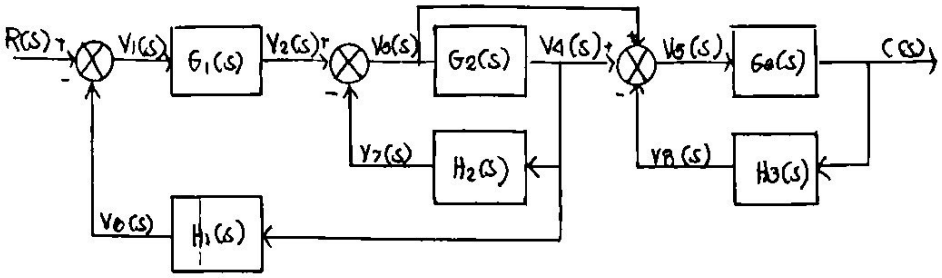
PROBLEM 1

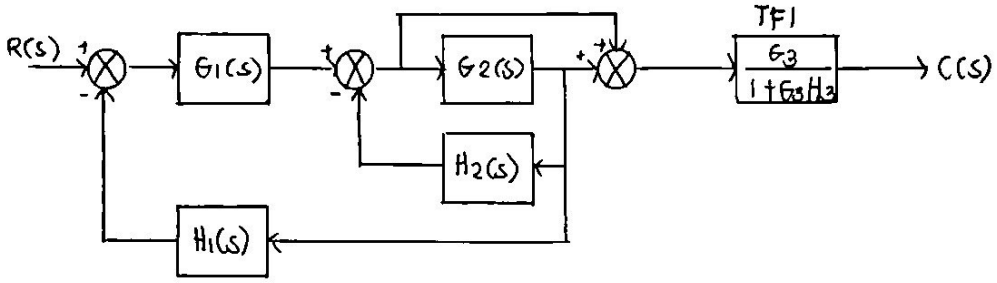


$G_1(s) = 1/s^2$ $\quad H_1(s) = 1/s$

$G_2(s) = 1/(s+1)$ $\quad H_2(s) = 1/(s-1)$

$G_3(s) = 1/s$ $\quad H_3(s) = 1/(s-2)$

SOLVING FOR TRANSFER FUNCTION 1



$$G_3H_3 = \frac{1}{s} \cdot \frac{1}{s-2}$$

$$G_3H_3 = \frac{1}{s^2-2s}$$

$$TF_1 = \frac{G_3}{1+G_3H_3} = \frac{1/s}{1+(1/s^2-2s)}$$

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

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

$$\boxed{TF1 = \frac{s^2-2s}{s^3-2s^2+s}}$$

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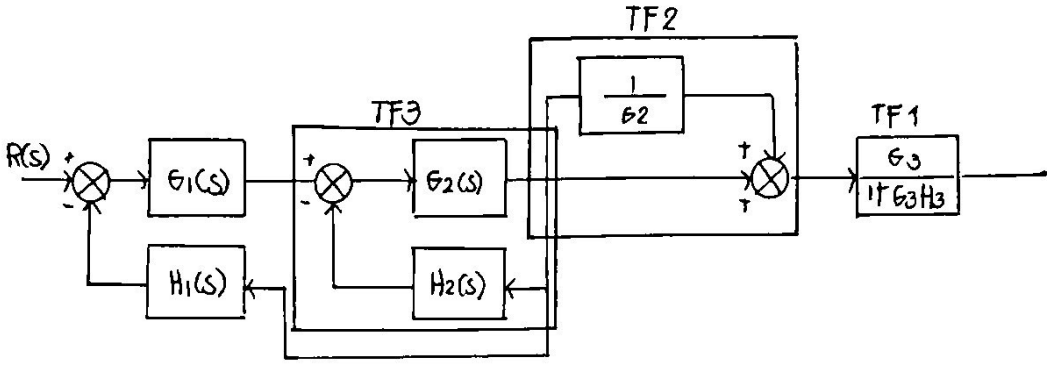
SOLVING FOR TRANSFER FUNCTION 2 AND 3



