ALE-ALABA OLUWASEUN 19/ENG06/064 MECHANICAL

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MATRIC NUMBER; 19/ENG06/064
DEPT; MECHANICAL
COURSE; ENG 282 [MATHEMATICS]

Question 1

Total number of gallons = 1200 gal
Initially = 150 lb of salt
1 gal of brine contains $[1 + \sin t]$ lb
50 gal of brine enters per minute
Outflow rate = 30 gal/minute

Accumulation rate of salt within a system = Input rate of salt into the system − Output rate of salt from the system

$\frac{dm}{dt}$ → amount of salt in tank at ~~a particular~~ per minute

Input rate of salt = $50[1 + \sin t]$ lb/min

Output rate of salt = $\frac{30}{1200} \times m$

$$\frac{dm}{dt} = 50(1 + \sin t) - \frac{30}{1200} \times m$$

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

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

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$$\frac{dM}{dt} + \frac{M}{40} = 50(1 + \sin t)$$

Solving the equation by using integrating factor

$$\frac{dM}{dt} + PM = Q$$

$$I.F = e^{\int P\,dt}$$

$$I.f = e^{\int \frac{1}{40}\,dt} = e^{\frac{1}{40}t}$$

$$M \cdot IF = \int Q \cdot IF$$

$$M \times e^{\frac{1}{40}t} = 50\int (1 + \sin t)\left(e^{\frac{1}{40}t}\right)$$

Integrating the R.H.S

$$50\int e^{\frac{1}{40}t} + (\sin t)\left(e^{\frac{1}{40}t}\right)$$

$$= 50\int e^{\frac{1}{40}t} + 50\int (\sin t)\left(e^{\frac{1}{40}t}\right)$$

Integrating $\int 50e^{\frac{1}{40}t} = \dfrac{50 \times e^{\frac{1}{40}t}}{\frac{1}{40}}$

$$= 2000e^{\frac{1}{40}t}$$

Integrating

$$50\int (\sin t)\left(e^{\frac{1}{40}t}\right)$$

Using integration by parts

$u = \sin t$ & $dv = e^{\frac{1}{40}t}$

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$u = \sin t$ & $dv = e^{\frac{1}{40}t}$

$\frac{du}{dt} = \cos t$ $\quad v = \int e^{\frac{1}{40}t} = 40e^{\frac{1}{40}t}$

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

$\int \sin t \cdot e^{\frac{1}{40}t} = (\sin t)(40e^{\frac{1}{40}t}) - \int (40e^{\frac{1}{40}t})(\cos t)$

Still integrating using integration by parts

$u = \cos t$ $\quad dv = e^{\frac{1}{40}t}$

$\frac{du}{dt} = -\sin t$ $\quad v = 40e^{\frac{1}{40}t}$

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

let $\int e^{\frac{1}{40}t} \cdot \sin(t) = I$

$I = (\sin t)(40e^{\frac{1}{40}t}) - 40((\cos t)(40e^{\frac{1}{40}t})) - 1600I$

$I + 1600I = (\sin t)(40e^{\frac{1}{40}t}) - 1600[\cos(t) \cdot e^{\frac{1}{40}t}]$

$1601I = (\sin t)(40e^{\frac{1}{40}t}) - 1600[\cos(t) \cdot e^{\frac{1}{40}t}]$

$I = \dfrac{40(\sin t)(e^{\frac{1}{40}t}) - 1600[\cos(t) \cdot e^{\frac{1}{40}t}]}{1601}$

$\therefore 50I = \dfrac{2000(\sin t)(e^{\frac{1}{40}t}) - 80000[\cos(t) \cdot e^{\frac{1}{40}t}]}{1601}$

