Code No: 07A52101 **R07** **Set No. 2**

III B.Tech I Semester Examinations,May 2011
FLIGHT MECHANICS-I
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Derive an expression for the maximum level speed, achievable by a turbojet propelled subsonic airplane. Assume a constant parabolic drag polar and variation of thrust as directly proportional to density ratio at altitude but invariant with Mach no. of flight.
   (b) Discuss the variation of maximum level speed with wing loading, altitude of flight and T/W ratio (take- off value at sea level) for an airplane.
   (c) Describe how the absolute ceiling of the airplane may be determined. [8+4+4]

2. (a) Name two principal aerodynamic characteristics each, of an airfoil that are most significantly affected by the following geometric parameters and describe how.
      i. Camber
      ii. Chordwise position of the maximum camber
      iii. Nose radius
   (b) Name two aspects of airplane performance that are most significantly affected by the critical Mach number of the wing and describe how. [12+4]

3. (a) For an airplane in steady, coordinated turn, at a speed of 60 m/s at a normal load factor of 2.0, at sea level, determine the rate of turn in degrees per minute.
   (b) Write down the three equations of motion of an airplane in steady, coordinated, shallow descending turn of an aircraft. [8+8]

4. (a) Classify the different flight regimes in terms of Mach number with neat sketches.
   (b) What are the flow conditions before and after a normal shock wave? Draw neat sketches. [8+8]

5. (a) What is a rocket? What are the different types of rockets? Give examples.
   (b) Explain the working of a turbo pump fed liquid propellant engine. [8+8]

6. Derive the Yawing moment & Pitching moment of a rigid body in terms of angular acceleration, gyro precession, and coupling terms. [16]

7. (a) Describe for each of the following types of drag , viz,. pressure drag and cooling drag of an airplane
      i. the physics of their generation,
      ii. how they may be estimated

iii. measures to be taken for their reduction and

iv. what the favorable and also adverse effects if any of the measures at iii) above on the performance of the aircraft will be.

(b) The power required to generate static thrust of T by a propeller is 2000 kW. Using momentum theory, determine the power required to generate static thrust of 1.7 T. [8+8]

8. What are P-s contours? Explain the optimization process by showing graph of specific excess power contour for a supersonic a/c. [16]

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Code No: 07A52101 **R07** **Set No. 4**

III B.Tech I Semester Examinations,May 2011
FLIGHT MECHANICS-I
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) Assuming the earth to be flat and non-rotating for simple analysis of flight trajectories of airplanes, show that the general dynamical equation is reduced to the form given below
$T + A + mg = m\frac{dv}{dt}$
where T,A,m,g and $\frac{dv}{dt}$ are thrust, aerodynamic forces, mass, acceleration due to gravity and the acceleration of the aircraft with respect to the earth. [16]
   (b) Set up the equations of motion of an aircraft, assuming the thrust lines are parallel to the longitudinal axis in the plane of the CG. The aircraft weighs 5500 N and each of the two engine is delivering 700 N of thrust. [8+8]

2. In steady and level flight, derive the expression for Velocity of airplane and lift coefficient for minimum thrust or drag. [16]

3. Describe for Pressure drag of an airplane
   (a) The physics of its generation,
   (b) How it may be estimated
   (c) Measures to be taken for its reduction and
   (d) What the favorable and also adverse effects if any of the measures at 'c' above on the performance of the aircraft will be. [4 × 4]

4. (a) For an airplane of gross weight = 10 tonnes, gross wing area = 33 m(C_D = 0.01 + 0.05*C_L^2), in a symmetric pull up (vertical loop) maneuver at constant speed = 100 m/s and constant radius = 1,000 m, determine
      i. The rate of change of flight path angle, and
      ii. The thrust required to execute such maneuver, when the flight path angle = 30 degrees to the horizon.
   (b) Write down the three equations of motion of an airplane in steady, coordinated, level turn of an aircraft. [12+4]

5. (a) Name two aerodynamic characteristics of wings that are affected by the twist of a wing and describe how.
   (b) Discuss how each of these aerodynamic characteristics in turn affect the performance characteristics of the airplane.
   (c) Name two geometric parameters of a wing section (airfoil) that most significantly affect its 'stalling characteristics' and describe how.

(d) Name two aspects of airplane performance that are most significantly affected by the stalling characteristics of the wing section and describe how. [4+4+4+4]

6. (a) What are the flow conditions before and after an oblique shock wave? Draw neat sketches.

   (b) A small instantaneous pressure disturbance occurs at a point in a fluid at speed v. The speed of sound in the fluid is a. Draw diagrams to show the region affected by the disturbance in time t if

      i. v=0
      ii. 0< v> a
      iii. v=a
      iv. v>a

   (c) Obtain the expression for the Mach angle α. Explain how a shock wave is formed. [4+4+8]

7. (a) Describe the long range ballistic trajectory of missiles. What are the performance parameters to be estimated? Explain the procedure in brief for the following

      i. Powered flight & equation of motion
      ii. Unpowered flight

   (b) Explain in detail about the tail control and canard control employed for a missile [8+8]

8. For a turbojet propelled high subsonic airplane, it is desired that the steepest angle of climb at sea level be increased by 10%. Assuming that this should be achieved solely through changes in the aerodynamic design of the wing,

   (a) Propose the required changes and their extent (in percentage) in any two aerodynamic characteristics of the airplane by which the above objective may be most effectively achieved

   (b) Discuss how the proposed measures can meet the desired objective and also how they may adversely affect the performance of the airplane in other respects.

