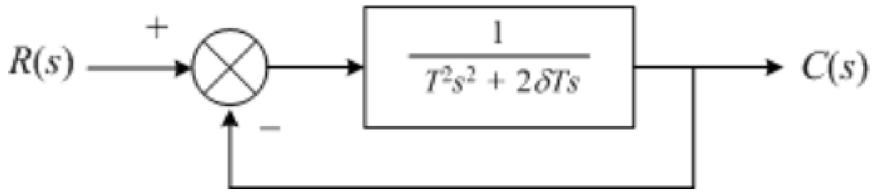
Q3 question

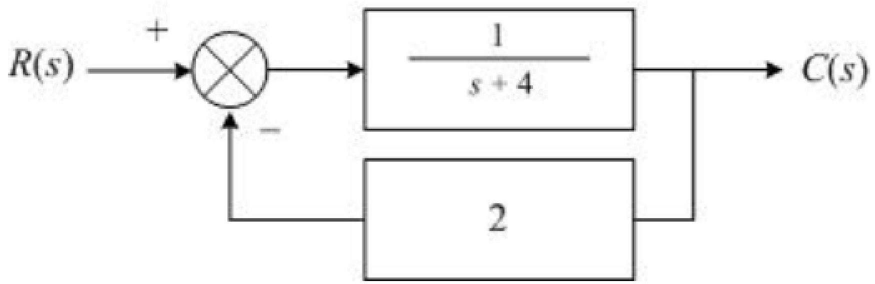
Find the closed-loop transfer function for the systems shown below.

(a)



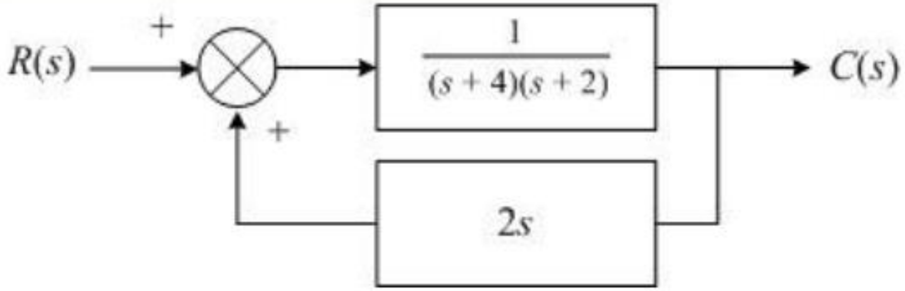
Ans: $\frac{C(s)}{R(s)} = \frac{1}{T^2s^2 + 2\delta Ts + 1}$

(b)



Ans: $\frac{C(s)}{R(s)} = \frac{1}{s+6}$

(c)



Ans: $\frac{C(s)}{R(s)} = \frac{1}{s^2 + 4s + 8}$

Q3 solution

3. (a)

$$\frac{C(s)}{R(s)} = \frac{\frac{1}{T^2s^2 + 2\delta Ts}}{1 + \frac{1}{T^2s^2 + 2\delta Ts}} = \frac{1}{T^2s^2 + 2\delta Ts + 1}$$

(b)

$$\frac{C(s)}{R(s)} = \frac{\frac{1}{s+4}}{1 + (2)\left(\frac{1}{s+4}\right)} = \frac{1}{s+6}$$

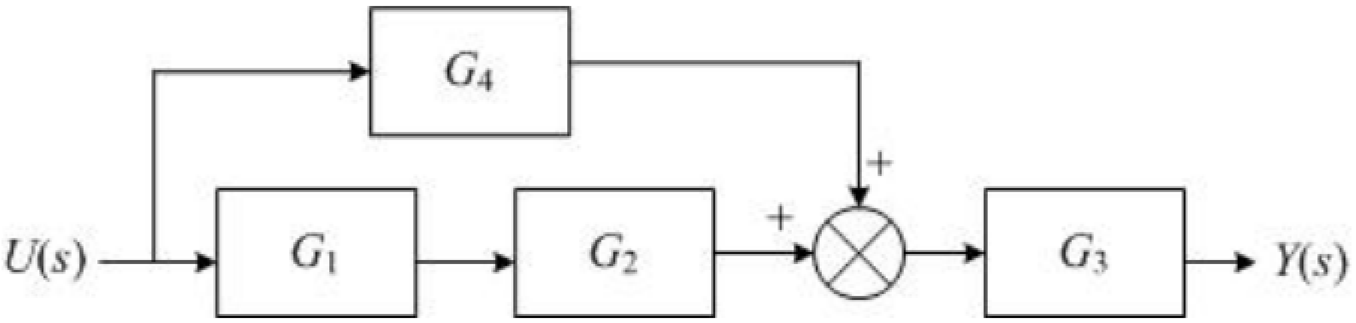
(c)

