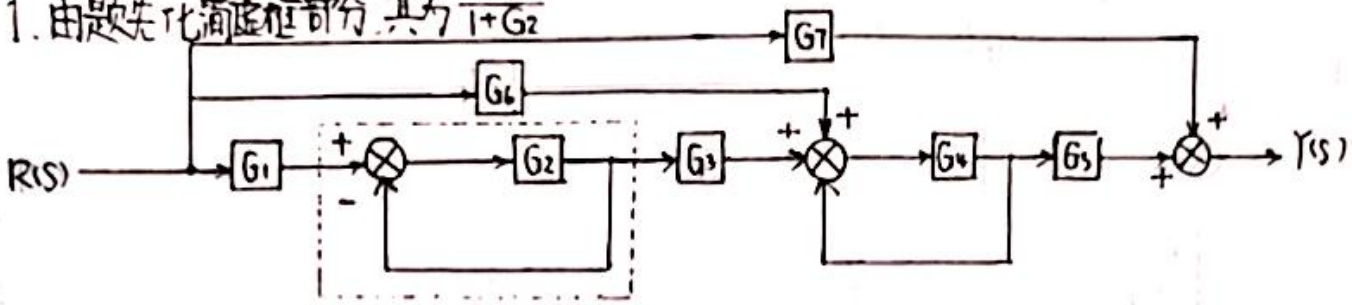
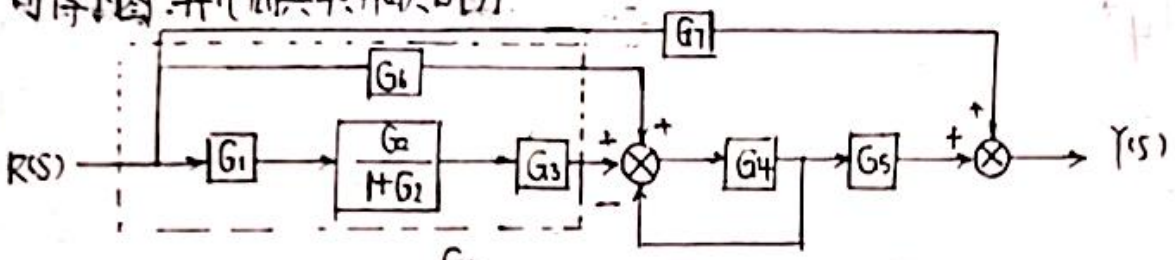
自动控制理论A-作业2

