Dept: Mechanical Engineering
Matric no: 17/ENG06/075
Course code: ENG282

Inflow rate = 600ft^3/min
Amount of air in the room = 20000ft^3
Outflow rate = x

$y(t)$ = Inflow rate − Outflow rate

Outflow rate $= \frac{600}{2000} \times A$

Outflow rate = $0.03A$

$\therefore$ ~~Outflow rate~~ $y(t) = 600 - 0.03A$

$y(t) = 0.03A\left(\frac{20000}{A} - 1\right)$

$$\frac{dy}{dt} = 0.03y\left(\frac{20000}{y} - 1\right)$$

$$dy/dt = -0.03y\left(1 - \frac{20000}{y}\right)$$

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

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

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

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

$$y - 20000 = e^{-0.03t} \cdot e^{c} \quad \text{where } e^{c} = y_0$$

$$y - 20000 = e^{-0.03t} \cdot y_0$$

$$y - 20000 = y_0 e^{-0.03t}$$

$$y = y_0 e^{-0.03t} + 20000$$

1 At $y(t) = 0$

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

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

$$0 = y_0 + 20000$$

$$\therefore y_0 = -20000$$

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

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

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

$18000 - 20000 = -20000 e^{-0.03t}$

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

$e^{-0.03t} = 0.1$

$0.03t = \ln 0.1$

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

$t = 76.75 min$

(b) The time at which there is 90% of air in the room = 76.75 min

(c) Command window

```
Clear
Clear all
syms t
y = 20000 - 20000*exp(-0.03*t)
t = (0:5:360)
yn = subs(y)
ynn = Double(yn)
plot(t, ynn)
```

(d) The steady value of the fresh air in the room
The steady value is about 180 min 1.0 3 hours

(e) The steady state error is equals to Zero. The difference of output to input equals Zero