

$$\textcircled{1} Y = (GH + I)^{-1} GR ; Y = TR \rightarrow T = (GH + I)^{-1} G$$

$$R - Z - E \Rightarrow R - E = HY \Rightarrow R - G^{-1}Y = HY$$

$$R = (H + G^{-1})Y$$

$$R = (HG - I)G^{-1}Y$$

$$R = \underline{G(I + HG)^{-1}} R$$

$$Y = TR$$

$$(I + GH)^{-1} G = G(I + L)^{-1} \quad (L = HG)$$

$$\textcircled{2} Z = HY = HGE = HG(R - Z)$$

$$Z(I + HG) = HGR \Rightarrow ZR^{-1} = (I + HG)^{-1} HG$$

$$Y = GE \Rightarrow H^{-1}Z = G(R - Z)$$

$$(H^{-1} + G)Z = GR$$

$$(I + GH)HZ = GR \Rightarrow ZR^{-1} = H(I + GH)^{-1}$$

$$\frac{Z}{R} = \frac{L}{I + L} = \frac{GH}{I + GH} = \frac{HG}{I + HG} \rightarrow Z = HY = HG(R - Z) \Rightarrow \frac{Z}{R} = \frac{HG}{I + HG}$$

$$\textcircled{3} \begin{array}{c} R \rightarrow \boxed{1/H} \rightarrow \text{summing junction} \rightarrow \boxed{GH} \rightarrow Y \\ \text{feedback path from } Y \rightarrow \text{summing junction} \end{array} \quad Y = \left(\frac{R}{H} - Y\right)GH \Rightarrow Y = GR - YGH$$

$$Y = \frac{GR}{I + GH}$$

$$\textcircled{4} \begin{array}{c} R \rightarrow \text{summing junction} \rightarrow \boxed{\frac{G}{I + G(H - I)}} \rightarrow Y \\ \text{feedback path from } Y \rightarrow \text{summing junction} \end{array} \quad Y = (R - Y) \cdot \frac{G}{I + G(H - I)} = Y(I + G(H - I)) = GR - GY$$

$$Y = \frac{GR}{I + GH}$$

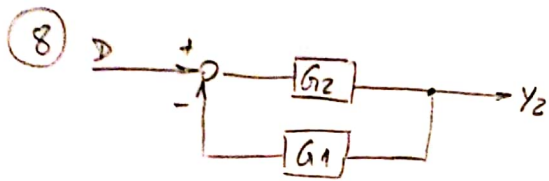
$$\textcircled{5} \begin{array}{c} R \rightarrow \text{summing junction} \rightarrow \text{summing junction} \rightarrow \boxed{G} \rightarrow Y \\ \text{feedback path from } Y \rightarrow \text{summing junction} \\ \text{feedback path from } Y \rightarrow \text{summing junction} \\ \text{feedback path from } Y \rightarrow \text{summing junction} \end{array} \quad Y = (R - Y - Y(H - 1))G$$

$$Y = (R - YH)G \Rightarrow Y = \frac{GR}{1 + HG}$$

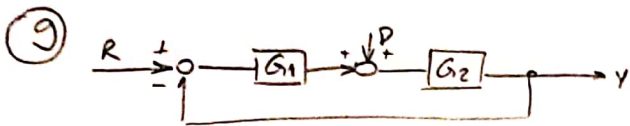
$$\textcircled{6} \begin{array}{c} R \rightarrow \text{summing junction} \rightarrow \text{summing junction} \rightarrow \boxed{G} \rightarrow Y \\ \text{feedback path from } Y \rightarrow \text{summing junction} \\ \text{feedback path from } Y \rightarrow \text{summing junction} \end{array} \quad Y = (R - Y(H - 1) - Y)G$$

$$Y = (R - YH)G \Rightarrow Y = \frac{GR}{I + GH}$$

$$\textcircled{7} \begin{array}{c} R \rightarrow \text{summing junction} \rightarrow \boxed{G_1} \rightarrow \text{summing junction} \rightarrow \boxed{G_2} \rightarrow Y_1 \\ \text{feedback path from } Y_1 \rightarrow \text{summing junction} \end{array} \quad Y_1 = (R - Y_1)G_1G_2 \quad Y_1 = \frac{R G_1 G_2}{I + G_1 G_2}$$



$$Y_2 = (D - G_1 Y_2) G_2 \Rightarrow Y_2 = \frac{D G_2}{1 + G_1 G_2}$$



$$Y = ((R - Y) G_1 + D) G_2$$

$$Y = \frac{(R G_1 + D) G_2}{1 + G_1 G_2}$$

10

$$Z = (W \pm X) \pm Y$$

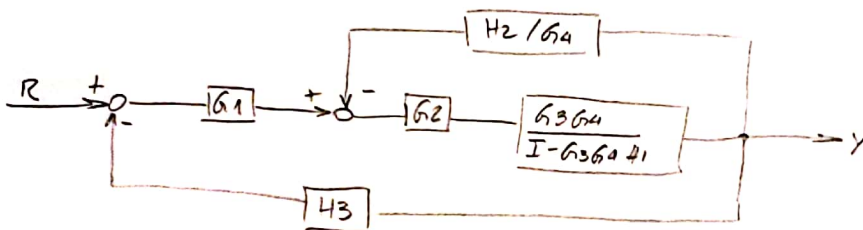
$$Z = (\pm Y \pm X) + W$$

$$\Rightarrow Z = W \pm X \pm Y$$

$$\Rightarrow Z = W \pm X + Y$$

bloco com mesma função

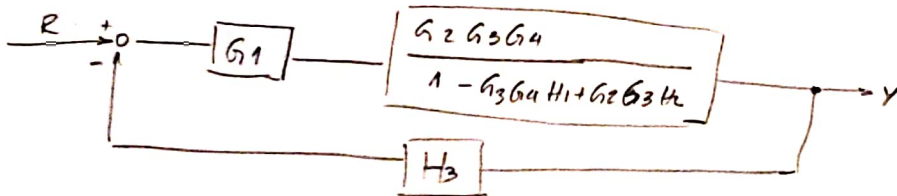
11



$$Y = \left( (R - Y H_3) G_1 - \frac{H_2 Y}{G_4} \right) \frac{G_2 G_3 G_4}{1 - G_3 G_4 H_1}$$

$$Y = \frac{R G_1 G_2 G_3 G_4}{1 - H_1 G_3 G_4 + H_2 G_2 G_3 + H_3 G_1 G_2 G_3 G_4}$$

12



$$Y = (R - H_3 Y) G_1 \cdot \frac{G_2 G_3 G_4}{1 - G_3 G_4 H_1 + G_2 G_3 H_2}$$

$$Y = \frac{R G_1 G_2 G_3 G_4}{1 - H_1 G_3 G_4 + H_2 G_2 G_3 + H_3 G_1 G_2 G_3 G_4}$$