12. A wing body model is tested in a subsonic wind tunnel : Wing lift slope = 0.08 per degree

Wing area = 0.1 m^2

Wing chord = 0.1 m

Tail area = 0.02 m^2

Tail setting angle = 2.7°

Tail lift slope = 0.1 per degree

$$\varepsilon_0 = 0$$

$$\frac{\partial \varepsilon}{\partial \alpha} = 0.35$$

Also at α = 1.0° and 7.88°. The moment coefficient about the center of gravity are –0.01 and 0.05 resp. The center of gravity is located at 0.35 C. Calculate the neutral point location. 13

NTK/KW/15/7459

Faculty of Engineering and Technology

Fifth Semester B.E. (Aeronautical Engg.)
(C.B.S.) Examination

AIRCRAFT FLIGHT MECHANICS

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve Question No. **1 OR** Question No. **2**

(3) Solve Question No. **3 OR** Question No. **4**

(4) Solve Question No. **5 OR** Question No. **6**

(5) Solve Question No. **7 OR** Question No. **8**

(6) Solve Question No. **9 OR** Question No. **10**

(7) Solve Question No. **11 OR** Question No. **12**

(8) Due credit will be given to neatness and adequate dimensions.

(9) Assume suitable data wherever necessary.

(10) Diagrams and Chemical equations should be given wherever necessary.

(11) Illustrate your answers wherever necessary with the help of neat sketches.

(12) Use of non-programmable calculator is permitted.

(B) An Airplane weighing 100,000 N is powered by an engine producing 20,000 N of thrust under sea level condition. If the wing area be 25 m^2, calculate :

(i) Stalling speed at mean sea level

(ii) $(C_L/C_D)_{Min}$

(iii) $\left(C_L^{3/2}/C_D\right)_{Min}$

(iv) $V_{Minimum\ drag}$

(v) $V_{Minimum,\ power}$

Assuming $C_{L\ max} = 1.5$, $C_D = 0.016 + 0.064\ C_L^2$. 7

OR

6. (A) Derive the following relation between Parasite drag and drag due to lift :

Parasite drag = drag due to lift. 10

(B) Define and explain absolute ceiling and service ceiling. 4

7. (A) An airplane having a weight of 11000 N has a wing area of 15 m^2 and drag polar of $C_D = 0.032 + 0.06\ C_L^2$. Obtain the radius of turn in a steady level

co-ordinate turn at a speed of 160 kmph. at sea level :

Assume $C_{Lmax} = 1.4$, $(THP)_{available} = 90$ kW

Maximum load factor = 3.5.

What is the time taken to turn through 180° ? 8

(B) Derive the equation for radius of turn and angular velocity for the pullup manoeuvre condition. 5

OR

8. (A) The maximum lift to drag ratio for a given aircraft is 13.6. Calculate the minimum glide angle and the maximum range measured along the ground, covered by the aircraft in a power off glide that starts at an altitude of 8000 M. 8

(B) Describe the various phase of take off flight. Write down the equation of motion during take off run. 5

9. (A) Define absolute angle of attack and explain with figure :

(i) Absolute angle of attack versus C_L

(ii) Geometric angle of attack verses C_L for a cambered airfoil. 6

1. (A) Derive an Expression for the variation of pressure and density in troposphere. 9

(B) Explain in brief the need of International Standard Atmosphere. 4

OR

2. (A) Calculate the temperature, pressure, density and speed of sound in ISA at an altitude of 8 km, 16 km. 10

(B) Write a short note on Stratosphere. 3

3. (A) Explain in brief with well labeled diagram :

(i) Boundary layer separation

(ii) Adverse pressure gradient

(iii) Favourable pressure gradient. 8

(B) Explain in brief with well labeled diagram different forces acting on an aircraft. 5

OR

4. (A) Explain in brief with well labeled diagram the power available and power required curve for a piston driven aircraft. 7

(B) Why SFC varies with velocity and altitude ? 6

5. (A) Derive the equation of motion for an airplane in translational flight. 7

(B) Derive the equation for co-efficient of moment about centre of gravity of the airplane for wing alone configuration. 8

OR

10. (A) Consider the wing body model. The area and chord of the wing are 0.1 m^2 and 0.1 m.resp. Assume that a horizontal tail is added to this model. The distance from the airplane center of gravity to the tail's aerodynamic center is 0.17 m, the tail area is 0.02 m^2, the tail setting angle is 27°, the tail lift slope is 0.1 per degree, and $\varepsilon_0 = 0, \frac{\partial \varepsilon}{\partial \alpha} = 0.35$, $C_{m\ acwb} = -0.032$, $a = 0.08$, $\alpha_a = 9.38°$, $(h - h_{acwb}) = 0.11$.

Calculate C_{mcg} for the airplane model for $\alpha = 7.88°$ 10

(B) Derive the stability criteria for the wing alone configuration. 4

11. (A) Define neutral point and derive the equation for the neutral point. 3

(B) Write short notes on :

(i) Acrodynamic Balance

(ii) Horn Balance. 10

OR