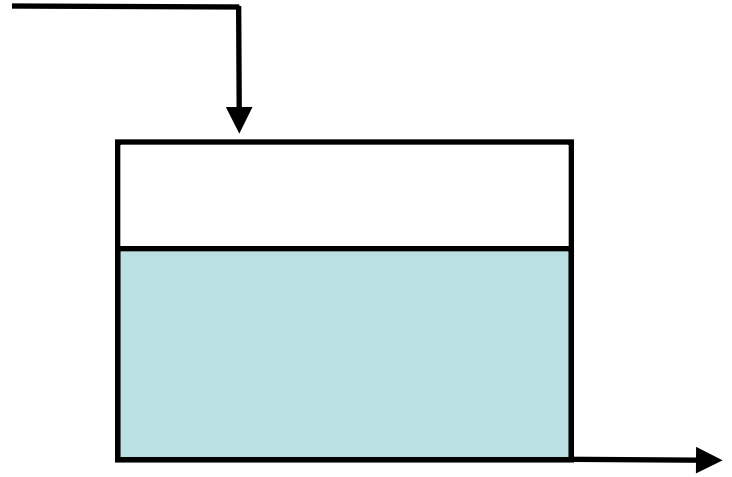


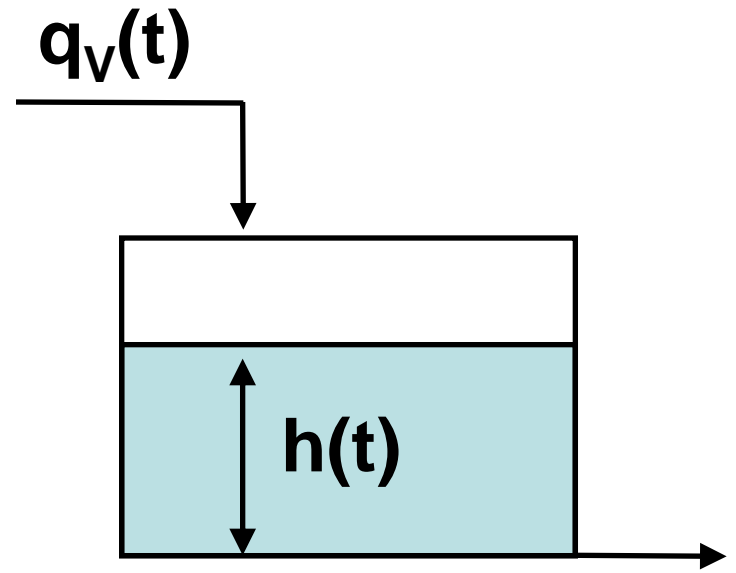
Uzavretý regulačný obvod

Juraj Oravec

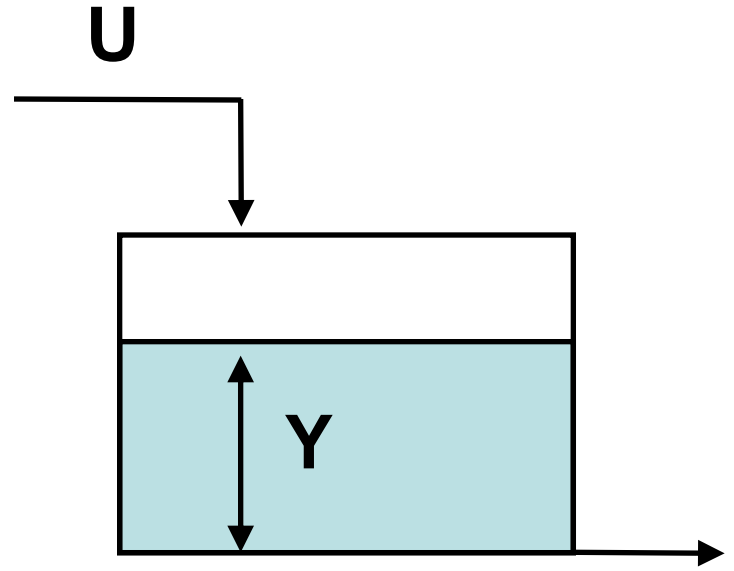
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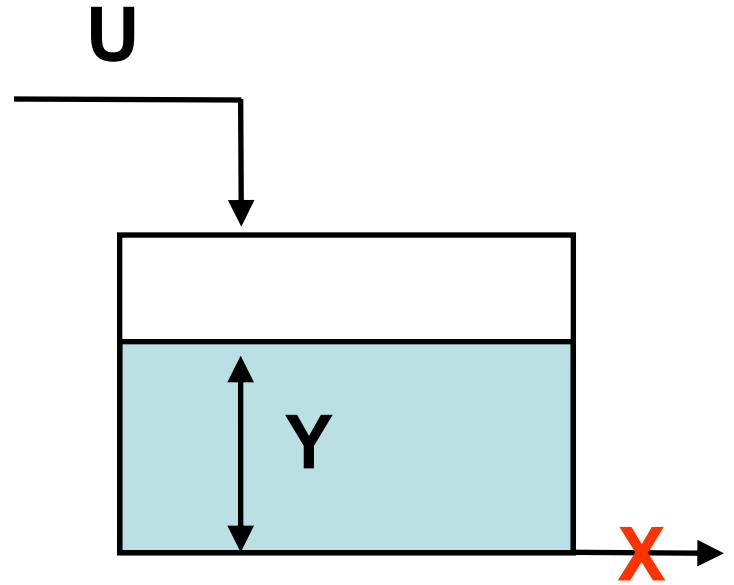
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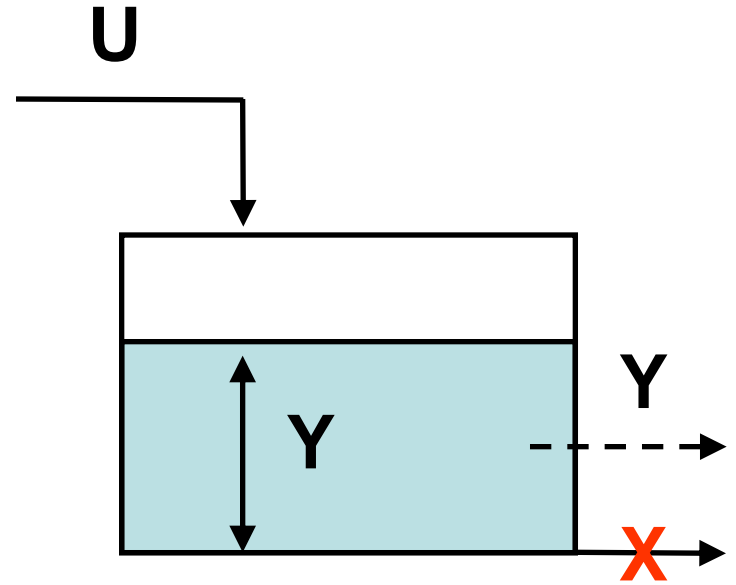
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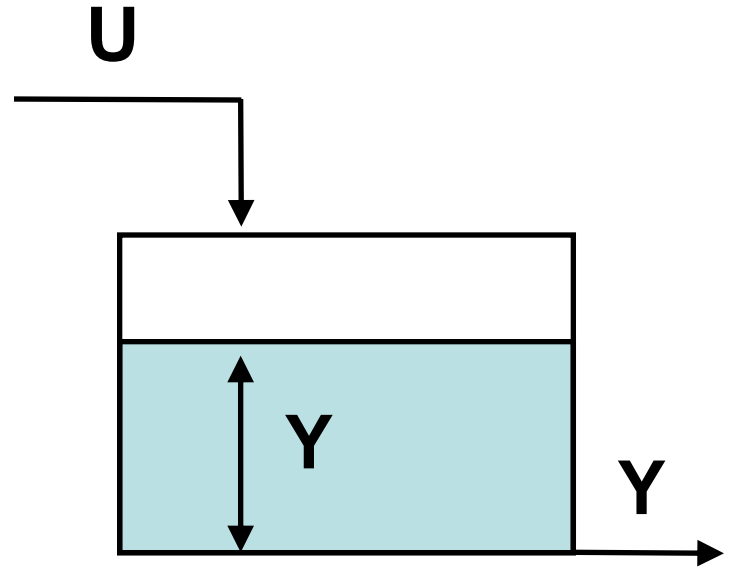
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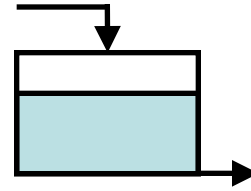
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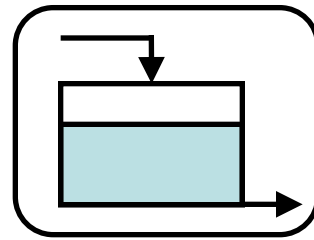
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URO



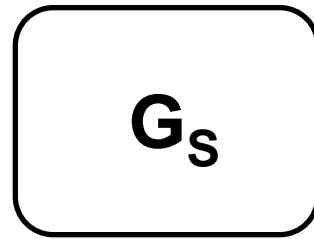
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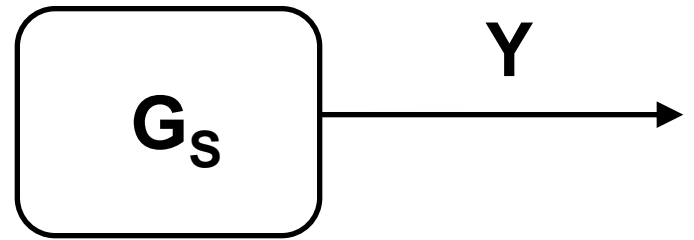
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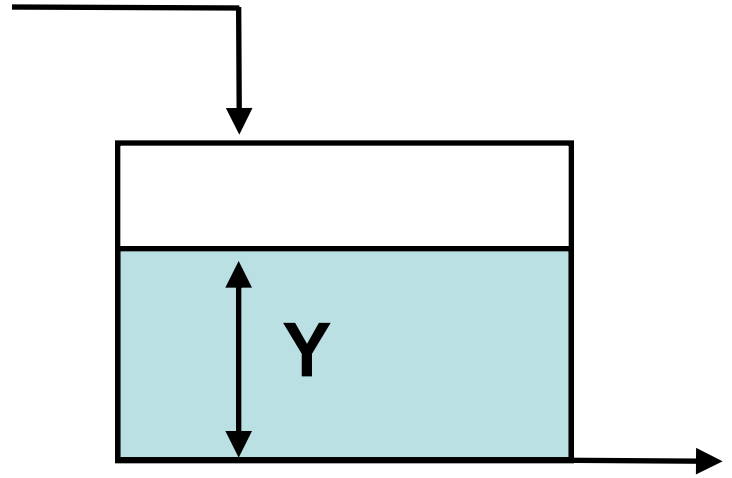
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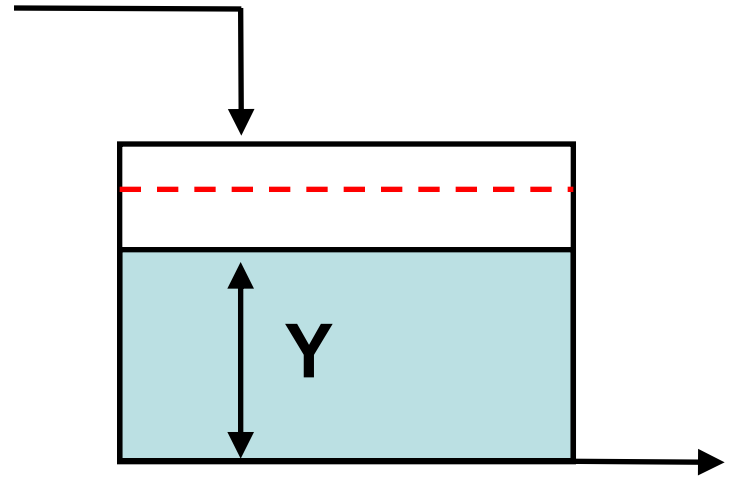
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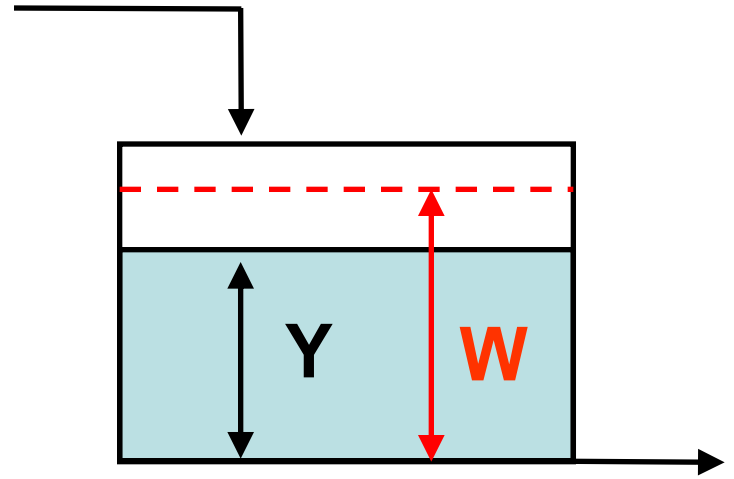
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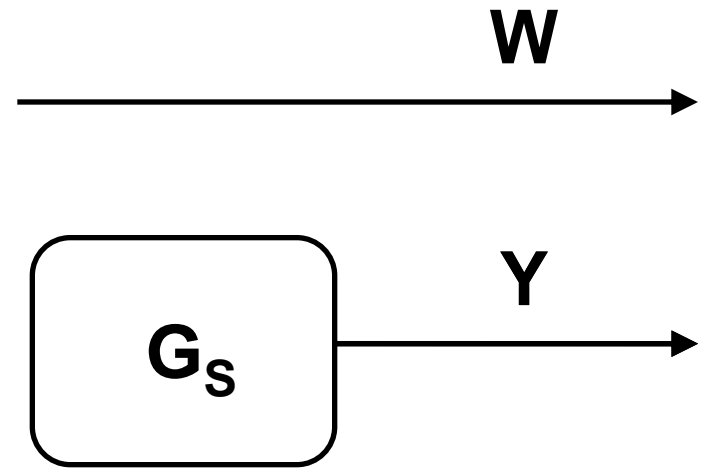
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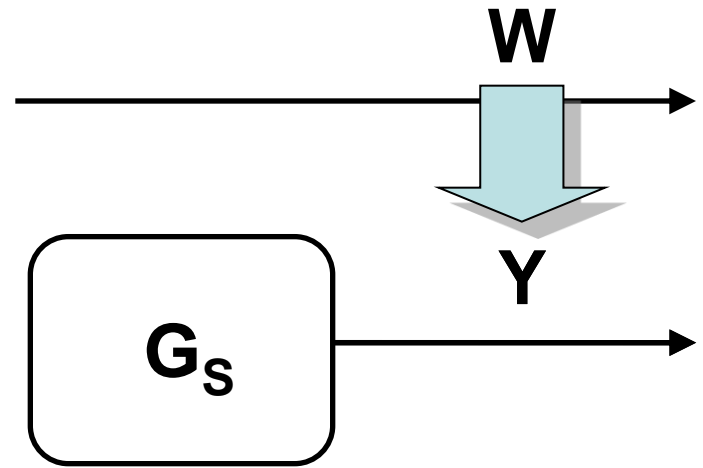
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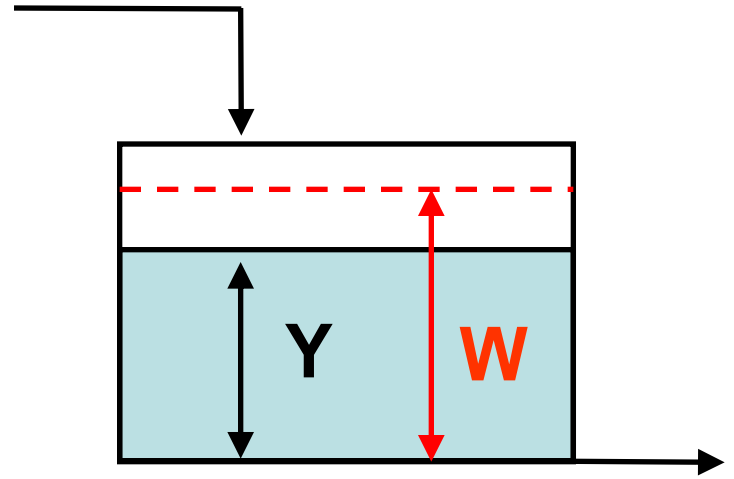
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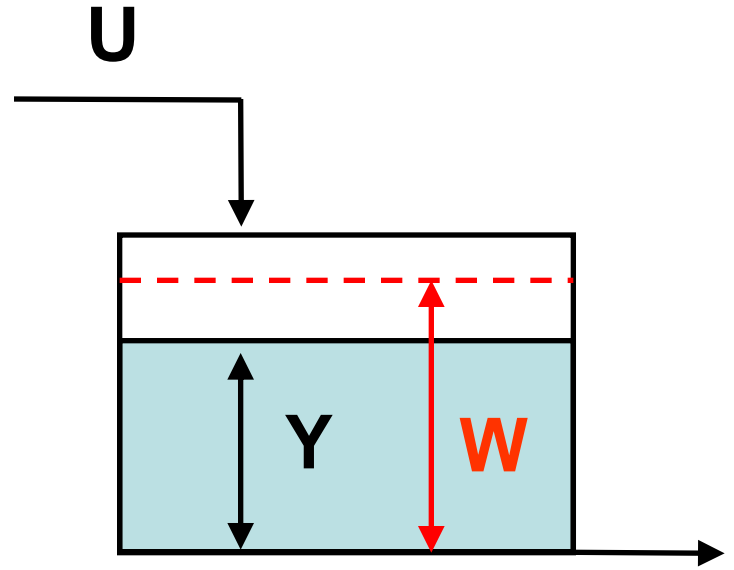
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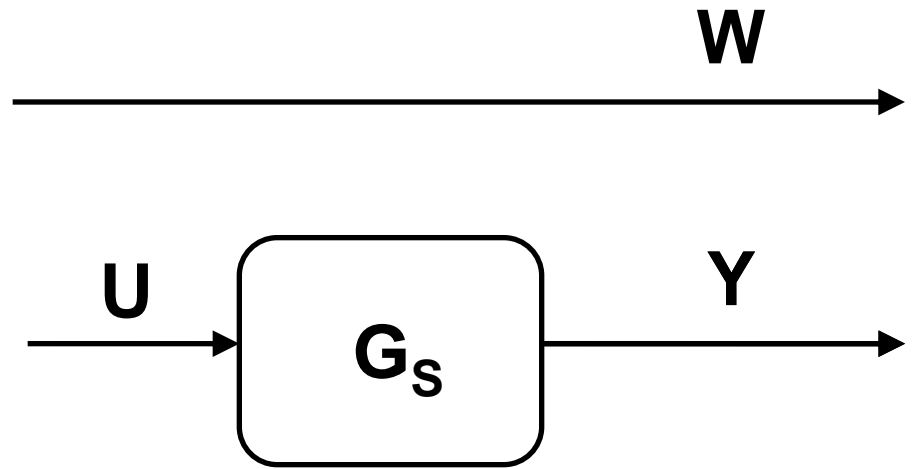
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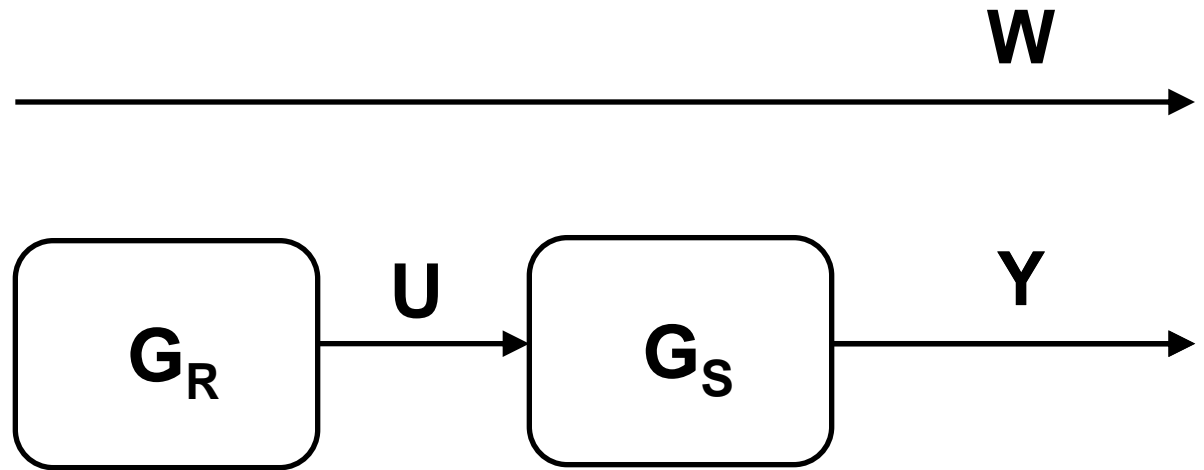
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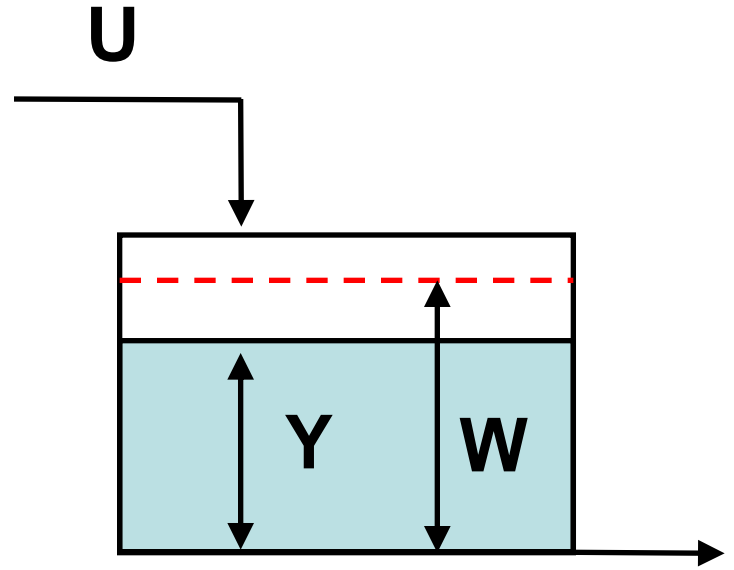
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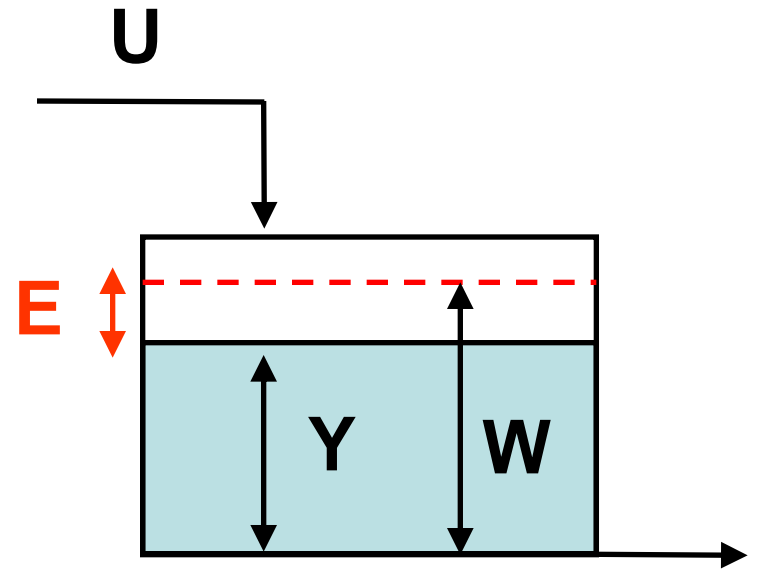
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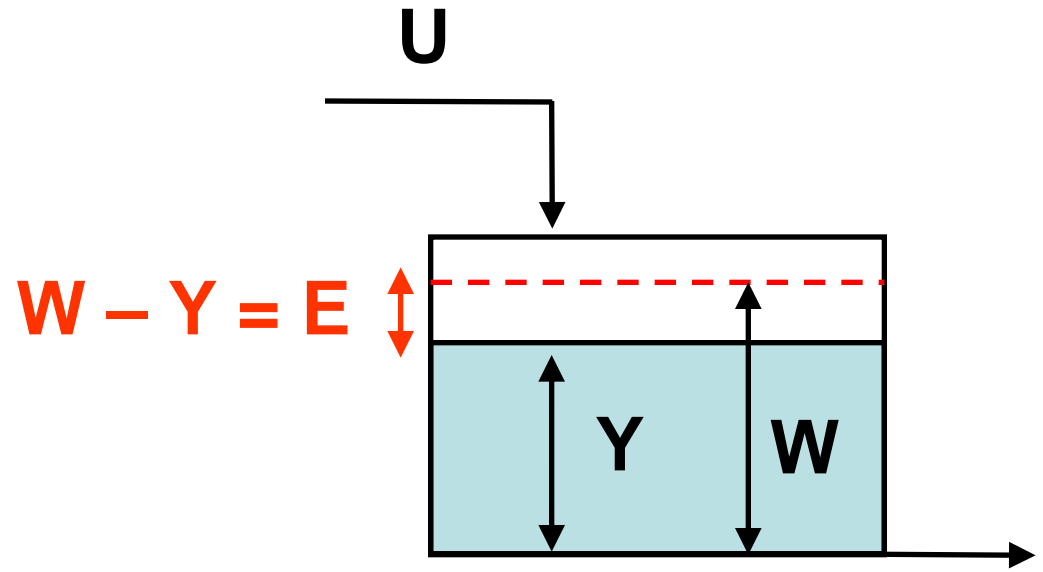
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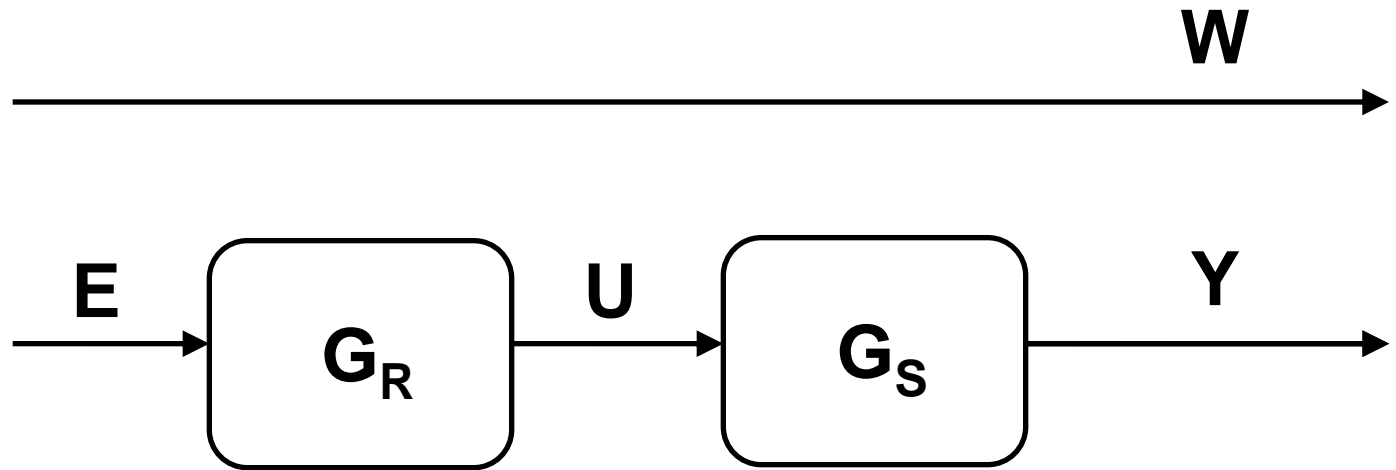
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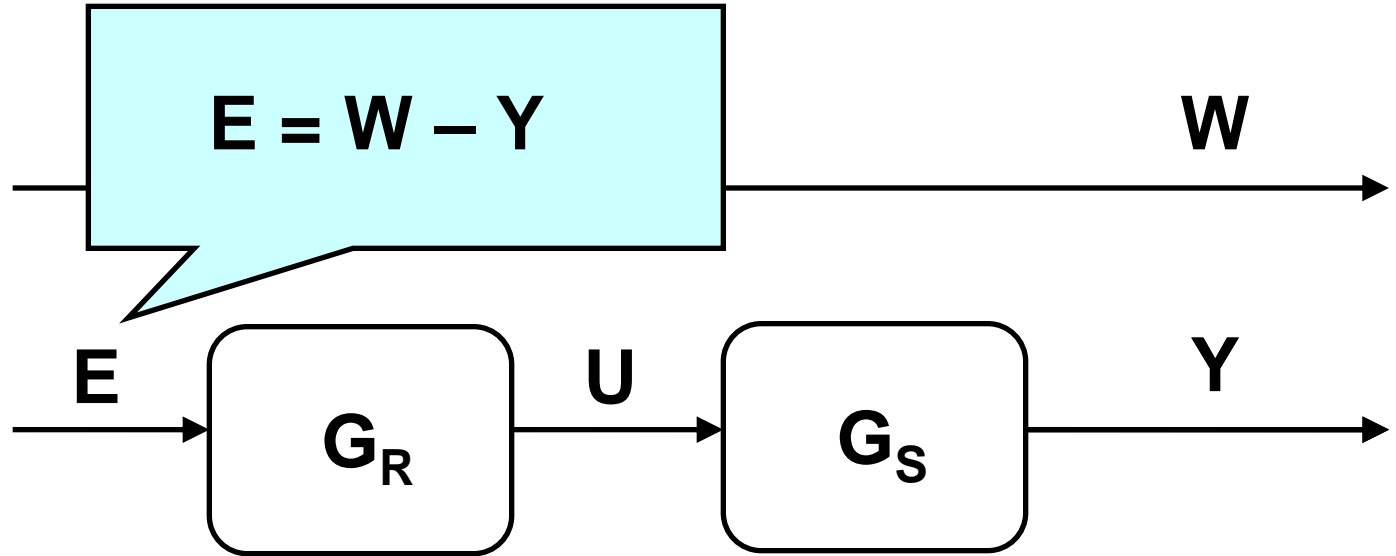
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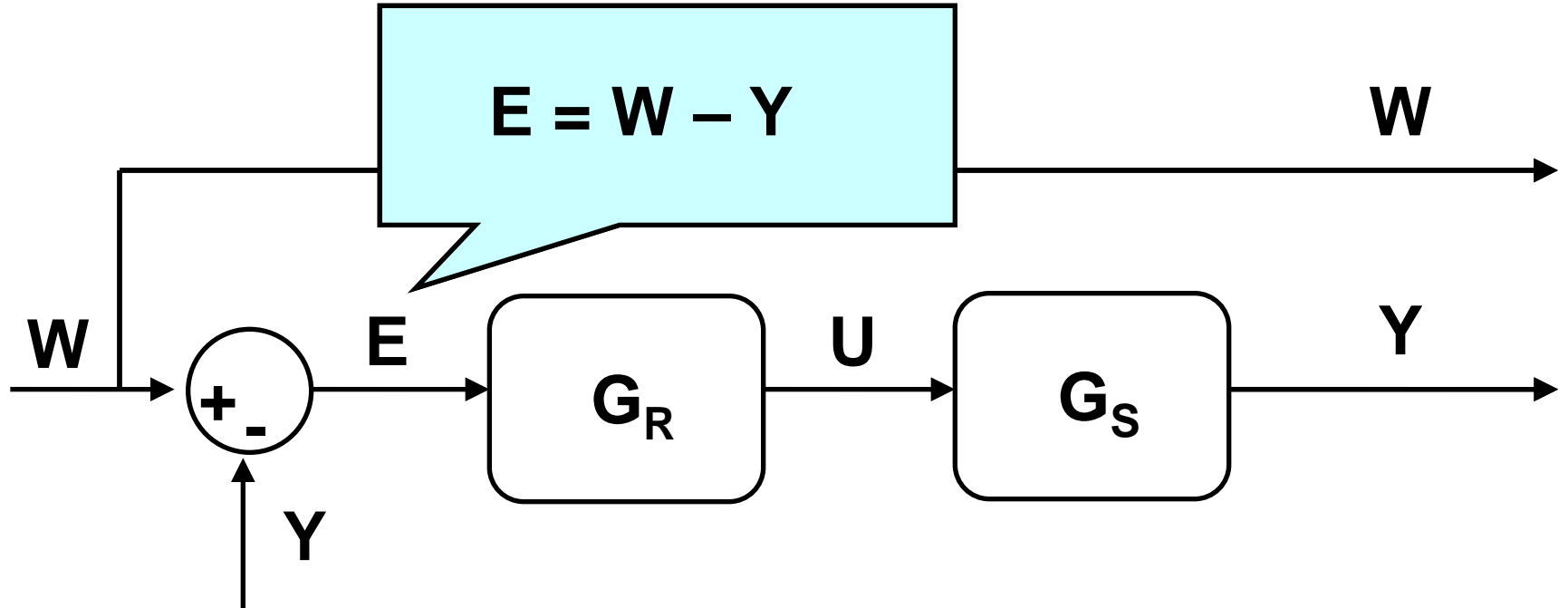
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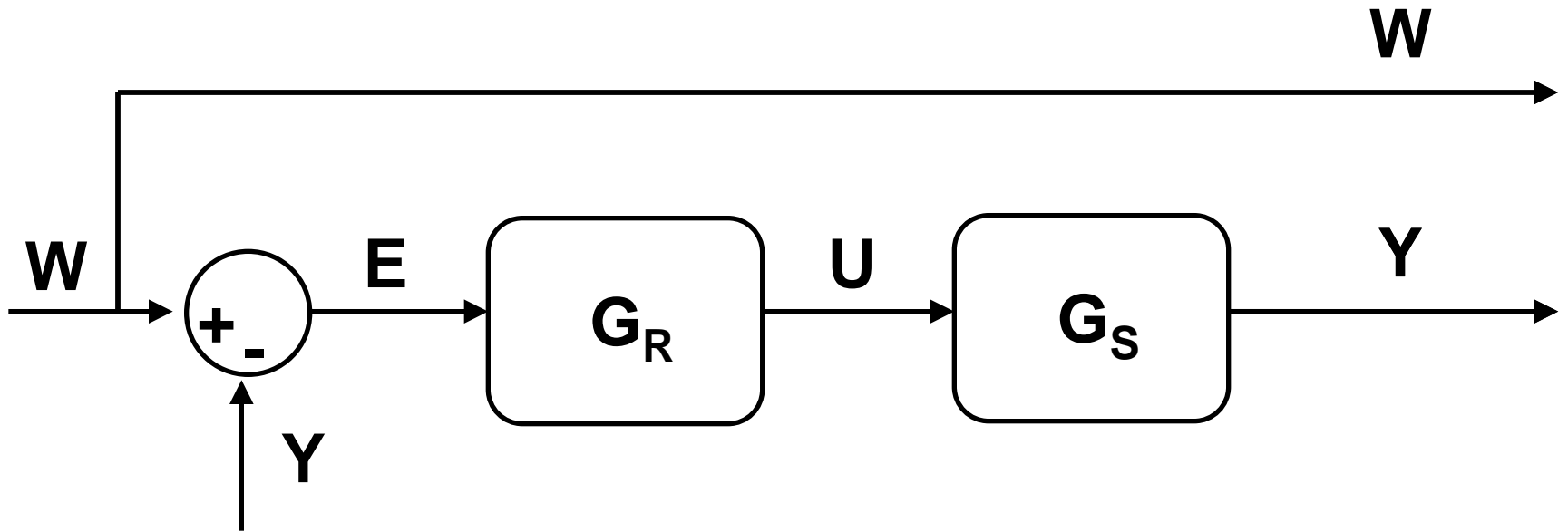
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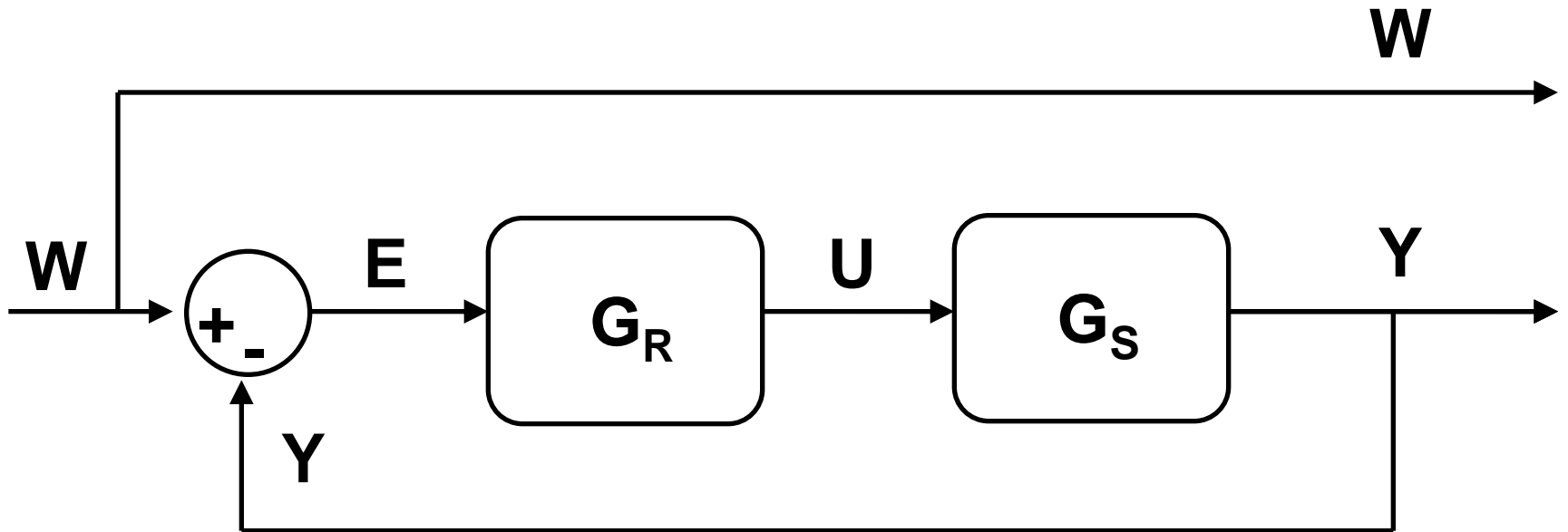
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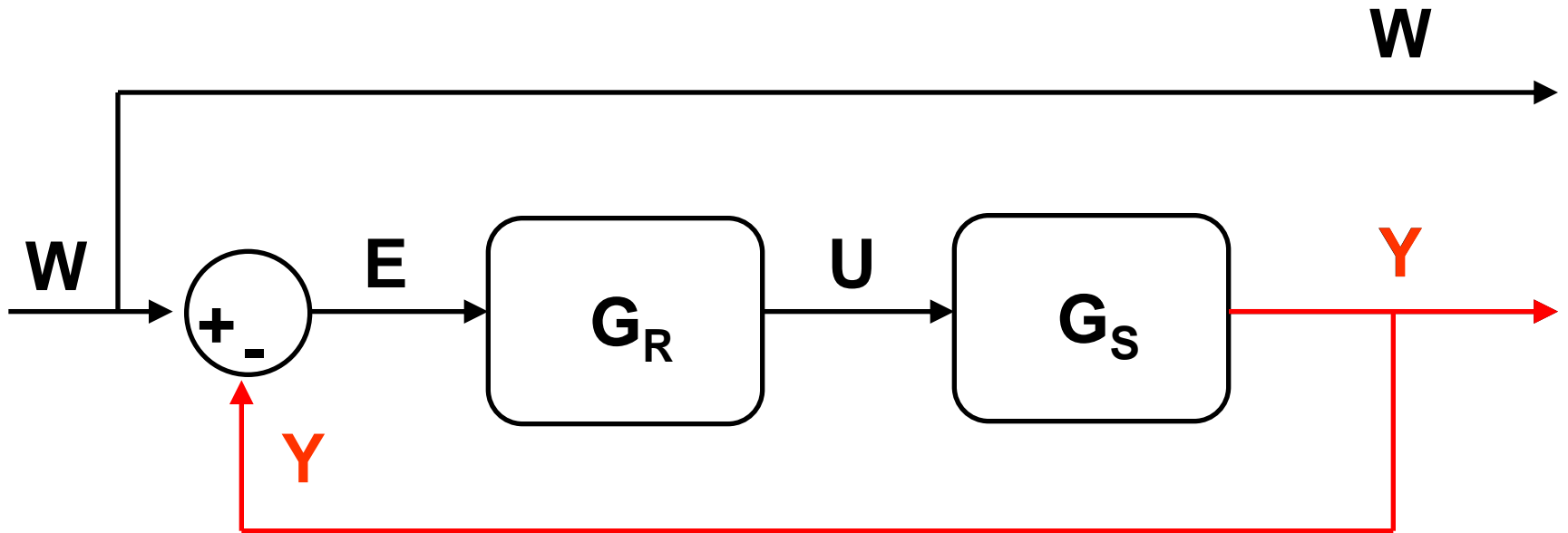
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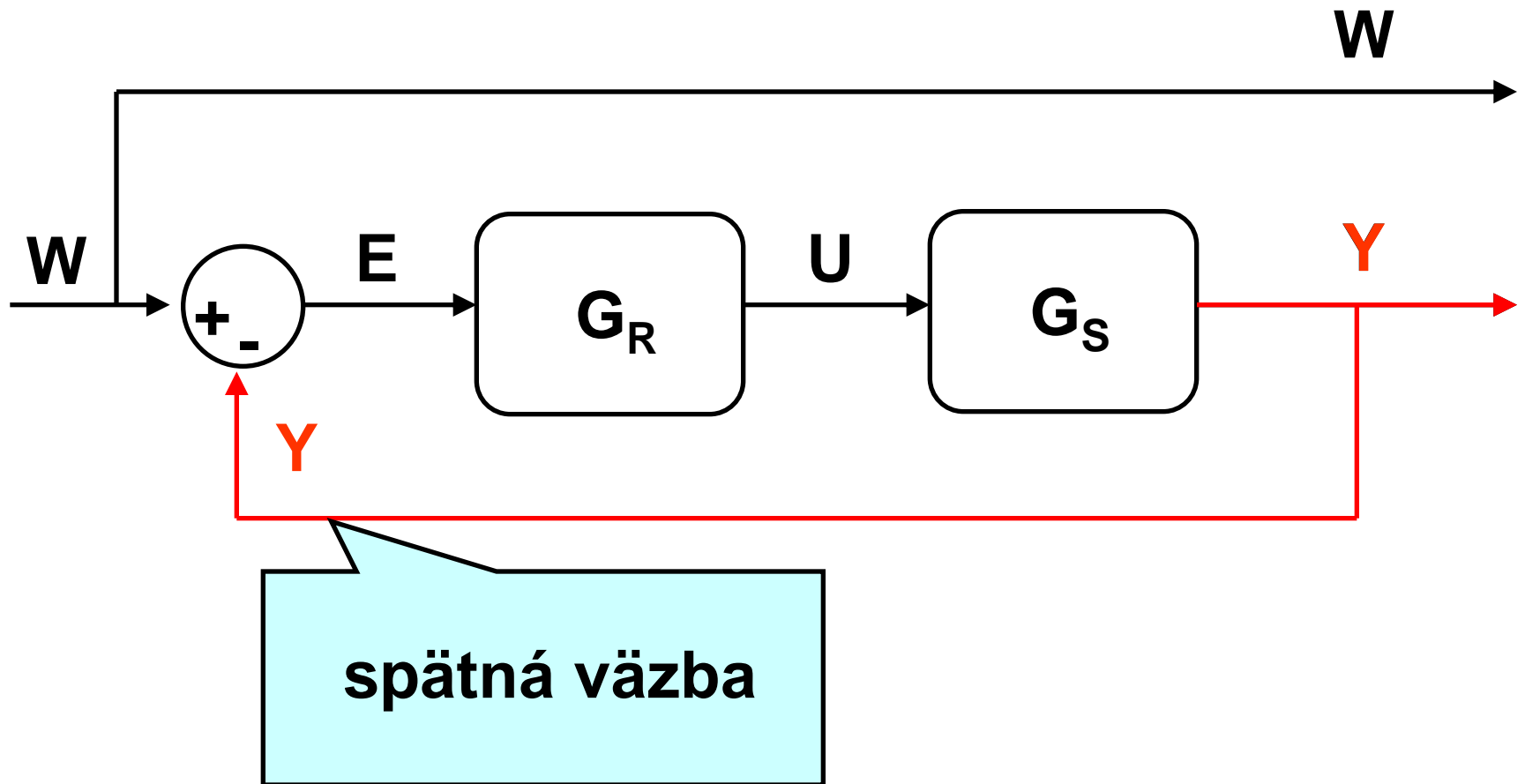
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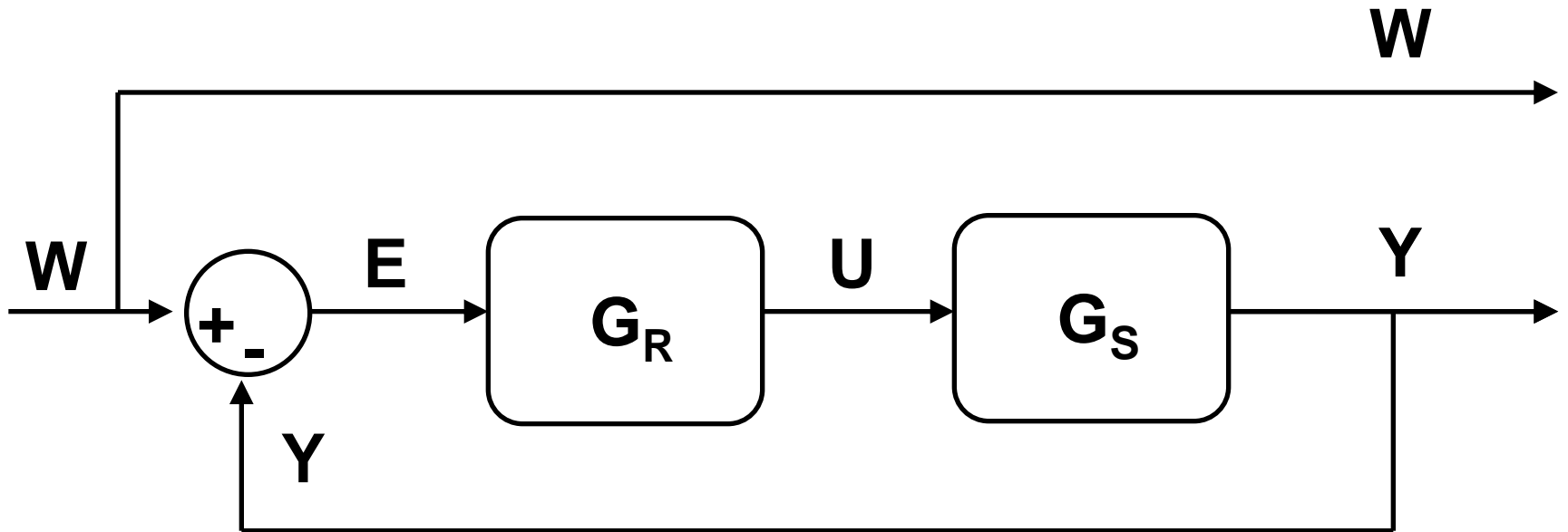
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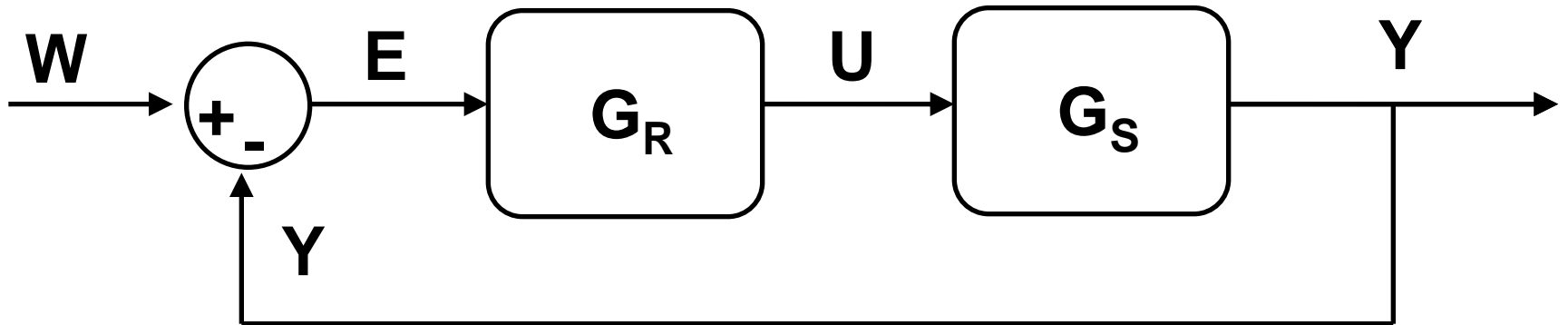
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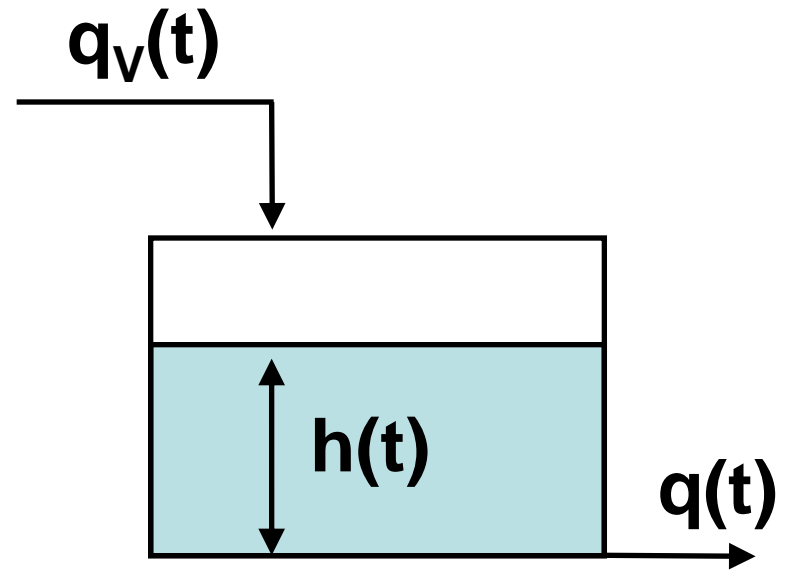
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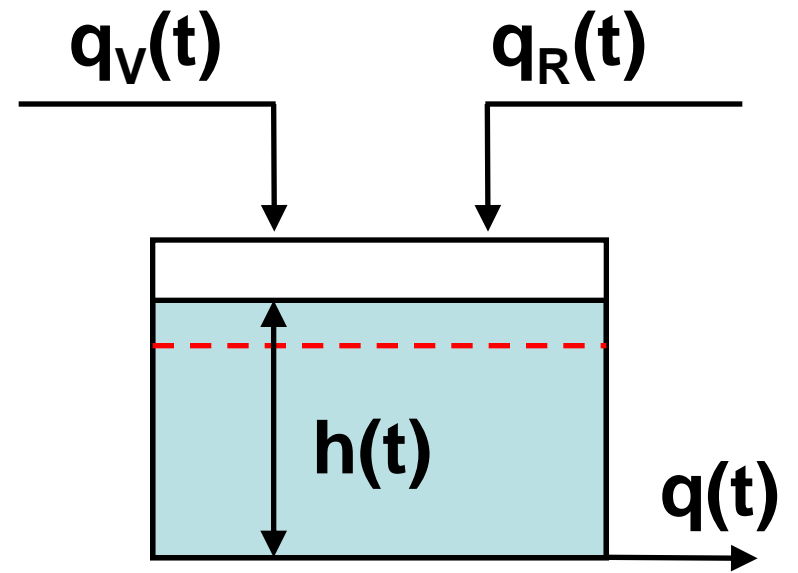
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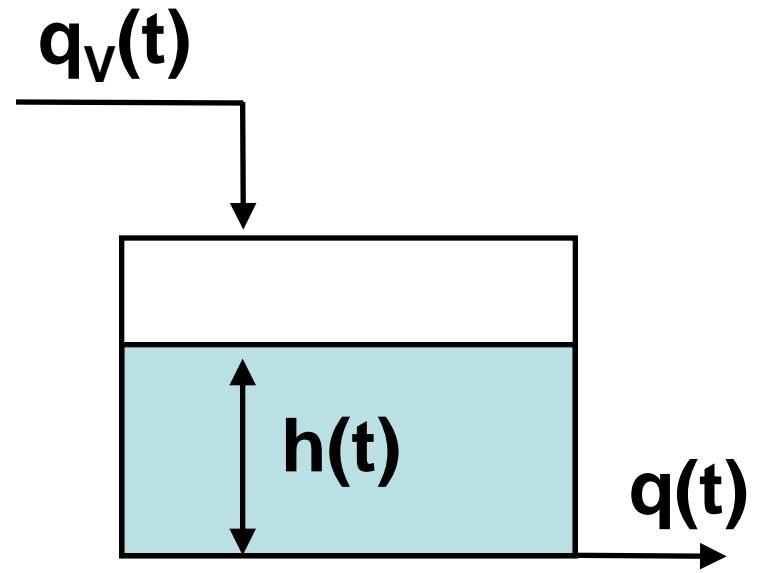
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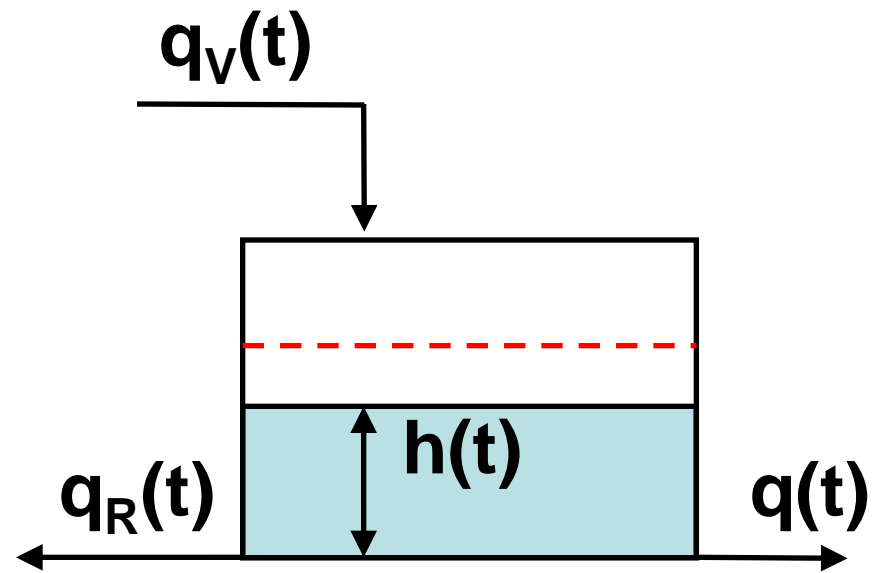
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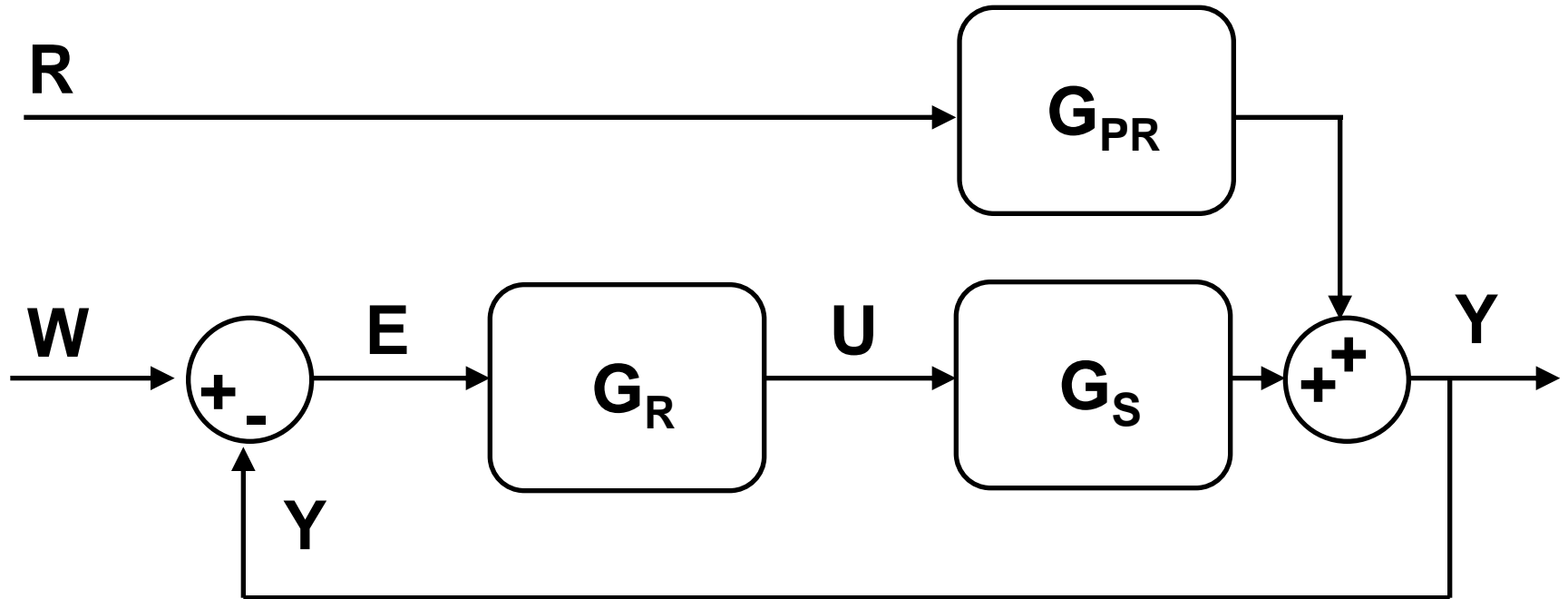
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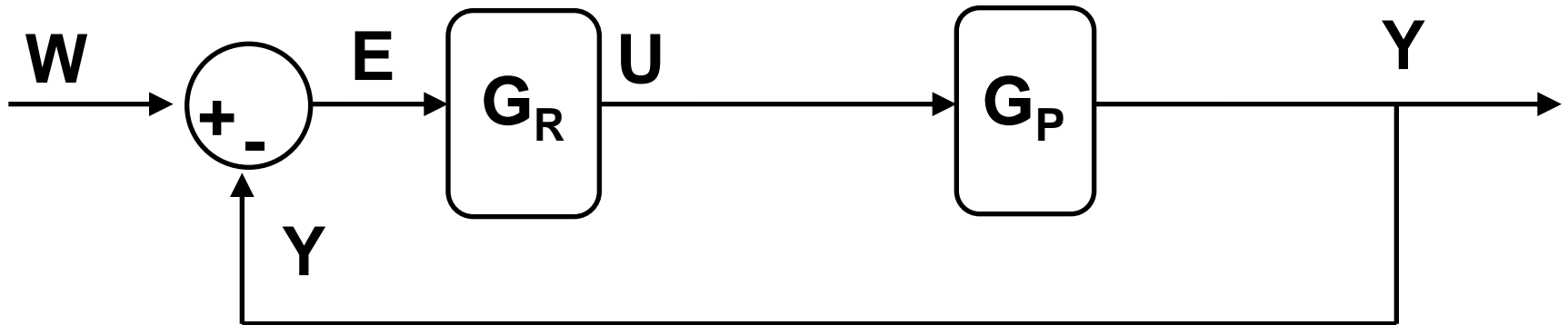
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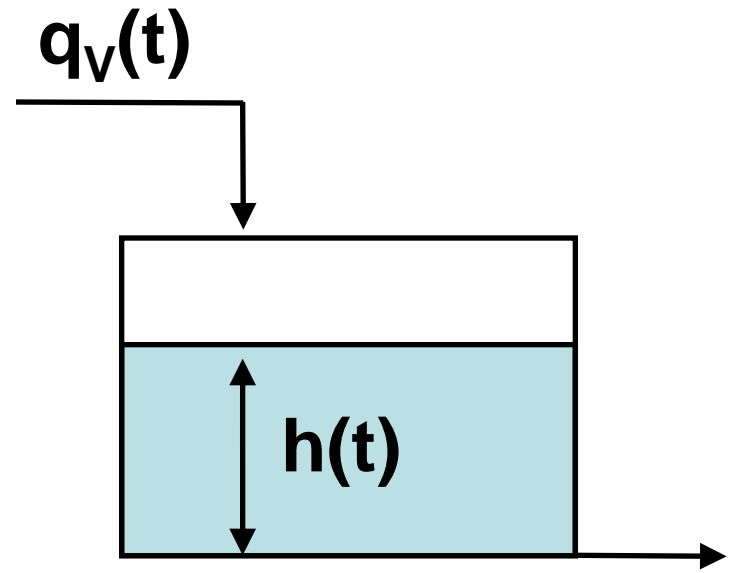
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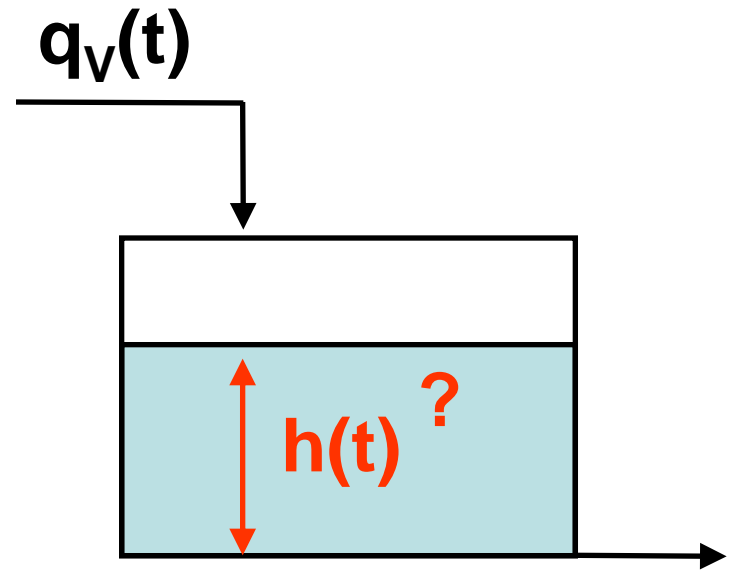
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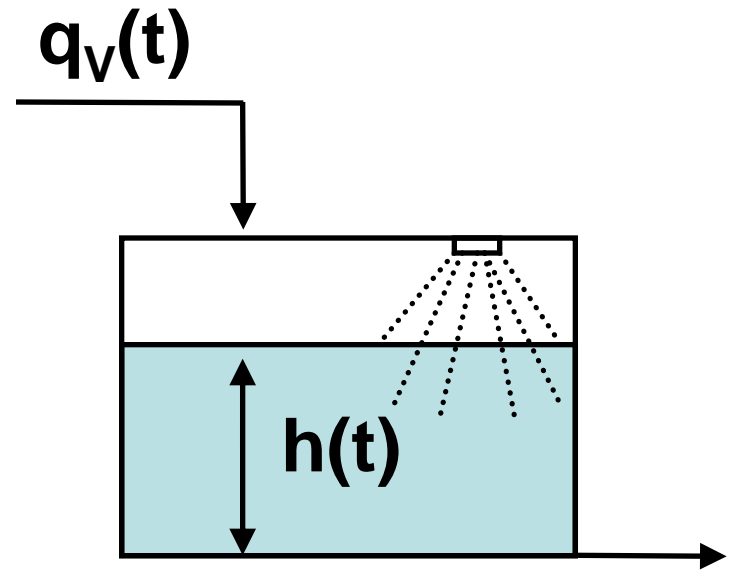
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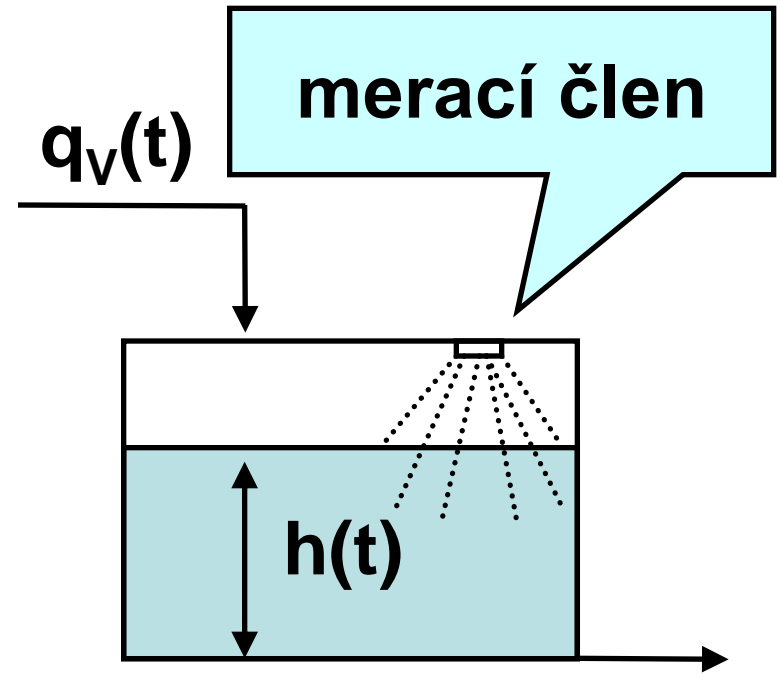
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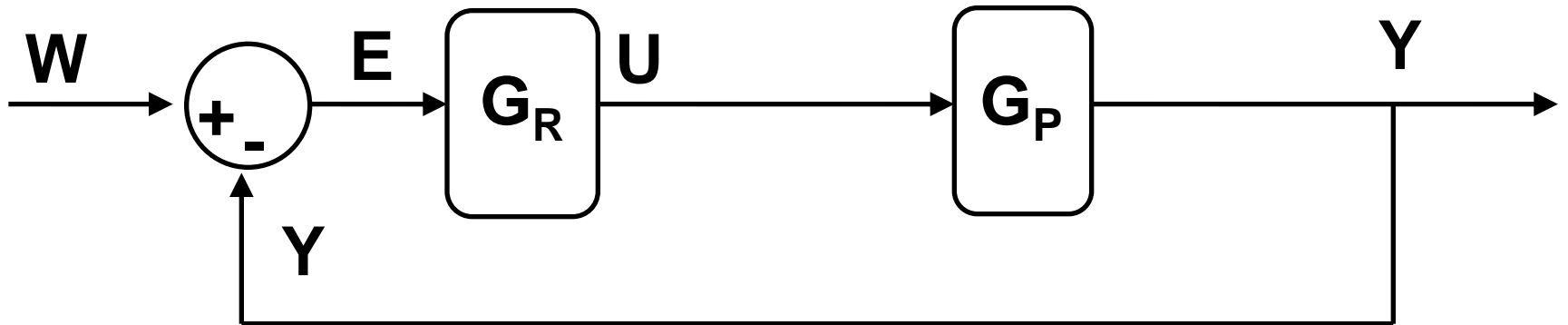
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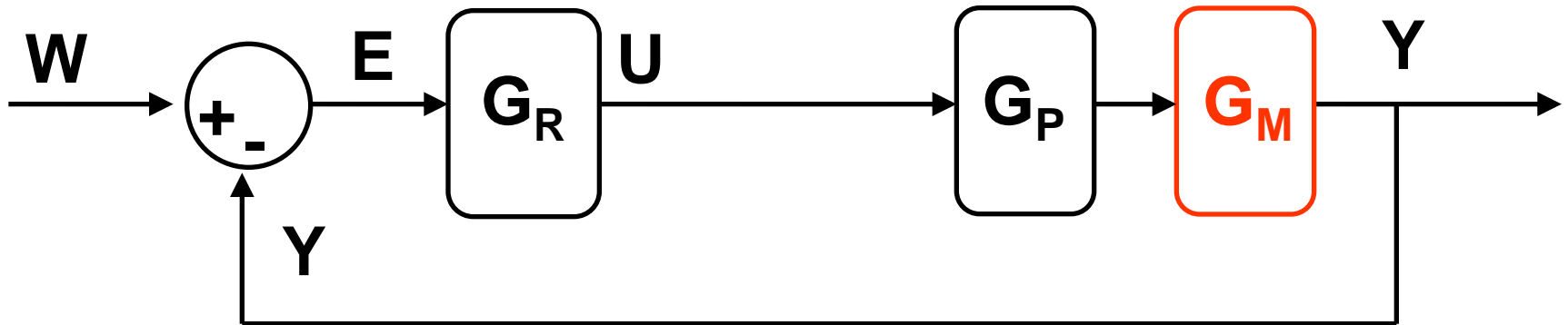
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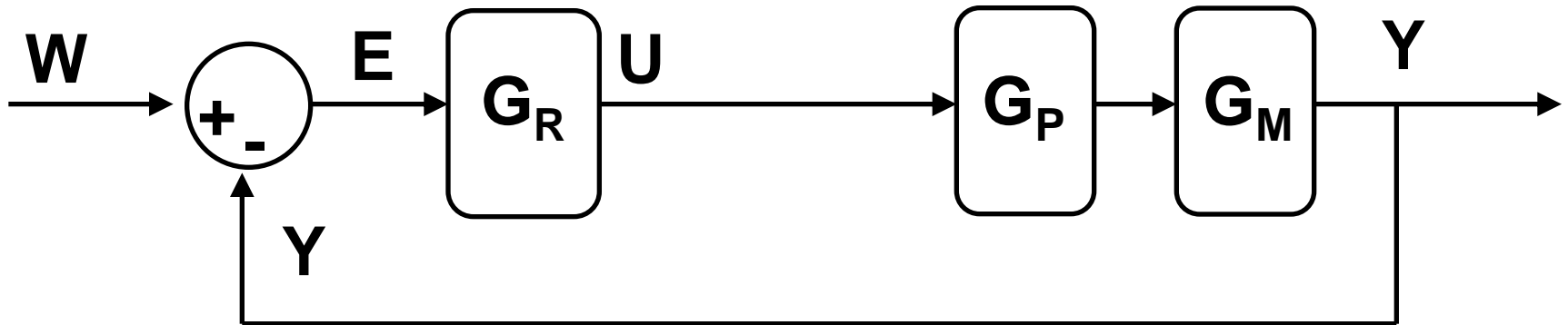
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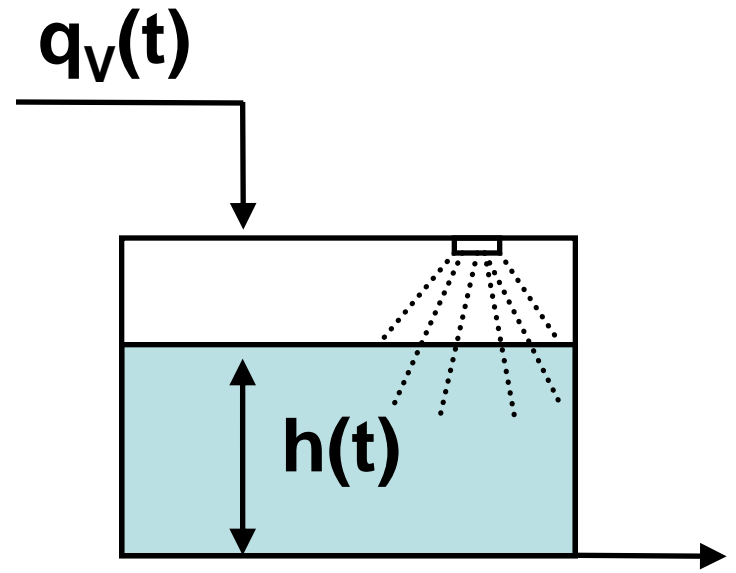
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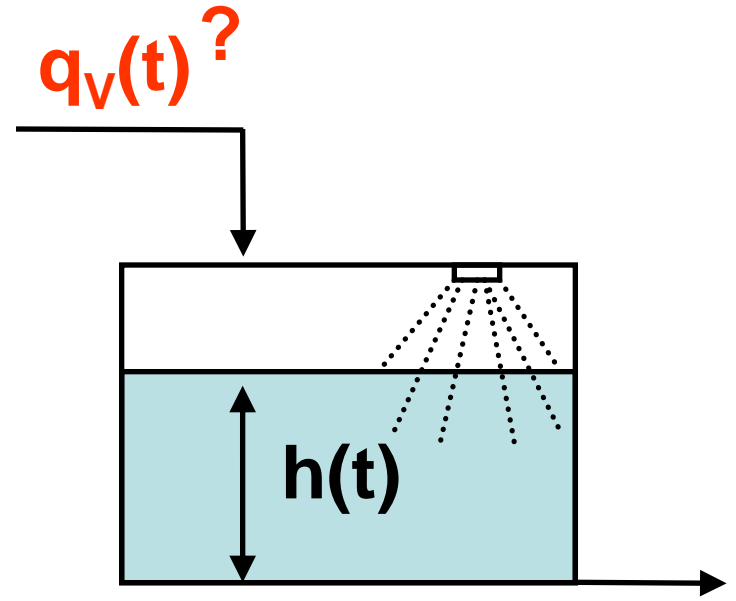
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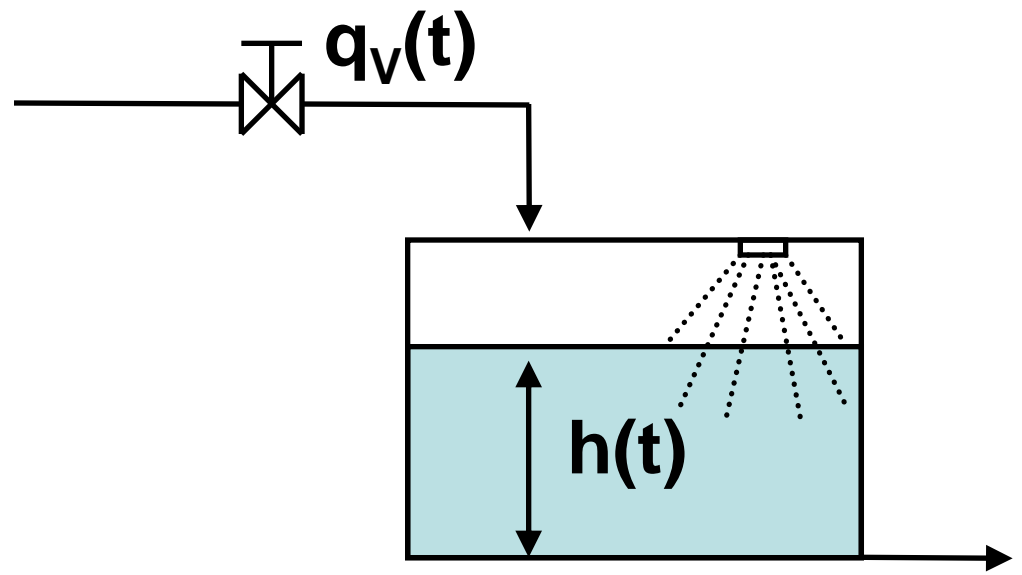
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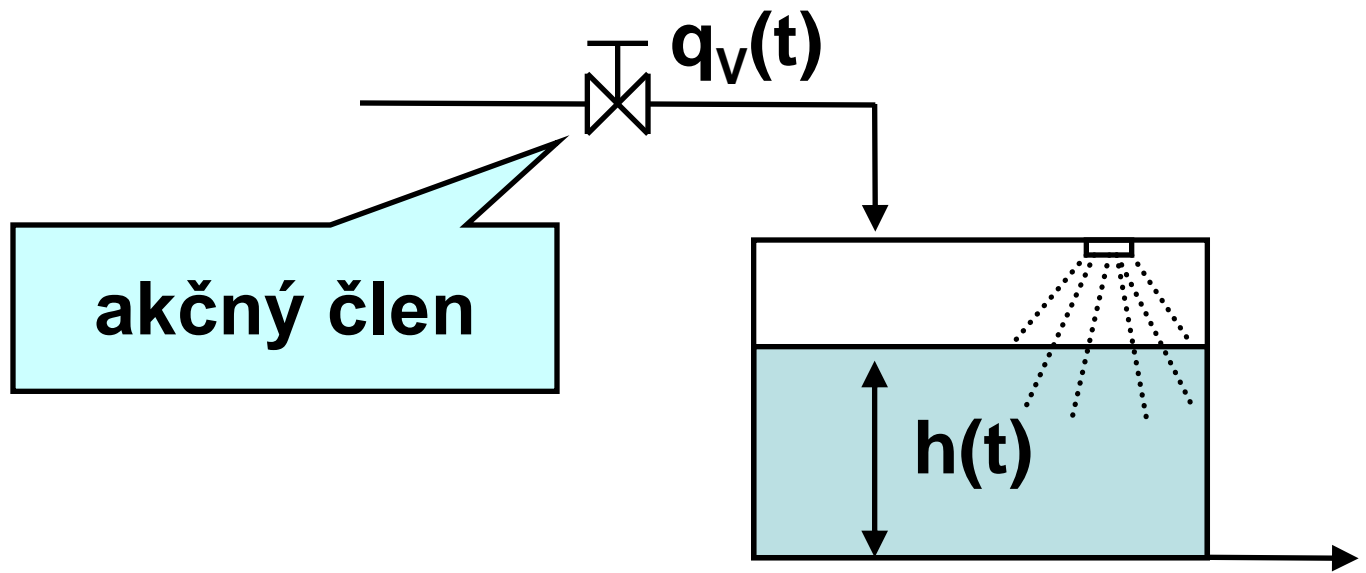
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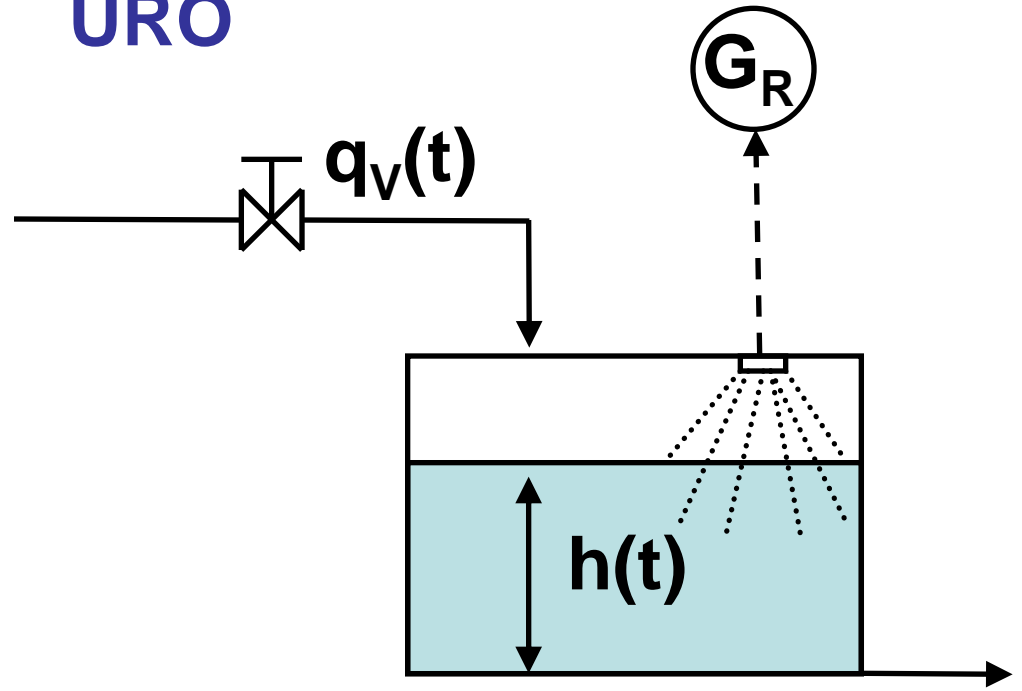
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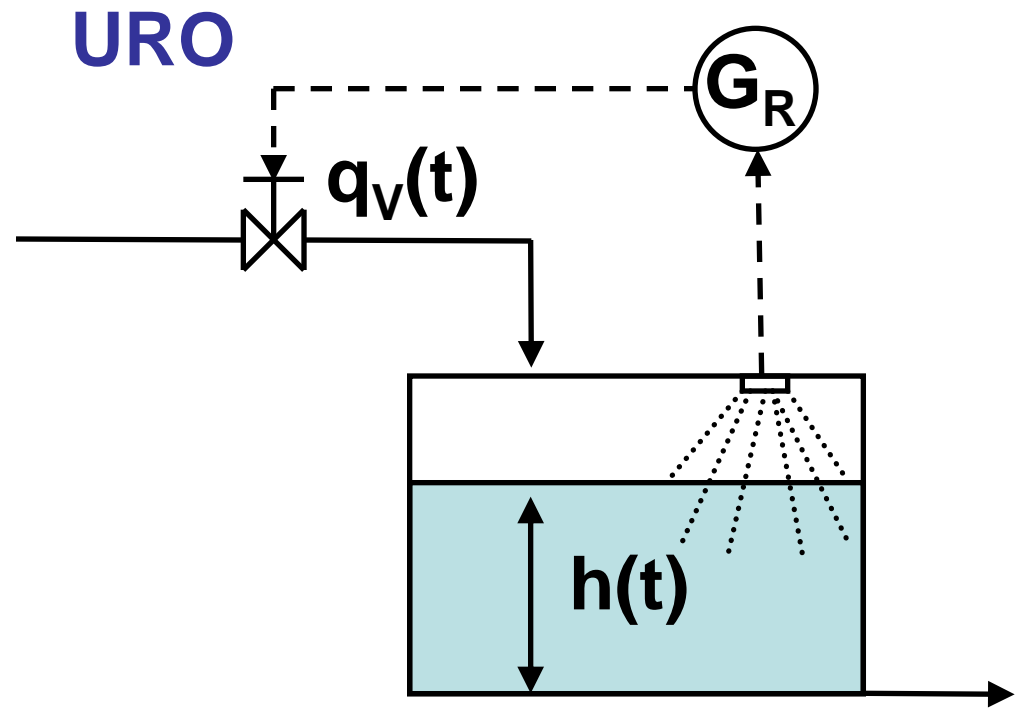


