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

III B.Tech. I Semester Supplementary Examinations, May -2005
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 normal pressure drag. Explain its occurrence. Now consider a flat plate at $\alpha = 0$ and 90 .Compare normal pressure drag in these two cases along with respective flow patterns around these two configurations. Does the Reynolds number bear an influence on this component of drag?

2. Explain the formation of horse shoe vortex system over a wing flying in an air stream of velocity V. Illustrate the flow field with sketches and diagrams. What are its
consequences?

3. An airplane weighing 2,10,000 N has a gross wing area of 70 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 ($\sigma =$ 0.6685).Further explain the significance of equivalent air speed.

4. Develop a condition for minimum sinking speed of an airplane in power off flight. A glider weighing 5200 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.

5. Define service ceiling and absolute ceiling of an airplane. An airplane weighing 165,000 N and a wing area of 42 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 110 m/s is 28,000 N, determine the rate of climb and angle of climb and the load factor at the flight speed.

6. Obtain the condition for maximum endurance of a jet driven airplane. A jet plane has its maximum all up weight of 533,000 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 33% 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.

7. Show with a schematic plot, the variation of forces acting on a propeller driven airplane in the process of take- off. An airplane weighing 200,000 N with a wing area of 100 sq. m. has its flaps down deflected for a max. C_L of 2.2.The airplane takes off in this configuration at a speed , 15% higher than that at stalling. The drag polar is given by $C_D = 0.024 + 0.04\ {C_L}^2$ The ground friction coefficient is 0.025. The total shaft power produced by two engines is 3.6 MW, and the total thrust

produced by the engine and airscrew is 58.000 N. Taking the propeller efficiency as 0.75, calculate the minimum ground run in standard conditions.

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?

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

III B.Tech. I Semester Supplementary Examinations, May -2005
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?

2. Consider a rectangular 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.

3. An airplane weighing 2,50,000 N has a gross wing area of 80 sq. m. and its drag polar is given by $C_D = 0.016 + 0.045\ {C_L}^2$, Calculate its Velocity for minimum speed and minimum power at sea level and at an altitude of 10,000 m ($\sigma = 0.3367$).

4. Develop an expression for the maximum endurance of an airplane in power off flight when the engines are shut at an altitude H1.A sailplane weighing 4500 N and a wing loading of 600 N / sq.m has a drag polar $C_D = 0.010 + 0.022\ {C_L}^2$ .After completing a launch at 500 m height in still air, determine the greatest distance it could cover in landing on an airstrip at height H2 and what was its greatest duration in still air? Find the corresponding speeds of flight.

5. Define service ceiling and absolute ceiling of an airplane. An airplane weighing 165,000 N and a wing area of 42 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 110 m/s is 28,000 N, determine the rate of climb and angle of climb and the load factor at the flight speed.

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 28% 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.

7. Show with a schematic plot, the variation of forces acting on a propeller driven airplane in the process of take- off. An airplane weighing 250,000 N with a wing area of 100 sq. m. has its flaps down deflected for a max. C_L of 2.2.The airplane takes off in this configuration at a speed , 20% higher than that at stalling. The drag polar is given by$C_D = 0.024 + 0.04\ {C_L}^2$. The ground friction coefficient is 0.025. The total shaft power produced by two engines is 3.5 MW, and the total thrust produced by the engine and airscrew is 60,000 N. Taking the propeller efficiency as 0.75, calculate the minimum ground run in standard conditions

8. Define the terms load factor, 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 pull-up maneuver. What is the expression for its rate of turn?

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

III B.Tech. I Semester Supplementary Examinations, May -2005
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 normal pressure drag over a flying object, as applicable in aerodynamics. Compare it over a flat plate and an airfoil. Make use of flow patterns to illustrate the effect of Reynolds number in this case.

2. Write down the drag polar for an arbitrary wing. What have been the contributions of various components of drag in making the final expression? Hence explain the effect of aspect ratio and plan form shape on the drag polar. Which part of the drag is actually affected?

3. An airplane weighing 2,45,000 N has a gross wing area of 80 sq. m. and its drag polar is given by $C_D = 0.016 + 0.042\ {C_L}^2$, Calculate its Velocity for minimum speed and minimum power at sea level and at an altitude of 10,000 m ($\sigma = 0.3367$).

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.

5. What should be the condition for maximum rate of climb of a jet driven airplane at shallow angles of attack? An airplane has following data; W = 160,000 N, S = 42 sq.m , $C_D = 0.014 + 0.052\ {C_L}^2$.The jet engine develops a thrust of T = 28,000 N at a flight speed of 110 m/s. Estimate the maximum rate of climb for this airplane.

6. Obtain the condition for maximum endurance of a jet driven airplane. A jet plane has its maximum all up weight of 534,000 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.

7. Show the schematics of the variation of forces acting on a jet driven airplane in the process of take off. Hence work out an expression for the ground roll run of an airplane. What should be the condition for minimum ground run in take off?

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.

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Code No: RR312102 **Set No.4**

III B.Tech. I Semester Supplementary Examinations, May -2005
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 normal pressure drag over a flying object, as applicable in aerodynamics. Compare it over a flat plate and a circular cylinder. Make use of flow patterns to illustrate the effect of Reynolds number in this case.

2. Consider an airfoil and plot the C_L - α curve for it. Now take a wing of elliptic plan form and plot the C_L - α curve for this wing. What are your observations and on what basis?

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.

4. Develop an expression for rate of descent of an airplane in a power off flight.A glider weighing 2900 N, S= 9.25 sq. m ,AR = 18.5 , e = 0.95 and C_{Do} =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.

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 230 HP at the propeller efficiency of 0.85.The airplane flies at speed of 60 m/s. Determine the rate of climb, angle of climb and load factor of the airplane.

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 32% 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.

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 11% of the fuel still remains at the touch down, estimate the landing ground roll distance.

8. Define load factor , angle of banking, angle of turning ,radius of turning and rate of turning for an airplane in a level turning flight of radius R. Establish expressions for radius of turning and rate of turning of an airplane from the first principle.

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