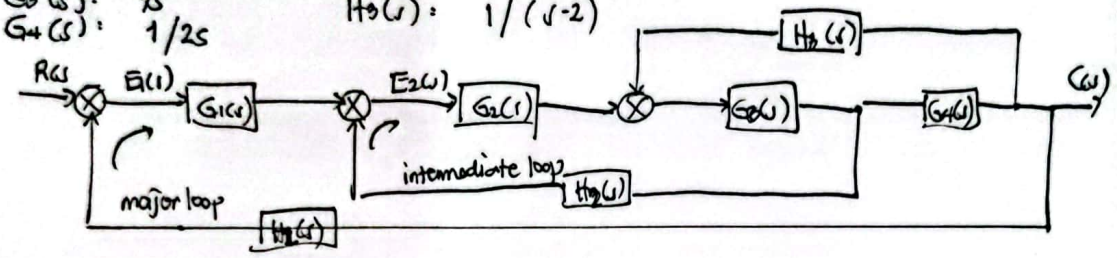
GROUP 5:
Gamboa, Edrian M.
Villavicencio, Nathaniel R.

(Manual Calculation)

2. $G_1(s) = \frac{1}{s^2}$ $H_1(s) = 1/s$
$G_2(s) = 1/(s+1)$ $H_2(s) = 1/(s-1)$
$G_3(s) = 1/s$ $H_3(s) = 1/(s-2)$
$G_4(s) = 1/2s$



$s^2 - 4s + 1$

Parallel

$$\frac{G_3}{1+G_3G_4H_3} = \frac{\frac{1}{s}}{1+\left(\frac{1}{s}\right)\left(\frac{1}{2s}\right)\left(\frac{1}{s-2}\right)} = \frac{\frac{1}{s}}{1+\frac{1}{2s^2}\left(\frac{1}{s-2}\right)}$$

$$= \frac{\frac{1}{s}}{1+\frac{1}{2s^3-4s^2}} = \frac{1}{s}\cdot\frac{2s^3-4s^2}{2s^3-4s^2+1}$$

$$= \frac{2s^3-4s^2}{2s^4-4s^3+s}$$

SERIES: $G_2G_3H_3G_2$

$G_2 = \frac{1}{s+1}$

$$G_2G_3H_3H_4: \left[\frac{2s^4-4s^3}{2s^4-4s^3+s}\right]\left(\frac{1}{s+1}\right) = \frac{2s^3-4s^2}{2s^5-4s^4+s^2+2s^4-4s^3+s}$$

$$= \frac{2s^3-4s^2}{2s^5-2s^4-4s^3+s^2+s}$$

$$= \frac{2s^3-4s^2}{2s^5-2s^4-4s^3+3s^2+s}$$

$$\frac{2s^6-4s^5-2s^4+7s^3-2s^2-s+(2s^3-4s^2)}{2s^6-4s^5-2s^4+2s^3-2s^2-s}$$

Parallel: $G_2G_3H_3G_2H_2$

$$\frac{G_2G_3H_3G_2}{1+G_2G_3H_3G_2H_2} = \frac{\frac{2s^2-4s^2}{2s^5-2s^4-4s^3+s^2+s}}{1+\frac{2s^3-4s^2}{2s^5-2s^4-4s^3+s^2+s}\left(\frac{1}{s-1}\right)}$$

Block Diagram 2:

$$\frac{G_2G_3H_3G_2}{1+G_2G_3H_3G_2H_2}: \frac{\frac{2s^3-4s^2}{2s^5-2s^4-4s^3+s^2+s}}{\frac{2s^3-4s^2}{2s^6-2s^5-2s^5+2s^4-4s^4+4s^3+s^3}}$$

$$= \frac{2s^3 - 4s^2}{2s^5 - 2s^4 - 4s^3 + s^2 + s}$$
$$1 + \frac{2s^3 - 4s^2}{2s^4 - 4s^3 - 2s^4 + 5s^3 - s}$$