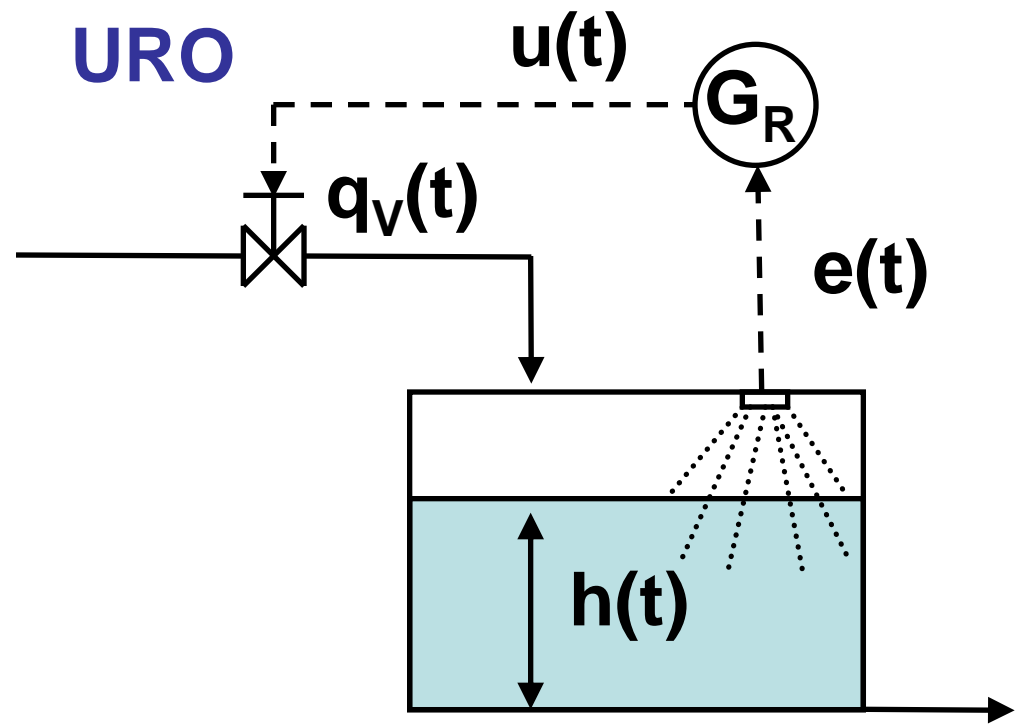
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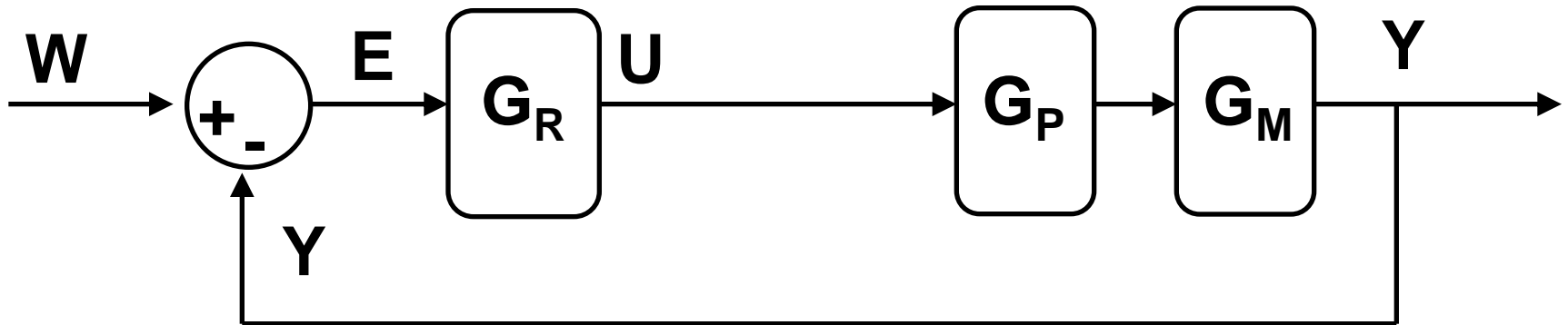
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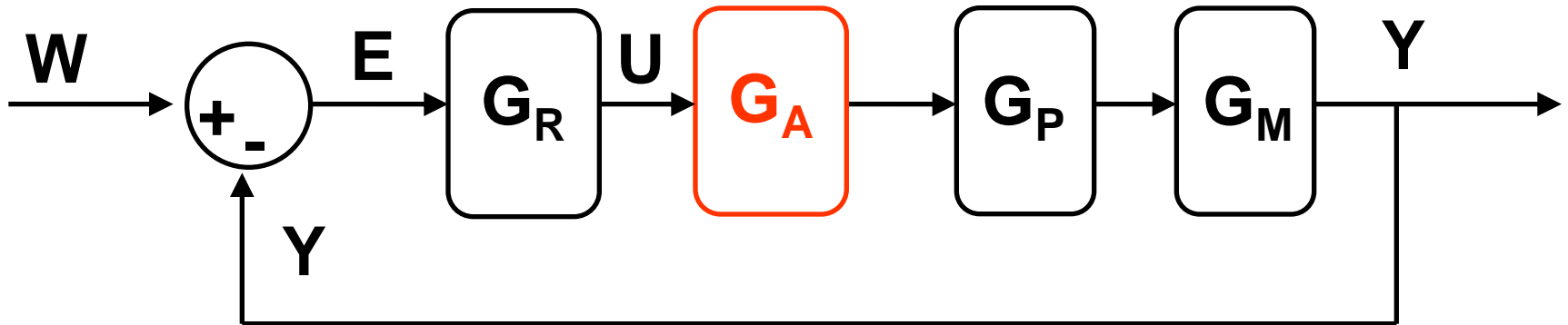




