



Egbaswe Kelvin Olamide

Council for the Regulation of Engineering in Nigeria

Established By Decrees 55/70 and 27/92 (Now Act CAP E11/2004)

18/ENIG-04/02/21  
Elect-Elect

ENIG 282

COREN

Engineering Mathematics 11

1) Accumulation rate  $\dot{M} =$  Input rate of salt into the system - Output rate of salt from the system

Let  $M$  be the amount of salt present in the tank at time  $t$

Concentration of water in tank = 1200 g/l

Amount of salt initially dissolved = 150 lb

Inflow rate of brine = 50 g/l/min

Amount of salt in solution =  $(1 + S_{int})$  lb/gal

Outflow rate of brine = 30 g/l/min

$$\frac{dM}{dt} = M_{in} - M_{out}$$

$$M_{in} = \text{Inflow rate of brine} \times \text{Amount of salt in solution}$$

$$M_{in} = 50 \frac{\text{gal}}{\text{min}} \times (1 + S_{int}) \text{ lb/gal}$$

$$M_{in} = 50(1 + S_{int}) \text{ lb/min}$$

$$M_{out} = \text{Outflow rate of brine}$$

$$\text{Total salt in tank}$$



THEME  
Entrepreneurship and Manufacturing in Nigeria:  
Challenges and Opportunities for a Better Future  
7<sup>TH</sup> - 9<sup>TH</sup> AUGUST, 2017  
VENUE: INTERNATIONAL CONFERENCE CENTRE (ICC), ABUJA  
9:00AM DAILY

$$M_{out} = \frac{30}{1200} = 0.025 = 2.5\% \text{ of } M_{in}$$

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

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

Using integrating factor (I.F)

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

$$P \frac{dm}{dt} + Pm = Q$$

$$P = 0.025, \quad Q = 50(1 + \sin t)$$

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

$$IF = e^{\int P dt} = e^{0.025t}$$

$$m \cdot IF = \int Q \cdot IF dt$$

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

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

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

$$m \cdot e^{0.025t} = \int 50e^{0.025t} + \int 50 \sin t e^{0.025t}$$

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



$$\int 50 \sin t e^{0.025t} = 50 \int \sin t e^{0.025t}$$

Using integration by parts

$$\text{Let } u = e^{0.025t}, \quad dv = \sin t, \quad du = 0.025e^{0.025t}, \quad v = -\cos t$$

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

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

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

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

$$u = e^{0.025t}, \quad dv = \cos t, \quad du = 0.025e^{0.025t}, \quad v = \sin t$$

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

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

$$\int \sin t e^{0.025t} = -e^{0.025t} \cos t + 0.025 e^{0.025t} \sin t - 0.000625 \int \sin t e^{0.025t}$$

Using I for the integral of  $\int e^{0.025t} \sin t$

$$I = -e^{0.025t} \cos t + 0.025 e^{0.025t} \sin t - 0.000625 I$$

$$1.000625 I = e^{0.025t} (0.025 \sin t - \cos t) + C_1$$

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

$$50 \int \sin t e^{0.025t} = 50 \left( \frac{e^{0.025t} (0.025 \sin t - \cos t) + C}{1.000625} \right)$$

$$m \cdot e^{0.025t} = 2000e^{0.025t} + 50 \left[ \frac{e^{0.025t} (0.025 \sin t - \cos t)}{1.000625} + C \right]$$

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

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

When  $t=0$ ,  $y=150$

$$150 = 2000 + 49.9687 (0.025 \sin 0 - \cos 0) + \frac{C}{e^{0.025(0)}}$$

$$150 = 2000 + 49.9687 (0 - 1) + C$$

$$150 = 2000 + 49.9687 + C$$

$$C = 150 - 2000 + 49.9687$$

$$C = -1800.0313$$

$$m = 2000 + 49.9687 (0.025 \sin t - \cos t) + \frac{-1800.0313}{e^{0.025t}}$$

MATLAB R2018a

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FILE NAVIGATE EDIT BREAKPOINTS RUN

C:\Users\HP PC\Documents\MATLAB

Current Folder

- abass44r43.m
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- browson443.m
- caprojectkelvin1.asv
- caprojectkelvin1.m
- caprojectkelvin2.m
- classquiz111.m
- classwoek3.m
- classwork1.m
- classwork4.m
- classwork4 - Shortcut.lnk
- classwork5.m
- classwork6.m
- classwork33.m

matlab.mat (MAT-file)

