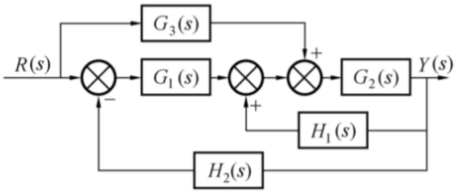
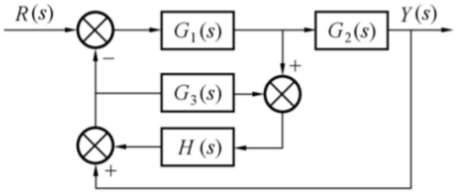
自动控制理论 A 作业 2

2019 年 9 月 11 日

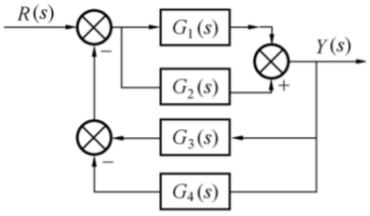
2.7　控制系统的方框图如题 2.7 图所示，试用方框图化简的规则化简方框图，求传递函数 $Y(s)/R(s)$。



(a)

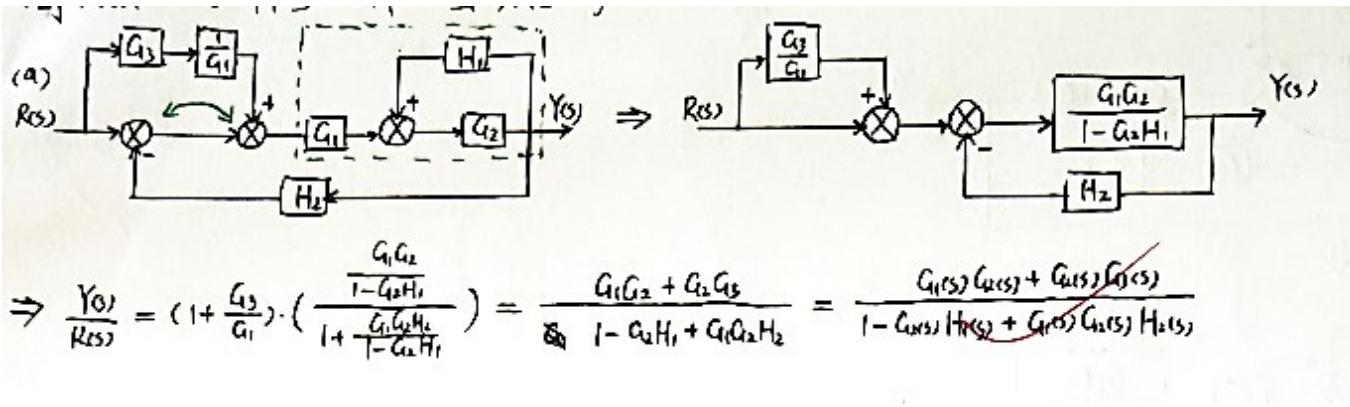


(c)

