NAME: ABUBAKAR HANNY OSHIOZOKHAI

MAT NO: 18/ENG05/003

DEPT: MECHATRONICS

COURSE CODE: ENG 282

1a.

1a) Recall from the balance law,

Accumulation Rate of salt inside tank = Input rate of salt into tank − Output rate of salt out of tank

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

$$\text{Input rate} = 50\ \text{gal/min} \times (1 + \sin t)\ \text{lbs/gal}$$
$$= 50(1 + \sin t)\ \text{lbs/min} \quad \text{——— (2)}$$

$$\text{Output rate} = \frac{30\ \text{gal}}{120\ \text{gal}} \times 100 = 2.5\%\ \text{of } n \quad \text{——— (3)}$$

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

$$\frac{dA}{dt} = 50(1 + \sin t) - \frac{2.5}{100} \times n$$
$$= 50(1 + \sin t) - 0.025n$$
$$\frac{dA}{dt} = 50(1 + \sin t) - n/40$$

a) (i) $$\frac{dA}{dt} + n/40 = 50(1 + \sin t) \quad \text{——— (4)}$$

1b.

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ASSIGNMENT

1b) $\frac{dy}{dt} = y_{in} - y_{out}$ $\quad y = m$

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

$M_{out} = \frac{30 gal}{1200 gal} = 0.025m$

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

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

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

Using Integrating Factor Method

$P = 0.025 \quad \int P\,dt = 0.025t$

$\therefore IF = e^{0.025t}$

But $m(IF) = \int Q(IF)\,dt$

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

Using Integration by parts

where $u = 1+\sin t \quad du = \cos t$

$dv = e^{0.025t} \quad v = e^{0.025t}/0.025$

$\therefore m(e^{0.025t}) = 50\left[(1+\sin t)\left(\frac{e^{0.025t}}{0.025}\right) - \int \frac{e^{0.025t}}{0.025} \cdot \cos t \cdot dt\right]$

$m(e^{0.025t}) = 50\left[\frac{(1+\sin t)(e^{0.025t})}{0.025} - \frac{1}{0.025}\int e^{0.025t} \cdot \cos t \cdot dt\right]$

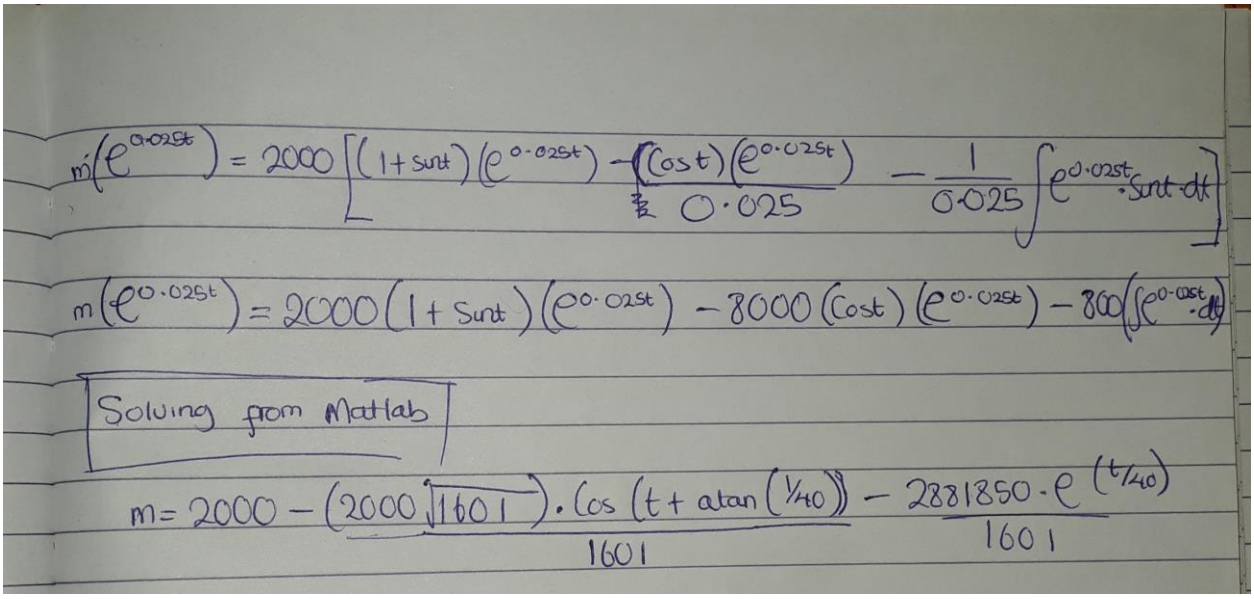
$m(e^{0.025t}) = 2000\left[(1+\sin t)(e^{0.025t}) - \int e^{0.025t} \cdot \cos t \cdot dt\right]$

