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18/ENG03/052

Civil Engineering

Applying the balance law  
(Accumulation rate of salt within a system) = (Input rate of salt into the system) - (Output rate of salt within the system)

$$\frac{dm}{dt} = M_{in} - M_{out}$$

$$M_{in} = \frac{50 \text{ gal}}{\text{min}} \times (1 + 5\%) \frac{\text{lb}}{\text{gal}} = 50(1 + 5\%) \frac{\text{lb}}{\text{min}}$$

$$m_{out} = \frac{30 \text{ gal}}{1200 \text{ gal}} = 0.025 = 2.5\% \\ = 2.5\% \text{ of } m$$

$$\frac{dm}{dt} \cdot \frac{\text{lb}}{\text{min}} = 50(1 + 5\%) \frac{\text{lb}}{\text{min}} - 2.5\% \text{ of } m \frac{\text{lb}}{\text{min}}$$

$$\frac{dm}{dt} = 50(1 + 5\%) - 0.025m$$

$$\frac{dm}{dt} = \cancel{0.025m} + 50(1 + 5\%)$$

$$= -0.025m + 50(1 + 5\%)$$

$$= -0.025 \left( \frac{-0.025m}{-0.025} + \frac{50(1 + 5\%)}{-0.025} \right)$$

$$\frac{dm}{dt} = -0.025(m - 2000(1 + 5\%))$$

$$\frac{dm}{m - 2000(1 + 5\%)} = -0.025 dt$$

$$\int \frac{dm}{m - 2000(1 + 5\%)} = \int -0.025 dt$$

$$\left[ \frac{dm}{m - 2000(1 + 5\%)} \right] = \int -0.025 dt$$

$$\left[ \frac{dm}{m - 2000(1 + 5\%)} \right] = -0.025 dt$$

$$\ln [m - 2000(1 + sint)] = -0.025t + C$$

$$m - 2000(1 + sint) = e^{-0.025t + C}$$

$$m - 2000(1 + sint) = e^{-0.025t} e^C$$

$$m - 2000(1 + sint) = e^{-0.025t} m_0$$

$$m - 2000(1 + sint) = m_0 e^{-0.025t}$$

$$m = m_0 e^{-0.025t} + 2000(1 + sint)$$

Given that when  $t = 0$  min initially  $m = 1500$  g

$$1500 = m_0 e^{-0.025(0)} + 2000(1 + \sin(0))$$

$$1500 = m_0 + 2000$$

$$-m_0 = 2000 - 1500$$

$$m_0 = -1850$$

$$m = -1850 e^{-0.025t} + 2000(1 + \sin t)$$

$$m = 2000(1 + \sin t) - 1850 e^{-0.025t}$$

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1 - commandwindow
2 - clear
3 - clc
4 - close all
5 - syms m t
6 - ans = dsolve('Dm+0.025*m=50+50*sin(t)', 'm(0)=150')
7 - t = 0:0.5:450
8 - tn = subs(ans, t)
9 - plot(t, tn)

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Command Window

New to MATLAB? See resources for [Getting Started](#).

