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MATRIC NO: 19/ ENG01/020

DEPARTMENT: CHEMICAL

COURSE CODE: ENG 282

Assignment 5

Question 1

Accumulator rate = Input rate − Output rate.

$\frac{dm}{dt} = m_{in} - m_{out}$.

$m_{in} = \frac{(1+\sin t)\ lb}{gallons} \times \frac{50\ gallons}{min} = 50(1+\sin t)\ \frac{lb}{min}$

$m_{out} = \frac{80\ gals}{1200\ gals} = 0.025$ water runs out hence 0.025 salt runs out.

$= 0.025m$.

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

$\frac{dm}{dt} + 0.025m = 50(1+\sin t)$

Comparing to $\frac{dy}{dx} + Py = Q$

$dy = dm$, $dt = dx$, $Py = 0.025m$, $Q = 50(1+\sin t)$,

Hence

$m \cdot IF = \int Q \cdot IF\ dt$ where $IF = e^{\int P dx}$;

$\int P\ dt = \int 0.025\ dt = 0.025t$.

$I.F = e^{0.025t}$.

Integrating

$m \cdot e^{0.025t} = \int 50(1+\sin t) \cdot e^{0.025t}\ dt$.

$m e^{0.025t} = 50\int (e^{0.025t} + e^{0.025t}\sin t)\ dt$.

$m \cdot e^{0.025t} = 50\left\{\left[\frac{e^{0.025t}}{0.025}\right] + \int e^{0.025}\sin t\ dt\right\}$ → (8)

$\int e^{0.025t}\sin t\ dt = uv - \int v\ du$.

$u = e^{0.025t}$ $dv = \sin t$

$du = 0.025e^{0.025t}$ $v = -\cos t$

$\int e^{0.025t}\sin t\ dt = -e^{0.025t}\cos t + 0.025\int e^{0.025t}\cos t$ → (1)

Integrating a second time.

$\int e^{0.025t}\cdot\cos t = uv - \int v\ du$.

$u = e^{0.025t}$ $dv = \cos t$

$du = 0.025e^{0.025t}$ $v = \sin t$.

$\int e^{0.025t}\cdot\cos t = e^{0.025t}\cdot\sin t - \int \sin t \cdot 0.025e^{0.025t}$

$\int e^{0.025t}\cdot\cos t = e^{0.025t}\cdot\sin t - 0.025\int e^{0.025t}\cdot\sin t\ dt$ → (2)

Substituting (2) in (1)

$\int e^{0.025t}\sin t\ dt = -e^{0.025t}\cos t + 0.025\left\{e^{0.025t}\cdot\sin t - 0.025\int e^{0.025t}\sin t\ dt\right\}$.

$\int e^{0.025t}\cdot\sin t\ dt = -e^{0.025t}\cos t + 0.025e^{0.025t}\sin t - 6.25\times10^{-4}\int e^{0.025}\sin t\ dt$

(3) (5)

Grouping like terms (a) and (b).

$1.000625\int e^{0.025t}\cdot\sin t\ dt = -e^{0.025t}\cos t + 0.025e^{0.025t}\sin t$.

$1.000625\int e^{0.025t}\cdot\sin t\ dt = e^{0.025t}\{-\cos t + 0.025\sin t\}$.

$\int e^{0.025t}\cdot\sin t\ dt = \frac{e^{0.025t}}{1.000625}\{0.025\sin t - \cos t\}$ → (5)

Returning to eqn 8 and substituting (3) in 8

$m \cdot e^{0.025t} = 50\left\{\frac{e^{0.025t}}{0.025} + \frac{e^{0.025t}}{1.000625}\{0.025\sin t - \cos t\} + c\right\}$

$m \cdot e^{0.025t} = \frac{50e^{0.025t}}{0.025} + \frac{50e^{0.025t}}{1.000625}\{0.025\sin t - \cos t\} + 50c$

$m = 2000 + 49.689\{0.025\sin t - \cos t\} + \frac{50c}{e^{0.025t}}$

Recall that $m\cos 5 = 150$

Hence

$150 = 2000 + 49.96\left\{\int 0.025\sin(0)\cos(0) - \int \cos(0)\right\} + \frac{50c}{e^{0.025\cos 5}}$

$150 = 2000 + 49.969\{-1\} + 50c$

$150 = 1950.031 + 50c$

$c = \frac{-1950.031 + 150}{50} = \frac{-1800}{50}$

$c = -36.00062$

Hence the model equation =

$m = 2000 + \frac{50}{1.000625}\{0.025\sin t - \cos t\} - \frac{1800.031}{e^{0.025t}}$

Final Ans

$m = 2000 + \frac{50}{1.000625}\{0.025\sin t - \cos t\} - \frac{1800.031}{e^{0.025t}}$

$m = 2000 + 1.249\sin t - 50\cos t - 1800e^{-0.025t}$

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```
1  -    commandwindow
2  -    clear
3  -    clc
4  -    close all
5  -    syms t
6  -    M=dsolve('Dm+(0.025*m)=50*(1+sin(t))','m(0)=150')
7  -    M1=simplify(M)
8  -    t=0:0.5:450;
9  -    Mn=subs(M,t);
10 -    plot(t,Mn)
11 -    grid on
12 -    grid minor
13 -    xlabel('Time(min)')
14 -    ylabel('Amount of salt in the tank(lb)')
15
```


Command Window