$$= \frac{2s^3 - 4s^2}{2s^5 - 2s^4 - 4s^3 + s^2 + s} \cdot \frac{2s^4 - 4s^3 - 2s^4 + 5s^3 - s}{2s^4 - 4s^3 - 2s^4 + 5s^3 \cdot s + 2s^3 - 4s^2}$$

$$= \frac{2s^3 - 4s^2}{2s^5 - 2s^4 - 4s^3 + s^2 + s} \cdot \frac{2s^4 - 4s^3 - 2s^4 + 5s^3 \cdot s}{2s^4 - 4s^3 - 2s^4 + 7s^3 - 4s^2 - s}$$

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{4s^{11} - 12s^{10} - 4s^9 + 36s^8 - 16s^7 - 28s^6 + 23s^5 + 7s^4 - 5s^3 - s^2}$$

FOR G1:

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{4s^{11} - 12s^{10} - 4s^9 + 36s^8 - 16s^7 - 28s^6 + 23s^5 + 7s^4 - 5s^3 - s^2} \quad \left(\frac{1}{s^2}\right)$$

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 + 2s^5 - 2s^4 + 4s^3}{4s^{13} - 12s^{12} - 4s^{11} + 36s^{10} - 16s^9 - 28s^8 + 23s^7 + 7s^6 - 5s^5 - s^4}$$

FOR G4:

$$= \frac{4s^9 - 16s^4 + 12s^2 + 18s^6 - 20s^5 \cdot 2s^4 + 4s^3}{8s^{14} - 24s^{13} - 8s^{12} + 72s^4 - 32s^{10} - 59s^9 + 46s^2 + 14s^7 - 10s^6 - 2s^5}$$

FOR G2G3H3G2H2G1G4H1

$$= \frac{G_2G_3H_3G_2H_2G_1G_4H_1}{1 + G_2G_3H_3G_2H_2G_1G_4H_1}$$

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 32s^{10} - 5Gs^9 + 46s^6 + 14s^7 - 10s^6 - 2s^5}$$
$$1 + \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{8s^{14} - 24s^{13} - 8s^{12} + 7s^{11} - 32s^{10} - 3Gs^9 + 46s^8 + 14s^7 + 10s^6 - 2s^5} \quad \left(\frac{1}{s}\right)$$

BLOCK DIAGRAM NO. 2 :

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 32s^{10} - 36s^9 + 46s^8 + 14s^7 + 10s^6 - 2s^5}$$
$$\left(\frac{8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 32s^{10} - 36s^9 + 46s^8 + 14s^7 - 10s^6 - 2s^5}{8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 32s^{10} - 36s^9 + 46s^8 + 14s^7 - 10s^6 - 2s^5 + 4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}\right)(s)$$

SIMPLIFYING :

$$= \frac{4s^{10} - 16s^8 + 12s^7 + 18s^6 - 2s^5 + 4s^4}{8s^{15} - 24s^{14} - 8s^{13} + 72s^{12} - 32s^{11} - 36s^{10} + 4s^9 + 14s^8 - 10s^7 - 2s^6 + 4s^5 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}$$

$$= \frac{1}{2s^4(s+1)}$$
$$\frac{2s^7 - 6s^6 + 4s^5 + 3s^4 \cdot 7s^3 + 6s^2 - 5s - 2}{2s^5(s-1)(s-2)}$$

$$= \frac{2s^5(s-1)(s-2)}{2s^4(s+1)(2s^7 - 6s^6 + 4s^5 + 3s^4 \cdot 7s^3 + 6s^2 + 5s + 2)}$$

$$= \frac{s(s-1)(s-2)}{(s+1)(2s^7 - 6s^6 + 4s^5 + 3s^4 - 7s^3 + 6s^2 - 3s + 2)}$$

$$= \frac{s^2 - 3s + 2}{2s^8 - 4s^7 - 2s^6 + 7s^5 - 4s^4 - s^3 + s^2 - 3s + 2}$$