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17/ENG06/029
MECHANICAL ENGINEERING
ENG 282.
ASSIGNMENT 4.

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

$\partial y / \partial x$ = fresh air in flow rate - fresh air outflow rate.

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

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

i.e 0.03 of $y(t)$ is the outflow

Now,

$$\partial y / \partial t = 600 - 0.03y$$
$$= -0.03y + 600$$
$$= -0.03(y - 20000)$$

Thus the eqn is seperable and can be written as

$$\frac{\partial y}{y - 20000} = -0.03 \partial t$$

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

$$y - 20000 = e^{-0.03t} c. \quad \circledast$$

at $t = 0$ $y(t) = 0$ Since the room contained no fresh air

Initially

$y = 20000 = Ce^{-0.03(t)}$

$0 - 20000 = c$

$(t) = c = -20000$ (a)

Put a in equation (*)

$y = 20000 - 20000e^{-0.03t}$.

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

The equation 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

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

$= 0.9$

$y = 0.9$ of 20000

$= 18000\, ft^2$

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

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

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

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

$e^{-0.03t} = 0.1$

$-0.03t = \ln(0.1)$

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

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$$t = \frac{-2303}{-0.03}$$
$= 76.77$
$\simeq 77 mins$

c) With the aid of matlab Plot a dynamic response.

N/B $t = 6 hours = 6 \times 60 = 360 minutes$

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('Time(min'))
ylabel('FLOWRATE OF FRESHAIR(ft^3/min)')
gridon.
grid minor
axis right
```

d) Determine the steady-state value of the amount of fresh air in the room

The Steady-state value is 20000 ft3/ at 215 mins of exponential approach

e) Comment on answer

The function shows an exponential approach to the limit of 20000 ft^2 as y increases with time. Also when the steady state value approach 20000 ft^3 at 45mins and continues till 360 minutes