Workspace

Name	Value
A	1x1 sym
An	1x901 sym
cond	1x1 sym
equ	1x1 symfun
m	1x1 symfun
t	1x901 double

Editor - C:\Users\HP PC\Documents\MATLAB\caprojectkelvin2.m

```

1 - commandwindow
2 - c1c
3 - clear
4 - close all
5 - syms m(t) t equ
6 - syms A(t)
7 - equ = diff(m,t) == 50*(1 + sin(t)) - 0.025*m;
8 - cond = m(0)==150;
9 - A = dsolve(equ,cond)
10 - t = [0:0.5:450]
11 - An=subs(A,t)
12 - plot(t,An,'black')
13 - ylabel('Amount of salt in the tank(lb)')
14 - xlabel('Time(mins)')
15 - grid on
16 - grid minor

```

Command Window

```

450.0000

An =

[ 150, 2000 - (2000*1601^(1/2))*cos(atan(1/40) + 1/2)]/1601 - (2881850*exp(-1/80))/1601, 2000 - (2000*1601^(1/2))*cos(atan(1

```

Figure 1

Amount of salt in the tank(lb)

Time(mins)

11:44 PM  
5/6/2020

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t	1x901 double

Editor - C:\Users\HP PC\Documents\MATLAB\caprojectkelvin2.m

```

1 - commandwindow
2 - c1c
3 - clear
4 - close all
5 - syms m(t) t equ
6 - syms A(t)
7 - equ = diff(m,t) == 50*(1 + sin(t)) - 0.025*m;
8 - cond = m(0)==150;
9 - A = dsolve(equ,cond)
10 - t = [0:(0.5/60):7.5]
11 - An=subs(A,t)
12 - plot(t,An,'black')
13 - ylabel('Amount of salt in the tank(lb)')
14 - xlabel('Time(hrs)')
15 - grid on
16 - grid minor

```

Command Window

```

7.5000
An =
[ 150, 2000 - (2000*1601^(1/2))*cos(atan(1/40) + 1/120)]/1601 - (2881850*exp(-1/4800))/1601, 2000 - (2000*1601^(1/2))*cos(at
fx >>

```

Figure 1

Amount of salt in the tank(lb)

Time(hrs)

11:35 PM 5/6/2020

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- classwork5.m
- classwork6.m
- classwork33.m

matlab.mat (MAT-file)

Workspace

Name	Value
col_header	1x2 cell
t	1x501 double
T	1x501 double
tm	1x251 double
to	1x250 double
y	1x250 double
Y	1x501 double
ym	1x251 double

Editor - C:\Users\HP PC\Documents\MATLAB\caprojectkelvin1.m

```
caprojectkelvin1.m x caprojectkelvin2.m x +
4 - close all
5 - syms t tm to
6 - t=0:1:500
7 - to=1:2:500
8 - tm=0:2:500
9 - y=50/0.05 + 50/1.0025*sin(to) + 50*(0.05)/1.0025*cos(to) - 802.49*exp(-0.05*to)
10 - ym=1000 - 800*exp(-0.05*tm)
11 - T=[to,tm]
12 - Y=[y,ym]
13 - plot(T,Y,'blue')
14 - xlabel('time (min)')
15 - ylabel('V(litre)')
16 - grid on
17 - grid minor
18 - col_header=['t (min)', 'V(litre)']
19 - xlsxwrite('odevbesdata.xlsx', [T(:), Y(:)], 'veriler', 'A2')
20 - xlsxwrite('odevbesdata.xlsx', col_header, 'veriler', 'A1')
```

Command Window

```
col_header =
1x2 cell array
    't (min)'    'V(litre)'
```

script Ln 20 Col 55

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matlab.mat (MAT-file)

Workspace

Name	Value
col_header	1x2 cell
t	1x501 double
T	1x501 double
tm	1x251 double
to	1x250 double
y	1x250 double
Y	1x501 double
ym	1x251 double

Figure 1

File Edit View Insert Tools Desktop Window Help

V (litre)

time (min)

col\_header =

```
1x2 cell array
    {'t (min)'} {'V (litre)'}
```

script Ln 20 Col 55

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