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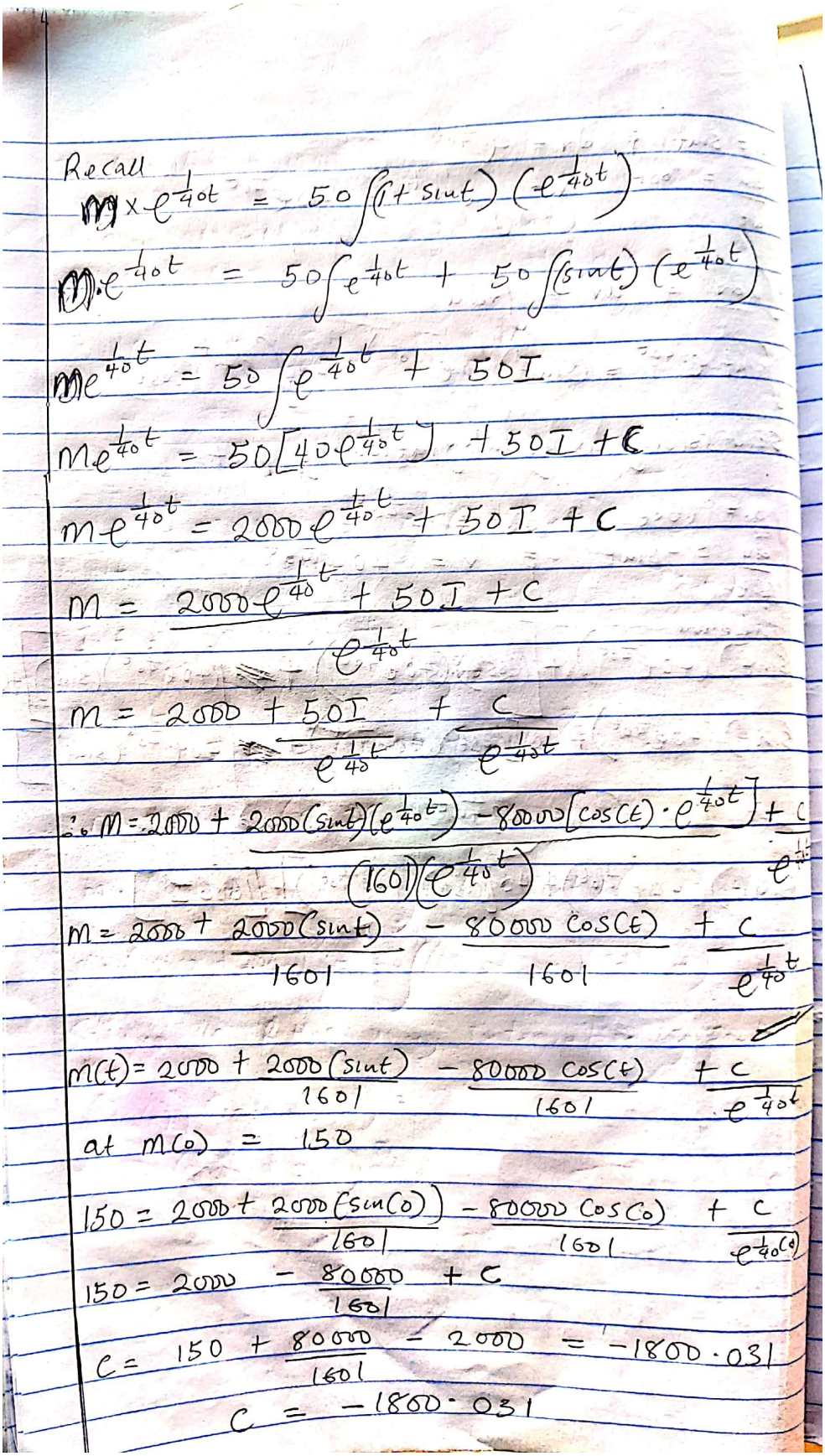

Recall

$$m \times e^{\frac{1}{40}t} = 50\int (1+\sin t)\left(e^{\frac{1}{40}t}\right)$$

$$m.e^{\frac{1}{40}t} = 50\int e^{\frac{1}{40}t} + 50\int (\sin t)\left(e^{\frac{1}{40}t}\right)$$

$$me^{\frac{1}{40}t} = 50\int e^{\frac{1}{40}t} + 50I$$

$$me^{\frac{1}{40}t} = 50\left[40e^{\frac{1}{40}t}\right] + 50I + C$$

$$me^{\frac{1}{40}t} = 2000e^{\frac{1}{40}t} + 50I + C$$

$$m = \frac{2000e^{\frac{1}{40}t} + 50I + C}{e^{\frac{1}{40}t}}$$

$$m = 2000 + \frac{50I}{e^{\frac{1}{40}t}} + \frac{C}{e^{\frac{1}{40}t}}$$

$$\therefore m = 2000 + \frac{2000(\sin t)(e^{\frac{1}{40}t}) - 80000[\cos(t)\cdot e^{\frac{1}{40}t}]}{(1601)(e^{\frac{1}{40}t})} + \frac{C}{e^{\frac{1}{40}t}}$$

