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18/ENGD3/047

CNIL ENGINEERING

1. Recall from the balance law,
Accumulation Rate of salt inside tank = Input rate of salt into tank - Output rate of salt out of tank

$$\frac{dA}{dt} = \text{Input rate} - \text{Output rate} \dots (1)$$

$$\begin{aligned} \text{Input rate} &= 50 \text{ gal/min} \times (1 + \sin t) \text{ lbs/gal} \\ &= 50(1 + \sin t) \text{ lbs/min} \dots (2) \end{aligned}$$

$$\text{Output rate} = \frac{30 \text{ gal}}{1200 \text{ gal}} \times 100 = 2.5\% \text{ of } m \dots (3)$$

Substituting equations (2) and (3) in (1)

$$\frac{dA}{dt} = 50(1 + \sin t) - \frac{2.5}{100} \times m$$

$$= 50(1 + \sin t) - 0.025m$$

$$\frac{dm}{dt} = 50(1 + \sin t) - \frac{m}{40}$$

$$(4) \text{ is } \frac{dm}{dt} + \frac{m}{40} = 50(1 + \sin t) \dots (4)$$

(5) Solve using Integrating factor, (4)

$$\frac{dy}{dx} + P_y = Q = S$$

comparing coefficients in (4) and (5),

$$P = \frac{1}{40}, \quad Q = 50(1 + \sin t)$$

$$\begin{aligned} I.F. &= e^{\int P dt}, \quad \int P dt = \int \frac{1}{40} dt \\ &= \frac{t}{40} \end{aligned}$$

$$\therefore IF = e^{t/40}$$

$$n. IF = \int Q \cdot IF dt$$

$$n e^{t/40} = \int 50 e^{t/40} (1 + \sin t) dt \quad \dots (6)$$

Solving RHS

$$50 \int e^{t/40} (1 + \sin t) dt \quad \dots (7)$$

$$let \ t/40 = u; \ t = 40u$$

$$\frac{du}{dt} = 1/40$$

$$dt = 40 du$$

substitute for dt in (7)

$$2000 \int e^u (1 + \sin 40u) du$$

Integrating by parts,

$$\int u dv = uv - \int v du$$

$$making \ u = \sin 40u, \ dv = e^u$$

$$du = 40 \cos 40u, \ v = e^u$$

$$= 2000 [e^u (\sin 40u + 1) - \int 40 e^u \cos 40u \cdot du] \quad \dots (8)$$

Solving for $\int e^u \cos 40u \cdot du$

Integrating by part,

$$\int u dv = uv - \int v du$$

$$= e^u \cos 40u - (-40 e^u \sin 40u - \int -6000 e^u \cos 40u)$$

$$= e^u \cos 40u - (-40 e^u \sin 40u + 6000 \int e^u \cos 40u)$$

solving for $\int e^u \cos 40u \cdot du$ the second time,

$$= 40 e^u \sin 40u + e^u \cos 40u$$

1601

Remember,

$$\int e^u \cos 40u \cdot du = eqn (2)$$

$$\text{therefore, } = 40 [40 e^u \sin 40u + e^u \cos 40u]$$

IMPORT VIEW

Range: A2:B501

Output Type:

Table

Text Options

Replace unimportable cells with NaN



SELECTION

IMPORTED DATA

UNIMPORTABLE CELLS

IMPORT

onlinequizdata.xlsx.xlsx

odevbesdata.xlsx

	A	B
	odevbesdata	
	t(minutes)	volumelitres
	Number	Number
1	t(minutes)	volume(litres)
2	1	279.9639
3	2	318.1907
4	3	313.8601
5	4	303.6010
6	5	327.9009
7	6	393.9593
8	7	469.1423
9	8	511.0566
10	9	506.5922
11	10	484.0395
12	11	487.1398
13	12	534.9268
14	13	604.2824
15	14	651.2431
16	15	651.4694
17	16	622.6706
18	17	608.3676
19	18	637.9229
20	19	699.5850
21	20	751.3315
22	21	759.5410

Veriler

substituting in (8)

$$= 2000 \left[e^{t/40} (\sin 40t + 1) - 40 \left(\frac{40e^{t/40} \sin 40t + e^{t/40} \cos 40t}{1601} \right) \right]$$

recall, $u = t/40$

$$= 2000 e^{t/40} (\sin t + 1) - 80000 \left(\frac{40 e^{t/40} \sin t + e^{t/40} \cos t}{1601} \right)$$

$$= 2000 e^{t/40} (\sin t + 1) - \frac{80000}{1601} (40 e^{t/40} \sin t + e^{t/40} \cos t)$$

$$= 2000 e^{t/40} \left[(\sin t + 1) - 40 \left(\frac{40 \sin t + \cos t}{1601} \right) \right] + C$$

$$= 2000 e^{t/40} \left[(\sin t + 1) - \frac{1600 \sin t + \cos t}{1601} \right] + C$$

$$= 2000 e^{t/40} \left(\frac{1601 \sin t - 1600 \sin t - \cos t + 1601}{1601} \right) + C$$

$$= \frac{2000 e^{t/40}}{1601} (\sin t - \cos t + 1601) + C$$

Substituting back into (6)

$$n(t) = \frac{2000 e^{t/40}}{1601} (\sin t - \cos t + 1601) + C$$

$$n(t) = \frac{2000}{1601} (\sin t - \cos t + 1601) + \frac{C}{e^{t/40}}$$

n is a function of t , and recall there is 150 lb of salt with a time rate of 0 min.

