(a) Mathematical modelling is defined as the mathematical representation of a system and simulation of a system involves solving the mode and obtaining its mathematical solution and its physical solution.

(b)- By differentiation
- By the use of balance law
- By the use of newton's law of cooling

(C) From newton's law of cooling

$$\frac{dt}{dt} \propto (T - T_n)$$

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

$$\frac{dT}{(T - T_A)} = u\,du$$

integrate both sides

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

$$-(T - T_A) = e^{KT+C}$$

$$(T - T_A) = e^{KT} \cdot e^{c}$$

But $e^{c} = T^{o}$

$$T - T_A = T_o e^{KT} \text{ ------ } ①$$

initially at $t=0$, $T = 10^{\circ}C$ and atual temp. $T_A = 25^{\circ}C$

equation ① becomes

$$10 - 25 = T_o e^{K(0)}$$

$$-15 = T_o \times e = T_u$$

$$T_u = -15^{\circ}C$$

$$\therefore T = T_A + T_u e^{KT}$$

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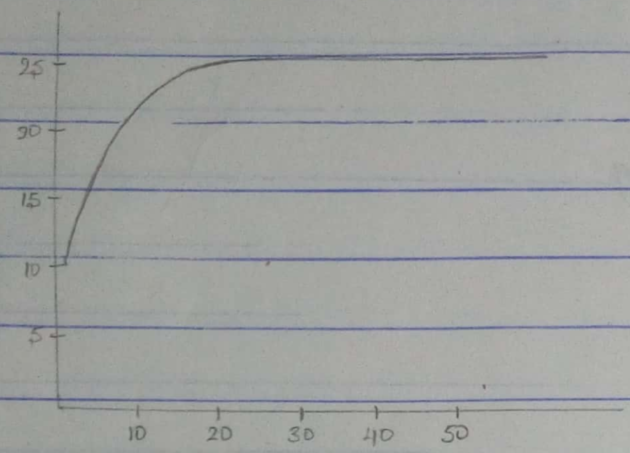
$-5 = -15e$

$\ln(1/3) = 5k$

$k = \ln(1/3)/5 = -0.22$

$\therefore$ The model for the system

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



iii) commandwindow

```
clear
clc
close all
t=0.0:5:50
T=25-15*exp(-0.22*t)
Plot (t,T)
grid on
grid minor
x label ("Time (sec)")
y label ("Temperature (c)")
```

iv) The steady-state temperature of the system is 25°C.

v) At the temperature of 25°C, it was 0·5second. There was no change in the temperature despite the increase in the time, therefore, the system is said to be stable at low temperature.

vi) For t = ? and t = 24·9°C

From the equation $T = 25 - 15e^{-0xt}$

$24 - 9 = 25 - 15e^{-022t}$

$0 \cdot 1 = 15e^{-0 \cdot 22t}$

$t = 22 \cdot 76$ mins

0·76mins ⟶ secs

$0 \cdot 76 \times 60 = 45 \cdot 6 \rightarrow 40$secs

∴ The time required is 22mins 46secs