Code No: RR312102 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006
AIRCRAFT PERFORMANCE
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Define skin friction drag and normal pressure drag.Consider a flat plate , a circular cylinder and an airfoil.Compare the sum of skin friction drag and normal pressure drag over these two dimensional objects by drawing flow patterns around these figures. [16]

2. Distinguish between flow over a two dimensional airfoil and that over a finite wing. What are the characteristics of flow in both the cases? Illustrate with neat sketches by considering a rectangular wing. [16]

3. An airplane weighing 2,40,000 N has a gross wing area of 80 sq. m. It has a maximum level speed of 120 m/s, a max. C_L of 2.2 with flaps down and C_L max. without flaps is 1.5. Plot the variation of C_L with V , and hence estimate the speed below which flaps must be lowered at sea level and at an altitude of 4,000 m (σ = 0.6685).Further explain the significance of equivalent air speed. [16]

4. Develop an expression for rate of descent of an airplane in a power off flight.A glider weighing 2600 N, S= 8.50 sq. m ,AR = 17 , e = 0.95 and C_{D^o} =0.015 is launched from a height of 300 m. Determine the maximum range,corresponding glide angle,forward velocity and lift coefficient at sea level. [16]

5. Explain briefly the climb performance hodograph of an airplane. A piston-prop airplane has the following data; W = 13,000 N, S = 16.2 sq.m, b = 10.9 m, C_{D^o} = 0.025, e = 0.8. The single engine supplies a maximum of 245 HP at the propeller efficiency of 0.85.The airplane flies at speed of 61.5 m/s. Determine the rate of climb, angle of climb and load factor of the airplane. [16]

6. Obtain the condition for maximum range of a jet driven airplane. A jet plane has its maximum all up weight of 555,000 N and gross wing area of 320 sq. m. The drag polar is given by $C_D = 0.015 + 0.055\ {C_L}^2$ .The weight fraction of usable fuel is 31% for a long range version. The specific fuel consumption of the jet engines is 0.07 kg /N-hr. Determine the maximum range and endurance for this airplane. [16]

7. Show the schematics of the variation of forces acting on a jet driven airplane in the process of take off. A jet executive airplane weighing 90,000 N has wing area of 30 sq.m and wing span of 16.5 m. Its C_{D^o} is 0.02 and e = 0.81. The max. C_L is limited to 1.0 at take off due to its configuration and the ground friction coefficient is 0.02.The wings are just 1.85 m above the ground .Estimate the take off distance if the two jet engines deliver a total of 37,000 N of thrust. [16]

8. How does true airspeed differ from equivalent airspeed? Show the importance of equivalent airspeed for V-n plot. Explain the corner points for their significance and importance in the aerodynamic / structural considerations during the life cycle of an airplane. [16]

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Code No: RR312102 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2006
AIRCRAFT PERFORMANCE
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Define skin friction drag as applicable in aerodynamics. Compare it over an airfoil and a circular cylinder. Make use of flow patterns to illustrate the effect of Reynolds number in this case. [16]

2. Consider a straight tapered plan form wing flying with a velocity V. What is the variation of its lift curve slope from that for the airfoil section of the wing for two aspect ratios of the wing namely AR = 8 and 10. Explain the aerodynamics involved. [16]

3. Explain the significance of stalling speed, stalling angle and indicated airspeed. An airplane has a wing loading of 2450 N / sq. m and has drag polar given by
$C_D = 0.016 + 0.055C\ {C_L}^2$
Calculate its maximum L / D ratio, V for minimum drag and L / D at a speed of 100 m/s. [16]

4. Develop a condition for minimum sinking speed of an airplane in power off flight. A glider weighing 5300 N with elliptic wing has a gross area of 10.5 sq. m. It is required to maintain a glide angle of 3 degrees at a fwd. speed of 50 m / s.If the glider has $C_{Do} = 0.015$, determine its aspect ratio. [16]

5. Define service ceiling and absolute ceiling of an airplane. An airplane weighing 165,000 N and a wing area of 42.5 sq.m has the drag polar as $C_D = 0.014 + 0.05\ {C_L}^2$ .If the thrust developed by the engine at a flight speed of 100 m/s is 28,500 N, determine the rate of climb and angle of climb and the load factor at the flight speed. [16]

6. Obtain the condition for maximum endurance of a jet driven airplane. A jet plane has its maximum all up weight of 535,000 N and gross wing area of 300 sq. m. The drag polar is given by $C_D = 0.015 + 0.05\ {C_L}^2$ .The weight fraction of usable fuel is 34% for a long range version. The specific fuel consumption of the jet engines is 0.07 kg /N-hr. Determine the maximum range and endurance for this airplane. [16]

7. Explain the basic principles underlying the aerodynamics of High lift devices. Hence describe in details the functioning of the wing of a modern airplane like Boeing 767 during its take off and landing. [16]

8. Define true airspeed, equivalent airspeed and indicated airspeeds. Which one of these is used for plotting V-n diagram? Explain this diagram in full for a highly maneuverable airplane. [16]

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Code No: RR312102 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2006
AIRCRAFT PERFORMANCE
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the term skin friction drag and develop an expression for the same. Now consider a flat plate at $\alpha = 0^o$ and 90^o .Compare skin friction drag in these two cases along with respective flow patterns around these two configurations. Does the Reynolds number bear an influence on skin friction drag? [16]

