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18/ENIG06/002

Mechanical Engineering

ENG 282 (Engineering Maths II)

1. Using 'Balance Law', the acceleration rate of salt within a system is equal to the input rate of salt into the system minus output rate of salt from the system.

Acceleration rate of salt within a system = Input rate of salt into the system - Output rate of salt from the system

Let the amount of salt present in the tank at any time be ' $y$ '. Time rate of change of  $y = \frac{dy}{dt} = y_{in} - y_{out}$

If 50 gal of brine enters the tank per minute & one gallon contains  $(1 + 5\%)$  lb of salt, then

$$\text{at } t = 1, (1 + 5\%) = (1 + 5\%(1)) = 1.05 \text{ lb}$$

Hence, the amount of salt entering the tank is  
 $50 \text{ gal/min} \times 1.05 \text{ lb/gal} = 52.5 \text{ lb/min}$

The tank contains 1200 gal of water with dissolved salt and 30 gal of the solution exits the tank per min. i.e;  $\frac{30 \text{ gal}}{1200 \text{ gal}} = 0.025 = 2.5\%$

of the content of the tank. So 2.5% of the salt present inside the tank will also leave the tank per minute. i.e

$$y_{out} = 2.5\% \text{ of } y$$

$$a) \frac{dy}{dt} \text{ lb/min} = 52.5 \text{ lb/min} - 2.5\% \text{ of } y \text{ lb/min}$$

$$b) \frac{dy}{dt} = 52.5 - 0.025y; \frac{dy}{dt} = -0.025y + 52.5$$

$$\frac{dy}{dt} = -0.025 \left( \frac{-0.025y + 52.5}{-0.025} \right); \frac{dy}{dt} = -0.025(y - 2100)$$