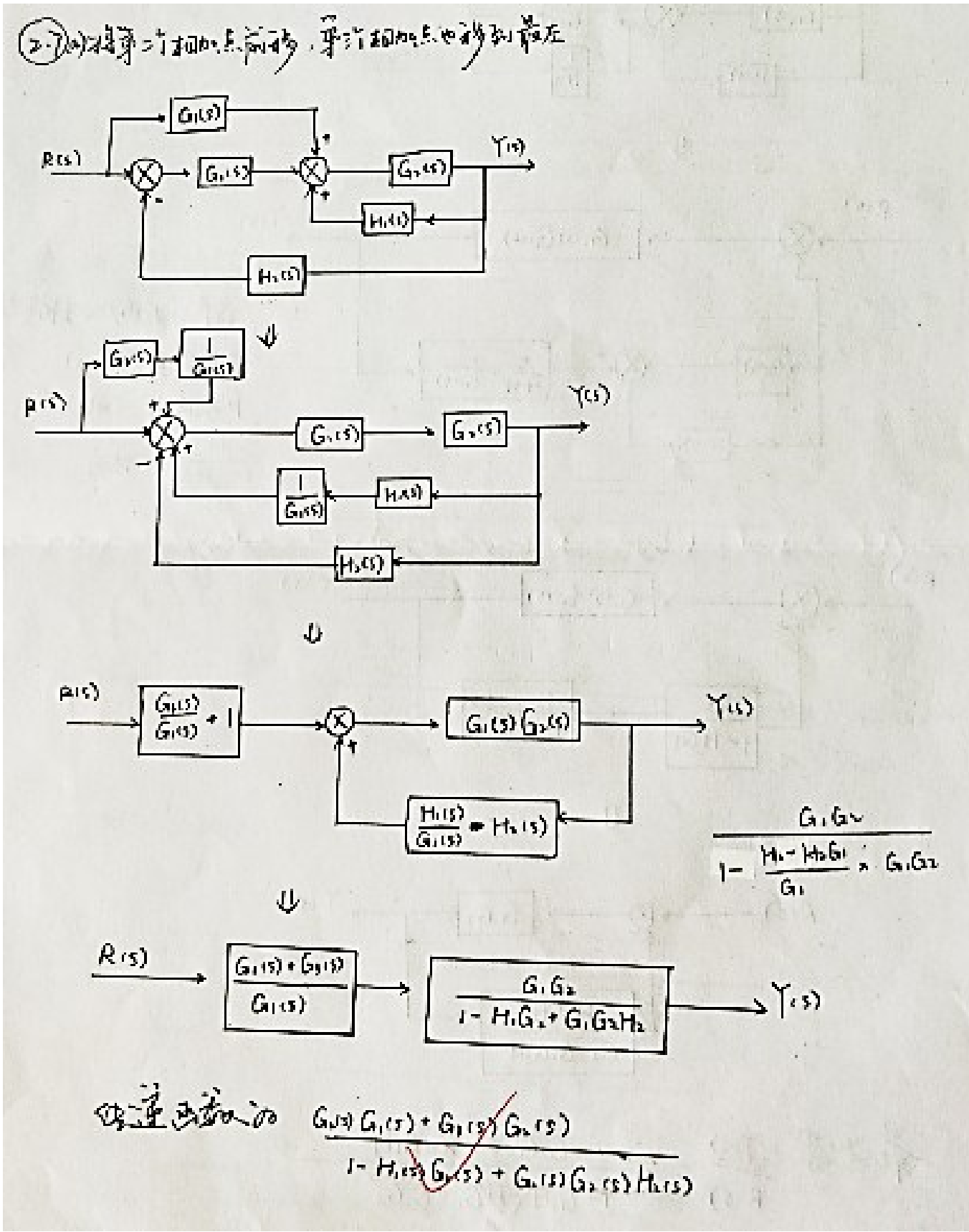


(e)

