

## Assignments

## Define mathematical modelling

Mathematical modelling is a mathematical representation of a system and simulation of a 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.

## Methods of obtaining a model

## - Differentiating

## - Use of Balance Law

## Solution

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

$$T(5) = 20^{\circ}\text{C}$$

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

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

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

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

$$(T - T_A)$$

Integrating both sides

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

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

Let  $e^C$  be  $A$

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

$$T - T_A = A e^{kt}$$

$$T = A e^{kt} + T_A$$

When  $T = 10$

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

$$10 = A + 25$$

$$A = 10 - 25$$

$$A = -15$$

$$T = 25 - 15e^{5k t}$$

$$At t(5) = 20$$

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

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

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

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

$$e^{25k} = 0.3333$$

$$25k = \ln 0.3333$$

$$5k = -1.0986$$

$$k = -0.22$$

$$T(t) = 25 - 15e^{-0.22t}$$

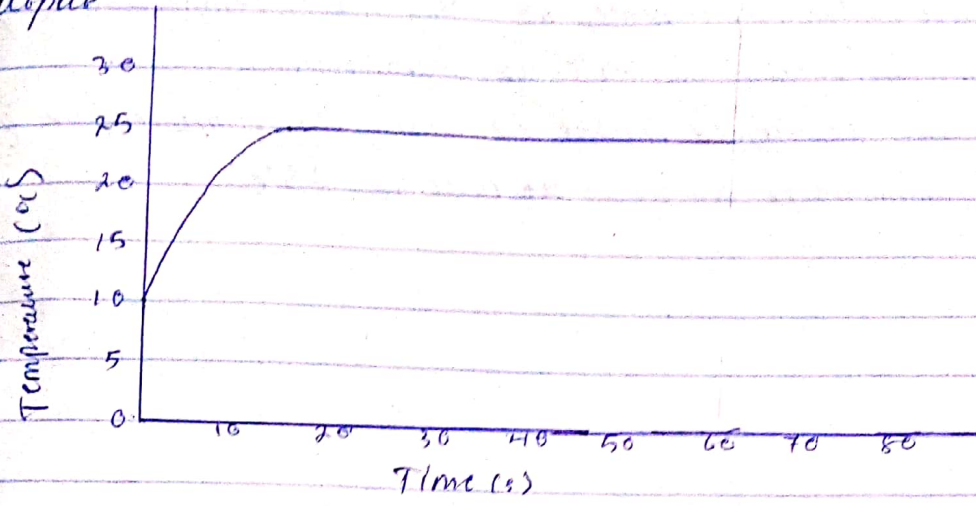
→ Replacing Equation

ii Using Microsoft Excel

- Pick a box insert (2)
- Pick another box insert (7)
- Under the already labeled box 1 (2)
- Insert a value of 0 in an empty box
- Go to fill
- Click on series
- Insert a step <sup>value</sup> ~~value~~ of 1
- Change the series into columns
- Insert a step value of 60
- Under the already labeled box 2 (7)
- Pick a box
- Insert " $= 25 - (15 * \text{Exp}(-0.22 * A2))$ "
- Auto fill
- Go to insert
- Pick a graph of choice
- Label the graph



Output



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

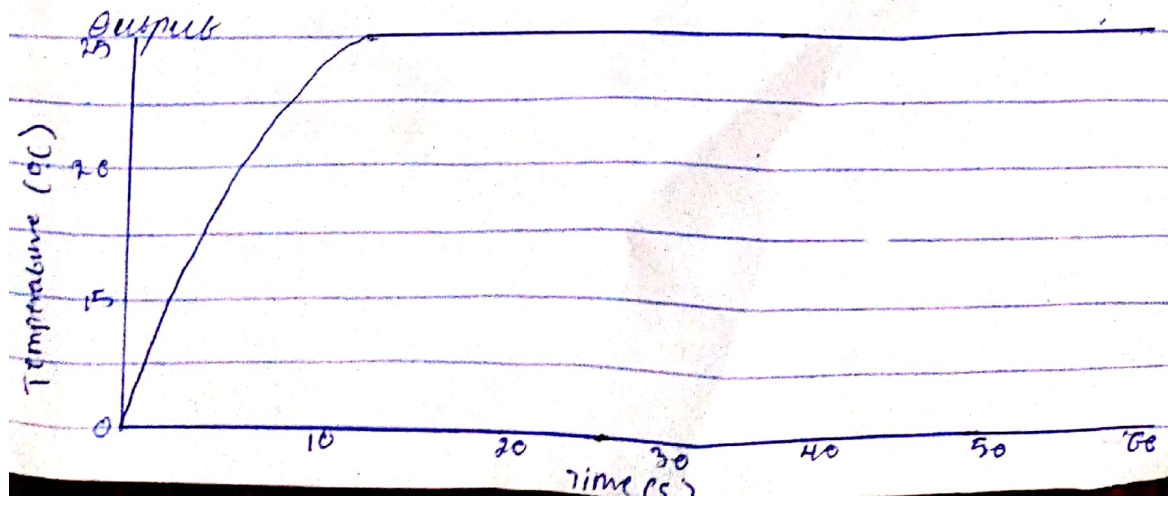
xlabel('Time (sec)')

ylabel('Temperature')

grid on

grid minor

Output



(i) Using coil's dynamic response, The steady state, temperature of the system would be  $25^{\circ}\text{C}$  at 20 minutes.

(ii) Using the developed model equation, the temperature of the thermometer at  $t \rightarrow \infty$  will be  $25^{\circ}\text{C}$