$$\frac{C(s)}{R(s)} = \frac{\frac{1}{(s+4)(s+2)}}{1 - \frac{1}{(s+4)(s+2)}(2s)} = \frac{\frac{1}{(s+4)(s+2)}}{\frac{(s+4)(s+2) - 2s}{(s+4)(s+2)}} = \frac{1}{s^2 + 4s + 8}$$

Q4 question

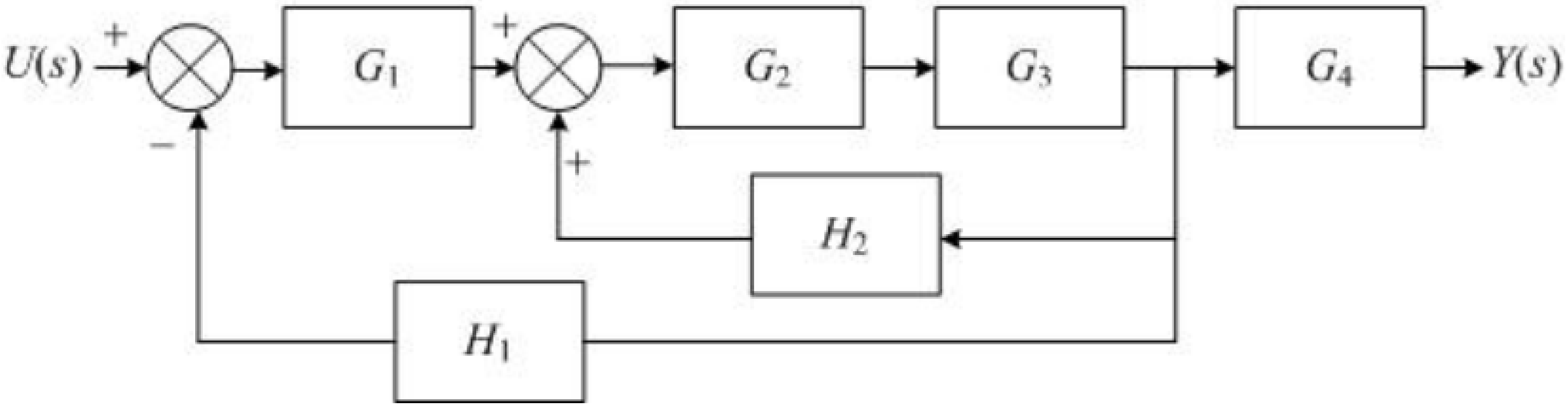
4. Reduce the block diagrams shown below to obtain the transfer function using block combination rules.

(a)



Ans: $\frac{Y(s)}{U(s)} = (G_1G_2 + G_4)G_3$

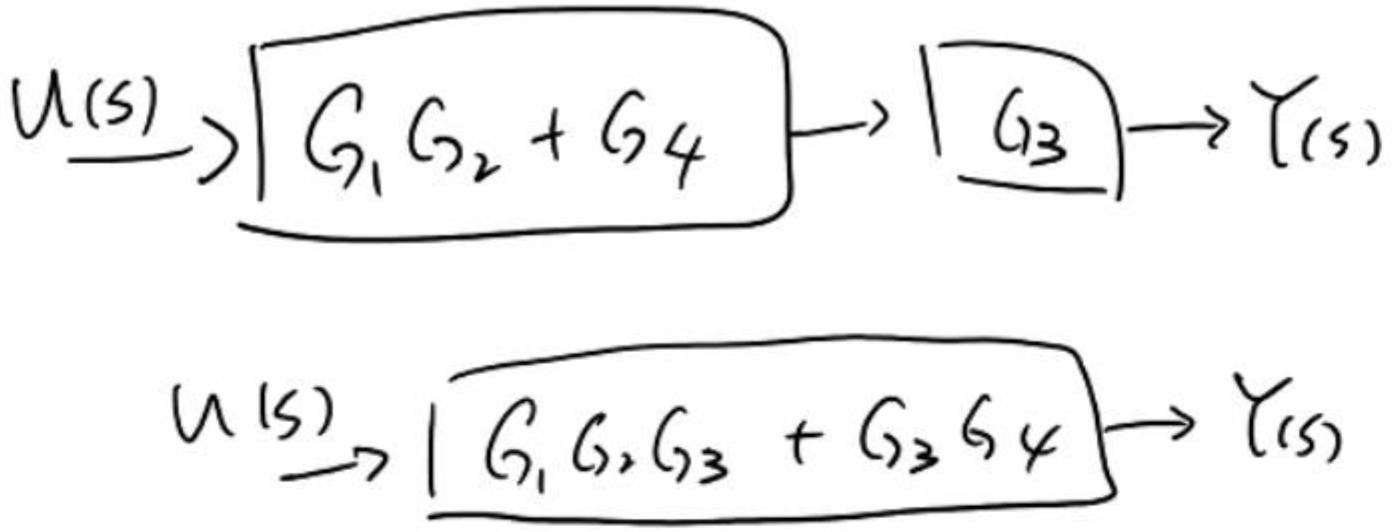
(b)