$$n(0) = \frac{2000}{1601} (\sin(0) - \cos(0) + 1601) + \frac{C}{e^{-t/40}}$$

$$150 = \frac{2000 \times 1561}{1601} + C$$

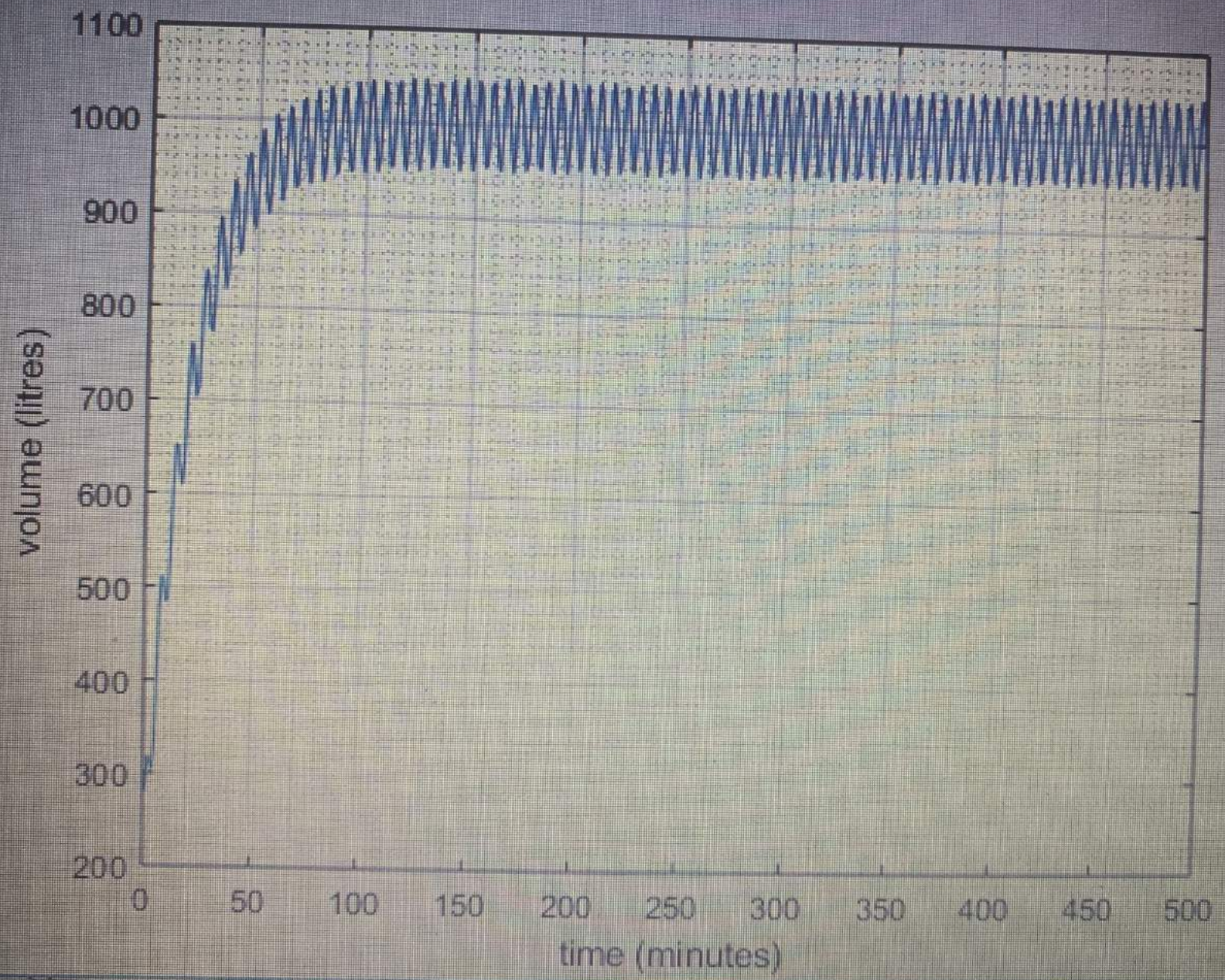
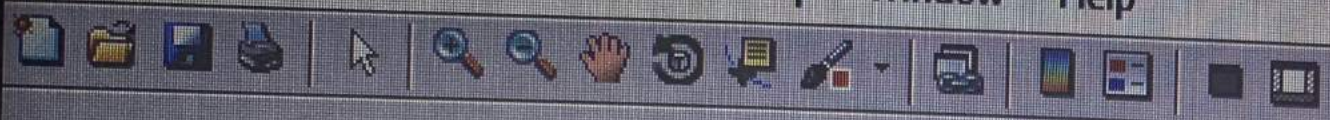
$$C \approx 150 - 1950.03$$

