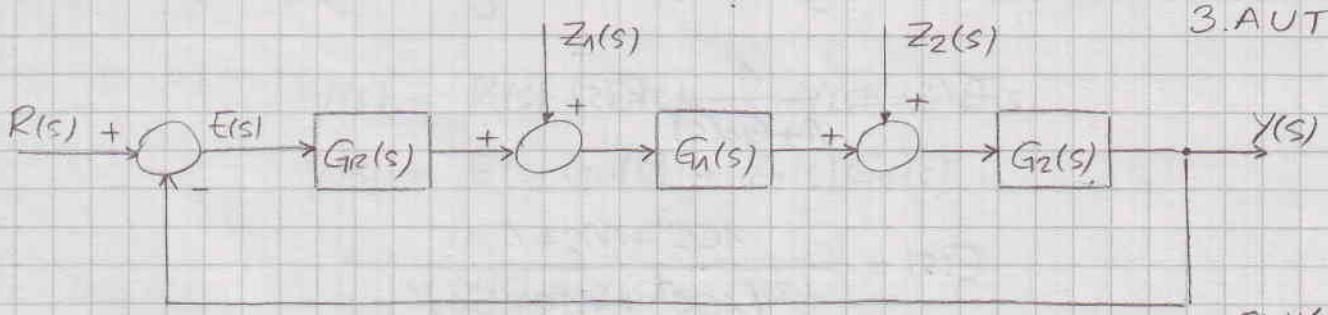
PRIMJER 13.1

MARKO GULIN
0036428227
3. AUT 1



SLIKA 1.

$$Y(s) = R(s)\,G(s) + Z_1(s)\,G_1(s)\,G_2(s) + Z_2(s)\,G_2(s)$$

$$Y(s) = E(s)\,G_0(s) + Z_1(s)\,G_1(s)\,G_2(s) + Z_2(s)\,G_2(s)$$

$$Y(s) = R(s) - E(s)$$

$$G_1(s) = \frac{1}{1+10s}\,, \quad G_2(s) = \frac{10}{1+s}\,, \quad G_0(s) = G_R(s)\,G_1(s)\,G_2(s)$$

(A) $G_R = K_R = 5$

(a) (1) $R(s) = \frac{1}{s}\,, \quad G_0(s) = \frac{50}{(1+10s)(1+s)}$

$$Y(s) = R(s) - E(s)$$

$$Y(s) = E(s)\,G_0(s)$$

$$Y(s) = Y(s)$$

$$R(s) - E(s) = E(s)\,G_0(s)$$

$$E(s)\left(1 + G_0(s)\right) = R(s)$$

$$E(s) = \frac{1}{1+G_0(s)}\,R(s)$$

$$E(s) = \frac{10s^2 + 11s + 1}{s(10s^2 + 11s + 51)}$$

$$e_\infty = \lim_{s \to 0} sE(s) = \frac{1}{51}$$

(a) (2) $R(s) = \frac{1}{s^2}$

$$E(s) = \frac{1}{1 + G_0(s)} R(s)$$

$$E(s) = \frac{10s^2 + 11s + 1}{s^2(10s^2 + 11s + 51)}$$

$$e_\infty = \lim_{s \to 0} sE(s) = \infty$$

(b) (1) $Z_1(s) = \frac{1}{s}$

$$Y(s) = R(s) - E(s) \rightarrow Y(s) = -E(s)$$

$$Y(s) = E(s)G_0(s) + Z_1(s)G_1(s)G_2(s)$$

$$Y(s) = Y(s)$$

$$-E(s) - E(s)G_0(s) = Z_1(s)G_1(s)G_2(s)$$

$$E(s) = \frac{-G_1(s)G_2(s)}{1 + G_0(s)} Z_1(s)$$

$$E(s) = \frac{-10}{10s^2 + 11s + 51} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s \to 0} sE(s) = -\frac{10}{51}$$

(2) $Z_1(s) = \frac{1}{s^2}$

$$E(s) = \frac{-10}{10s^2 + 10s + 51} \cdot \frac{1}{s^2}$$

$$e_\infty = \lim_{s \to 0} sE(s) = -\infty$$

(c) (1) $Z_2(s) = \frac{1}{s}$

$$Y(s) = R(s) - E(s) \rightarrow Y(s) = -E(s)$$

$$Y(s) = E(s)\,G_0(s) + Z_2(s)\,G_2(s)$$

$$Y(s) = Y(s)$$

$$E(s)\left(-1 - G_0(s)\right) = Z_2(s)\,G_2(s)$$

$$E(s) = \frac{-G_2(s)}{1 + G_0(s)}\,Z_2(s)$$

$$E(s) = \frac{-10(10s+1)}{s^2+11s+51} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s\to 0} sE(s) = -\frac{10}{51}$$

