CBCS SCHEME

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18AE61

Sixth Semester B.E. Degree Examination, June/July 2023
Aircraft Performance

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Represent the forces on the airplane in steady level flight and derive the expressions for thrust required and power required using analytical method. **(10 Marks)**

b. Sketch the variation of power available and power required curves for propeller driven and Jet- driven airplane. **(05 Marks)**

c. An airplane weighing 100,000N is powered by an engine producing 20,000N of thrust under sea level standard conditions. If the wing area be $25m^2$ calculate :
i) Stalling speed at sea level and at 10km altitude
ii) $(CD/CL)_{min}$, $(CD/CL^{3/2})_{min}$
Assume $C_{L_{max}} = 1.5$, $C_D = 0.016 + 0.064C_L^2$. **(05 Marks)**

OR

2 a. What is ISA? Explain the various layers of atmosphere and sketch the variation of temperature with altitude. **(10 Marks)**

b. Consider the twin – turbofan executive transport having the following airplane data : Weight : 73000lb, $S = 950ft^2$, AR = 5.92, $C_{D_{10}} = 0.015$ and K = 0.08. Calculate the minimum thrust required and the velocity at which it occurs. Also evaluate $\left(\frac{L}{D}\right)$ for a velocity of 400 ft/s. Take density at sea level ($\rho_\infty = 0.002377$ slug/ft^3). **(10 Marks)**

Module-2

3 a. Represent the forces on the airplane in steady climb and derive the expression for rate of climb in terms of T/W, W/S and density. **(12 Marks)**

b. Using the appropriate analytical expressions, calculate directly the values of θ_{max}, $V_{\theta_{max}}$. Consider the following airplane data : Weight = 73,000 lb, $S = 950ft^2$, AR = 5.92, $C_{D_{10}} = 0.015$ and K = 0.08. Assume density at sea level ($\rho_\infty = 0.002377$ slug/ft^3). **(08 Marks)**

OR

4 a. Sketch the hodograph for unpowered flight. Also plot the rate of descent Vs equilibrium velocity. **(08 Marks)**

b. A glider weighting 4905N has an area of $25m^2$, $C_{D_{10}} = 0.012$, AR = 16 and e = 0.87. Determine :
i) Minimum angle of glide, minimum rate of sink and corresponding under sea level standard conditions
ii) The greatest duration of flight and the greatest distance that can be covered when glided from a height of 300m. Neglect the changes in density during glide. **(12 Marks)**

Module-3

5 a. Obtain the aerodynamic relations associated with maximum : $\left(\frac{C_L}{C_D}\right)\left(\frac{C_L^{3/2}}{C_D}\right)$ and $\left(\frac{C_L^{1/2}}{C_D}\right)$. **(12 Marks)**

b. Estimate the maximum range at 30,000 ft for Rolls Royle turbofan engine. Also calculate the flight velocity to obtain this range. The maximum usable fuel weight is 29,500lb. The thrust specific fuel consumption of the Rolls-Royle Tay Turbofan is 0.69lb of fuel consumed per hour per pound of thrust. Give a/p Weight = 73,000lL. $\rho_\infty = 8.9068 \times 10^{-4}$slug/ft^3, S = 950ft^2, $C_{D_{10}} = 0.015$, K = 0.08. **(08 Marks)**

OR

6 a. Derive the equation of maximum range and endurance for reciprocating/engine propeller combination airplane. Also list out the conditions at which it occurs. **(15 Marks)**

b. A jet airplane has a weight of 922,140N and using area of 158m^2. The weight of the fuel and oil together is 294,300N. The drag polar is given by $C_D = 0.017 + 0.0663C_L^2$. Obtain the maximum range in constant C_L flight at an altitude of 10km assuming BSFC to be 0.95hr^{-1}. **(05 Marks)**

Module-4

7 a. Represent the forces acting on an airplane during takeoff and obtain the expression for ground roll. **(12 Marks)**

b. Calculate the airborne distance to clear an obstacle of 35ft. Airplane data : Weight = 73000lb, S = 950ft^2, AR = 5.92, $C_{D_{10}} = 0.015$ and K = 0.08, $C_{L_{max}} = 1.86$. **(08 Marks)**

OR

8 a. Sketch the landing path and landing distance. Derive the expression for approach distance and flare distance. **(08 Marks)**

b. Calculate the flare distance for airplane at standard sea level. Assuming that the landing weight is the same as the take off gross weight of 73,000lb. Assume that no thrust reversal is used and that the runway is dry concrete with a brakes-on value of $\mu_r = 0.4$. The approach angle is 3 degree. $C_{L_{max}} = 2.39$, $\rho_\infty = 0.002377$ slug/ft^3, S = 950ft^2. **(12 Marks)**

Module-5

9 a. With a neat sketch explain level turn measures and derive the expression for turn radius and turn rate. **(10 Marks)**

b. An airplane has a jet engine which produces a thrust of 24525N at sea level. The weight of the airplane is 58860N. The wing has an area of 28m^2 zero lift angle of –2.2° and slope of lift curve is 4.6per radian. Find :

i) The radius of a correctly banked 4g level turn at the altitude where $\sigma = 0.8$ and the wing incidence is 8 degree.

ii) Time required to turn through 180°. **(10 Marks)**

OR

10 a. Draw a V-n diagram for typical jet trainer A/C and briefly, explain the salient parameters. **(10 Marks)**

b. With a neat sketch explain the pull-up and pull-down manoeuvre. **(10 Marks)**

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