QUESTION 1 [20 Marks]

A flat plate of mass m falling freely in air with velocity V is subjected to a downward gravitational force and an upward frictional drag force due to air. If the drag force, FD, is given by Equation (1),

and the terminal velocity is reached when the drag force equals the gravitational force, that is,

 $F_D = mg \qquad (2)$

taking the values of m and g to be 3.5 kg and 9.8 m/s2 respectively, using a guess value of $V_0 = 0.5$ m/s and employing fixed-point iteration method, develop a MATLAB program to estimate the terminal velocity. Take the absolute percentage relative error tolerance to be less than or equal to 1E-11.

SOLUTION

Using fixed-Point iteration Method:

since equation (1) = equation (2) = F_D

Hence, $F_D = mg = \frac{0.3V^2}{500 + (lnV)^3} - 0.02V$

m = 3.5 kg and g=9.8 m/s2

Hence, $F_D = mg = 3.5 X 9.8 = 34.3$

Therefore,

$$F_{\rm D} = \frac{0.3V^2}{500 + (lnV)^3} - 0.02V = 34.3$$

making $F_D = 0$

 $\frac{0.3V^2}{500+(lnV)^3} - 0.02V - 34.3 = 0$

Making V as subject of formula

$$0.02V + 34.3 = \frac{0.3V^2}{500 + (lnV)^3}$$

$$(0.02V + 34.3) X (500 + (lnV)^3) = 0.3V^2$$

$$((0.02V + 34.3) X (500 + (lnV)^3))/0.3 = V^2$$

$$V = (((0.02V + 34.3) X (500 + (lnV)^3))/0.3)^{(0.5)}$$

$$Vi+1 = (((0.02Vi + 34.3) X (500 + (lnVi)^3))/0.3)^{(0.5)}$$

Ans = V = 304.0675323m/s

Codes for the Fixed-Point Iteration using MATLAB

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