NWUDU OKECHUKWU JEREMIAH
18/ENG04/055
ELECTRICAL/ELECTRONICS ENGINEERING

Question 1

a) Mixing

1200gal of water } initially
150lb of salt }

50gal of brine (salt and water), each contain (1+sint)lb of salt

30gal/min removes from the tank
Accumulation rate within a system
INPUT rate into the system − OUTPUT rate from the system

$\frac{dy}{dt} = y_{in} - y_{out}$ ∴ $\frac{dm}{dt} = m_{in} - m_{out}$

Since 30gal removes per minute, and one gallon contains (1+sint)lb of salt, it means that the amount of salt leaving the tanks

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

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

The tank contains 1200gal of water with dissolved salt, and 30gal of the solution leaves the tank per minute

$\frac{30gal}{1200gal} = 0.025 = 2.5\%$ of the content of the tank. If that is the case, 2.5% of salt present in the tank will also leave the tank per minute, therefore,

$m_{out} = 2.5\%$ of m

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

$\frac{dm}{dt} = 50(1+\sin t) - 2.5\%$ of m

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

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

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

Using linear equation method,

$\frac{dy}{dx} + Py = Q$;

$\frac{dm}{dt} + Pm = Q$, where $P = 0.025$, $Q = 50(1+\sin t)$

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

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

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

$\therefore M.I.F = \int Q\,I.F\,dt$

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

$me^{0.025t} = 50\int e^{0.025t}\,dt + 50\int e^{0.025t}\sin t\,dt$

(equ 1.5) $me^{0.025t} = 50\cdot\frac{e^{0.025t}}{0.025} + 50\int e^{0.025t}\sin t\,dt$

$\therefore$ To integrate

$\int e^{0.025t}\sin t\,dt$

we'll use integration part

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

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

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

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

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

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

Using integration by part for $\int e^{0.025t}\cos t$,

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

$du = 0.025e^{0.025t}$, $V = \sin t$

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

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

Therefore

$\int e^{0.025t}\sin t = -e^{0.025t}\cos t + 0.025\left[e^{0.025t}\sin t - 0.025 V\right]$

$\int e^{0.025t}\sin t = -e^{0.025t}\cos t + 0.025\left[e^{0.025t}\sin t - 0.025\int \sin t e^{0.025t}\right]$

$\int e^{0.025t}\sin t = -e^{0.025t}\cos t + 0.025\left[e^{0.025t}\sin t - 0.025\int e^{0.025t}\sin t\right]$

Let $W = \int e^{0.025t}\sin t$

$\therefore W = -e^{0.025t}\cos t + 0.025[e^{0.025t}\sin t - 0.025W]$

$W = -e^{0.025t}\cos t + 0.025e^{0.025t}\sin t - 5.25\times10^{-4}W$

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

$1.000625W = -e^{0.025t}\cos t + 0.025e^{0.025t}\sin t$

$1.000625W = -e^{0.025t}(\cos t - 0.025\sin t)$

$W = \frac{-e^{0.025t}}{1.000625}(\cos t - 0.025\sin t)$

Recall $W = \int e^{0.025t}\sin t$

$\therefore \int e^{0.025t}\sin t = \frac{-e^{0.025t}}{1.000625}(\cos t - 0.025\sin t) + C$

From equ(1.5)

$me^{0.025t} = \frac{50\cdot e^{0.025t}}{0.025} + 50\int e^{0.025t}\sin t\cdot dt$

Therefore

$me^{0.025t} = 50\cdot\frac{e^{0.025t}}{0.025} + 50\left[\frac{-e^{0.025t}}{1.000625}(\cos t - 0.025\sin t + C\right]$

$me^{0.025t} = 2000e^{0.025t} - \frac{50\cdot e^{0.025t}}{1.000625}(\cos t - 0.025\sin t) + 50C$

divide through by $e^{0.025t}$

$$\therefore m = 2000 - \frac{50}{1.000625}(\cos t - 0.025\sin t) + \frac{50C}{e^{0.025t}}$$

when $m = 150$, $t = 0$

$$150 = 2000 - \frac{50}{1.000625}(\cos(0) - 0.025\sin(0)) + \frac{50C}{e^{0.025(0)}}$$