Applying Integration by parts

$u = \cos t \quad du = -\sin t$

$dv = e^{0.025t} \quad v = e^{0.025t}/0.025$

$m(e^{0.025t}) = 2000\left[(1+\sin t)(e^{0.025t}) - \left[(\cos t)\left(\frac{e^{0.025t}}{0.025}\right) - \left[\frac{e^{0.025t}}{0.025}(-\sin t)\right]\right]\right.$



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- printsupport
- qtwebengine

Details

Workspace

Name	Value
A	1x901 sym
ans	1x1 sym
con	1x1 sym
eqn	1x1 symfun
m	1x1 symfun
t	1x901 double

Editor - C:\Users\Hanny Abubakar\Documents\MATLAB\bin\win64\newquiz.m

newquiz.m

```
1 -    commandwindow
2 -    clc
3 -    close all
4 -    syms m(t)
5 -    eqn = diff(m,t)+ 0.025 * m == 50 * (1 + sin(t))
6 -    con = m(0) == 150
7 -    ans = dsolve(eqn, con)
8 -    pretty(ans)
9 -    t = [0:0.5:450]
10 -   A = subs(ans)
11 -   plot(t,A)
12 -   xlabel('time(min)')
13 -   ylabel('amonut of salt')
14 -   grid on
15 -   grid minor
```