(2) $Z_2(s) = \frac{1}{s^2}$

$$E(s) = \frac{-10(10s+1)}{s^2+11s+51}\;\frac{1}{s^2}$$

$$e_\infty = \lim_{s\to 0} sE(s) = -\infty$$

(B) $G_R = \frac{K_{I2}}{s}$, $K_R = 5$

(a) (1) $R(s) = \frac{1}{s}$, $G_0(s) = \frac{50}{s(s+1)(10s+1)}$

$$E(s) = \frac{s(s+1)(10s+1)}{s(s+1)(10s+1)+50} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s\to 0} sE(s) = 0$$

(2) $R(s) = \frac{1}{s^2}$

$$E(s) = \frac{s(s+1)(10s+1)}{s(s+1)(10s+1)+50} \cdot \frac{1}{s^2}$$

$$e_\infty = \lim_{s\to 0} sE(s) = \frac{1}{50}$$

(b) (1) $Z_1(s) = \frac{1}{s}$

$$E(s) = \frac{-10s}{s(s+1)(10s+1)+50} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s\to 0} sE(s) = 0$$

(2) $Z_1(s) = \frac{1}{s^2}$

$$E(s) = \frac{-10s}{s(s+1)(10s+1)+50} \cdot \frac{1}{s^2}$$

$$e_\infty = -\frac{1}{5}$$

(c) (1) $Z_2(s) = \frac{1}{s}$

$$E(s) = \frac{-10s(10s+1)}{s(s+1)(10s+1)+50} \cdot \frac{1}{s}$$

$$e_\infty = 0$$

(2) $Z_2(s) = \frac{1}{s^2} \rightarrow e_\infty = \lim_{s\to 0} sE(s) = -\frac{1}{5}$

PRIMJER 13.2

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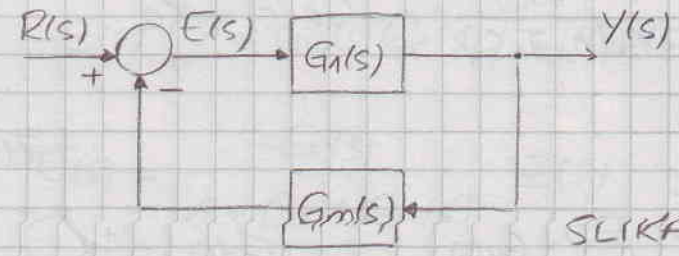


SLIKA 2.

$$G_1(s) = \frac{K}{(1+T_1 s)(1+T_2 s)}, \quad G_m(s) = K_m$$

$$r(t) = S(t) \circ\!\!-\!\!\bullet\; R(s) = \frac{1}{s}, \quad e_\infty < 0.5$$

$$Y(s) = E(s)\, G_1(s)$$

$$Y(s) = R(s)\, G(s), \quad G(s) = \frac{G_1(s)}{1 + G_m(s) G_1(s)}$$

$$Y(s) = Y(s)$$

$$E(s) \cancel{G_1(s)} = R(s) \frac{\cancel{G_1(s)}}{1 + G_m(s) G_1(s)}$$

$$E(s) = \frac{1}{s} \cdot \frac{T_1 T_2 s^2 + (T_1 + T_2) s + 1}{T_1 T_2 s^2 + (T_1 + T_2) s + 1 + K K_m}$$

