ME4203

GROUP 4
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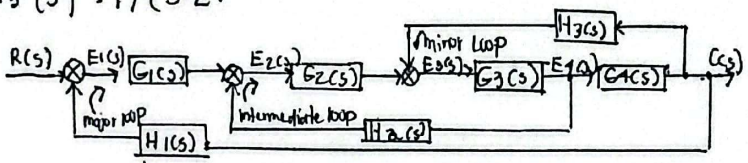
MANUAL CALCULATION
(BLOCK DIAGRAM NO. 2)

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



$s^2 - 4s + 1$

PARALLEL

$$\frac{G3}{1+G3G4H3} = \frac{\frac{1}{s}}{1+\left(\frac{1}{s}\right)\left(\frac{1}{2s}\right)\left(\frac{1}{s-2}\right)}$$

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

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

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

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

SERIES : $G_2G_3H_3G_2$

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

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

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

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

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

PARALLEL $G_2G_3H_3G_2H_2$

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

BLOCK DIAGRAM NO.2

$$\frac{C2G3H3G2}{1+G2G3H3G2H2} = 1 + \frac{\frac{2s^3-4s^2}{2s^5-2s^4-4s^3+s^2+s}}{\frac{2s^3-4s^2}{2s^6-2s^5-2s^5+2s^4-4s^4+4s^3+s^3}}$$

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

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

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

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

FOR G1

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

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

FOR G4

$$= \frac{4s^9-16s^8+12s^7+18s^6-20s^5-2s^4+4s^3}{8s^{14}-24s^{13}-8s^{12}+72s^{11}-32s^{10}-56s^9+46s^8+14s^7-10s^6-2s^5}$$

FOR G2G3H3G2H2G1G4H1

$$= \frac{C2G3H3G2H2G1G4H1}{1+G2G3H3G2H2G1G4H1}$$

$$= \frac{4s^9-16s^8+12s^7+18s^6-20s^5-2s^4+4s^3}{8s^{14}-24s^{13}-8s^{12}+72s^{11}-32s^{10}-56s^9+46s^8+14s^7-10s^6-2s^5}$$

$$1+\frac{4s^9-16s^8+12s^7+18s^6-20s^5-2s^4+4s^3}{8s^{14}-24s^{13}-8s^{12}+72s^{11}-32s^{10}-56s^9+46s^8+14s^7-10s^6-2s^5}\left(\frac{1}{s}\right)$$

BLOCK DIAGRAM NO.2

$$= \frac{4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}{8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 36s^6 - 56s^2 + 46s^8 + 14s^8 + 14s^7 - 10s^6 - 2s^5}$$

$$\left(\frac{(8s^{14} - 24s^{13} - 8s^{12} + 72s^{11} - 32s^{10} - 56s^4 + 46s^8 + 14s^7 - 10s^{11} - 2s^5)(s)}{8s^{15} - 24s^{14} - 8s^{13} + 72s^{12} - 32s^{11} - 56s^4 + 46s^9 + 14s^8 - 10s^7 - 2s^6 + 4s^3 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3} \right]$$

SIMPLIFYING THIS

$$= \frac{4s^{10} - 16s^8 + 12s^7 + 18s^6 - 2s^5 + 4s^4}{8s^{15} - 24s^{14} - 8s^{13} + 72s^{12} - 32s^{11} - 56s^4 + 4s^9 + 14s^8 - 10s^7 - 2s^6 + 4s^9 - 16s^8 + 12s^7 + 18s^6 - 20s^5 - 2s^4 + 4s^3}$$

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

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

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

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