Name: Alegbeleye Oluwafemi Oladipupo

Mat No: 17/ENG04/011

Dept: - Electrical/Electronics Engineering.

ENG282 Assignment 4

It is discovered that 600ft^3/min of fresh air flows into a room containing 20000 ft^3 of air. The mixture, which is made practically uniform by circulating fans, is exhausted at a rate of 600 cubic feet per minute (cfm). If the room contain no fresh air initially.

(a) develop a model for the amount of fresh air in the room at any time t.

(b) Calculate the time at which 90% of the air in the room will become fresh.

(c) with the aid of MATLAB, plot the dynamic response of the amount of fresh air in the room for t=0 to t=6hr using a step time of 5min.

etermine the steady-state value of the amount of fresh air in the room, and omment on the result obtained in (d).

olution.

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

$\frac{dy}{dt}$ = Air inflow rate - flesh air outflow rate

fresh Air inflow → 100 ft^3/min.

fresh air outflow → $\frac{600}{2000} = 0.03\text{min}$.

The amount flowing out of the room is ~~given~~ a function of the amount in the room.

$= 0.03y\ ft^3/min.$

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

$$= -0.03y + 600$$

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

Equation can be resolved as

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

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

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

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

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

$= y - 2000 = e^{-0.03t} \cdot e^{c}$

$C = e^{c}$ = intial condition.

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

At $t=0$, $y(t)=0$ Since no fresh air was contained in the room initially

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

$0 - 20000 = C$

$C = -20000$

Substituting $C = -20000$

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

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

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

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

The equation above is the model for the amount of fresh air in the room

b. Calculate the time at which 90% of the air in the room will become fresh

$90\% = \frac{90}{100} = 0.9$

$y = 0.9$ of 20000

$0.9 \times 20000 = 18000 ft^3$

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

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

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

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

$e^{-0.03t} = 0.1$

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

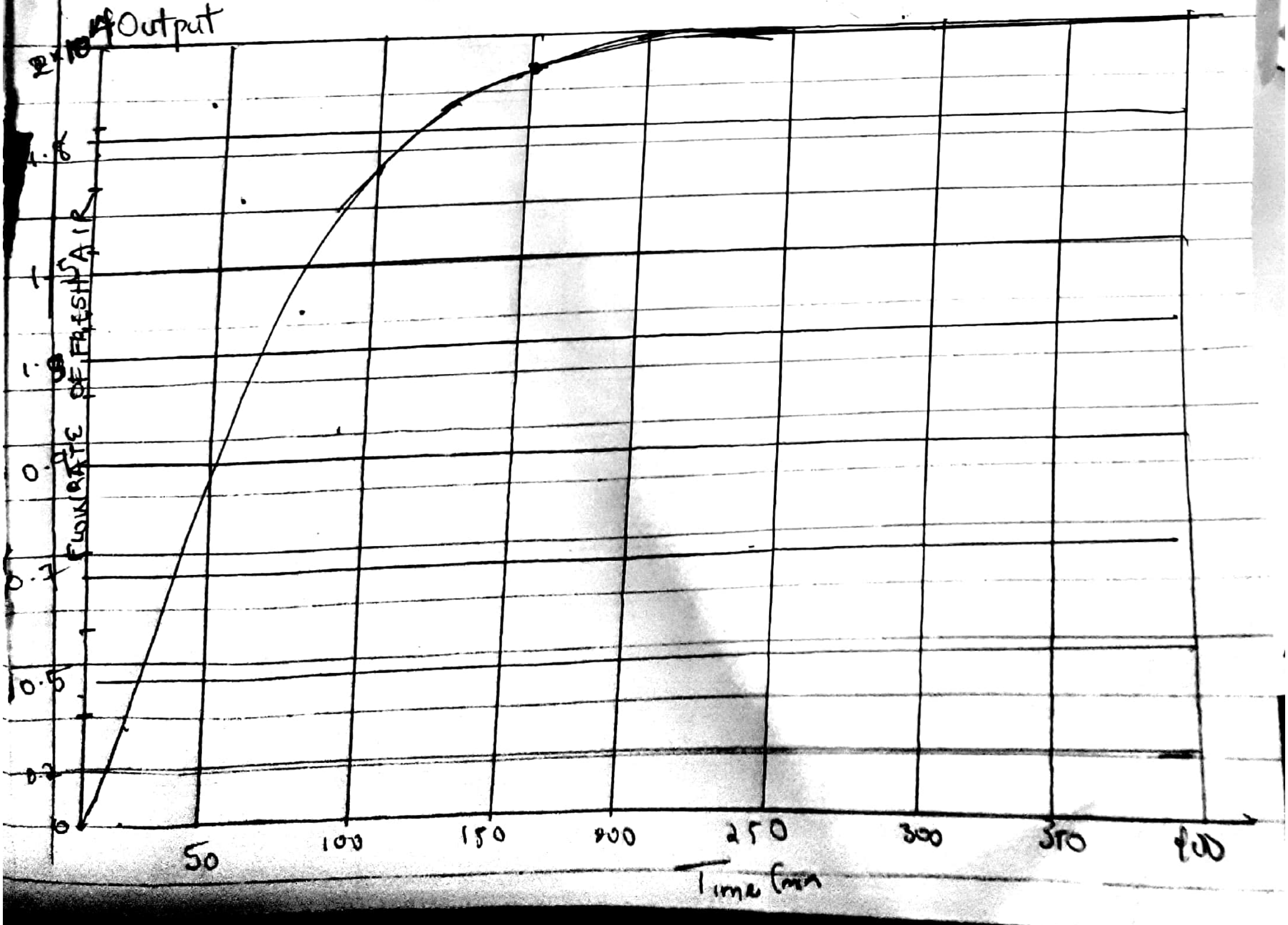
$-0.03t = \ln(0.1)$

$t = \frac{-2.3026}{-0.03}$ $t = 77 mins$

with the aid of matlab.

```
Commandwindow
Clear
clc
Close all
Syms t
y = 20000* (1- exp(-0.03*t))
t = 0:5:360
yn = Subs(y)
Plot (t, yn)
xlabel ('Time (min)')
ylabel ('Flowrate of fresh air')
gridon
grid minor
axis tight
```

Output



d Determine the steady-state value of the amount of fresh air
The Steady state-value is $20000 ft^3$ at 215min of the exponential approach.

ⓔ Comment on the result obtained in d
The function shows an exponential growth / approach to the limit of $20000 ft^3$ as y increase with time and the Steady value was $20000 ft^3$ at 215min ~~[illegible]~~ while it worked for 6hours.