Command Window

```
con =

m(0) == 150


ans =

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

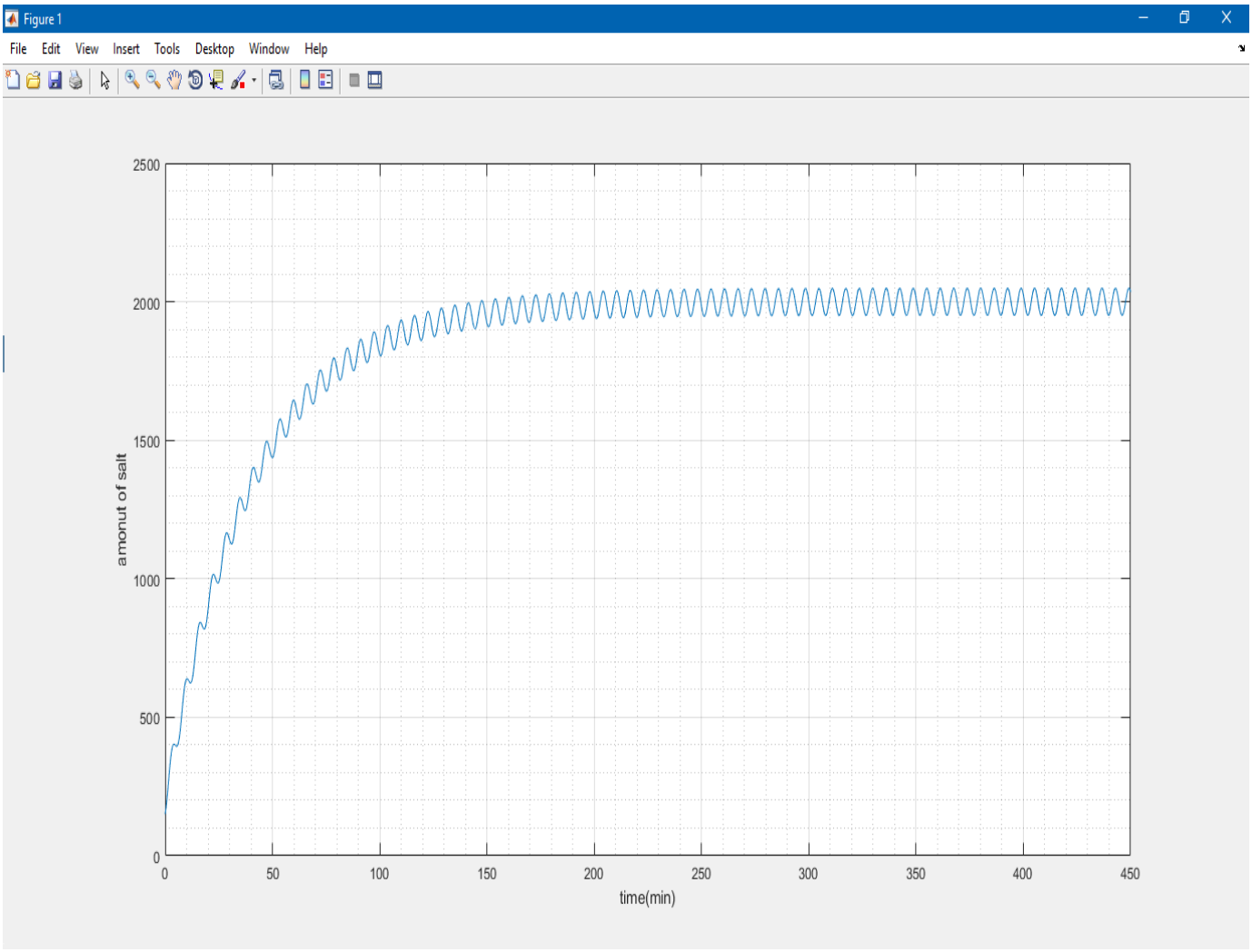
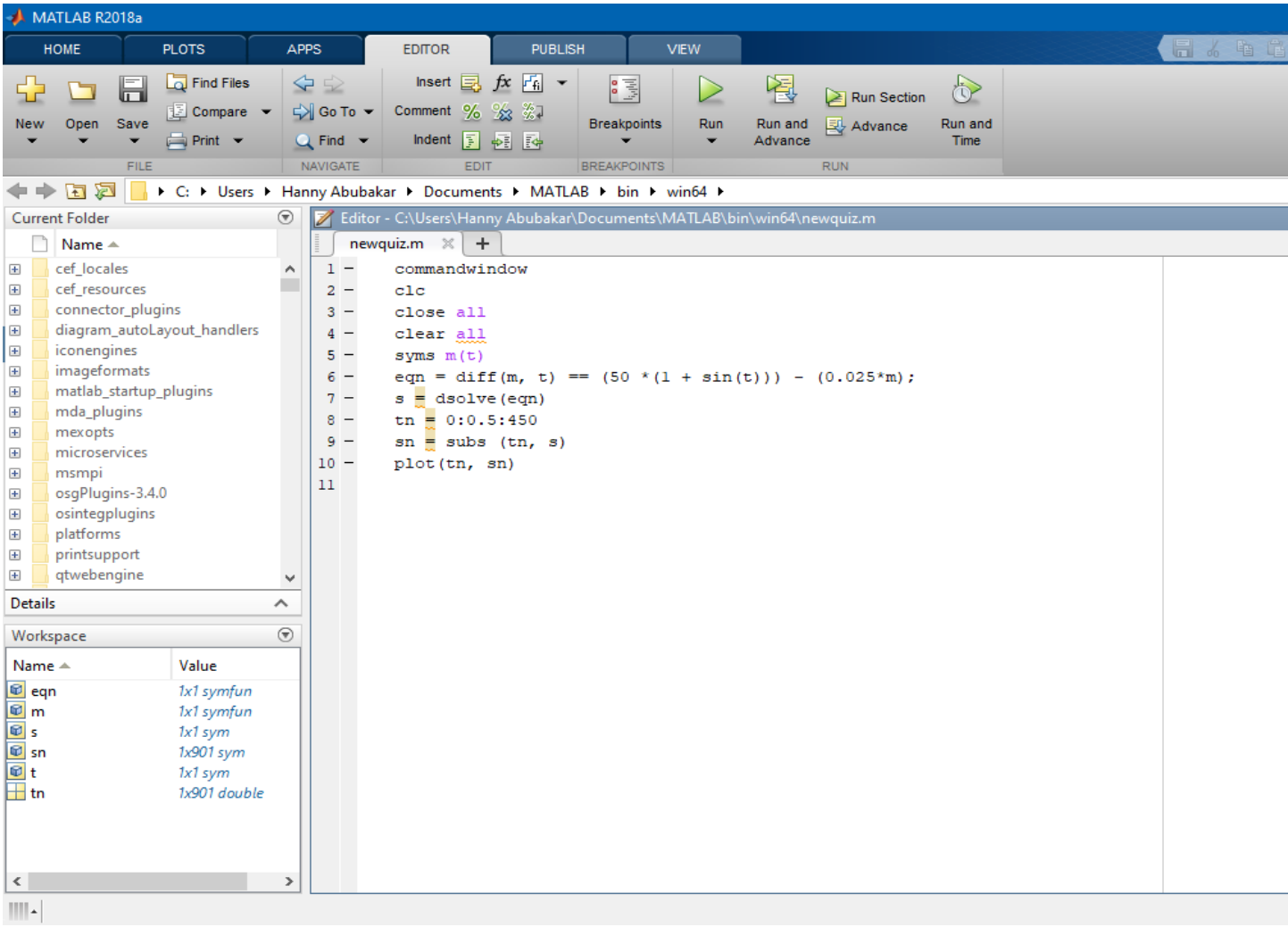


Figure 1
File Edit View Insert Tools Desktop Window Help
amonut of salt
time(min)
0
500
1000
1500
2000
2500
0
50
100
150
200
250
300
350
400
450

1c.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osintegplugins
platforms
printsupport
qtwebengine
Details
Workspace
Name
Value
eqn 1x1 symfun
m 1x1 symfun
s 1x1 sym
sn 1x901 sym
t 1x1 sym
tn 1x901 double
