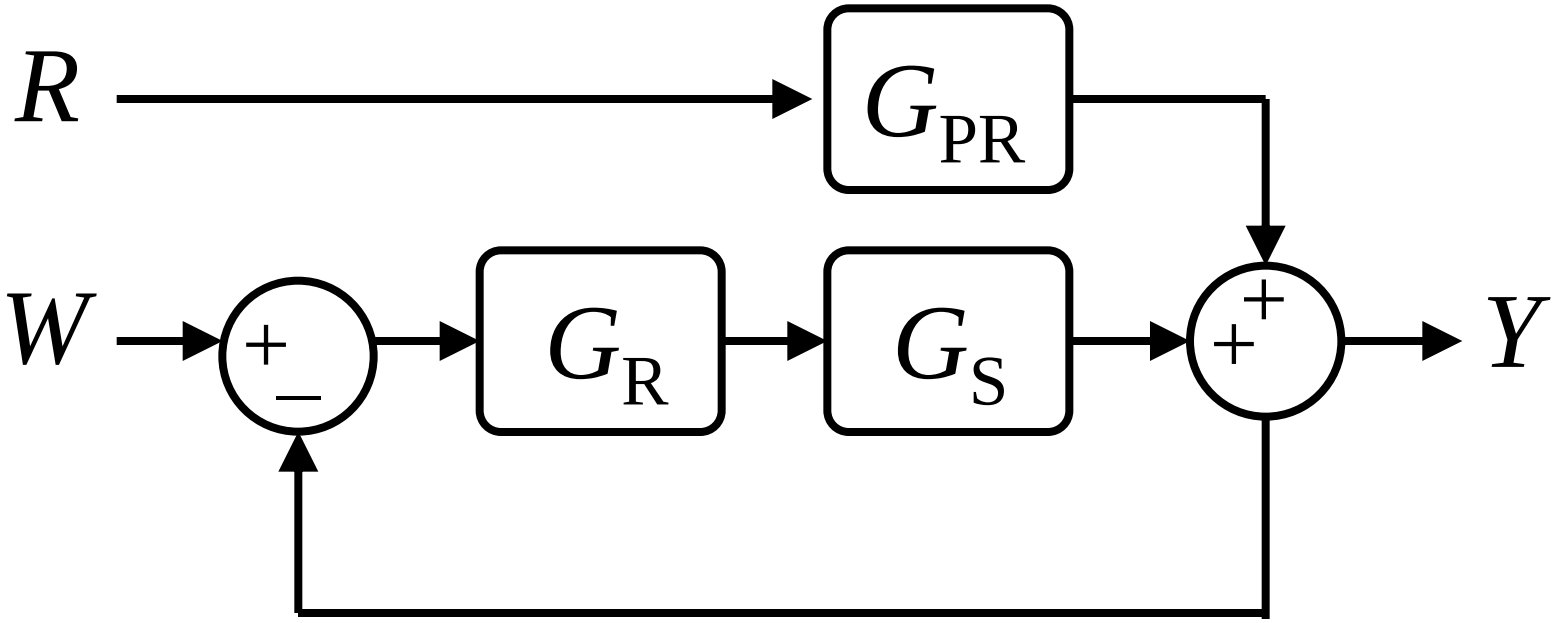
PID regulátor

Juraj Oravec

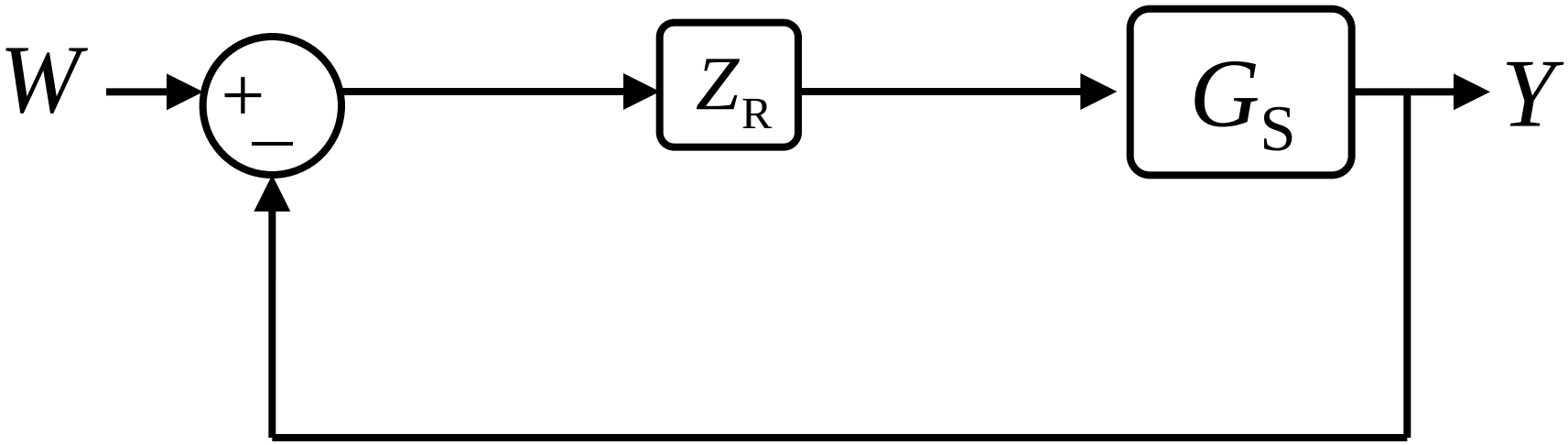
URO



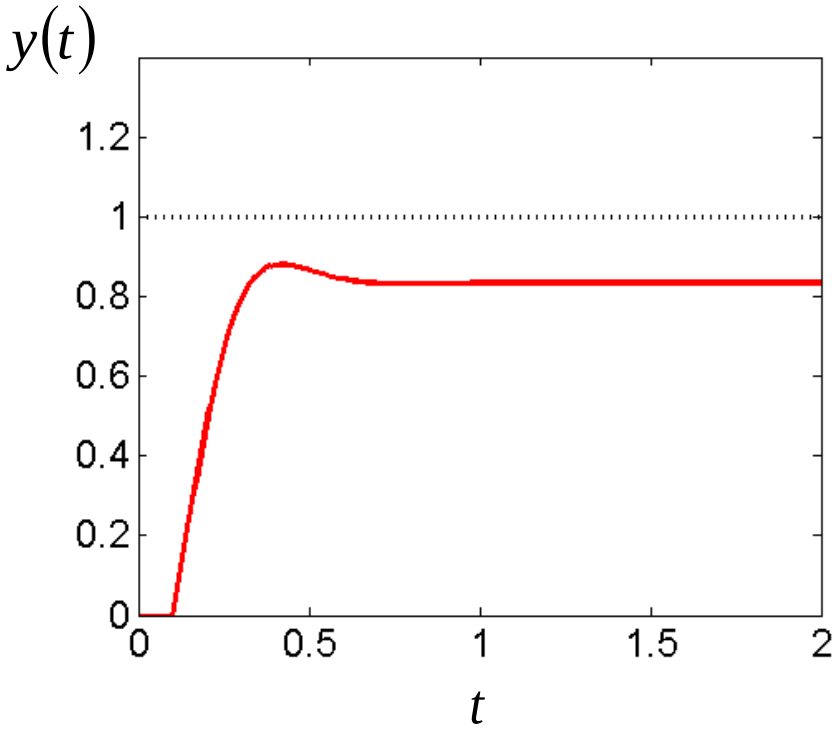
P – regulátor