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

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

at $m(0) = 150$

$$150 = 2000 + \frac{2000(\sin(0))}{1601} - \frac{80000\cos(0)}{1601} + \frac{C}{e^{\frac{1}{40}(0)}}$$

$$150 = 2000 - \frac{80000}{1601} + C$$

$$C = 150 + \frac{80000}{1601} - 2000 = -1800.031$$

$$C = -1800.031$$

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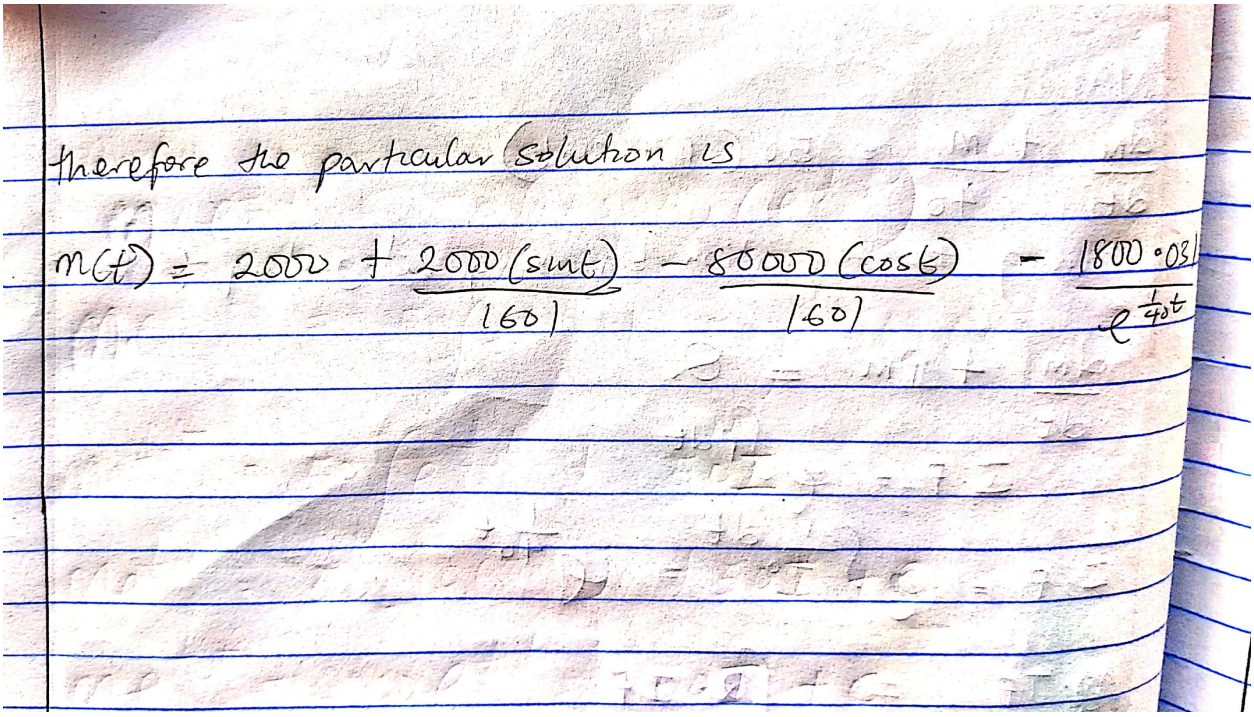

pls check below for the matlab code

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```
%NAME; ALE-ALABA OLUWASEUN OLUMIDE
%MATRIC NUMBER; 19/ENG06/064
%DEPT; MECHANICAL
%COURSE; ENG282 (ENGINEERING MATHEMAICS)
commandwindow
clc
clear
close all
syms t
diffEqua = 'Dm + 0.025*m == 50*(1+sin(t))'
answer = dsolve(diffEqua,'m(0)=150')
pretty(answer)
tn=0:0.5:450
yValue = subs(answer,tn)
plot(tn, yValue)
grid on
grid minor
xlabel('Time(min)')
ylabel('quantity of salt')
```

Command Window

