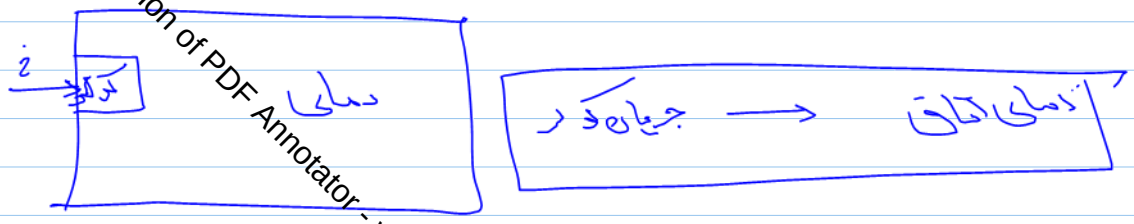
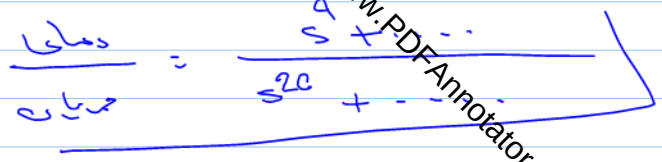
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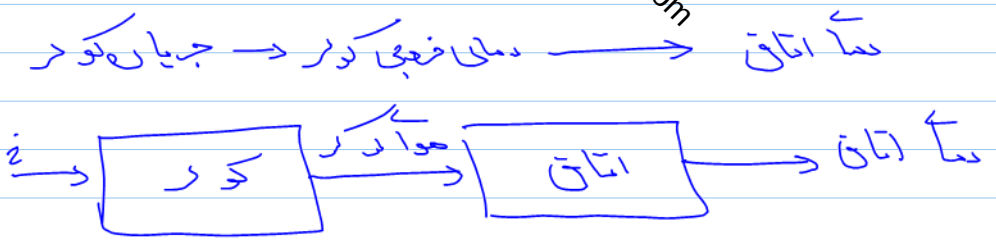
جلسه شش کنترل خطی