$$u(t) = u_{\mathrm{P}}(t)$$

$$u(t) = Z_{\mathrm{R}} e(t)$$

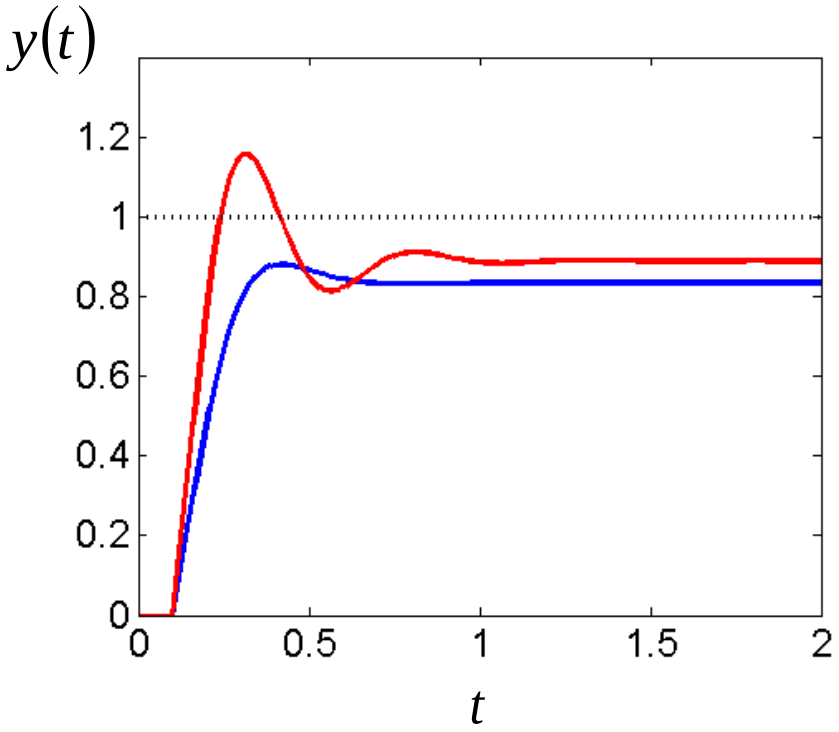


P – regulátor



$Z_{R,1} = 5$

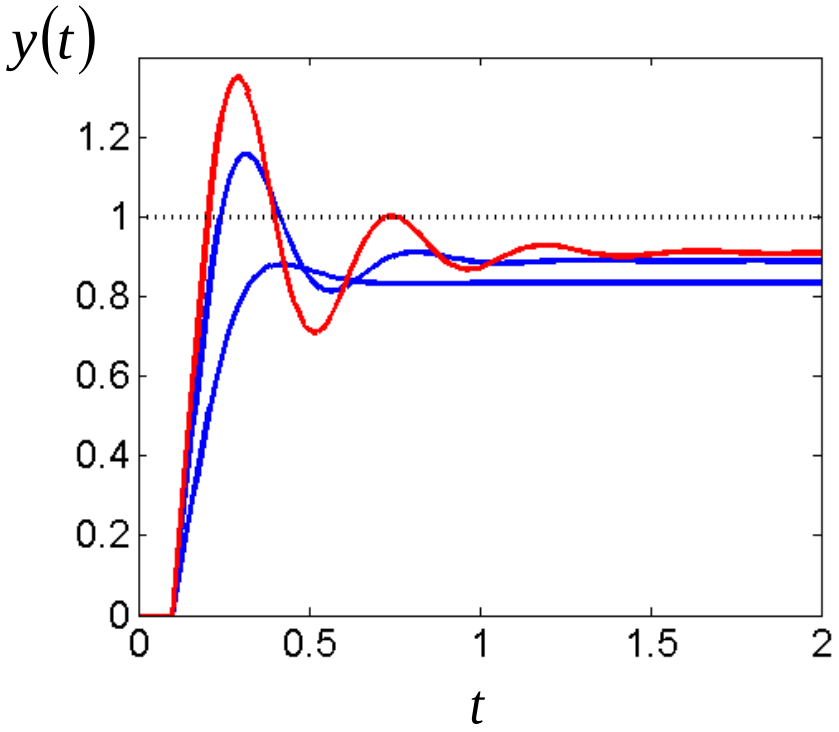
