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17/SCI14/038
Civil Engr.
ENG 282

(5) Let $f(t)$ = amount of air at time t in (ft^3) in the room.

$\frac{df}{dt}$ = Air inflow rate − Outflow rate of air

Air inflow = $600ft^3/min$

Recall: The amount of air flowing out is a function of the amount of air in the room

$\frac{600}{20000} = 0.03 min$

ie 0.03 of $f(t)$ is the outflow $= 0.03yft^3$

$\therefore \frac{df}{dt} = 600 - 0.03f$

$= -0.03f + 600$

$= -0.03(f - 20,000)$

Using separating the variable method

$\int \frac{df}{(f - 20000)} = \int -0.03dt$

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

$f - 20,000 = e^{-0.03t + c}$

$f - 20,000 = e^{-0.03t} \cdot e^{c}$

Recall $C = e^{c}$ = initial condition

$\therefore y - 20,000 = e^{-0.03t}C$ ——— (1)

At $t = 0$, $f(t) = 0$

$f - 20000 = Ce^{-0.03(0)}$

$0 - 20000 = C$

$\therefore C = -20,000$ ——— (2)

Put eqn (2) in (1)

$f - 20,000 = -20,000e^{-0.03t}$ ——— (3)

Equation (3) is the model for the amount of fresh air in the room.

$f = 0.9 \times 20,000$

$= 18,000 ft^3$

$f = 20,000 - 20,000 e^{-0.03t}$ from eqn (3)

$f = 20,000(1 - e^{-0.03t})$

$\therefore 18,000 = 20,000(1 - e^{-0.03t})$

$\frac{18,000}{20,000} = 1 - e^{-0.03t}$

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

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

$e^{-0.03t} = 0.1$

$-0.03t = \ln(0.1)$

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

$t = 76.75$ mins

$t \simeq 77$ mins

(c) $t = 6hrs = 360mins$

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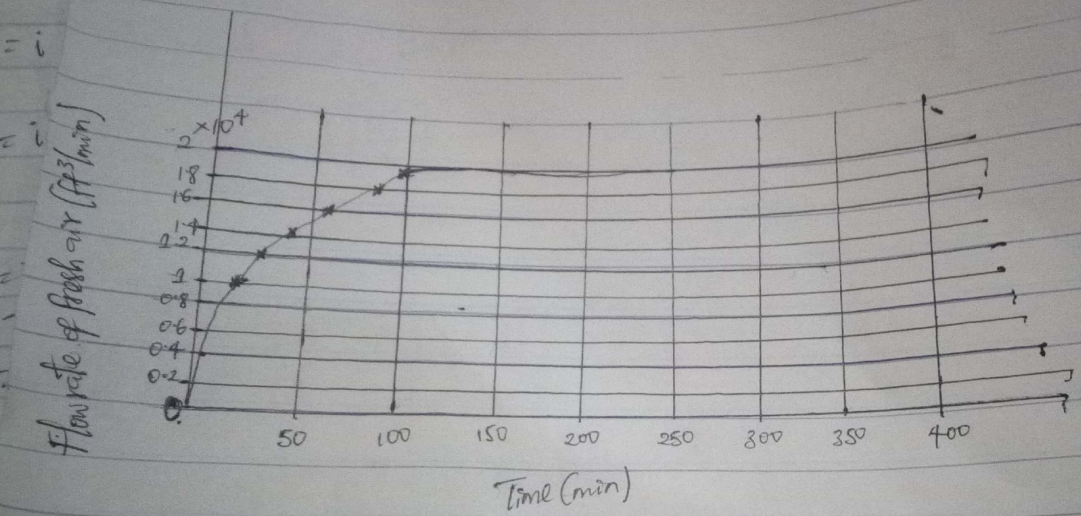
Command window
clear
clc
close all
Syms f, t
f = 20,000 * (1 - exp(-0.03*t))
t = 0:5:360
fn = Subs(f)
Plot (t, fn)
xlabel('Time(MIN)')
ylabel('Flowrate of fresh Air (FT^3/MIN)')
grid on
grid minor
```

$\int_i^o$ Output

$= i$

$= i$



(d) The steady-state ~~value~~ value is 20000 ft³/min at ~~215~~ 3hours 35minutes (215mins) of exponential approach.

(e) The function shows an exponential concept to the limit of 20000ft³ as f increases with time.