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CHEMICAL ENGINEERING

17/ENG01/013

ENGINEERING MATHEMATICS II ASSIGNMENT 6

a) Modelling is mathematical representation of a system and simulation of a system involves solving the model and obtaining its output variable for different values of its input variable or as its input variable is changed from one value to another. A mathematical model is a description of a system using mathematical concepts and lang. The process of developing a model is modelling.

b) (1) Differentiating E.g Exponential growth/decay

(2) Balanced Law E.g Mixing problem

(3) Integrating Factor E.g Electric Circuit

c)i) $dT/dt = K(T-T_a)$

$(1/T-T_a).dT = Kdt$

Integrate both sides

$\ln(T-T_a) = Kt + c$

$T - T_a = e^{Kt + c}$

$T - T_a = e^{Kt} \cdot e^c$

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

$T_a = 25^\circ\text{C}$

$T - 25 = T_0 e^{kt}$

At $t=0$; $T=10^\circ\text{C}$

$10-25 = T_0 e^{k(0)}$

$T_0 = -15$

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

At $t=5$; $T=20$

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

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

$$1/3 = e^{5k}$$

$$5k = \ln(1/3) = -1.0986$$

$$K = -0.2197$$

$$T - 25 = -15e^{-0.2197t}$$

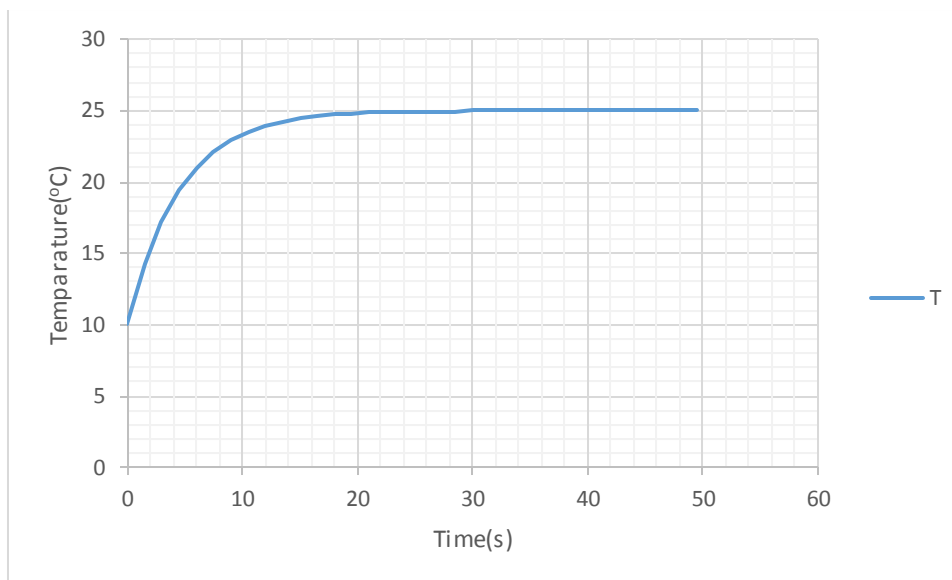
$$T = 25 - 15e^{-0.2197t} \text{-----Model}$$

ii)

t	T
0	10
1.5	14.21129
3	17.24025
4.5	19.41882
6	20.98575
7.5	22.11276
9	22.92336
10.5	23.50638
12	23.92572
13.5	24.22733
15	24.44426
16.5	24.60028
18	24.7125
19.5	24.79322
21	24.85127
22.5	24.89303
24	24.92306
25.5	24.94466
27	24.9602
28.5	24.97137
30	24.97941
31.5	24.98519
33	24.98935
34.5	24.99234
36	24.99449
37.5	24.99604
39	24.99715

40.5	24.99795
42	24.99853
43.5	24.99894
45	24.99924
46.5	24.99945
48	24.99961
49.5	24.99972

