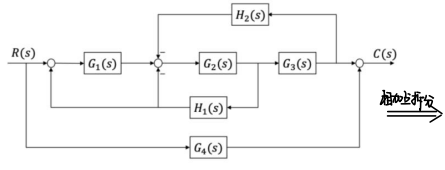
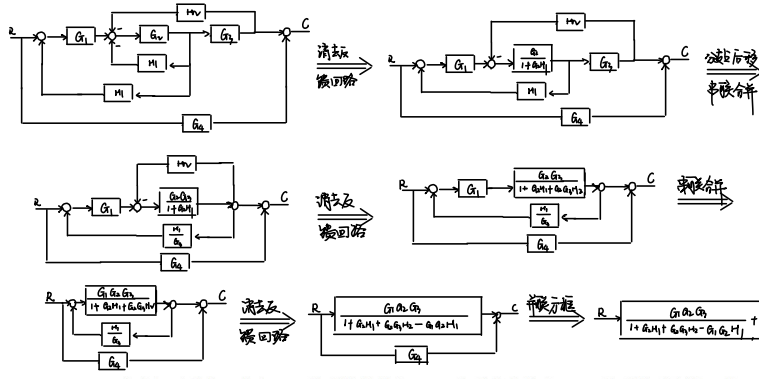
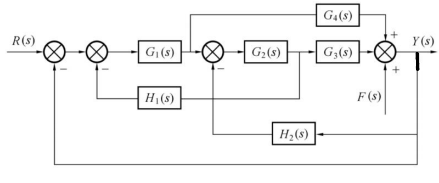
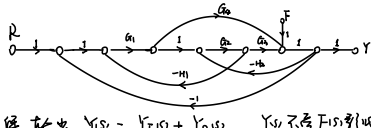
1. (20′) 已知某系统结构框图如下所示，请用方框图化简法求其闭环传递函数$G(s)=\frac{C(s)}{R(s)}$。（注意：请写出详细的解题步骤）




2. (30′) 考虑如下系统，其中 $R(s)$为系统的输入，$Y(s)$为系统的输出，$F(s)$为系统受到的干扰。请分析当$G_1,G_2,G_3,G_4,H_1$和$H_2$满足什么关系时，系统的输出信号 $Y(s)$将不受干扰信号 $F(s)$的影响。




由线性性可得 输出 $Y(s)=Y_F(s)+Y_R(s)$. $Y(s)$不受$F(s)$影响即 $Y_F(s)=0$

对扰动信号 $F(s)$.

$L_1=-G_1G_2H_1$　$L_2=-G_2G_3H_2$　$L_3=-G_1G_2G_3$　$L_4=-G_1G_4$　$L_5=G_1G_4H_2G_2H_1$

$\Delta=1-\sum L_a=1+G_1G_2H_1+G_2G_3H_2+G_1G_2G_3+G_1G_4-G_1G_2G_4H_1H_2$

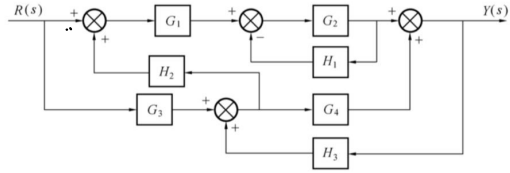
$P_1=1$.　$\Delta_1=1+G_1G_2H_1$

由Mason公式：$G_F(s)=\frac{1}{\Delta}P\Delta_1=\frac{1+G_1G_2H_1}{1+G_1G_2H_1+G_2G_3H_2+G_1G_2G_3+G_1G_4-G_1G_2G_4H_1H_2}$

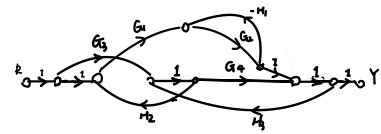
当 $1+G_1G_2H_1=0$ 即 $1+G_1G_2H_1+G_2G_3H_2+G_1G_2G_3+G_1G_4-G_1G_2G_4H_1H_2\neq 0$ 时，$Y(s)$不受$F(s)$影响

