Instrumentation and Controls

ETM 3301

Lecture 11

Instructor

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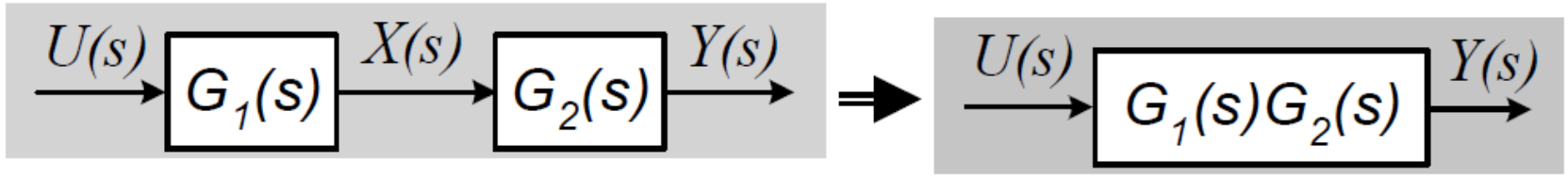
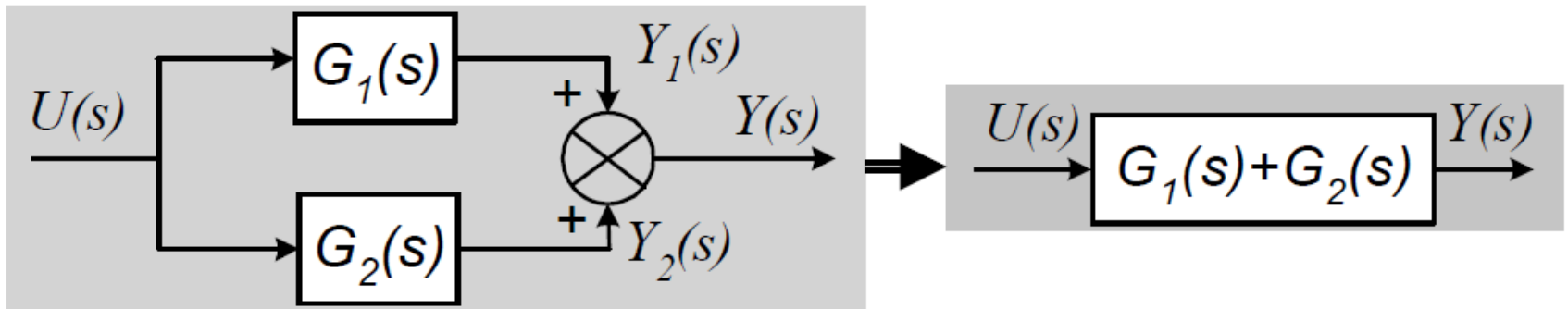
Three Typical Cases

