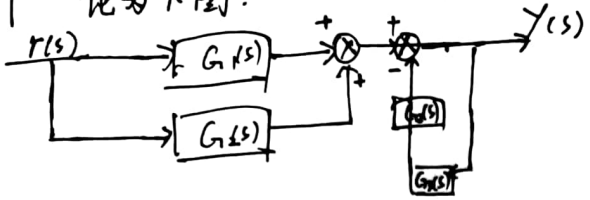
1. 解：化为下图：

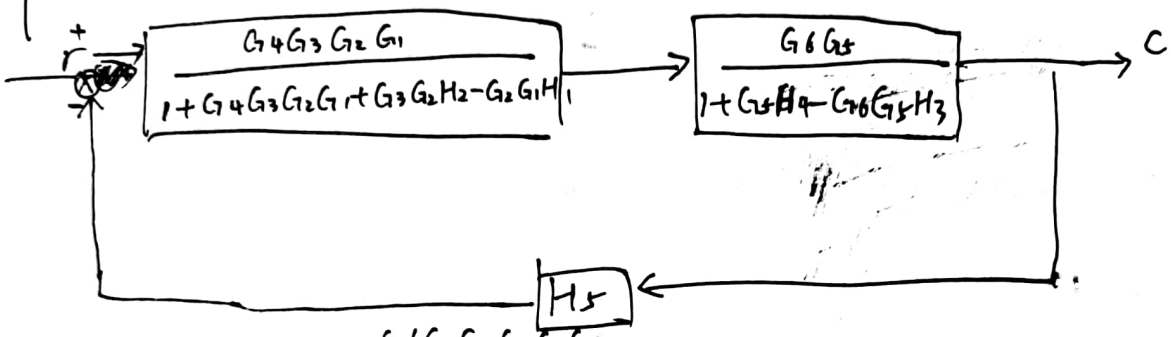


$$\therefore Y(s) = \left[\frac{1}{1+G_2G_3}\cdot(G_1+G_2)\right]r(s)$$

$$= \frac{G_1+G_2}{1+G_2G_3}r(s)$$

$$\therefore G(s) = \frac{G_1+G_2}{1+G_2G_3}$$

2. 解：先化简，可得下图。



$$\therefore G(s) = \frac{\dfrac{G_6G_5G_4G_3G_2G_1}{(1+G_5H_4-G_6G_5H_3)(1+G_4G_3G_2G_1+G_3G_2H_2-G_2G_1H_1)}}{1+\dfrac{G_6G_5G_4G_3G_2G_1H_5}{(1+G_5H_4-G_6G_5H_3)(1+G_4G_3G_2G_1+G_3G_2H_2-G_2G_1H_1)}}$$

$$= \frac{G_6G_5G_4G_3G_2G_1}{G_6G_5G_4G_3G_2G_1H_5+(1+G_5H_4-G_6G_5H_3)(1+G_4G_3G_2G_1+G_3G_2H_2-G_2G_1H_1)}$$

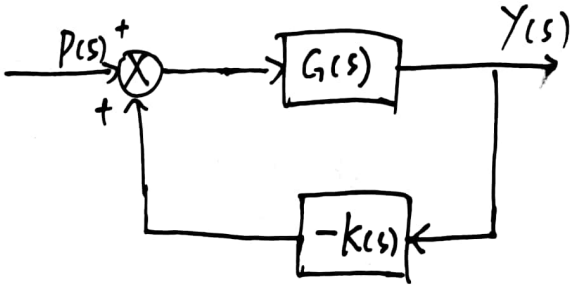
3. 解：$\because r(s)=0 \quad \therefore e(s)=-Y(s)$

$$\therefore \frac{e(s)}{P(s)} = G'(s) = -\frac{Y(s)}{P(s)}$$

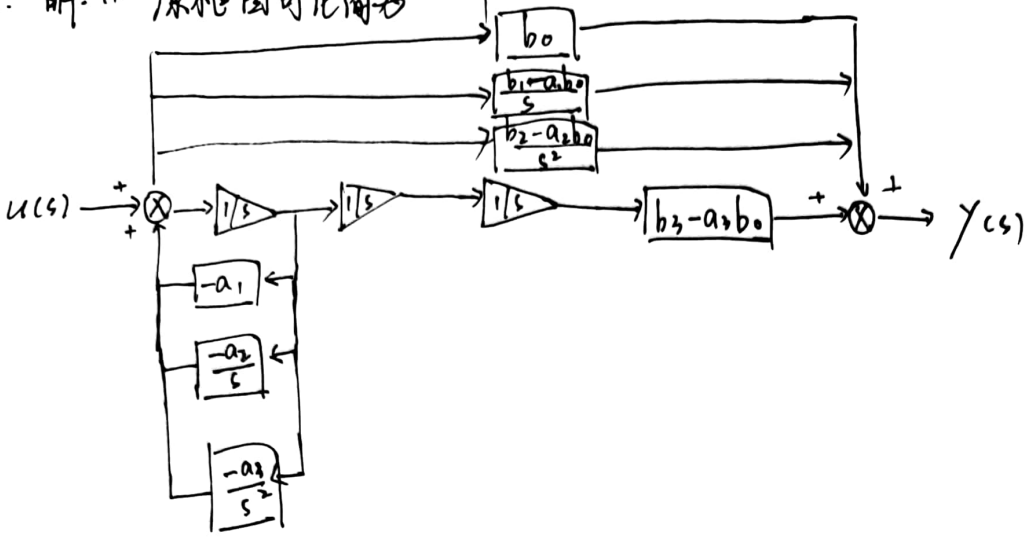
$$\therefore \frac{Y(s)}{P(s)} = \frac{G(s)}{1+G(s)K(s)}$$