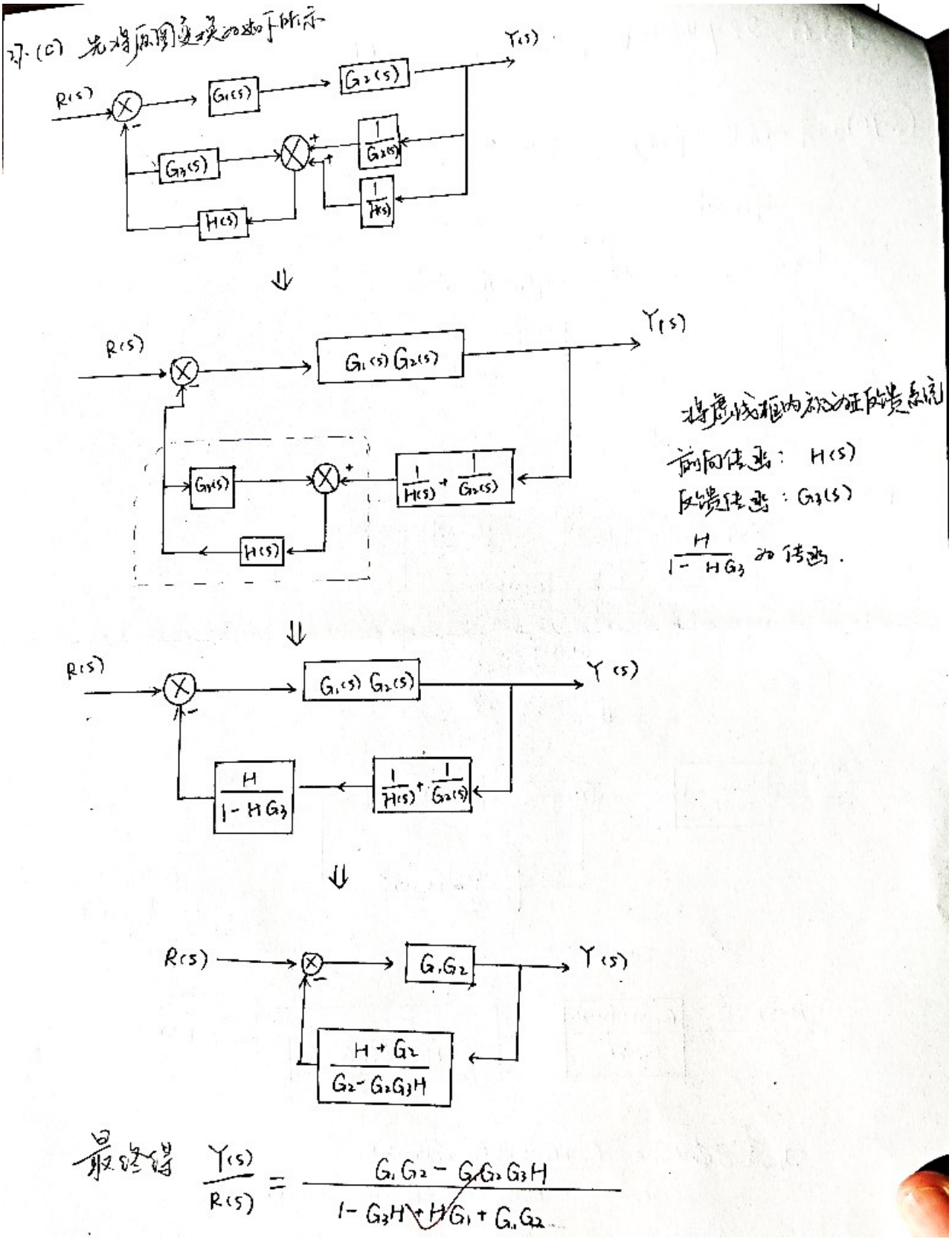
a)



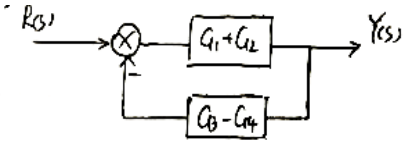
$$\Rightarrow \frac{Y(s)}{R(s)} = \left(1+\frac{G_3}{G_1}\right)\cdot\left(\frac{\frac{G_1G_2}{1-G_2H_1}}{1+\frac{G_1G_2H_2}{1-G_2H_1}}\right) = \frac{G_1G_2+G_2G_3}{1-G_2H_1+G_1G_2H_2} = \frac{G_1(s)G_2(s)+G_2(s)G_3(s)}{1-G_2(s)H_1(s)+G_1(s)G_2(s)H_2(s)}$$