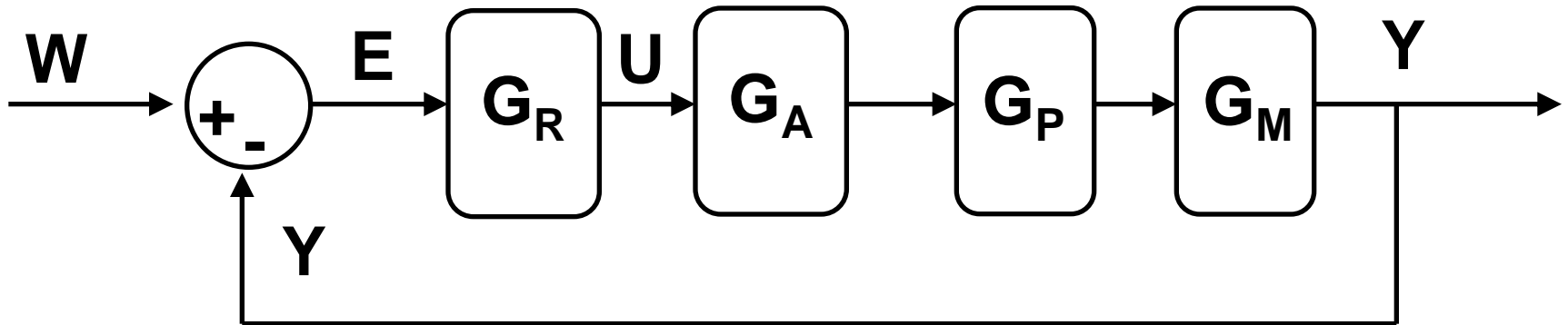
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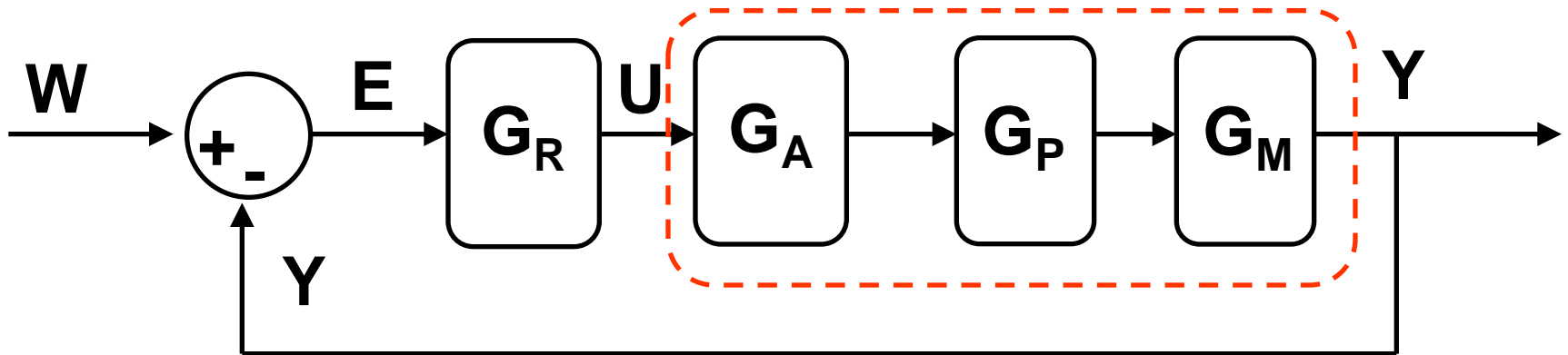
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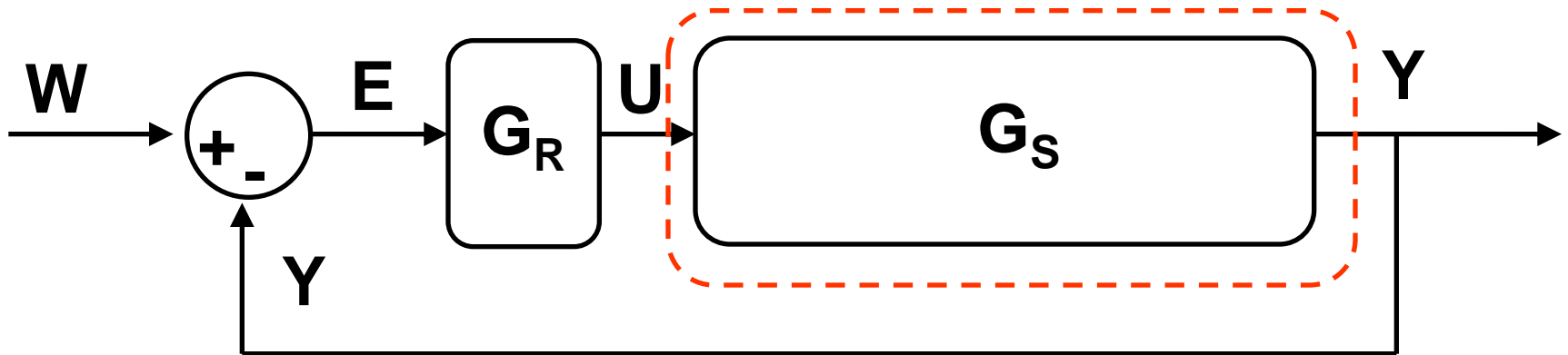
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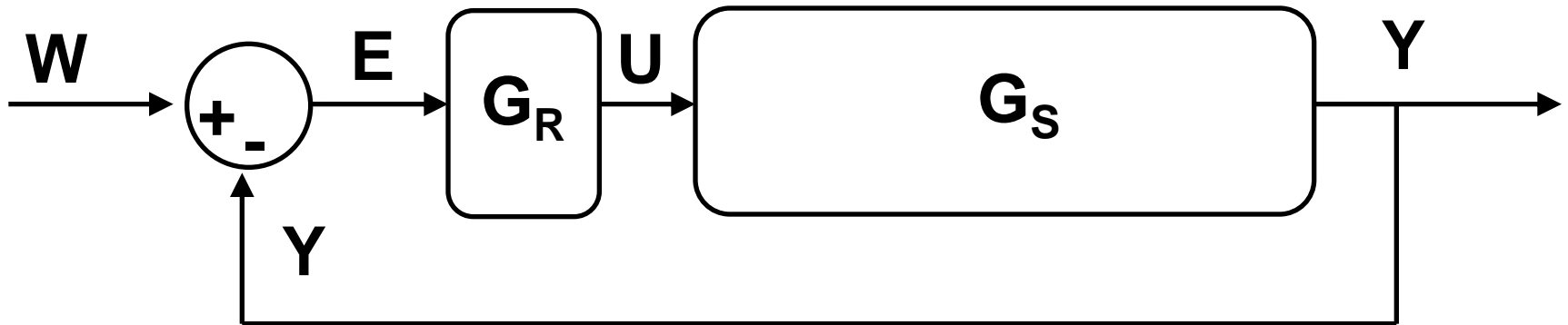
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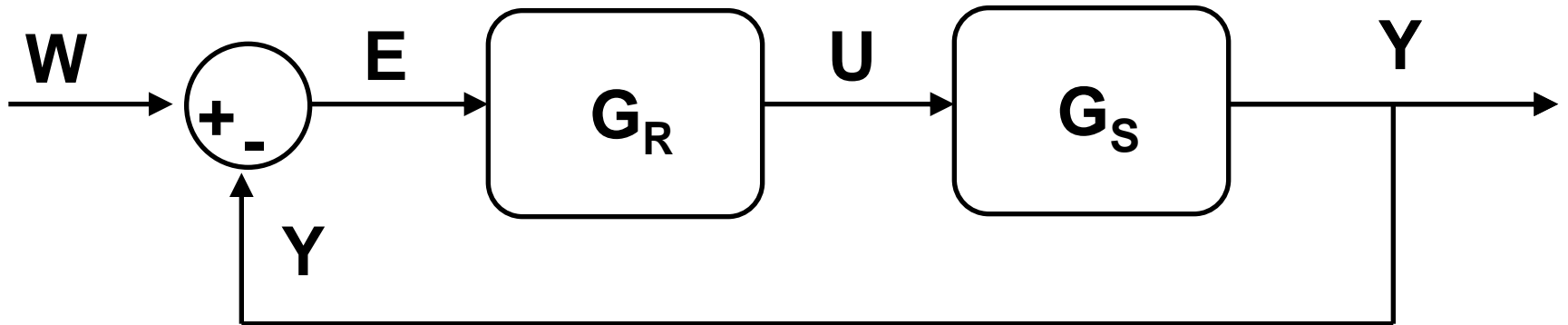
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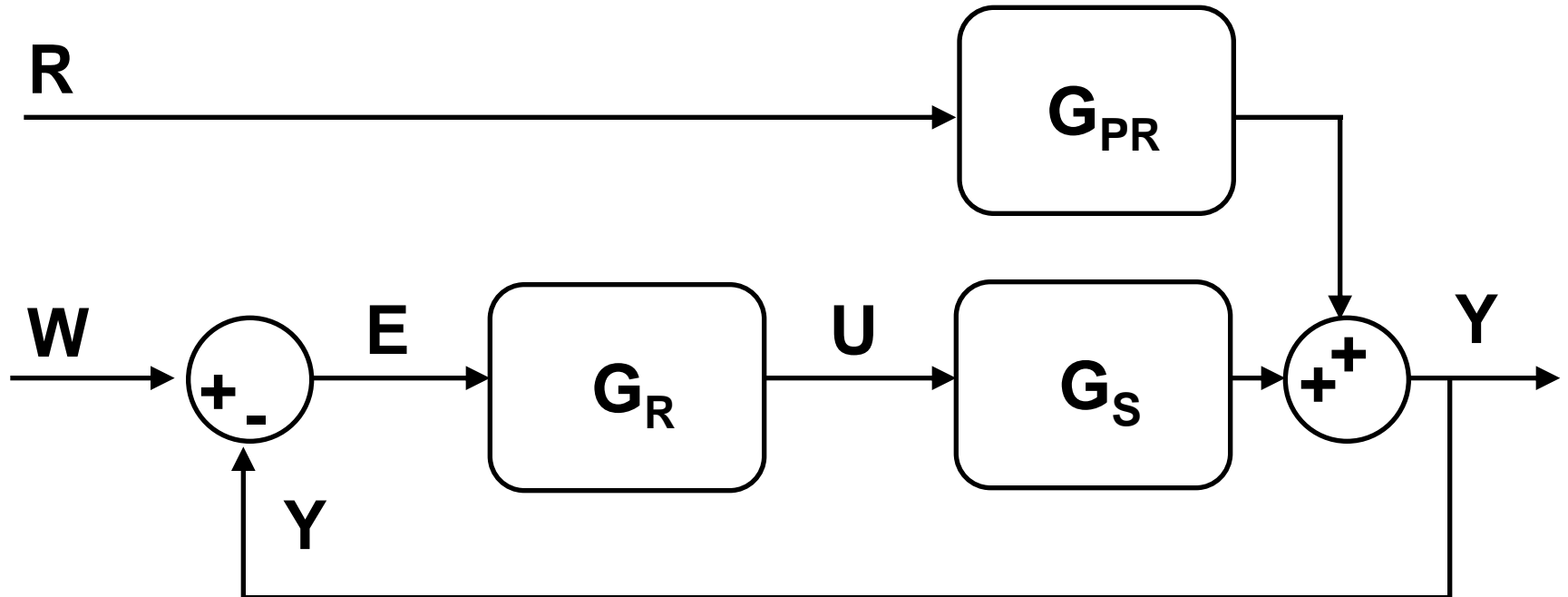
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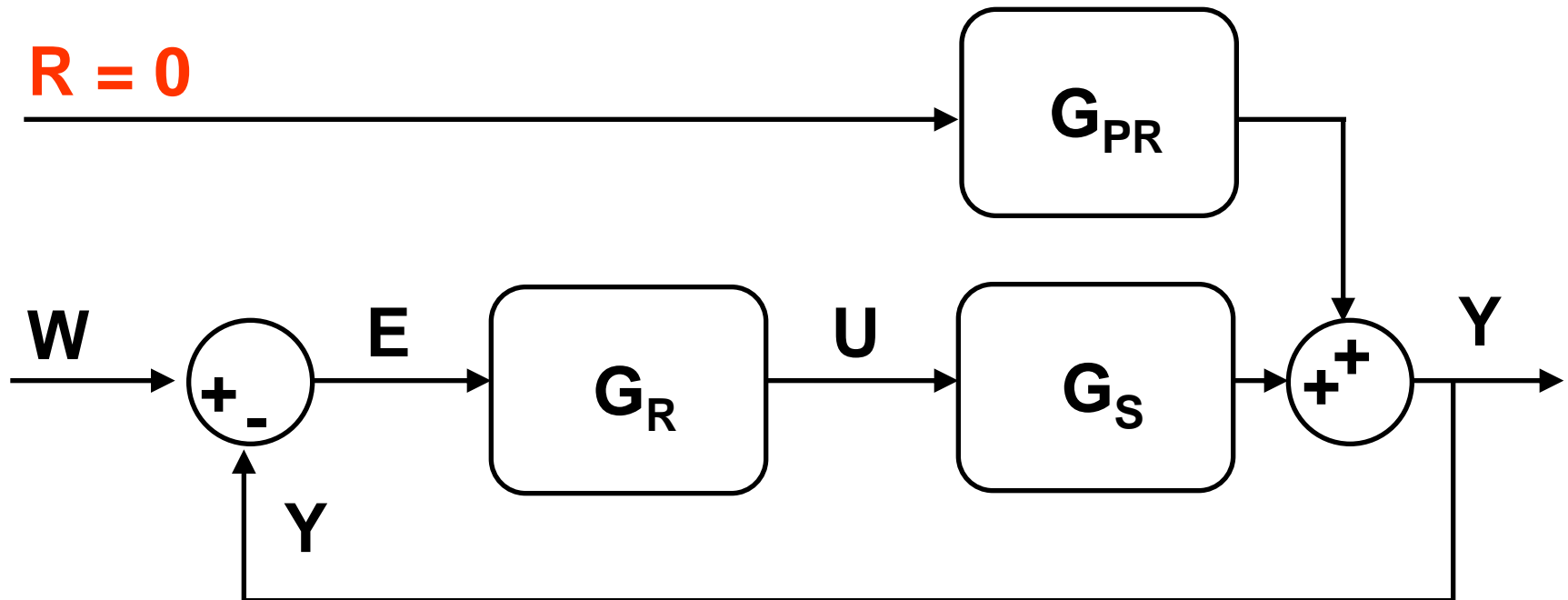
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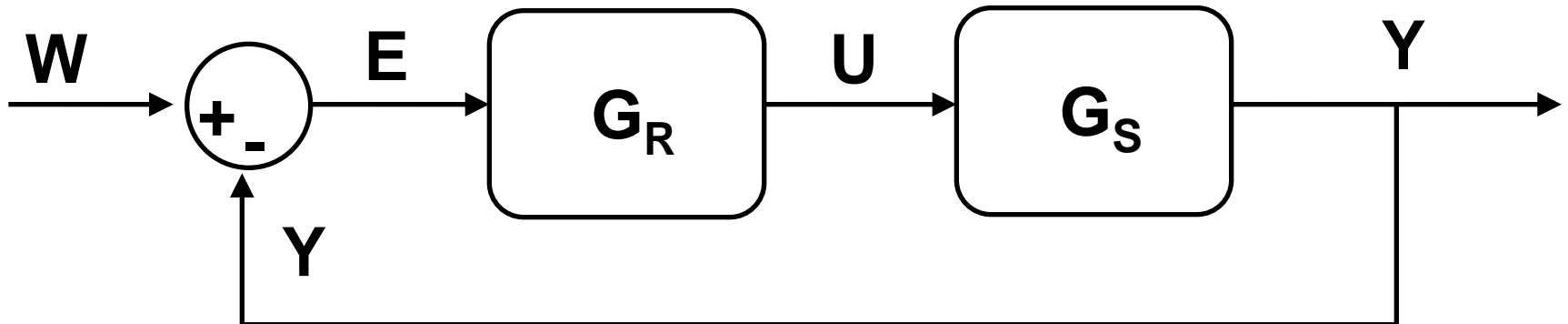
Prenos URO



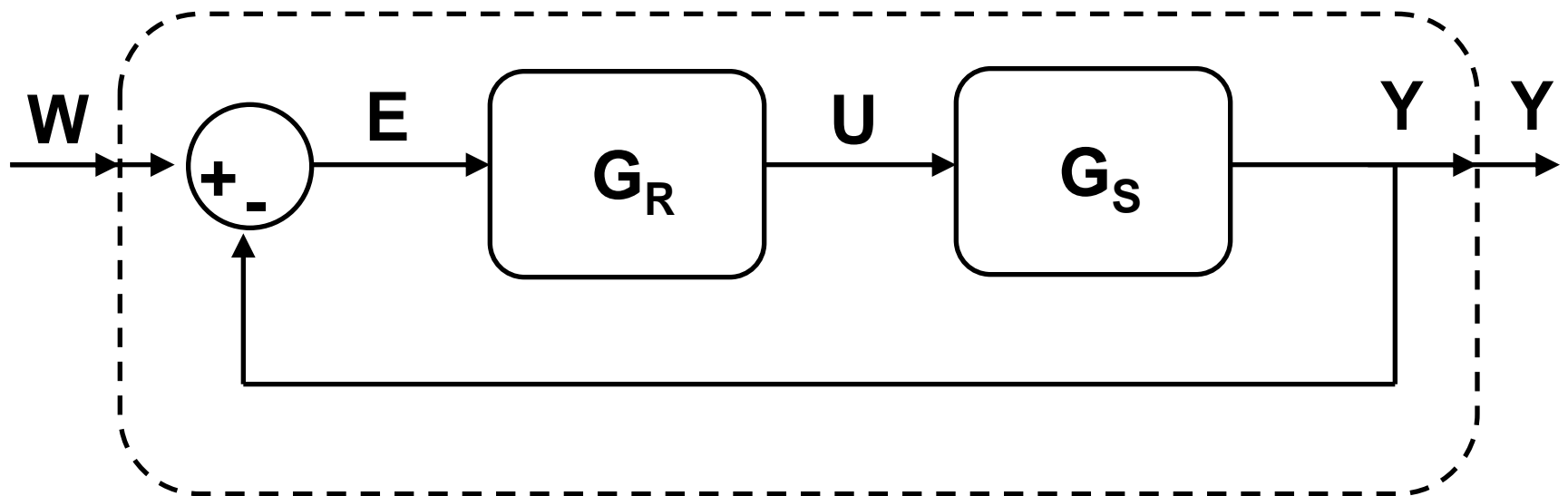
Prenos URO



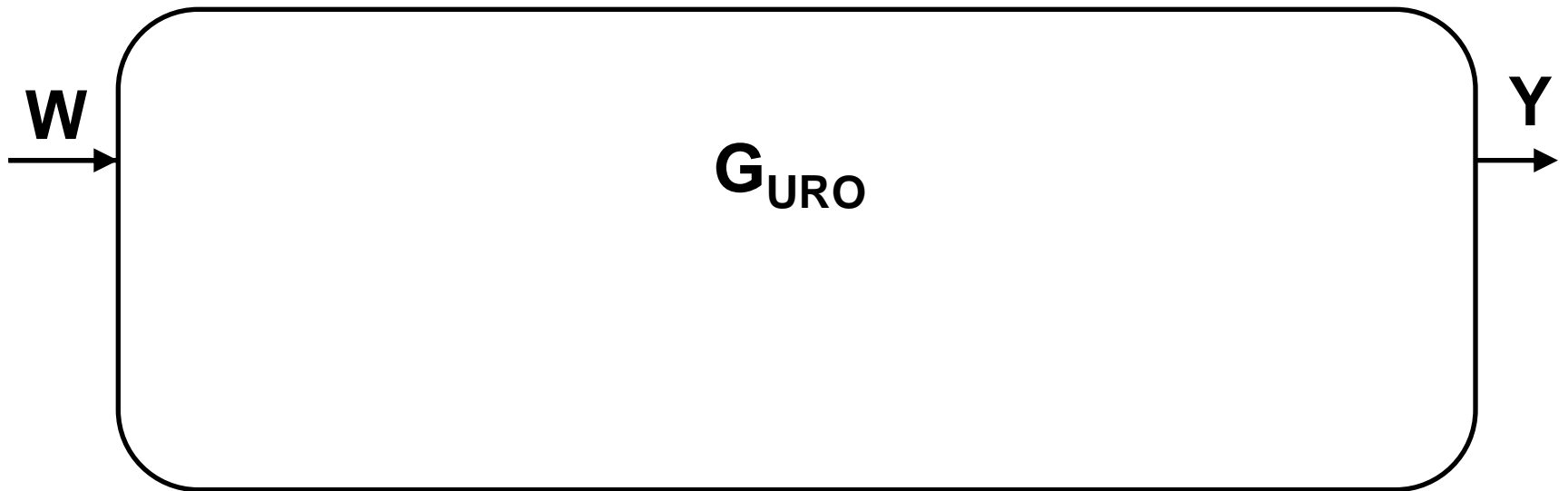
Prenos URO



Prenos URO



Prenos URO



Prenos URO



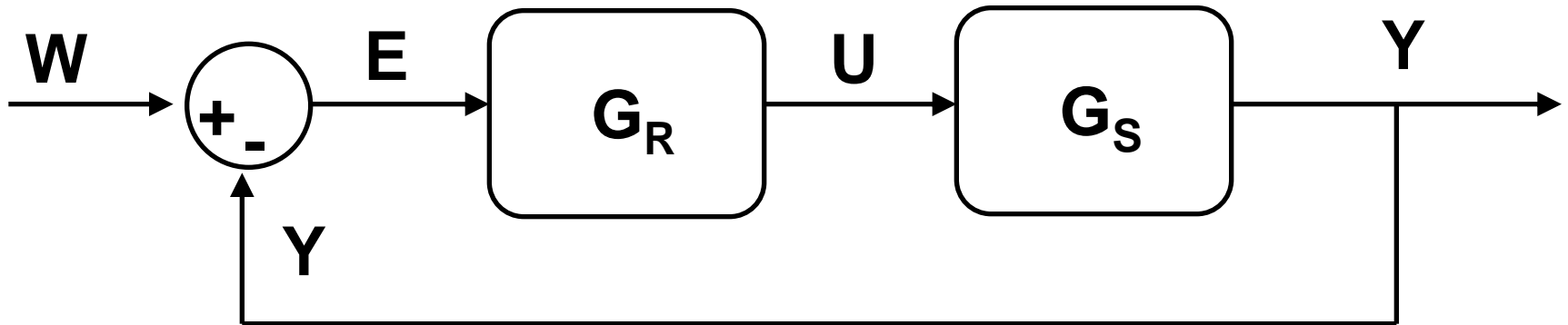
$$Y = G_{URO}W$$

Prenos URO



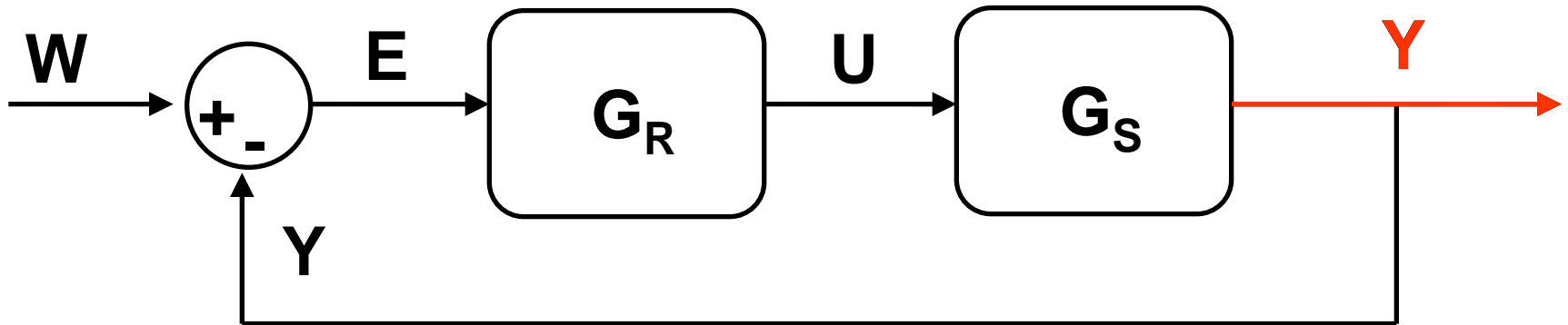
$$Y = G_{URO}^? W$$

Prenos URO



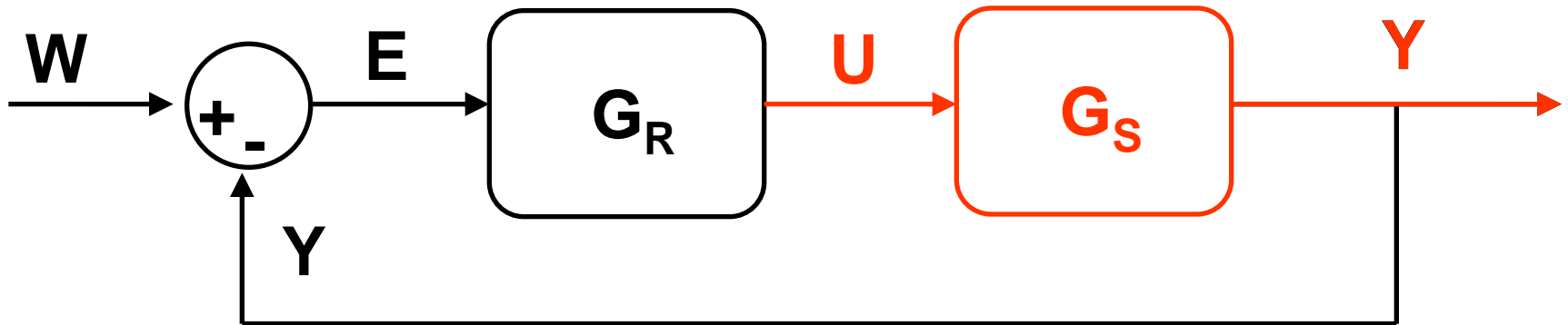
$$Y = G_{URO}^? W$$

Prenos URO



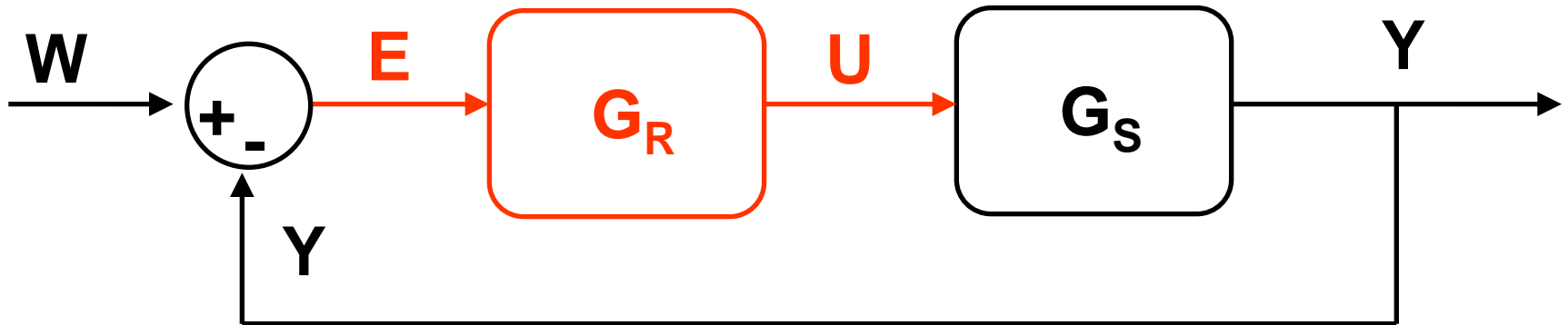
Y

Prenos URO



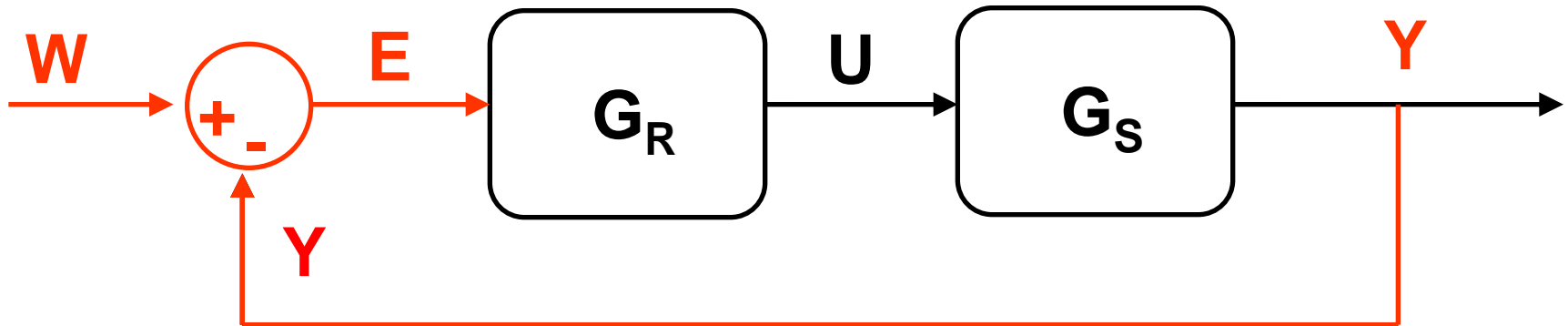
$$Y = G_S U$$

Prenos URO



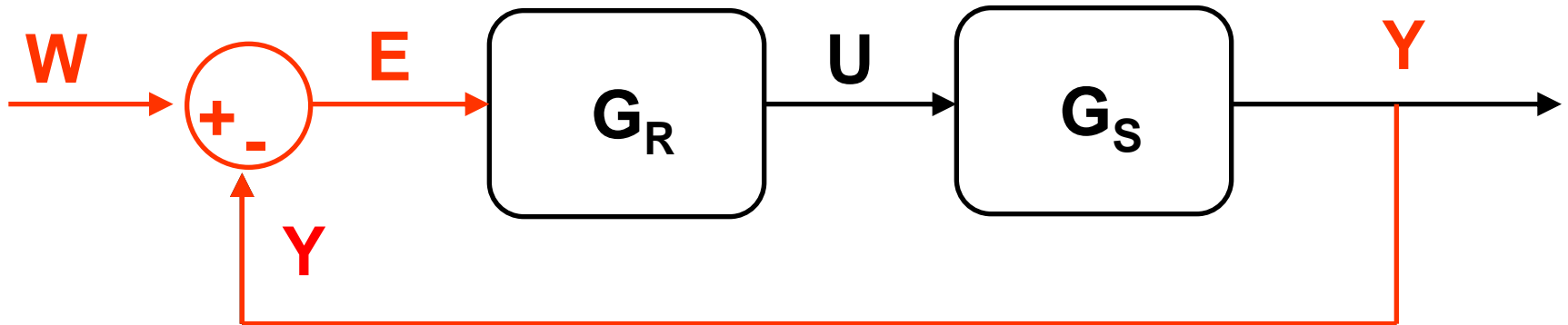
$$Y = G_S U = G_S G_R E$$

Prenos URO



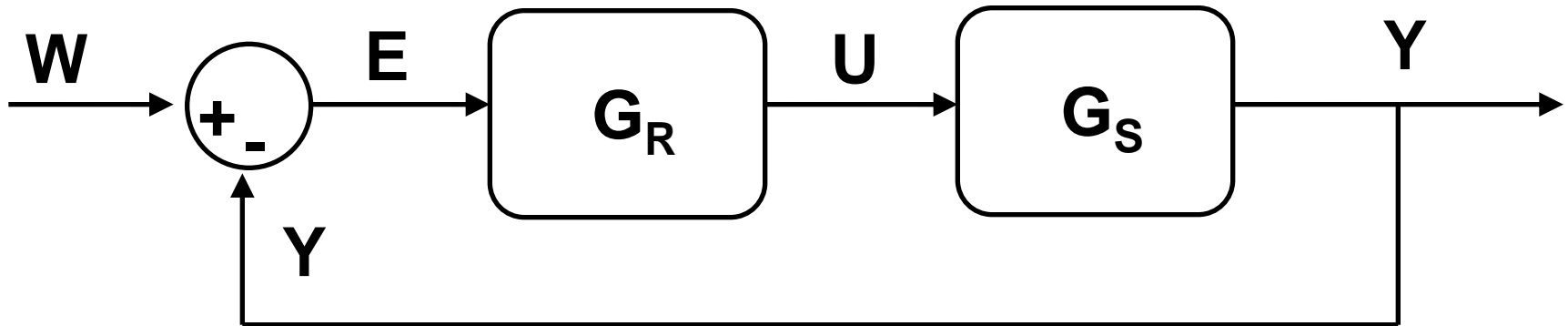
$$Y = G_S U = G_S G_R E = G_S G_R (W - Y)$$

Prenos URO



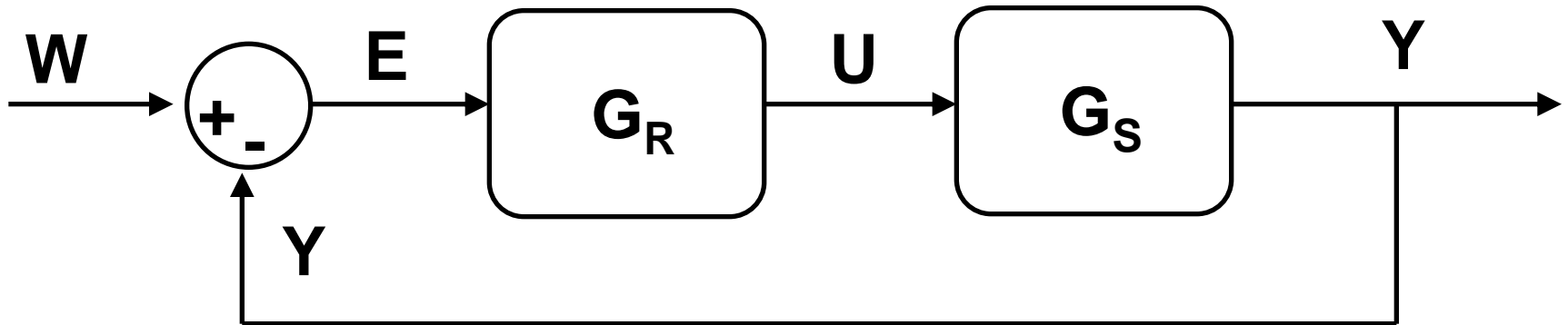
$$\begin{aligned} Y &= G_S U = G_S G_R E = G_S G_R (W - Y) = \\ &= G_S G_R W - G_S G_R Y \end{aligned}$$

Prenos URO



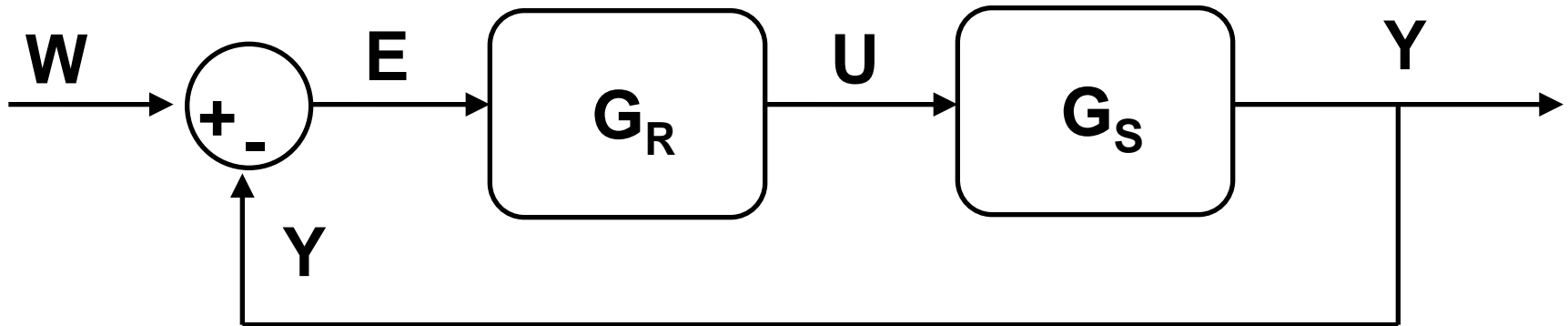
$$Y = G_S G_R W - G_S G_R Y$$

Prenos URO



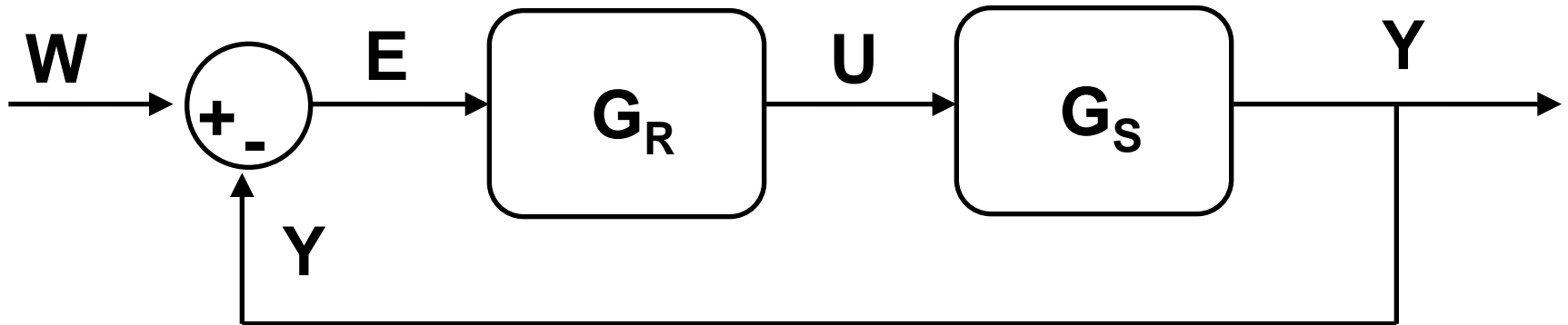
$$Y = \frac{G_S G_R W - G_S G_R Y}{1 + G_S G_R Y}$$