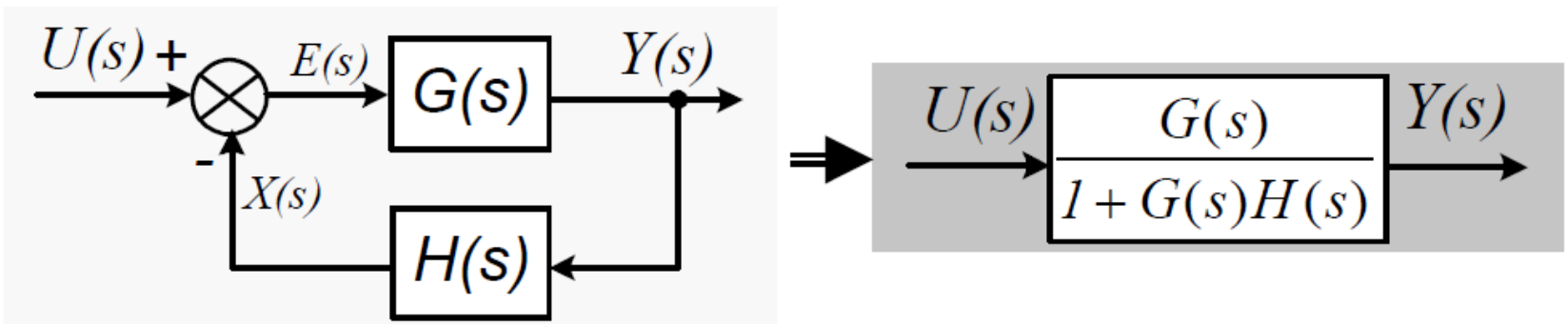
- Series Connection



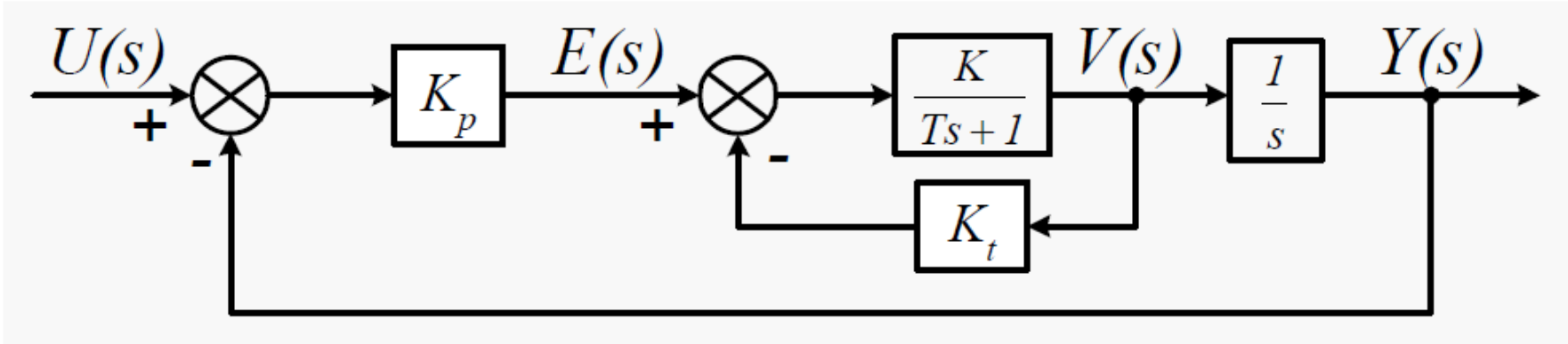
- Parallel Connection

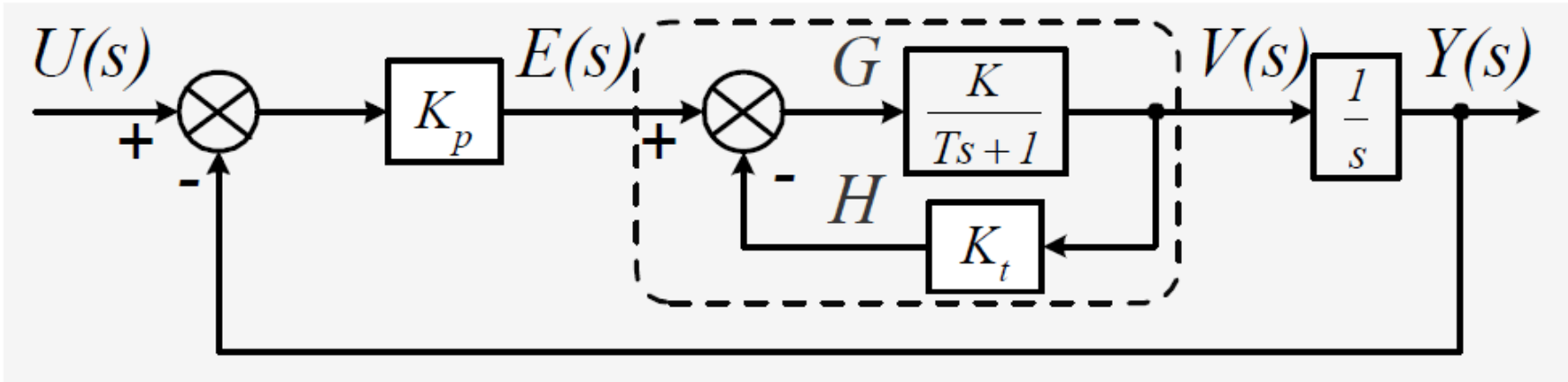


- Negative Feedback Connection



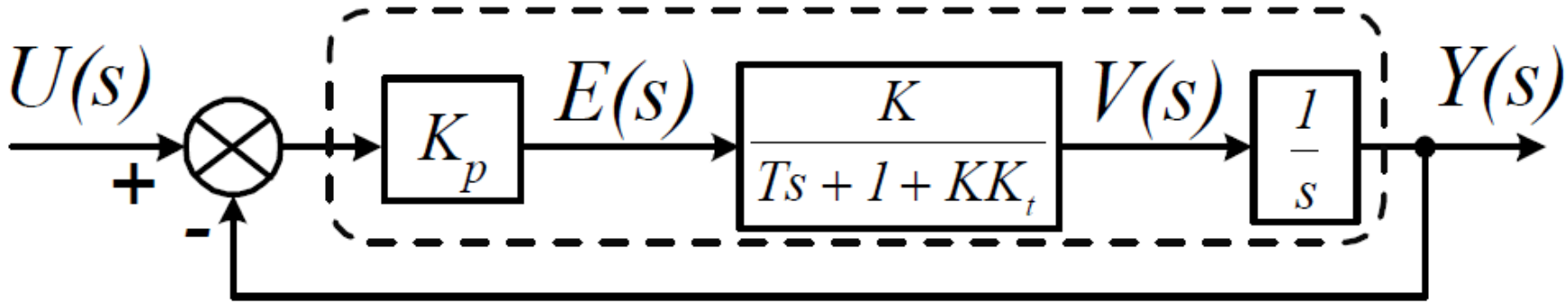
Complex Negative Feedback Example, 1

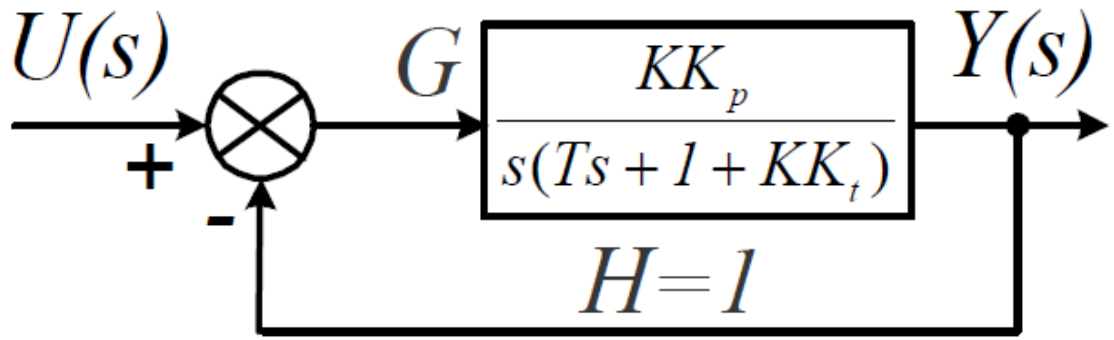




$$\frac{V(s)}{E(s)} = \frac{\frac{K}{Ts+1}}{1+\frac{K}{Ts+1}K_t} = \frac{K}{(Ts+1)\left(1+\frac{K}{Ts+1}K_t\right)} = \frac{K}{Ts+1+KK_t}$$