GRAPH



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iii) commandwindow
clear
clc
close all
t=0:0.5:50
T=25-(15*exp(-0.2197*t))
plot(t,T)
xlabel('Time(s)')
ylabel('Temp(^0C)')
grid on
grid minor

```

OUTCOME

t =

Columns 1 through 12

0 0.5000 1.0000 1.5000 2.0000 2.5000 3.0000 3.5000 4.0000 4.5000 5.0000
5.5000

Columns 13 through 24

6.0000 6.5000 7.0000 7.5000 8.0000 8.5000 9.0000 9.5000 10.0000 10.5000 11.0000
11.5000

Columns 25 through 36

12.0000 12.5000 13.0000 13.5000 14.0000 14.5000 15.0000 15.5000 16.0000 16.5000
17.0000 17.5000

Columns 37 through 48

18.0000 18.5000 19.0000 19.5000 20.0000 20.5000 21.0000 21.5000 22.0000 22.5000
23.0000 23.5000

Columns 49 through 60

24.0000 24.5000 25.0000 25.5000 26.0000 26.5000 27.0000 27.5000 28.0000 28.5000
29.0000 29.5000

Columns 61 through 72

30.0000 30.5000 31.0000 31.5000 32.0000 32.5000 33.0000 33.5000 34.0000 34.5000
35.0000 35.5000

Columns 73 through 84

36.0000 36.5000 37.0000 37.5000 38.0000 38.5000 39.0000 39.5000 40.0000 40.5000
41.0000 41.5000

Columns 85 through 96

42.0000 42.5000 43.0000 43.5000 44.0000 44.5000 45.0000 45.5000 46.0000 46.5000
47.0000 47.5000

Columns 97 through 101

48.0000 48.5000 49.0000 49.5000 50.0000

T =

Columns 1 through 12

10.0000 11.5605 12.9586 14.2113 15.3337 16.3393 17.2402 18.0475 18.7708 19.4188
19.9994 20.5197

Columns 13 through 24

20.9858 21.4034 21.7775 22.1128 22.4131 22.6822 22.9234 23.1394 23.3330 23.5064
23.6618 23.8010

Columns 25 through 36

23.9257 24.0375 24.1376 24.2273 24.3077 24.3797 24.4443 24.5021 24.5539 24.6003
24.6419 24.6791

Columns 37 through 48

24.7125 24.7424 24.7692 24.7932 24.8147 24.8340 24.8513 24.8667 24.8806 24.8930
24.9042 24.9141

Columns 49 through 60

24.9231 24.9311 24.9382 24.9447 24.9504 24.9556 24.9602 24.9643 24.9680 24.9714
24.9744 24.9770

Columns 61 through 72

24.9794 24.9816 24.9835 24.9852 24.9867 24.9881 24.9893 24.9905 24.9914 24.9923
24.9931 24.9938

Columns 73 through 84

24.9945 24.9951 24.9956 24.9960 24.9964 24.9968 24.9971 24.9974 24.9977 24.9979
24.9982 24.9984

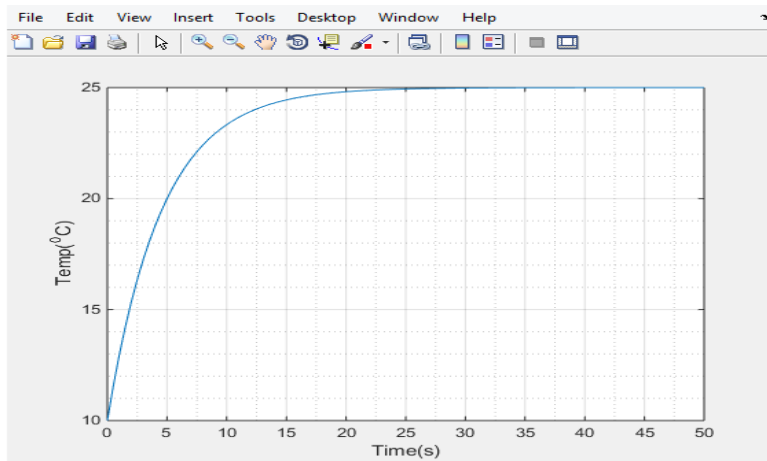
Columns 85 through 96

24.9985 24.9987 24.9988 24.9989 24.9990 24.9991 24.9992 24.9993 24.9994 24.9995
24.9995 24.9996

Columns 97 through 101

24.9996 24.9996 24.9997 24.9997 24.9997

GRAPH



iv) Steady State Temperature = 25°C

v) Initially in the system, Increase in time will lead to a proportionate increase in Temperature, until the steady state temperature is reached and Temperature becomes constant even on increase in time.

vi) $T = 24.9^{\circ}\text{C}$; $t=?$

$$T = 25 - 15e^{-0.2197t}$$

$$24.9 = 25 - 15e^{-0.2197t}$$

$$-0.1 = -15e^{-0.2197t}$$

$$6.67 \times 10^{-3} = e^{-0.2197t}$$

$$\ln(6.67 \times 10^{-3}) = -0.2197t$$

$$-5.0101 = -0.2197t$$

$$t = 22.8\text{min}$$