2. Consider a trapezoidal plan form wing flying with a velocity V. What is the variation of its lift curve slope from that for the airfoil section of the wing for two aspect ratios of the wing namely AR = 8 and 10. Explain the aerodynamics involved. [16]

3. Establish the condition for minimum thrust in level flight from the drag polar of an airplane. A turbojet airplane weighing 45,000 N has a wing loading of 1450 N / sq.m ,its drag polar is $C_D = 0.014 + 0.038\ {C_L}^2$ and has its max. $C_L = 1.5$.The engine delivers a max. thrust of 20,000 N at sea level. Determine its minimum and maximum level speeds at sea level. [16]

4. Develop a condition for minimum sinking speed of an airplane in power off flight. A glider weighing 5250 N with elliptic wing has a gross area of 10.5 sq. m. It is required to maintain a glide angle of 3 degrees at a fwd. speed of 50 m / s.If the glider has $C_{D^o} = 0.015$, determine its aspect ratio. [16]

5. Define service ceiling and absolute ceiling of an airplane. An airplane weighing 160,000 N and a wing area of 42.5 sq.m has the drag polar as $C_D = 0.014 + 0.052\ {C_L}^2$ .If the thrust developed by the engine at a flight speed of 100 m/s is 28,000 N, determine the rate of climb and angle of climb and the load factor at the flight speed. [16]

6. Obtain the condition for maximum range of a jet driven airplane. A jet plane has its maximum all up weight of 550,000 N and gross wing area of 320 sq. m. The drag polar is given by $C_D = 0.015 + 0.055\ {C_L}^2$ .The weight fraction of usable fuel is 30% for a long range version. The specific fuel consumption of the jet engines is 0.07 kg /N-hr. Determine the maximum range and endurance for this airplane. [16]

7. Show the schematics of the variation of forces acting on a jet driven airplane in the process of landing. A jet executive airplane weighing 90,000 N (of which 33300 N weight is of fuel), has wing area of 30 sq.m and wing span of 16.5 m. Its C_{D^o} is 0.02 and e = 0.81. The ground friction coefficient is 0.02.The wings are just 1.85 m above the ground .The two jet engines deliver a total of 35,000 N of thrust. With the deployment of spoilers at touch down (L = 0), the parasite drag coefficient

increases by 10% and full flaps down make the $C_L = 2.5$. If 10% of the fuel still remains at the touch down, estimate the landing ground roll distance. [16]

8. Define the term load factor and pull-up maneuver of an aircraft. Show that V-n diagram combines both for describing the whole flight regime of the airplane. Hence illustrate with examples the V-n diagram. [16]

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1. Explain the term skin friction drag and develop an expression for the same. Now consider a thin circular arc airfoil at $\alpha = 0^o$ and 90^o (concave face in upstream side) .Compare skin friction drag in these two cases along with respective flow patterns around these two configurations. Does the Reynolds number bear an influence on skin friction drag? [16]

2. Consider an elliptic plan form wing flying with a velocity V. What is the variation of its lift curve slope from that for the airfoil section of the wing for two aspect ratios of the wing namely AR = 8 and 10. Explain the aerodynamics involved. [16]

3. Explain the significance of stalling speed, stalling angle and indicated airspeed. An airplane has a wing loading of 2640 N / sq. m and has drag polar given by
$C_D = 0.016 + 0.055{C_L}^2$
Calculate its maximum L / D ratio, V for minimum drag and L / D at a speed of 110 m/s. [16]

4. Develop a condition for minimum sinking speed of an airplane in power off flight. A glider weighing 5000 N with elliptic wing has a gross area of 10 sq. m. It is required to maintain a glide angle of 3 degrees at a fwd. speed of 50 m / s.If the glider has $C_{Do} = 0.015$, determine its aspect ratio. [16]

5. Explain briefly the climb performance hodograph of an airplane. A piston-prop airplane has the following data; W = 13,000 N, S = 16.2 sq.m, b = 10.9 m, $C_{Do} = 0.025$, e = 0.8. The single engine supplies a maximum of 245 HP at the propeller efficiency of 0.85.The airplane flies at speed of 61.5 m/s. Determine the rate of climb, angle of climb and load factor of the airplane. [16]

6. Derive expressions for range and endurance of a propeller driven airplane. A piston-prop airplane has the following data; W = 14,500 N, S = 16.2 sq.m, b = 10.9 m, $C_{Do} = 0.025$, e = 0.8. The single engine supplies a maximum of 350 HP at the propeller efficiency of 0.85. It carries a weight fraction of usable fuel as 14% in one version. The engine consumes 0.274 kg mass of fuel per kW per hr. Determine its maximum range and endurance. [16]

7. Show the schematics of the variation of forces acting on a jet driven airplane in the process of landing. A jet executive airplane weighing 90,000 N (of which 33000 N weight is of fuel), has wing area of 30 sq.m and wing span of 16.5 m. Its C_{Do} is 0.02 and e = 0.81. The ground friction coefficient is 0.02.The wings are just 1.85 m above the ground .The two jet engines deliver a total of 35,000 N of thrust. With

the deployment of spoilers at touch down (L = 0), the parasite drag coefficient increases by 10% and full flaps down make the $C_L = 2.5$. If 10% of the fuel still remains at the touch down, estimate the landing ground roll distance. [16]

8. Describe the loading and forces occurring on an airplane during the vertical loop of an airplane. Develop relations between load factor and the radius of turns for a push-over maneuver. What is the expression for its rate of turn? [16]

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