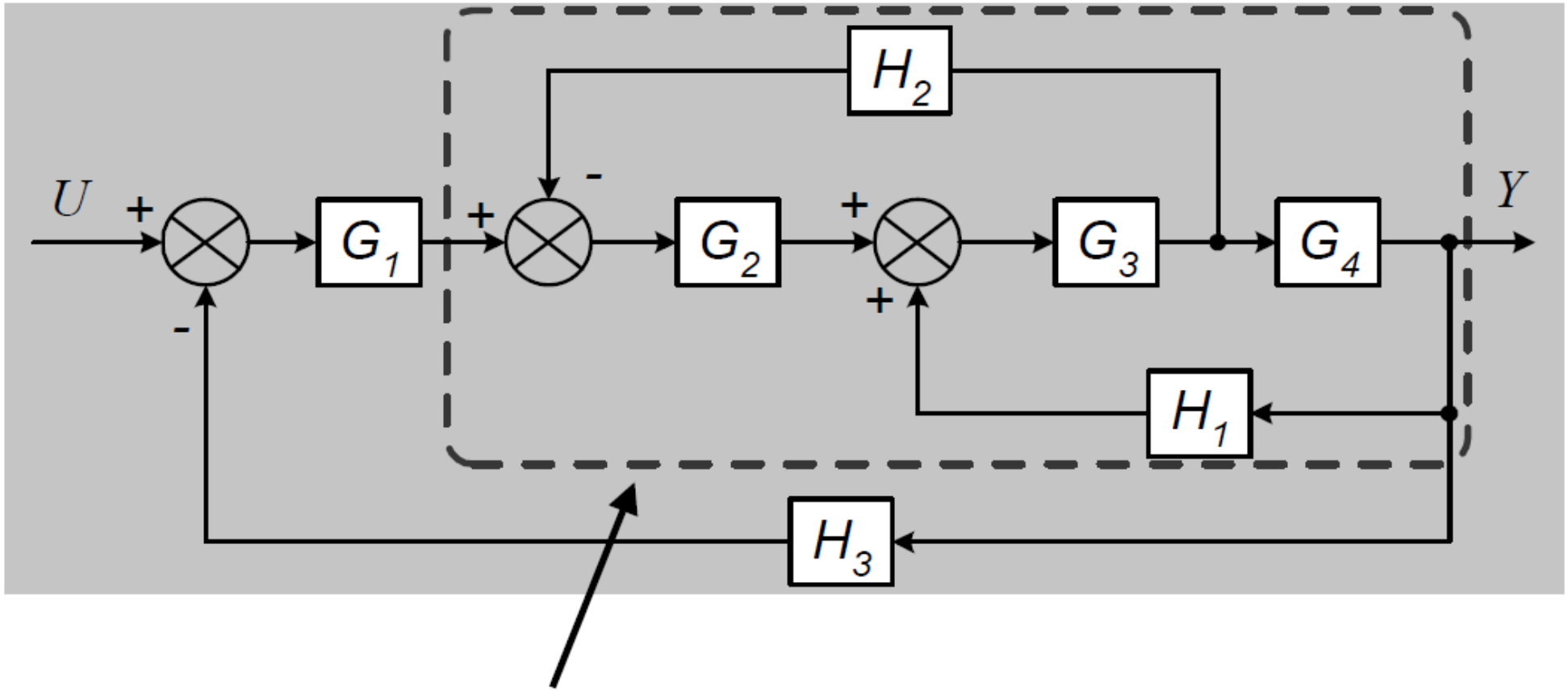
Complex Negative Feedback Example, 2





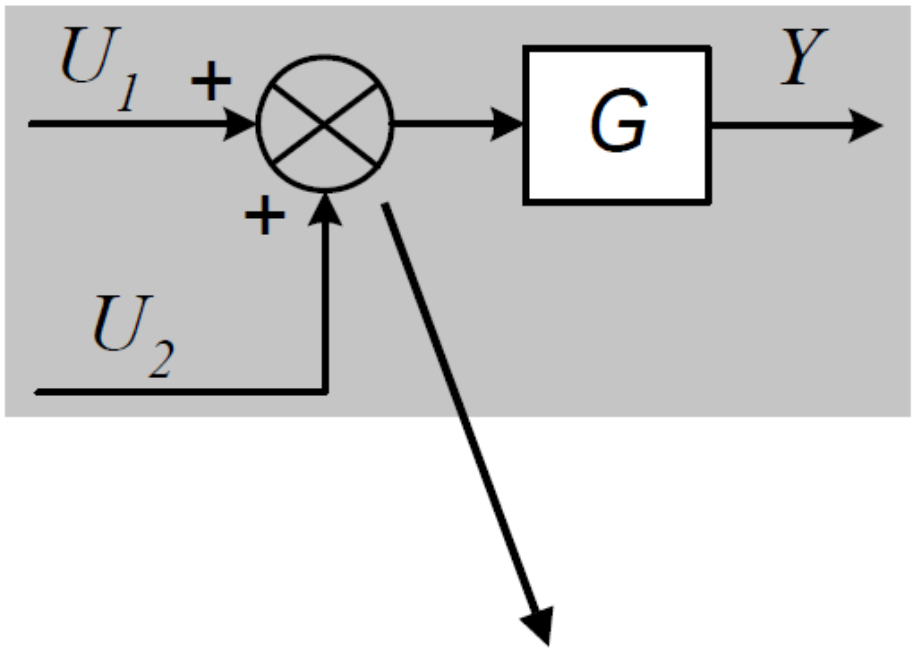
$$T(s)=\frac{Y(s)}{U(s)}=\frac{\dfrac{KK_p}{s(Ts+1+KK_t)}}{1+\dfrac{KK_p}{s(Ts+1+KK_t)}\times 1}=\frac{KK_p}{Ts^2+(1+KK_t)s+KK_p}$$

