Aruna [illegible]
17/[illegible]/03
[illegible]

2 a) [illegible] [illegible] of fresh air [illegible] [illegible] [illegible] [illegible] of air. The [illegible] which is made [illegible] [illegible] [illegible] is [illegible] at the rate 600 ft^3/min. If the [illegible] [illegible] is fresh [illegible]

a) develop a model for the amount of fresh air in the room at [illegible]

Answer.

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

$\frac{dy}{dt}$ = fresh air inflow rate - fresh air [illegible]

fresh air inflow = 600 ft^3/min

Fresh air outflow: Note the amount flowing out of the room is a fraction of the amount in the room

$$\frac{600}{20{,}000} = 0.03 \text{ min}$$

i.e. 0.03 or $y(t)$ in the outflow 0.03 ft^3/min

Now

$$\frac{dy}{dt} = 600 - 0.03y$$

$$= -0.03y + 600$$

$$= -0.03y\,(y - 20000)$$

This equation can be separable & integrable

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

from the integral of both side

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

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

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

Letting $C = e^{c}$ = [illegible] equation

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

At $t = 0$, $y(t) = 0$ [illegible] the room [illegible] no fresh

air [illegible]

Put $y=0$; $t=0$ in equ (1)

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

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

$0 - 20000 = 1(c)$

$c = -20000$ ..... (2).

Put eqn (2) in eqn (1)

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

$y = 20000(1 - e^{-0.03t})$ ..... (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 $90\% = \frac{90}{100} = 0.9$.

$y = 0.9 \times 20000$ is 90% of air in the room.

$= 18000 ft^3$.

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

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

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

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

$e^{-0.03t} = 0.1$

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

$= \frac{-2.303}{-0.03}$

$= 76.77 min$

$= 77 mins$

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

Note $t = 8hrs$

$= 6 \times 60$

$= 800 mins$

Solution

```
Command window
clear all
cls
Close all
syms y, t
y = 20000 * (1 - exp(-0.03*t))
t = 0.5
yn = subs(y)
plot (t,yn)
xlabel ('Time (min)')
Ylabel ('flowrate of fresh air (ft^3/min
Grid on
Grid minor
Axis tight
```

output

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

A : The steady state value is 20000 Ft^3 at 215min (3hr and 35 min) at exponential approach.

e.) Comment on answer

The functions above shows an exponential approach to the limit of 20000ft^3 as y increases with time. Also, when the steady state value approaches 20000ft^3 at 215min and continues for 300min (5hrs). The model becomes more realistic in primary technology, although, maybe difficult because mixing may be imperfect