```
M =

2000 - (2000*1601^(1/2)*cos(t + atan(1/40)))/1601 - (2881850*exp(-t/40))/1601


M1 =

2000 - (2000*1601^(1/2)*cos(t + atan(1/40)))/1601 - (2881850*exp(-t/40))/1601

fx >>
```

Workspace

Name	Value	
M	1x1 sym	sym
M1	1x1 sym	sym
Mn	1x901 sym	sym
t	1x901 double	doul

Figure 1

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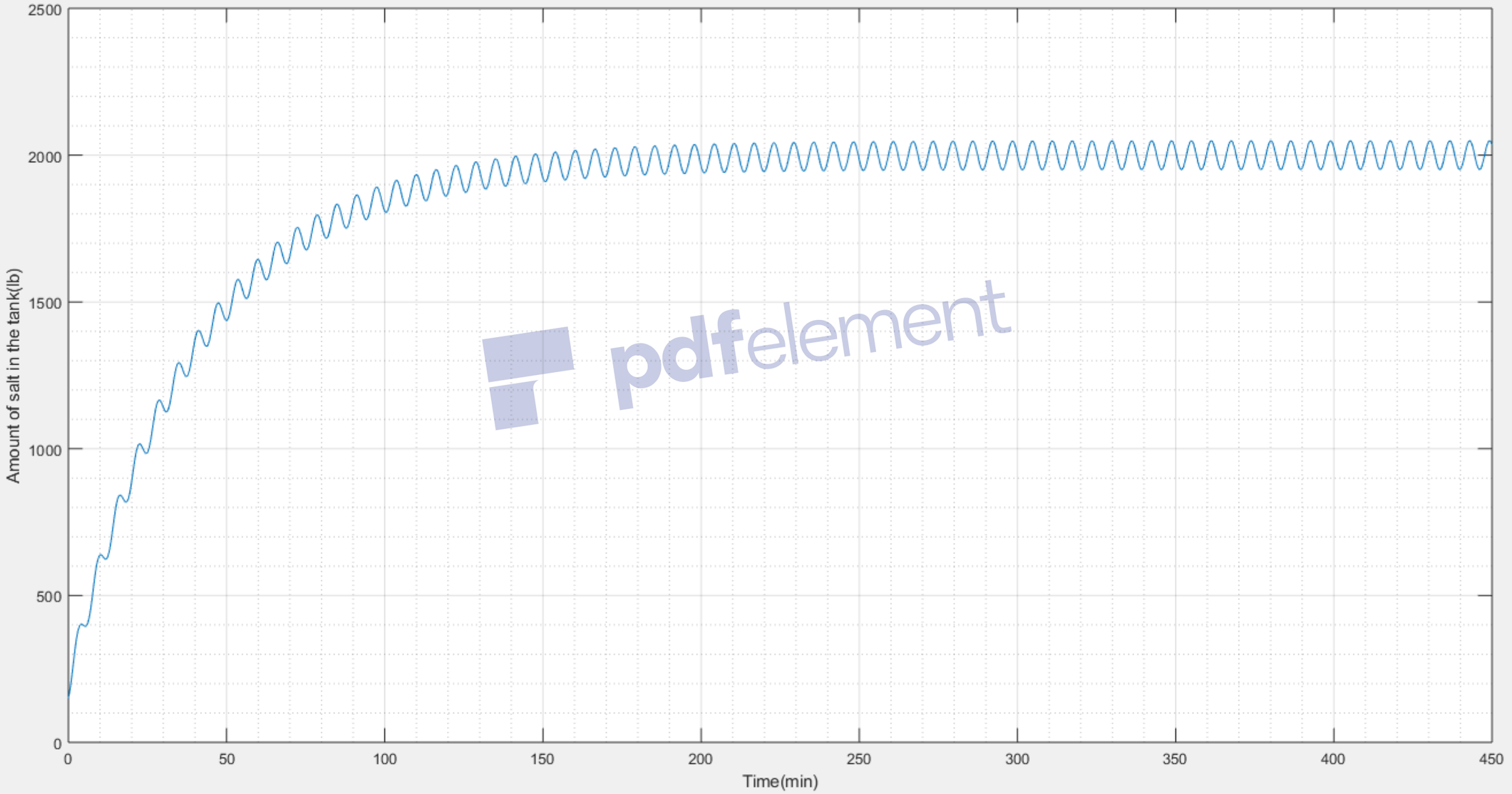

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```
commandwindow
clear
clc
close all
t1=1:2:500;
t2=0:2:500;
y1=(50/0.05)+((50*sin(t1))/1.0025)+((50*0.05*cos(t1))/1.0025)-(802.49*exp(-0.05*t1));
ym1=1000-(800*exp(-0.05*t2));
xcom=[t1,t2];
ycom=[y1,ym1];
plot(xcom,ycom)
grid on
grid minor
xlabel('time(min)')
ylabel('Volume(litre)')
heading1={'t(mins)'}
heading2={'V(litres)'}
xlswrite('odevbesdata.xlsx',[xcom(:),ycom(:)],'veriler','A2')
xlswrite('odevbesdata.xlsx',heading1,'veriler','A1')
xlswrite('odevbesdata.xlsx',heading2,'veriler','B1')

```


Command Window