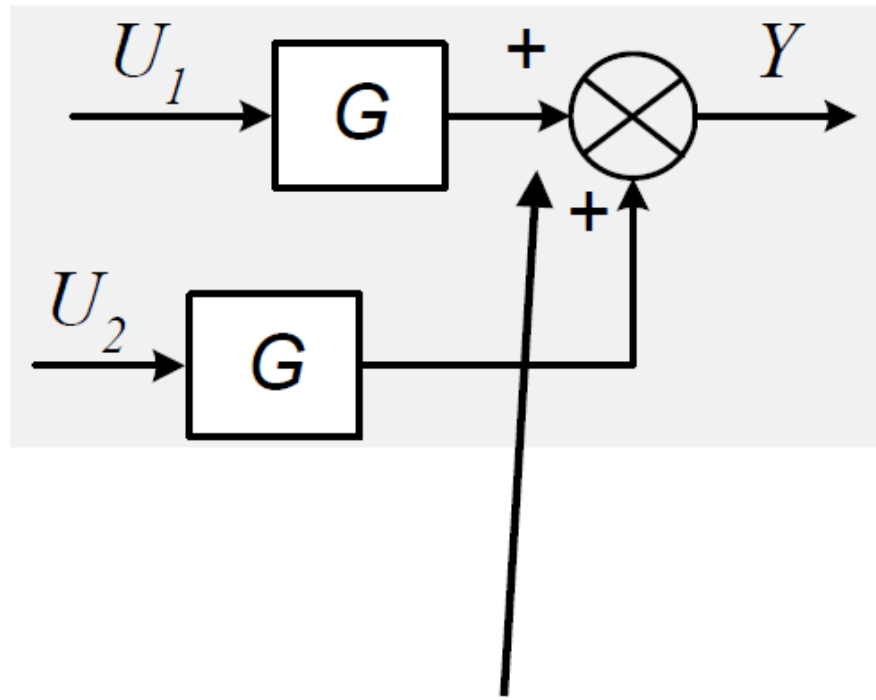
Moving Summing and Pickup Points



Cannot deal with using three typical cases!!

Moving a summing point behind a block



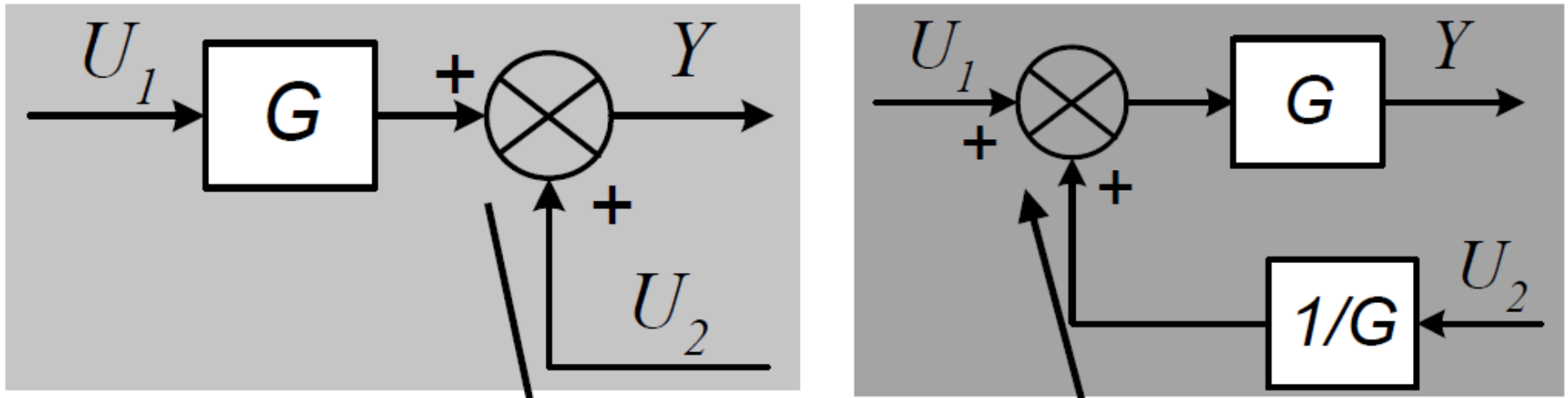


$$Y = G\,[U_1 + U_2]$$

$$Y = G\,U_1 + G\,U_2$$

- Write the same equation in different ways!
- Keep the signal relationship the same.