Prenos URO



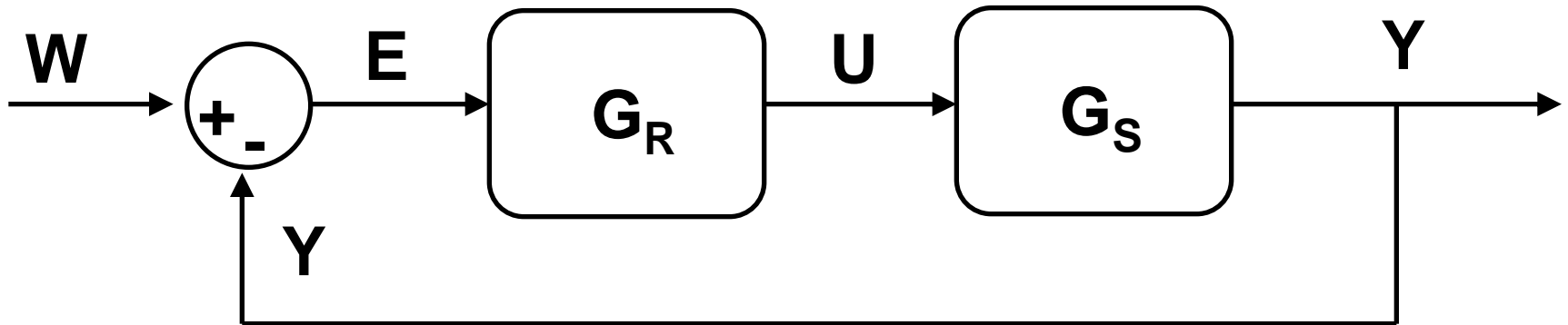
$$Y + G_S G_R Y = G_S G_R W$$

Prenos URO



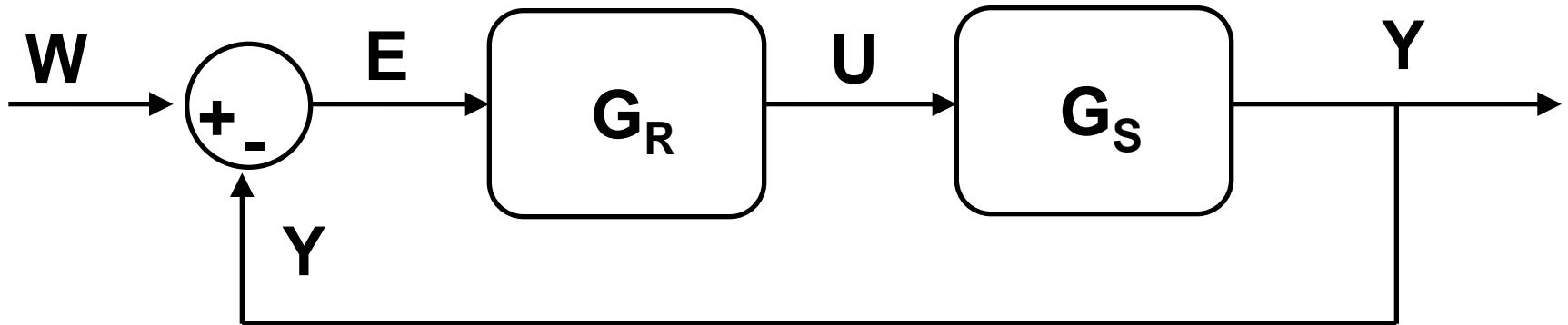
$$Y(1 + G_S G_R) = G_S G_R W$$

Prenos URO



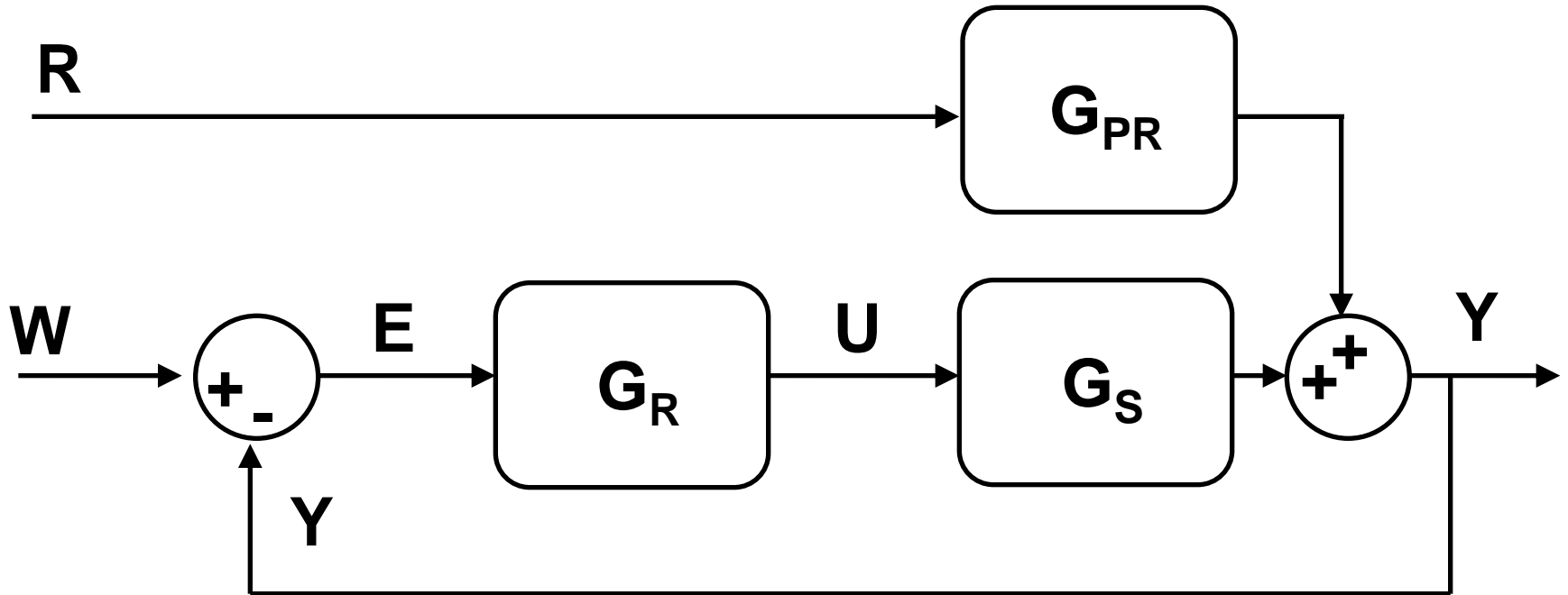
$$Y / W = G_S G_R / (1 + G_S G_R)$$

Prenos URO

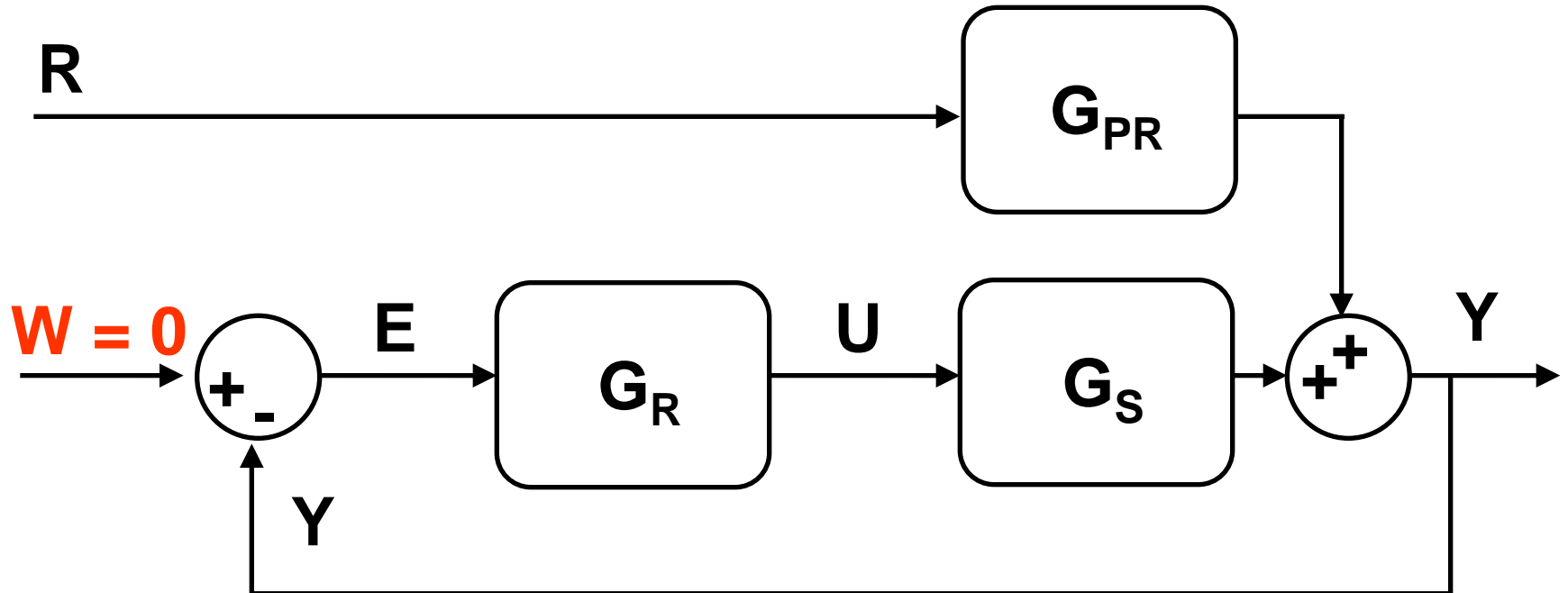


$$G_{URO} = \frac{Y}{W} = \frac{G_R G_S}{1 + G_R G_S}$$

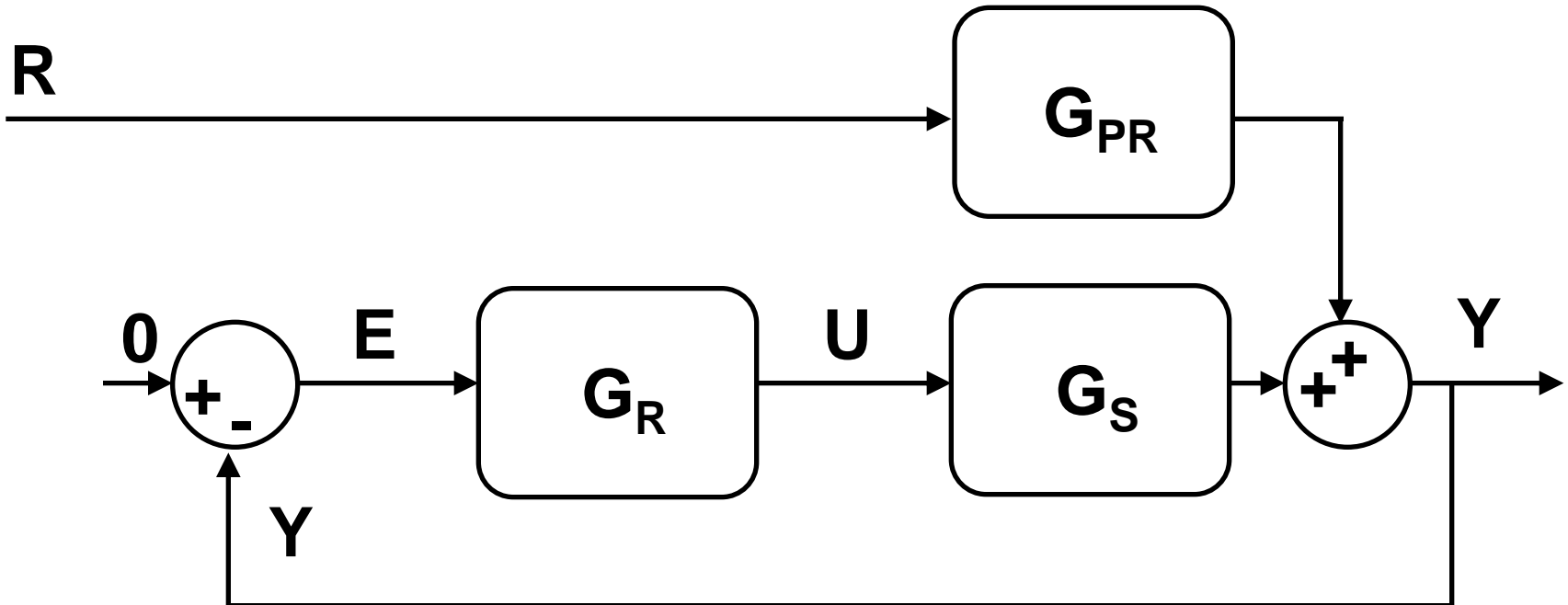
Prenos URO



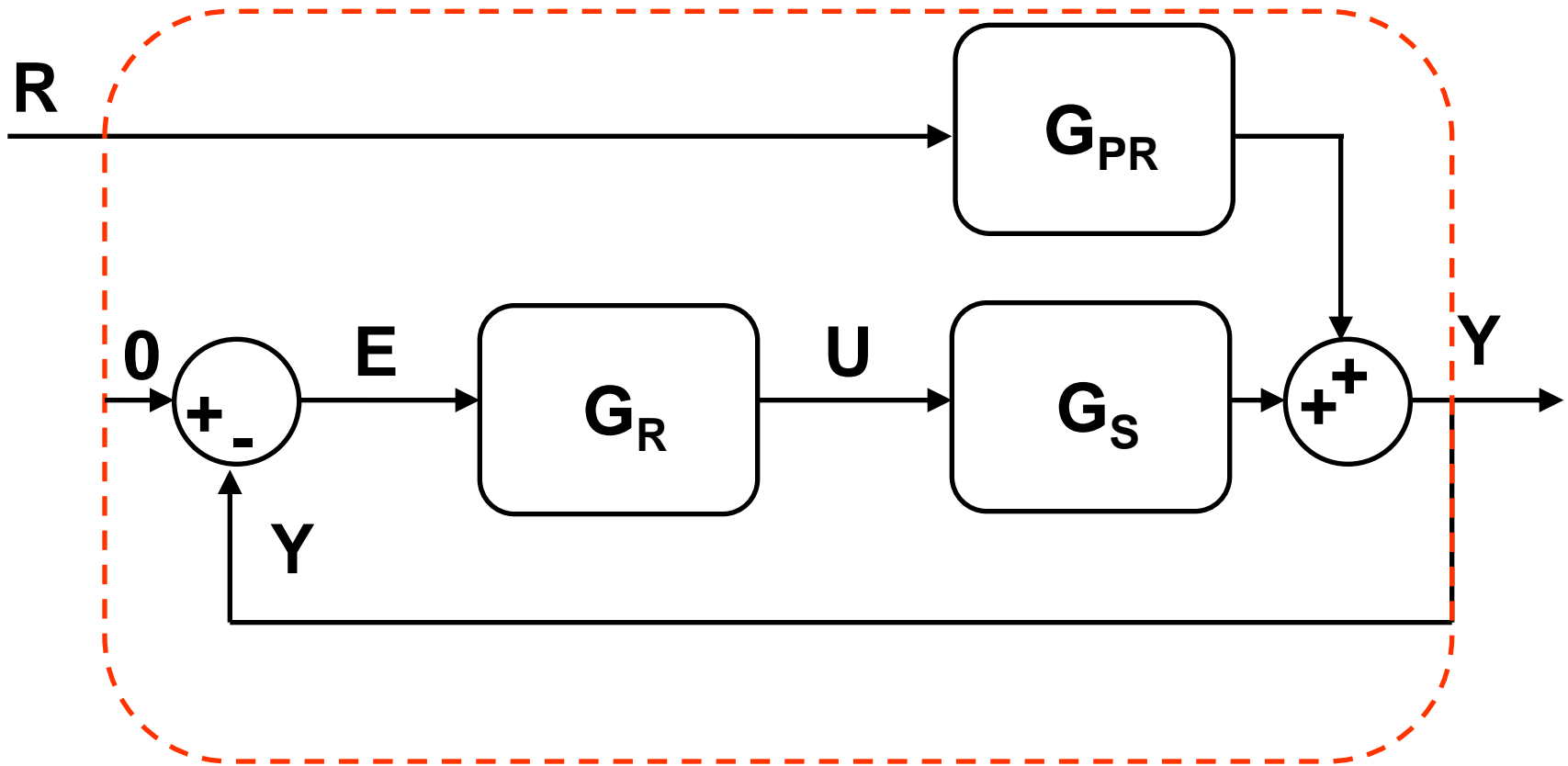
Prenos URO



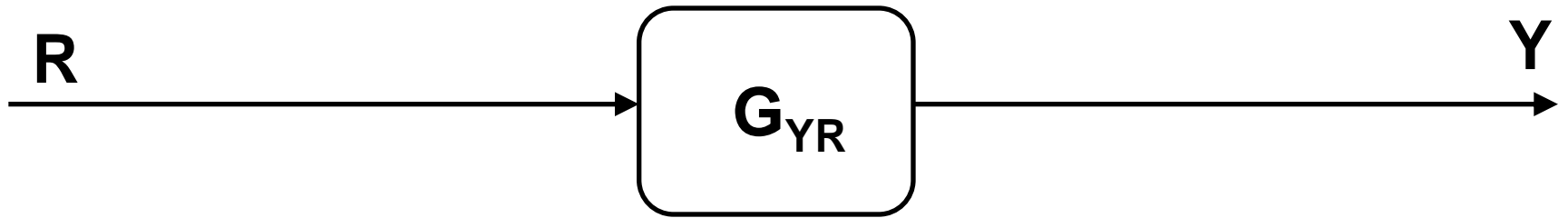
Prenos URO



Prenos URO

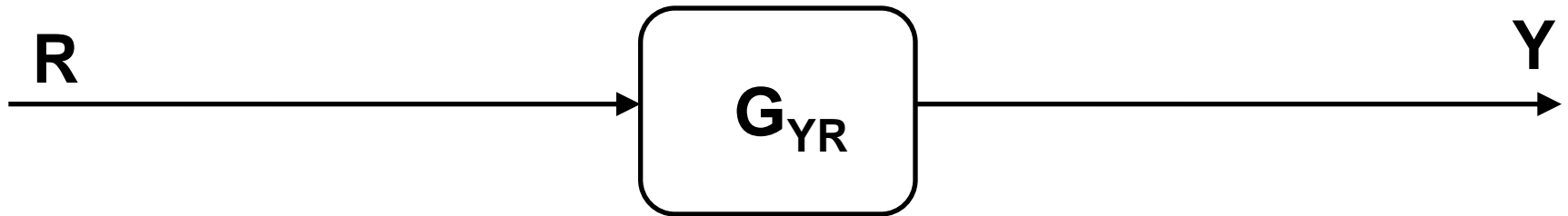


Prenos URO



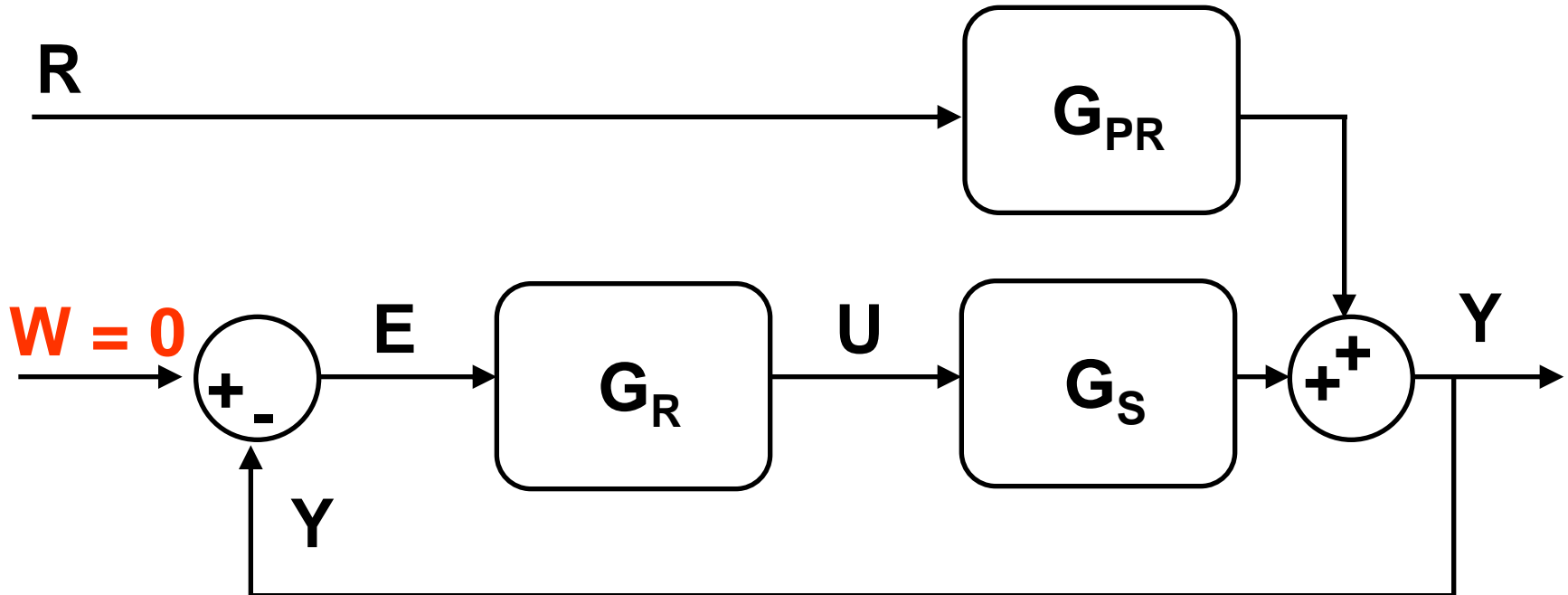
$$Y = G_{YR}R$$

Prenos URO

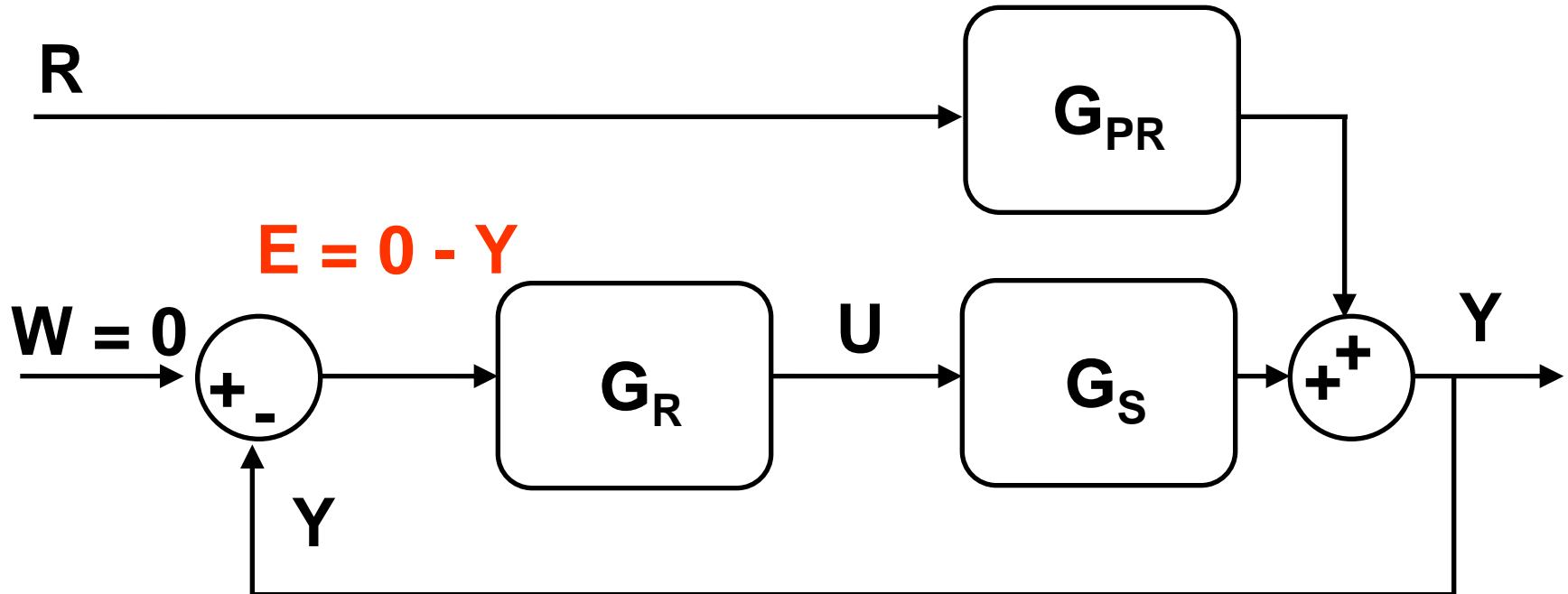


$$Y = G_{YR}^? R$$

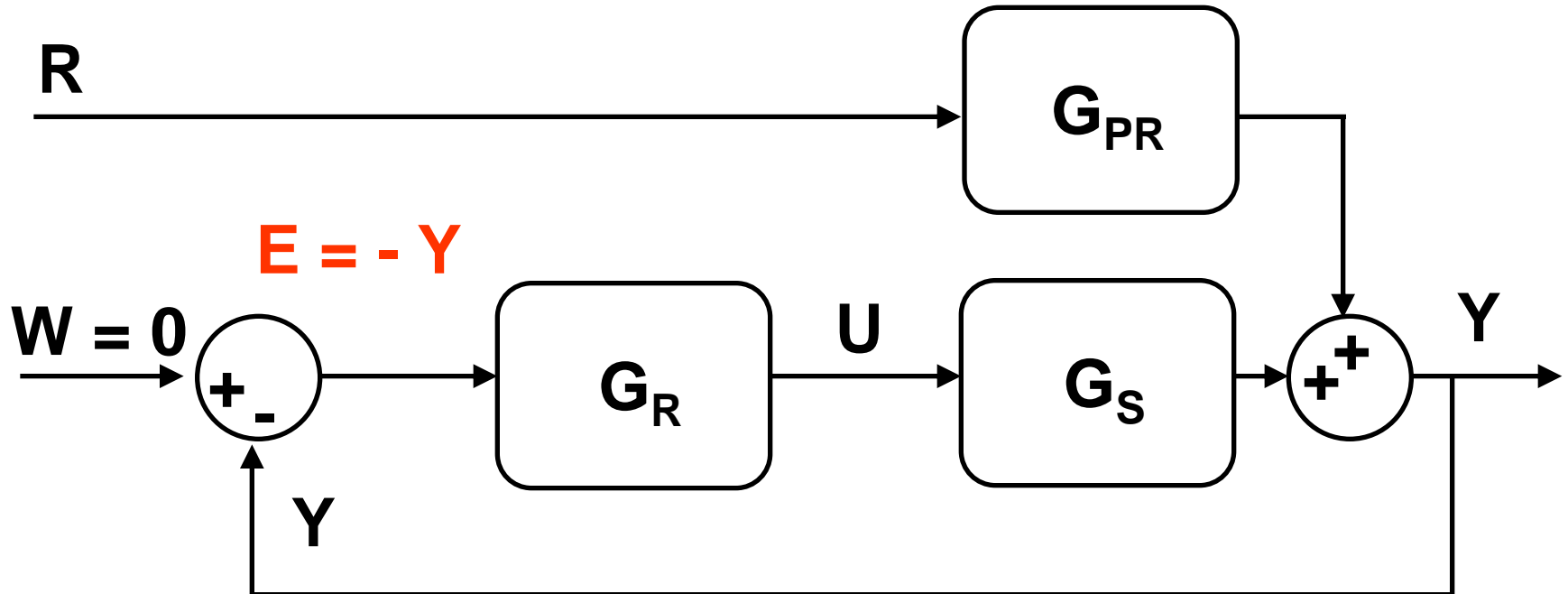
Prenos URO



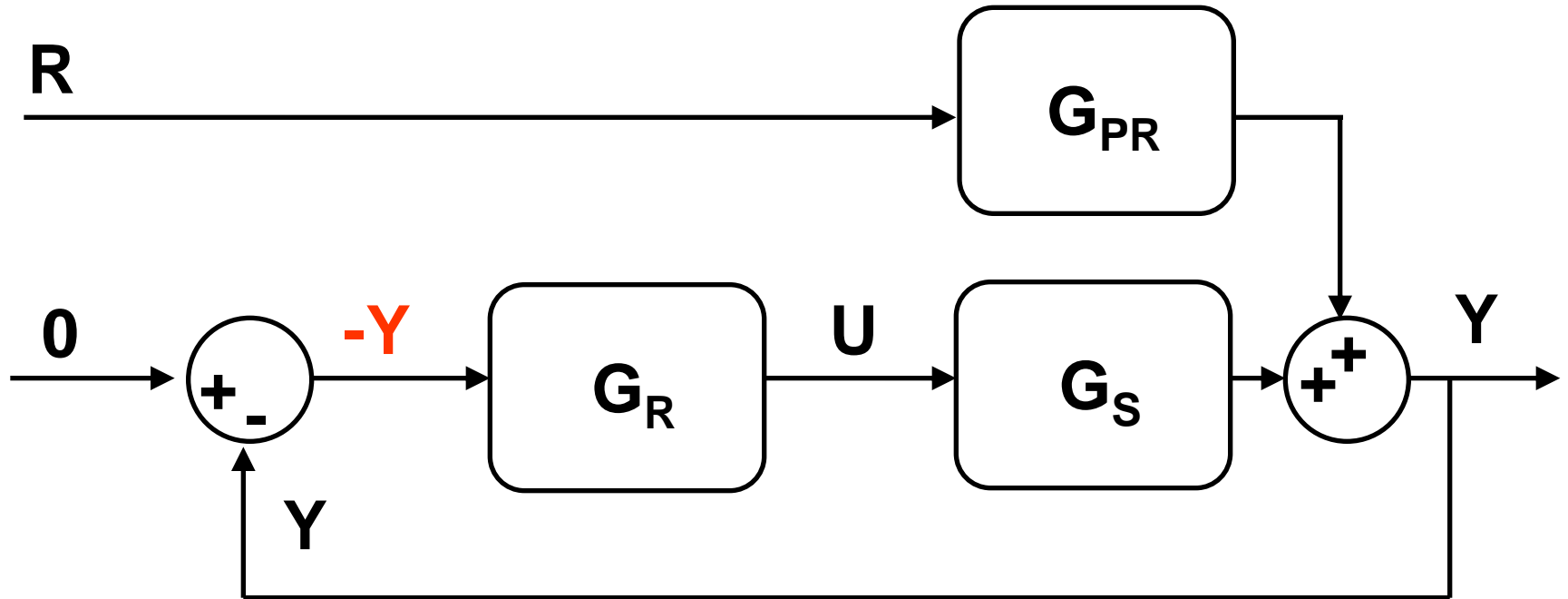
Prenos URO



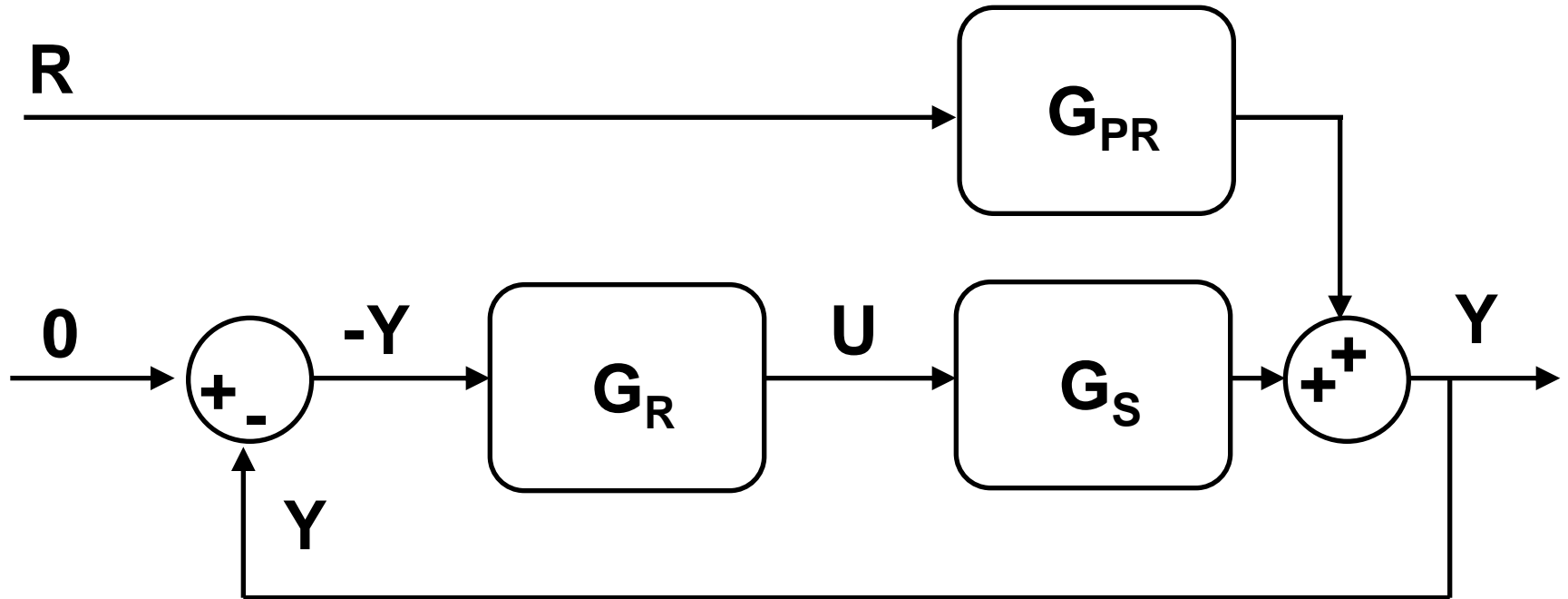
Prenos URO



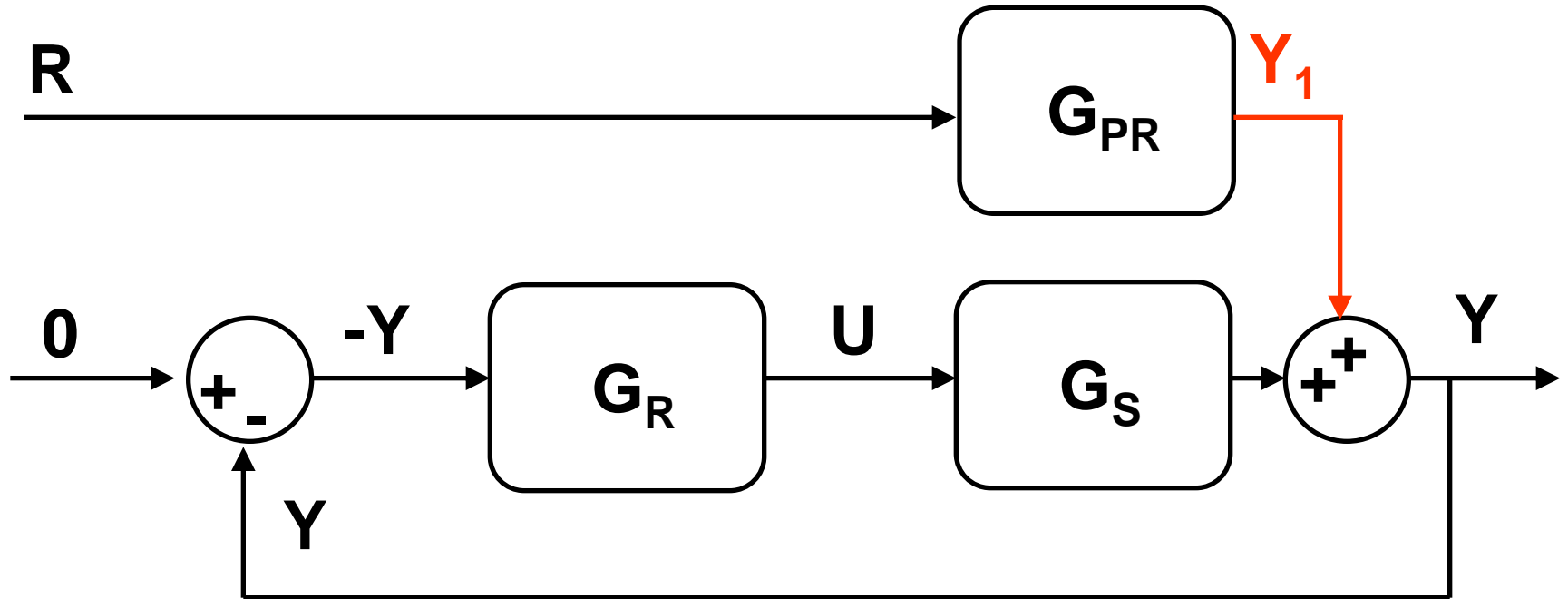
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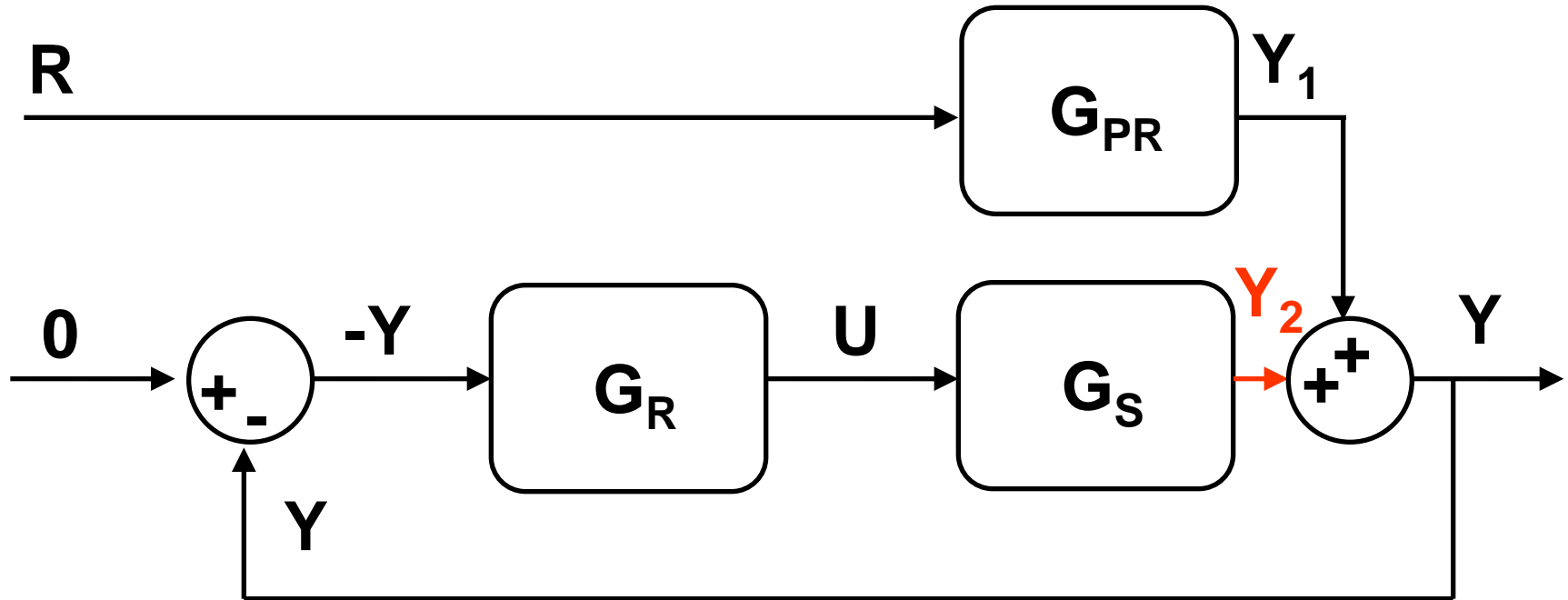
Prenos URO



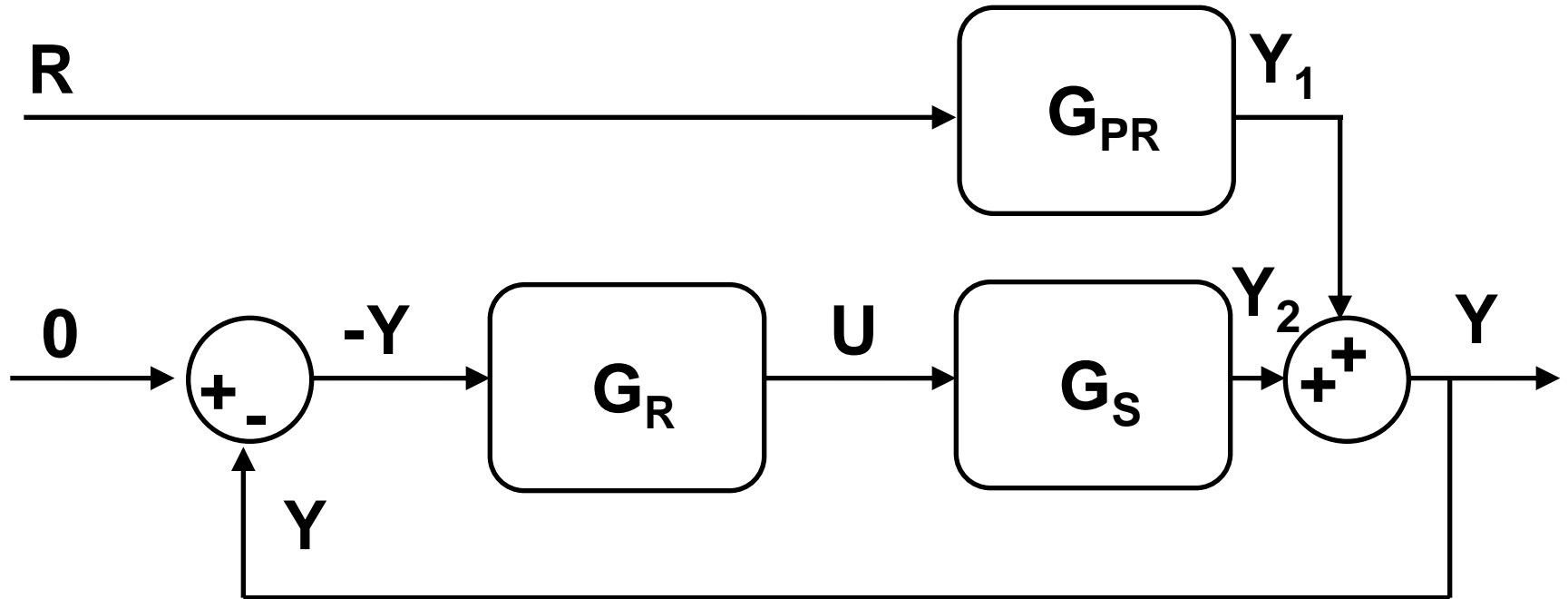
Prenos URO



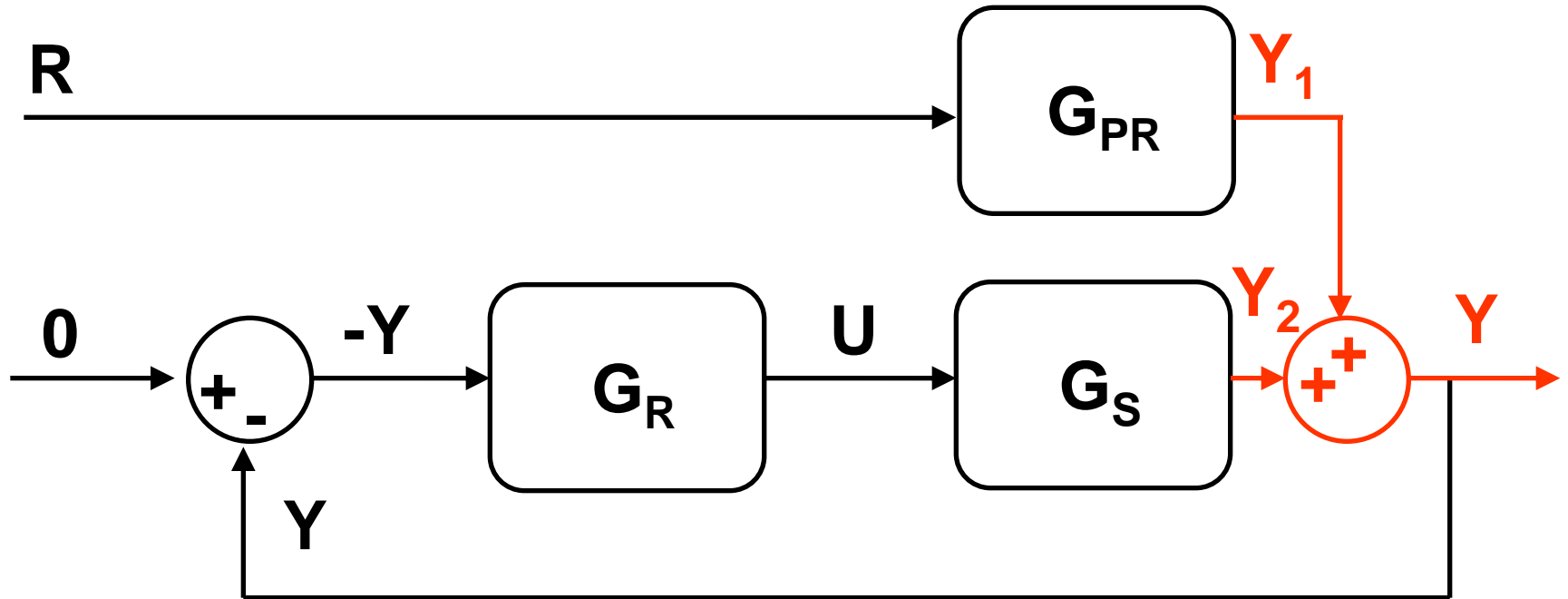
Prenos URO



Prenos URO

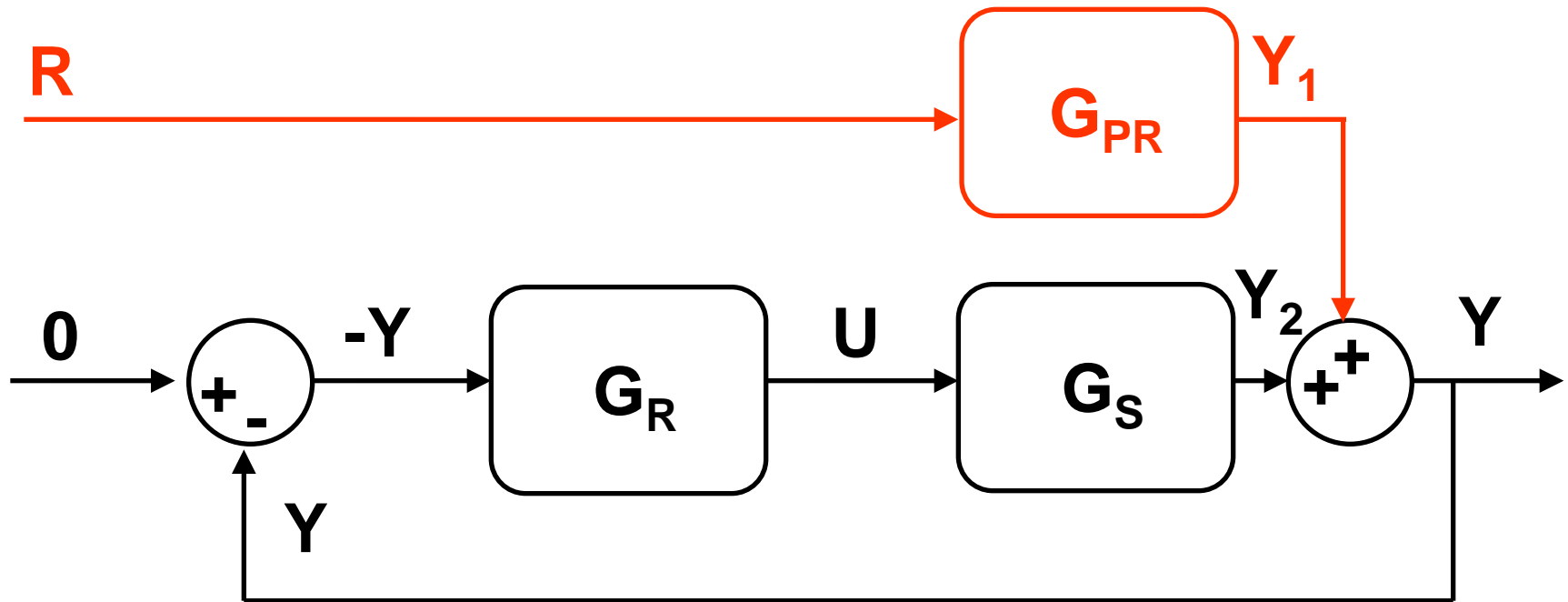


Prenos URO



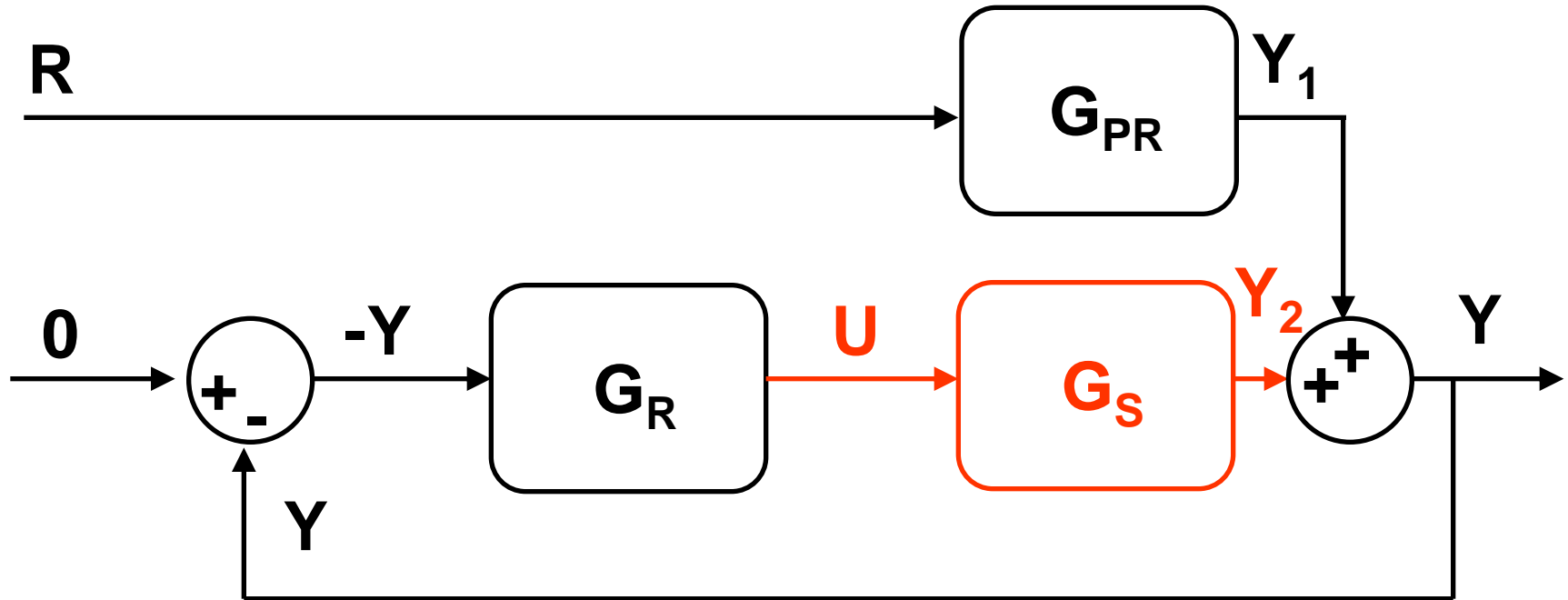
$$Y = Y_1 + Y_2$$

Prenos URO



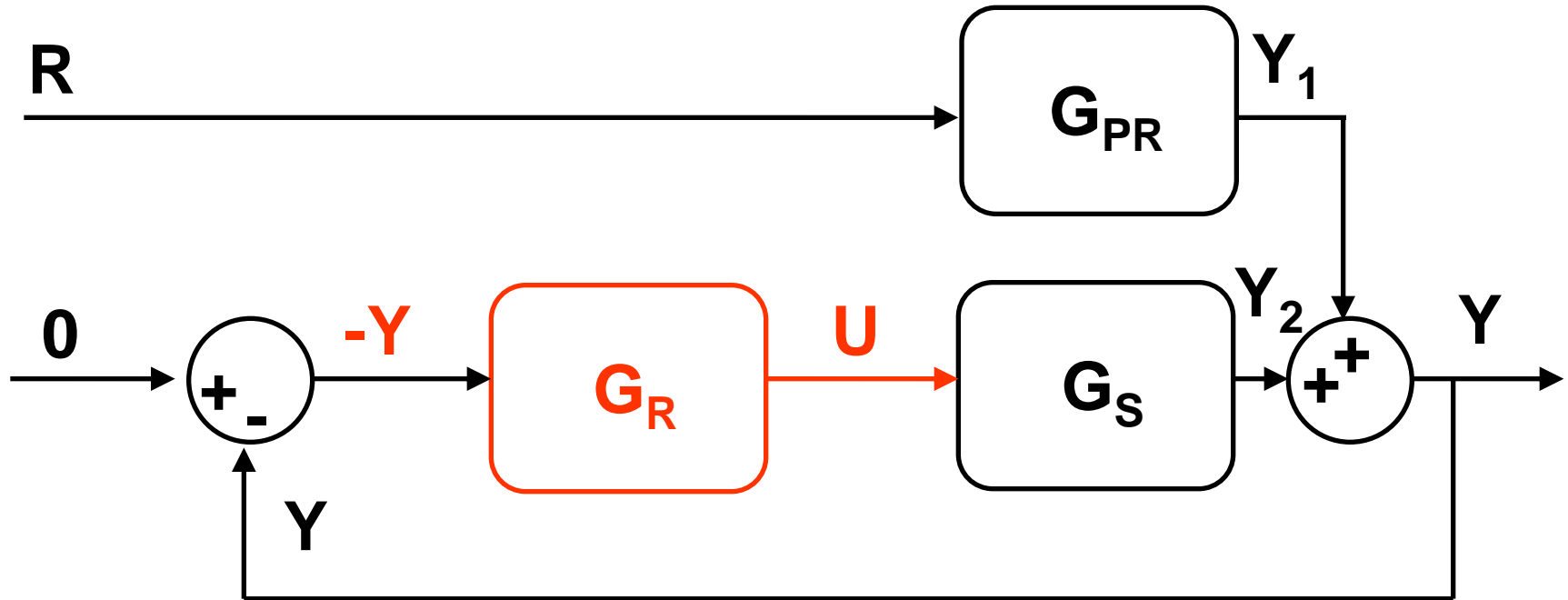
$$Y = Y_1 + Y_2 = G_{PR}R + Y_2$$

Prenos URO



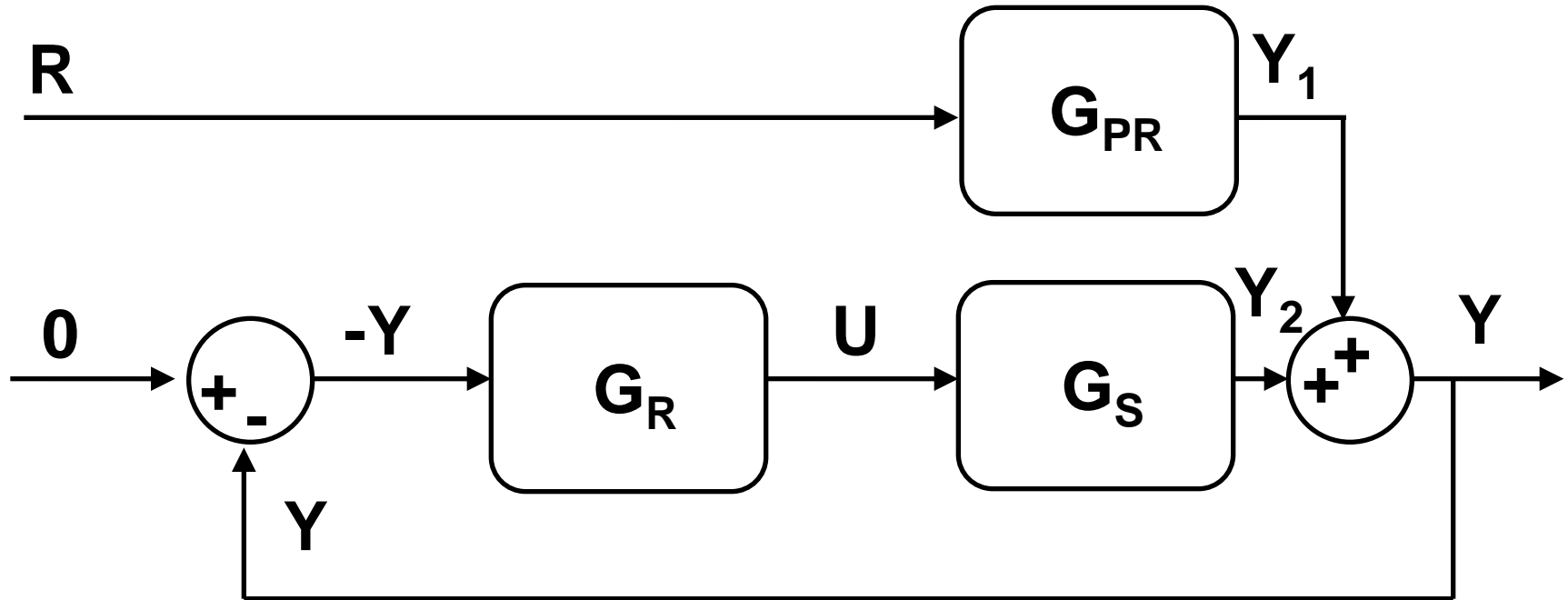
$$Y = Y_1 + Y_2 = G_{PR}R + G_S U$$

Prenos URO



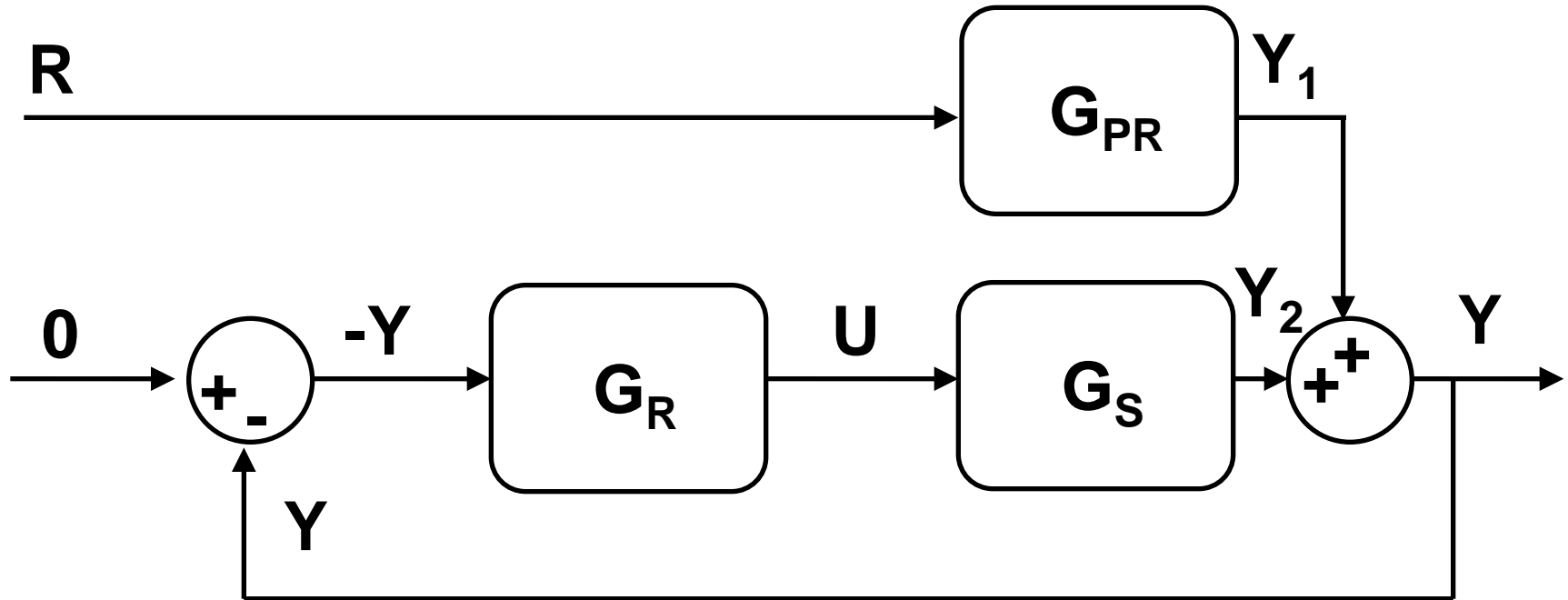
$$Y = Y_1 + Y_2 = G_{PR}R + G_S U = G_{PR}R - G_S G_R Y$$