P – regulátor



$Z_{R,2} = 8$

$Z_{R,1} = 5$

P – regulátor

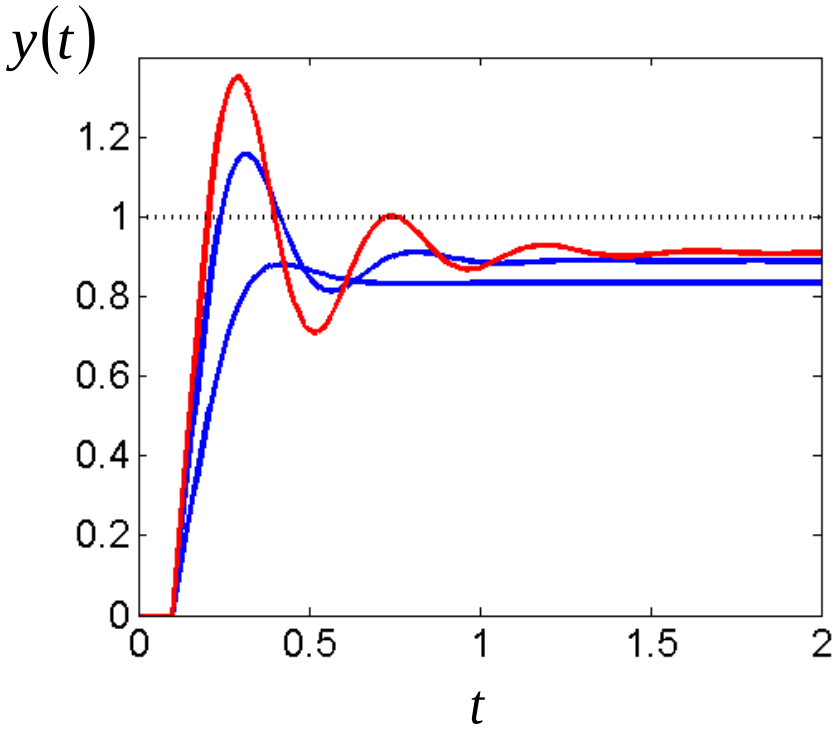


$Z_{R,3} = 10$

$Z_{R,2} = 8$

$Z_{R,1} = 5$

P – regulátor



$Z_{R,3} = 10$