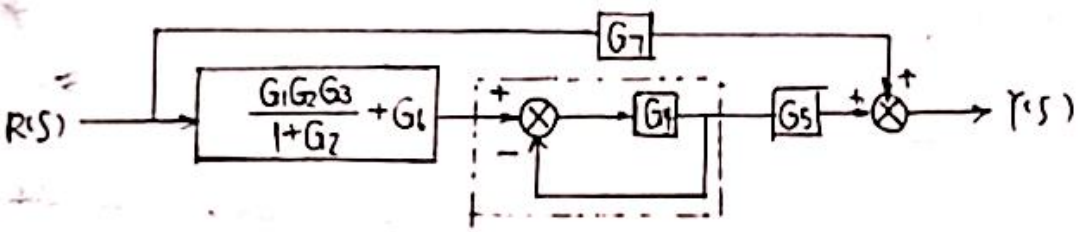
1. 由题先化简虚框部分，其为 $\frac{G_2}{1+G_2}$



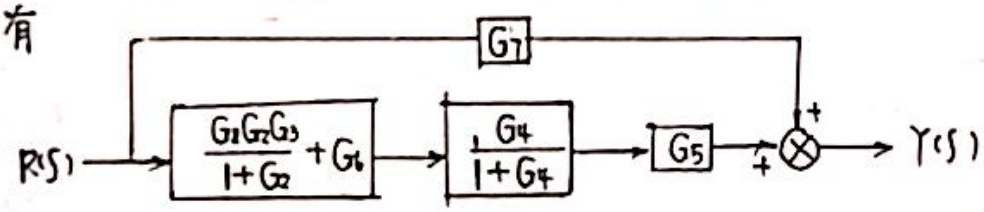
可得下图，再化简其串并联部分



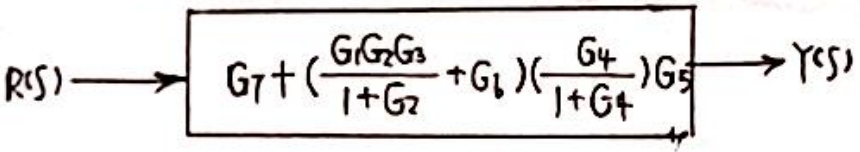
可得，再化虚线部分，其为 $\frac{G_4}{1+G_4}$



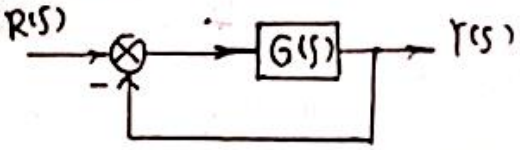
有



继续化简串并联部分得



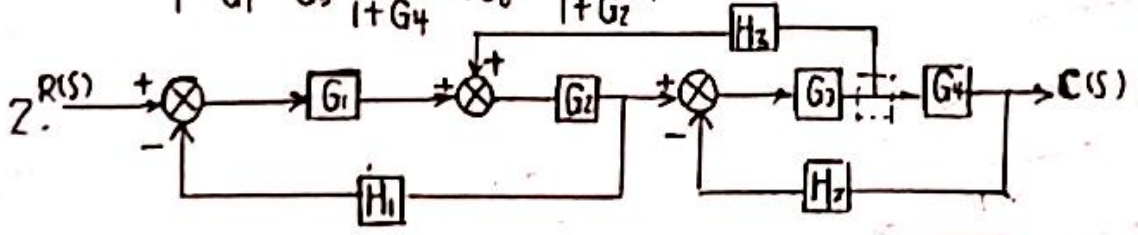
题目要求化为



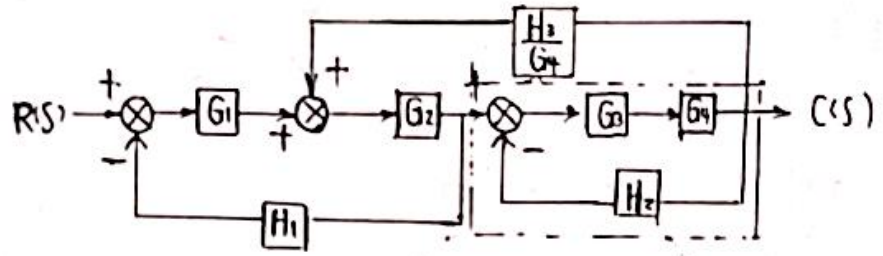
令 $A = G_7+(\frac{G_1G_2G_3}{1+G_2}+G_6)(\frac{G_4}{1+G_4})G_5$，有 $Y(S)=A(S)R(S)=\frac{G(S)}{1+G(S)}R$ 得 $G(S)=\frac{A(S)}{1-A(S)}$

故 $$G(S)=\frac{G_7+G_5(\frac{G_4}{1+G_4})(G_6+\frac{G_1G_2G_3}{1+G_2})}{1-G_7-G_5(\frac{G_4}{1+G_4})(G_6+\frac{G_1G_2G_3}{1+G_2})}$$ 化简

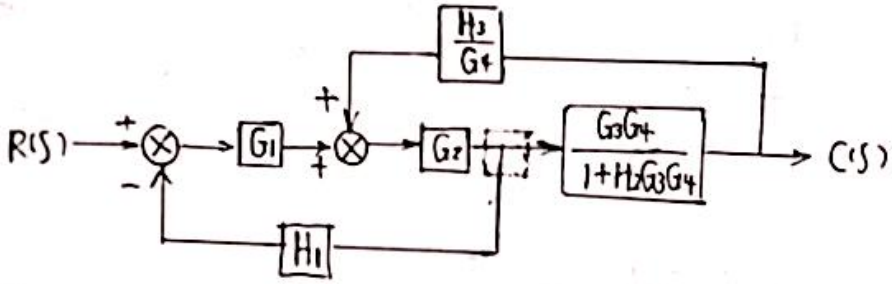
2.