$$150 = 2000 - 49.9687(1-0) + \frac{50C}{e^{0}}$$

$$150 = 2000 - 49.9687 + 50C$$

$$150 = 1950.0313 + 50C$$

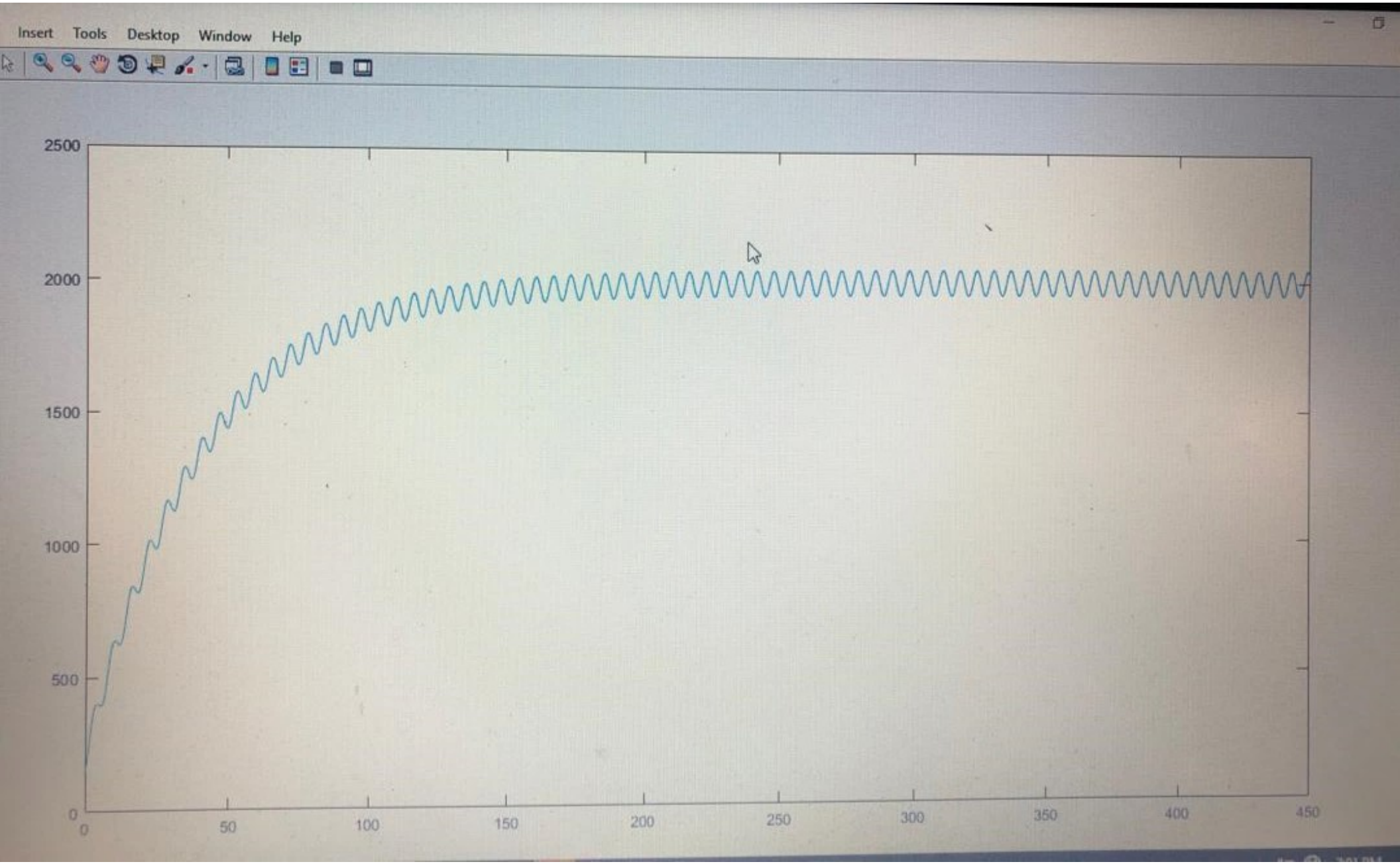
$$150 - 1950.0313 = 50C$$

$$C = -36.00626$$

$$C \approx -36$$

$$\therefore m = 2000 - \frac{50}{1.000625}(\cos t - 0.025\sin t) + \frac{50(-36)}{e^{0.025t}}$$

$$m = 2000 - 49.9687(\cos t - 0.025\sin t) + \frac{(-1800)}{e^{0.025t}}$$


Insert
Tools
Desktop
Window
Help
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
450

assignment.m

```
commandwindow
clear
clc
close all
syms t
y = (50/0.05)+((50/1.0025)*sin(t))+(((50*(0.05))/1.0025)*cos(t)
ym = 1000-(800*exp(-0.05*t))
oddValues = 1:2:500
evenValues = 2:2:500
ym = double(subs(y, oddValues))
ymm = double (subs(ym, evenValues))
totTime = 1:1:500
timeTrans = totTime'
c = reshape([ym,ymm],[],1)
combVal = double(c)
plot(totTime, c)
grid on
grid minor
xlabel('T(min)'), ylabel('V(litre)')
col_header = {'t(min)', 'V(Litre)'}
xlswrite['odevbesdata.xlsx',col_header,'veriler','A2')
xlswrite['odevbesdata.xlsx',timeT,'veriler','A3')
xlswrite['odevbesdata.xlsx',combined,'veriler','B2')
```

