

a) Mathematical modelling is a mathematical representation of a system ~~and system~~ which involves solving the model and obtaining its output variable for different values of its input variable or as input variable is changed from one value to another.

b) Methods of obtaining a model

- Differentiating
- use of Balance law

c)  $T(0) = 10^\circ\text{C}$

$$T(\infty) = 20^\circ\text{C}$$

$$\text{Actual temp} = 25^\circ\text{C} = T_A$$

$$\frac{dT}{dt} = K(T - T_A)$$

$$dT = K(T - T_A) dt$$

$$\frac{dT}{(T - T_A)} = K dt$$

Integrating both sides

$$\ln(T - T_A) = Kt + C$$



$$T - T_A = e^{kt} + e^c$$

Let  $e^c$  be  $A$

$$T - T_A = Ae^{kt}$$

$$T = Ae^{kt} + T_A$$

when  $T = 10$ ,  $t = 0$

$$10 = Ae^{k(0)} + 25$$

$$10 = A + 25$$

$$A = 10 - 25$$

$$= -15$$

$$T = 25 - 15e^{kt}$$

$$\Delta t \quad t(s) = 20$$

$$20 = 25 - 15e^{k(5)}$$

$$20 - 25 = 15e^{5k}$$

$$15e^{5k} = 5$$

$$e^{5k} = 0.3333$$

$$5k = \ln 0.3333$$

$$5k = -1.0980 \quad k = -0.22$$

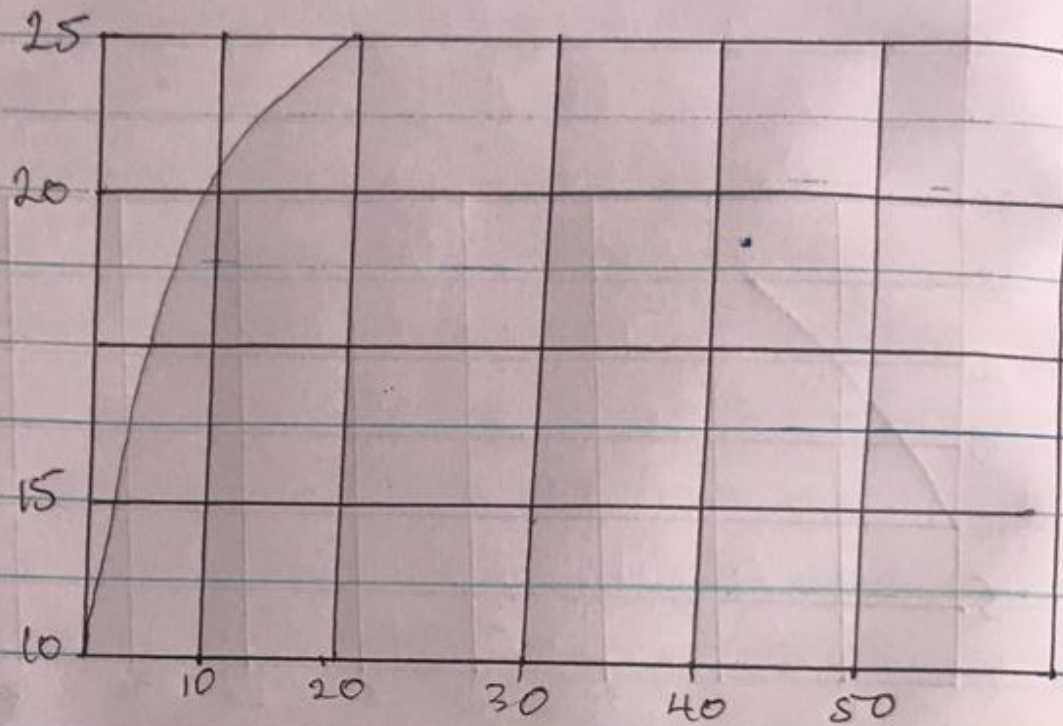
$$T(t) = 25 - 15e^{-0.22t} \quad \text{-- Rotating Equation}$$