① معادلات دیفرانسیل ② تابع تبدیل

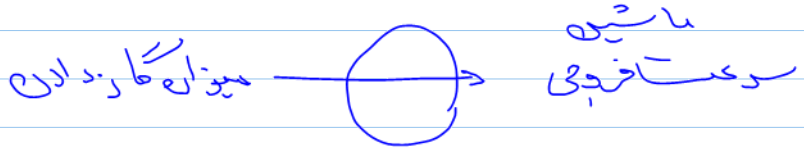
③ نمایش بلوک دیاگرام

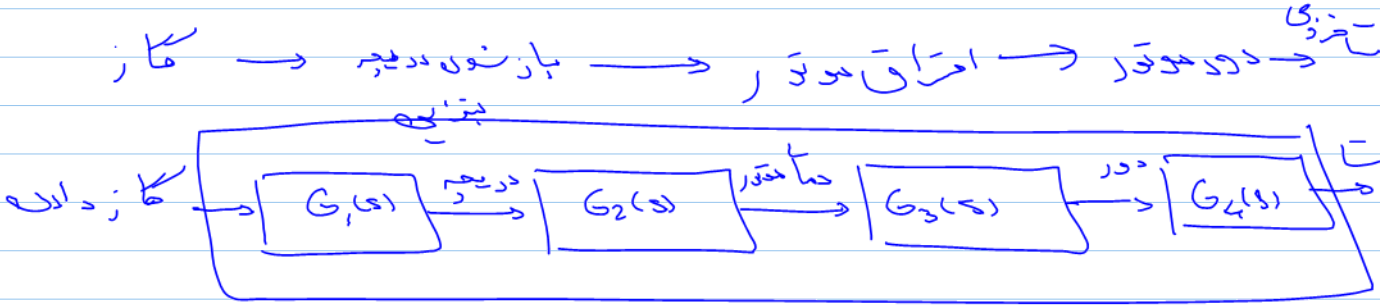




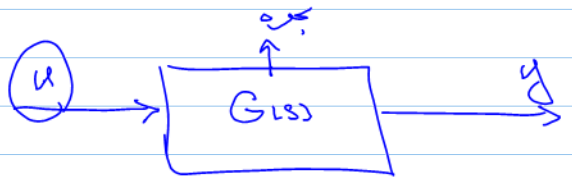


کنترل حلقه باز

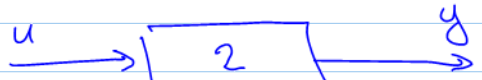




نمایش بلوک دیاگرام

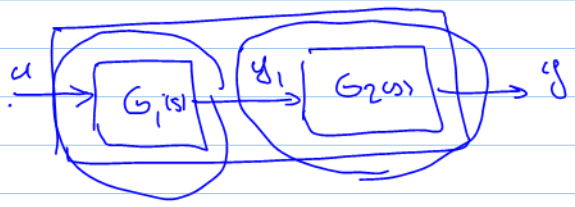


$$Y(s) = U(s) \times G(s)$$



$$y = 2 \times u$$

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$Y(s) = ?\ U(s)$

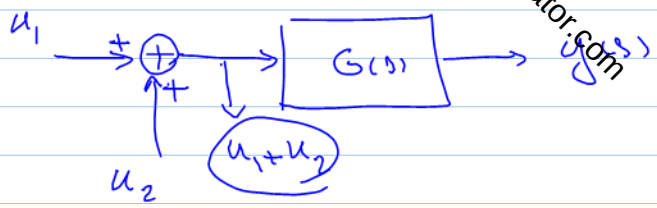
← أو نأخذ على خطوة

$y(s) = G_2(s) \times y_1(s)$

$y_1(s) = G_1(s) \times u(s)$

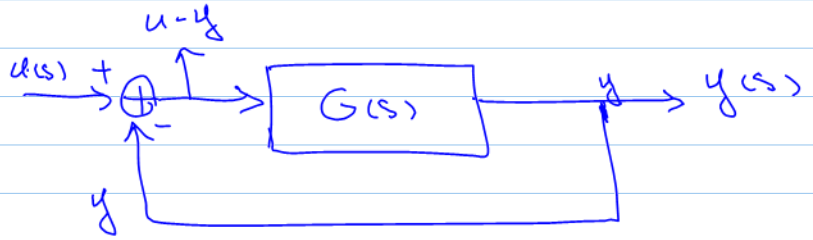
$y(s) = G_2(s) \times (G_1(s) \times u(s))$