```
diffEqua =

    'Dm + 0.025*m == 50*(1+sin(t))'


answer =

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

                      /        /  1 \ \     /   t \
      2000 sqrt(1601) cos| t + atan| -- | |   exp| - -- | 2881850
                      \        \ 40 / /     \   40 /
2000 - ------------------------------------ - ------------------
                     1601                         1601
```

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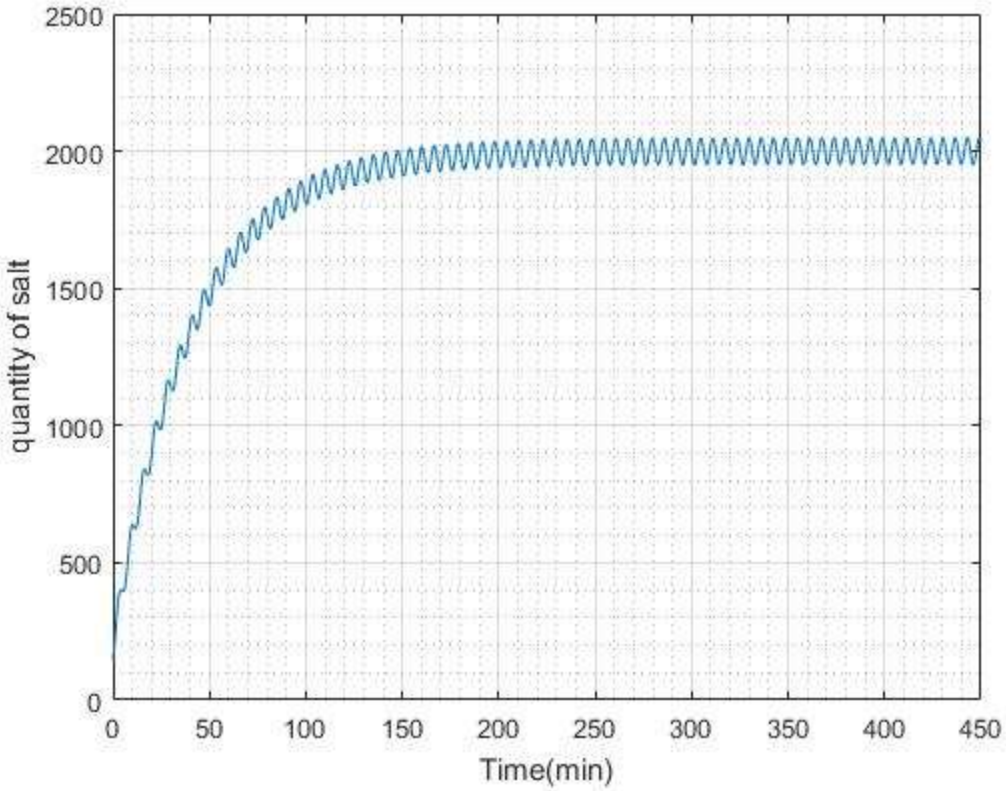

Pls scroll down for number 2

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QUESTION 2:

Editor - C:\Users\ALE\Desktop\Excel and Matlab\asg5.m

+25 | MATEXCEL1.m | quizz.m | contatenationOfMatrices.m | mex.bat | quiz2.m | Untitled.m | differentiation.m | asg5.m