Workspace

Name	Value
c	62750x1 double
combVal	62750x1 double

script

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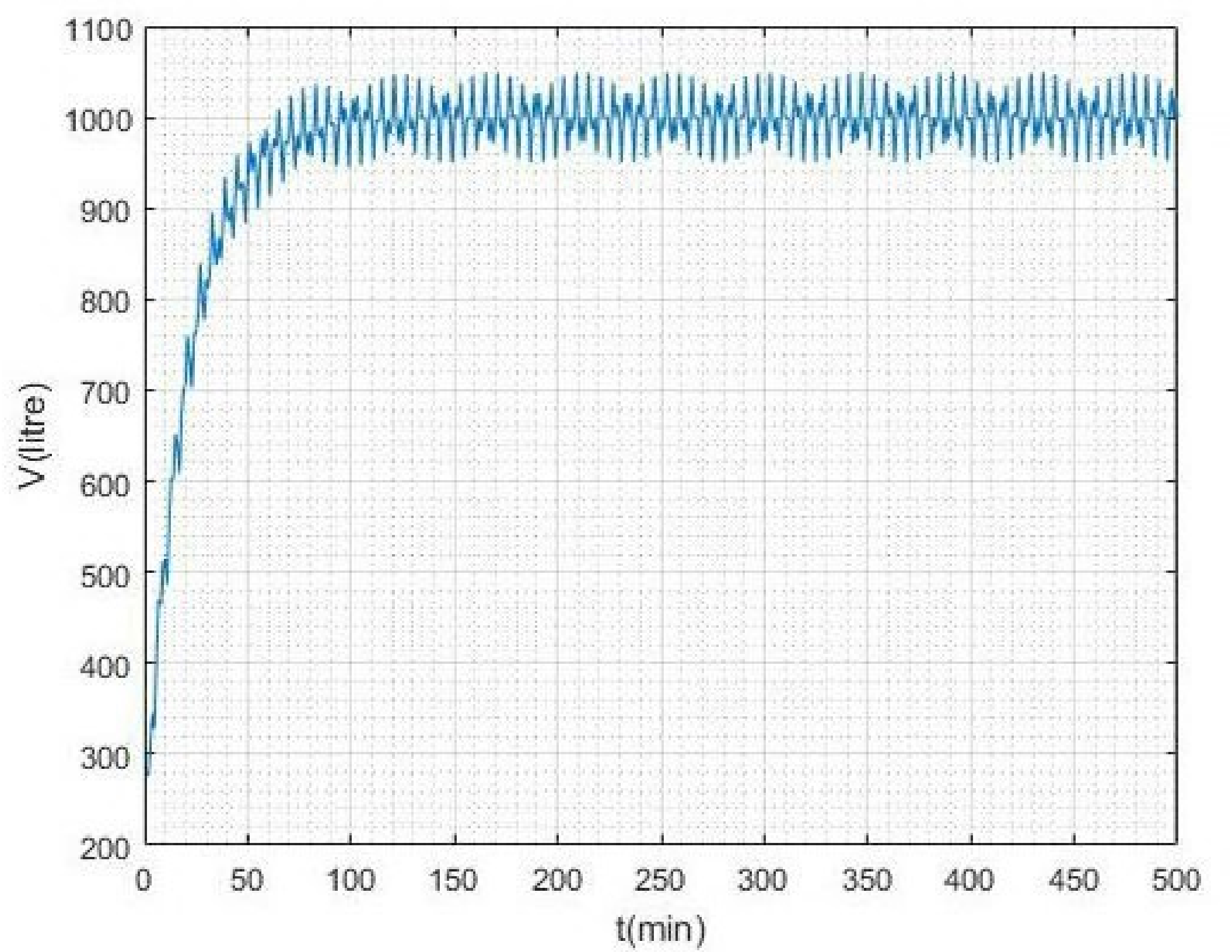
6:52 PM
5/6/2020


1100
1000
900
800
700
600
500
400
300
200
V(litre)
0
50
100
150
200
250
300
350
400
450
500
t(min)