$y(s) = G_2(s)\, G_1(s)\, u(s) \rightarrow \frac{y(s)}{u(s)} = G_1(s) G_2(s)$



← نقطة جمع

$y(s) = G(s) \times (u_1(s) + u_2(s))$



نقطة تفرع

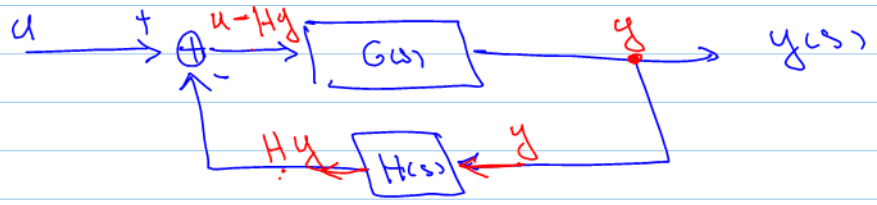
$\frac{Y(s)}{U(s)} = ?$

$y(s) = G(s) \times (u - y) = G(s)\, u(s) - G(s)\, y(s)$

$y(s) + G(s)\, y(s) = G(s)\, u(s)$

$y(s)(1 + G(s)) = G(s)\, u(s)$

$$\frac{y}{u} = \frac{G(s)}{1 + G(s)}$$

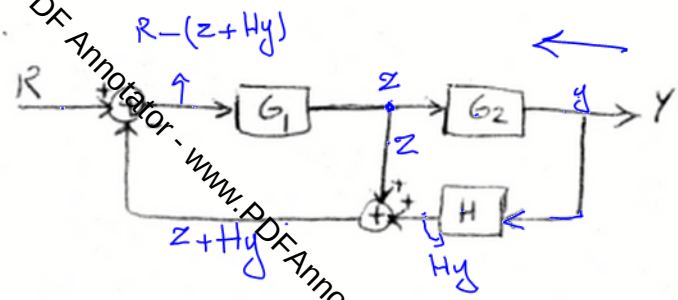


خروج = $H(s)\, y$

$$y(s) = G(s)(u - Hy)$$

$$\frac{y}{u} = \frac{G(s)}{1 + G(s)H(s)}$$ ✓

مثال: مکانیک ۷۸) تابع تبدیل سوک دیاگرام شکل زیر را بیابید.



$\frac{Y(s)}{R(s)} = ?$

برای هر خط اسم بنویسید.

$y = G_2 z$

z : R , y

$z = G_1(R - z - Hy) \rightarrow$

$z = G_1 R - G_1 z - G_1 H y$ $\qquad z + G_1 z = G_1 R - G_1 H y$

$z(1 + G_1) = G_1 R - G_1 H y$

$$z = \frac{G_1 R}{1 + G_1} - \frac{G_1 H y}{1 + G_1}$$

$$y = G_2\left(\frac{G_1 R}{1 + G_1} - \frac{G_1 H y}{1 + G_1}\right)$$

$$y = \frac{G_2 G_1 R}{1 + G_1} - \frac{G_2 G_1 H y}{1 + G_1}$$

$$y + \frac{G_2 G_1 H}{1 + G_1} y = \frac{G_1 G_2 R}{1 + G_1}$$

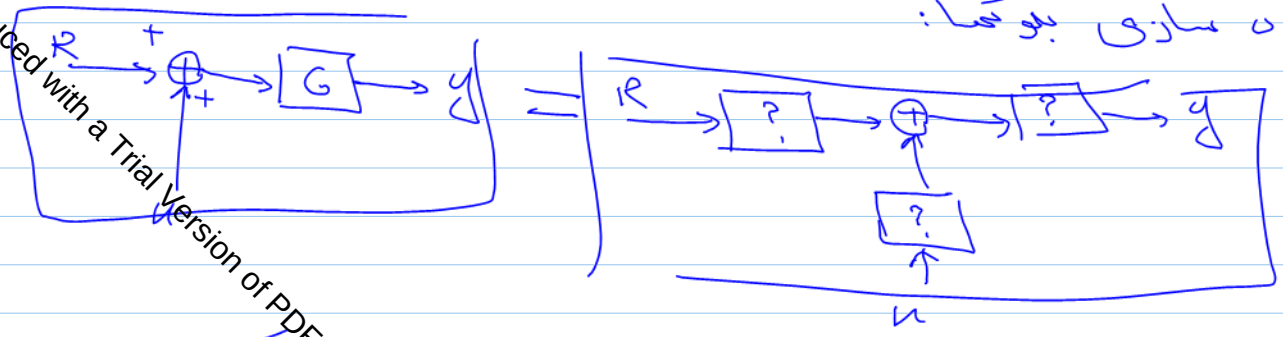
$$y\left(1 + \frac{G_1 G_2 H}{1 + G_1}\right) = \frac{G_1 G_2 R}{1 + G_1}$$

$$\frac{y}{R} = \frac{\cancel{1+G_1} \times \frac{G_1 G_2}{\cancel{1+G_1}}}{(1+G_1)\left(1 + \frac{G_1 G_2 H}{\cancel{1+G_1}}\right)} = \frac{G_1 G_2}{1 + G_1 + G_1 G_2 H}$$ ✓

