ISSANG ROSEMARY 17/ENG04/023 Civil/Elect Engineering

ENG 282 ASSIGNMENT IV

According to balance law;

a) $\frac{dA}{dt} = A_{in} - A_{out}$

$= 600 ft^3/min - \left(\frac{600}{20,000} \times A\right) ft^3/min$

$= 600 - (0.03A)$

$= -0.03(-20000 + A)$

$\frac{dA}{dt} = -0.03(A - 20000)$

$\frac{1}{(A-20000)} \cdot dA = -0.03dt$

$\ln(A-20000) = -0.03t + C$

$A - 20000 = e^{-0.03t + C}$

$A - 20000 = e^{-0.03t} \cdot e^{C}$

$A - 20000 = A_0 e^{-0.03t}$

When $t=0$, $A > 0$ (Because initially there was no fresh air in the room)

So,

$0 - 20000 = A_0 e^{-0.03(0)}$

$-20000 = A_0$

$\therefore$

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

$A = 20000 - 20000e^{-0.03t}$ (model of the system)

b) 90% of $20,000 ft^3$

$= \frac{90}{100} \times 20000$

$= 18,000 ft^3$

So,

When $A = 18000 ft^3$ $t = ?$

$$18000 - 20{,}000 = -20000 e^{-0.03t}$$

$$-2000 = -20000 e^{-0.03t}$$

Divide both sides by '-20000'

$$\frac{-2000}{-20000} = e^{-0.03t}$$

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

Taking the ln of both sides

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

$$-2.3026 = -0.03t$$

Divide both sides by '-0.03'

$$\frac{-2.3026}{-0.03} = \frac{-0.03t}{-0.03}$$

$$76.75 \text{ min} = t$$

c)

```
1 - commandwindow
2 - clear
3 - clc
4 - close all
5 - t = [0 : 5 : 360] (6 hours)
6 - A = 20000 - 20000 * (exp(-0.03 * t))
7 - plot (t, A)
8 - xlabel ('Time (min)')
9 - ylabel ('Volume of air (ft^3)')
10 - grid on
11 - grid minor
```

d) Steady state Value from the graph = 20,000 ft^3

e) The implication of the steady state value being 20,000 ft^3 is this:

The volume of the fresh air will keep increasing with respect to time up until it attains a volume of 20,000 ft^3 where it will no longer vary but will remain constant for any time $t \geq$ as from 170 mins