R(s)
G1(s)
G2(s)
H1(s)
H2(s)
Y(s)
1/G1(s)
G1(s)G2(s)
H1(s)/G1(s) + H2(s)
R(s)
Y(s)
G1(s)G2(s) + G3(s)G2(s)
1 - H1(s)G2(s) + G1(s)G2(s)H2(s)

c)

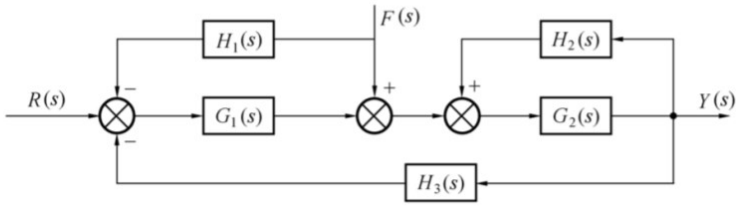

3. (c) 先将原图变换如下所示
R(s)
G1(s)
G2(s)
Y(s)
G3(s)
H(s)
1/G2(s)
1/H(s)
R(s)
G1(s)G2(s)
Y(s)
G3(s)
H(s)
1/H(s) + 1/G2(s)
将虚线框内部分化为传递系统
前向传递：H(s)
反馈传递：G3(s)
H/(1-HG3) 为传递.
R(s)
G1(s)G2(s)
Y(s)
H/(1-HG3)
1/H(s) + 1/G2(s)
R(s)
G1G2
Y(s)
(H+G2)/(G2-G2G3H)
最终得 Y(s)/R(s) = (G1G2 - G1G2G3H)/(1 - G3H + HG1 + G1G2)

e)



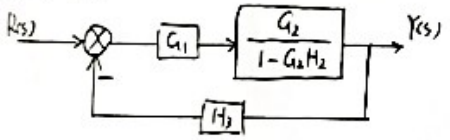
$$\Rightarrow \frac{Y(s)}{R(s)} = \frac{G_1+G_2}{1+(G_1+G_2)(G_3-G_4)} = \frac{G_1(s)+G_2(s)}{1+(G_1(s)+G_2(s))(G_3(s)-G_4(s))}$$

2.8　用方框图化简规则化简题 2.8 图所示的方框图，求系统传递函数$\frac{Y(s)}{R(s)}$及$\frac{Y(s)}{F(s)}$。



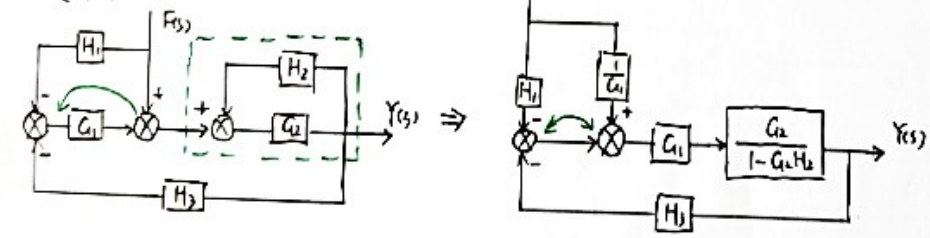
(a)

