NAME: ODUNBYE LEONARD MOTOSOREOLUWA
MATRIC NO: 17/ENG02/061
DEPARTMENT: COMPUTER ENGINEERING

QUESTION 4

(a) Mathematical modelling is a mathematical representation of a system and the simulation of the system which involves solving the model and obtaining its output variable for different values of its input variable

(b) (i) By Differentiating e.g Exponential Growth
(ii) By use of the Balance Law e.g Mixing problem
(iii) By use of Torricelli's Law e.g Outflow of water through a hole

(c) Applying Newton's Law of Cooling

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

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

$$\frac{dT}{T-T_A} = kdt$$

$$\int\frac{dT}{T-T_A} = \int kdt$$

$$\ln|T-T_A| = kt + C^*$$

$$T-T_A = e^{kt} \cdot e^{C^*}$$

Since $e^{C^*} = C$

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

Initial temperature $T_0 = 10°C$

Actual temperature of the system, $T_A = 25°C$

$$10 = 25 + Ce^{kt}$$

At $T_{(0)}$, $t = 0$

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

$$10 = 25 + C$$

$C = 10 - 25$

$C = -15$

$\therefore T_{(t)} = T_s - 15e^{kt}$

At a temperature reading of 20°C after 5 minutes

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

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

$e^{5k} = \frac{-5}{-15}$

$e^{5k} = 0.33$

$5k = \ln 0.33$

$5k = -1.1087$

$k = -0.22$

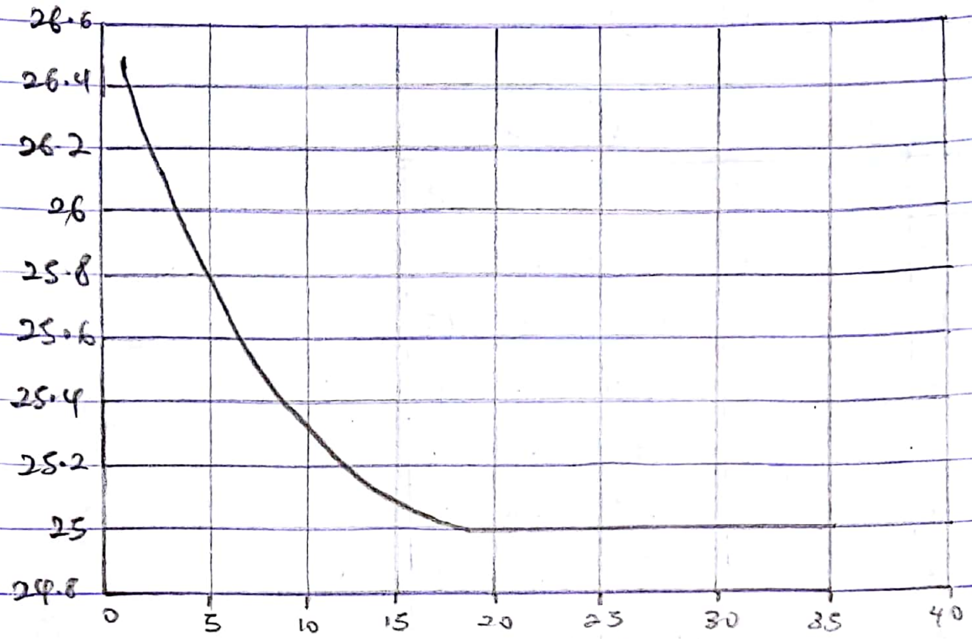
$\therefore T_t = 25 - 15e^{-0.22t}$

4(c)(ii) <u>Output</u>

fx = 25+1.5*EXP(-0.22*A2)

	A	B
1	t	T
2	0	26.5
3	1.5	26.07839
4	3	25.77528
5	4.5	25.55737
6	6	25.4007
7	7.5	25.28807
8	9	25.2071
9	10.5	25.14889
10	12	25.10704
11	13.5	25.07695
12	15	25.05532
13	16.5	25.03977
14	18	25.02859
15	19.5	25.02056
16	21	25.01478
17	22.5	25.01063
18	24	25.00764
19	25.5	25.00549
20	27	25.00395
21	28.5	25.00284
22	30	25.00204
23	31.5	25.00147
24	33	25.00105
25	34.5	25.00076
26	36	25.00055
27	37.5	25.00039
28	39	25.00028
29	40.5	25.0002
30	42	25.00015
31	43.5	25.0001
32	45	25.00008
33	46.5	25.00005
34	48	25.00004
35	49.5	25.00003

Graph

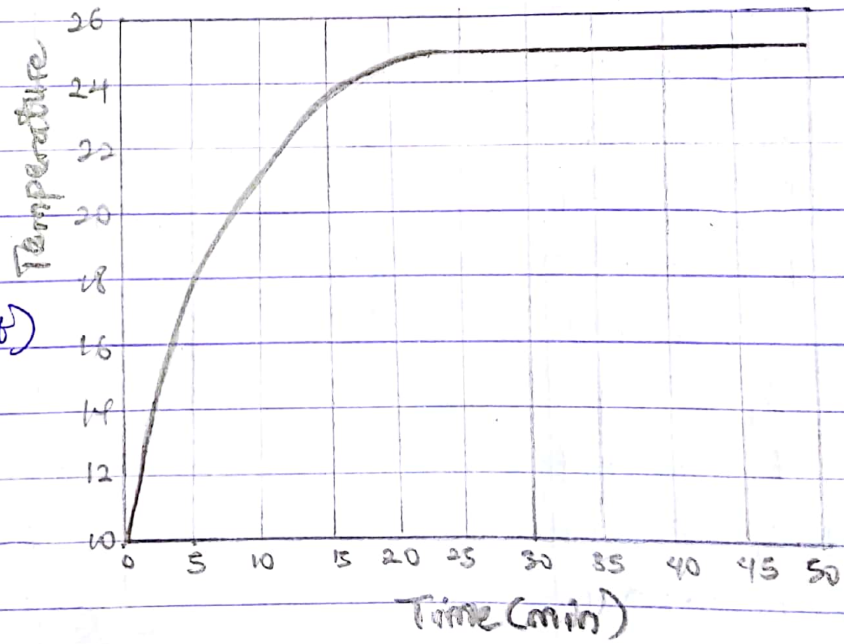


4(c)(iii) ~~OUTPUT~~

command window

```
clear
clc
close all
syms t T
t = 0:0.5:50
T = 25-1.5*exp(-0.22*t)
T2 = subs(T)
plot(t,T2)
grid on
grid minor
axis tight
xlabel('Time (min)')
ylabel('Temperature')
```

Graph



(iv) The steady-state temperature of the system is $25^\circ C$

(v) The system is stable when the temperature is at $25^\circ C$.

(vi) The time required for the thermometer to reach $24.9^\circ C$ is 23 minutes