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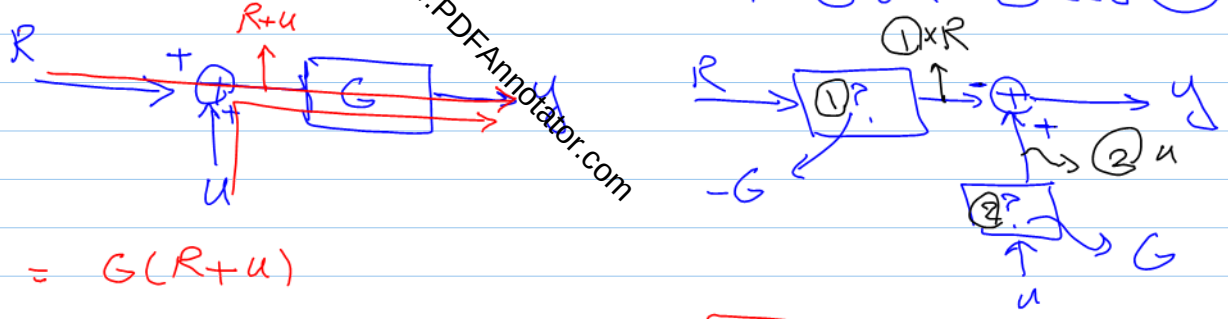
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ساده سازی بلوکها:



① بهره مسیر از هر ورودی به خروجی باید یکسان شود.

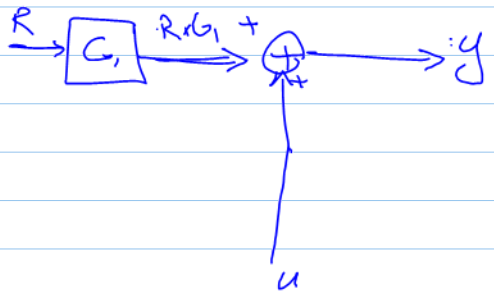
② ورودی جدیدی نباید اضافه شود.

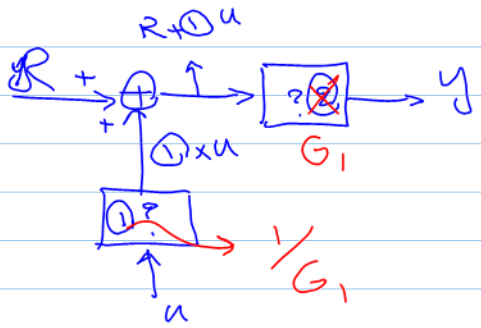


$$y = G(R+u)$$

$$y = GR + Gu \quad = \quad y = -①\times R + ②\times u$$

$$y = -(-G)R + (G)u$$





$$y = R\times G_1 + 1u$$

$$y = R\times \frac{G_1}{②} + \frac{G_1}{②}\times ①\, u$$

$$y = ②\times(R + ①\times u)$$

$$G_1 \times ① = 1 \rightarrow ① = \frac{1}{G_1}$$

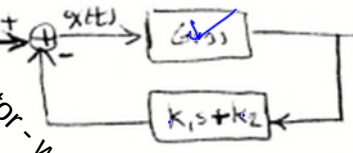
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مثال: معادله دیفرانسیل سیستم حلقه باز $G(s)$ به صورت زیر است:

$$y''(t) + 3y'(t) + 2y(t) = x(t)$$

ضرایب k_1 و k_2 چه مقدار باشد تا قطبهای تابع تبدیل حلقه بسته برابر -1 و -3 گردد؟

$\frac{Y(s)}{R(s)}$?