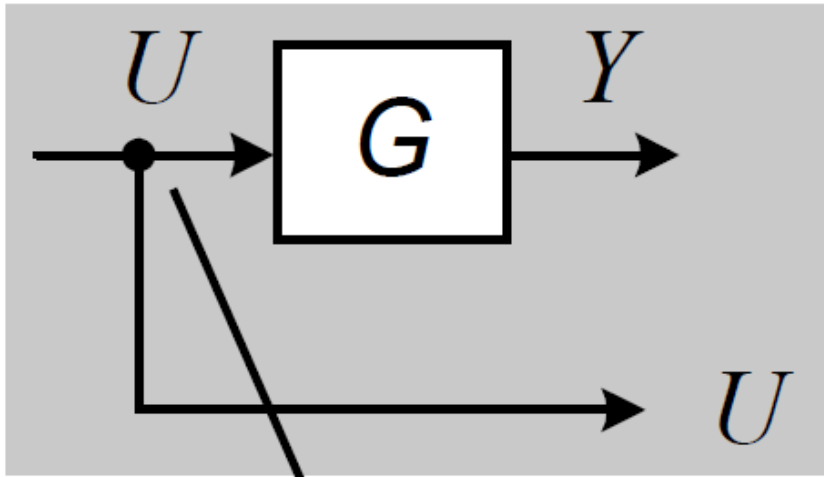
Moving a summing point ahead a block

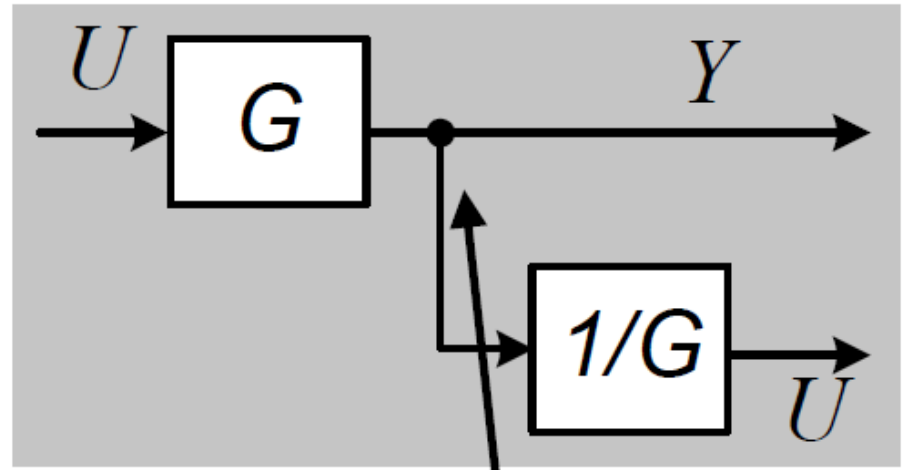


$$Y = GU_1 + U_2 \quad = \quad G[U_1 + \frac{1}{G}U_2]$$

- Write the same equation in different ways!
- Keep the signal relationship the same.

