Assignment 2

Flight Mechanics (AE 321A)

September 2019

Total Marks: 100

Question 1. A light turbojet airplane weighs 20000 N, has a wing loading of 1000 N/m^2 and produces a sea level thrust of 2000 N. Thrust varies with altitude as $T = T_0\sigma^{0.8}$. Assuming $C_D = 0.015 + 0.024C_L^2$ and $C_{L,max} = 1.4$. Find (a) the absolute ceiling and corresponding flight velocity and lift coefficient (b) the service ceiling and corresponding flight velocity, thrust available and lift coefficient. **(12.5)**

Question 2. A piston-prop aircraft has a wing loading of 1400 N/m^2, wing area of 24 m^2, and its drag polar is given by $C_D = 0.025 + 0.05C_L^2$. The maximum lift coefficient is 1.5. The reciprocating engine develops 250 kW at sea level and $P = P_0\sigma$ at an altitude, and propulsive efficiency of the engine-propeller combination is 0.85. Determine, (a) absolute ceiling and corresponding flight velocity and lift coefficient (b) the service ceiling and corresponding flight velocity, power available and lift coefficient. **(12.5)**

Question 3. A propeller aircraft weighs 35000 N and has a wing area of 21.8 m^2. The drag polar is given by $C_D = 0.021 + 0.045C_L^2$ and the maximum lift coefficient is 1.5. The power developed by engine is 700 kW and propulsive efficiency of 0.85. The structural limit load factor is 3.0. Determine, the load factor, velocity, angular rate and radius of turn for (a) fastest sustained rate of turn, (b) sharpest sustained turn, and (c) maximum load factor turn. **(12.5)**

Question 4. A jet aircraft weighs 60000 N and has a maximum thrust of 22500 N. The lift curve slope of wing is 5.0 per radian, the zero-lift incidence is -2.0 deg, and maximum lift coefficient is 1.5. The wing area is 18.75 m^2, and the drag polar is given by $C_D = 0.018 + 0.08C_L^2$. The structural limit load factor is 6.0. For flight at an altitude of 1500 m ($\rho = 1.058$ kg/m^3), determine, the load factor, velocity, angular rate and radius of turn for (a) fastest sustained rate of turn, (b) sharpest sustained turn, and (c) maximum load factor turn. **(12.5)**

Question 5. A light turbojet airplane weighs 20000 N, has a wing loading of 1000 N/m^2 and produces a sea level thrust of 2000 N. Thrust varies with altitude as $T = T_0\sigma^{0.8}$. Assuming $C_D = 0.015 + 0.024C_L^2$ and $C_{L,max} = 1.4$. The positive and negative structural limit load factors are 6.0 and 3.0, respectively. Draw the V-n diagram at an altitude of 1.5 km ($\rho = 1.058$ kg/m^3). At an altitude of 1.5 km, find, (a) the corner velocity, (b) corner radius of turn, (c) corner angular rate, and (d) time to perform 180^o turn with corner angular rate. **(12.5)**

Question 6. An aircraft weighs 10000 N and has a wing area of 3.4 m^2 develops a seal level thrust of 2500 N. The drag polar is given by $C_D = 0.021 + 0.045C_L^2$ and the maximum lift coefficient

with flaps deployed is 1.8. Assume that the coefficient of friction between aircraft tires and concrete runway is 0.05. Find (a) minimum ground run and (b) corresponding time at sea level. **(12.5)**

Question 7. Derive the expression for landing distance, consider landing phase has three subphases descend, flair, and ground run. Assume the descend angle is small and air density is constant throughout the landing phase. **(12.5)**

Question 8. An aircraft weighs 62784 N and has a wing area of 20 m^2 . The drag polar is given by $C_D = 0.0254 + 0.178C_L^2$ and the maximum lift coefficient with flaps deployed is 0.95. This aircraft is required to land on a run way located an altitude of 1000 m ($\sigma = 0.9074$). Assume that the coefficient of friction between aircraft tires and concrete runway is 0.02 and approach glide angle is 3.5 deg. Estimate (a) the airborne distance (including flare), and (b) ground run. **(12.5)**