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newquiz.m
1 commandwindow
2 clc
3 close all
4 clear all
5 syms m(t)
6 eqn = diff(m, t) == (50 *(1 + sin(t))) - (0.025*m);
7 s = dsolve(eqn)
8 tn = 0:0.5:450
9 sn = subs (tn, s)
10 plot(tn, sn)
11

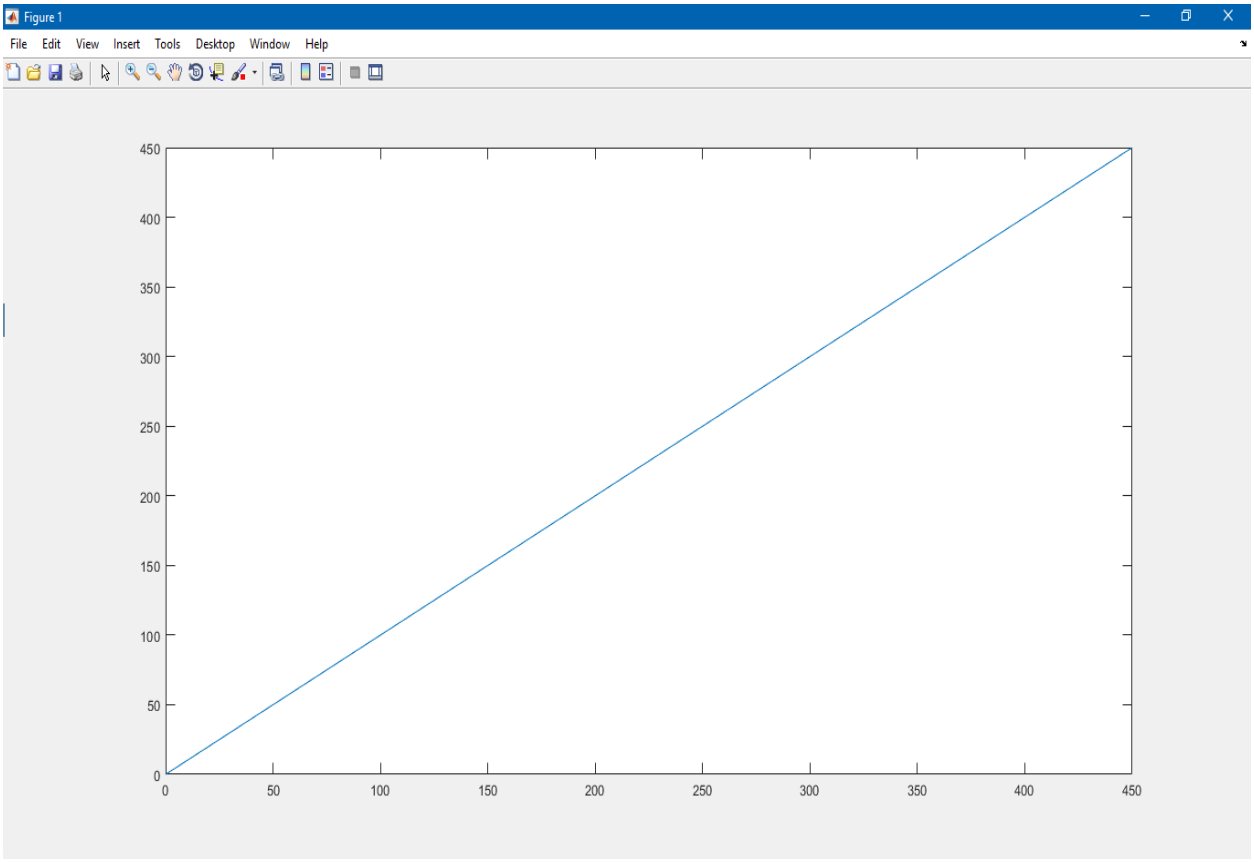
Figure 1
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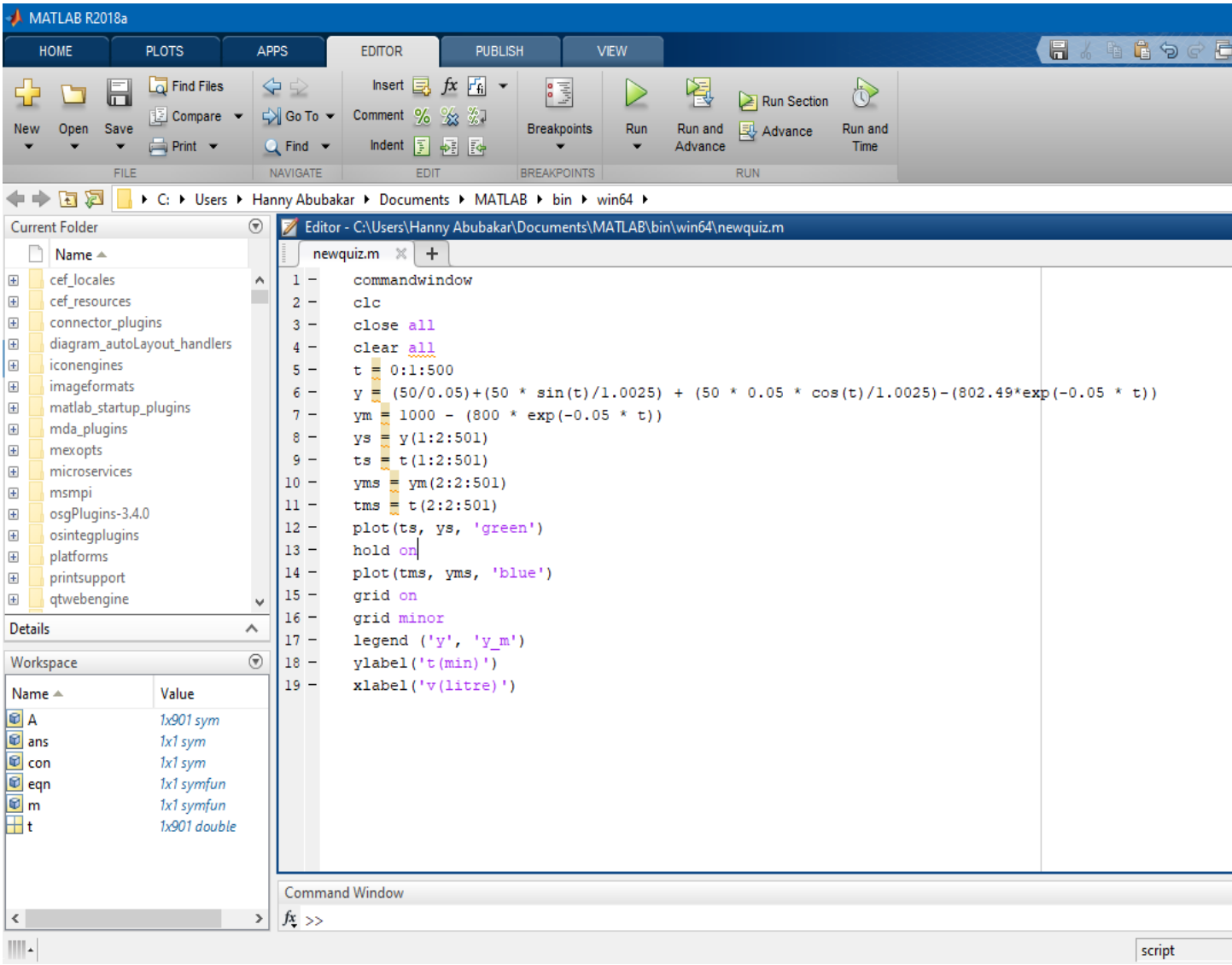
450
400
350
300
250
200
150
100
50
0
0 50 100 150 200 250 300 350 400 450

2a.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Details
Workspace
