Week 6 assn 4 2026

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Assignment # 4 Part I

For a jet in steady, level flight, thrust balance drag and lift balances weight. Under these conditions, the optimal cruise speed is one which provides the smallest ratio of the drag force to velocity. The drug, C_D can be computed as

$$C_D = C_{D0} + \frac{C_L^2}{\pi\ AR}$$

where C_{D0} is the drag at the zero lift and AR is the aspect ratio.For a steady level flight, the lift coefficient could be computed as

$$C_L = \frac{2W}{\rho v^2 A}$$

where W is the weight of the plane (N), ρ is the air density kg/m^3, v velocity m/s, and A is the wing platform area m^2. The drag force is then computed as

$$F_D = W\frac{C_D}{C_L}$$

Assignment # 4, Con't

- Use the formulas to determine optimal steady state velocity for 670 kN jet flying at 10 km above the ground level for the folliwng values of the plane parameters $A = 150\ m^2$, $AR = 6.5$, $C_{D0} = 0.018$ and $\rho = 0.413\ kg/m^3$
- Develope a MATLAB code to generate a plot of the optimal velocity versus elevation above the sea level. Use the mass of the plane to be $68,300\ kg$. The gravitational acceleration could be calculated as

$$g(h) = 9.8066 \left(\frac{r_e}{r_e + h} \right)^2$$

$r_e = 6.37110^6\ m$ is the Earth radius and

$$\rho(h) = -9.57926 \times 10^{-14} h^3 + 4.71260 \times 10^{-9} h^2$$

$$-1.18951 \times 10^{-4} h + 1.22534$$

Assignment # 4, Cont'd

- The range of heights $0 < h < 12$ km
- Use bisection method to define the point of maximum deflection (*i.e.* such x that $dy/dx = 0$.

Assn 4 Part II

A total charge Q is uniformly spread over the ring of radius a. A force exhorted on a charge q located on the axis of the ring at distance x is given by

$$F = \frac{1}{4\pi\epsilon_0}\frac{qQx}{(x^2 + a^2)^2}$$

Here $\epsilon_0 = 8.85 \times 10^{12}\ C/N/m^2$, $a = 0.9\ m$, $q = q = 2 \times 10^{-5}\ C$. Determine the distance x where the force is at maximum. Use corresponding MATLAB function for optimization.

References

Dr. David Houcque, MATLAB tutorial
Original manual by Dr. David Houcque

Applied numerical methods, Chapra, Steven, 2012, McGraw-Hill Columbus

The End