18/ENG07/002

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∴ From

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

$$\frac{dy}{dt} = 50(1+\sin t) - 2.5\%\text{ of } y.$$

$$\frac{dy}{dt} = 50(1+\sin t) - 0.025y.$$

∴ By seperating the variables,

$$\frac{dy}{dt} + 0.025y = 50(1+\sin t)$$

multiply both sides by dt.

$$1 + 0.025y\,dy = 50\cdot(1+\sin t)\,dt$$

$Q = -e^{0.025} \cos t \times$

$0.05 \sin t$

Engineering method

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

$\therefore \frac{dy}{dt} + 0.025y = 50(1+\sin t)$

using the linear equation method,

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

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

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

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

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

$\therefore y * I.F = \int Q \, I.F \cdot dt$

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

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

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

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

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

using integration by part, $\int u \, dv = uv - \int v \, du$

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

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

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

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

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

$50C = 5$

$e^{x} = e^{x}$

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

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

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

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

using integration by part,

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

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

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

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

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

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

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

$Q = -e^{0.025t}\cos t + 0.025e^{0.025t} - 6.25^{-4}Q$

$Q + 6.25^{-4}Q = -e^{0.025t}\cos t + 0.025e^{0.025t}$

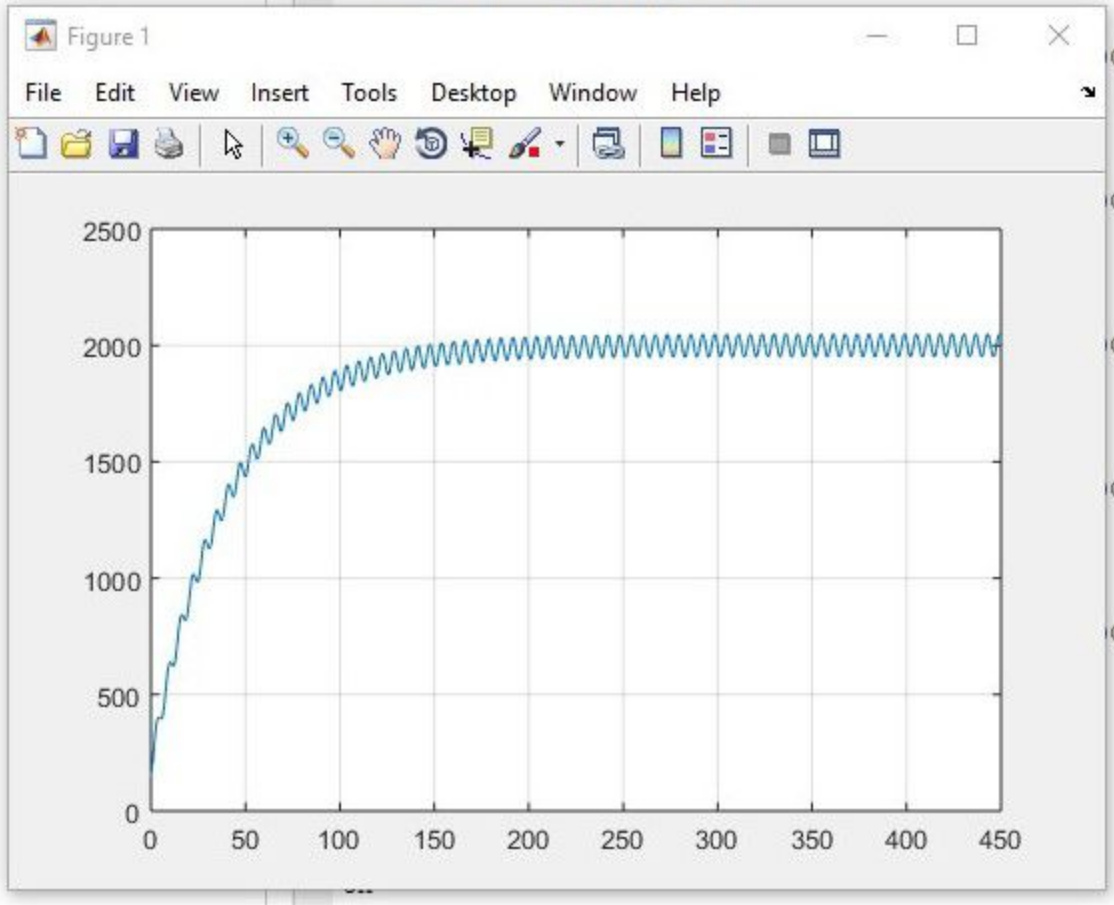
$Q + 0.000625Q = -e^{0.025t}\cos t + 0.025e^{0.025t}$

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

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

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

```
commandwindow
clear
clc
close all
syms m t
ans=dsolve('Dm+0.025*m=50+50*sin(t)','m(0)=150')
t=0:0.5:450
tn=subs(ans,t)
plot(t,tn)
grid on
```




```
Columns 876 through 880
[ 150, 2000 - (2000*1601^(1/2)*cos(atan(1/40) + 1/2))/1
>>
```

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

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

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

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

$$ye^{0.025t} = 2000e^{0.025t} + \frac{50 \times e^{0.025t}}{1.000625}(\cos t - 0.025) + C$$

divide through by $e^{0.025t}$

$$y = 2000 + \frac{50}{1.000625}(\cos t - 0.025) + 50C.$$

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

divide through by $e^{0.025t}$

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

$$y = 2000 - \frac{50}{1.000625}(\cos t - 0.025 \sin t) + \frac{50c}{e^{0.025t}}$$

when $y = 150$

$t = 0$

$$150 = 2000 - \frac{50}{1.000625}(1 - 0) + \frac{50c}{1}$$

$$150 = 2000 - 49.968(1) + 50c$$

$$150 = 1950.032 + 50c$$

$$-1800.032 = 50c$$

$$c = -36.00064$$