Name
Value
A 1x901 sym
ans 1x1 sym
con 1x1 sym
eqn 1x1 symfun
m 1x1 symfun
t 1x901 double
Editor - C:\Users\Hanny Abubakar\Documents\MATLAB\bin\win64\newquiz.m
newquiz.m
1 commandwindow
2 clc
3 close all
4 clear all
5 t = 0:1:500
6 y = (50/0.05)+(50 * sin(t)/1.0025) + (50 * 0.05 * cos(t)/1.0025)-(802.49*exp(-0.05 * t))
7 ym = 1000 - (800 * exp(-0.05 * t))
8 ys = y(1:2:501)
9 ts = t(1:2:501)
10 yms = ym(2:2:501)
11 tms = t(2:2:501)
12 plot(ts, ys, 'green')
13 hold on
14 plot(tms, yms, 'blue')
15 grid on
16 grid minor
17 legend ('y', 'y_m')
18 ylabel('t(min)')
19 xlabel('v(litre)')
Command Window
>>
script

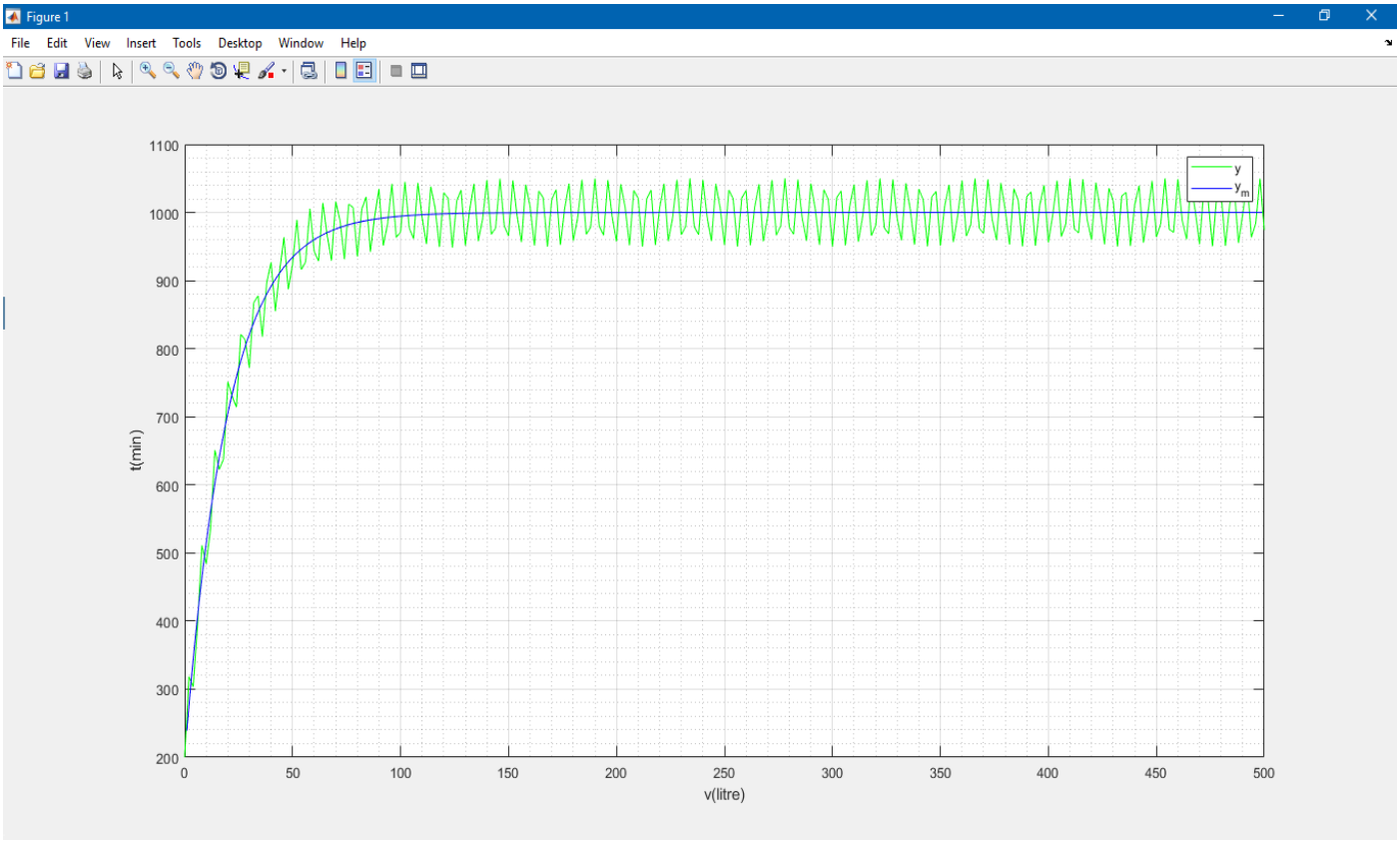
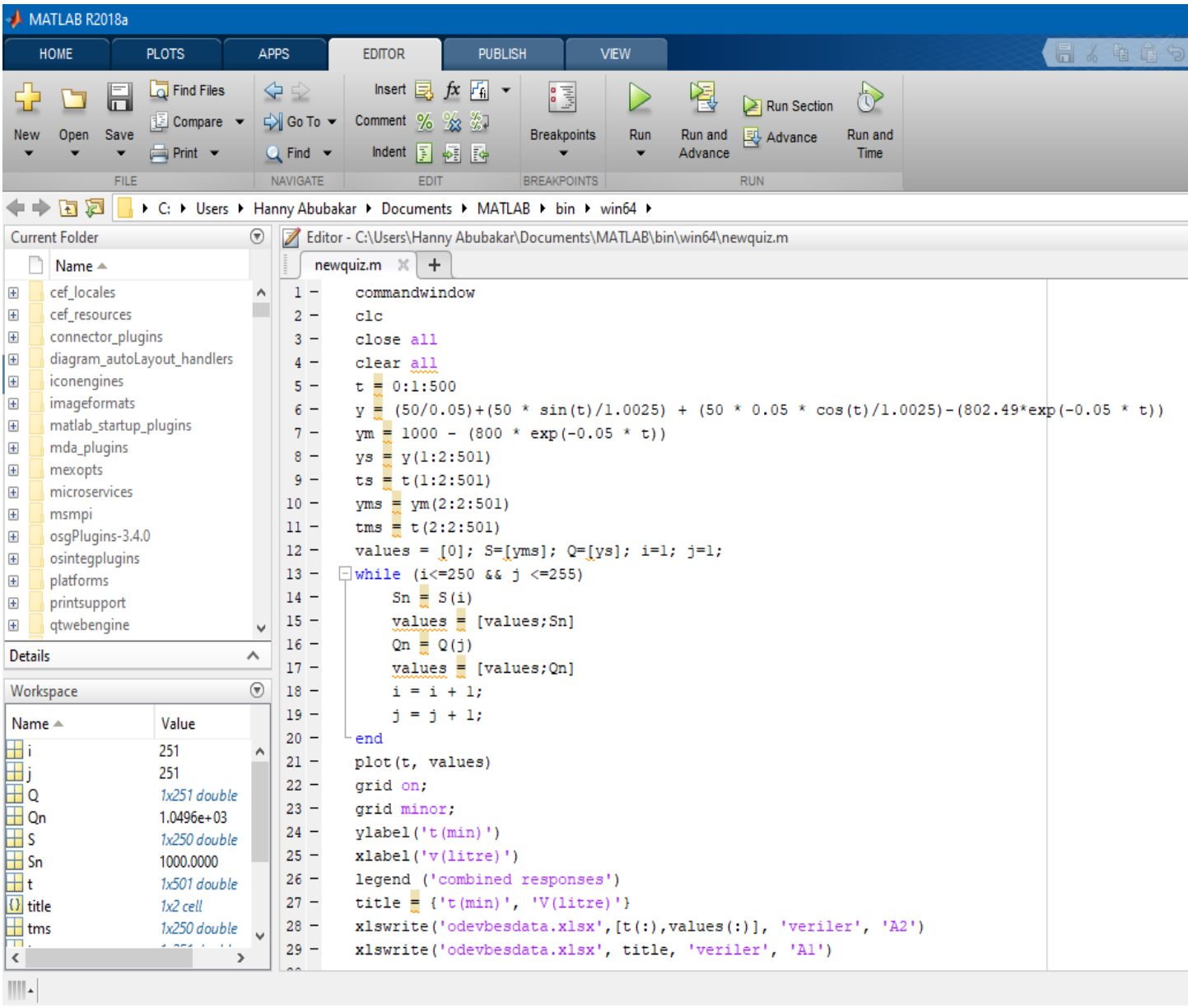


Figure 1
File Edit View Insert Tools Desktop Window Help
1100
1000
900
800
700
600
500
400
300
200
t(min)
0 50 100 150 200 250 300 350 400 450 500
v(litre)
y
y_m

2b.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mda_plugins
mexopts
microservices
msmpi
osgPlugins-3.4.0
osintegplugins
platforms
printsupport
qtwebengine
Details
Workspace
Name
Value
i 251
j 251
Q 1x251 double
Qn 1.0496e+03