$k_1=5, k_2=3$ (2 $\quad$ $k_1=7, k_2=1$ (1

$k_1=13, k_2=3$ (4 $\quad$ $k_1=16, k_2=5$ (3

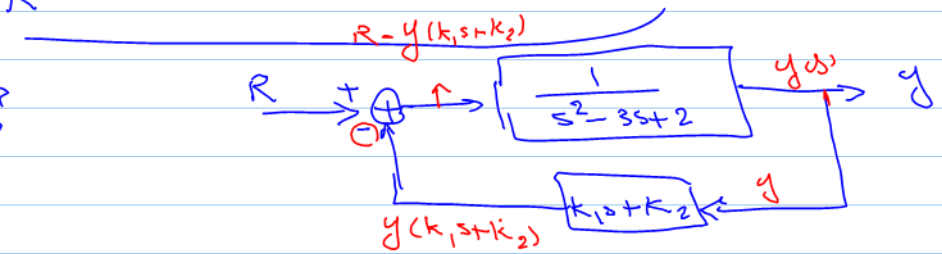
بنابراین $x \rightarrow \boxed{G(s)} \rightarrow y$ $\quad$ $Y(s) = G(s) \times X(s)$

معادله $y''(t) - 3y'(t) + 2y(t) = x(t)$ $\quad$ $G(s) = \frac{y(s)}{x(s)}$ = تابع تبدیل

$s^2 y(s) - 3s y(s) + 2y(s) = x(s)$ $\quad$ $\frac{y(s)}{x(s)} = \frac{1}{s^2-3s+2} = G(s)$

$y(s)(s^2 - 3s + 2) = x(s)$

-3 و -1 = قطبهای حلقه بسته = ریشه های مخرج تابع تبدیل $\frac{Y}{R}$



$\frac{Y(s)}{R(s)} = ?$

$y(s) = \frac{1}{s^2-3s+2}(R - y(k_1 s + k_2))$

$(s^2 - 3s + 2)\, y(s) = R - y(s)(k_1 s + k_2)$

$y(s)(s^2 - 3s + 2 + k_1 s + k_2) = R(s)$

$\frac{y(s)}{R(s)} = \frac{1}{s^2 - 3s + 2 + k_1 s + k_2}$ حلقه بسته

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$s^2 + (k_1 - 3)s + 2 + k_2 = 0 \rightarrow$ $\begin{cases} s = -1 \\ s = -3 \end{cases}$

$1 + (k_1 - 3)(+1) + 2 + k_2 = 0$

① $k_2 - k_1 = -6$

$9 + (k_1 - 3)(-3) + 2 + k_2 = 0$

$k_2 - 3k_1 = -20$

$$\begin{cases} k_2 - k_1 = -6 \\ k_2 - 3k_1 = -20 \end{cases}$$

$2k_1 = 14 \rightarrow k_1 = 7$

$k_2 = 7 - 6 = 1$

$1s^2 + (k_1 - 3)s + 2 + k_2 = 0$

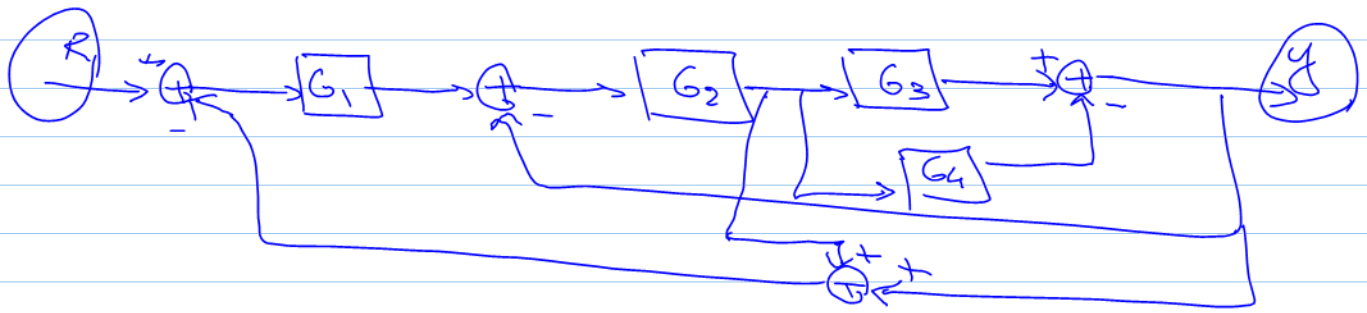
$-1, -3$

$(s - (-1))(s - (-3)) = 0$

$(s+1)(s+3) = 0$

$1s^2 + 4s + 3 = 0$

$$\begin{cases} k_1 - 3 = 4 \rightarrow k_1 = 7 \\ k_2 + 2 = 3 \quad k_2 = 1 \end{cases}$$



