Assignment 1

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Elect/Elect

Question 1

A flat plate of mass "m" falling freely in air with velocity "V" is subjected to a ~~downw~~ downward gravitational force and an upward frictional drag force due to air if the drag force "FD" is given by Equation(1) below:

$$F_D = \frac{0.3V^2}{500+(\ln V)^3} - 0.02V \quad \text{----(1)}$$

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

$$F_D = mg \quad \text{-----(ii)}$$

taking the radius of m and g to be 3.5kg and 9.8m/s², respectively, using $V_0 = 0.5$m/s, and employing fixed - pair iteratioc method, develop a MATH LAP Program to estimate terminal velocity. Take the absolute percentage relative error tolerance to be less than or equal to 9E-11

Solution

$$F_D = m \times g$$

$$m = 3.5; \quad g = 9.8$$

$$F_D = 3.5 \times 9.8$$

$$F_D = 34.3$$

hence

$$34.3 = \frac{0.3v^2}{500+(\ln v)^3} - 0.02v$$

$$34.3 = \frac{0.3v^2}{500+(\ln v)^3} - \frac{0.02v}{1}$$

$$34.3 = \frac{0.3v^2 - (500 + (\ln v)^3)(0.02v)}{(500 + (\ln v)^3)}$$

$$17150 + (34.3(\ln v)^3) = 0.3v^2 - (10v + 0.02v(\ln v)^3)$$

$$17150 + 34.3(\ln v)^3 = 0.3v^2 - 10v - 0.02v(\ln v)^3$$

$$17150 + 34.3(\ln v)^3 + 10v + 0.02v(\ln v)^3 = 0.3v^2$$

$$v^2 = \frac{17150}{0.3} + \frac{34.3(\ln v)^3}{0.3} + \frac{10v}{0.3} + \frac{0.02v}{0.3}(\ln v)^3$$

$$v^2 = 57166.67 + 114.33(\ln v)^3 + 33.33v + 0.0667v(\ln v)^3$$

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$$v = (57166.67 + 114.33(\ln v)^3 + 33.33v + 0.0667v(\ln v)^3)^{1/2}$$

$$v_{i+1} = (57166.67 + 114.33(\ln v(i))^3 + 33.33v(i) + 0.0667(v(i))(\ln v(i))^3)$$

MATLAB CODE

Command window

```
clear
clc
format short g
v=0.5
for i = 1:inf
Iter = (i+1)=i
v(i+1) = Sqrt(57166.67)+(114.33x(log(v(i)^3))+
        33.33*v(i))+(0.0607*v(i)* log(v(i)^3))
ea(i+1) = (abs((v(i+1)-v(i))/v(i+1)*100))
    if ea(i+1)<= 1E-11
    break
    end
    end
tab = [Iter'v'ea']
```

tab =

iter	V	ε_a
0	0.5	0
1	239.05	99.991
2	294.17	18.736
3	302.61	2.7895
4	303.85	0.40996
5	304.04	0.060153
6	304.06	0.0688241
7	304.07	0.0012944
8	"	"
9	"	"
17	304.07	5.9635e-12

Converging at iter = 7, to give $v = 304.07$.

Hence the lower going value of the iteration was seen as 304.07

Proof

$$F_p = \frac{0.3v^2}{500 + (\ln v)^3} - 0.02v$$

If $v = 304.7$

then $F_p = 9.8 \times 3.5 = 34.3$

$$\to \frac{0.3 \times (304.07)^2}{500 \times (\ln 304.07)^3} - 0.02(304.07)$$

$= 34.25$

$= 34.3$