$$\frac{dy}{(y-2040)} = -0.025 dt; \int \frac{dy}{(y-2040)} = \int -0.025 dt$$

$$\int \frac{dy}{(y-2040)} = -0.025 \int dt; \ln(y-2040) = -0.025t + C$$

$$y-2040 = e^{-0.025t+C}; y-2040 = e^{-0.025t} e^C$$

$$y-2040 = e^{-0.025t} \cdot y_0; y-2040 = y_0 e^{-0.025t}$$

$$y = y_0 e^{-0.025t} + 2040; \text{Initially, when } t=1, y=150 \text{ lb}$$

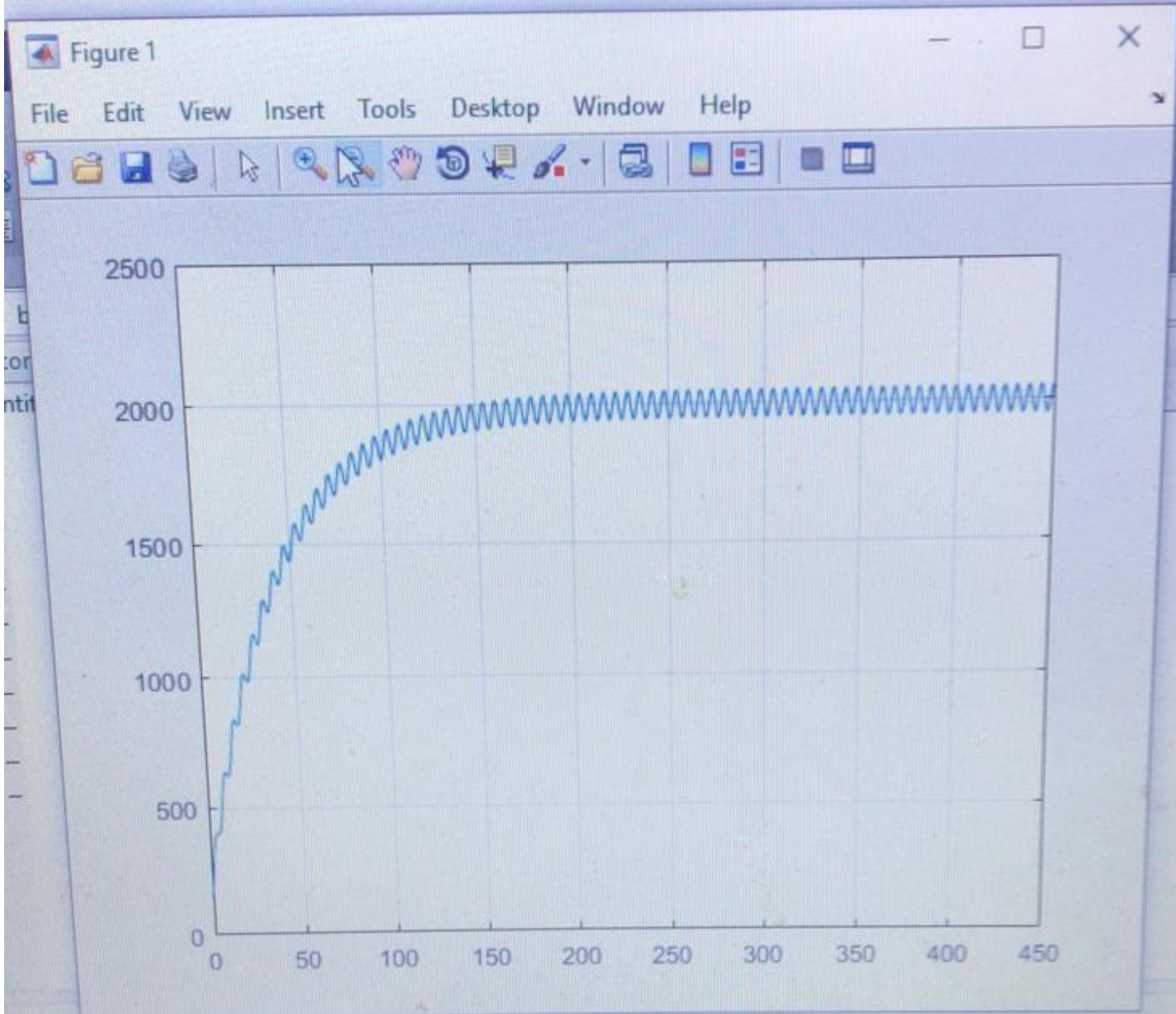
$$150 = y_0 e^{-0.025t} + 2040; 150 - 2040 = y_0 \times 1$$

$$y_0 = -1890$$

50;