```
1 -  commandwindow
2 -  clear
3 -  clc
4 -  close all
5 -  syms t
6 -  format short
7    %note matlab is calculating in radians for trig functions
8 -  y = (50/0.05)+((50*sin(t))/1.0025)+(((50*(0.05)*cos(t))/1.0025))-(802.49*exp(-0.05*t))
9 -  ym = 1000-(800*exp(-0.05*t))
10 - tOdd=1:2:500
11 - tEven=2:2:500
12 - yn=double(subs(y,tOdd))
13 - ymn=double(subs(ym,tEven))
14 - totalTime = 1:1:500 % since 0 is neither even nor odd
15 - timeTranspose = totalTime'
16 - combine = reshape([yn; ymn],[],1)
17 - values = combine
18 - combinedValues=double(values)
19 - plot(totalTime,values)
20 - grid on, grid minor
21 - legend({'Single Curve for mean and dynamic model'}, 'Location', 'southwest')
22 - xlabel('t(min)'), ylabel('V(litre)')
23 - header = {'t(min)', 'V(Litre)'}
24 - xlswrite('C:\Users\ALE\Desktop\Excel and Matlab\odevbesdata.xlsx',header,'veriler','A1')
25 - xlswrite('C:\Users\ALE\Desktop\Excel and Matlab\odevbesdata.xlsx',timeTranspose,'veriler','A2')
26 - xlswrite('C:\Users\ALE\Desktop\Excel and Matlab\odevbesdata.xlsx',combinedValues,'veriler','B2')
27
```

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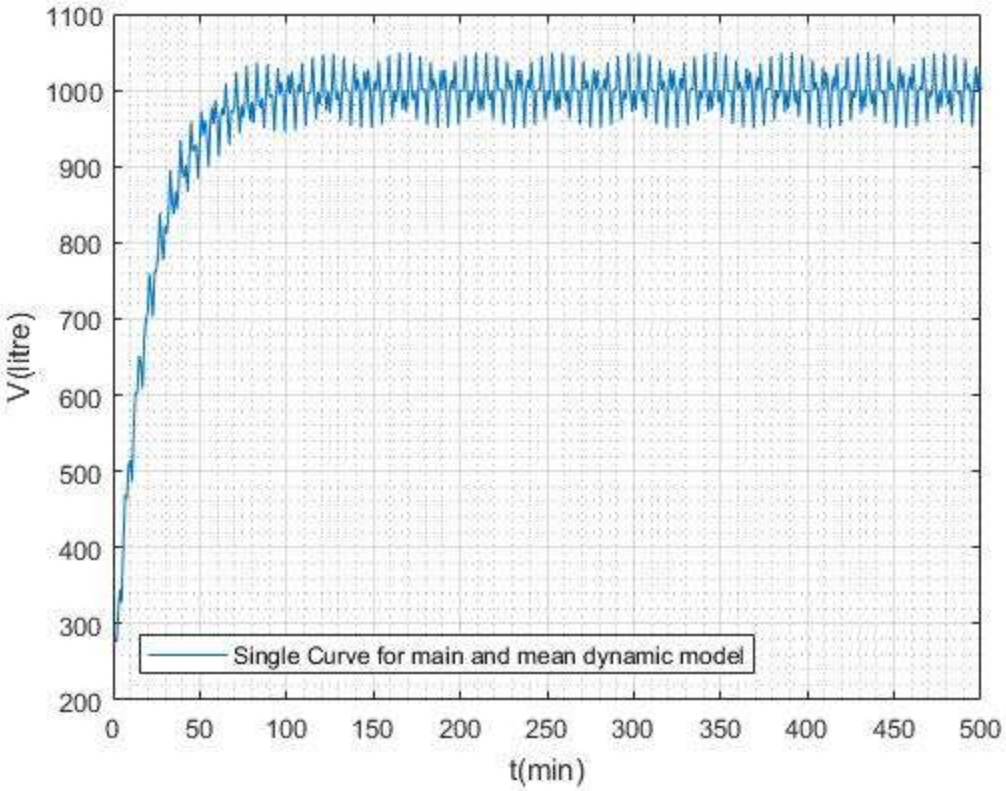

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	t(min)	V(Litre)													
2	1	279.9639													
3	2	276.1301													
4	3	313.8601													
5	4	345.0154													
6	5	327.9009													
7	6	407.3454													
8	7	469.1423													
9	8	463.744													
10	9	506.5922													
11	10	514.7755													
12	11	487.1398													