Prenos URO



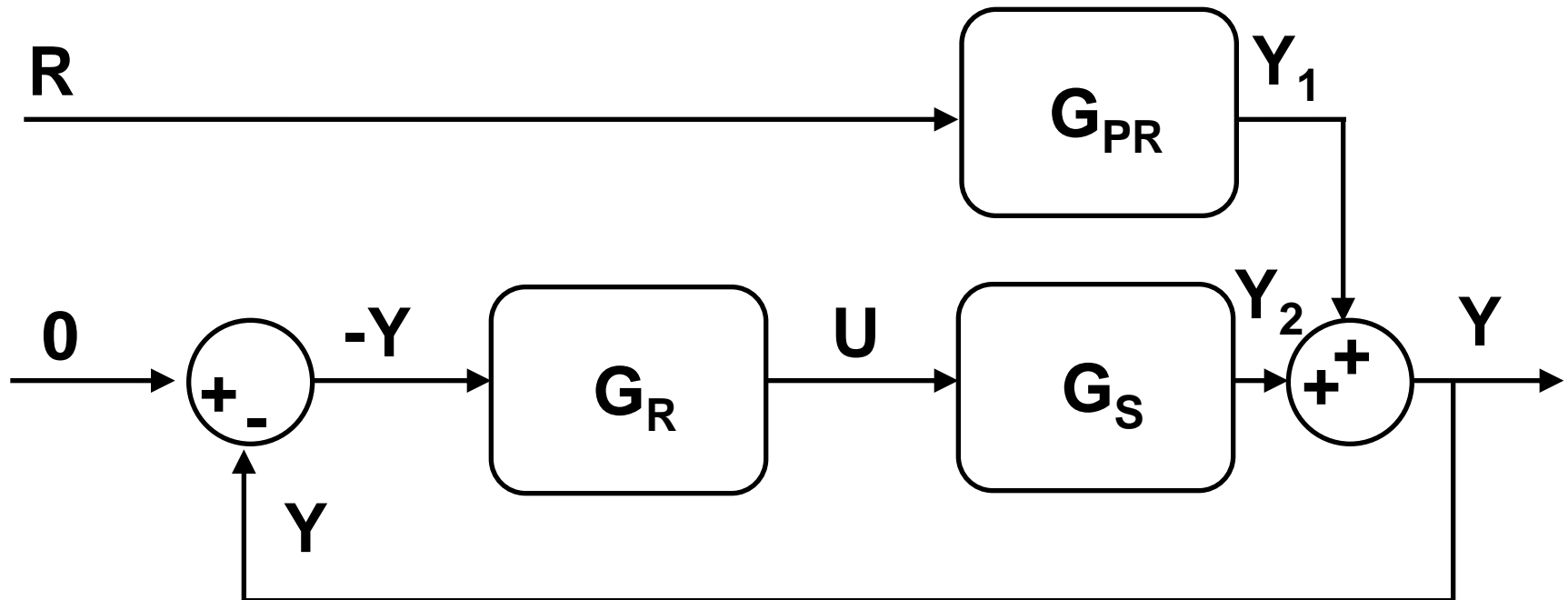
$$Y = Y_1 + Y_2 = G_{PR}R + G_S U = G_{PR}R - G_S G_R Y$$

Prenos URO



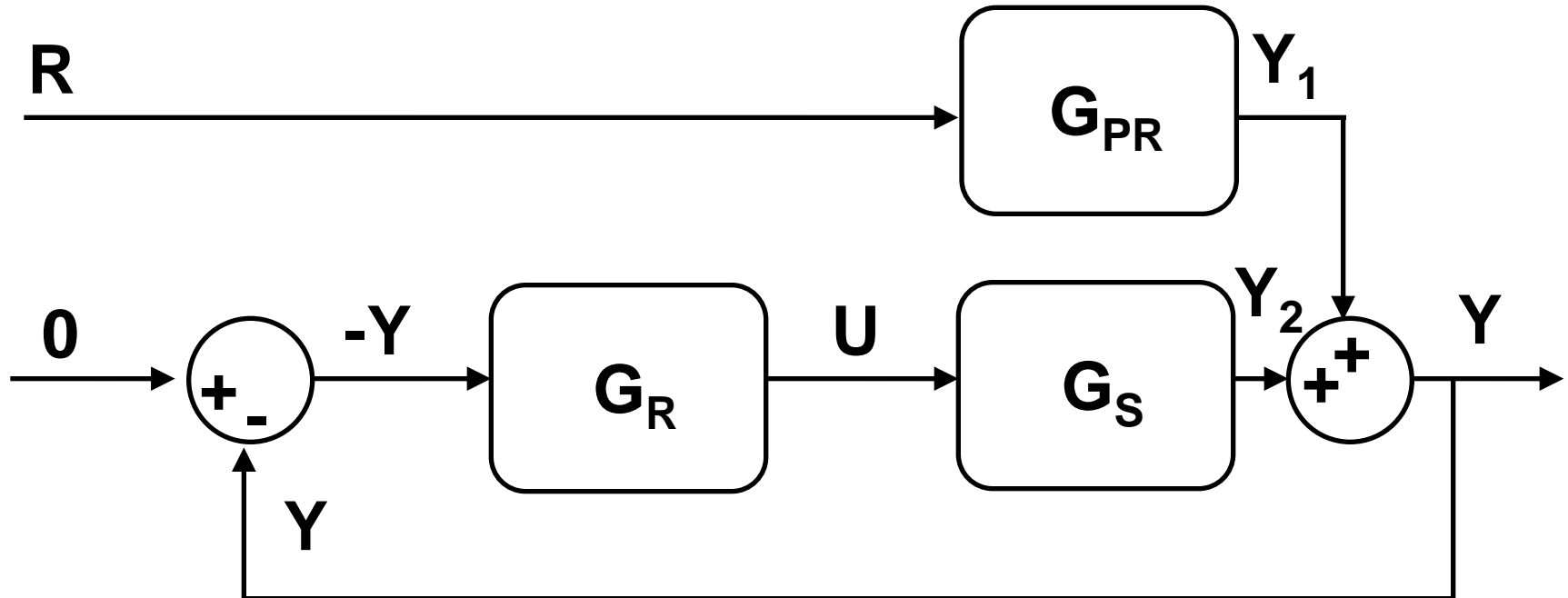
$$Y = G_{PR}R - G_S G_R Y$$

Prenos URO



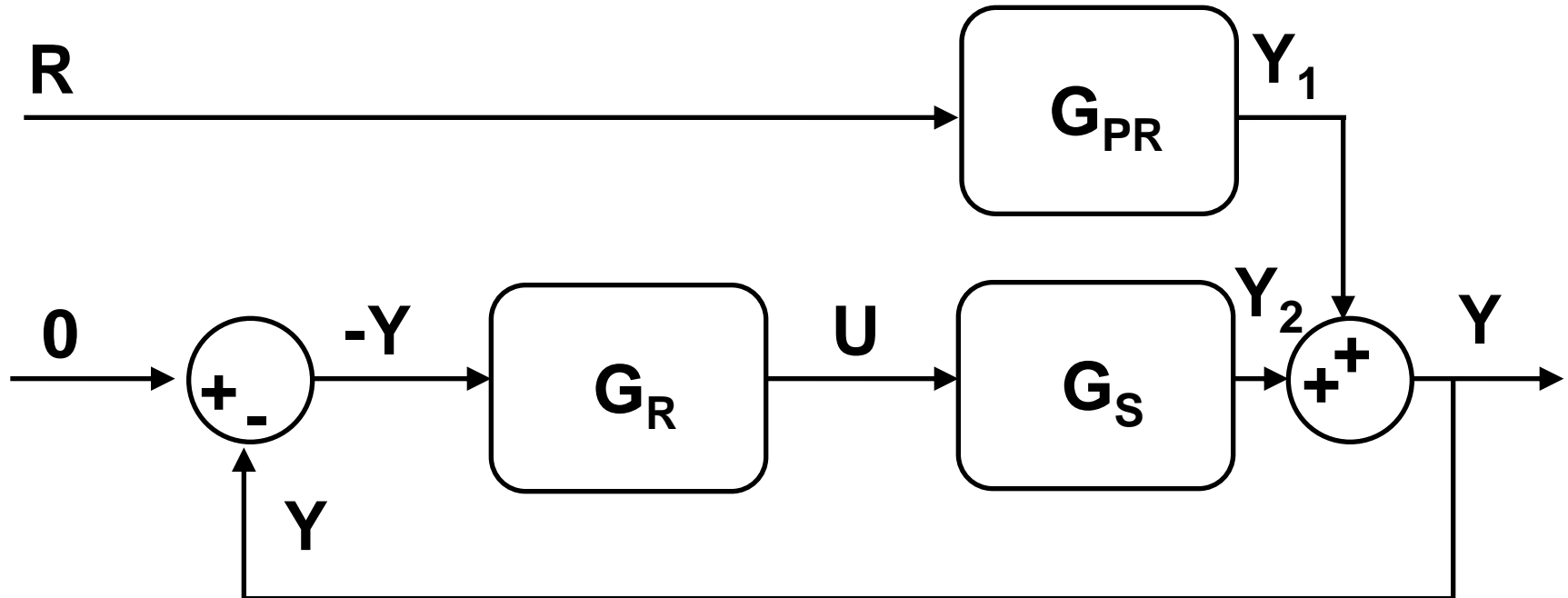
$$Y = G_{PR}R - G_S G_R Y \quad / \quad + G_S G_R Y$$

Prenos URO



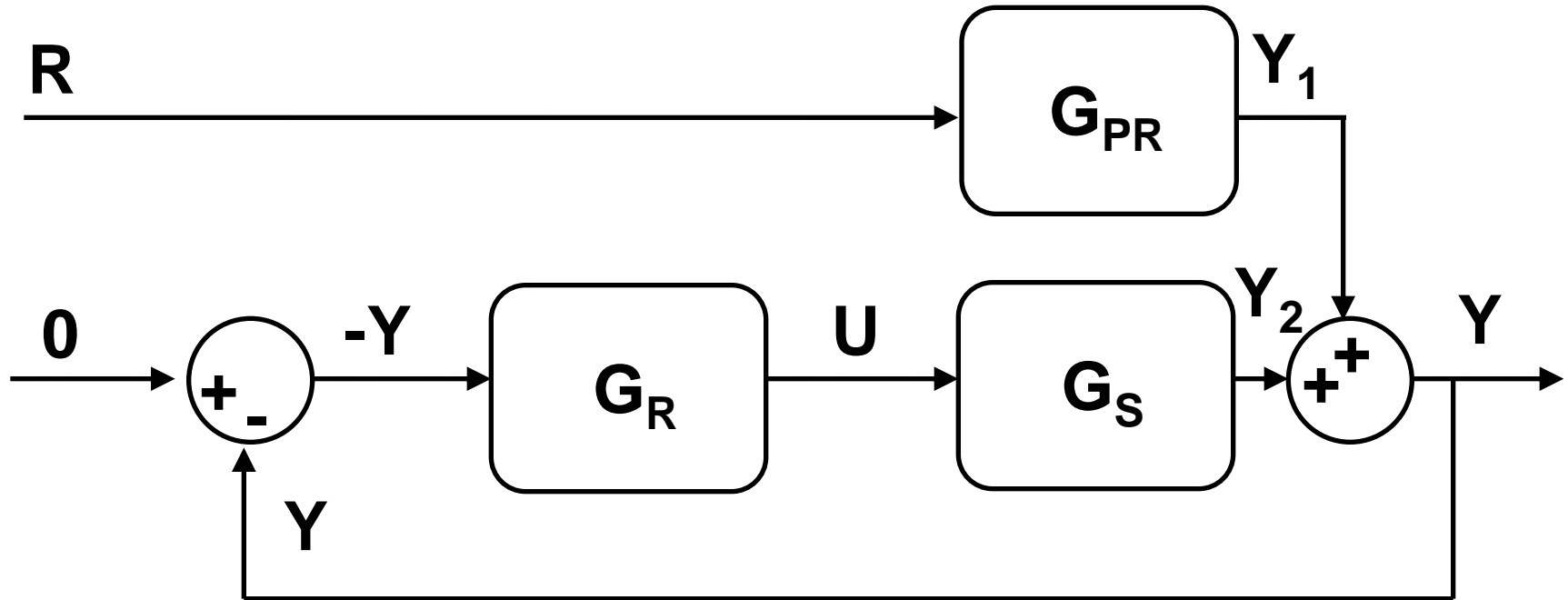
$$Y + G_S G_R Y = G_{PR} R$$

Prenos URO



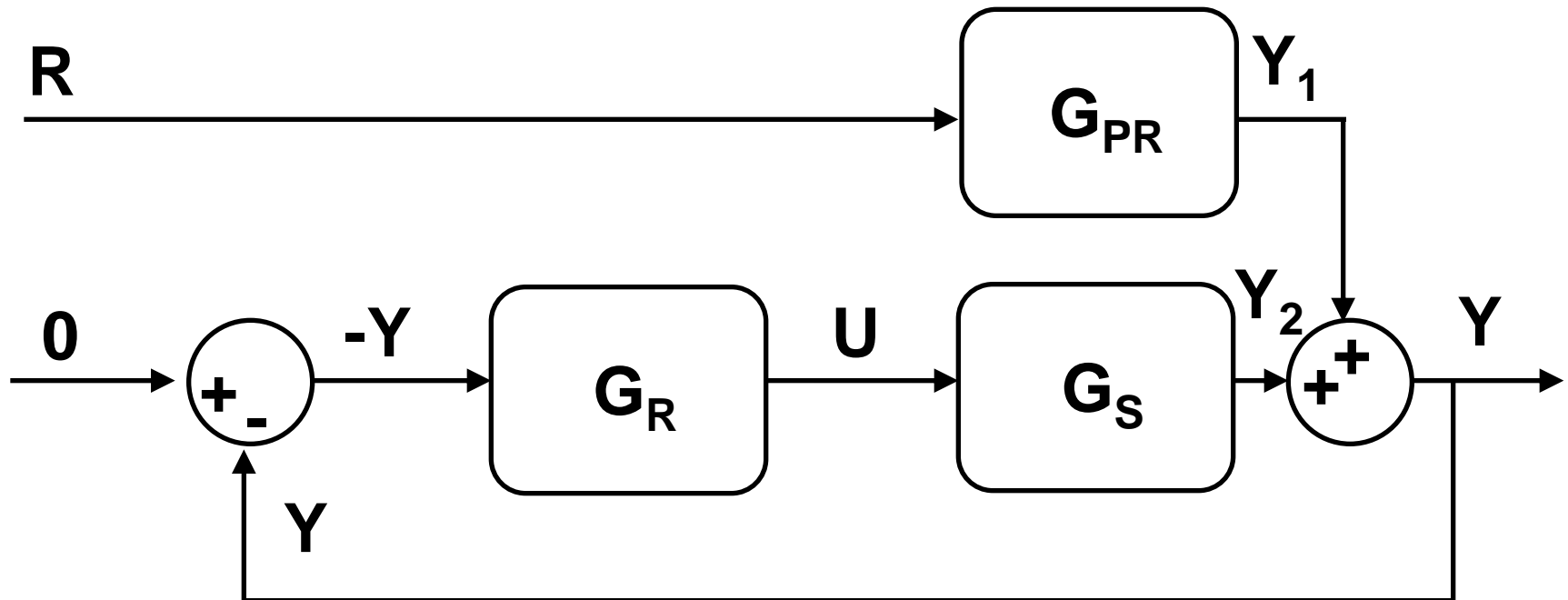
$$Y(1 + G_S G_R) = G_{PR} R$$

Prenos URO



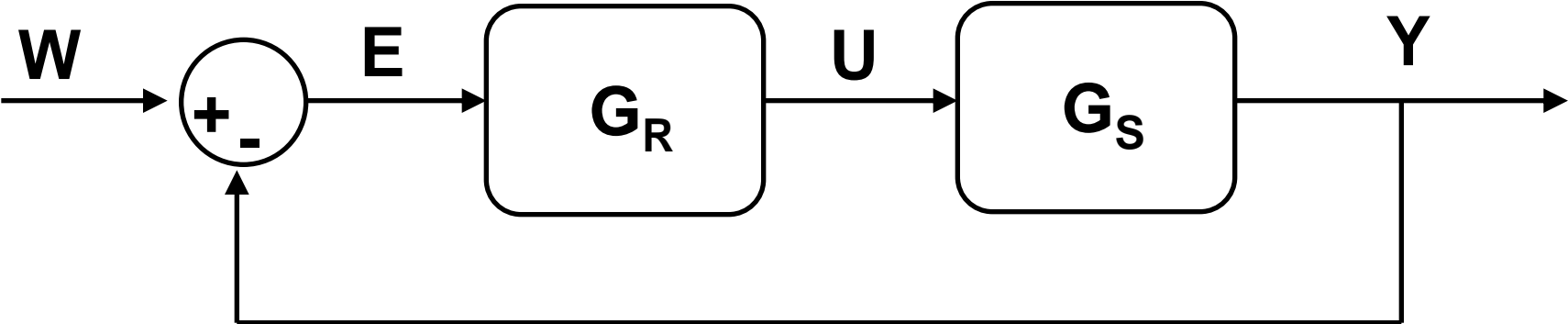
$$Y / R = G_{PR} / (1 + G_S G_R)$$

Prenos URO



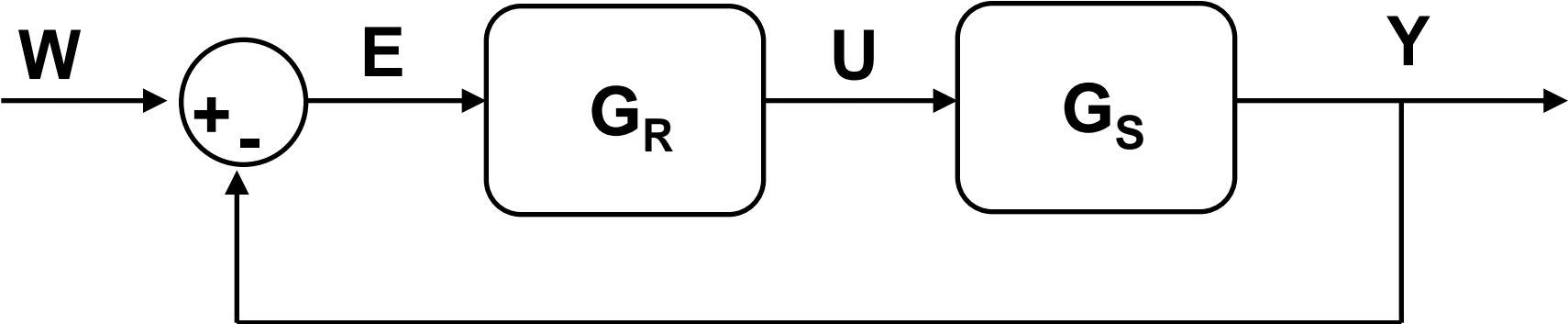
$$G_{YR} = \frac{Y}{R} = \frac{G_{PR}}{1 + G_R G_S}$$

CHR URO



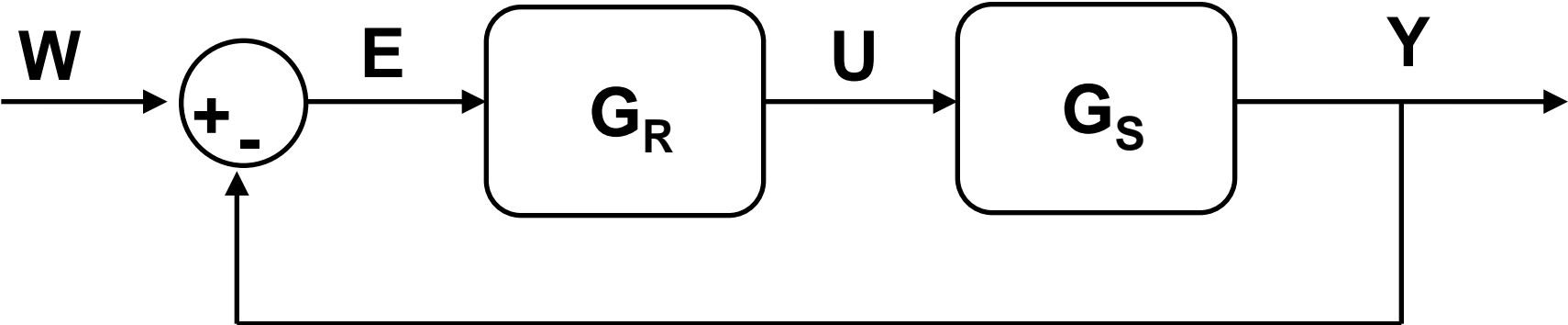
$$G_{URO} = \frac{G_R G_S}{1 + G_R G_S}$$

CHR URO



$$G_{URO} = \frac{G_R G_S}{1 + G_R G_S} \Rightarrow 1 + G_R G_S = 0$$

CHR URO

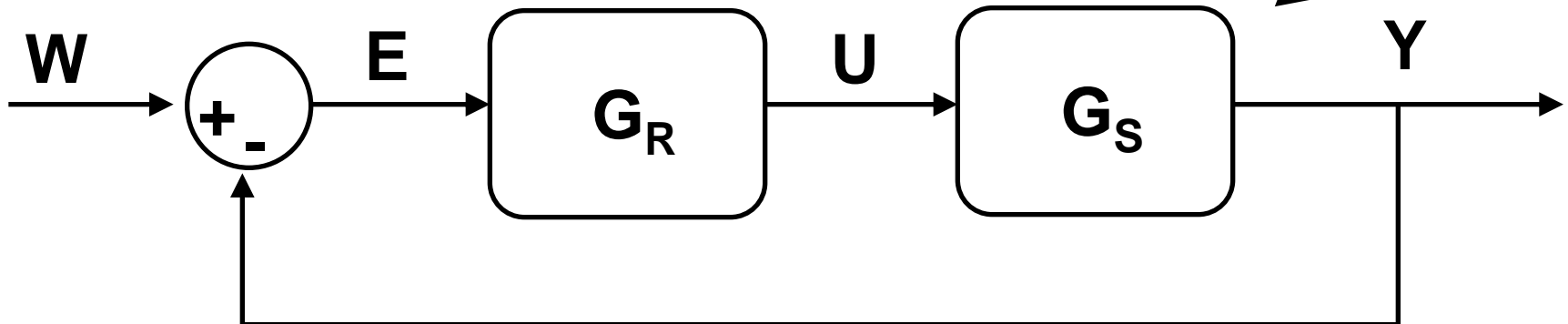


$$G_{URO} = \frac{G_R G_S}{1 + G_R G_S} \Rightarrow 1 + G_R G_S = 0$$

CHR URO

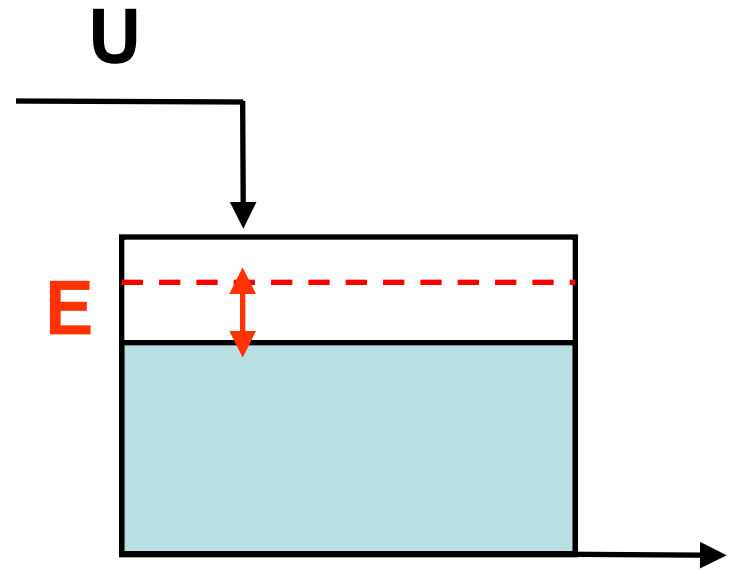
CHR URO

URO je stabilný, ak všetky korene CHR URO majú zápornú reálnu časť

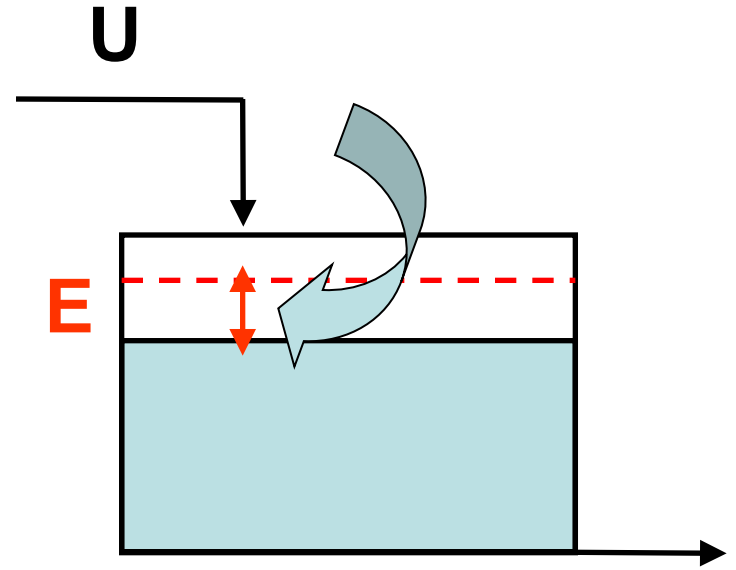


$$G_{URO} = \frac{G_R G_S}{1 + G_R G_S} \Rightarrow 1 + G_R G_S = 0$$

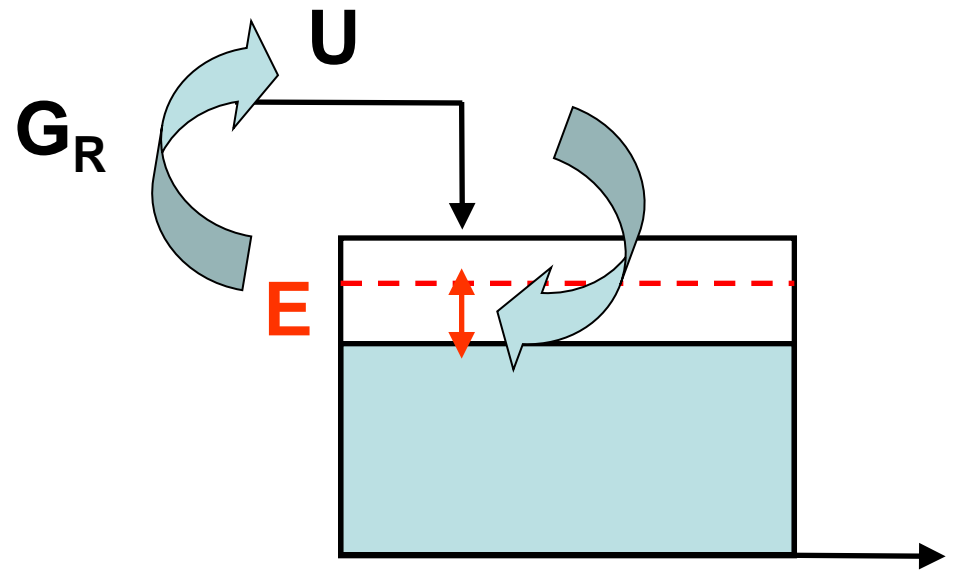
Zákon riadenia



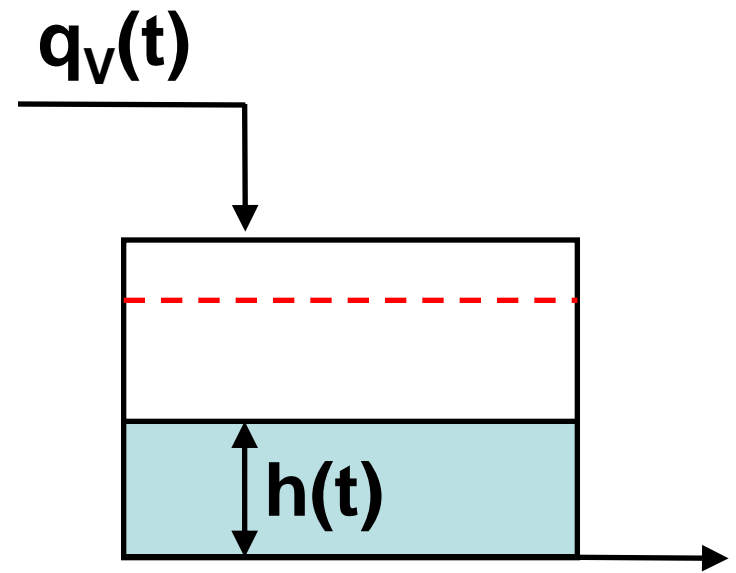
Zákon riadenia



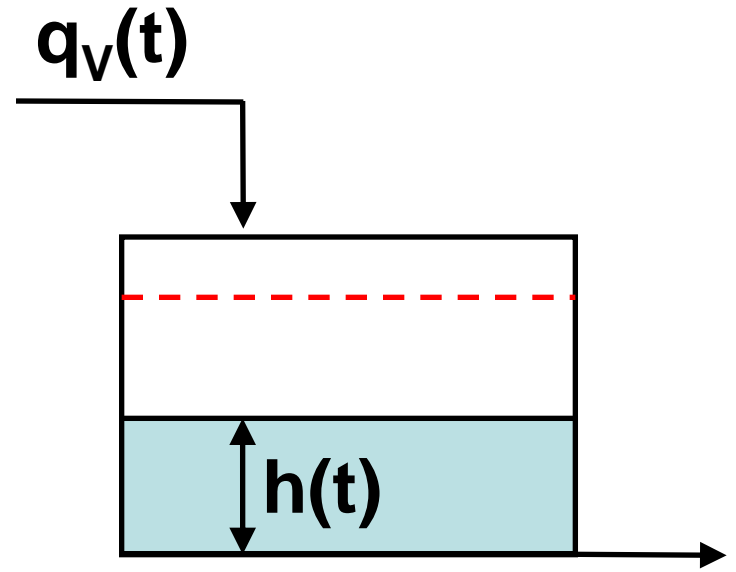
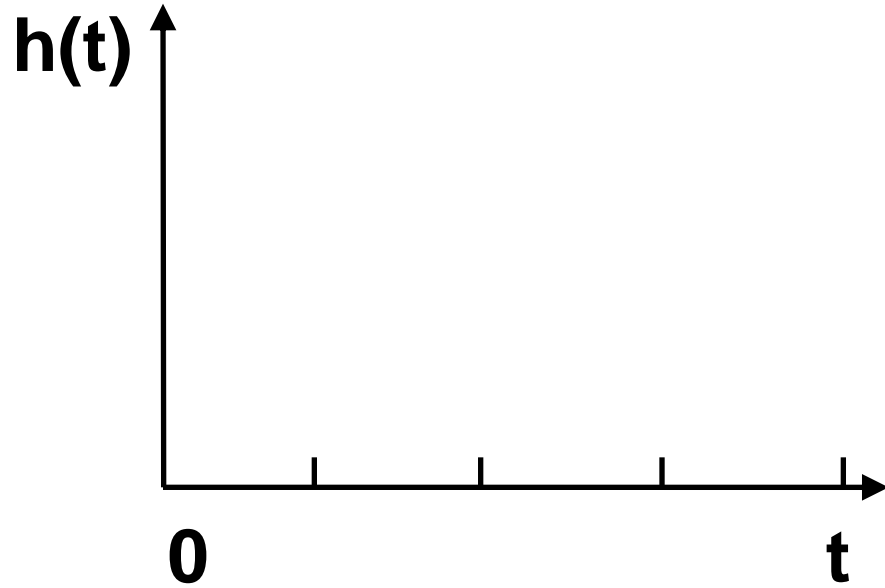
Zákon riadenia



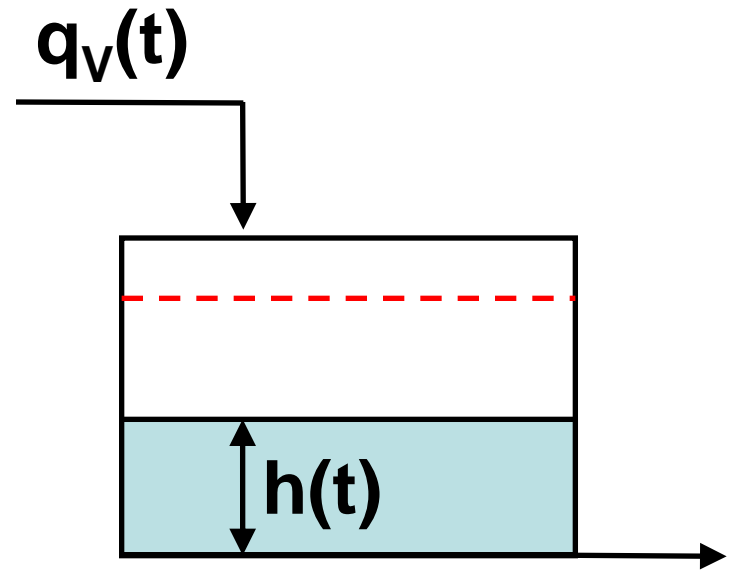
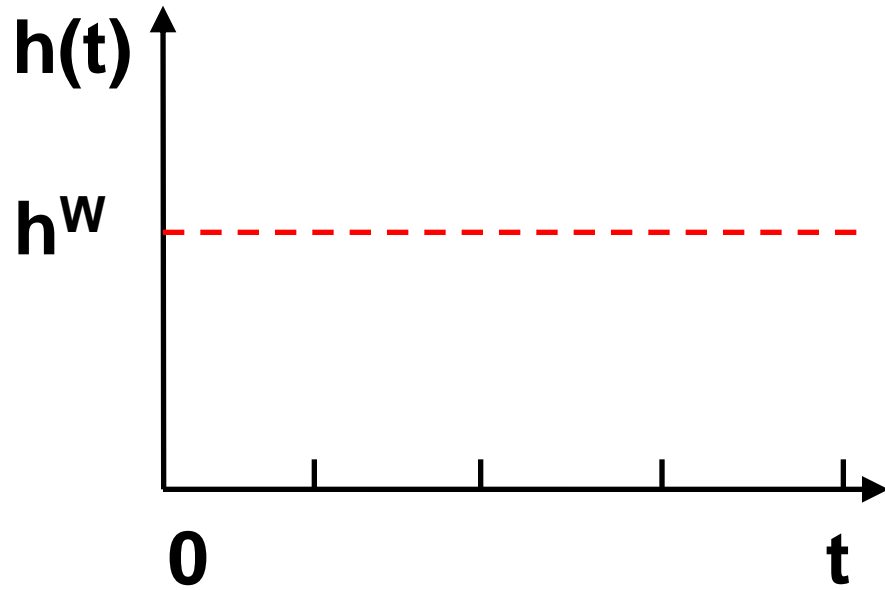
Zákon riadenia



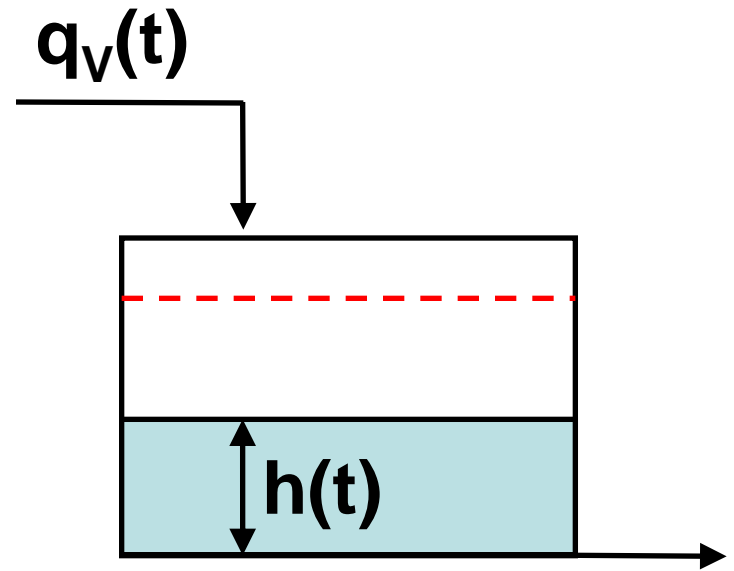
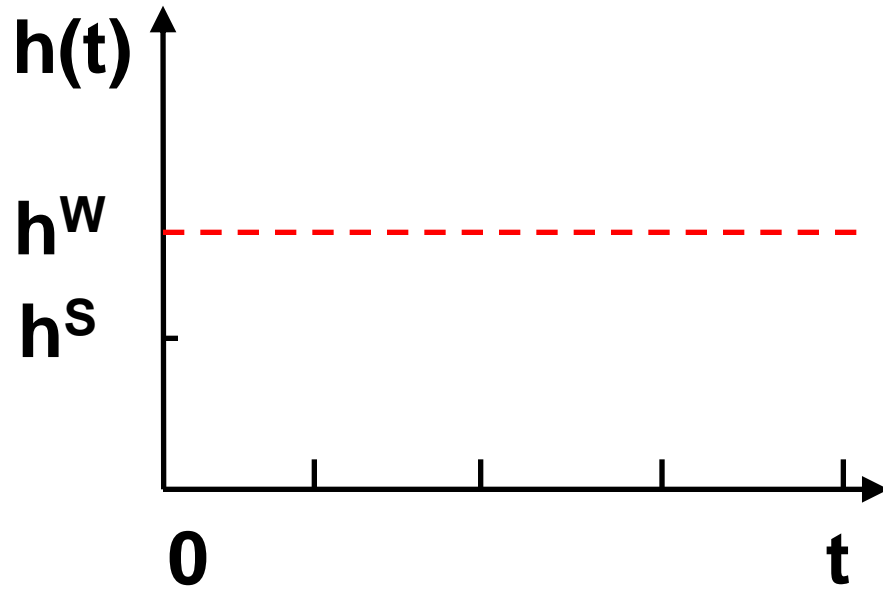
Zákon riadenia



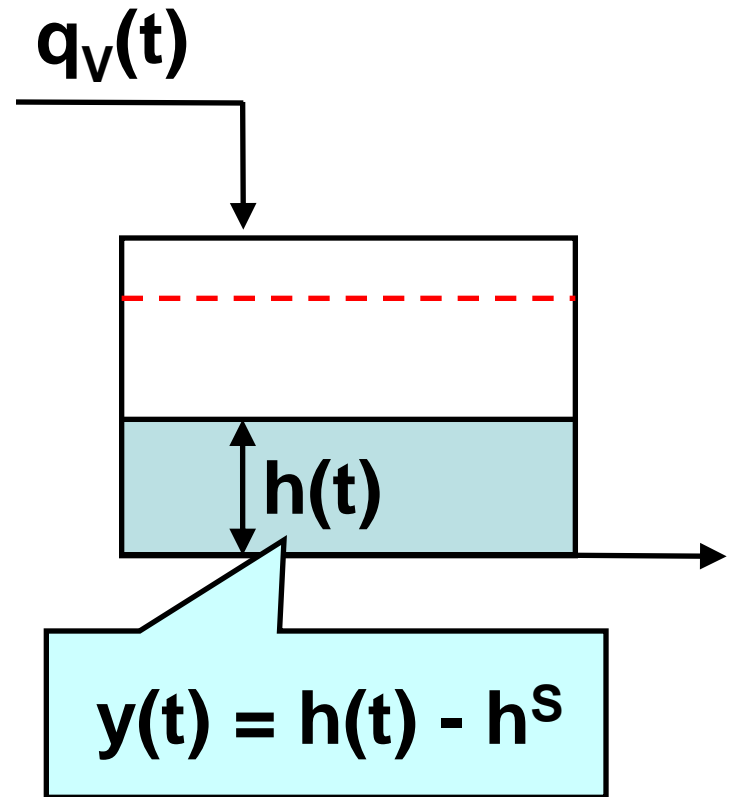
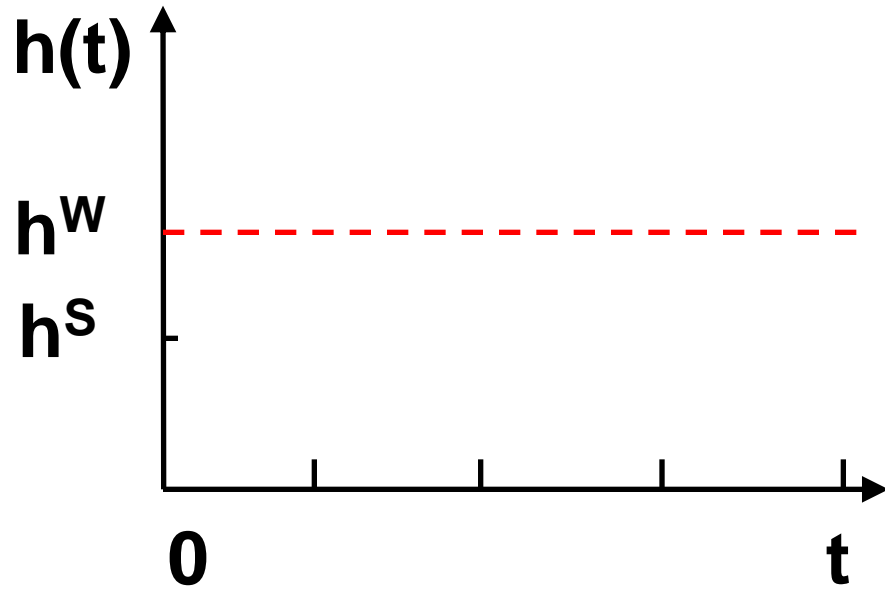
Zákon riadenia