Ans: $\frac{Y(s)}{U(s)} = \frac{G_1G_2G_3G_4}{1 - G_2G_3H_2 + G_1G_2G_3H_1}$

Q4 solution

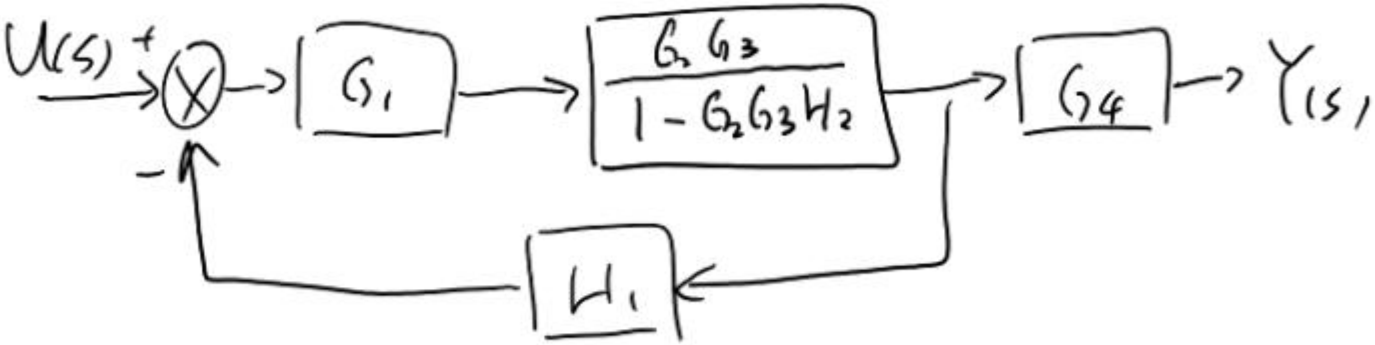
(a)

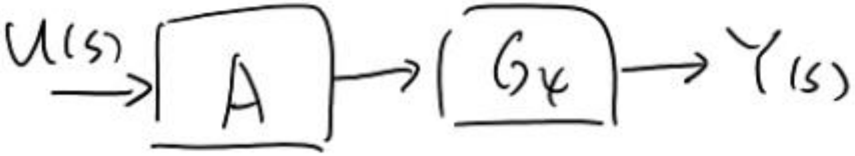


$$\frac{Y(s)}{U(s)} = G_1G_2G_3 + G_4G_3$$

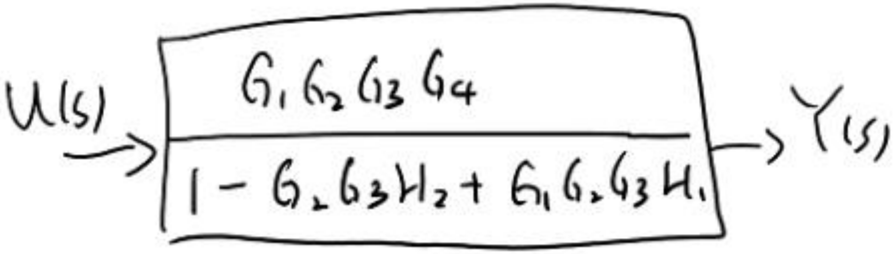
Q4 solution

(b)





