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17HENG031028

CIVIL ENGINEERING

ASSIGNMENT

Let $y(t)$ be the amount of air at any time t in ft^3 in the room.

$$\frac{dy}{dt} \rightarrow \text{fresh air inflow rate} - \text{fresh air outflow rate}$$

Fresh air inflow - $600 \text{ft}^3/\text{min}$

Fresh air outflow - Note: The amount flowing out of the room is a function of the amount in room.

$$\therefore \frac{600}{20000} = 0.03 \text{ min}^{-1}$$

i.e. 0.03 of $y(t)$ is the outflow $= 0.03y \text{ft}^3/\text{min}$.

Now;

$$\begin{aligned} \frac{dy}{dt} &= 600 - 0.03y \\ &= -0.03y + 600 \\ &= -0.03(y - 20000) \end{aligned}$$

This equation can be separated and integrated = 1

$$\frac{dy}{y - 20000} = -0.03 dt$$

$(y - 20000)$

Find the integral of both sides

$$\ln(y - 20000) = -0.03t + c$$

$$y - 20000 = e^{-0.03t + c}$$

$$y - 20000 = e^{-0.03t} \cdot e^c$$

Recall $c = e^c = \text{initial equation}$

$$\therefore y - 20000 = e^{-0.03t} \cdot c \quad (1)$$

At $t=0$, $y(t) = 0$ since the room contained no fresh air initially.

put $y=0$; $t=0$ in eqn (1)

$$y = 20000 = e^{-0.03t} \cdot c$$

$$0 - 20000 = e^0 \cdot c$$

$$0 - 20000 = \pm(c)$$

$$c = -20000 \quad (2)$$

Put eqn (2) in eqn (1)

$$y = 20000 - 20000e^{-0.03t}$$
$$y = 20000(1 - e^{-0.03t}) \quad (3)$$

Equation (3) above is the model for the amount of fresh air in the room.

Calculate the time at which 90% of the air in the room will become fresh.

$$90\% = \frac{90}{100} = 0.9$$

$$y = 0.9 \times 20,000 \text{ i.e. } 90\% \text{ of air in the room.}$$
$$= 18000 \text{ ft}^3$$

$$y = 20000(1 - e^{-0.03t})$$
$$18000 = 20000(1 - e^{-0.03t})$$

$$0.9 = 1 - e^{-0.03t}$$

$$e^{-0.03t} = 1 - 0.9$$

$$e^{-0.03t} = 0.1$$

$$-0.03t = \ln(0.1)$$

$$t = \frac{\ln(0.1)}{-0.03}$$

$$= -2.303$$

Close all

Syms y, T

$$y = 20000 * (1 - \exp(0.03 * T))$$

$$T = 0.5 : 360$$

$y_n = \text{subs}(y)$

$P_{10} = (T, y_n)$

X Label (Time (min))

Y Label (Flowrate of fresh air (ft^3/min))

Grid on.

Grid minor.