$Z_{R,2} = 8$

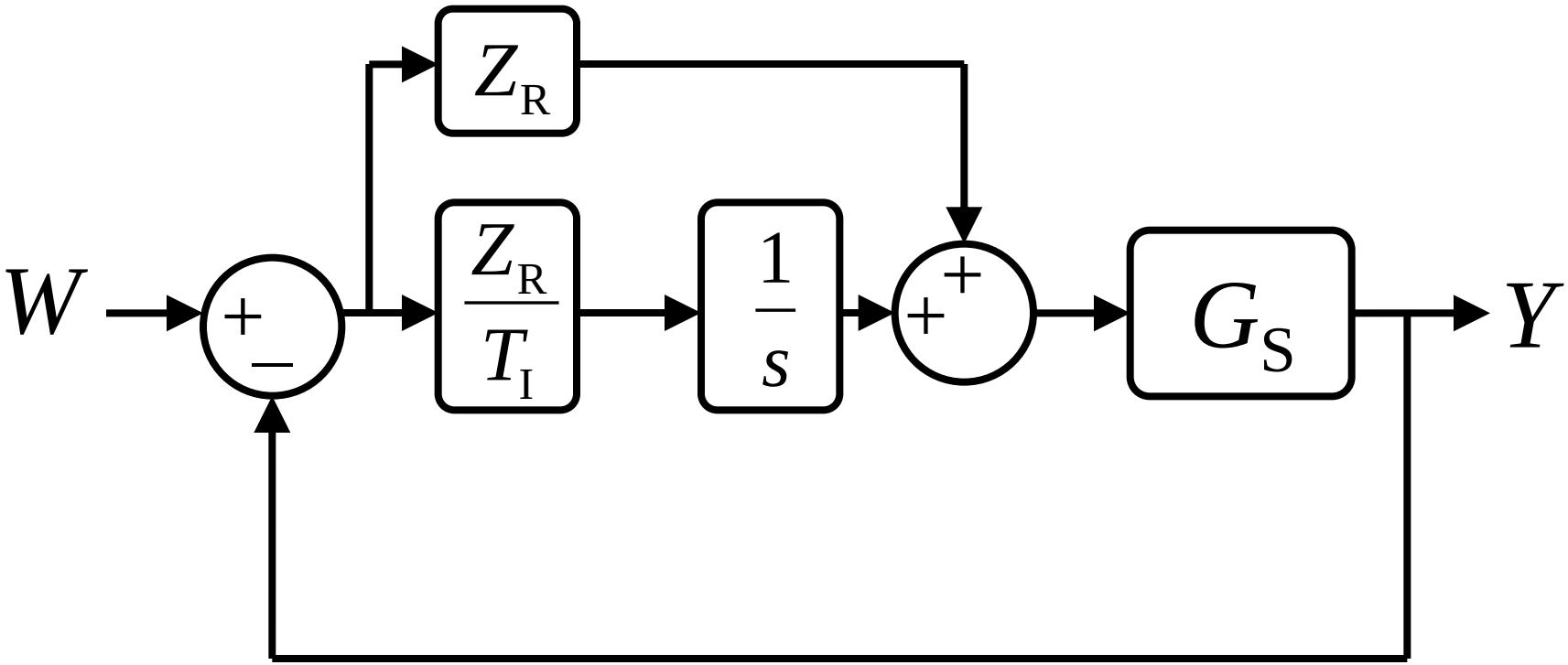
$Z_{R,1} = 5$

$$\uparrow Z_R \Rightarrow \downarrow TRO, \uparrow \sigma_{max}$$

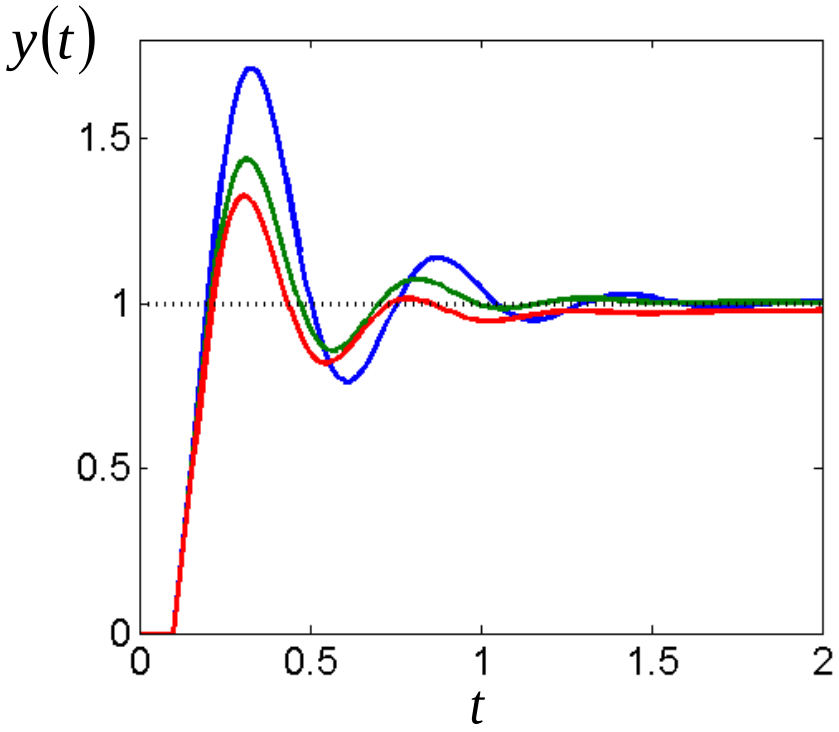
PI – regulátor

$$u(t) = u_{\mathrm{P}}(t) + u_{\mathrm{I}}(t)$$

$$u(t) = Z_{\mathrm{R}} e(t) + \frac{Z_{\mathrm{R}}}{T_{\mathrm{I}}} \int_0^t e(\tau)\,\mathrm{d}\tau$$



