EGBOCHUKWU EBENEZER UZOCHUKWU
CHEMICAL ENGINEERING
17/ENG01/005
ENG 282 - ENGINEERING MATHEMATICS 2 ASSIGNMENT

1. Define Mathematical modelling?

Mathematical modelling can be defined as the 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 variables or input variables from one form to another.

(2) Outline two methods of obtaining models for engineering system

Answer:

(a) By the use of Balance law
(b) By differentiation

(3) A thermometer that initially reads 10°C is used to measure the temperature of a system. The temperature of the thermometer is discovered to be 20°C after 5 minutes of inserting it into the system. If the actual temperature of the system is 25°C,

(a) Develop a model for the system

SOLUTION: Newton's law of cooling

$$\frac{dT}{dt} \quad \frac{d(T-T_A)}{}$$

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

T is the temperature reading of thermometer

T_A is the actual temperature of the system

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

Integrating through
We have

$$\ln(T-T_A) = \int k\,dt = kt + c$$

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

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

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

where $e^{c} = T_0$

$$T-T_A = T_0 e^{kt}$$

$$T = T_A + T_0 e^{kt}$$

At the initial temperature, $T(0) = 10°C$

$$T_0 = 25 + ce^{k(0)}$$

$$10 = 25 + c$$

$$-15 = c$$

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

To determine K

At a temperature, $T = 20°C$ at time $t = 5$ minutes

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

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

$$\left(\tfrac{1}{3}\right) = e^{5k}$$

$$\ln\left(\tfrac{1}{3}\right) = 5k$$

$$k = \frac{\ln(1/3)}{5} = 0.22$$

$$k = -0.22$$

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

(b) Simulate the developed model for time $t=0$ to $t=60$min using a steptime of 1min with the aid of microsoft excel

F(X) = 25-15* exp(-0.22*A2)

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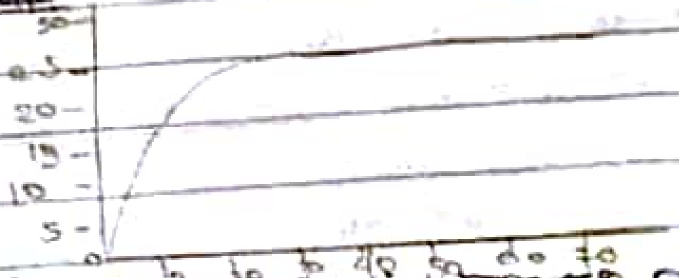
i	t	T
2	0	10
3	1	12.9622
4	2	15.33945
5	3	17.24723
6	4	18.77826
7	5	20.00693
8	6	21.7828
9	7	22.41933
10	8	22.92896
11	9	23.33745
12	10	23.66618
13	11	23.92958
14	12	24.14097
15	13	24.14097
16	14	24.31061
17	15	24.44675
18	16	24.55601
19	17	24.64369
20	18	24.71405
21	19	24.77052
22	20	24.81584
23	21	24.85221
24	22	24.88139
25	23	24.9032
26	24	24.93361
27	25	24.9387
28	26	24.9508
29	27	24.9605
30	28	24.9683
31	29	24.9746
32	30	24.9796
33	31	24.9836
34	32	24.9889
35	33	24.9885
36	34	24.9906
37	35	24.9945
38	36	24.9952
39	37	24.9983
40	38	24.9972
41	39	24.9977
42	40	24.9982
43	41	24.9985
44	42	24.9988
45	43	24.9991
46	44	24.9992
47	45	24.9994
48	46	24.9995
49	47	24.9996
50	48	24.9997
51	49	24.9997
52	50	24.9998
53	51	24.9998
54	52	24.9999
55	53	24.9999
56	54	24.9999
57	55	24.999.
58	56	24.9999
59	57	24.9999
60	58	25
61	59	25
62	60	25

Graph

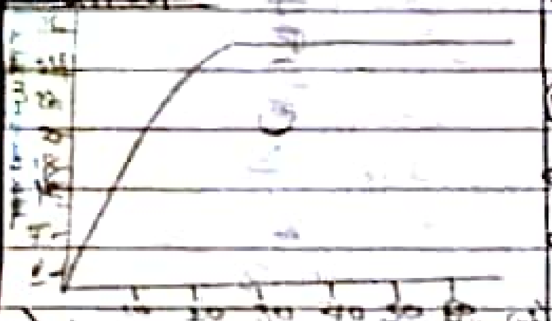


(3) Obtain the dynamic response of the system with the aid of MATLAB, without using 'syms' command for t=0, to t=60min using a step of 1min

ANSWER: 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 (seconds)')
Ylabel ('Temperature')
axis Tight
```

OUTPUT



4) Using either of the dynamic responses, write the steady state temperature of the system

Answer: From the dynamic response obtained, the steady state temperature

of system is 25°C at 24 minutes

5) Using the developed equation evaluate the temperature of the thermometer at t→∞

SOLUTION:

At t→∞, the temperature of the thermometer (T)

$\lim T = ?$ To find the limiting value of T, try for different values of t →∞, when t = 40

$T = 25 - 15e^{-0.22(40)}$

$T = 24.998°C$

t = 400

$T = 25 - 15e^{-0.22(400)}$

$= 25°C$

t = 4000

$T = 25 - 15e^{-0.22(4000)}$

$T = 25°C$

$t = 4 \times 10^3$

$T = 25 - 15e^{-0.22(4\times10^3)}$

$T = 25°C$

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

As time (t) increases, the temperature remains 25°C, therefore, the temperature at t→∞ is 25°C