$$\therefore \frac{e(s)}{P(s)} = \frac{-G(s)}{1+G(s)K(s)}$$

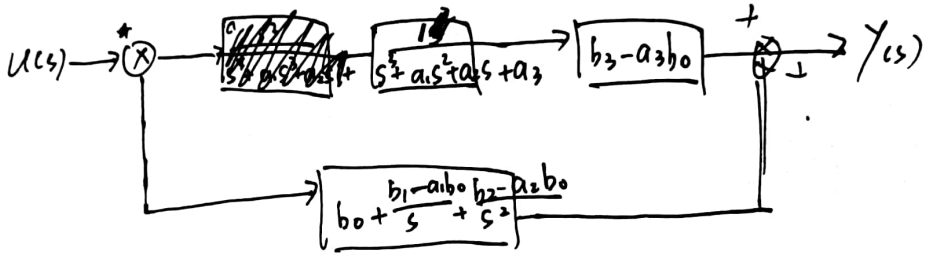
原框图可化为



4. 解：(1) 原框图可化简为



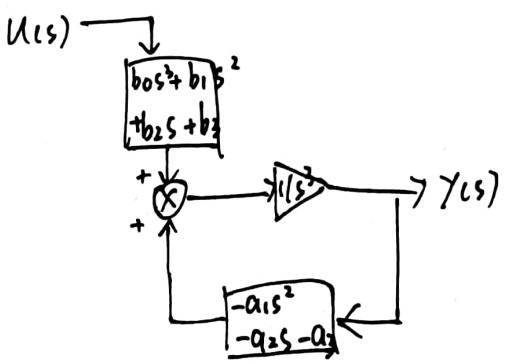
再化简可得：



$$\therefore \frac{Y(s)}{U(s)} = \frac{b_3 - a_3 b_0}{s^3 + a_1 s^2 + a_2 s + a_3} + b_0 + \frac{b_1 - a_1 b_0}{s} + \frac{b_2 - a_2 b_0}{s^2}$$

(2)
$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = x_3 \\ \dot{x}_3 = -a_3 x_1 - a_2 x_2 - a_1 x_3 + u \\ y = (b_3 - a_3 b_0) x_1 + (b_2 - a_2 b_0) x_2 + (b_1 - a_1 b_0) x_3 \end{cases}$$

解：(1) 原框图可化为



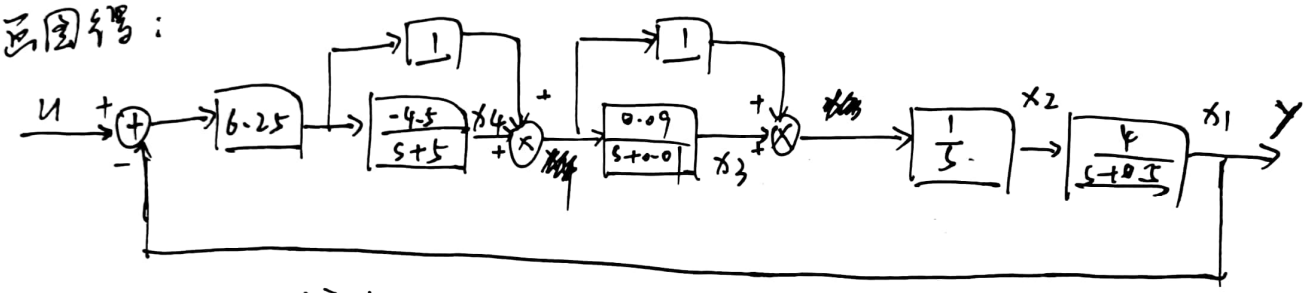
$$\therefore \frac{Y(s)}{U(s)} = \left(b_0 s^3 + b_1 s^2 + b_2 s + b_3\right) \times \frac{\frac{1}{s^3}}{1 + \frac{a_1 s^2 + a_2 s + a_3}{s^3}} = \frac{b_0 s^3 + b_1 s^2 + b_2 s + b_3}{s^3 + a_1 s^2 + a_2 s + a_3}$$

(2)
$$\begin{cases} \dot{x}_1 = -a_3 x_3 + (b_3 - a_3 b_0) u \\ \dot{x}_2 = x_1 - a_2 x_3 + (b_2 - a_2 b_0) u \\ \dot{x}_3 = x_2 - a_1 x_3 + (b_1 - a_1 b_0) u \\ y = x_3 + b_0 u \end{cases}$$

6. 解：根据题设可得 $G_c(s) = 6.25 \cdot (1 - \frac{4.5}{s+5}) \cdot (1 + \frac{0.09}{s+0.01})$

$G_p(s) = \frac{1}{s} \cdot \frac{4}{s+0.5}$

系统结构图：



则系统状态空间表达式为：

$$\begin{cases} \dot{x}_1 = -0.5 x_1 + 4 x_2 \\ \dot{x}_2 = -6.25 x_1 + x_3 + x_4 + 6.25 u \\ \dot{x}_3 = -0.5625 x_1 - 0.01 x_3 + 0.09 x_4 + 0.5625 u \\ \dot{x}_4 = -6.25 x_1 + 6.25 u \\ y = x_1 \end{cases}$$