S 1x250 double
Sn 1000.0000
t 1x501 double
title 1x2 cell
tms 1x250 double
Editor - C:\Users\Hanny Abubakar\Documents\MATLAB\bin\win64\newquiz.m
newquiz.m
1 commandwindow
2 clc
3 close all
4 clear all
5 t = 0:1:500
6 y = (50/0.05)+(50 * sin(t)/1.0025) + (50 * 0.05 * cos(t)/1.0025)-(802.49*exp(-0.05 * t))
7 ym = 1000 - (800 * exp(-0.05 * t))
8 ys = y(1:2:501)
9 ts = t(1:2:501)
10 yms = ym(2:2:501)
11 tms = t(2:2:501)
12 values = [0]; S=[yms]; Q=[ys]; i=1; j=1;
13 while (i<=250 && j <=255)
14 Sn = S(i)
15 values = [values;Sn]
16 Qn = Q(j)
17 values = [values;Qn]
18 i = i + 1;
19 j = j + 1;
20 end
21 plot(t, values)
22 grid on;
23 grid minor;
24 ylabel('t(min)')
25 xlabel('v(litre)')
26 legend ('combined responses')
27 title = {'t(min)', 'V(litre)'}
28 xlswrite('odevbesdata.xlsx',[t(:),values(:)], 'veriler', 'A2')
29 xlswrite('odevbesdata.xlsx', title, 'veriler', 'A1')

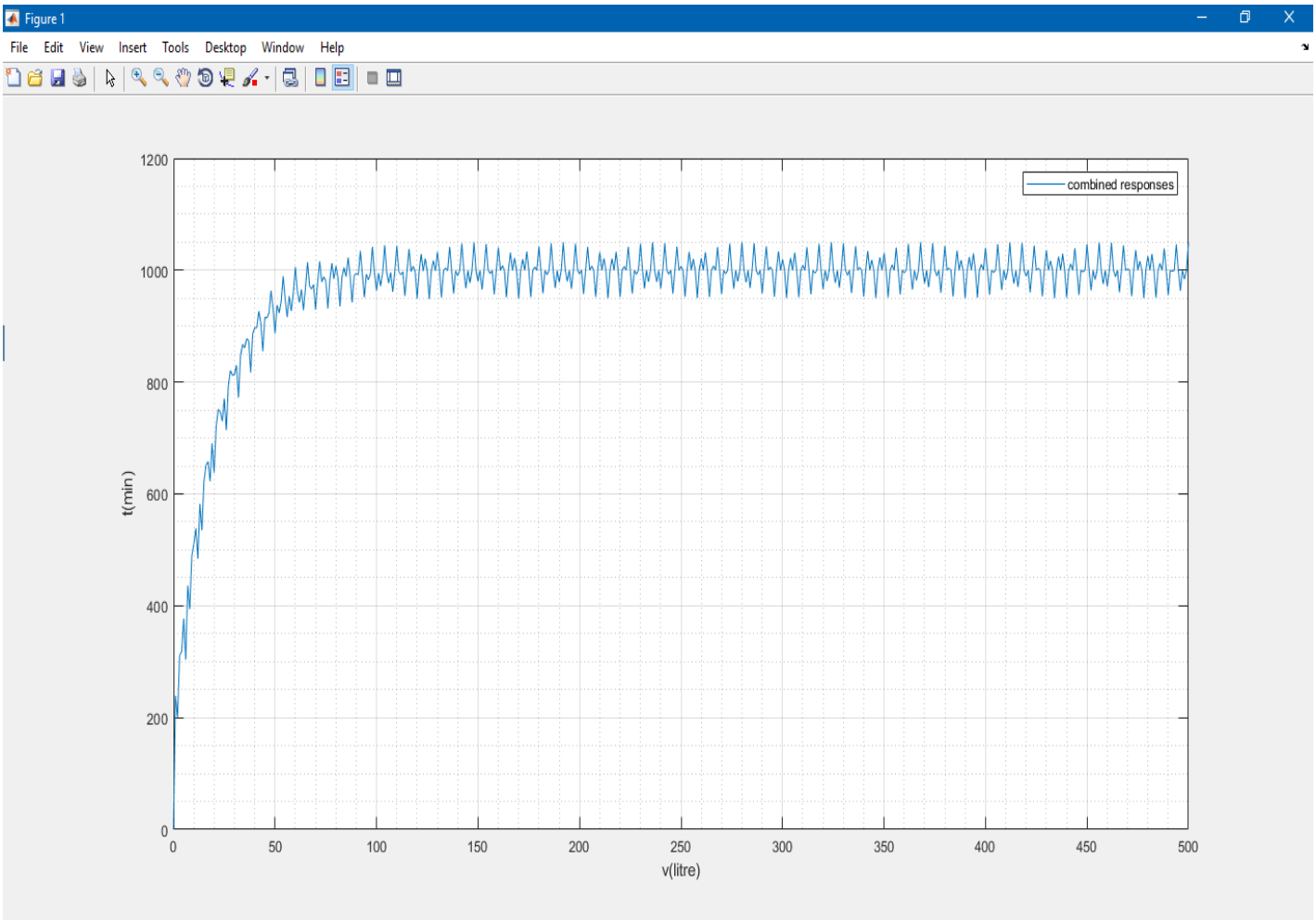
Figure 1
File Edit View Insert Tools Desktop Window Help
combined responses
t(min)
v(litre)
0
200
400
600
800
1000
1200
0
50
100
150
200
250
300
350
400
450
500