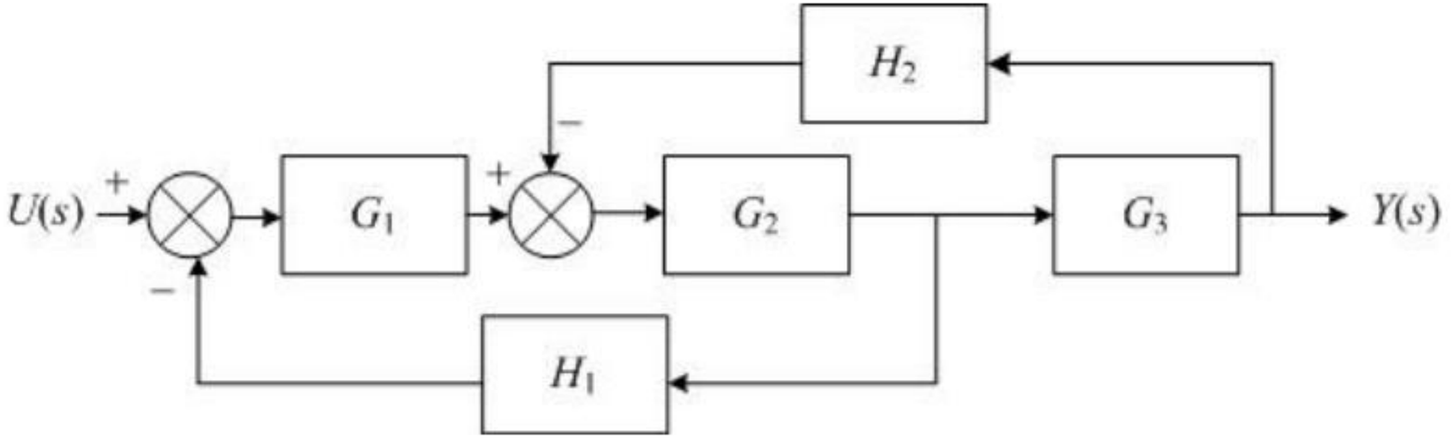
$$A = \frac{\frac{G_1 G_2 G_3}{1 - G_2 G_3 H_2}}{1 + \left(\frac{G_1 G_2 G_3}{1 - G_2 G_3 H_2}\right)(H_1)} = \frac{G_1 G_2 G_3}{1 - G_2 G_3 H_2 + G_1 G_2 G_3 H_1}$$



$$\frac{Y(s)}{U(s)} = \frac{G_1 G_2 G_3 G_4}{1 - G_2 G_3 H_2 + G_1 G_2 G_3 H_1}$$

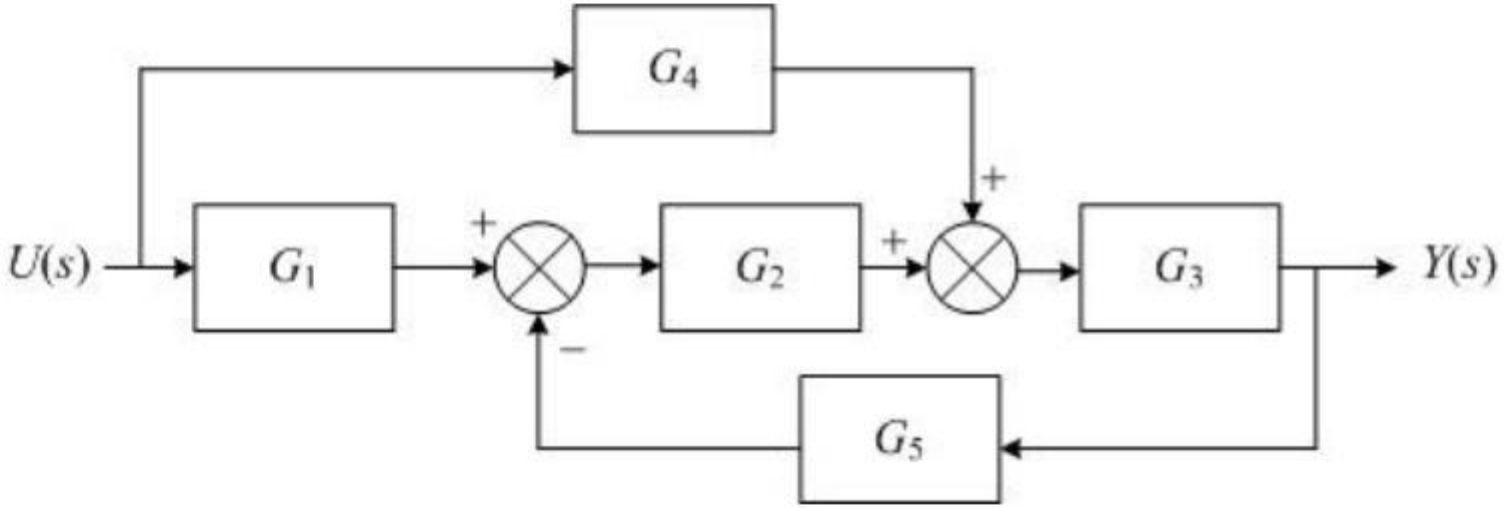
Q4 question

(c)



