

What is mathematical modelling

Mathematical modelling can be defined as a description of a system using mathematical concepts and languages. Mathematical models are used in the natural sciences and engineering disciplines as well as the social sciences.

Methods of obtaining a model

- > Differentiating
- > Use of Balance laws

Example

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

$$T(1) = 20^\circ\text{C}$$

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

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

dt

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

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

$-T_A$

Integrating both sides:

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

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

$$\ln + e^C = A$$

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

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

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

$$\text{When } t = 0$$

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

$$10 = A + 25$$

$$A = 10 - 25$$

$$A = -15$$

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

$$\text{At } t=3: \text{ end } T = 20$$

$$20 - 25 = -15e^{3k}$$

$$20 - 25 = -15e^{3k}$$

$$15e^{3k} - 5 = -15e^{3k}$$

$$15e^{3k} = 5$$

$$e^{3k} = 5/15$$

$$e^{3k} = 0.3333$$

$$e^{3k} = \ln 0.3333$$

$$3k = -1.0987$$

$$k = \frac{-1.0987}{3}$$

$$k = -0.22$$

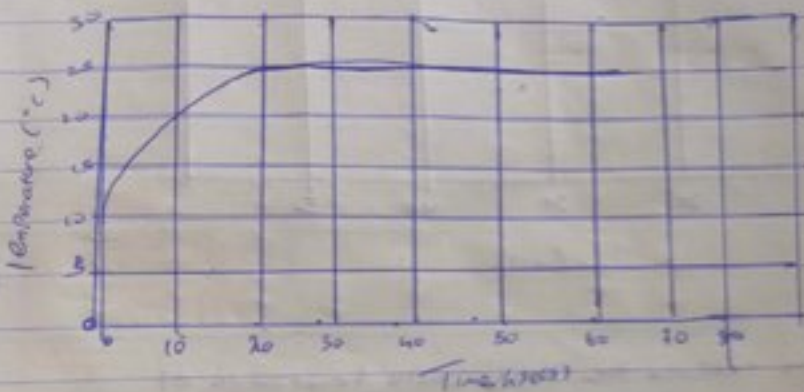
$$T(t) = 25 - 15e^{-0.22t} \rightarrow \text{Model equation}$$

Using Microsoft Excel:

- > Pick a cell insert 't'
- > Pick another cell insert 'T'
- > Under the already labeled cell 't'
- > Insert a value at 0 to an empty cell
- > Click on Series
- > Insert a Step Value of 1
- > Change the Series into columns
- > Insert a Step Value of 60

- > Under the already labeled ($\text{C} = 25 - 15e^{-0.22t}$)
- > Press a row
- > Insert $\text{C} = 25 - 15e^{-0.22t}$ (-0.22 A2)
- > Auto fill
- > Go to insert
- > Press a gram of share
- > Label the gram

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

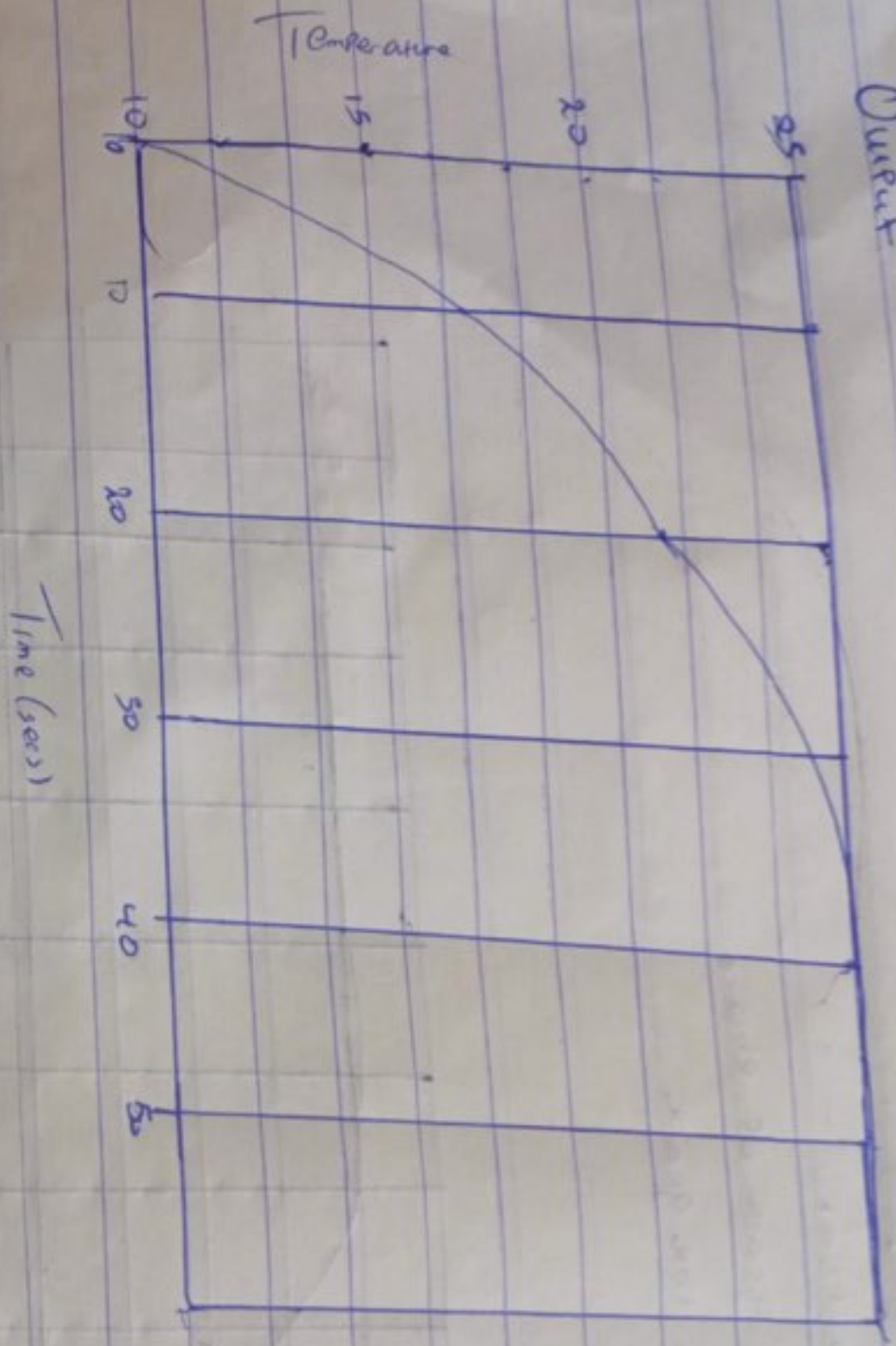
x label ('Time (secs)')

y label ('Temperature')

grid on

g-r-a m-m-a-r-i

Output



(12) Using grid dynamic response the Steady State temperature of