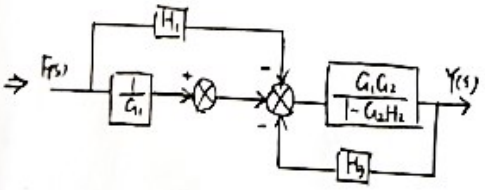
2.8. (1) 令 $F(s)=0$



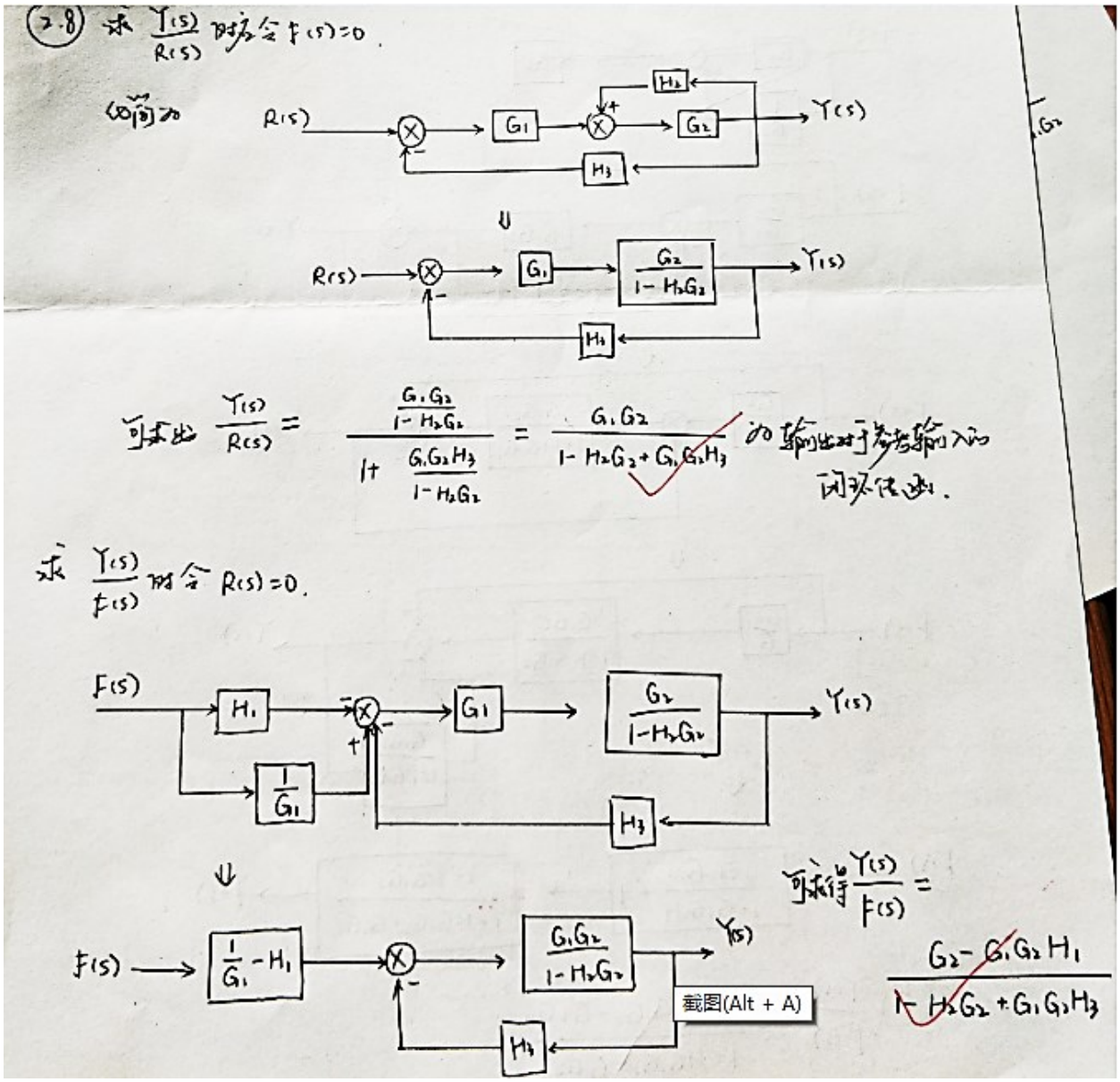
$$\Rightarrow \frac{Y(s)}{R(s)} = \frac{\frac{G_1G_2}{1-G_2H_2}}{1+\frac{G_1G_2H_3}{1-G_2H_2}} = \frac{G_1(s)G_2(s)}{1-G_2(s)H_2(s)+G_1(s)G_2(s)H_3(s)}$$