Ans: $\frac{Y(s)}{U(s)} = \frac{G_1G_2G_3}{1 + G_2G_3H_2 + G_1G_2H_1}$

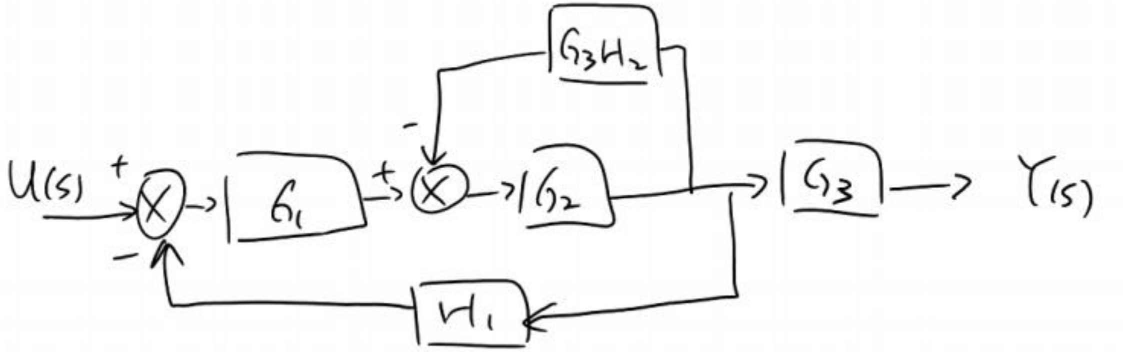
(d)

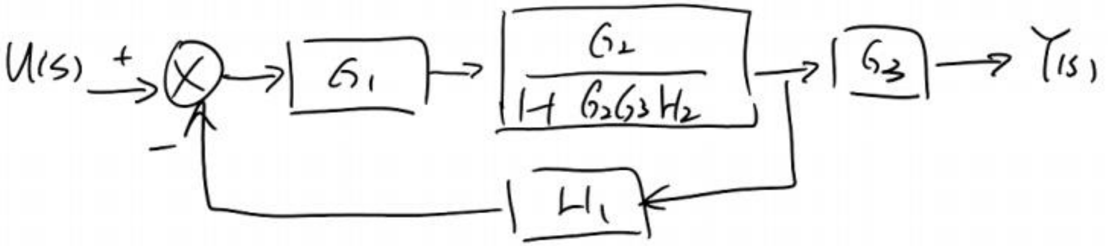


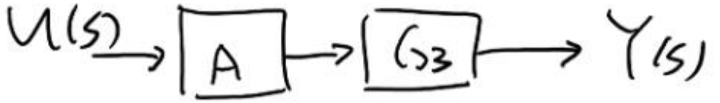
Ans: $\frac{Y(s)}{U(s)} = \frac{G_3(G_1G_2 + G_4)}{1 + G_2G_3G_5}$

Q4 solution

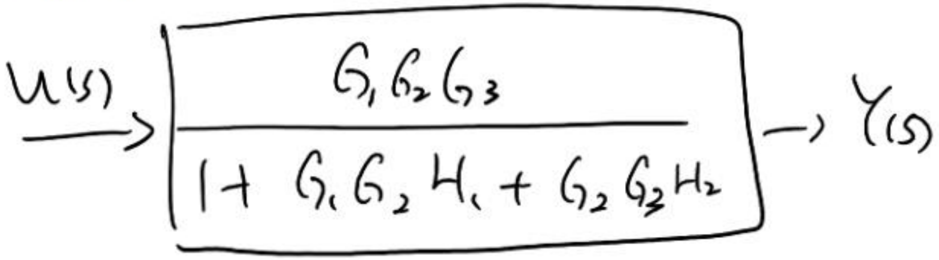
(c)