## ii Using Microsoft Excel

- Pick a box Insert(t)
- Pick another box Insert(T)
- Under the already labelled box 1(t)
- Insert the value of 0 in an empty box
- Go to fill
- Adjust to click on series
- Insert a step value of 1
- Change the series to columns
- Insert a stop value of 60
- Under the already (labelled box 2 (T)
- Pick a box
- Insert " $= 25 - (15 * \text{Exp}(-0.22 * A_2))$ "
- Auto fill
- Go to Insert
- Pick a graph of choice
- Label the graph

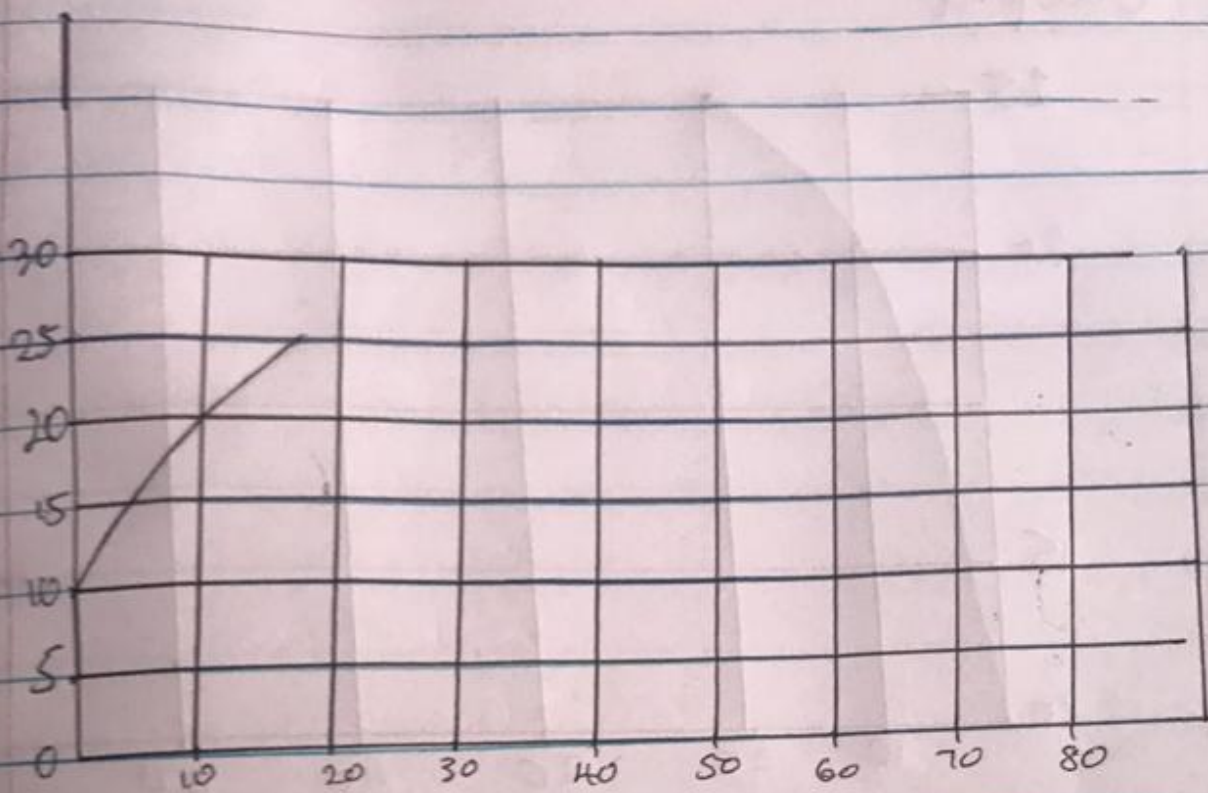


## Output



IV. Using Excel's dynamic response, the steady state temperature of the system would be  $26^{\circ}\text{C}$  at 20mins

V. Using the developed Model equation, the temperature of the thermometer at  $t=0$  will be  $28^{\circ}\text{C}$



Using Matlab.

Command window

Clear

clc

close all

t = 0:1:60

T = 25 - 15 \* exp(-0.22 \* t)

Plot (t, T)

grid on

grid minor

x label ('Time (secs)')

y label ('Temperature')