$$e_\infty = \lim_{s \to 0} s E(s) < 0.5$$

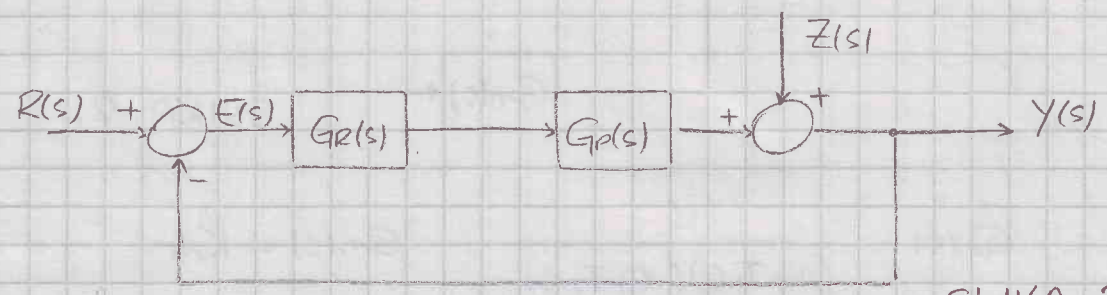
$$\frac{1}{1 + K K_m} < \frac{1}{2} \rightarrow 1 + K K_m > 2$$

$$\cdot \; K > \frac{1}{K_m}$$

ZADATAK 13.1

$$G_P(s) = \frac{K_1}{s(1+T_1 s)} \quad ; \quad G_R(s) = K_R$$

(a)



SLIKA 3.

$$Z(s) = \frac{1}{s}$$

$$Y(s) = E(s) G_R(s) G_P(s) + Z(s)$$

$$E(s) = R(s) - Y(s) \rightarrow E(s) = -Y(s), \quad R(s) = 0$$

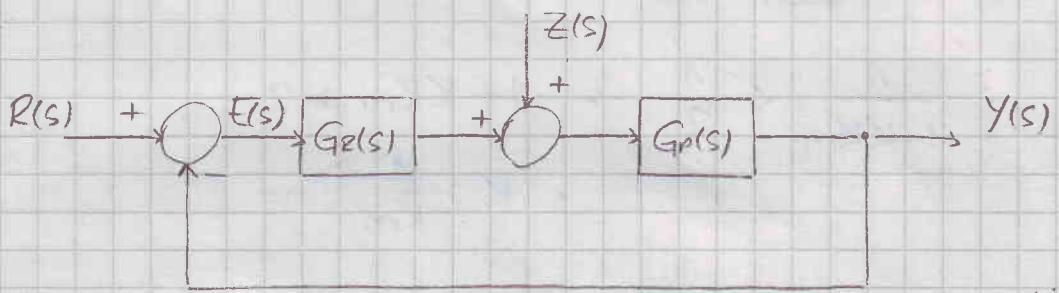
$$-E(s)\left(1 + G_R(s) G_P(s)\right) = Z(s)$$

$$E(s) = \frac{-1}{1 + G_R(s) G_P(s)} Z(s)$$

$$E(s) = \frac{-s(1+T_1 s)}{T_1 s^2 + s + K_R K_1} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s \to 0} s E(s) = 0$$

(b)



SLIKA 4.

$$Z(s) = \frac{1}{s^2}$$

$$Y(s) = E(s) G_R(s) G_P(s) + Z(s) G_P(s)$$

$$E(s) = R(s) - Y(s) \rightarrow E(s) = -Y(s)$$

$$y(s) = y(s)$$

$$-E(s)\left(1 + G_R(s)G_P(s)\right) = G_P(s)\,Z(s)$$

$$E(s) = \frac{-G_P(s)}{1 + G_R(s)G_P(s)}\,Z(s)$$

$$E(s) = \frac{-K_1}{T_1 s^2 + s + K_1 K_R} \cdot \frac{1}{s}$$

$$e_\infty = \lim_{s\to 0} sE(s) = -\frac{1}{K_R}$$

ZADATAK 13.2

$$G_P(s) = \frac{K_1}{s(1+T_1 s)}\,, \quad G_R(s) = K_R(s)$$

(a) SLIKA SUSTAVA → POGLEDAJ SLIKU 3.

$$Z(s) = \frac{1}{s^2}$$

$$E(s) = \frac{-s(1+T_1 s)}{T_1 s^2 + s + K_R K_1} \cdot \frac{1}{s^2}$$

$$e_\infty = \lim_{s\to 0} sE(s) = -\frac{1}{K_R K_1}$$

(b) SLIKA SUSTAVA → POGLEDAJ SLIKU 4.

$$Z(s) = \frac{1}{s^2}$$

$$E(s) = \frac{-K_1}{T_1 s^2 + s + K_1 K_R} \cdot \frac{1}{s^2}$$

$$e_\infty = \lim_{s\to 0} sE(s) = -\infty$$