(2) 令 $R(s)=0$

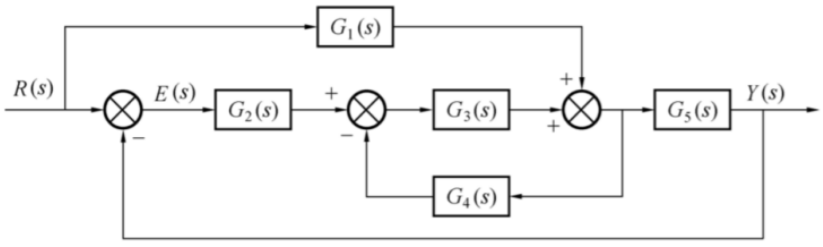




$$\Rightarrow \frac{Y(s)}{F(s)} = \left(\frac{1}{G_1}-H_1\right)\cdot\left(\frac{\frac{G_1G_2}{1-G_2H_2}}{1+\frac{G_1G_2H_3}{1-G_2H_2}}\right) = \frac{G_2(s)-G_1(s)G_2(s)H_1(s)}{1-G_2(s)H_2(s)+G_1(s)G_2(s)H_3(s)}$$

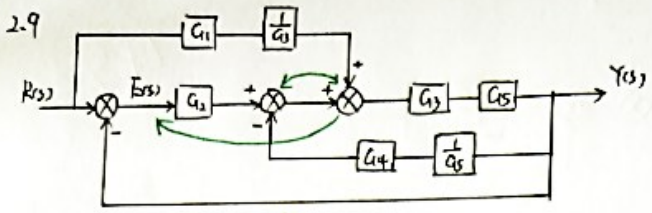


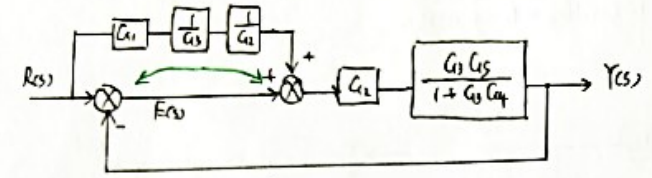
2.9　用方框图化简规则化简方框图，求 $\frac{Y(s)}{R(s)}$ 及 $\frac{E(s)}{R(s)}$。

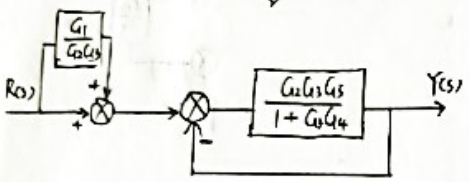


(b)

