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CHEMICAL ENGINEERING

17/ENG01/013

ENGINEERING MATHEMATICS II ASSIGNMENT 4

a) $Y(t)$ = amount of air in room at time t

dy/dt = rate of increase of fresh air per unit time

$$dy/dt = y_{in} - y_{out}$$

$$dy/dt = 600 - (600/20,000)y$$

$$dy/dt = -600/20,000 (-20,000+y)$$

$$dy/dt = -600/20,000 (y-20,000)$$

$$1/(y-20,000) dy = -600/20,000 dt$$

$$\ln(y-20,000) = -0.03t + c$$

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

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

LET $e^c = b$

$$Y(t) = 20,000 + be^{-0.03t} \text{-----} (*)$$

At initial condition, $y(0)=0$ and $t=0$

$$Y(0) = 0 = 20,000 + be^{-0.03(0)}$$

$$0 = 20,000 + b$$

$$b = -20,000$$

Substitute for b in eqn (*)

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

b) When 90% Of air will become fresh

$$\text{When } y = 90/100 * 20,000 = 18,000$$

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

$$-2,000 = -20,000e^{-0.03t}$$

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

$$\ln 0.1 = -0.03t$$

$$-2.3 = -0.03t$$

$$t = 76.6$$

= 77 minutes

```
c) commandwindow
clear
clc
close all
t=[0:5:360]
y=20000-20000*exp(-0.03*t)
xlabel('t(s)')
ylabel('Y')
grid on
grid minor
```

OUTPUT

t =

Columns 1 through 20

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95

Columns 21 through 40

100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190
195

Columns 41 through 60

200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290
295

Columns 61 through 73

300 305 310 315 320 325 330 335 340 345 350 355 360

y =

1.0e+04 *

Columns 1 through 12

0 0.2786 0.5184 0.7247 0.9024 1.0553 1.1869 1.3001 1.3976 1.4815 1.5537
1.6159

Columns 13 through 24

1.6694 1.7155 1.7551 1.7892 1.8186 1.8438 1.8656 1.8843 1.9004 1.9143 1.9262
1.9365

Columns 25 through 36

1.9454 1.9530 1.9595 1.9652 1.9700 1.9742 1.9778 1.9809 1.9835 1.9858 1.9878
1.9895

Columns 37 through 48

1.9910 1.9922 1.9933 1.9942 1.9950 1.9957 1.9963 1.9968 1.9973 1.9977 1.9980
1.9983

Columns 49 through 60

1.9985 1.9987 1.9989 1.9990 1.9992 1.9993 1.9994 1.9995 1.9996 1.9996 1.9997
1.9997

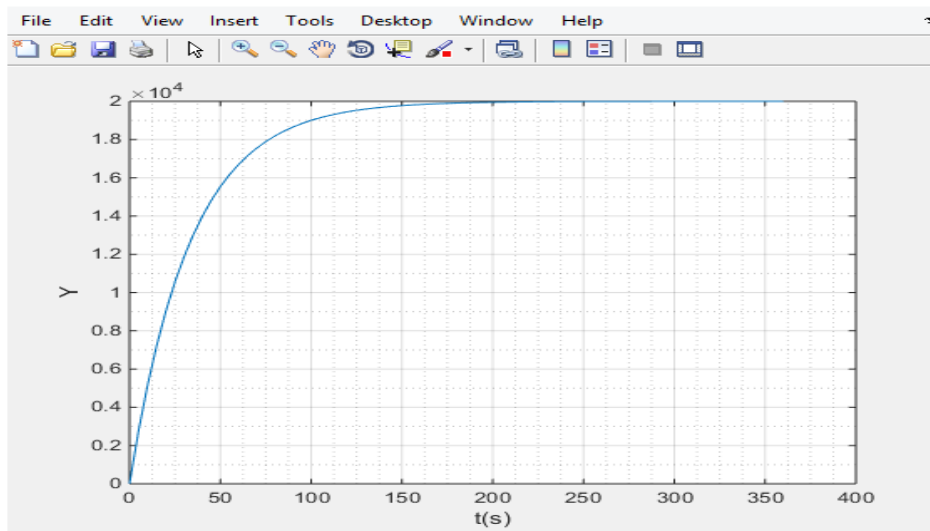
Columns 61 through 72

1.9998 1.9998 1.9998 1.9998 1.9999 1.9999 1.9999 1.9999 1.9999 1.9999 1.9999
2.0000

Column 73

2.0000

GRAPH



d) Steady state value is 200min = 3hrs 20 min

e) The result shows that at 200min, $y \rightarrow \infty$, giving a steady plot.