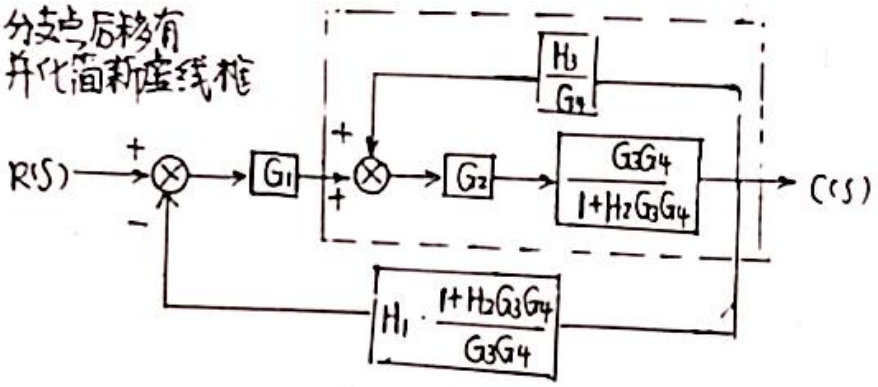
将虚线框中分支点后移，可有



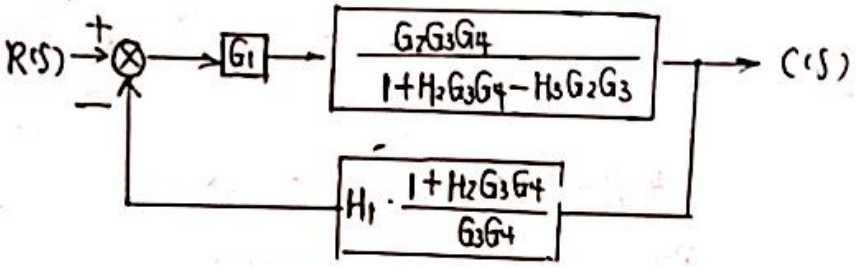
化简虚线框有



分支点后移有
并化简新虚线框



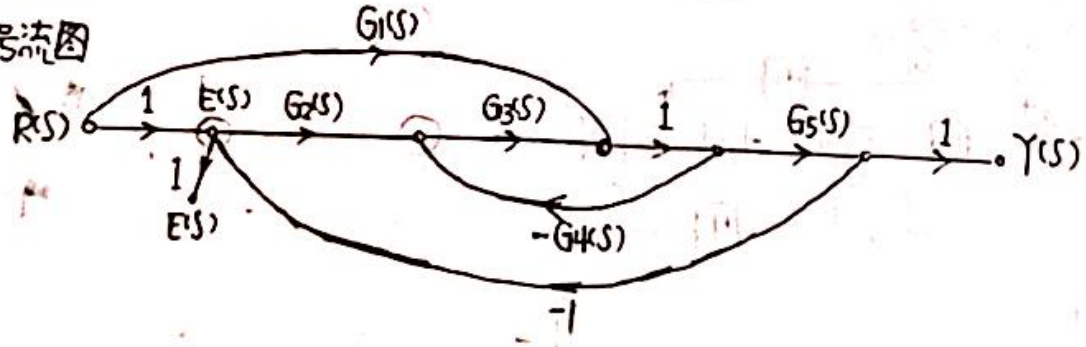
可得



继续整体化简得

$$G(s)=\frac{C(s)}{R(s)}=\frac{\dfrac{G_1G_2G_3G_4}{1+H_2G_3G_4-H_3G_2G_3}}{1-H_1\dfrac{1+H_2G_3G_4}{G_3G_4}\cdot\dfrac{G_1G_2G_3G_4}{1+H_2G_3G_4-H_3G_2G_3}}=\frac{G_1G_2G_3G_4}{1+H_2G_3G_4-H_3G_2G_3-H_1(1+H_2G_3G_4)\,G_1G_2}$$

3. 信号流图



先求 $G(S)=Y(S)/R(S)$，共有两条回路，且二者相接触

$\Delta=1-\sum_a L_a$

$L_1=-G_4(S)G_3(S)G_5(S)$　　$L_2=-G_3(S)G_4(S)$

即 $\Delta=1+G_2(S)G_3(S)G_5(S)+G_3(S)G_4(S)$

其有两条前向通路

$P_1=G_2(S)\cdot G_3(S)G_5(S)$　　$\Delta_1=1$

$P_2=G_1(S)G_5(S)$　　$\Delta_2=1$

故 $P=\frac{1}{\Delta}\sum_{k=1}^{n}P_k\cdot\Delta_k$ 可有 $G(S)=\frac{G_1(S)G_5(S)+G_2(S)G_3(S)G_5(S)}{1+G_3(S)G_4(S)+G_2(S)G_3(S)G_5(S)}$