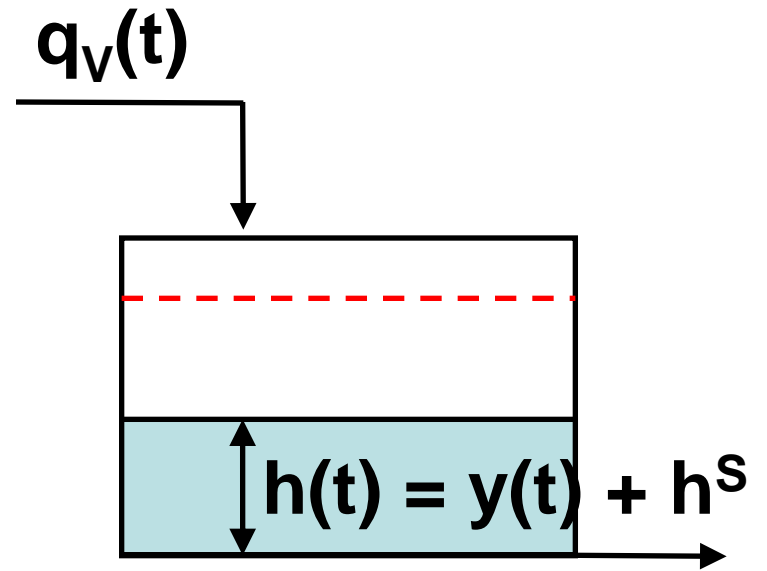
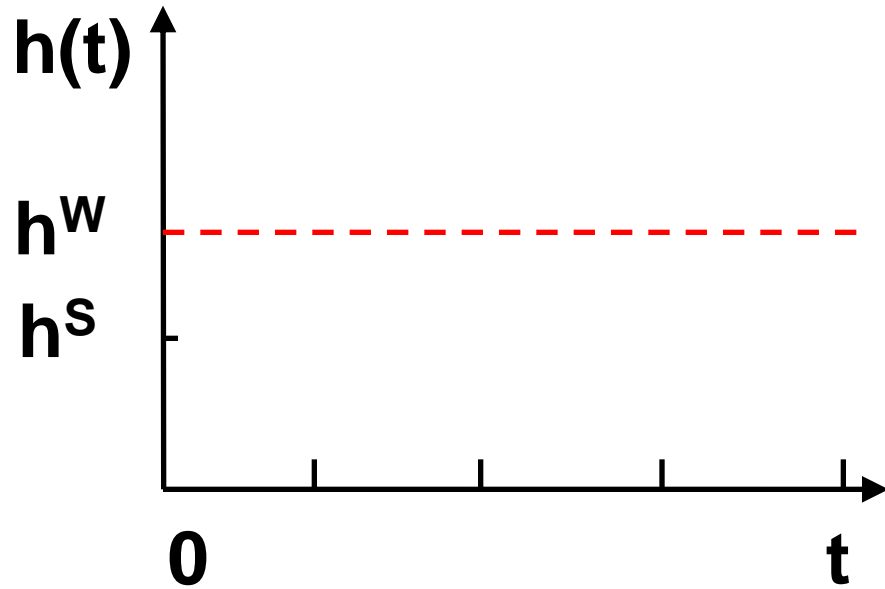
Zákon riadenia



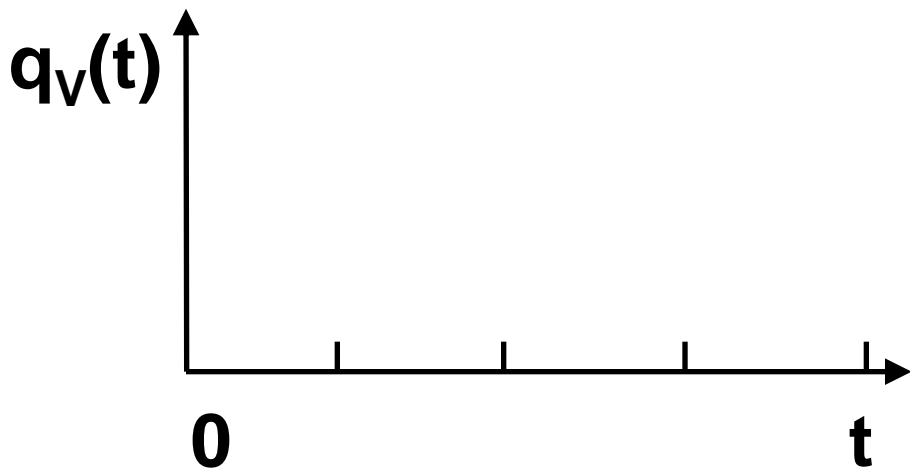
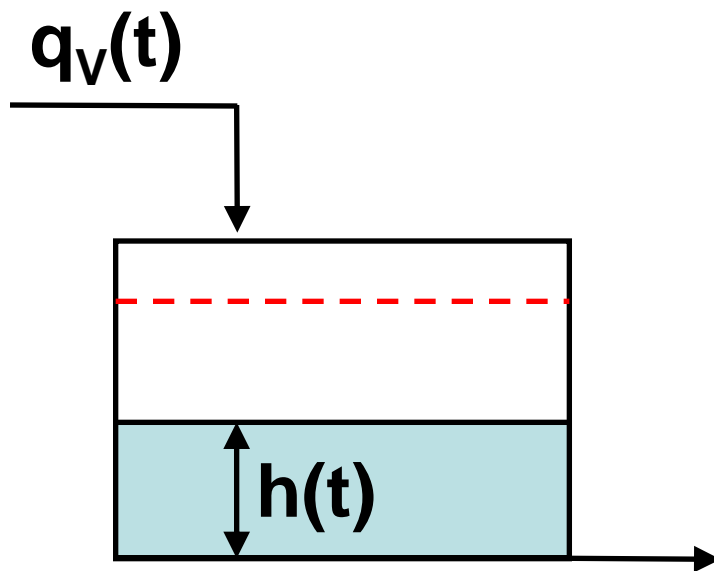
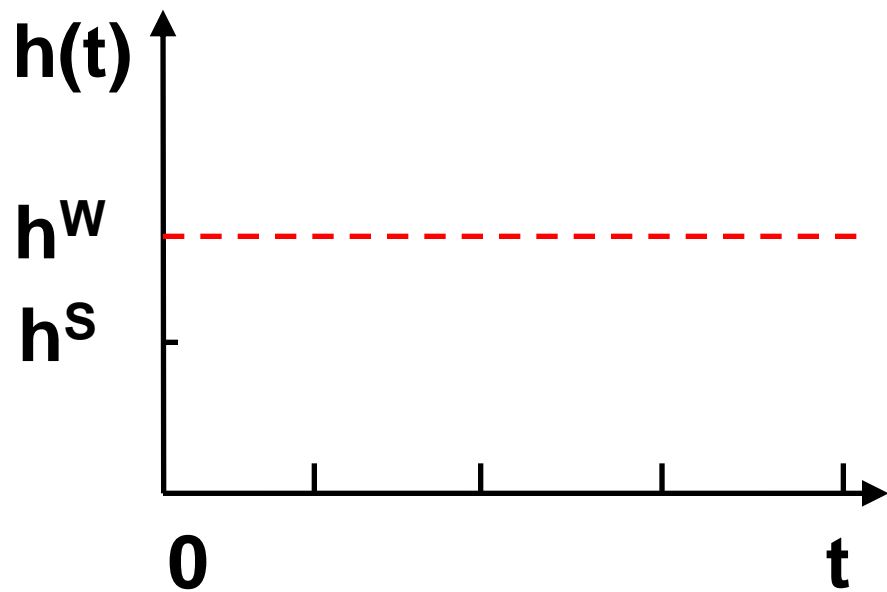
Zákon riadenia



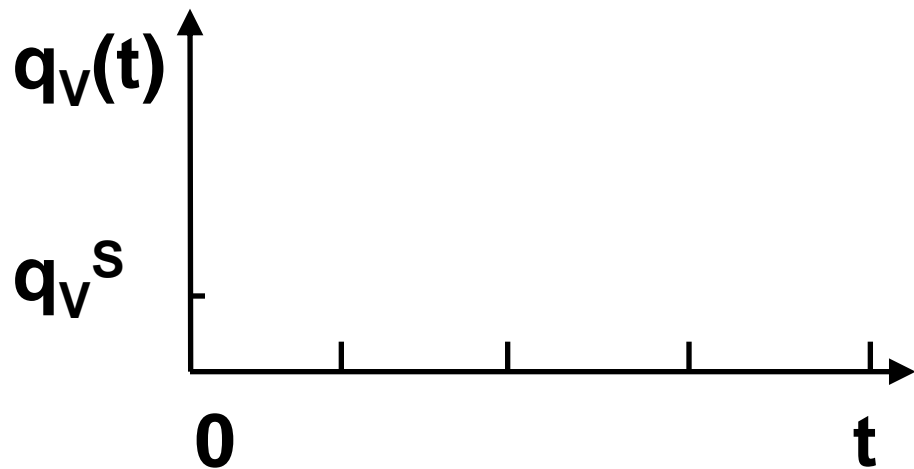
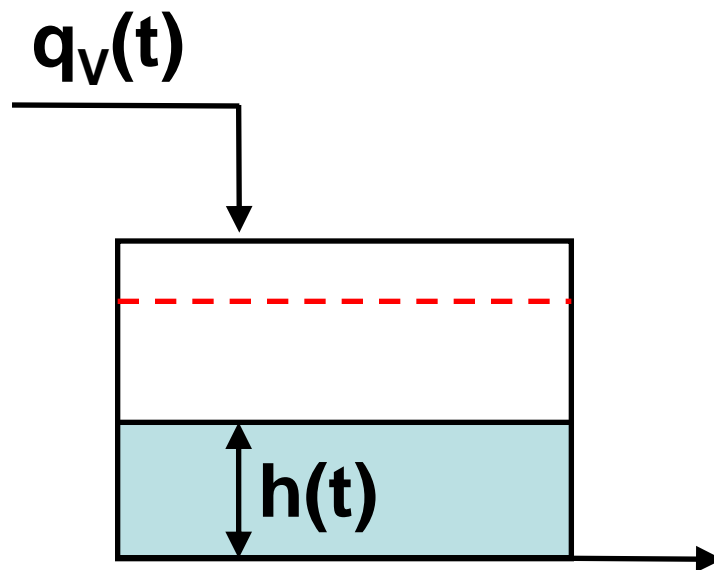
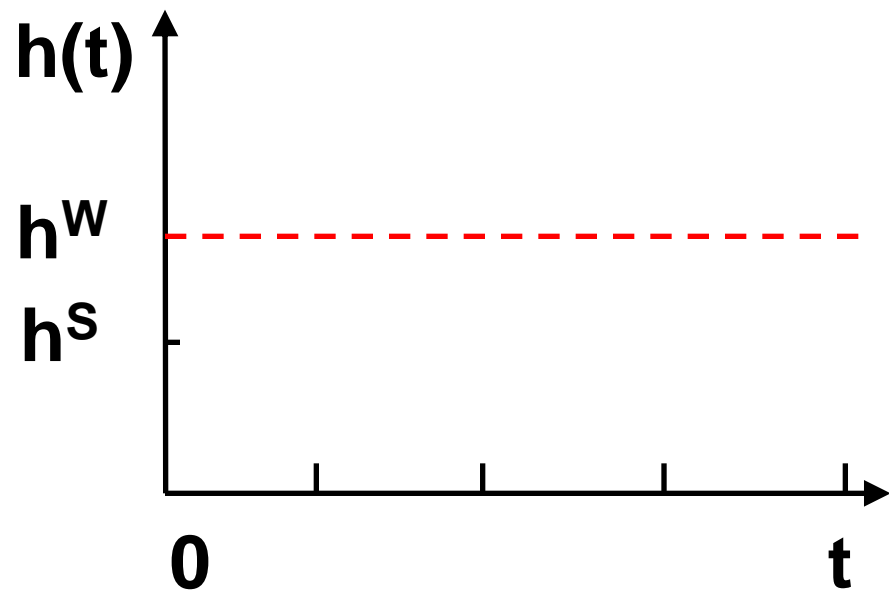
Zákon riadenia



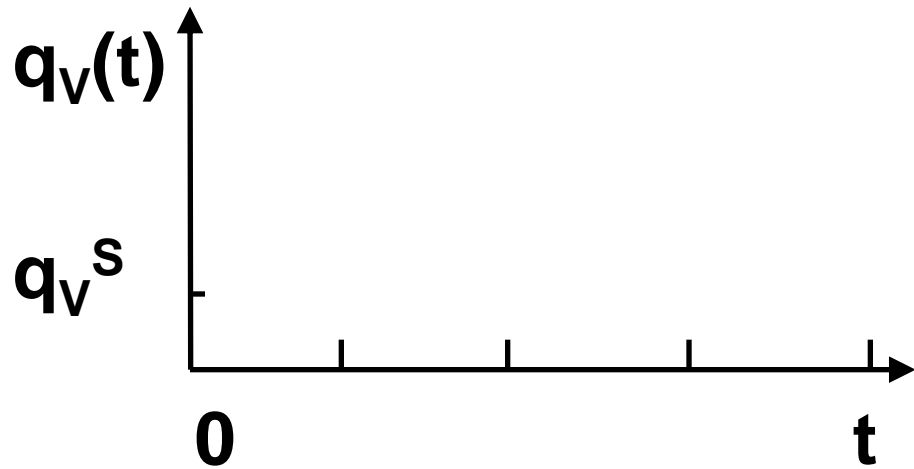
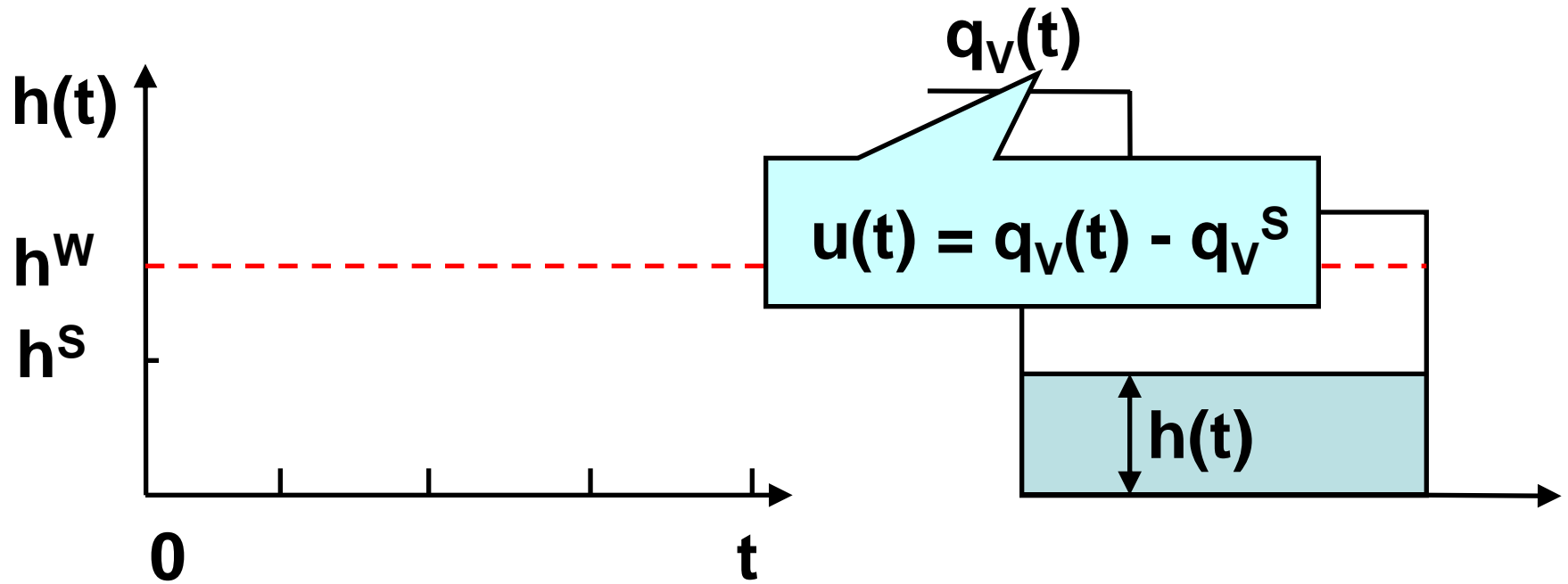
Zákon riadenia



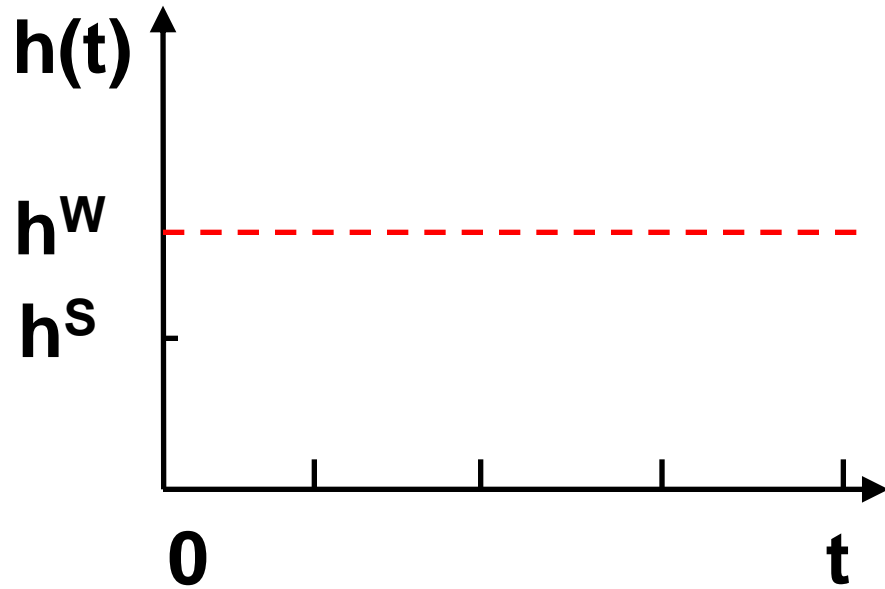
Zákon riadenia



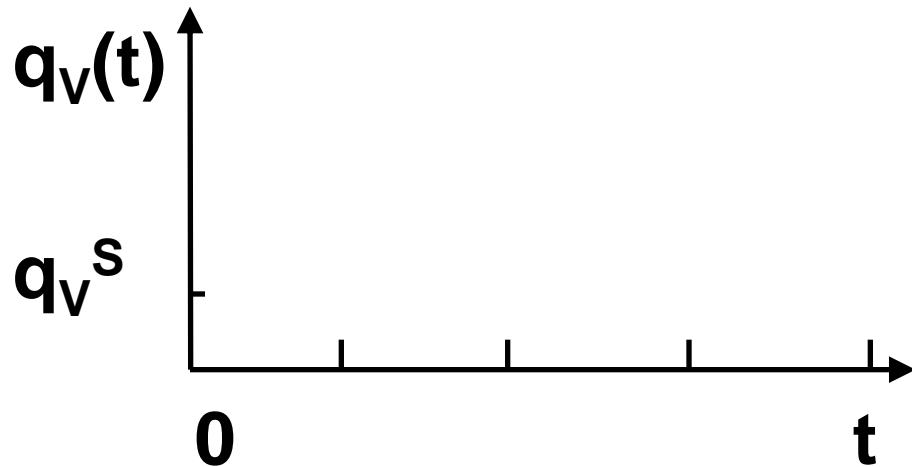
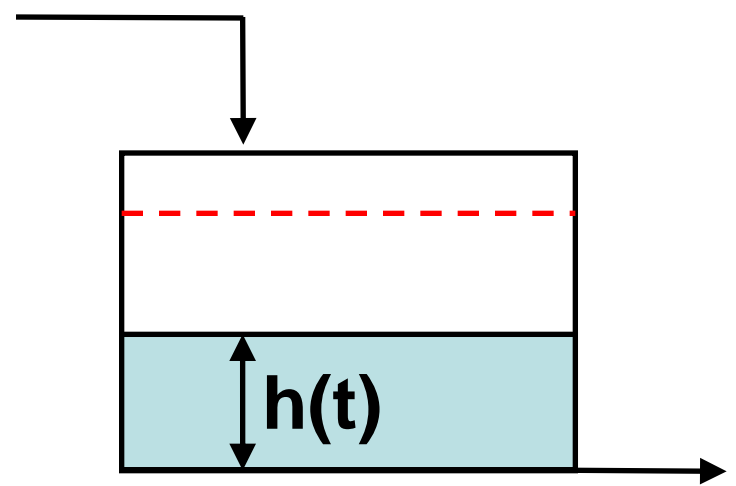
Zákon riadenia



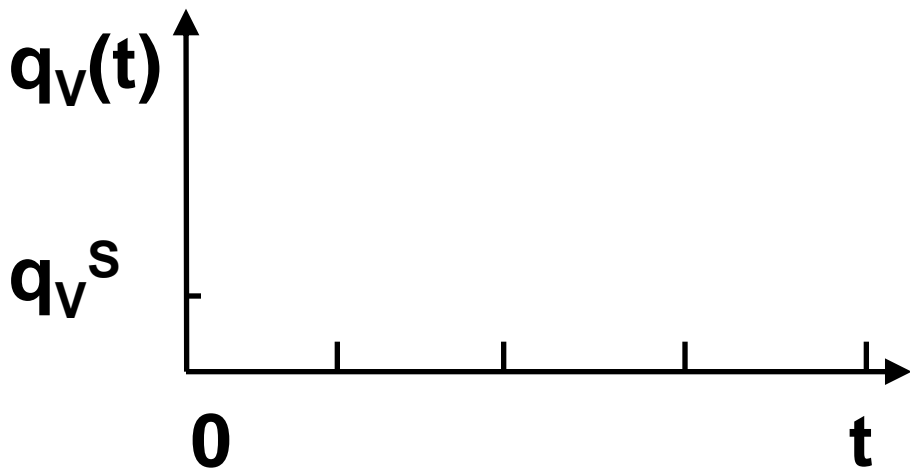
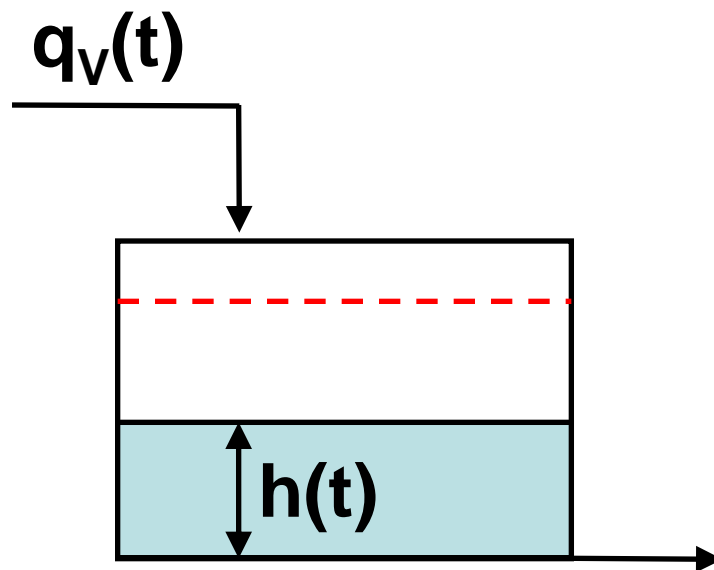
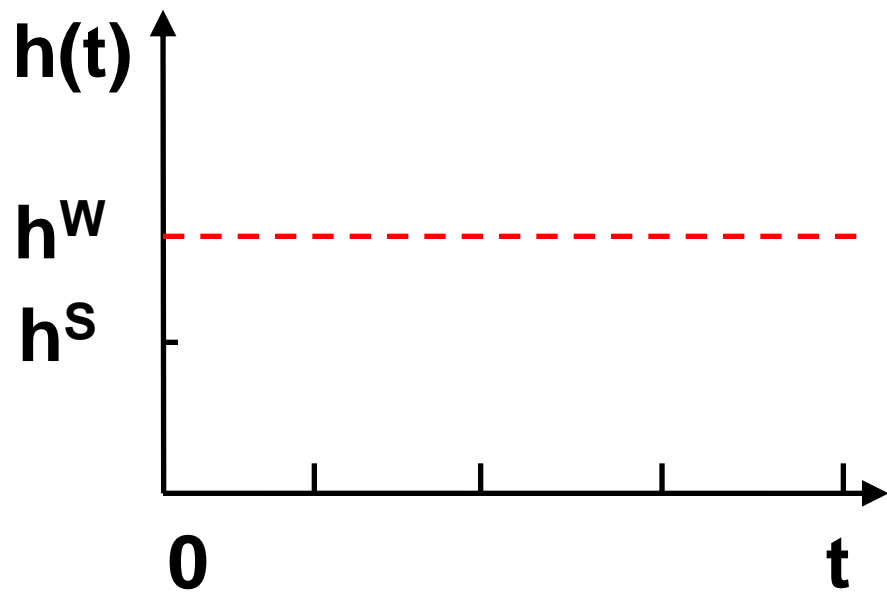
Zákon riadenia



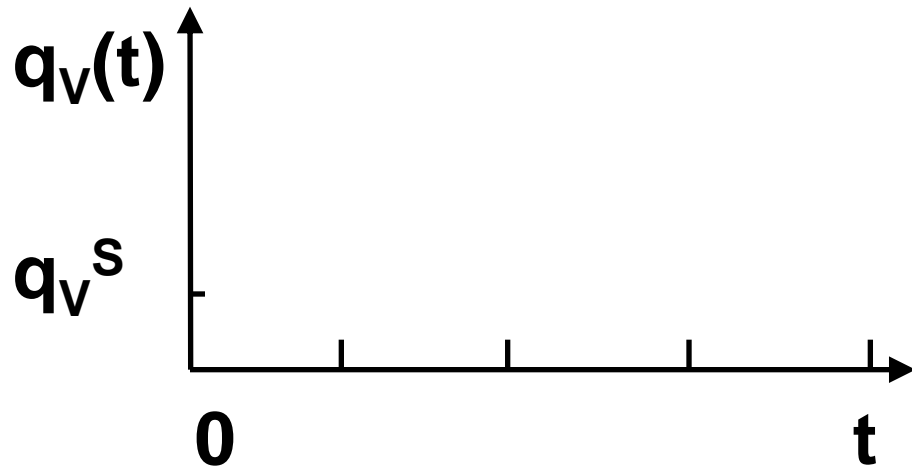
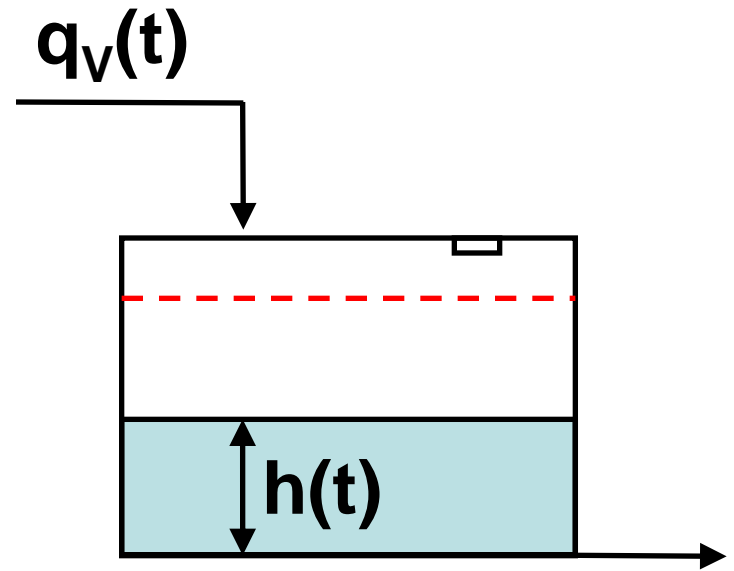
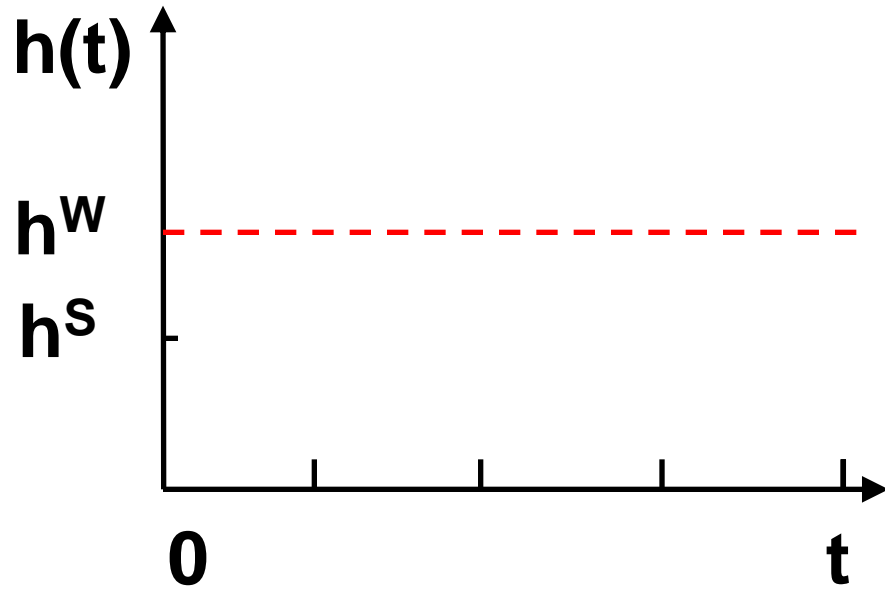
$$q_v(t) = q_v^S + u(t)$$



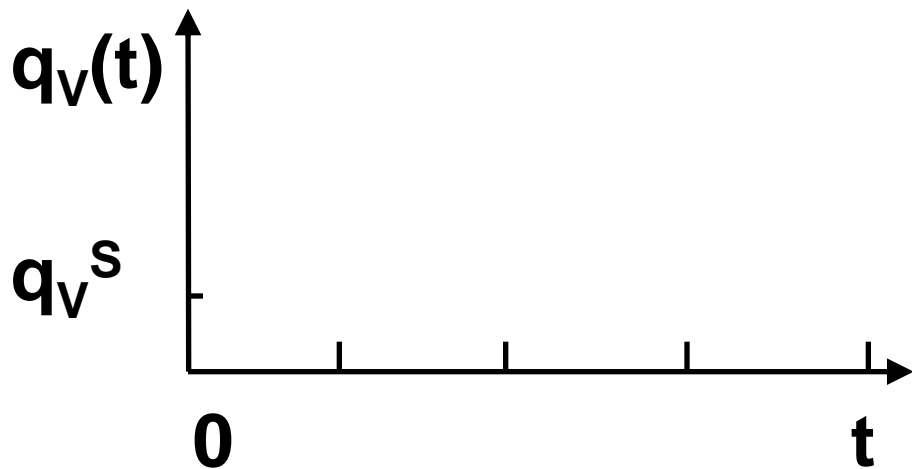
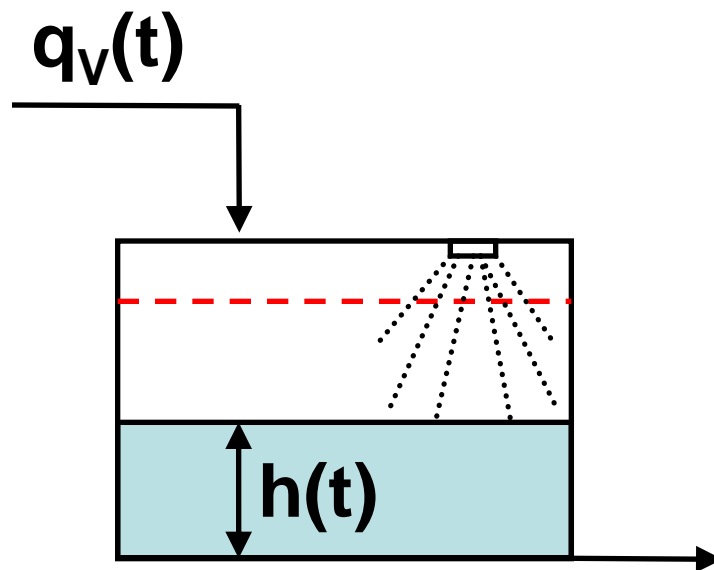
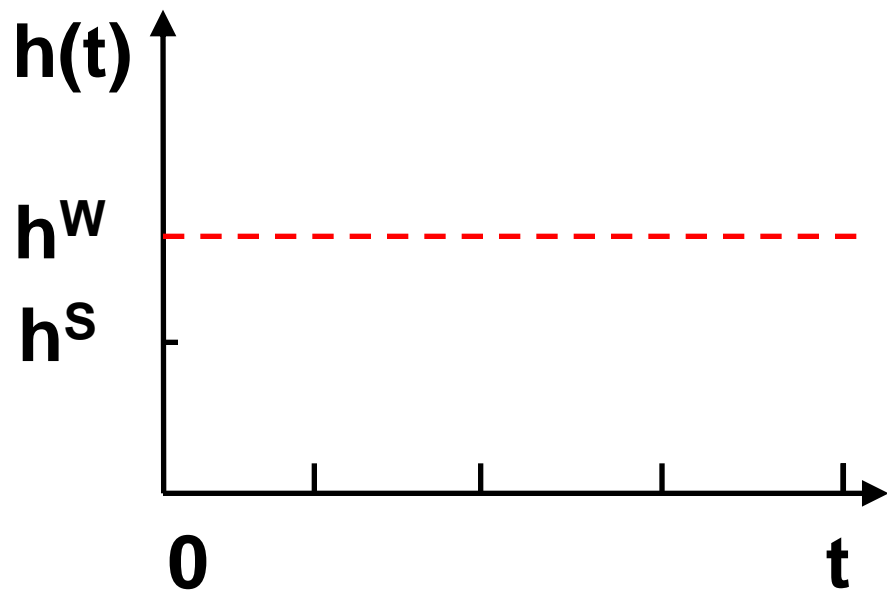
Zákon riadenia



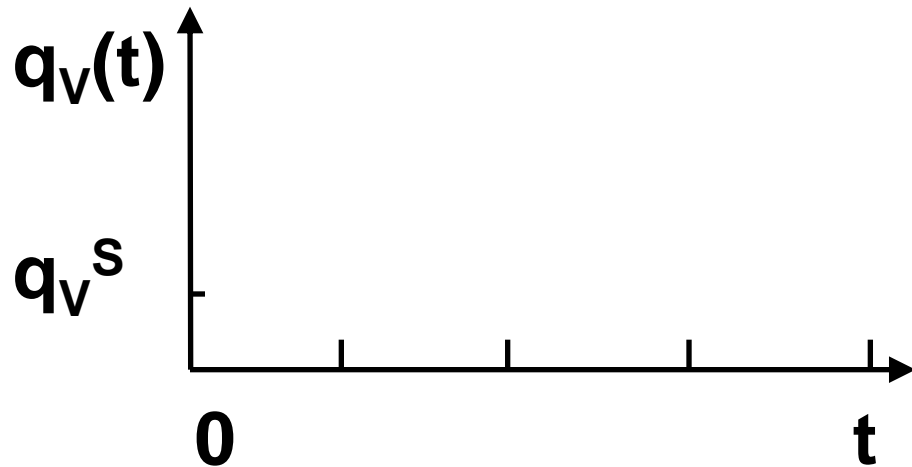
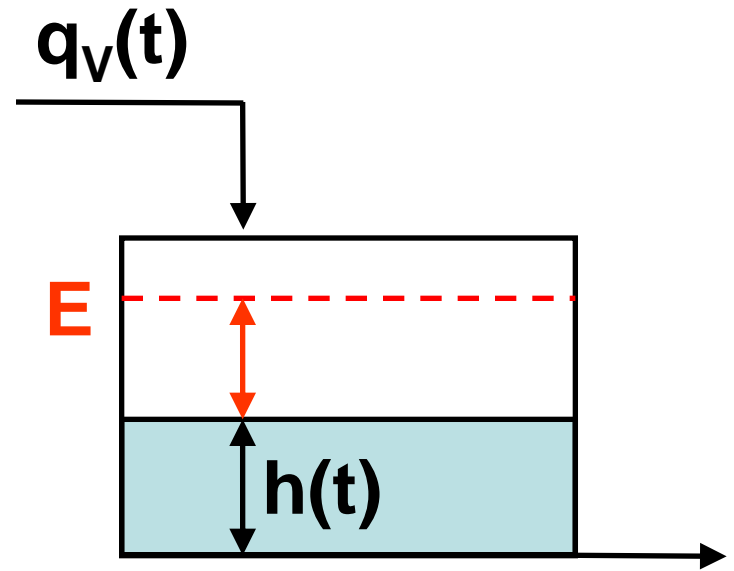
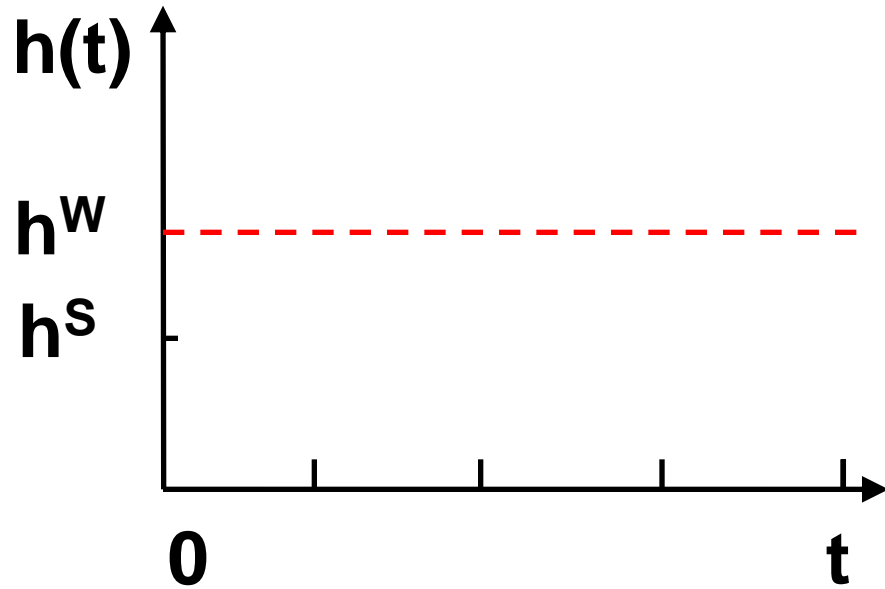
Zákon riadenia



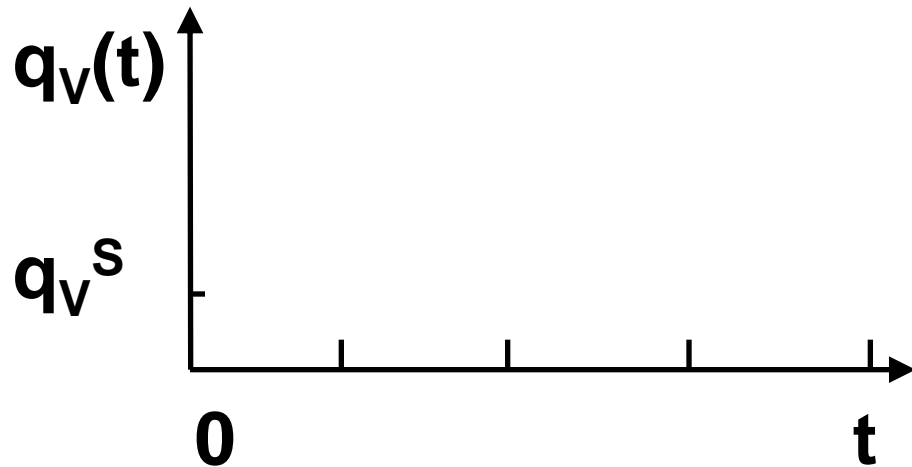
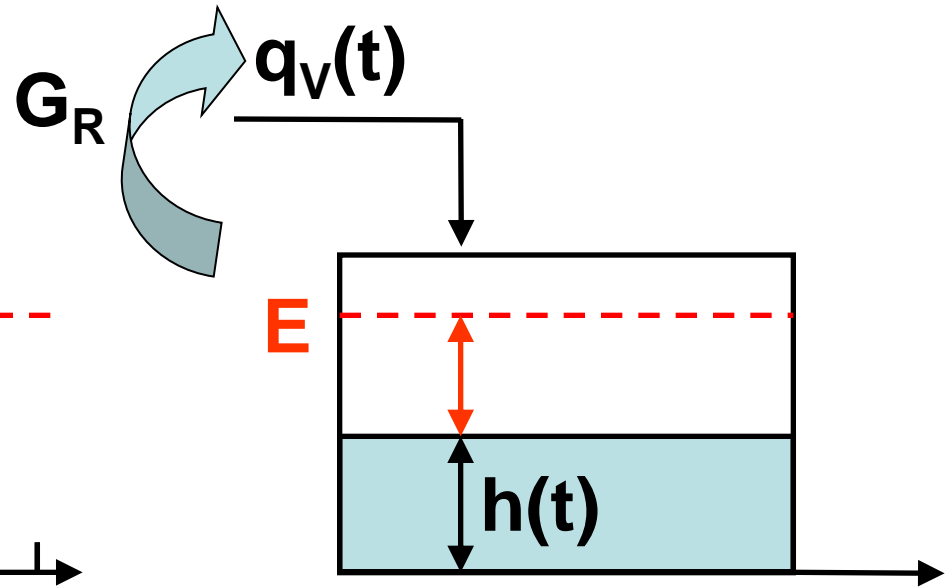
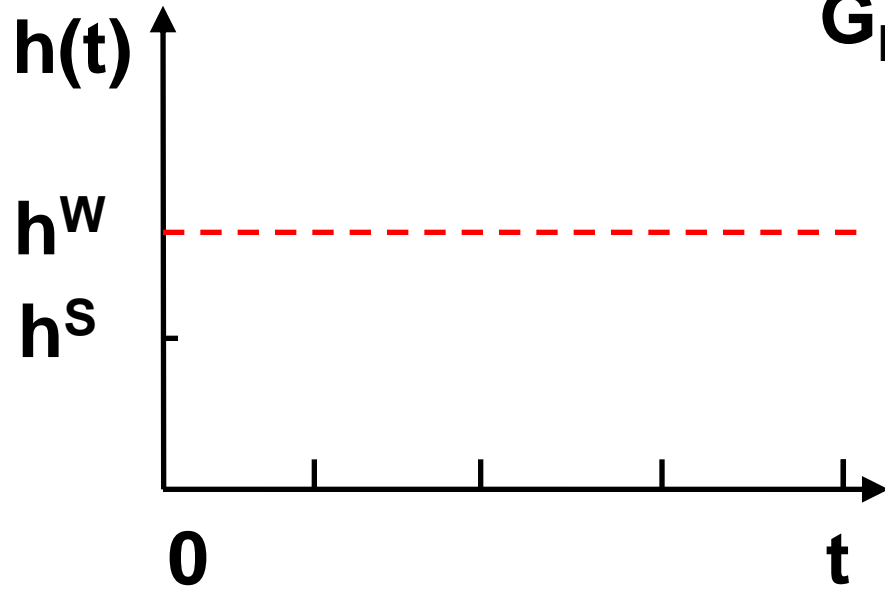
Zákon riadenia