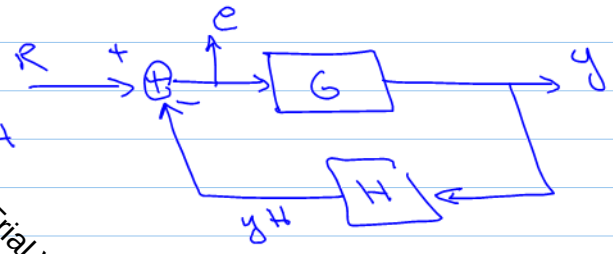
$y/R = ?$

عاملين (signal flow graph) SFG

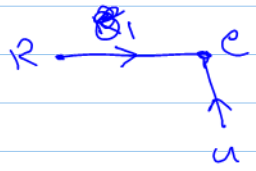




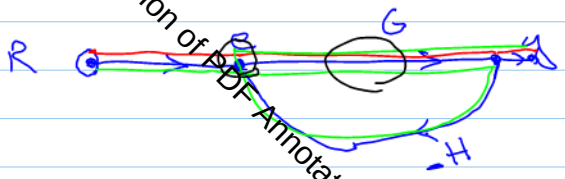
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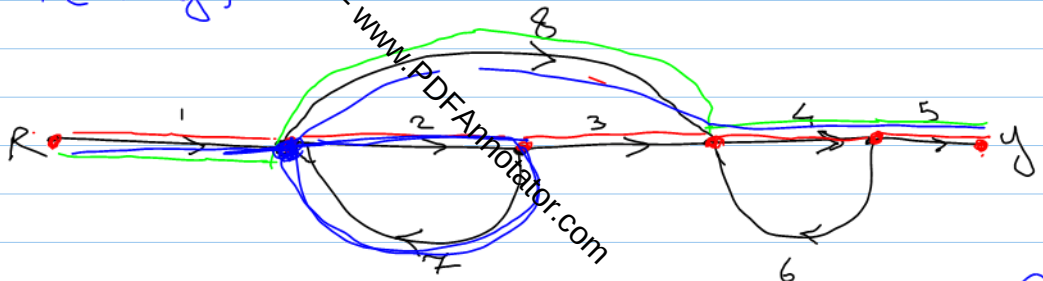
$e = R - H \times H$



$e = R + u$



$e = R + (-H \times y)$

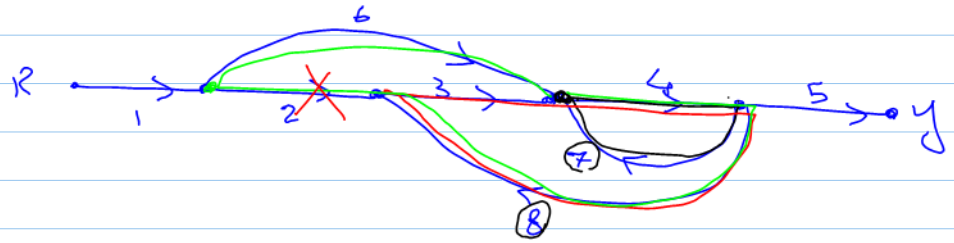


مسیر اول: ① ② ③ ④ ⑤ ✓

مسیر دوم: ① ⑧ ④ ⑤

✗ ① ② ⑦ ⑧ ④ ⑤

از گره دوم برگشت دارد



R → y

مسیر اول: ① ② ③ ④ ⑤ ✓

مسیر دوم: ① ⑥ ④ ⑤

حلقه‌ها: ④ ⑦ ، ③ ④ ⑧