3. (20′) 请将下列系统的方框图化为信号流图，并用梅森公式法求其闭环传递函数$G(s)=\frac{C(s)}{R(s)}$。

（注意：请写出详细的解题步骤）




信号流图如右所示：

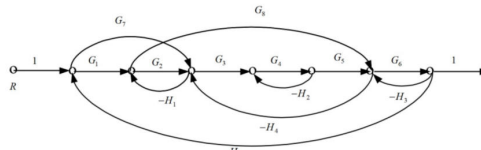



$\Delta = 1-(G_4H_3 - G_2H_1 + G_1G_2H_1H_3) + (G_2H_1)(G_4H_3) = 1 - G_4H_3 + G_2H_1 - G_1G_2H_1H_3 - G_2G_4H_1H_3$

$P_1 = G_1G_2$. $\Delta_1 = 1+G_4H_3$ $P_2 = G_1G_2$ $\Delta_2 = 1$ $P_3 = G_1H_2G_1G_2$ $\Delta_3 = 1$

由 Mason 公式得 $G(s) = \frac{1}{\Delta}(P_1\Delta_1 + P_2\Delta_2) = \frac{G_1G_2 + G_1G_2G_4 + G_2G_3G_4H_1 + G_1G_2G_3H_2}{1 - G_4H_3 + G_2H_1 - G_1G_2H_1H_3 - G_2G_4H_1H_3}$

4. (30′) 已知某系统信号流图如下图所示，请用梅森公式法求其闭环传递函数$G(s)=\frac{C(s)}{R(s)}$。（注意：请写出详细的解题步骤）




$\Delta = 1-(-G_2H_1 - G_4H_2 - G_6H_3 - G_7G_8G_5H_2 - G_1G_2G_3G_4G_5G_6H_5 - G_1G_2G_4G_5G_6H_5 - G_1G_8G_6H_5 + G_8H_1H_4 + G_6G_7G_8H_1H_5)$
$+[(-G_2H_1)\cdot(-G_4H_2) + (-G_1G_8G_6H_5)(-G_4H_2) + (-G_2H_1)\cdot(-G_6H_3) + (-G_4H_2)(-G_6H_3)) + G_8H_1H_4(-G_6H_3) + G_6G_7G_8H_1H_5(-G_2H_1)]$
$-(-G_2H_1)\cdot(-G_4H_2)\cdot(-G_6H_3))$

$P_1 = G_1G_2G_3G_4G_5G_6$ $\Delta_1 = 1$

$P_2 = G_7G_3G_4G_5G_6$ $\Delta_2 = 1$

$P_3 = G_1G_8G_6$ $\Delta_3 = 1 + G_4H_2$

$P_4 = -G_7H_1G_8G_6$ $\Delta_4 = 1 + G_4H_2$

由 Mason 公式得 $G(s) = \frac{1}{\Delta}(P_1\Delta_1 + P_2\Delta_2 + P_3\Delta_3 + P_4\Delta_4)$

$$= \frac{G_1G_2G_3G_4G_5G_6 + G_7G_4G_5G_6G_7 + G_1G_6G_8 + G_1G_4G_6G_8H_2 - G_6G_7G_8H_1 - G_4G_6G_7G_8H_1H_2}{1 + G_2H_1 + G_4H_2 + G_6H_3 + G_7G_8G_5H_2 + G_1G_2G_3G_4G_5G_6H_5 + G_2G_4G_5G_6G_7H_5 + G_1G_6G_8H_5 + G_8H_1H_4 + G_6G_7G_8H_1H_5 + G_2G_6H_1H_3 + G_1G_4G_6G_8H_2H_5 + G_2G_6H_1H_4 + G_4G_6H_2H_3 + G_2G_8H_1H_2H_4 + G_6G_7G_8H_1H_2H_5 + G_2G_4G_6H_1H_2H_3$