再求 $H(S)=E(S)/R(S)$，其有两条回路，与上述一致

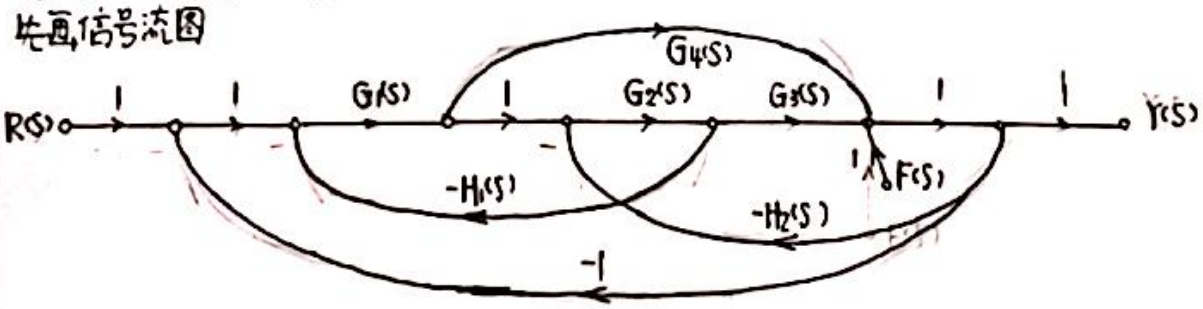
$P_1=1$　　$\Delta_1=1+G_3(S)G_4(S)$

$P_2=-G_1(S)G_5(S)$　　$\Delta_2=1$

故 $H(S)=\frac{E(S)}{R(S)}=\frac{1+G_3(S)G_4(S)-G_1(S)G_5(S)}{1+G_3(S)G_4(S)+G_2(S)G_3(S)G_5(S)}$

4. $F(S)$为系统受到干扰，当G_1、G_2、G_3、G_4、H_1、H_2满足什么关系时，$Y(S)$不受$F(S)$影响。

先画信号流图



由题图中有5条回路

$L_1=-G_1G_4$

$L_2=-G_1G_2G_3$

$L_3=-H_1G_1G_2$

$L_4=H_1H_2G_1G_2G_4$

$L_5=-H_2\cdot G_2\cdot G_3$

由于回路均有接触，则

$\Delta=1-\sum L_a$

$=1+G_1G_4+G_1G_2G_3+H_1G_1G_2+H_2G_2G_3-H_1H_2G_1G_2G_4$

且我们要求 $\frac{Y(S)}{F(S)}$（$R(S)=0$时）和 $\frac{Y(S)}{R(S)}$（$F(S)=0$时）

仅供参考 反对抄袭

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2023.6

对于 $\frac{Y(S)}{F(S)}$ 只有一条前向通路 $P_{F1}=1$，$\Delta_{F1}=1+G_1G_2H_1$，得 $\frac{Y(S)}{F(S)}=\frac{1+G_1G_2H_1}{1+G_1G_4+G_1G_2G_3+H_1G_1G_2+H_2G_2G_3-H_1H_2G_1G_2G_4}$

对于 $\frac{Y(S)}{R(S)}$ 有两条前向通路 $P_{R1}=G_1G_2G_3$，$\Delta_{R1}=1$；$P_{R2}=G_1\cdot G_4$，$\Delta_{R2}=1$：

故 $\frac{Y(S)}{R(S)}=\frac{G_1G_2G_3+G_1G_4}{1+G_1G_4+G_1G_2G_3+H_1G_1G_2+H_2G_2G_3-H_1H_2G_1G_2G_4}$　分母不为0

（这里字母均为关于S域函数，G_1表示$G_1(S)$）

由于让 $Y(S)$不受$F(S)$干扰，令 $1+G_1G_2H_1=0$，满足$Y(S)$不受$F(S)$影响，即 $\frac{Y(S)}{R(S)}=\frac{G_1G_2G_3+G_1G_4}{G_1G_4+G_1G_2G_3+H_2G_2G_3-H_1H_2G_1G_2G_4}$