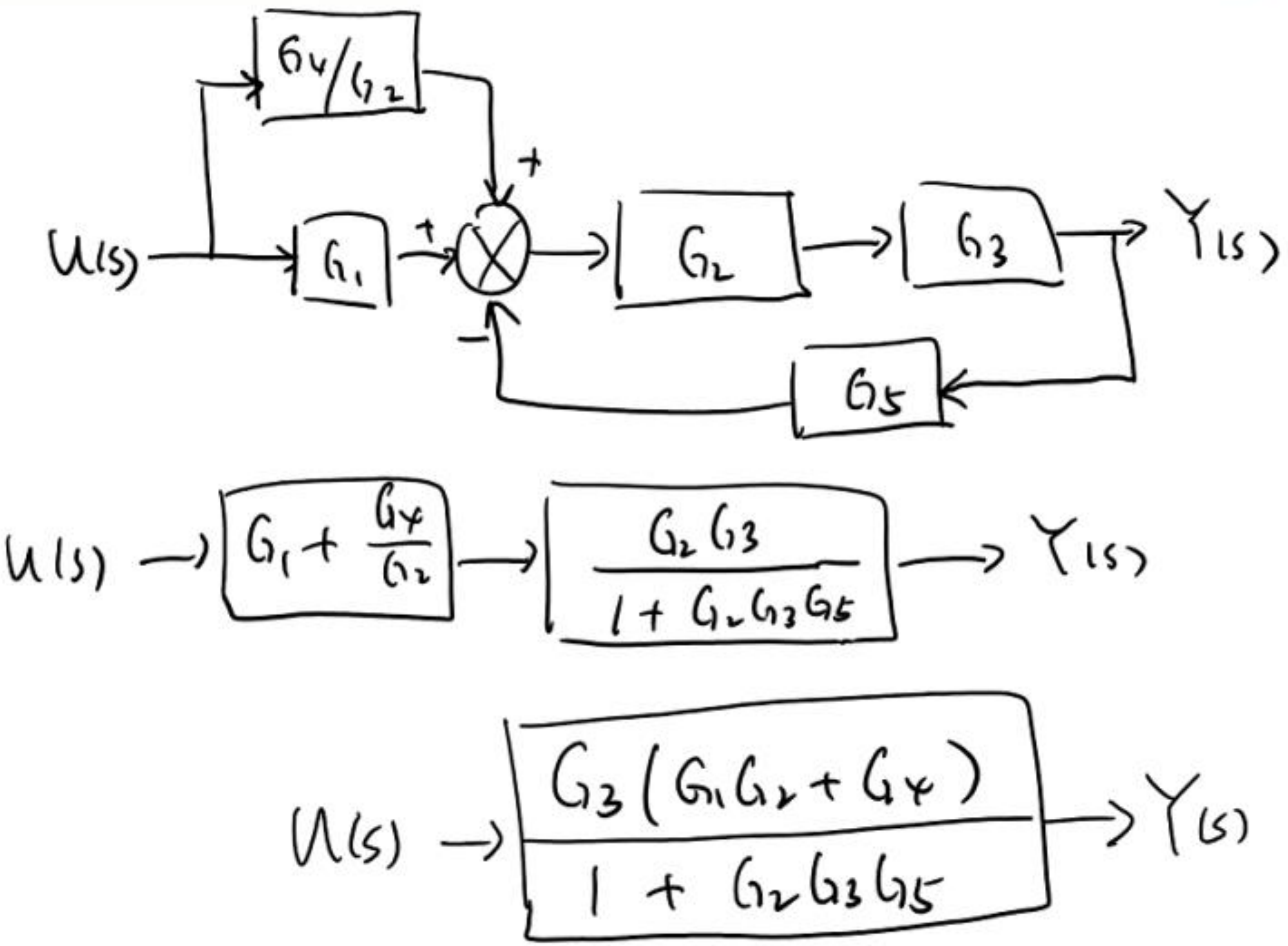
$$A = \frac{\frac{G_1G_2}{1+G_2G_3H_2}}{1+\frac{G_1G_2H_1}{1+G_2G_3H_2}} = \frac{G_1G_2}{1+G_2G_3H_2+G_1G_2H_1}$$



$$\frac{Y(s)}{U(s)} = \frac{G_1G_2G_3}{1+G_2G_3H_2+G_1G_2H_1}$$

Q4 solution

(d)



$$\frac{Y(s)}{U(s)} = \frac{G_3(G_1G_2 + G_4)}{1 + G_2G_3G_5}$$