Otukoya Ismail
16/ENG05/1028
Mechatronics Engineering

Assignment 2

A flat plate of mass m is 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, F_D is given by equation (1)

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

and the terminal velocity is reached when the drag force equals the gravitational force, i.e; $F_D = mg$ ---- (2). taking the values of m and g to be 3.5kg and $9.8\ m/s^2$ 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

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

$$F_D = mg = 3.5 \times 9.8 = 34.4 \quad \text{---- (2)}$$

Equating (1) and (2)

$$mg = 34.4 = \frac{0.3V^2}{500+(\ln V)^3} - 0.02V$$

Making V^2 subject of the equation:

$$34.34 + 0.02V = \frac{0.3V^2}{500+(\ln V)^3}$$

$$0.3V^2 = (34.4 + 0.02V) * (500+(\ln V)^3)$$

$$V^2 = ((34.4 + 0.02V) * (500+(\ln V)^3))/0.3$$

$$V = \sqrt{((34.4 + 0.02V) * (500+(\ln V)^3))/0.3}$$

From the question

$V_0 = 0.5 m/s$

Absolute percentage relative error, $\varepsilon_a(i+1) < 1E-11$

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MATLAB CODE Solution

```
- Command Window
- Clear
- clc
- Close all
- format short g
- Syms V
- V=0.5
- for i=1:inf
    iter(i+1)=i;
    V(i+1)=((34.4+(0.02*V(i)))*(500+(log(V(i)))^3))^0.5
    Ea(i+1)=abs((V(i+1)-V(i))/V(i+1)*100;
    if Ea(i+1)<=1E-11
        break
    end
end
table=[iter' V' Ea']
```

- Estimated terminal velocity = 257.86 m/s

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