SOLVING FOR TRANSFER FUNCTION 2

$$TF2 = \frac{1}{G_2} + 1 \rightarrow \frac{G_2+1}{G_2}$$

$$= \frac{(1/s+1)+1}{1/s+1}$$

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

$$= \frac{s+2}{s+1} \cdot \frac{s+1}{1}$$

$$\boxed{TF2 = \frac{s^2+3s+2}{s+1}}$$

SOLVING FOR TRANSFER FUNCTION 3

$$TF3 = \frac{G_2}{1+G_2H_2}$$

$$G_2H_2 = \frac{1}{s+1} \cdot \frac{1}{s+1} = \frac{1}{s^2-1}$$

THEREFORE,

$$TF3 = \frac{1/s+1}{1+(1/s^2-1)}$$

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

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

$$\boxed{TF3 = \frac{s^2-1}{s^3+s^2}}$$

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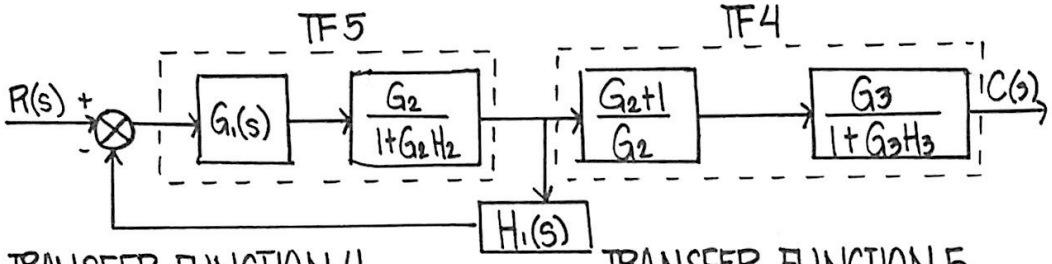
TRANSFER FUNCTION 4 + 5



TRANSFER FUNCTION 4

$TF4 = TF2(TF1)$

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

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

$$\boxed{TF4 = \frac{s^4+s^3-4s^2-4s}{s^4-s^3-s^2+s}}$$

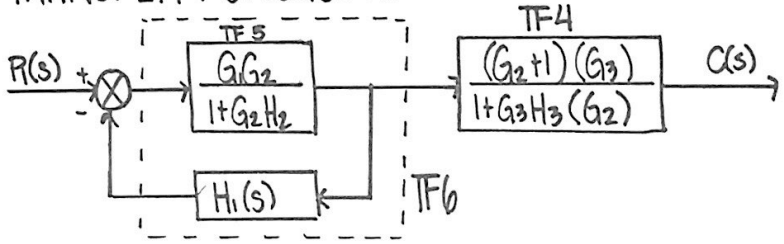
TRANSFER FUNCTION 5

$TF5 = G_1(TF3)$

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

$$\boxed{TF5 = \frac{s^2-1}{s^5+s^4}}$$

TRANSFER FUNCTION 6



$$\frac{TF5}{1+TF5(H_1)}$$

$TF6 = TF5(H_1)$

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

$TF6 = \frac{s^2-1}{s^6+s^5}$

$TF6 = \frac{TF5}{1+(TF5)(H_1)}$

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

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

$= \frac{\left(\frac{s^2-1}{s^2+s^5}\right)}{\left(\frac{s^6+s^5+s^2-1}{s^6+s^5}\right)}$

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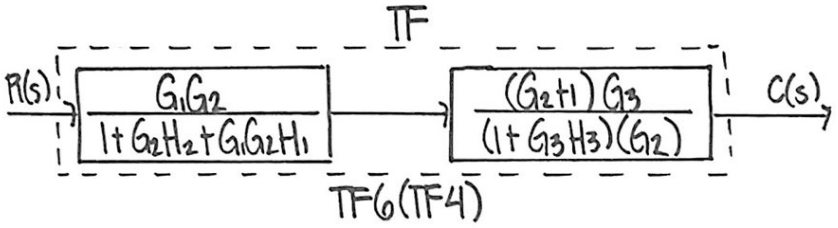
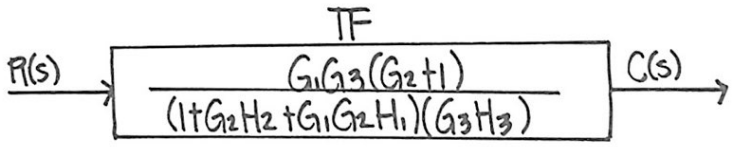
$$= \frac{s^2-1}{s^5+s^4} \cdot \frac{s^6+s^5}{s^6+s^5+s^2-1}$$

$$= \frac{s^8+s^7-s^6-s^5}{s^{11}+s^{10}+s^7-s^5+s^{10}+s^9+s^6+s^4}$$

$$\boxed{TF6 = \frac{s^8+s^7-s^6-s^5}{s^{11}+s^{10}+s^9+s^7+s^6-s^5+s^4}}$$





$$TF = \frac{s^8+s^7-s^6-s^5}{s^{11}+2s^{10}+s^9+s^7+s^6-s^5+s^4} \cdot \frac{s^4+s^3-4s^2-4s}{s^4+s^3-s^2+s}$$

$$\boxed{TF = \frac{s^{12}+2s^{11}-4s^{10}-10s^9-s^8+8s^7+4s^6}{s^{15}+s^{14}-2s^{13}-2s^{12}+2s^{11}+s^{10}-3s^9+3s^7-s^5}}$$

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