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LEVEL: 200 LEVEL

a) Mathematical modelling can be defined as the mathematical representation of a system and simulation of a system involves solving the mode and obtaining it's mathematical solution and its physical solution

b) By the use of balance law

ii) By differentiation

iii) The use of Newton law of cooling

c) From Newtons law of cooling states

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

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

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

integrate both sides

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

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

$$(T - T_A) = e^{kT} \cdot e^{C}$$

But $e^{C} = T^{0}$

$$T - T_A = T_0 e^{ut} \quad (1)$$

initially at $t = 0$ $T = 10°C$

and actual temperature

$T_A = 25°C$ equation one becomes

$$10 - 25 = T_C^{\times \cos}$$

$$15 = T_0 \times C = T_u$$

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

at $t = 5min$ $T = 20°C$

from $t = 25 - 15^{ut}$

$$20 = 25 - 15e^{-uw}$$

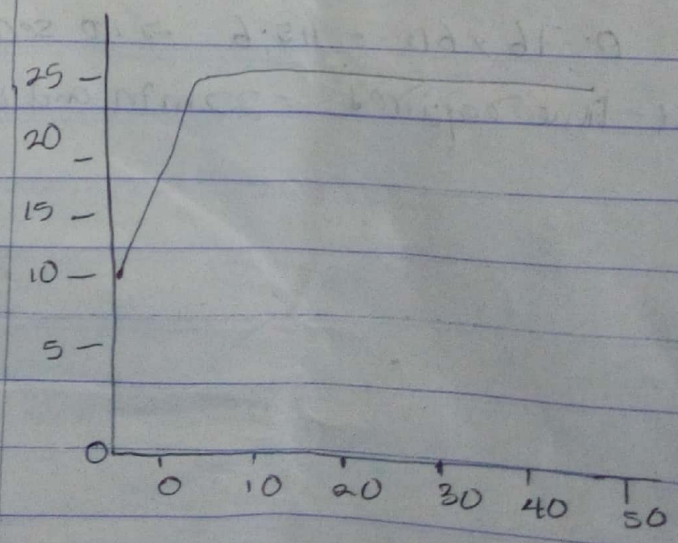
$$-5 = -15e^{5u}$$

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

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

$\therefore$ The model for the system

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



command window

Clear

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t = 0:0.5:50

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T = 25-15*exp(-0.22*t)
plot (t, T)
grid on
grid minor
x label ("Time (sec)")
y label ("Temperature (°C)")

The steady state temperature of the system = 25°C.

5) At the temp of 25°C it was 0.5 second that There was no change in the temp despite The increase in the time therefore the system is said to be stable at low temp.

6) for t = ? = t = 24.9°C
from equation $T = 25 - 15e^{-0.22t}$
$24.9 = 25 - 15e^{-0.22t}$
$0.1 = 15e^{-0.22t}$
$t = 22.76$ mins

0.76 mins → seconds
0.76 × 60 = 45.6 → 46 seconds
The time required = 22 min and 46 sec.

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