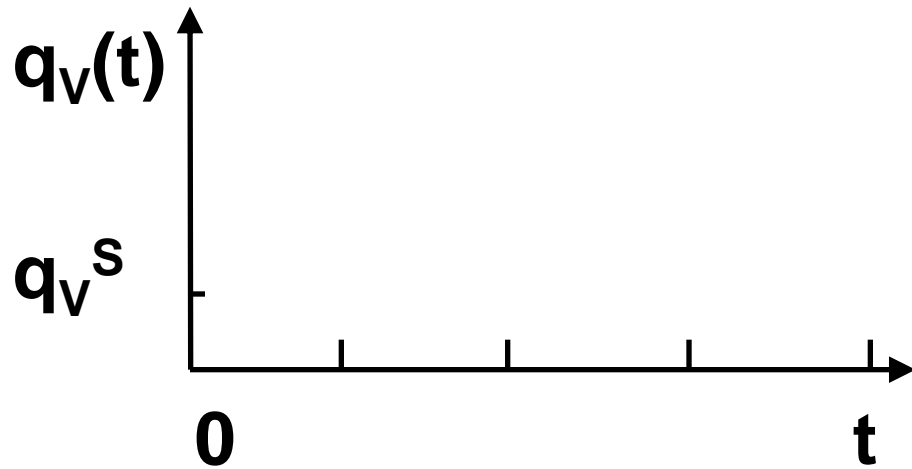
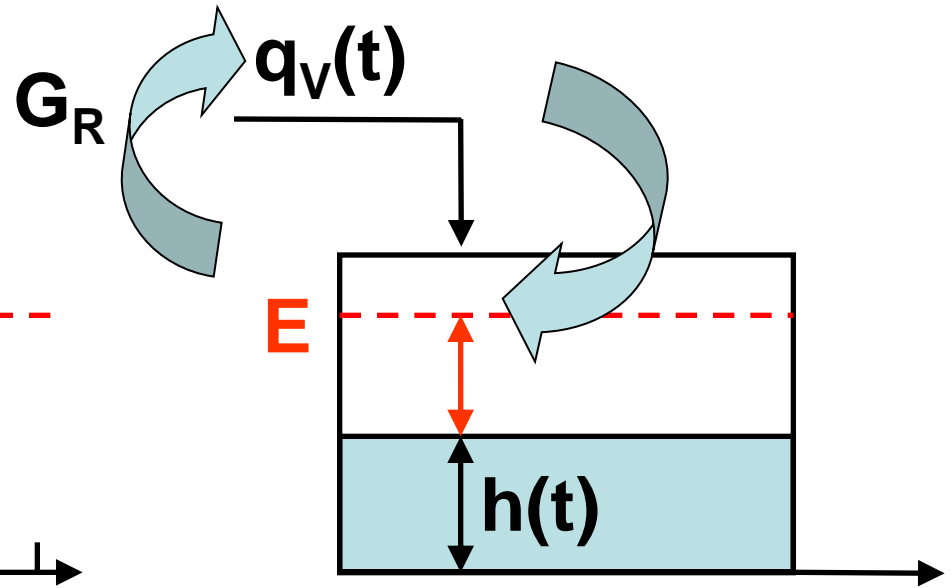
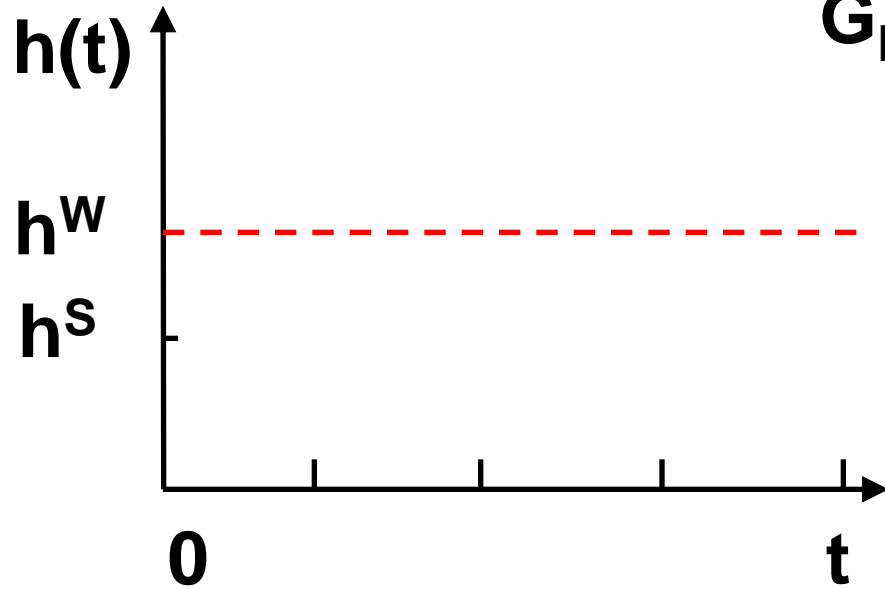
Zákon riadenia



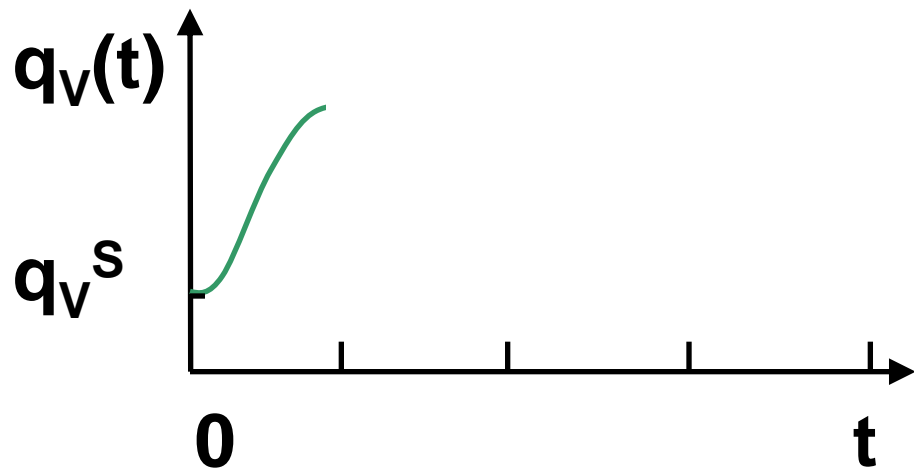
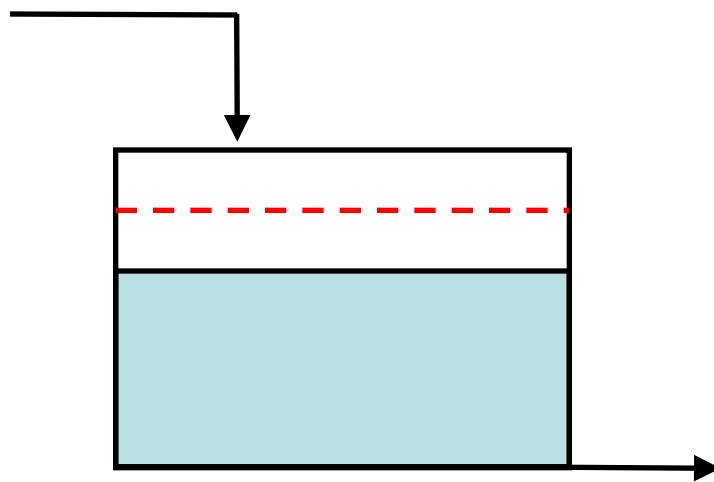
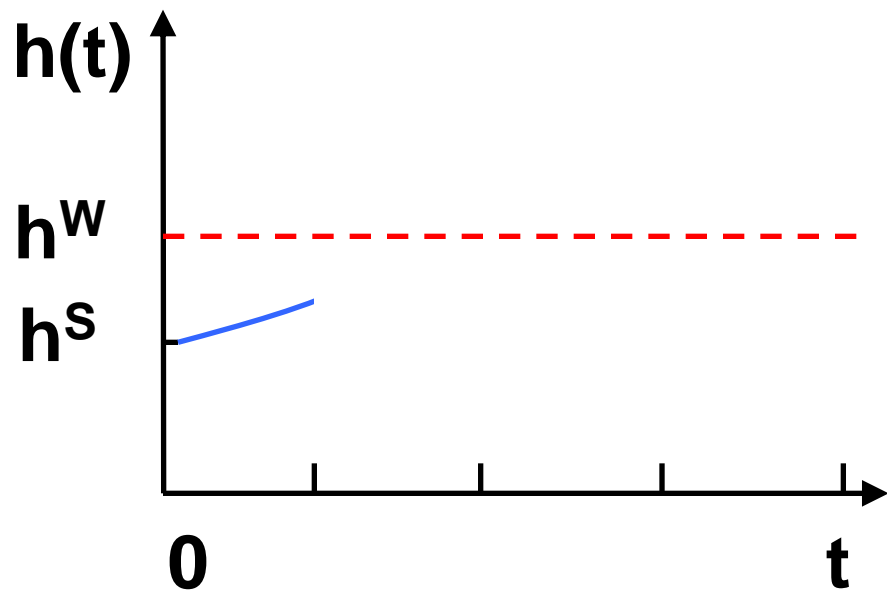
Zákon riadenia



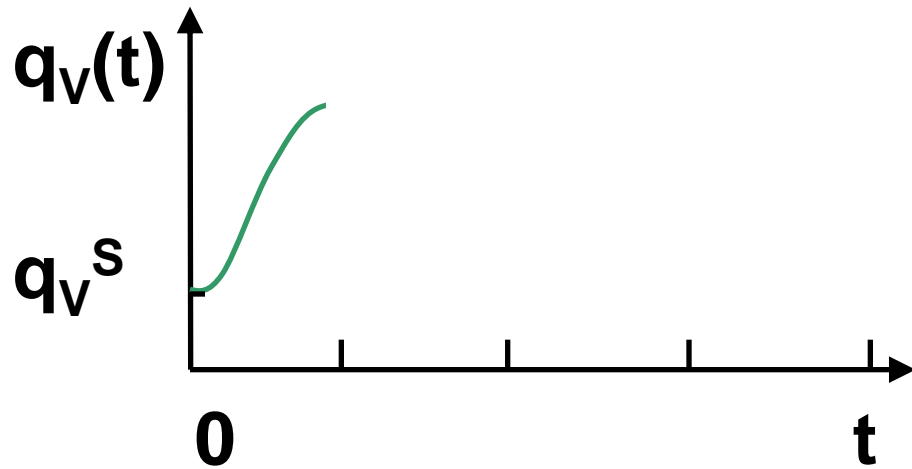
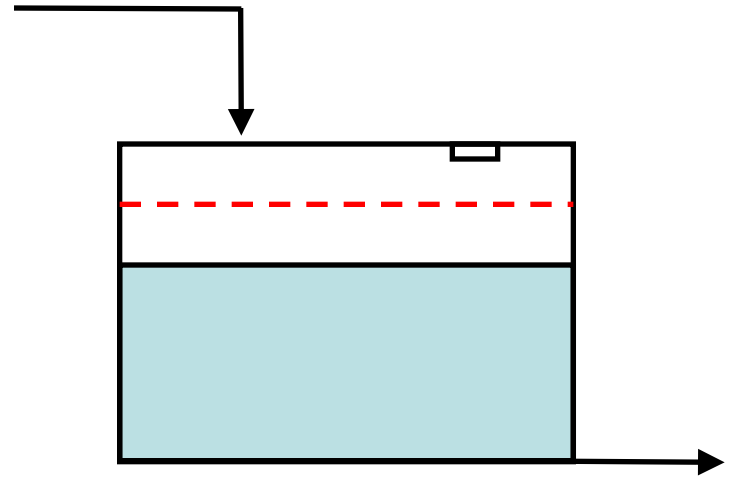
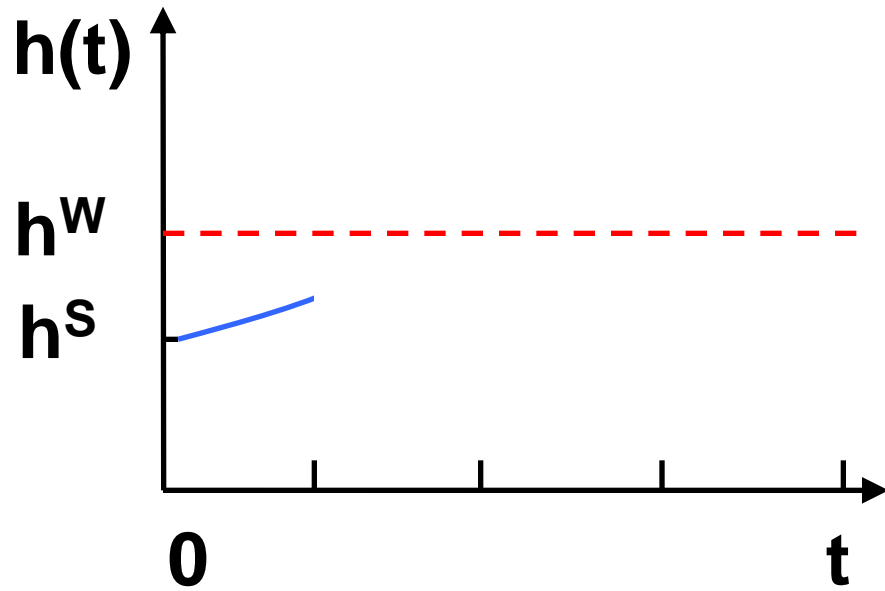
Zákon riadenia



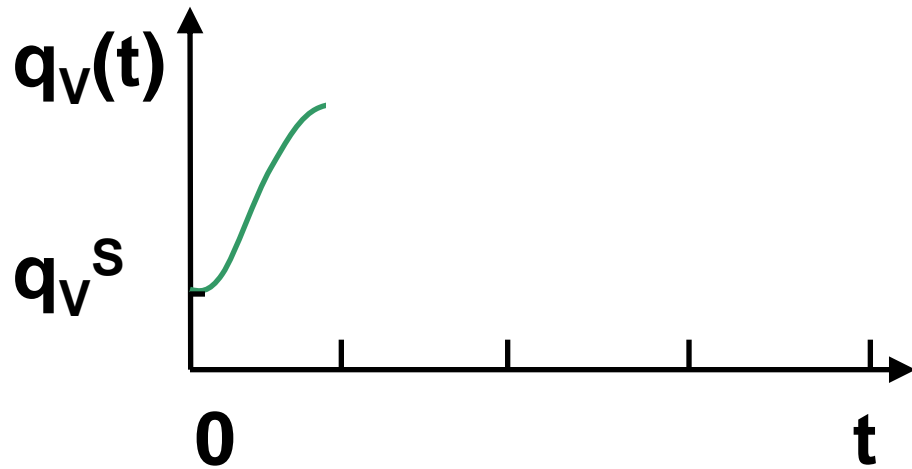
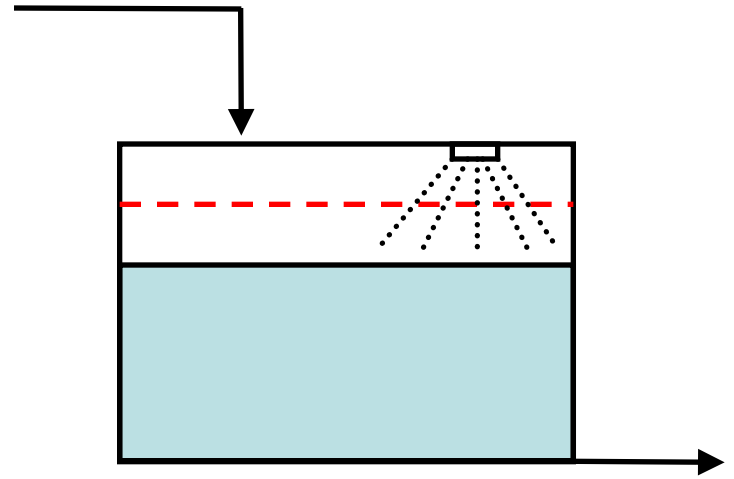
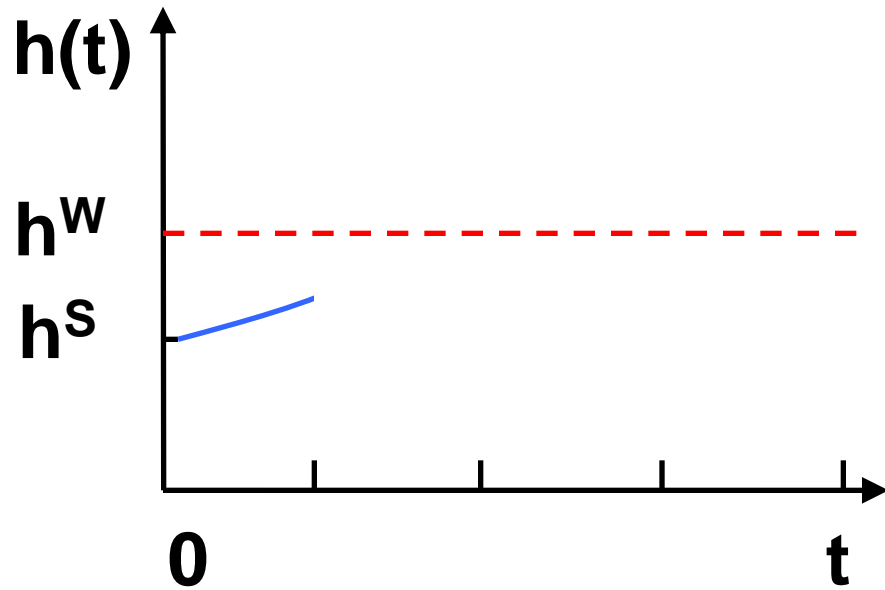
Zákon riadenia



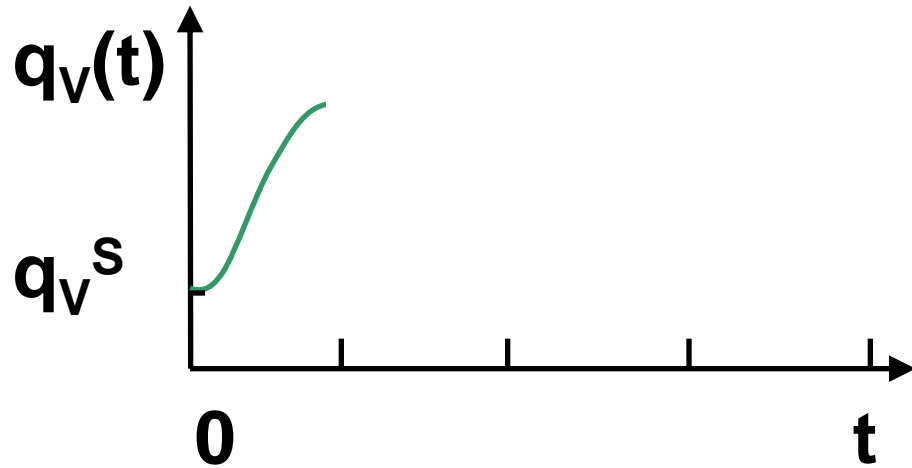
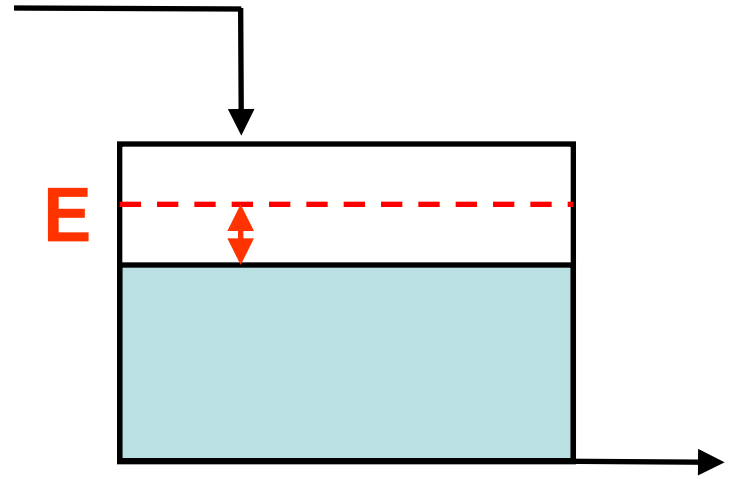
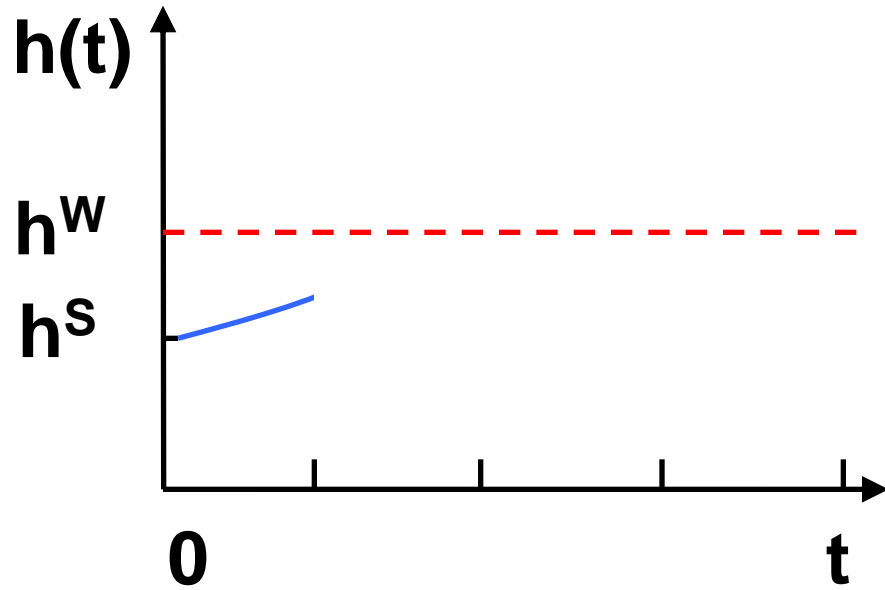
Zákon riadenia



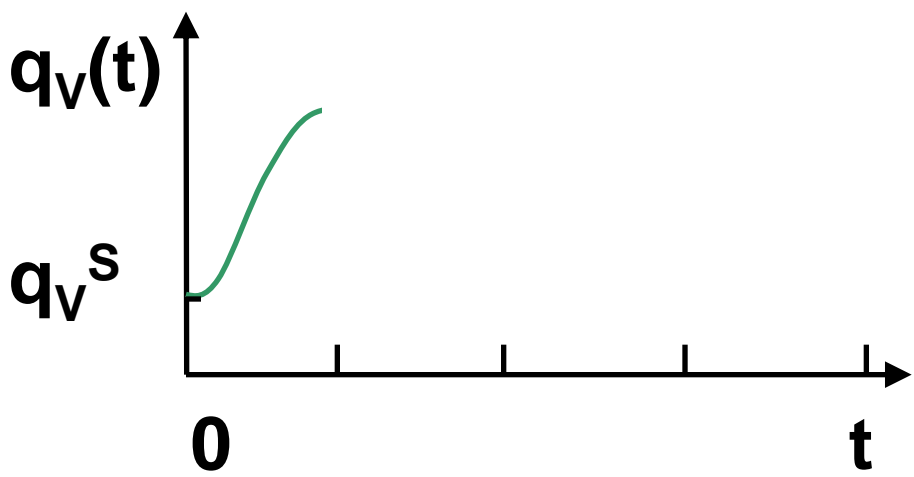
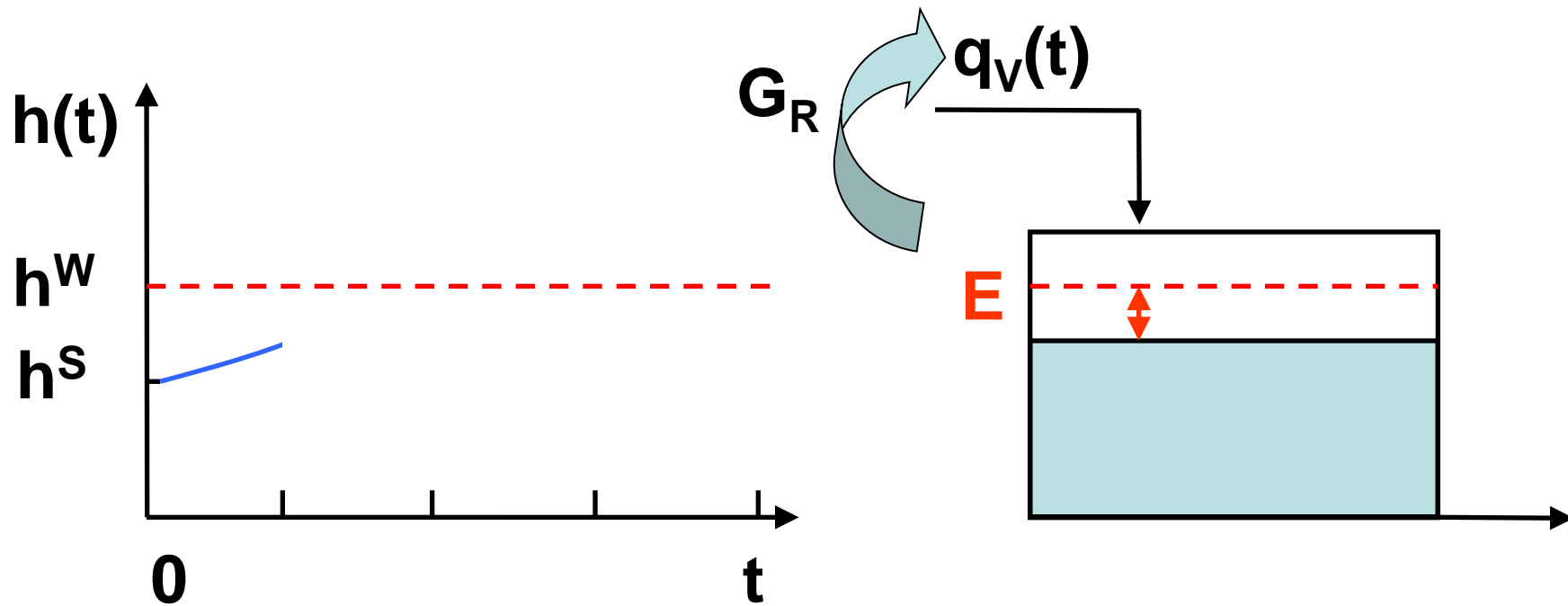
Zákon riadenia



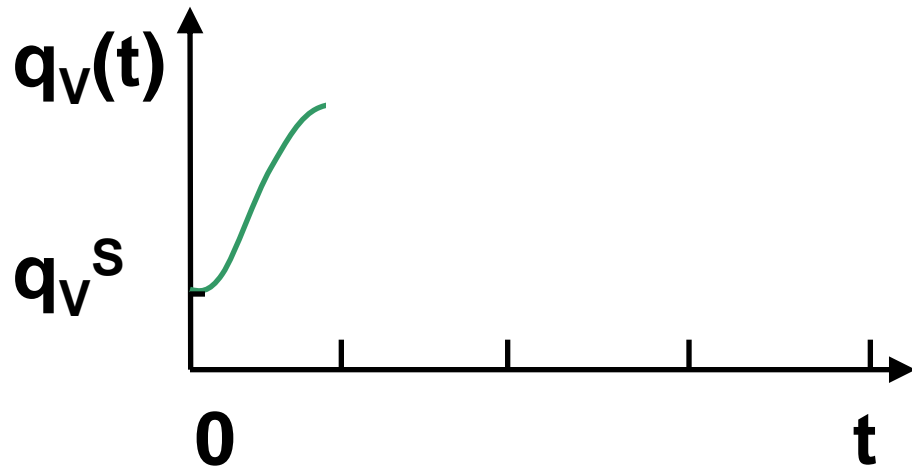
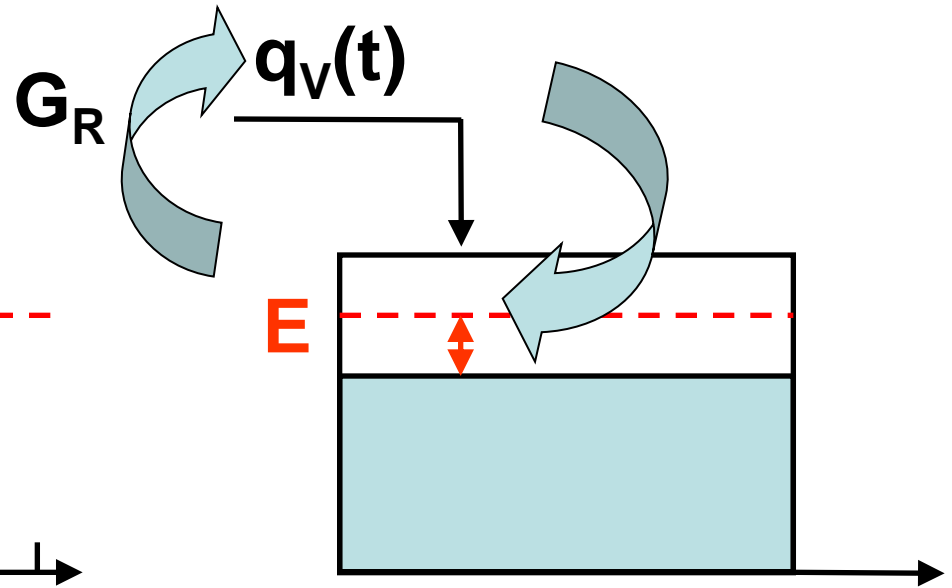
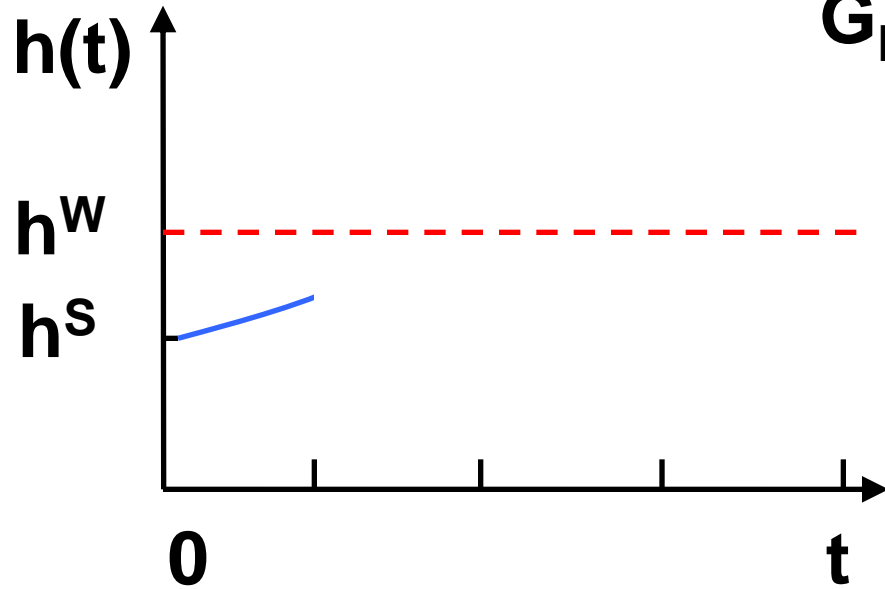
Zákon riadenia



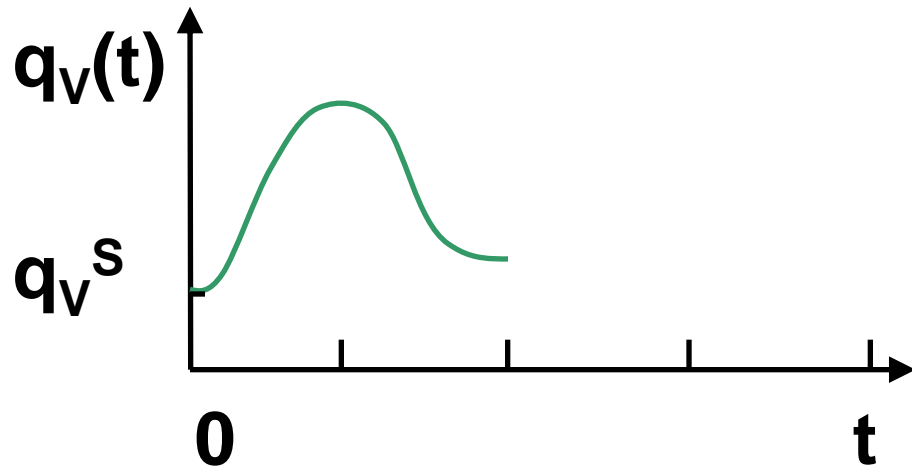
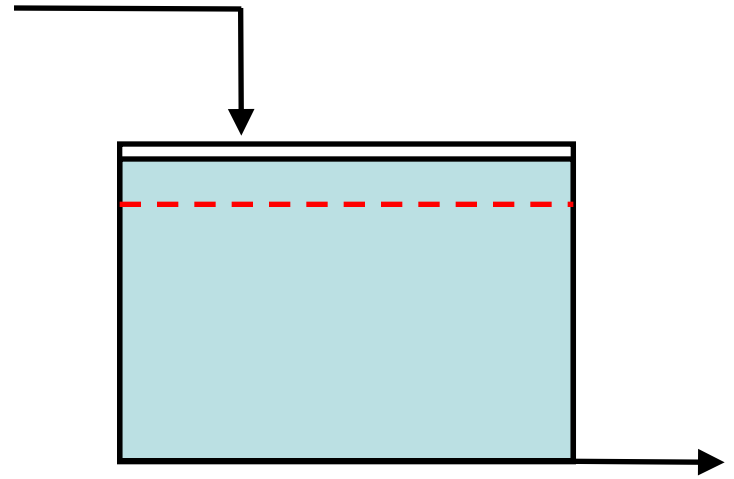
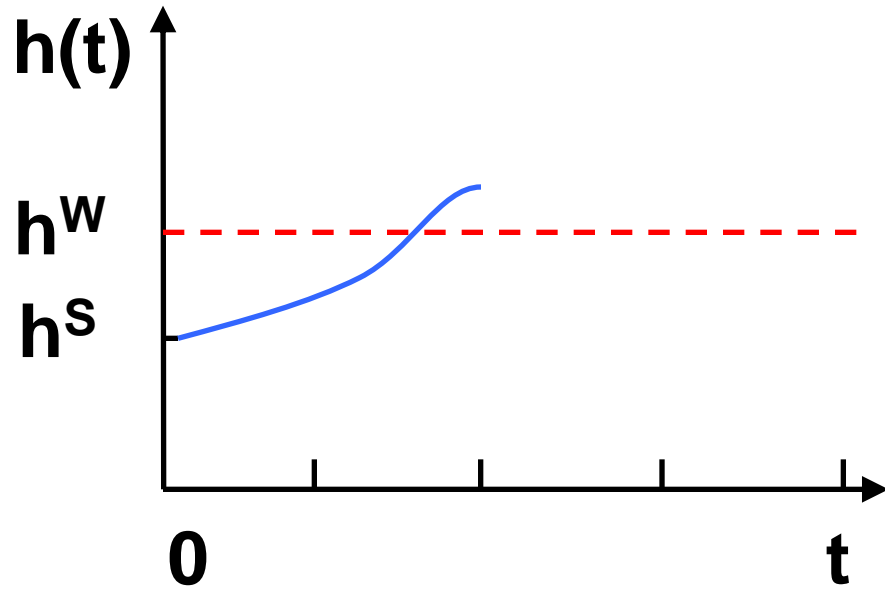
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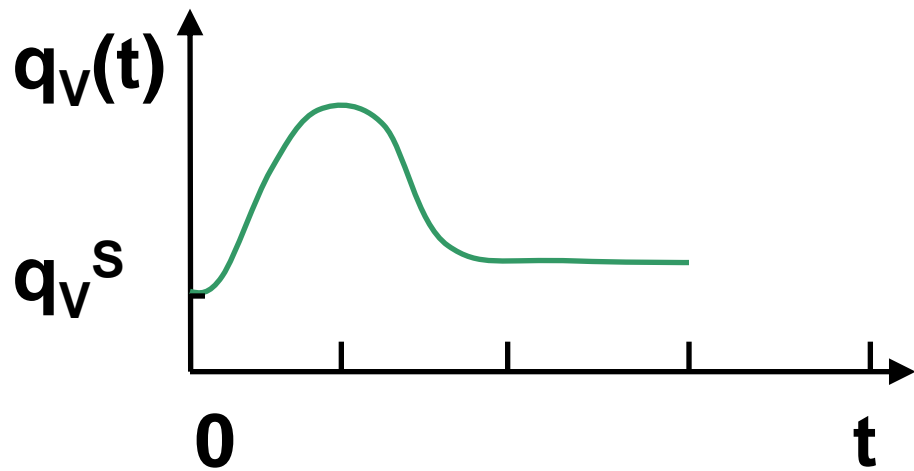
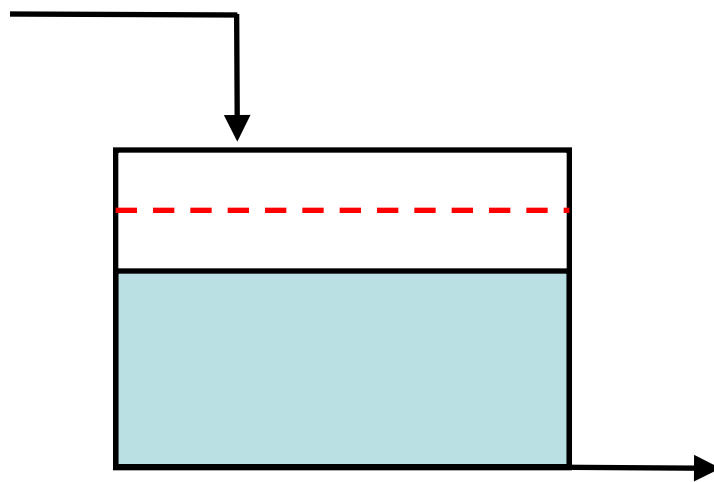
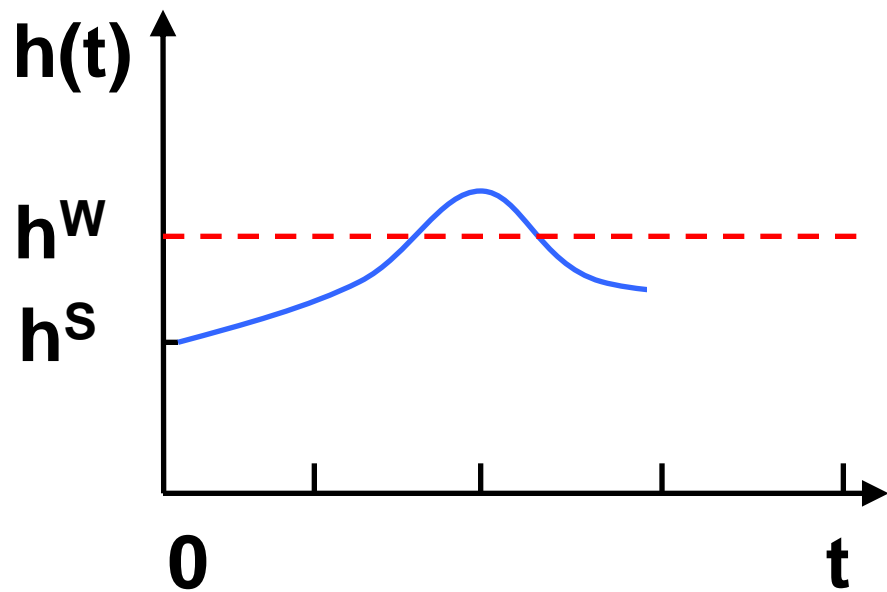
Zákon riadenia



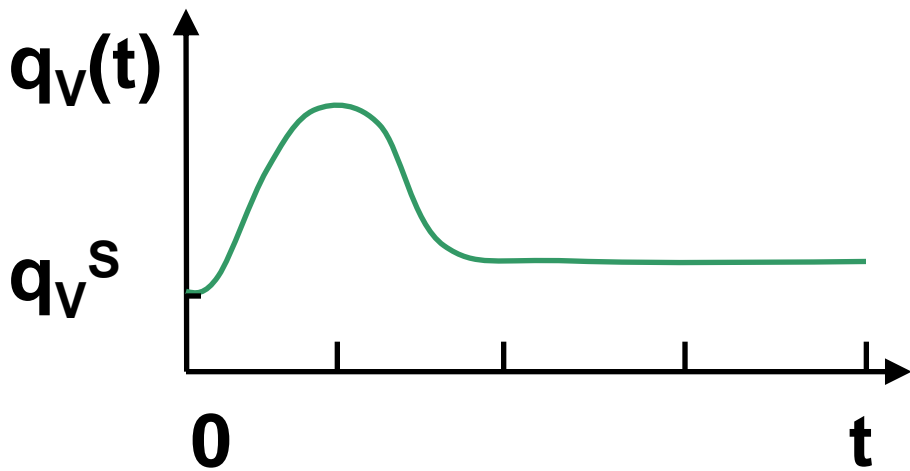
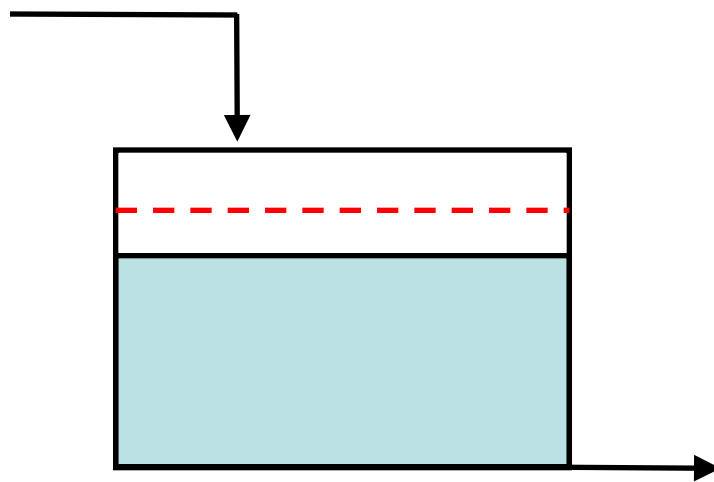
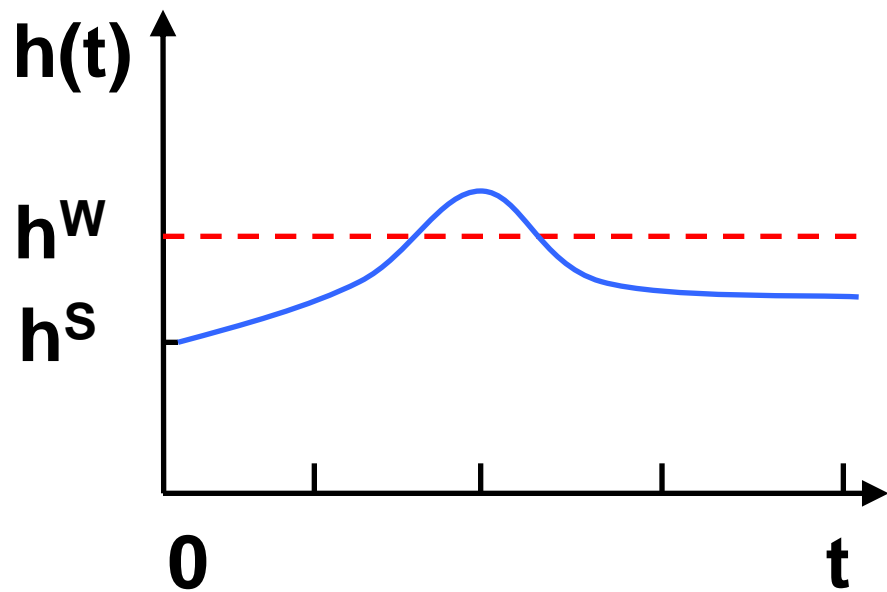
Zákon riadenia



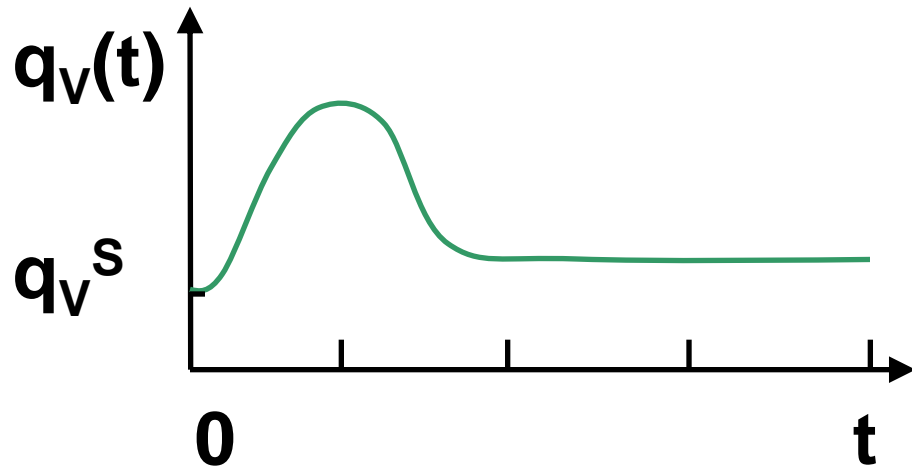
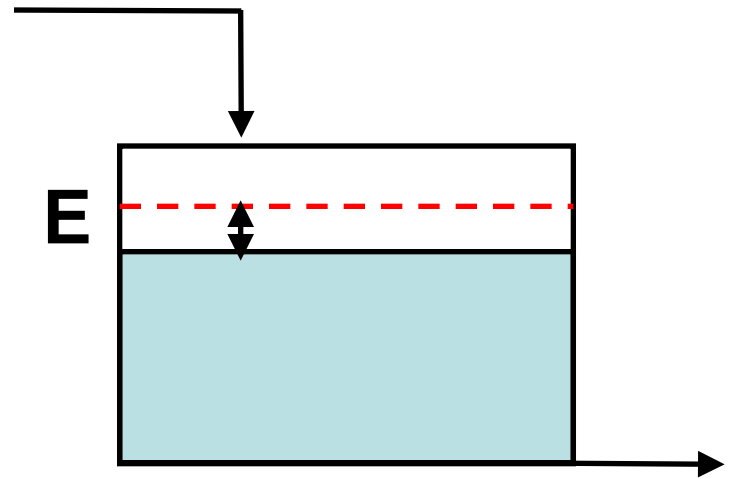
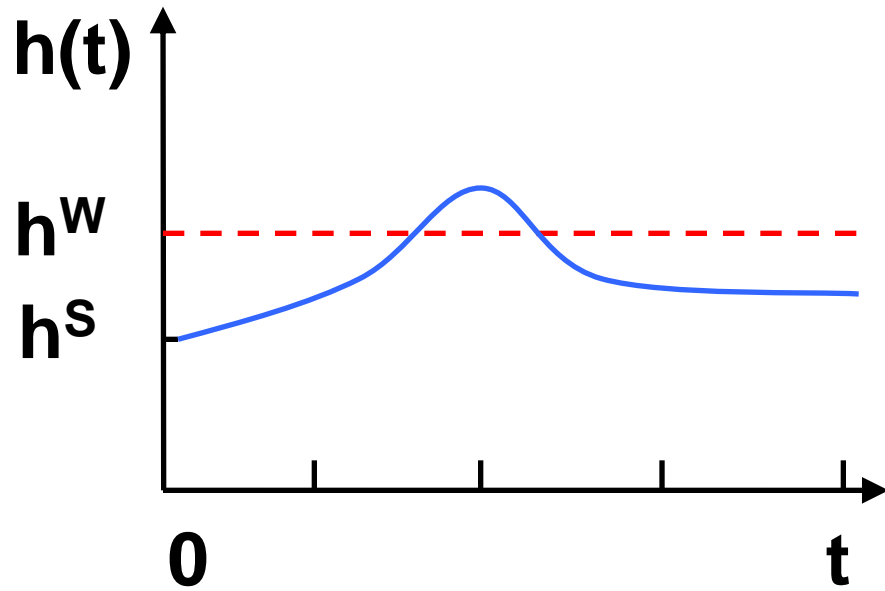
Zákon riadenia