Moving a Branch (pickup) point behind a block

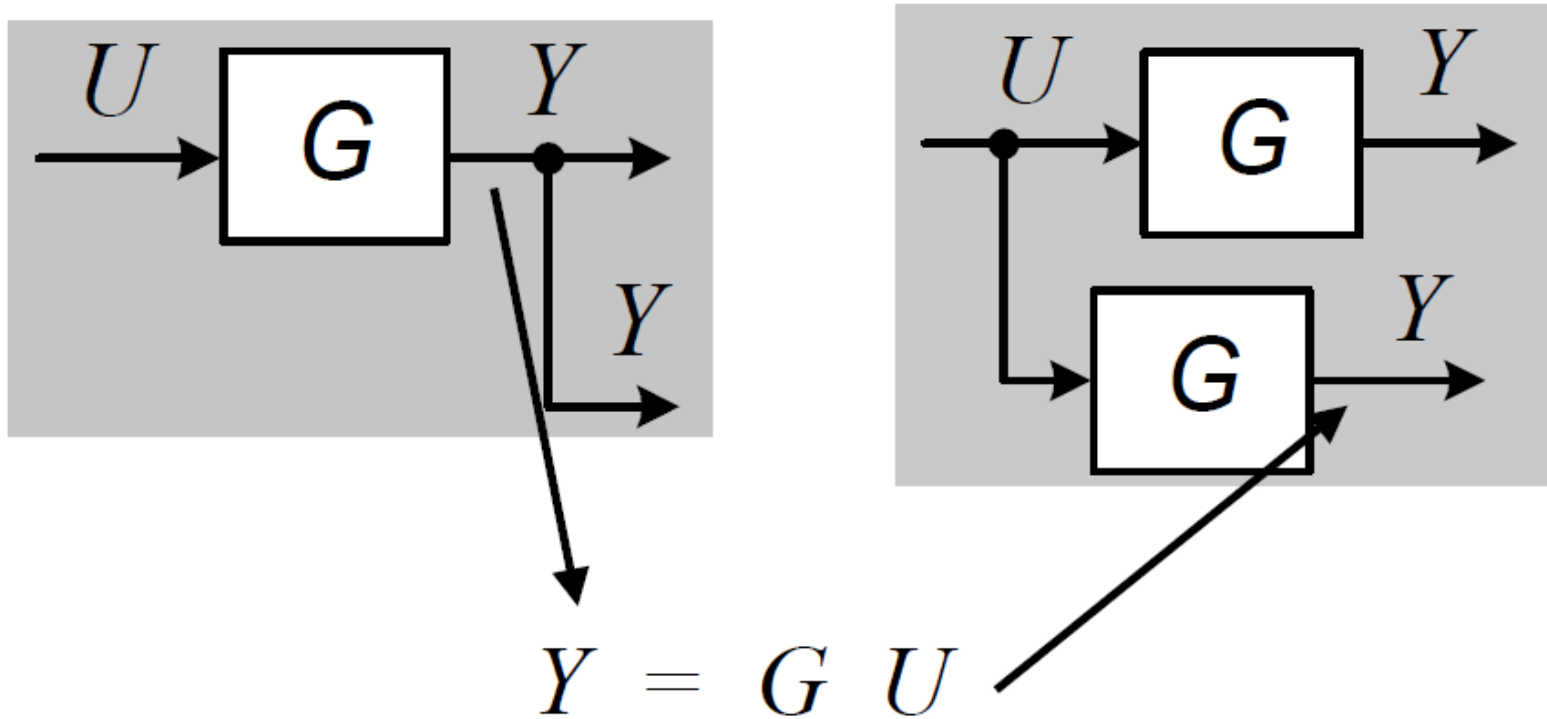




$$U = \left(\frac{1}{G}G\right)U = \frac{1}{G}(GU) \quad = \frac{1}{G}Y$$

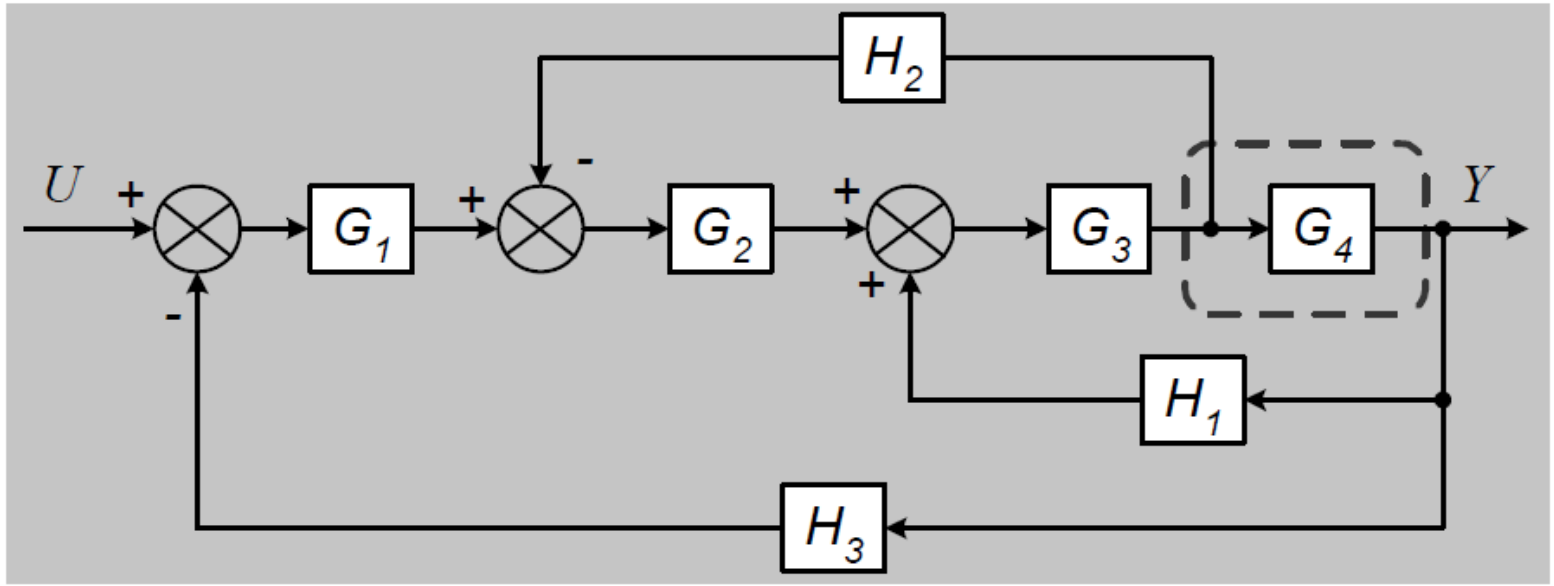
- Write the same equation in different ways!
- Keep the signal relationship the same.

Moving a Branch (pickup) point ahead a block

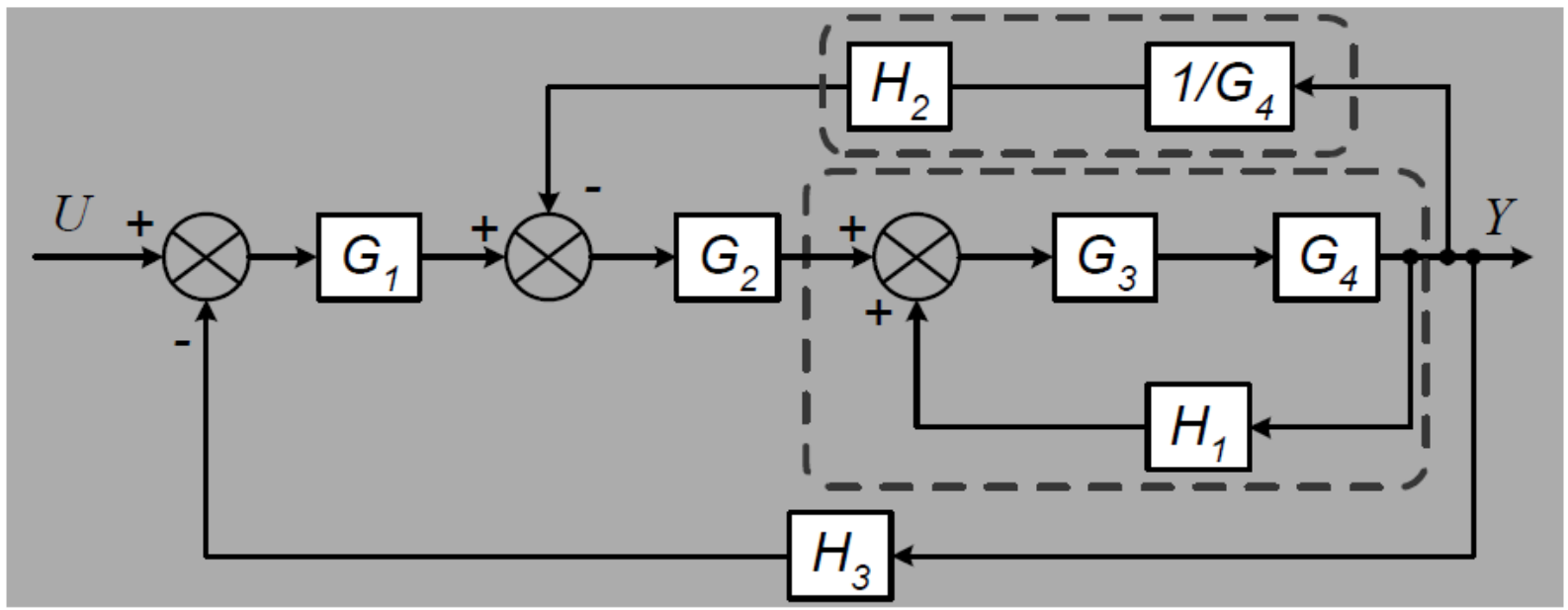


- Write the same equation in different ways!
- Keep the signal relationship the same.