$$y = -1890 e^{-0.025t} + 2040$$

$$y = 2040 - 1890 e^{-0.025t}$$



command window  
 column 504

450.0000

tn =

```
[ 150, 2000 - (2000*1601^(1/2)*cos(atan(1/40) + 1/2))/1601 - (2881850*exp(-1/80))/1601
>>
<
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Untitled3.m x +

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

Command Window

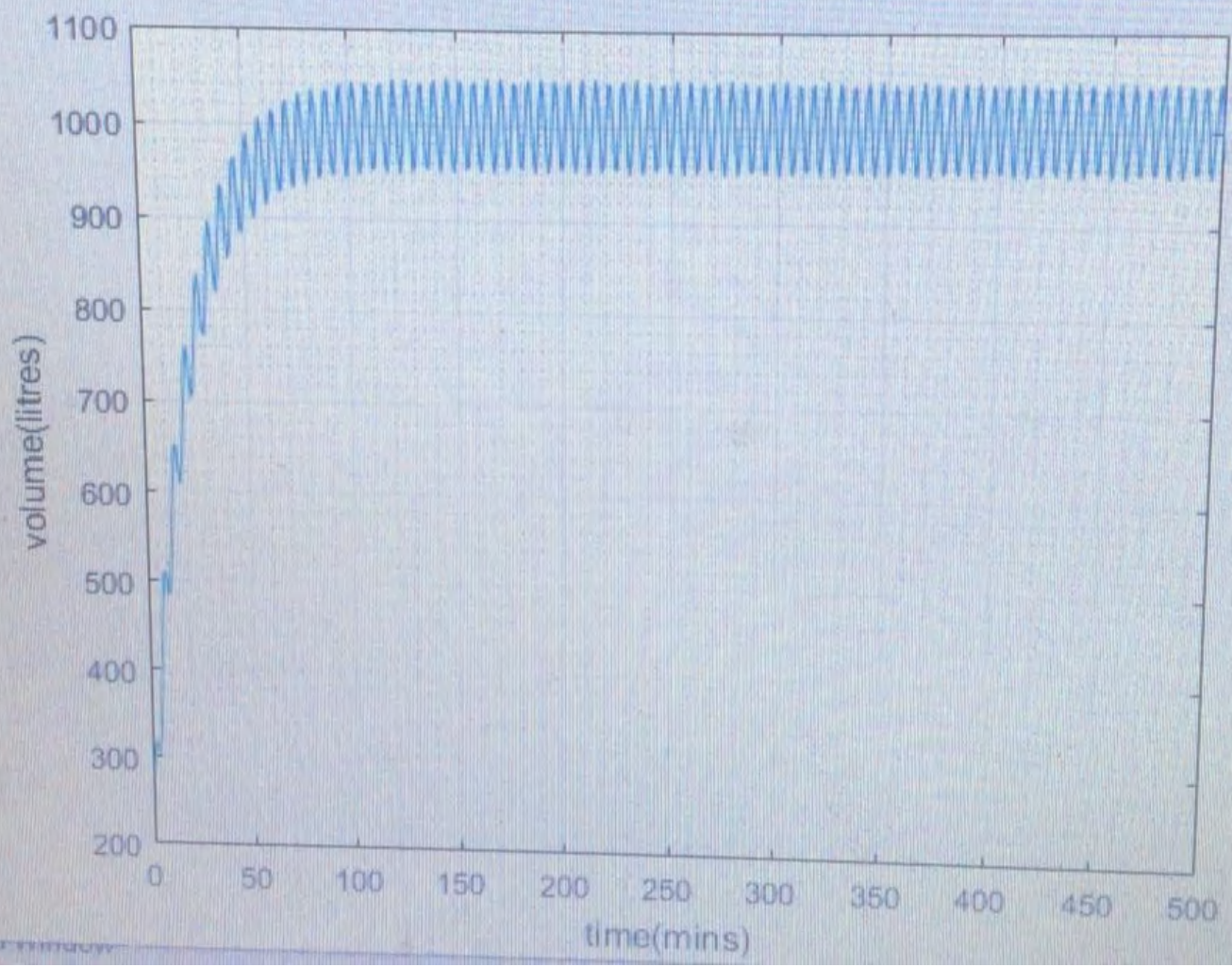

450.0000

tn =

[ 150, 2000 - (2000\*1601^(1/2)\*cos(atan(1/40) + 1/2))/1601 - (2881

Figure 1

File Edit View Insert Tools Desktop Window Help



```

1 -  commandwindow
2 -  clear
3 -  clc
4 -  close all
5 -  syms t
6 -  values=[]
7 -  t=1:1:500
8 -  mean=1000-((exp(-0.05*t))*800)
9 -  y=1000+(50/1.0025)*sin(t)+(2.5/1.0025)*cos(t)-((exp(-0.05*t)))*802.49
10
11 -  if rem(t,2) ==0
12 -      values=[values,mean]
13 -  else
14 -      values=[values,y]
15 -  end
16 -  excelvalues=transpose(values)
17 -  mins=transpose(t)
18 -  plot(t,values)
19 -  grid on
20 -  grid minor
21 -  xlabel ('time (mins)')
22 -  ylabel ('volume (litres)')
23 -  xlswrite('odevbesdata.xlsx',{'t (min)'},'veriler','A1')
24 -  xlswrite('odevbesdata.xlsx',mins,'veriler','A2')
25 -  xlswrite('odevbesdata.xlsx',{'V (litre)'},'veriler','B1')
26 -  xlswrite('odevbesdata.xlsx',excelvalues,'veriler','B2')

```

Command Window