2.9

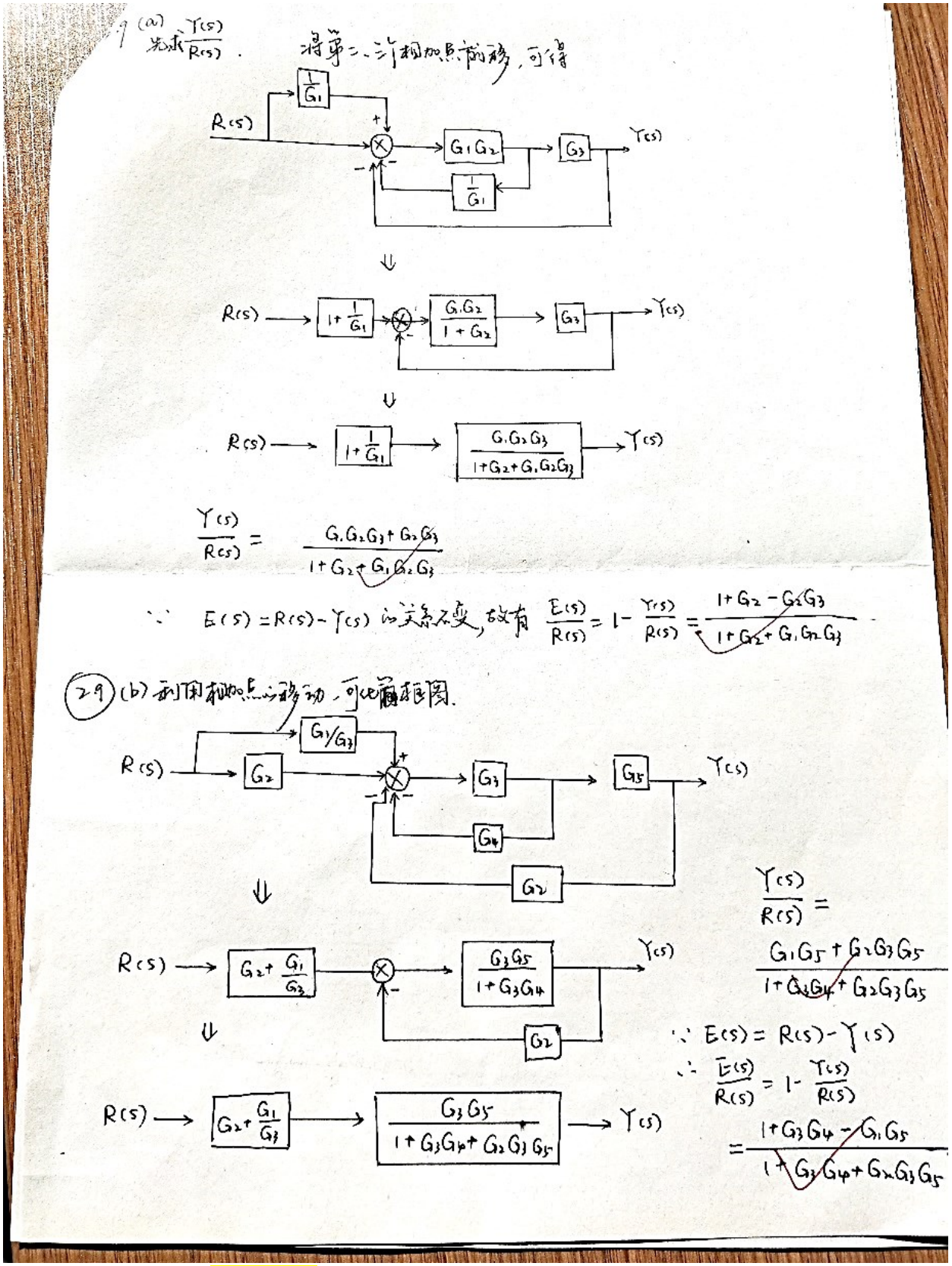






$$\Rightarrow \frac{Y(s)}{R(s)} = \left(1 + \frac{G_1}{G_2G_3}\right)\left(\frac{\frac{G_2G_3G_5}{1+G_3G_4}}{1+\frac{G_2G_3G_5}{1+G_3G_4}}\right) = \frac{G_1(s)G_2(s)G_3(s)G_5(s) + G_2(s)G_3(s)G_5(s)}{1+G_3(s)G_4(s)+G_2(s)G_3(s)G_5(s)}$$

$$\therefore \frac{E(s)}{R(s)} = \frac{R(s)-Y(s)}{R(s)} = 1 - \frac{Y(s)}{R(s)} = \frac{1+G_3(s)G_4(s) - G_1(s)G_2(s)}{1+G_3(s)G_4(s)+G_2(s)G_3(s)G_5(s)}$$



【问题 1】很多同学的化简不到位，最后的答案传函本来就是一个分式了，分子或者分母却还套着非常复杂的分式，没有化到最简；

【问题 2】框图化简到最简形式了，就直接画成 R 入 Y 出，框图里写传函这样的答案，但实际上题目要求计算 Y/R，结果一定是一个传递函数而不应该是一个框图，这样的写法是

不规范不标准的

【问题 3】框图化简求解传递函数比较复杂繁琐，同学们不熟练，很容易在分支点相加点移动过程中出错出错