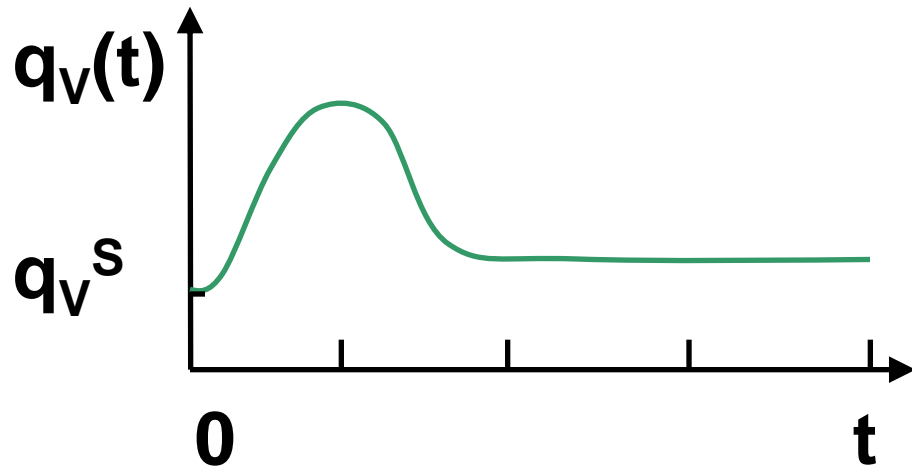
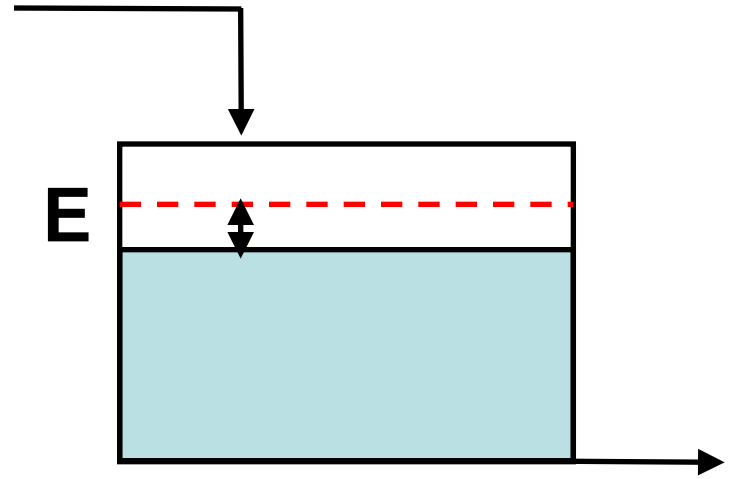
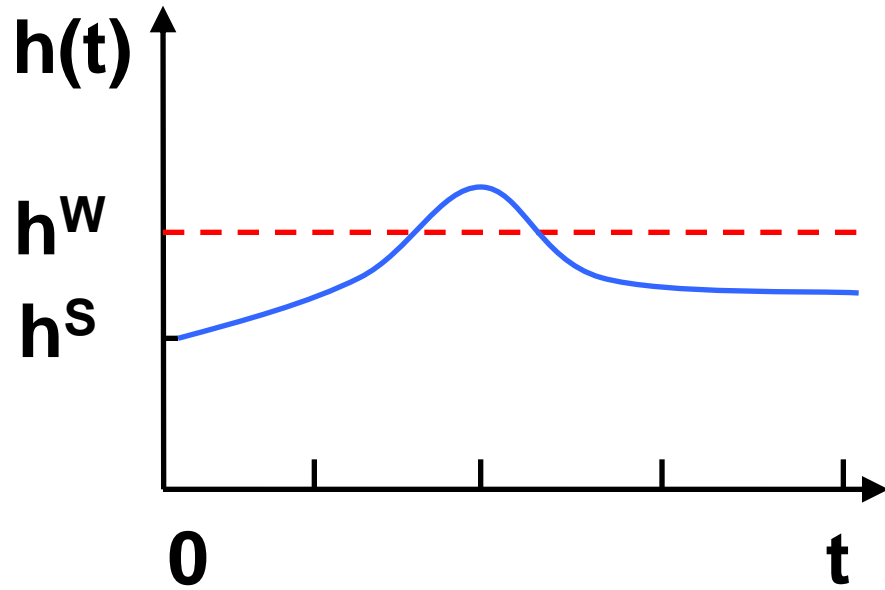
Zákon riadenia



Zákon riadenia

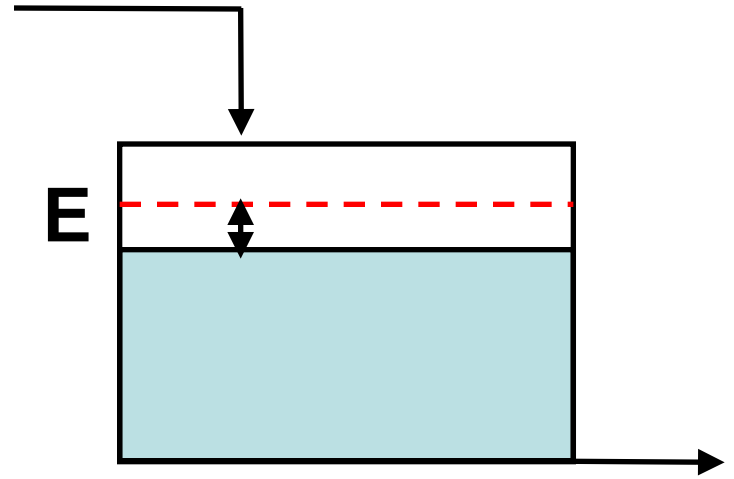
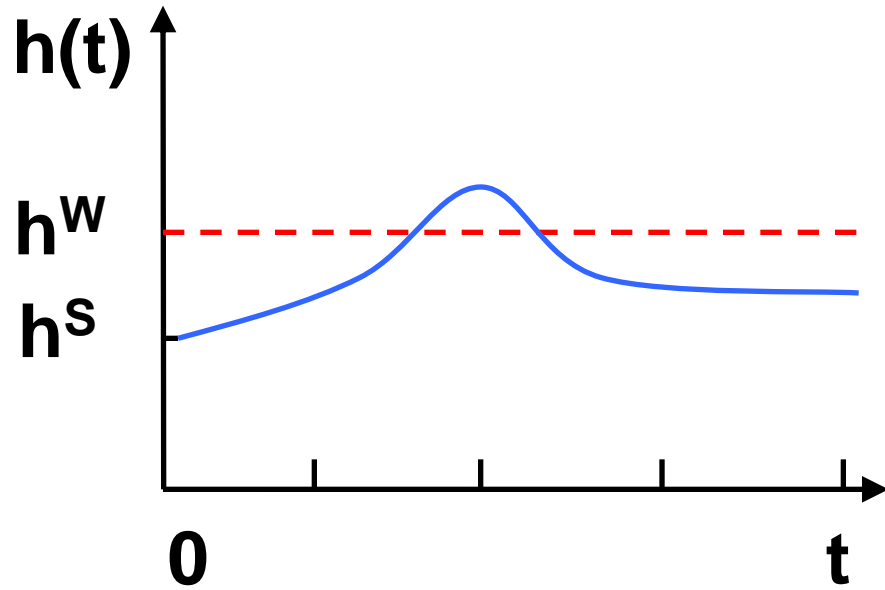


Zákon riadenia

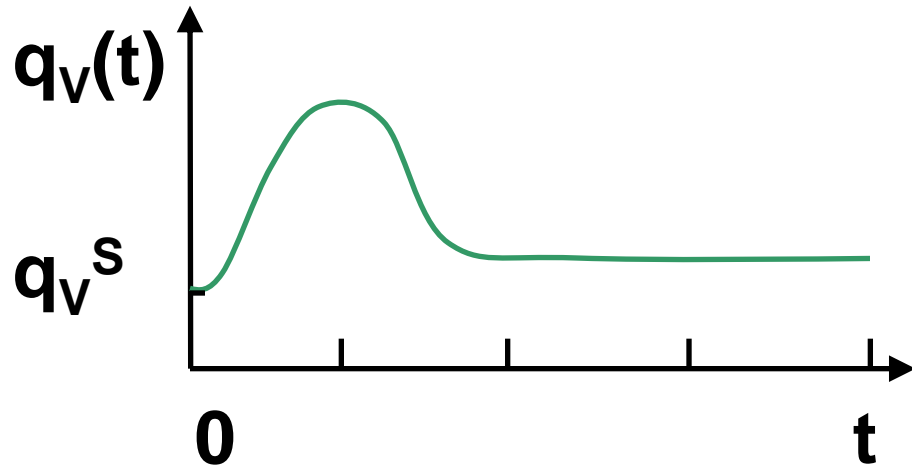


$$E = W - Y$$

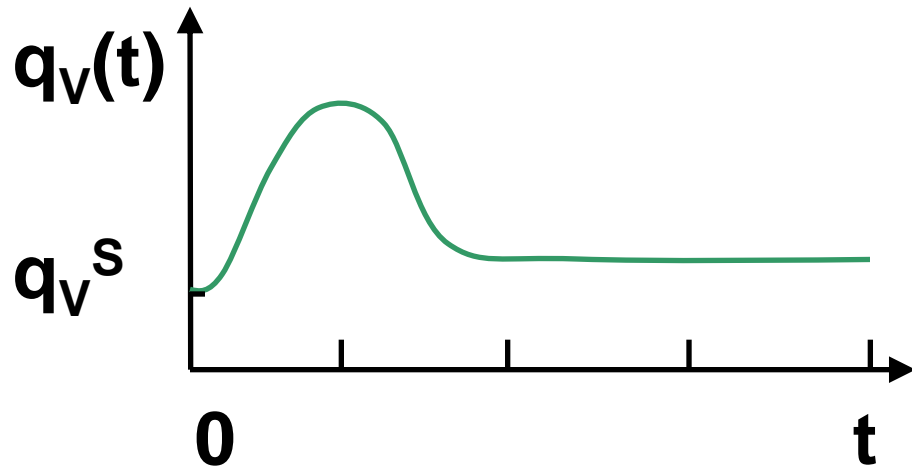
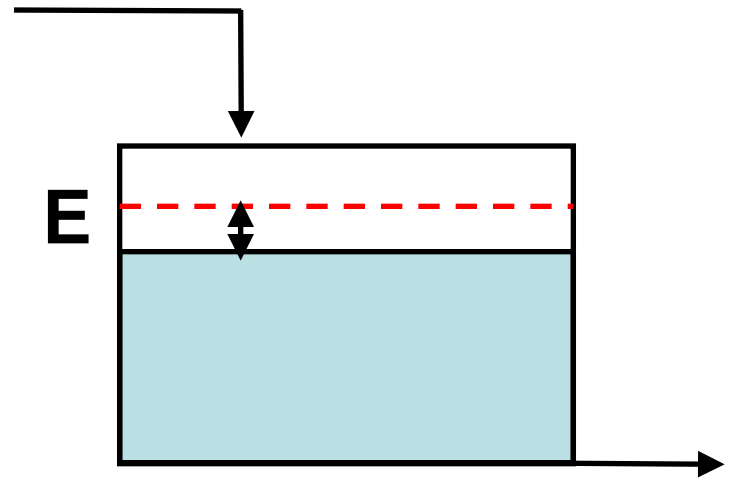
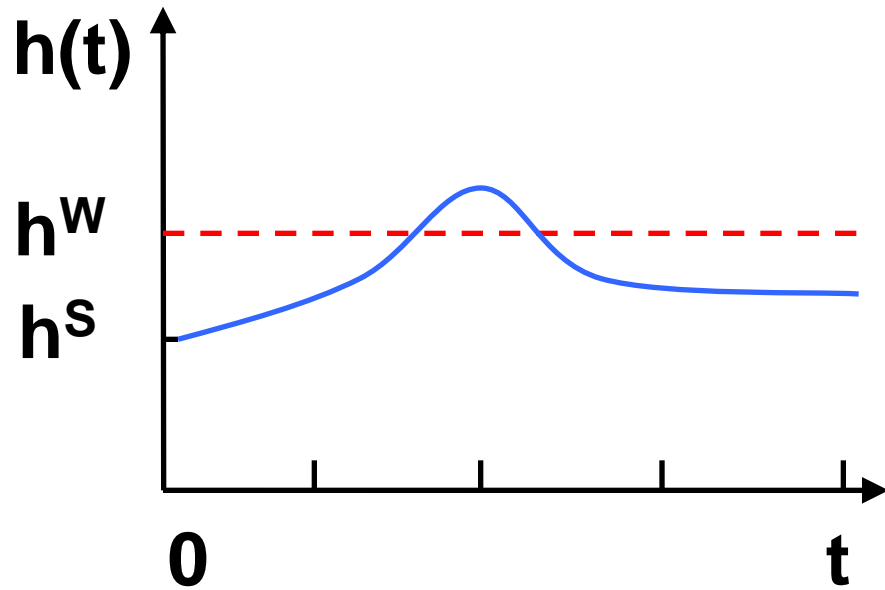
Zákon riadenia



$$E(\infty) = W(\infty) - Y(\infty)$$

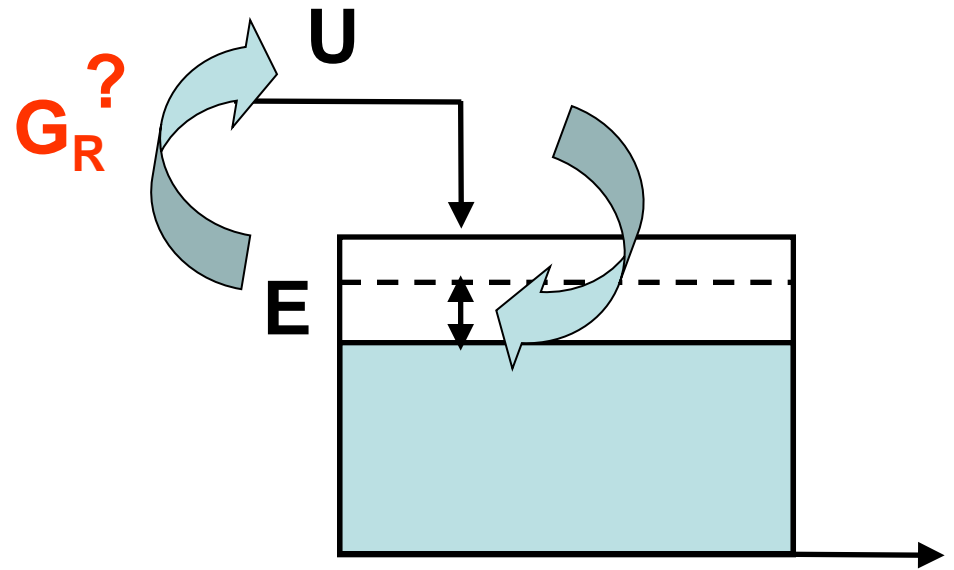


Zákon riadenia

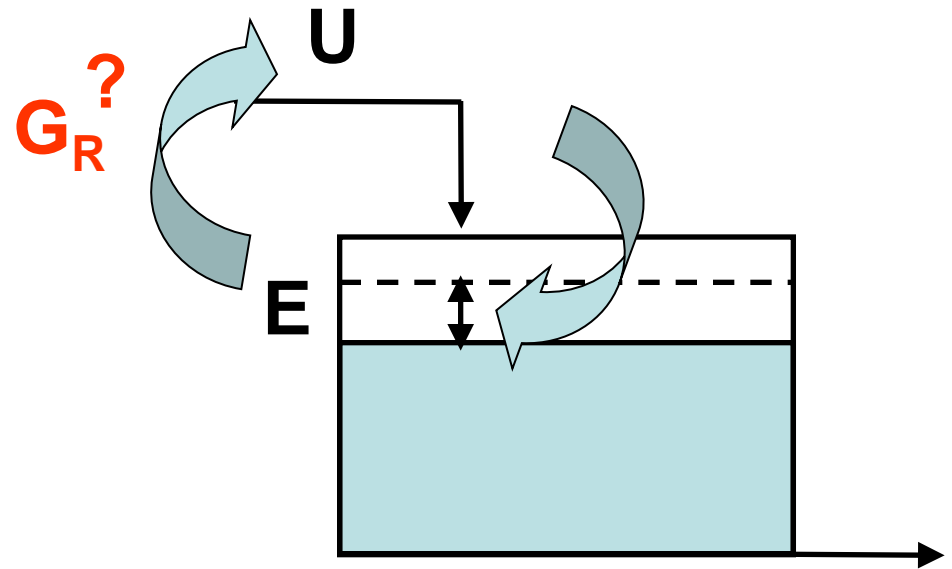


$$\text{TRO: } E(\infty) = W(\infty) - Y(\infty)$$

Zákon riadenia

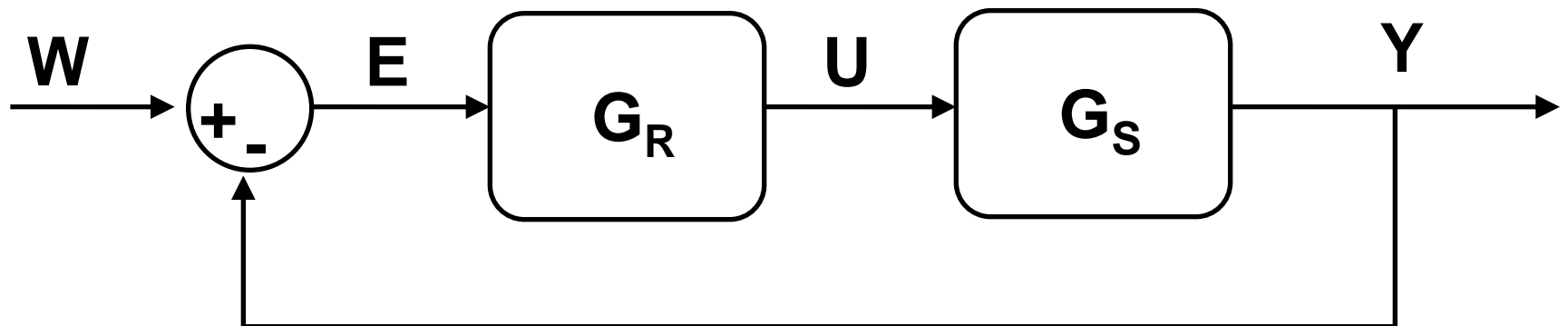


Zákon riadenia

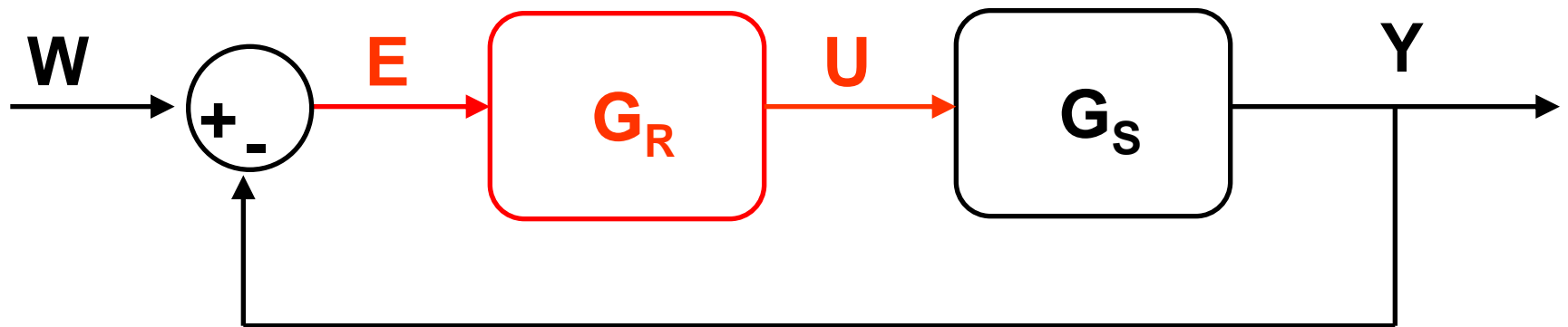


fyzické dynamické zariadenie, ktoré na základe regulačnej odchýlky vypočíta veľkosť akčného zásahu tak, aby výsledná regulačná odchýlka bola čo najmenšia

Zákon riadenia

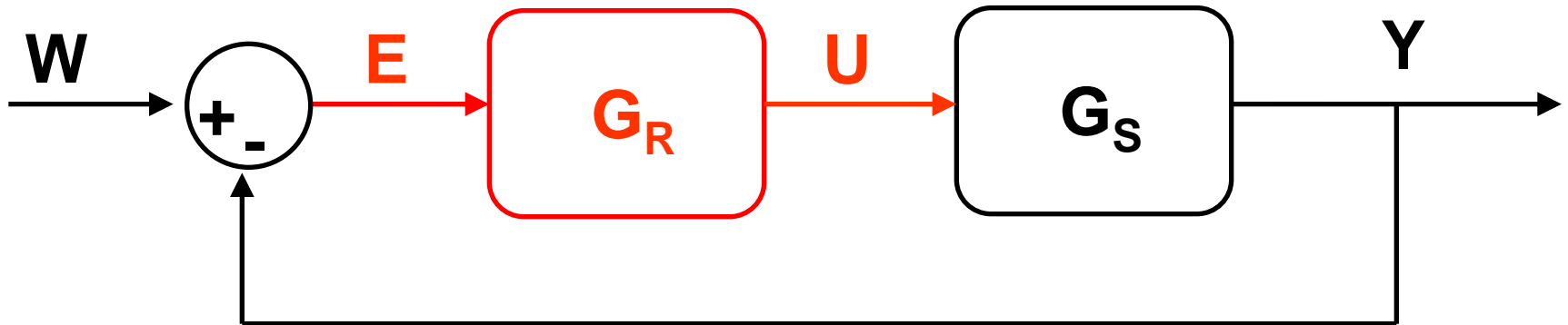


Zákon riadenia



Zákon riadenia

$$U = G_R E$$



Zákon riadenia

$$u(t) = G_R e(t)$$

Zákon riadenia

- **Proporcionálny regulátor:**

$$u(t) = G_{R,P}e(t)$$

Zákon riadenia

- **Proporcionálny regulátor:**

$$u(t) = G_{R,P} e(t)$$

- **Prenos:**

$$G_{R,P} = Z_R$$

- **Zákon riadenia:**

$$u(t) = Z_R e(t)$$

Zákon riadenia

- **Proporcionálno-integračný regulátor:**

$$u(t) = G_{R,PI} e(t)$$

Zákon riadenia

- **Proporcionálno-integračný regulátor:**

$$u(t) = G_{R,PI} e(t)$$

- **Prenos:**
$$G_{R,PI} = \frac{Z_R s + \frac{Z_R}{T_I}}{s}$$

- **Zákon riadenia:**

$$u(t) = Z_R e(t) + \frac{Z_R}{T_I} \int_0^t e(\tau) d\tau$$

Zákon riadenia

- **Proporcionálno-integračný regulátor:**

$$u(t) = G_{R,PI} e(t)$$

- **Prenos:**
$$G_{R,PI} = \frac{Z_R s + \frac{Z_R}{T_I}}{s}$$

- **Zákon riadenia:**

$$u(t) = u_P(t) + u_I(t)$$

Zákon riadenia

- **Proporcionálno-integračný regulátor:**

$$u(t) = G_{R,PI} e(t)$$

- **Prenos:**
$$G_{R,PI} = \frac{Z_R s + \frac{Z_R}{T_I}}{s}$$

- **Zákon riadenia:**

$$u_I(t) = \frac{Z_R}{T_I} \int_0^t e(\tau) d\tau$$

Zákon riadenia

- **Proporcionálno-integračný regulátor:**

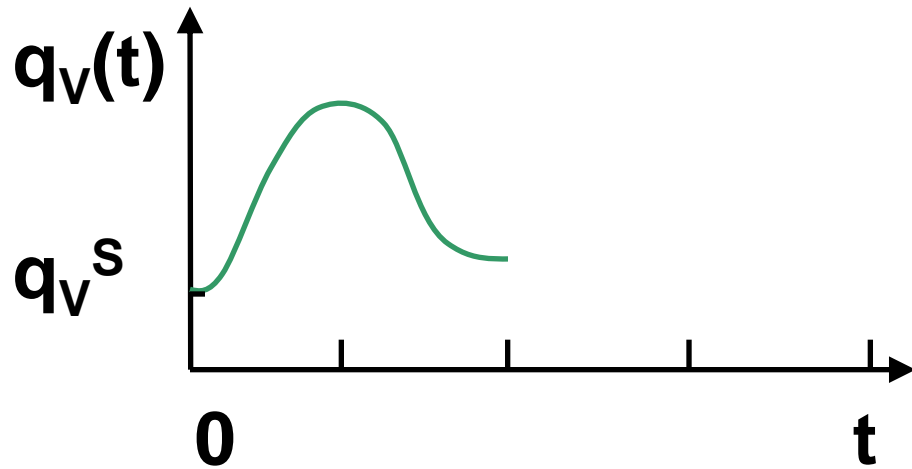
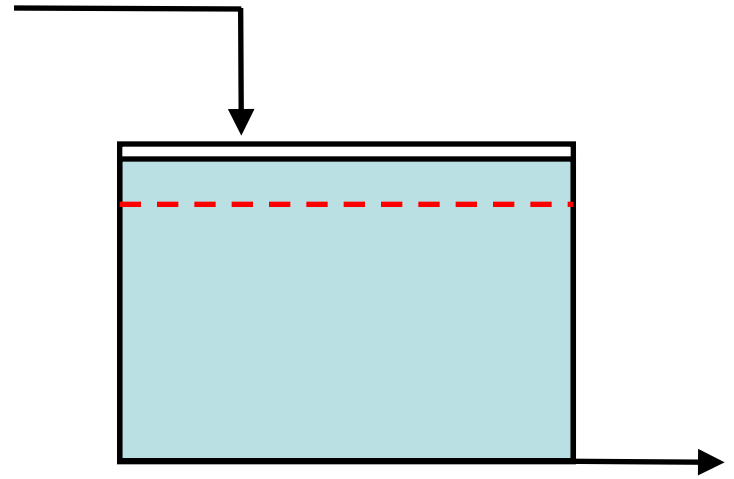
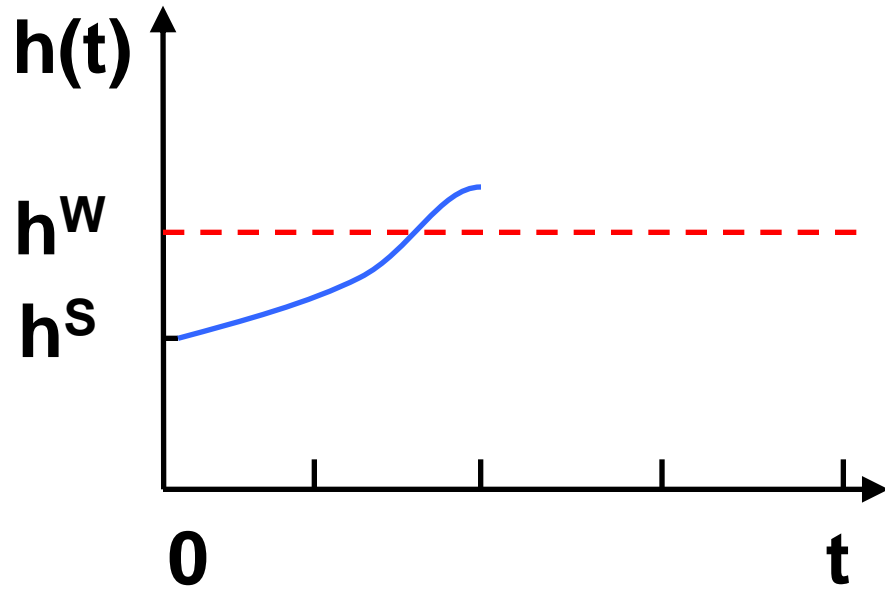
$$u(t) = G_{R,PI} e(t)$$

- **Prenos:**
$$G_{R,PI} = \frac{Z_R s + \frac{Z_R}{T_I}}{s}$$

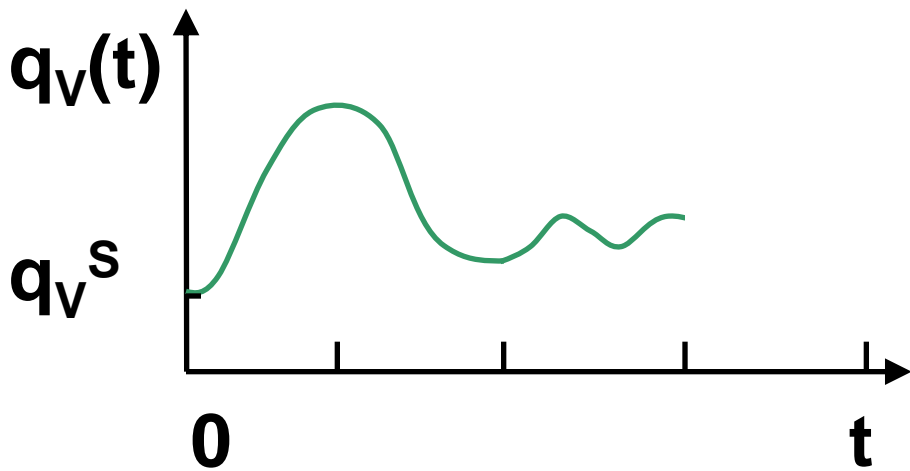
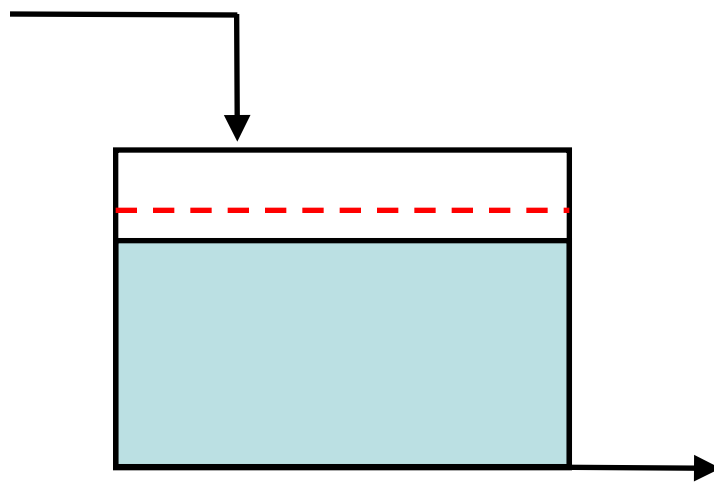
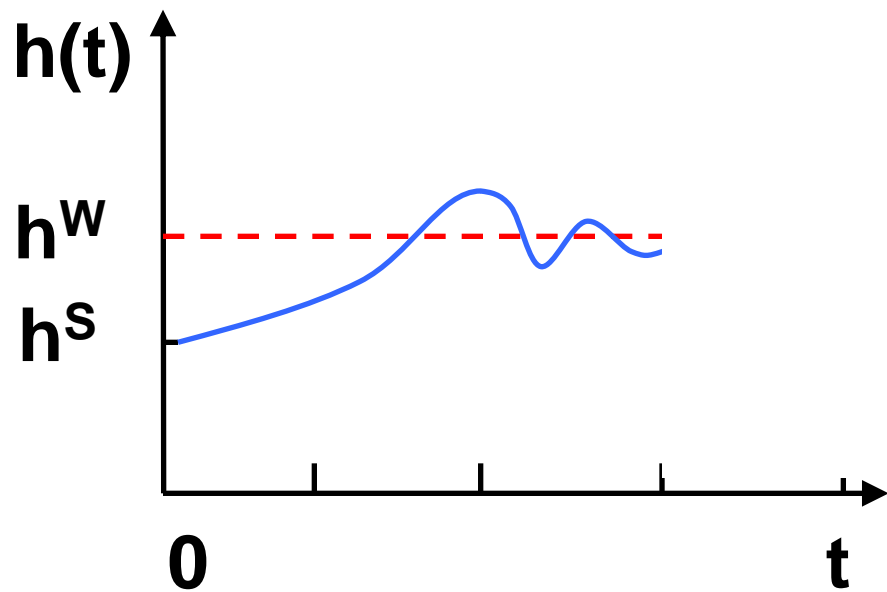
- **Zákon riadenia:**

$$\frac{du_I(t)}{dt} = \frac{Z_R}{T_I} e(t)$$

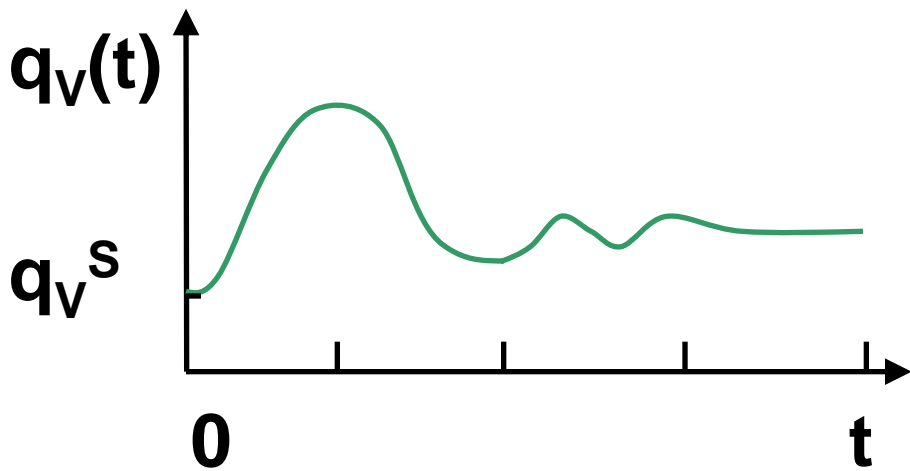
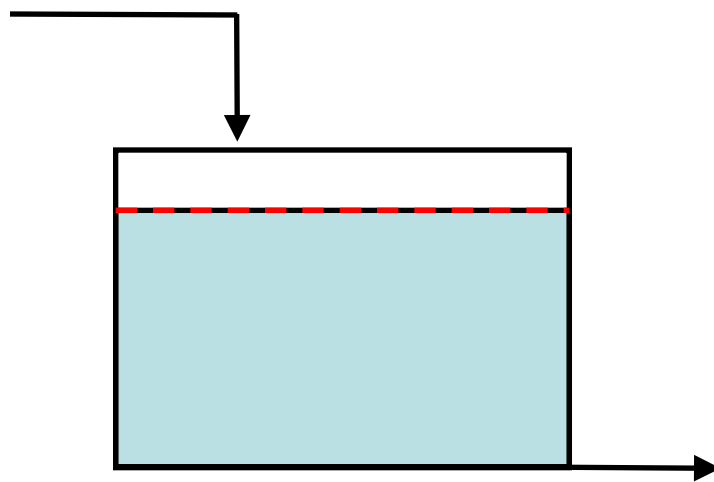
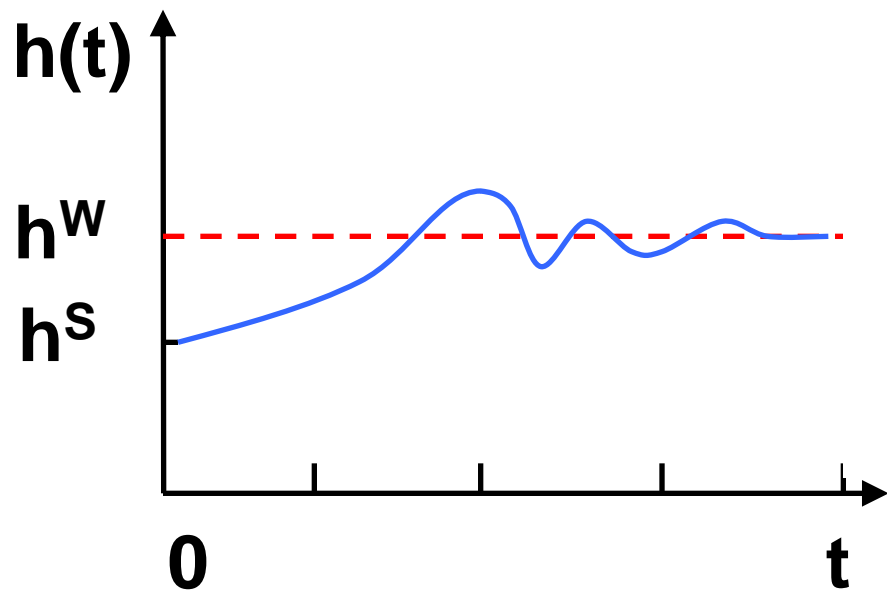
Zákon riadenia



Zákon riadenia



Zákon riadenia



Zákon riadenia

- **Proporcionálno-integračno derivačný regulátor:**

$$u(t) = G_{R,PID} e(t)$$

Zákon riadenia

- **Proporcionálno-integračno derivačný regulátor:**

$$u(t) = G_{R,PID} e(t)$$

- **Prenos:**

$$G_{R,PID} = \frac{Z_R s + \frac{Z_R}{T_I} + Z_R T_D s^2}{s}$$

- **Zákon riadenia:**

$$u(t) = Z_R e(t) + \frac{Z_R}{T_I} \int_0^t e(\tau) d\tau + Z_R T_D \frac{de(t)}{dt}$$

Zákon riadenia

- **Proporcionálno-derivačný regulátor:**

$$u(t) = G_{R,PD} e(t)$$

- **Prenos:** $G_{R,PD} = \frac{Z_R s + Z_R T_D s^2}{s}$

- **Zákon riadenia:**

$$u(t) = Z_R e(t) + Z_R T_D \frac{de(t)}{dt}$$

Zákon riadenia

- **Proporcionálno-derivačný regulátor:**

$$u(t) = G_{R,PD} e(t)$$

- **Prenos:** $G_{R,PD} = Z_R + Z_R T_D s$

- **Zákon riadenia:**

$$u(t) = Z_R e(t) + Z_R T_D \frac{de(t)}{dt}$$

Zákon riadenia

- **Proporcionálno-derivačný regulátor:**

$$u(t) = G_{R,PD} e(t)$$

- **Prenos:** $G_{R,PD} = Z_R + Z_R T_D s$

- **Zákon riadenia:**

$$u(t) = u_P(t) + u_D(t)$$

Zákon riadenia

- **Proporcionálno-derivačný regulátor:**

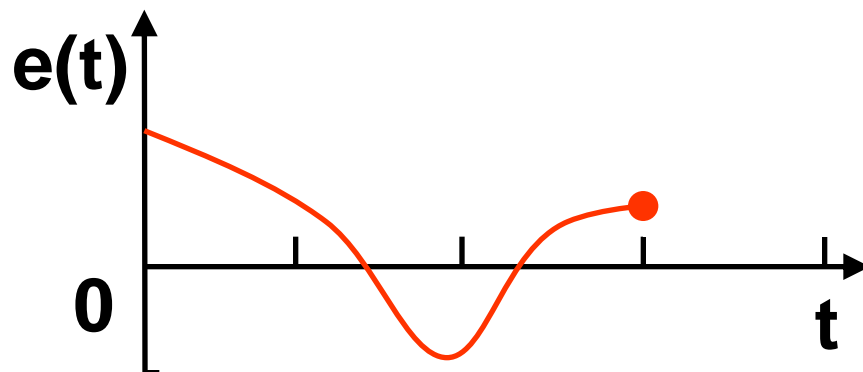
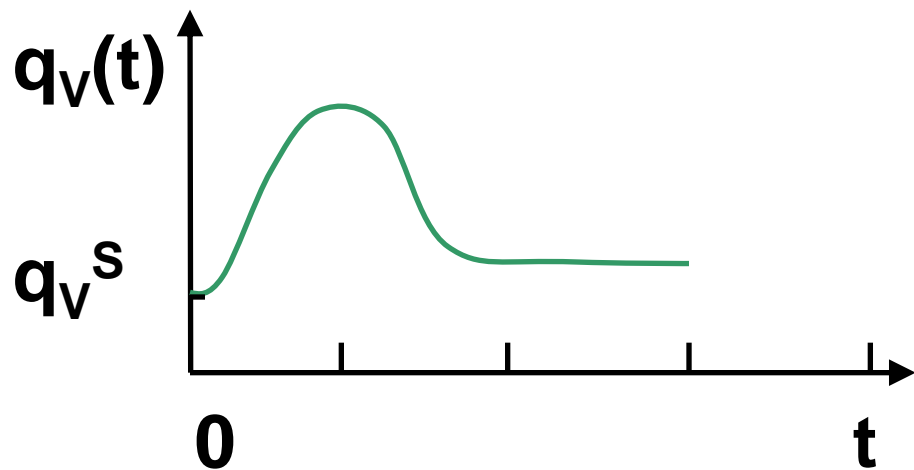
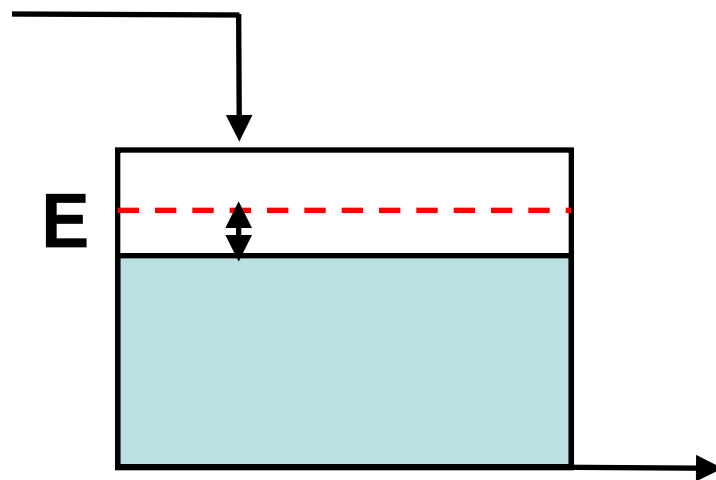
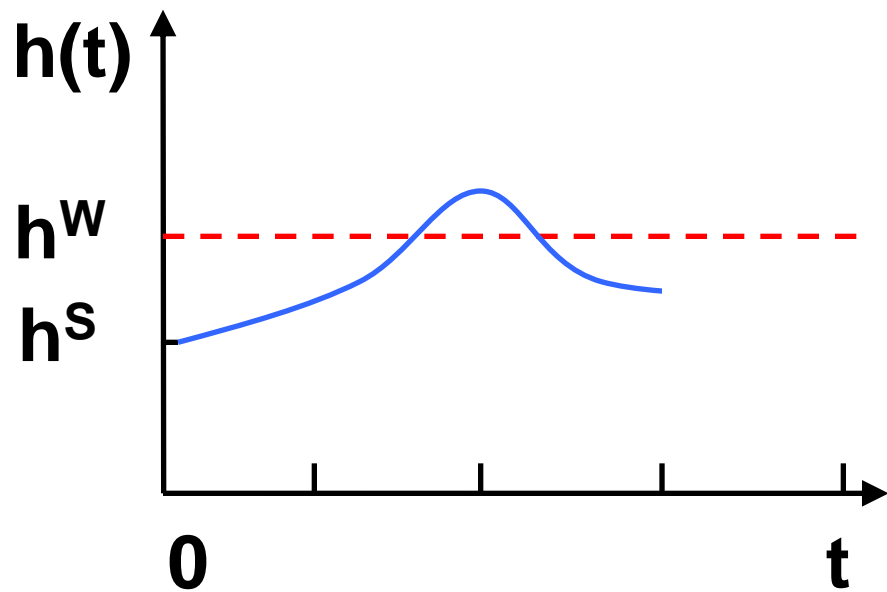
$$u(t) = G_{R,PD} e(t)$$

- **Prenos:** $G_{R,PD} = Z_R + Z_R T_D s$

- **Zákon riadenia:**

$$u_D(t) = Z_R T_D \frac{de(t)}{dt}$$

Zákon riadenia



Zákon riadenia

