OLOWOMEYE EMMANUEL OLAMIDE

14/ENG01/014

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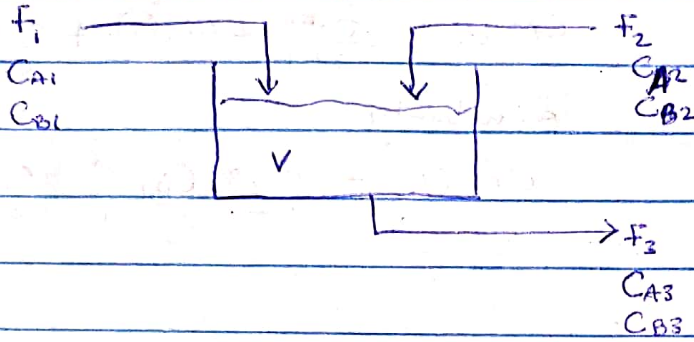


Assumption

- Constant volume.

$$F_1 + F_2 = F_3$$

Mole balance.

$$\frac{dn}{dt} = n_{in} - n_{out}$$

$$\frac{d(C_{A3} V)}{dt} = F_1 C_{A1} + F_2 C_{A2} - (F_1 + F_2) C_{A3}$$

$$V \frac{dC_{A3}}{dt} = F_1 C_{A1} + F_2 C_{A2} - (F_1 + F_2) C_{A3}$$

$$V \cdot \frac{dC_{A3}}{dt} + (F_1 + F_2) C_{A3} = F_1 C_{A1} + F_2 C_{A2}$$

divide through by $F_1 + F_2$

$$\frac{V}{F_1 + F_2} \frac{dC_{A3}}{dt} + C_{A3} = \frac{F_1}{F_1 + F_2} C_{A1} + \frac{F_2}{F_1 + F_2} C_{A2} \quad (1)$$

Similarly for Component B

$$\frac{V}{F_1 + F_2} \frac{dC_{A3}}{dt} + C_{B3} = \frac{F_1}{F_1 + F_2} C_{B1} + \frac{F_2}{F_1 + F_2} C_{B2} \quad (2)$$

Assuming no component in mixed stream initially

Using (1)

$$\frac{5.5}{3.2+2.3}\frac{dC_{A3}}{dt} + C_{A3} = \frac{3.2}{3.2+2.3} C_{A1} + \frac{2.3}{3.2+2.3} C_{A2}$$

$$\frac{dC_{A3}}{dt} + C_{A3} = 0.58\, C_{A1} + 0.42\, C_{A2}.$$

~~transfer~~ function:

$$C_{A3}(s)\,(s+1) = 0.58\, C_{A1}(s) + 0.42\, C_{A2}(s)$$

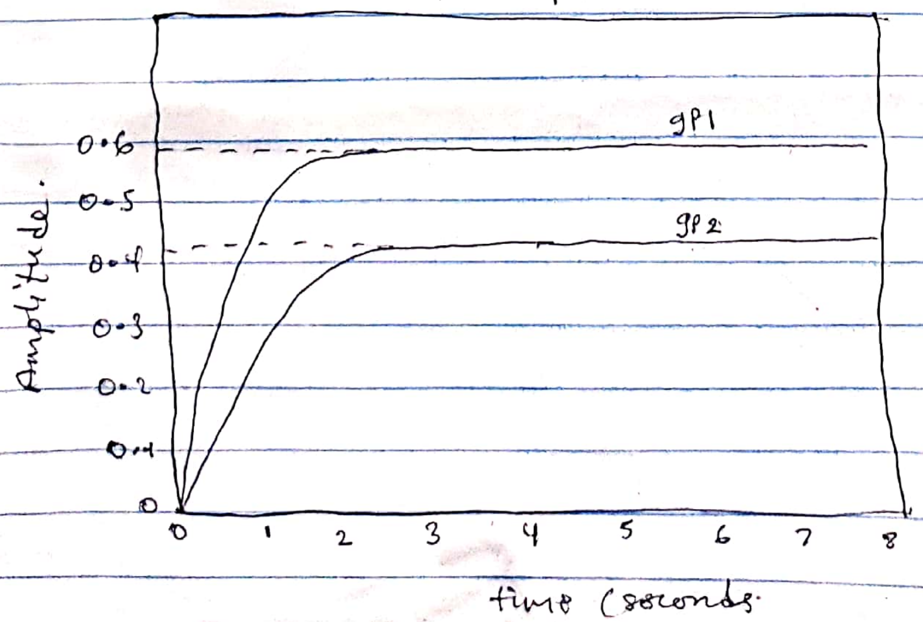
$$C_{A3}(s) = \frac{0.58}{s+1} C_{A1}(s) + \frac{0.42}{s+1} C_{A2}(s)$$