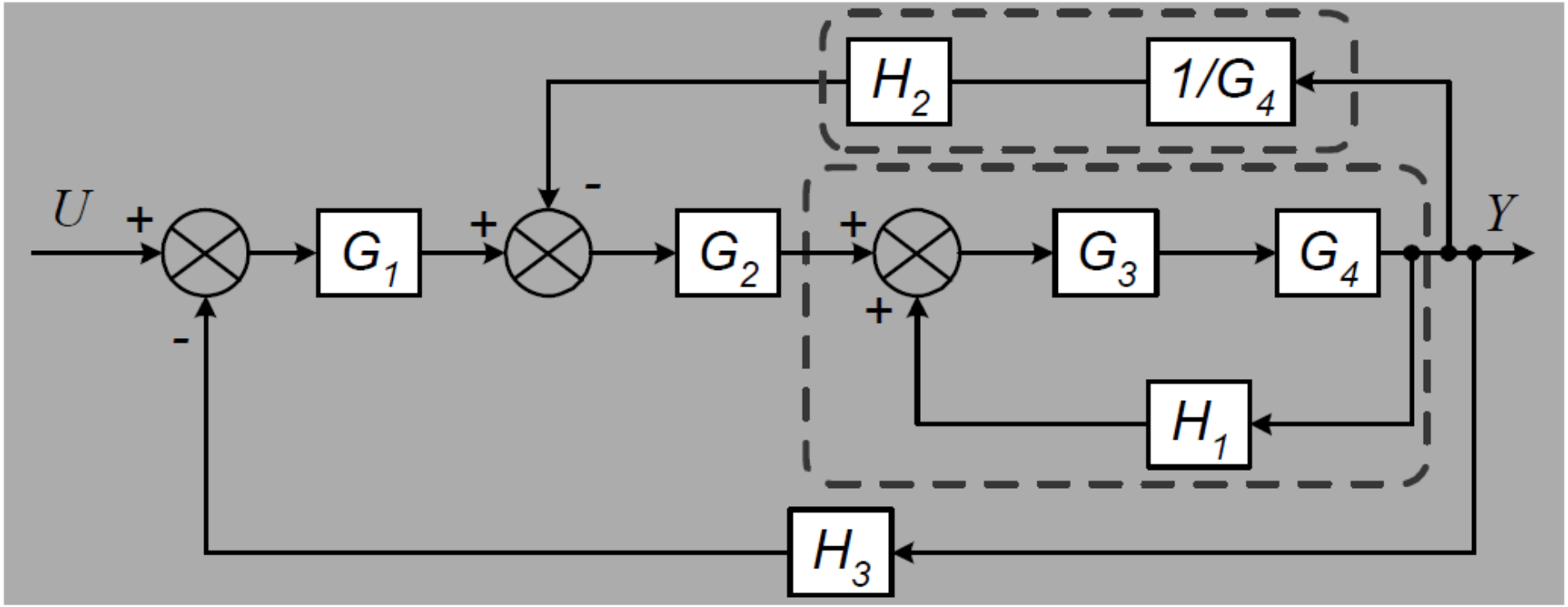
Block diagram simplification example, 1



Moving a pickup point behind a block



Block diagram simplification example, 2

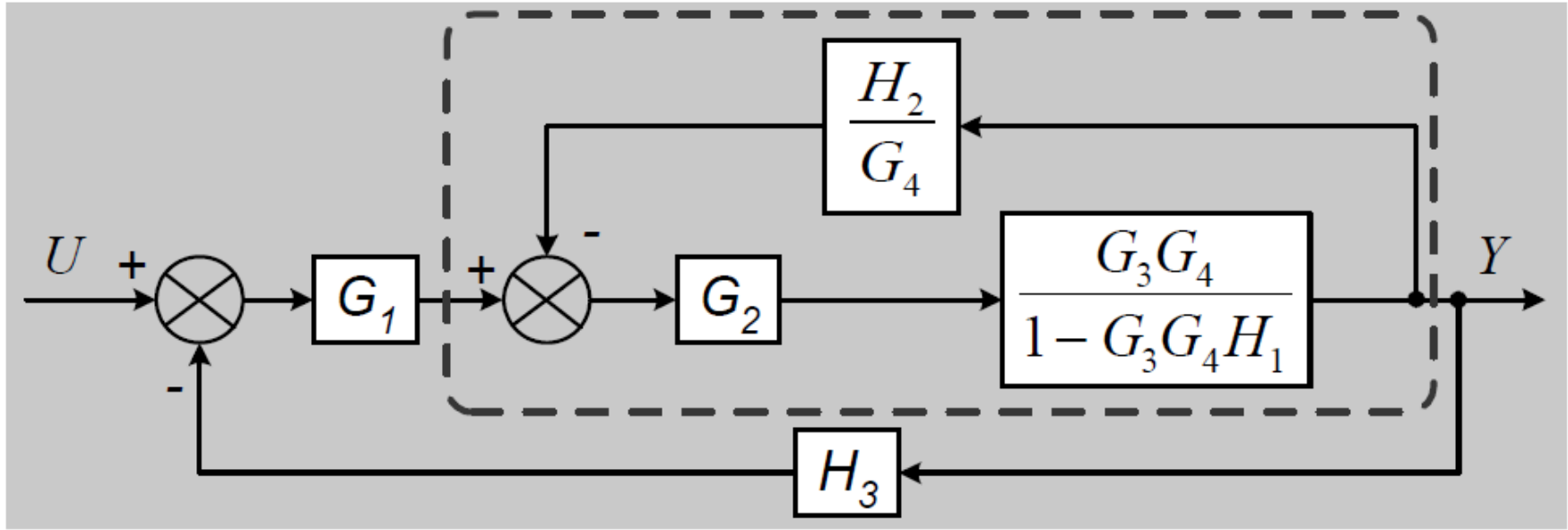


Series and Positive feedback connections

$$H_2 \frac{1}{G_4} = \frac{H_2}{G_4}$$

$$\frac{(G_3 G_4)}{1-(G_3 G_4)H_1} = \frac{G_3 G_4}{1-G_3 G_4 H_1}$$

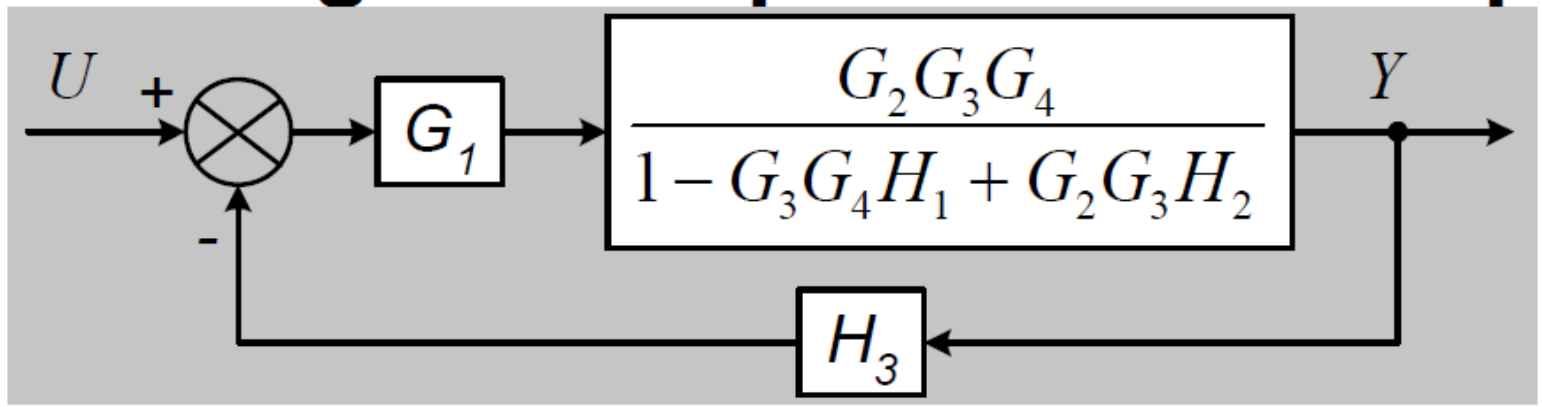
Block diagram simplification example, 3



Negative feedback connection

