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10AE62

Sixth Semester B.E. Degree Examination, Aug./Sept. 2020
Aircraft Performance

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define standard atmosphere. Explain the variation of thrust, power and SFC with velocity and altitude for air-breathing engines. **(04 Marks)**

b. Define the term 'Aerodynamic center' and centre of pressure and derive an expression to locate the aerodynamic center. **(06 Marks)**

c. Draw and explain the variation of lift, drag and moments with respect to angle of attack with a neat sketch. **(04 Marks)**

d. The Boeing 777 has the wing planform area of $4605 ft^2$ (i) Assume a take off 506000 lb and a take off velocity 160 mi/hr. Calculate the lift coefficient at take off for standard sea level conditions. (ii) Compare the above result with the lift coefficient for cruise at Mach no. 0.833 at 30,000 ft, assuming the same wt. **(06 Marks)**

2 a. Define four forces of flight. Derive the equations of motion of an airplane through three – dimensional space over a flat earth. **(08 Marks)**

b. Derive and explain thrust available and the max velocity of the airplane. **(08 Marks)**

c. For the Gulf stream IV at the conditions given below, calculate the min. thrust required and the velocity at which it occurs. Given $W = 73,000$ lb, $S = 950 ft^2$, $\rho_{ca} = 8.9068 \times 10^{-4}$ slug/ft^3, $C_{0,0} = 0.015$ and $K = 0.08$? **(04 Marks)**

3 a. Derive an expression for rate of climb and explain by graphical approach. **(08 Marks)**

b. For the unpowered gulf stream IV at 30,000 ft. Calculate
(i) The sink rate for the case of min. glide cycle and
(ii) The minimum sink rate. **(06 Marks)**

c. Explain with neat sketches the service and absolute ceilings. **(06 Marks)**

4 a. Obtain the expression for $V_{(C_L/C_D)_{max}}$, $V_{(C_L^{1/2}/C_D)_{max}}$ and $V_{(C_L^{3/2}/C_D)_{max}}$ and discuss effects on the aircraft flight speed and show their variation graphically. **(10 Marks)**

b. What are high lift devices and their requirements? List down and sketch the different types of trailing edge flaps, leading edge devices and explain the aerodynamic advantages with relevant graphs. **(10 Marks)**

PART - B

5 a. Develop quantitative formulation and derive the generic expression for Range and derive the Breguet Range equation for a propeller driven airplane and list down the parameters that maximize the range. **(12 Marks)**

b. An aircraft is being designed to fly on Mars (where the acceleration of gravity is $3.72 m/s^2$) at an altitude where $\rho = 0.01 kg/m^3$. The aircraft will be powered by a piston engine driving a propeller. The engine has, when tested, burned 50 kg of fuel and 400 kg of oxidizer in one hour while producing 104 kW of shaft power. The propeller efficiency has been measured in Mars-like conditions at 0.85. The aircrafts drag polar is $C_D = 0.03 + 0.07C_L^2$, and its wing area is $50 m^2$. What will be the aircraft maximum range at this altitude of 500 kg of propellants, if its mass with the propellant is 1500 kg? **(08 Marks)**

6 a. Explain with neat sketch various phases of airplane undergoes during takeoff. (10 Marks)
b. Derive expression for calculation of distance while airborne to clear an obstacle. (10 Marks)

7 a. Derive equation for calculating flare distance of airplane. (10 Marks)
b. The maximum lift to drag ratio for the CP–1 13.6, W = 2950, S = 174. Calculate the minimum glide angle and maximum range measured along the ground, covered by CP – I in a power off glide that starts at altitudes of 3048m and also calculate the equilibrium glade angle. (10 Marks)

8 a. Explain with neat sketch pull-up and pull-down maneuvers. (10 Marks)
b. Describe the importance of V-n diagram on aircraft performance and write the limitations of pull-up and push-down. (10 Marks)

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