$$C \approx -1800.03$$

```
1 -   commandwindow
2 -   clear
3 -   clc
4 -   close all
5
6 -   syms s
7
8 -   x = []
9 -   s = 1:1:500
10 -  y1 = 1000 - ((exp(-0.05*s))*800)
11 -  y = 1000 + (50/1.0025)*sin(s) + (2.5/1.0025)*cos(s) - ((exp(-0.05*s))*802.49)
12 -  if rem(s,2) == 0
13 -      x = [x, y1]
14 -  else
15 -      x = [x, y]
16 -  end
17 -  MATHQ = transpose(x)
18 -  mins = transpose(s)
19 -  plot(s, x)
20 -  grid minor
21 -  grid on
22
23 -  xlabel('time (minutes)')
24 -  ylabel('volume (litres)')
25 -  xlswrite('odevbesdata.xlsx', {'t (minutes)', 'Veriler', 'A1'})
26 -  xlswrite('odevbesdata.xlsx', mins, 'Veriler', 'A2')
27 -  xlswrite('odevbesdata.xlsx', {'volume (litres)', 'Veriler', 'B1'})
28 -  xlswrite('odevbesdata.xlsx', MATHQ, 'Veriler', 'B2')
```

29

30



```
command  
clear  
clc  
close a
```

```
syms s
```

```
x = []  
s = 1:1  
yl = 10  
y = 100  
if rem(  
    x =  
else  
    x =  
end  
MATHQ =  
mins = t  
plot(s,  
grid min  
grid on
```

```
xlabel(''  
ylabel(''
```

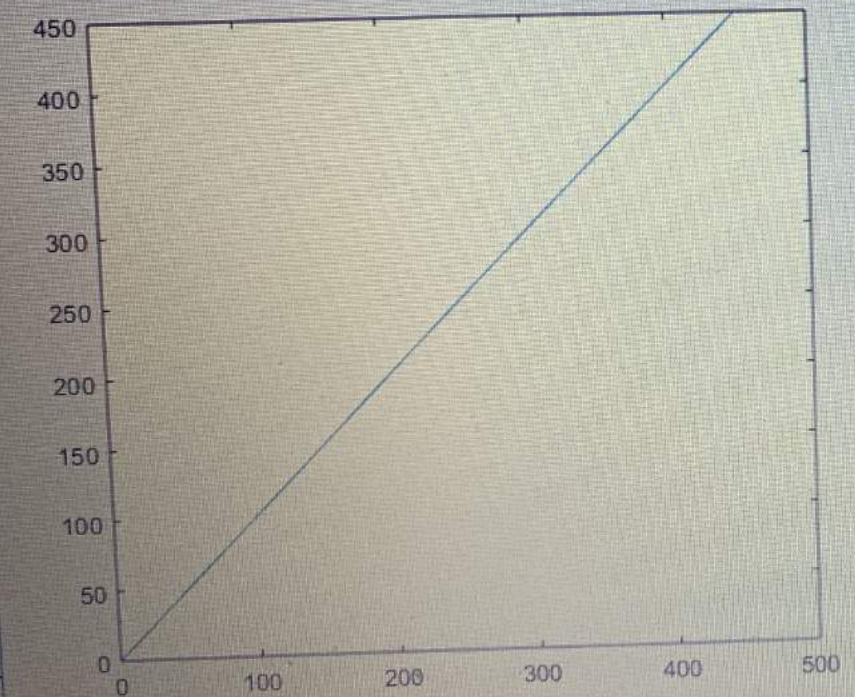
```
xlswrite  
xlswrite
```

C:\Program Files\MATLAB\R2018a\bin

Folder
Name
MAIHIES1.m

Figure 1

File Edit View Insert Tools Desktop Window Help



Editor - C:\Program Files\MATLAB\R2018a\bin\number1c.m

BABA3.m x MATHTEST.m x number1c.m x +

```
1 - commandwindow
2 - clear
3 - clc
4 - close all
5 - syms m(t)
6
7 - eqn = diff (m, t) == (50 * (1 + sin(t))) - (0.025 * m);
8 - s = dsolve (eqn)
9 - tn = 0:0.5:450
10 - sn = subs (tn, s)
11 - plot (tn,sn)
```

Command Window

```
448      448.5      449      449.5      450
sn =
[ 0, 1/2, 1, 3/2, 2, 5/2, 3, 7/2, 4, 9/2, 5, 11/2, 6, 13/2, 7, 15/2, 8, 17/2, 9,
```

>>
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