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CIVIL ENG

ASSIGNMENT 4

Let $y(t)$ be the amount of air in the room at anytime t

$\frac{dy}{dx}$ = Fresh air in flow rate - fresh air outflow rate

Fresh air inflow = $600 ft^3/min$

fresh air outflow = $\frac{600}{20000}$ = 0.03 min

ie 0.03 of $y(t)$ is the outflow

Now;

$$\frac{dy}{dx} = 600 - 0.03y$$
$$= -0.03y + 600$$
$$= -0.03(y - 20000)$$

Thus the equ is seperable and can be written as

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

Integrate both sides.

$$\ln(y - 20000) = -0.03t + c$$
$$y - 20000 = e^{-0.03t} + c$$
$$y - 20000 = e^{-0.03t}e^{c}$$

Recall $c = e^{c}$ = initial condition

$$y - 20000 = e^{-0.03t}c \quad \text{------ } (*)$$

At $t = 0$ $y(t) = 0$

Since the room containes no fresh air initially

$$y - 20000 = Ce^{-0.03(t)}$$
$$0 - 20000 = c$$
$$(t) = c = -20000 \quad \text{----- } a$$

Put a in equ $(*)$

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

The equation above is the model for the amount of fresh air in the room

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

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

$y = 0.9$ of 20000

$= 18000 \, ft^2$

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

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

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

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

$e^{-0.03t} = 0.1$

$-0.03t = \ln(0.1)$

~~t = ln (0.1)~~

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

$t = \frac{-2303}{-0.03}$

$= 76.77$

$\simeq 77 \text{mins}$

$\therefore$ The air in the room ~~will~~ will be 90% fresh at 77mins

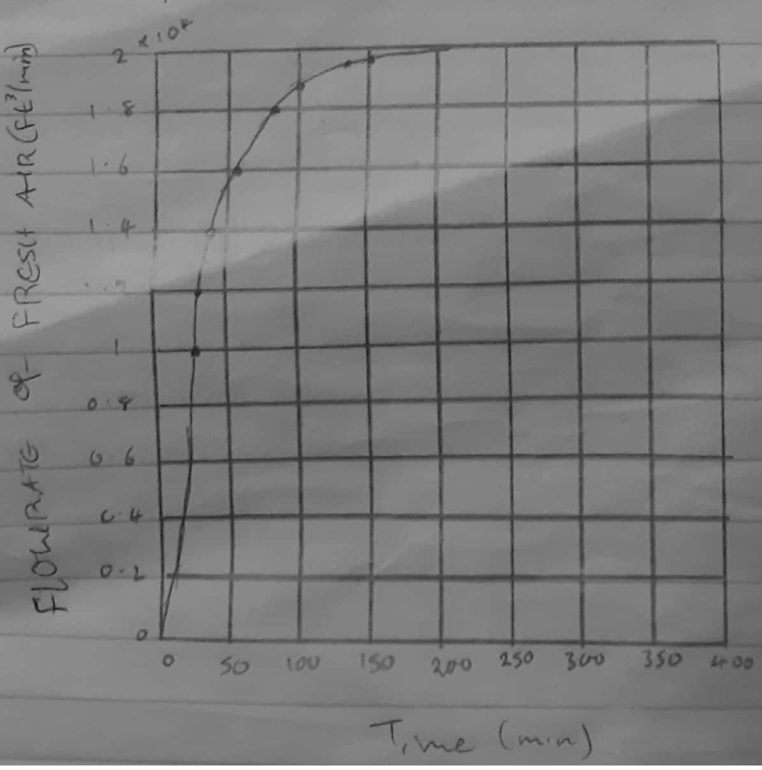
c) With the aid of ~~matlab~~ Matlab plot a dynamic response of the amount of fresh air in the room for t = 0 to t = 6hr using a step of 5min.

N/B : t = 6hours = 6 × 60 = 360min

Codes

```
Commandwindow
clear all
clc
close all
sym Y, t, k
Y = 20000*(1 - exp(-0.03*t))
t = 0:5:360
Yn = subs (Y)
Plot (t, Yn)
~~Xlabel (t, Yn)~~
XLabel ('TIME (min)')
YLabel ('FLOW RATE OF FRESH AIR (ft^3/min)')
gridon
grid minor
axis right
```

output



(d) The steady-state value is 20000 ft^3 at 215 mins (3 hours 35 min) of exponential approach

(e) The function shows an exponential approach to the limit of 20000 ft^3 as y increases with time. Also when the steady-state value approach 20000 ft^3 at 45 mins and continues till 360 min (6 hours). The model ~~discusses~~ becomes more realistic in pneumatic technology, although maybe different because mixing maybe imperfect.

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