Code No: 45045 **R07** **Set No - 1**

III B.Tech I Semester Regular Examinations,Nov/Dec 2009
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) Write down a differential equation for determining the ground roll distance during the landing phase of an airplane in terms of the landing weight, gross wing area, constants of the drag polar, maximum lift coefficient, braking friction coefficient of the runway, density of air, and the lift coefficient (assumed constant during the ground run). Make necessary assumptions.
   (b) What is side slip of an airplane? What do you understand by a coordinated turn of an airplane? What is the need for coordination? Explain how the turn and sideslip indicator assists the pilot in the execution of a coordinated turn. [10+6]
2. Describe for Skin friction 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 of the measures at 'c' above on the performance of the aircraft will be. [4×4]
3. For a piston engine driven propeller powered low subsonic airplane, it is desired that the stalling speed at sea level be decreased 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 and thereby
   (b) 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]
4. (a) Derive an expression for ROC(rate of climb) and TOC(time of climb) for accelerated flight.
   (b) Consider a/c flying with instantaneous acceleration of 5 m/s^2 at a instantaneous velocity of 500 m/s, excess power is 200 m/s. Calculate the instantaneous minimum rate of climb that can be obtained at the accelerated flight conditions.

   [8+8]

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5. (a) Classify the different flight regimes with neat sketches, with reference to Mach number.
   (b) What are the flow conditions before and after an expansion wave? Draw neat sketches. [8+8]

6. With the help of a sketch of a $C_L - \alpha$ curve, describe the effect of the following on the stall characteristics (maximum lift coefficient, stalling angle of attack, steepness of stall) of a wing
   (a) Trailing edge flap
   (b) Leading edge flap
   (c) Leading edge slot
   (d) Boundary layer control by suction. [4 × 4]

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

8. (a) Describe the long range cruise trajectory of missiles. What are the performance parameters to be estimated? Explain the procedure in brief for the following:
      i. time of climb
      ii. rate of climb
   (b) Explain in detail about the wing control and jet control employed for a missile. [8+8]

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Code No: 45045 **R07** **Set No - 2**

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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. How does a rocket differ from a missile? Describe the components of a rocket engine. Make use of sketches and plots. [16]
2. Describe for Wave 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 of the measures at 'c' above on the performance of the aircraft will be. [4 × 4]
3. (a) Derive an expression for the maximum angle of steady climb of a reciprocating engine-propeller powered low subsonic airplane.
   (b) Discuss the variation of the maximum rate of climb of the airplane with wing loading, power / weight ratio, the constants of the drag polar, density of the ambient air. [8+8]
4. (a) Name two aerodynamic characteristics of wings that are affected by the aspect ratio of a wing and describe how.
   (b) Discuss how each of these aerodynamic characteristics in turn affect the performance characteristics of the airplane.
   (c) Discuss how each of these aerodynamic characteristics in turn affect the performance characteristics of the airplane.
   (d) Name two geometric parameters of a wing section (airfoil) that most significantly affect the 'lift curve slope' and describe how. [4+4+4+4]
5. In steady and level flight, derive the expression for Velocity of airplane for minimum power. Derive the corresponding values for C_L and drag. [16]
6. (a) For an airplane of Gross Weight = 10 tonnes, gross wing area =33 m^2 in steady, coordinated turn, at normal load factor = 2, C_L = 1.2, at sea level, determine the radius of turn in meters. If the drag polar is(C_D = 0.01 + 0.05*C_L^2), estimate the power required for sustained level turn.
   (b) Describe how a pilot would, while approaching for landing in cross wind, align the aircraft flight path along the runway and how he would execute touch down (the runway) to initiate ground roll. [8+8]

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7. Using Newton's second law of motion derive L (roll moment), M (pitch moment) and N (yawing moment) for an aircraft. [16]

8. (a) Classify the different flight regimes in detail with neat sketches.
   (b) What are the flow conditions before and after an oblique shock wave? Draw neat sketches. [8+8]

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Code No: 45045 **R07** **Set No - 3**