13	12	560.9507													
14	13	604.2824													
15	14	602.7318													
16	15	651.4694													
17	16	640.5368													
18	17	608.3676													
19	18	674.7443													
20	19	699.585													
21	20	705.6964													
22	21	759.541													
23	22	733.7031													

veriler

Enter

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Question 1

Considering Inflow and Outflow rates

Total gallons = 1200

$M(0) = 150$

Inflow of Salt = $50(1 + \sin t)$

Since outflow and Inflow rate are not the same

$\therefore$

$$\text{Outflow} = \frac{30}{1200 + (50-30)t} \times M$$

$$= \frac{30M}{1200 + 20t}$$

$$\frac{dm}{dt} + \frac{30M}{1200+20t} = 50(1+\sin t)$$

$$I.F = e^{\int \frac{30}{1200+20t}} = e^{\frac{30}{20}\ln(1200+20t)}$$

$$I.F = e^{\ln(1200+20t)^{3/2}}$$

$$I.F = (1200 + 20t)^{3/2}$$

$$M \cdot IF = \int Q \cdot IF$$

$$M \cdot (1200+20t)^{3/2} = \int 50(1+\sin t)(1200+20t)^{3/2}$$

$$M \cdot (1200+20t)^{3/2} = 50\int (1200+20t)^{3/2} + (\sin t)(1200+20t)^{3/2}$$

Solving the R.H.S using integration by parts that is

$$50\int (\sin(t))(1200+20t)^{3/2}$$

$u = (1200+20t)^{3/2}$

$dv = \sin(t)$

$\frac{du}{dt} = 30(1200+20t)^{1/2}$

$v = -\cos(t)$

$$(1200+20t)^{3/2}(-\cos t) - \int (-\cos t)(30(1200+20t)^{1/2})$$

The integration goes on and on

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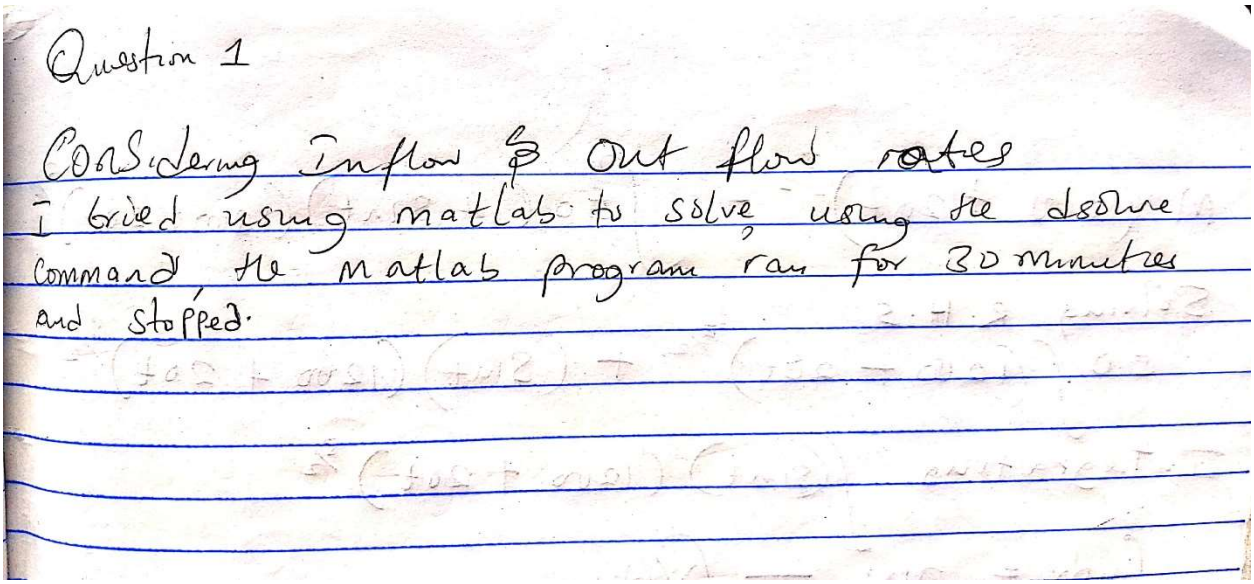

Question 1

Considering Inflow & Out flow rates
I tried using matlab to solve using the dsolve command, the matlab program ran for 30 minutes and stopped.