$$\frac{\left(G_2 \frac{G_3 G_4}{1 - G_3 G_4 H_1}\right)}{1 + \left(G_2 \frac{G_3 G_4}{1 - G_3 G_4 H_1}\right)\frac{H_2}{G_4}} = \frac{G_2 G_3 G_4}{1 - G_3 G_4 H_1 + G_2 G_3 H_2}$$

Block diagram simplification example, 4

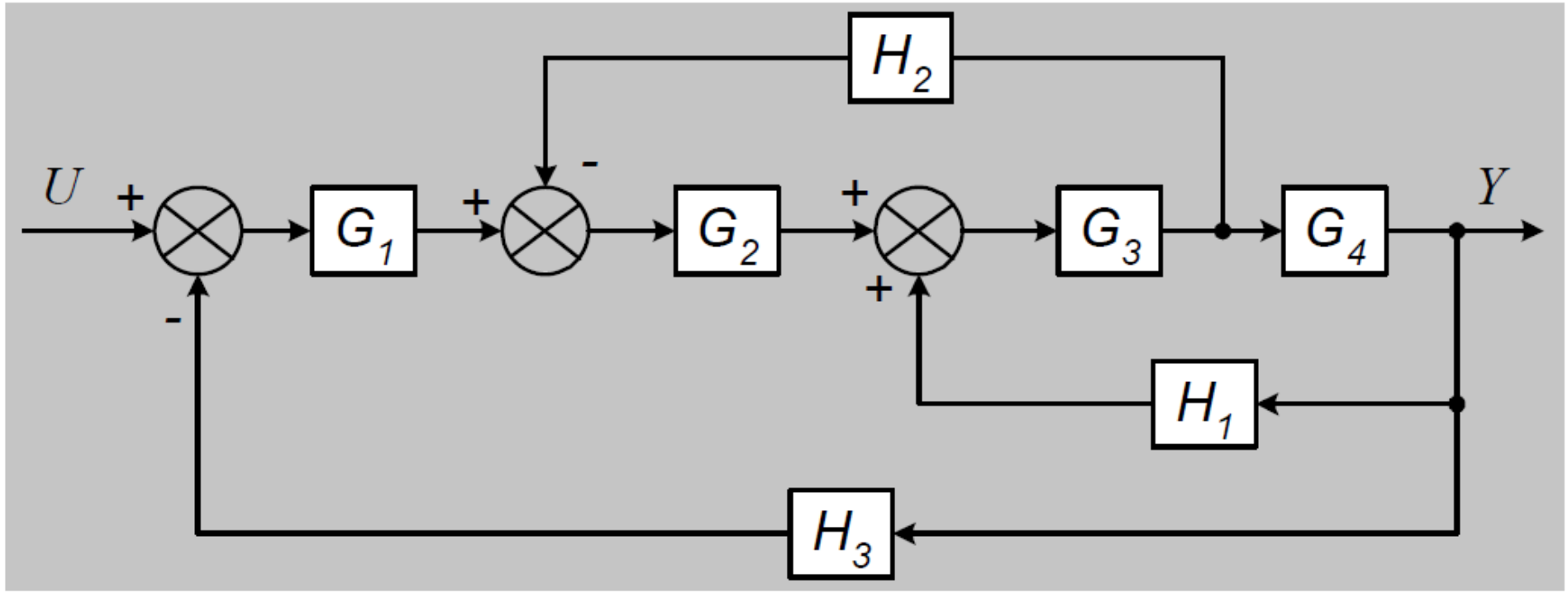


Negative feedback connection

$$\frac{G_1 \dfrac{G_2G_3G_4}{1 - G_3G_4H_1 + G_2G_3H_2}}{1 + G_1 \dfrac{G_2G_3G_4}{1 - G_3G_4H_1 + G_2G_3H_2} H_3}$$

$$= \frac{G_1G_2G_3G_4}{1 - G_3G_4H_1 + G_2G_3H_2 + G_1G_2G_3G_4H_3}$$

Block diagram simplification example, 5



$$U \rightarrow \frac{G_1 G_2 G_3 G_4}{1 - G_3 G_4 H_1 + G_2 G_3 H_2 + G_1 G_2 G_3 G_4 H_3} \rightarrow Y$$