43 respectively. Compute the length of the fuselage. What is the total weight you would assume and why? [2+6+5+3]
3. (a) Draw free body diagram of an airplane showing all the forces acting on the airplane during a ground roll.
   (b) Write down the force balance equations in the horizontal and the vertical directions. [16]
4. Detail out special considerations in the design of a new Executive class airplane with a cruise velocity of 600 km / hour, crew of 4 and seating capacity of 10 passengers. Draw neat sketches and graphs in support of your answer. [16]
5. (a) Derive the expression for the thrust - to - weight ratio of an aircraft in steady level flight in terms of lift to drag ratio (L/D), Wing loading (W/S), K (drag - due - to - lift factor), and other relevant parameters.
   (b) Using the above referred expression, derive the expressions for Velocity and C_L (Lift coefficient) for minimum thrust. [8+8]
6. (a) Explain why an elliptical wing is not chosen for a subsonic wing.
   (b) Using graphs, explain the trends for (local lift / mean lift) versus span location for various taper ratios of a trapezoidal wing.
   (c) What are the advantages of a trapezoidal wing over an elliptic wing?

(d) What is the taper ratio you would choose in case you opt for an unswept trapezoidal wing for a subsonic aircraft? [4+4+4+4]

7. (a) Express specific fuel consumption in terms of propeller power coefficient and other relevant parameters.

(b) Derive Breguet range equation R = (V/C) (L/D) ln (W_{i-1}/ W_i).

(c) Derive the endurance equation (W_{i-1}/ W_i) = exp { (-E C) / (L / D)

(d) Explain the mission fuel fraction equation (W_f / W_0) = 1.06 {1- (W_x / W_0) where n denotes the end of the last segment of the mission.

[4+4+4+4]

8. 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]

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