   (c) Discuss how the proposed measures can meet the desired objective and also how they may adversely affect the performance of the airplane in other respects. [8+4+4]

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Code No: 07A52101 **R07** **Set No. 1**

III B.Tech I Semester Examinations,May 2011
FLIGHT MECHANICS-I
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the terms with neat sketches:
   (a) Inertial axes system
   (b) Body axis system
   (c) Stability axis system
   (d) Euler angles. [4 × 4]

2. Explain the terms with equations.
   (a) Specific impulse and a Total impulse
   (b) Thrust
   (c) effective exhaust velocity
   (d) Mass ratio [4 × 4]

3. (a) Explain and derive energy height and specific excess power
   (b) Consider an a/c flying at altitude 10000 m at velocity 540 km/h, calculate energy height. [8+8]

4. (a) What are sonic booms? Explain clearly with neat sketches.
   (b) What are the flow conditions before and after a normal shock wave? Draw neat sketches. [8+8]

5. For a turbojet propelled high subsonic airplane, it is desired that the minimum level speed at sea level be increased by 10%. Assuming that this should be achieved solely through changes in the aerodynamic design of the wing,
   (a) Propose the required changes and their extent (in percentage) in any two aerodynamic characteristics of the airplane by which the above objective may be most effectively achieved
   (b) Thereby, identify the required changes in the corresponding geometrical parameters of the wing / aerofoil
   (c) Discuss how the proposed measures can meet the desired objective and also how they may adversely affect the performance of the airplane in other respects. [8+4+4]

6. (a) Define 'aerodynamic centre' of an airfoil. Describe its significance in the context of specifying the aerodynamic characteristics of airfoils.

(b) Show that the existence of aerodynamic centre of an airfoil is assured if the lift coefficient and pitching moment about any station, vary linearly with the angle of attack.

(c) Where the aerodynamic centre for an airfoil exists, show that the coefficient of pitching moment about the aerodynamic centre is equal to the coefficient of pitching moment at zero lift. [4+4+8]

7. (a) Assuming that the thrust is much larger than the drag and ground friction during take off, estimate the percentage of the total increase (or decrease) of the distance of ground roll for take off on account of 1% increase in the

   i. Maximum lift coefficient of the aircraft and
   ii. Density of ambient air
   iii. Slope upward of the runway.

   (b) For an airplane with gross weight = 10 tonnes, gross wing area = 30 m^2 in steady, coordinated turn at normal load factor = 2, C_L = 1.2, at sea level, estimate the rate of turn. If the drag polar is (C_D = 0.01 + 0.05 C_L^2), determine the power required for sustained level turn. [8+8]

8. (a) The power required to generate a thrust of T at a flight speed V by a propeller of diameter D is 800kW. Using simple momentum theory, determine the power required by a propeller of diameter 1.7 D to generate thrust of 1.6 T at an altitude where the density ratio is 0.7 at the same flight speed.

   (b) Discuss the effect of taper ratio of a wing on the lift dependent drag of a wing. [12+4]

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Code No: 07A52101 **R07** **Set No. 3**

III B.Tech I Semester Examinations,May 2011
FLIGHT MECHANICS-I
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. What is a trajectory? Explain the different types of trajectories in detail. [16]

2. Explain the terms with neat sketches
   (a) Normal Shock
   (b) Oblique shock
   (c) Expansion waves
   (d) Mach number (M=0.1 to 5) [4 × 4]

3. (a) Define ground speed, airspeed, indicated airspeed and equivalent airspeed
   (b) Explain the terms:
      i. Altitude
      ii. Endurance
      iii. Altimeter
      iv. Vertical speed indicator. [8+8]

4. (a) For an airplane of gross weight = 10 tonnes, gross wing area = 33 m^2 , drag polar ($C_D = 0.01 + 0.05*C_L^2$), in a symmetric pull up (vertical loop) maneuver at constant speed = 100 m/s and constant radius = 1,000 m, determine
      i. The normal load factor and
      ii. Lift coefficient, when the flight path angle = 30 degrees to the horizon.
   (b) What do you understand by Balanced (take-off) field length of an aircraft? What is its significance? [12+4]

5. (a) A reciprocating engine-propeller powered airplane is required to fly between two ground stations from south to north. Describe the effect of
      i. Head wind,
      ii. Tail wind and on the time of flight and on the fuel consumed to reach the destination, if the pilot chooses to fly at an airspeed of V.
      iii. Consider the special case of headwind w = V and comment.
   (b) Assuming the initial weight of the propeller powered airplane = W_i, gross wing area = S, parabolic drag polar ($C_D= C_{D0}+kC_L2$) and constant specific fuel consumption = c, density of air = ρ , determine the optimal speed V* and optimal heading ϕ^* pilot should choose to fly the airplane for minimum consumption of fuel in a crosswind (east to west) of speed w. [8+8]

6. (a) With the help of a sketch of a C_L - α curve, describe the effect of the following on the stall characteristics (maximum lift coefficient, stalling angle of attack, steepness of stall) of a wing
   i. Trailing edge flaps
   ii. Slotted flaps
   iii. Leading edge flaps

   (b) Name two aspects of airplane performance that are most significantly affected by the maximum ($L^{3/2}/D$) of the wing and describe how. [12+4]

7. Derive the angular acceleration terms, gyro precession terms, and coupling terms acting on a rigid body. [16]

8. (a) Describe for each of the following types of drag , viz. Wave drag and Trim drag of an airplane
   i. the physics of their generation,
   ii. how they may be estimated,
   iii. measures to be taken for their reduction and
   iv. what the favorable and also adverse effects of the measures at iii) above on the performance of the aircraft will be.

   (b) The power required to generate static thrust of T by a propeller at an altitude where the density ratio sigma is 1, is 600 kW. Using momentum theory, determine the power required to generate the same static thrust where the density ratio is 0.6. [8+8]

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