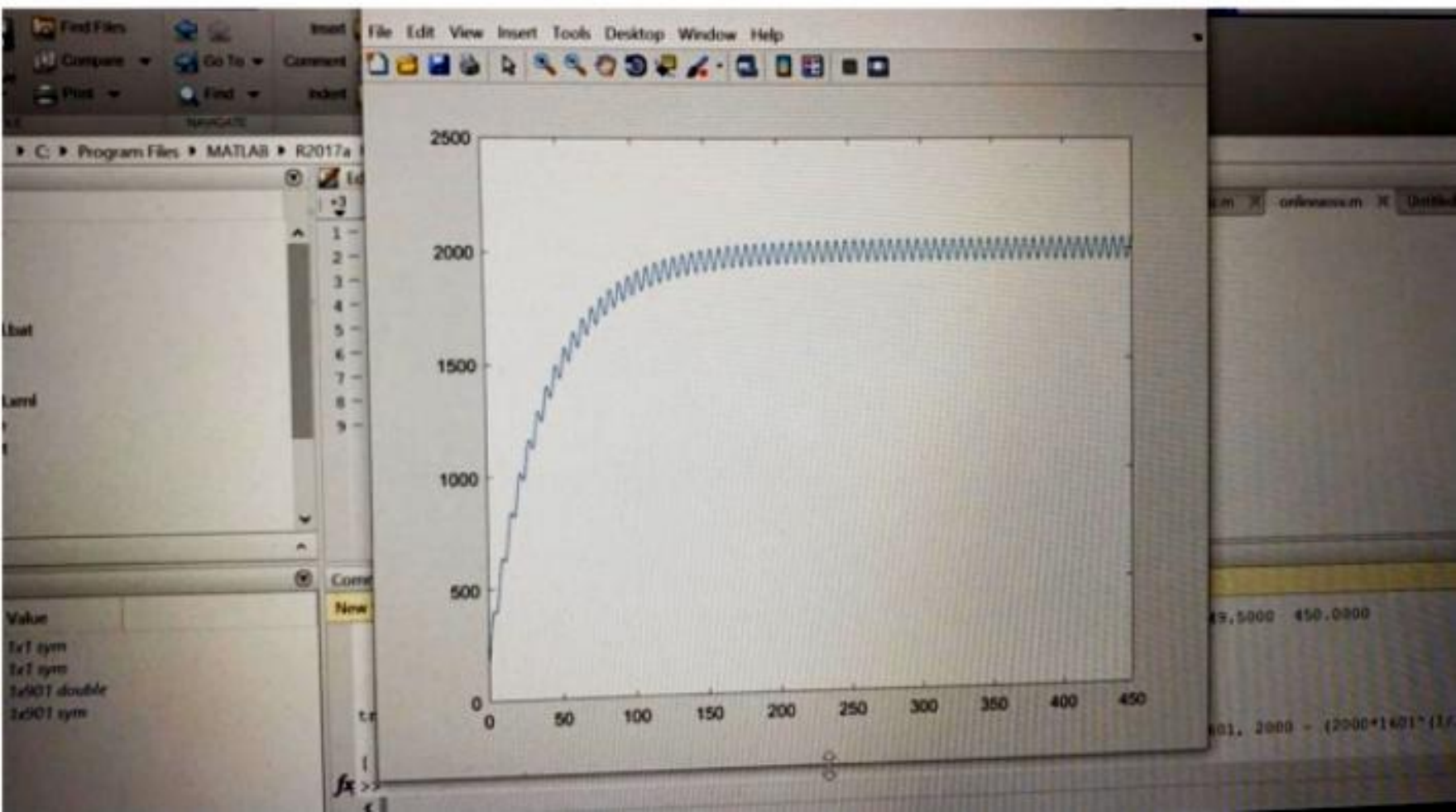
445.5000 446.0000 446.5000 447.0000 447.5000 448.0000 448.5000 449.0000 449.5000 450.0000

tn =

[ 150, 2000 - (2000\*1601^(1/2)\*cos(atan(1/40) + 1/2))/1601 - (2881850\*exp(-1/80))/1601, 2000 - (2881850\*exp(-1/80))/1601]

fx >>

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```
1 - commandwindow
2 - clc
3 - clear all
4 - close all
5 - t=0:1:499
6 - t1=1:2:499
7 - t2=0:2:500
8 - y= (50/0.05)+((50/1.0025)*sin(t1))+(((50*0.05)/1.0025)*cos(t1))-(802.4*exp(-0.05*t
9 - ym= 1000-(800*exp(-0.05*t2))
10 - T1=t1'
11 - T2=t2'
12 - Y=y'
13 - YM=ym'
14 - values=[]
15 - A=[Y']
16 - B=[YM']
17 - i=1
```

```
15 - A=[Y']
16 - B=[YM']
17 - i=1
18 - j=1
19 - while (i<=250 && j<=250)
20 -     Bn=B(j)
21 -     values=[values;Bn]
22 -     An=A(i)
23 -     values=[values;An]
24 -     i=i+1;
25 -     j=j+1;
26 - end
27 - plot(t,values,'black')
28 - grid on
29 - grid minor
30 - xlabel('t (min)')
```