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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 angle of steady climb of a turbojet propelled subsonic airplane.
   (b) Discuss the variation of the maximum rate of climb with the wing loading, thrust / weight ratio, the constants of the drag polar, density of the ambient air. [8+8]
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. Explain the terms with neat sketches:
   (a) Inertial axes system
   (b) Body axis system
   (c) Stability axis system
   (d) Euler angles. [4 × 4]
4. (a) The power required by a propeller to generate a thrust of T at a flight speed V at an altitude,(where the density ratio is 1), is 900 kW. Using momentum theory, determine the power required to generate the same thrust at a flight speed of 1.6V, at an altitude where the density ratio is 0.7.
   (b) Describe how the trim drag on an airplane may be reduced. [12+4]
5. (a) What is energy height? Derive expressions for specific energy and specific excess power.
   (b) Explain
      i. ROC (rate of climb) for accelerated flight
      ii. TOC (time of climb) for accelerated flight [10+6]
6. (a) For an airplane of Gross Weight = 10 tonnes, gross wing area =33 m^2 , maximum lift coefficient 2.0, maximum permissible normal load factor 3.5, determine the minimum radius of turn. Assuming a drag polar of (C_D = 0.008 + 0.04 C_L^2), estimate the power required for sustained level turn at this radius.

(b) Name the parameters of the aircraft and those of the operating conditions that affect the balanced field length and describe how. [8+8]

7. (a) Describe the effect of sweep on the lift curve slope of a wing of infinite aspect ratio.
   i. in incompressible flow
   ii. in subsonic compressible flow
   iii. in supersonic flow

   (b) Name two aspects of airplane performance that are most significantly affected by the chordwise position of the aerodynamic centre of the wing section and describe how. [12+4]

8. (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]

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Code No: 45045 **R07** **Set No - 4**

III B.Tech I Semester Regular Examinations,Nov/Dec 2009
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) Describe the significance of the following aerodynamic characteristics (parameters) in the context of the performance of an airplane.
   i. Minimum drag coefficient.
   ii. Lift coefficient corresponding to minimum drag coefficient
   iii. Range of lift coefficient over which the minimum drag coefficient is substantially constant (width of the drag bucket)
   (b) Name two geometric parameters of a wing that most significantly affect its 'induced drag' and describe how. [12+4]
2. What is a trajectory? Explain the different types of trajectories in detail. [16]
3. Explain:
   (a) Newton's second law of motion
   (b) Coriolis acceleration
   (c) Moments of inertia and Products of inertia
   (d) Euler angles. [2+4+4+6]
4. (a) Explain and derive expression for energy height and specific excess power
   (b) Consider an a/c flying with instantaneous acceleration of 3 m/s^2 at an instantaneous velocity of 300 m/s, excess power is 100 m/s. Calculate the instantaneous minimum rate of climb that can be obtained at the accelerated flight conditions. [8+8]
5. (a) Assuming that the thrust is much larger than the drag and ground friction on the aircraft 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 each in the
   i. Take off weight and
   ii. Take off thrust of the aircraft.
   (b) For an airplane in steady, coordinated turn, derive an equation for the radius of turn in terms of the normal load factor, lift coefficient and wing loading. [8+8]
6. (a) Discuss the effect of Mach number on

i. The zero lift pressure drag of an airfoil in supersonic flow.

ii. The skin friction drag of an airfoil in supersonic flow.

(b) The power required to generate a thrust of T at a flight speed V by a propeller is 200 kW. Using simple momentum theory, determine the power required to generate the same thrust at the same speed at the same altitude if the diameter of the propeller is increased by 20%. [4+12]

7. For a turbojet propelled high subsonic airplane, it is desired that the maximum rate of coordinated turn 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]

8. (a) What are the flow conditions before and after a normal shock wave? Draw neat sketches.

   (b) What do you mean by hypersonic flows? What are the possible physical changes in hypersonic flow, and what are the different characteristics of the flow? Draw neat sketches. [8+8]

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