ENGINEERING MATHEMATICS II

Assignment 4

Question 1

(1) Inflow rate = 600 Ft³/min

Amount of air in the room = 20000 Ft³

Outflow rate = ~~600 Ft³/m~~ x

$y(t)$ = Inflow rate − Outflow rate

Out Flow rate = ~~20,000~~ x

Out Flow rate = $\frac{600}{20,000} \times A$

Out Flow rate = $0.03A$

$y(t)$ = Inflow rate − Outflow rate

$y(t) = 600 - A0.03$

$y(t) = A0.03\left(\frac{20000}{A} - 1\right)$

or change of variable

$dy/dt = y0.03\left(\frac{20000}{y} - 1\right)$

$dy/dt = -y0.03\left(1 - \frac{20000}{y}\right)$

~~$\frac{dy}{-y0.03} =$~~

$dy/dt = -0.03(y - 20,000)$

$\int \frac{dy}{(y-20,000)} = \int -0.03\,dt$

$Ln(y-20,000) = -0.03t + C$

$y - 20,000 = e^{-0.03t+C}$

(2) Intially $y(t) = 0$

amount of air in the room

Inflow = time = 0

$(0) = y_0 e^{-0.03t} + 20000$

$y(t) = y_0 e^{-0.03t} + 20,000$

$(0) = y_0 + 20,000$

$y_0 = -20000$

$y(t) = 20,000 - y_0 e^{-0.03t}$

$y(t) = 20,000 - 20000e^{-0.03t}$

$y(t) = 20,000 - 20,000e^{-0.03t}$

$180000 - 20,000 = -20000e^{-0.03t}$

$\frac{72000}{20,000} = \frac{+20,000e^{-0.03t}}{20,000}$

$0.1 = e^{-0.03t}$

$\ln 0.1 = -0.03t$

$\frac{+2.3025}{0.03} = \frac{+0.03t}{0.03}$

$t = 76.75$ min to

Time at which 90% of air in the room = 76.75 min

(3)

Command Window

```
clear
clc
syms t
syms t
y = 20000 - 20000*exp(-0.03*t)
t = 0:5:360
yn = subs(y)
ynn = double(yn)
Plot(t, ynn, 'orange')
```

(e) The value of steady state is only attained when there is no step difference in input. The ~~rate of~~ difference in input to output is zero. And steady state error is equals 0.

Prove

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

$$y(t) = 20,000 - 20000\,e^{-0.03(180)}$$

19909 ft^3/min of air that is fresh.