Similarly

$$C_{B3}(s) = \frac{0.58}{s+1} C_{B1}(s) + \frac{0.42}{s+1} C_{B2}(s)$$

```
1 - commandwindow
2 - clear
3 - close
4 - clc
5 - num1 = 0.58;
6 - deno1 = [1 1];
7 - gp1 = tf(num1, deno1);
8 - num2 = 0.42;
9 - deno2 = [1 1];
10 - gp2 = tf(num2, deno2)
11 - Gp = [gp1 gp2];
12 - step(gp1)
13 - hold on
14 - step(gp2)
```

step response

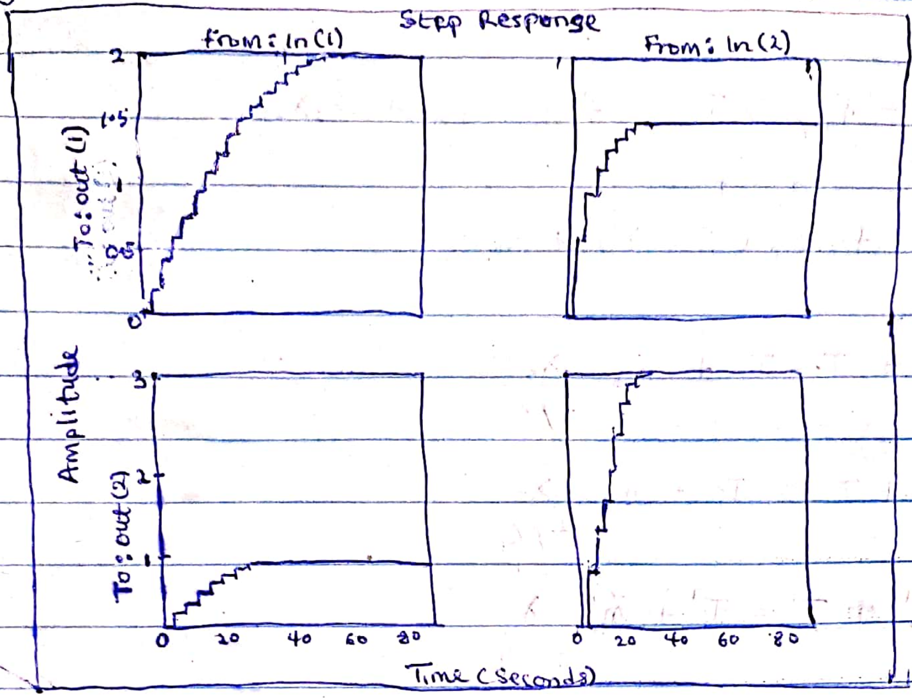


(b)

```
1-Commandwindow
2-Clear
3-Close
4-clc
5-num1 = 2;
6-deno1 = [11 1];
7-Gp1 = tf (num1, deno1);
8-num2 = 1.5;
9-deno 2 = [3 1];
10-Gp2 = tf (num2, deno2);
11-num3 = 1;
12-deno 3 = [10 1]
13-Gp 3 = tf (num3, deno 3)
14-num 4 = 3;
15-deno 4 = [5, 1];
16-Gp 4 = tf (num4, deno4)
17-Gp = [Gp1 Gp2 ; Gp 3 Gp 4]
18- figure (1)
19- Step (Gp)
20- GP = c2d (Gp, 1.5)
21- figure (2)
22- step (GP)
```

Scanned by CamScanner

Figure 2



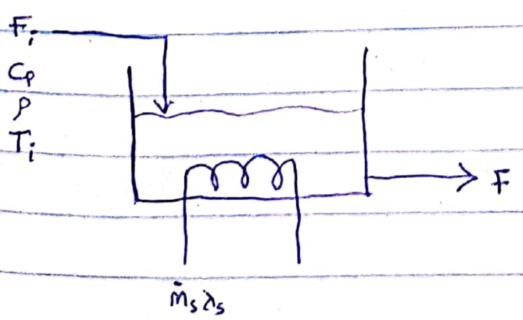
DISCRETE MODEL EQUIVALENT OF THE TRANSFER FUNCTION MATRIX

$$G_P = \begin{bmatrix} \dfrac{0.2549}{z - 0.8725} & \dfrac{0.5902}{z - 0.6065} \\ \\ \dfrac{0.1393}{z - 0.8607} & \dfrac{0.7775}{z - 0.7408} \end{bmatrix}$$

Sample time : 1.5 seconds.

QUESTION 2

a)



Taking the energy balance

$$\frac{dH_{sys}}{dt} = H_{in} - H_{out} + Q$$

$$\frac{d(M_{sys}.h)}{dt} = \dot{m}_{in}h_{in} - \dot{m}h + \dot{m}_s\lambda_s$$

$$\frac{d(V C_p \rho T)}{dt} = f_1 \rho C_p T_i - F \rho C_p T + \dot{m}_s\lambda_s$$

$$f_1 = F$$

$$\rho V C_p \frac{dT}{dt} = F\rho C_p (T_i - T) + \dot{m}_s\lambda_s$$

$$\frac{V}{F}\frac{dT}{dt} = T_i - T + \dot{m}_s \frac{\lambda_s}{F\rho C_p}$$

$$\frac{V}{F}\frac{dT}{dt} + T = T_i + \dot{m}_s \frac{\lambda_s}{F\rho C_p}$$

$$\frac{V}{F}\frac{dT'}{dt} + T' = T_i' + \dot{m}_s' \frac{\lambda}{F\rho C_p}$$

$$\frac{3}{0.15}\frac{dT'}{dt} + T' = T_i' + \dot{m}_s'\left(\frac{2258}{0.15 \times 1000 \times 4.181}\right)$$

$$20\frac{dT'}{dt} + T' = T_i' + 3.6\,\dot{m}_s'$$

$$20\left(sT'(s) - T'(0)\right) + T'(s) = T_i'(s) + 3.6\,\dot{m}_s'(s)$$

$$20sT'(s) + T'(s) = T_i'(s) + 3.6\,m_s'(s)$$

$$T'(s)\,(20s+1) = T_i'(s) + 3.6\,m_s'(s)$$

$$T'(s) = T_i'(s)\left(\frac{1}{20s+1}\right) + m_s'\left(\frac{3.6}{20s+1}\right)$$