PI – regulátor



$T_{I,1} = 0{,}3$

$T_{I,2} = 0{,}8$

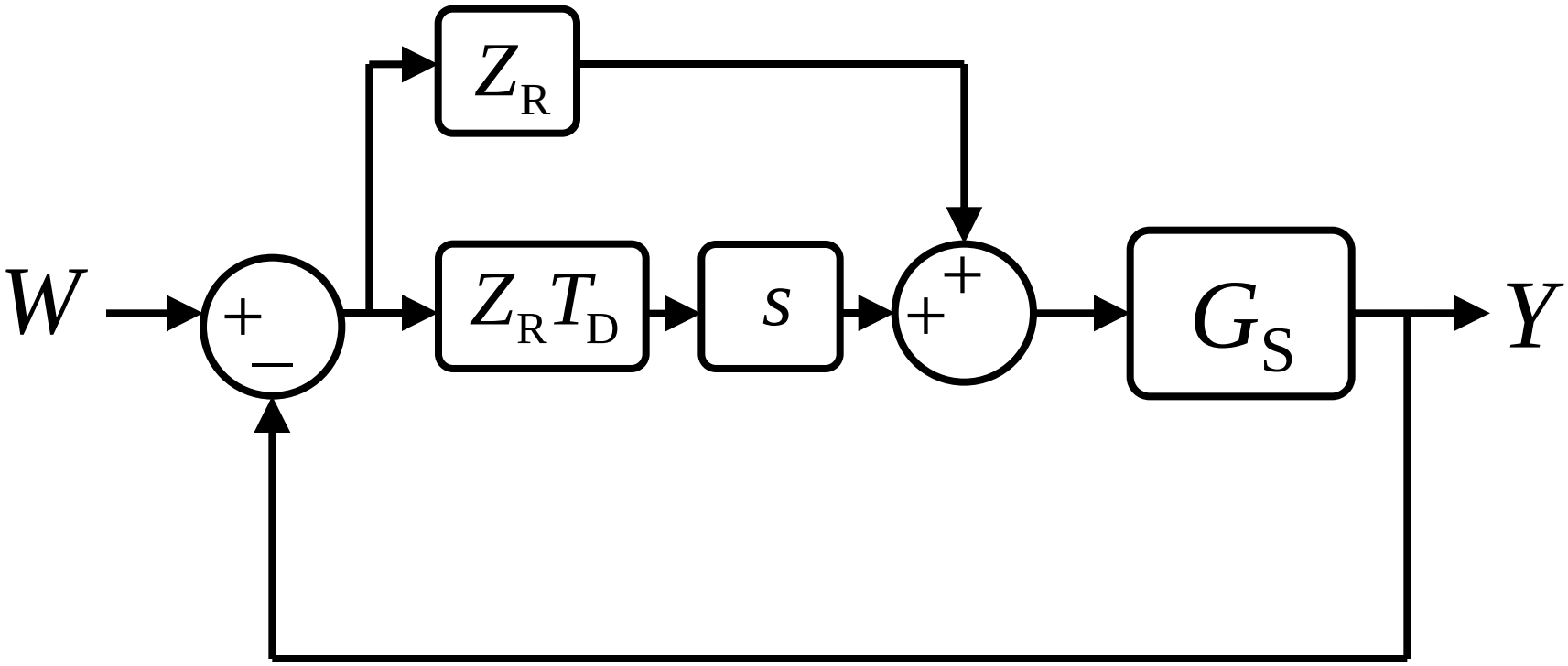
$T_{I,3} = 2{,}0$

$$\uparrow T_I \Rightarrow \downarrow t_{reg}, \downarrow \sigma_{max}$$

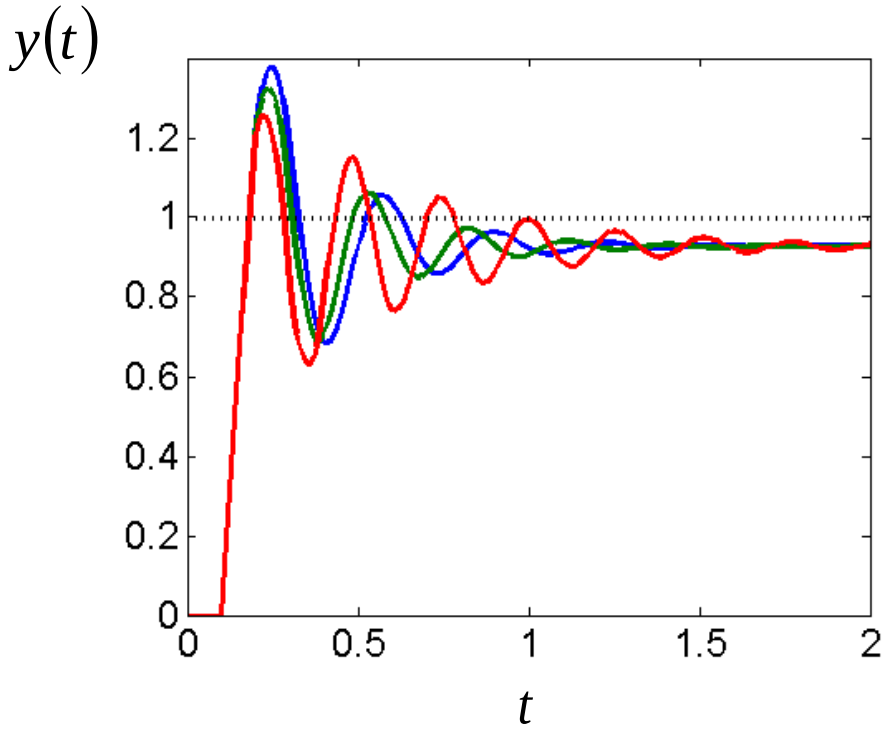
PD – regulátor

$$u(t) = u_{\mathrm{P}}(t) + u_{\mathrm{D}}(t)$$

$$u(t) = Z_{\mathrm{R}} e(t) + Z_{\mathrm{R}} T_{\mathrm{D}} \frac{\mathrm{d}e(t)}{\mathrm{dt}}$$



PD – regulátor



$T_{D,1} = 0{,}025$

$T_{D,2} = 0{,}035$

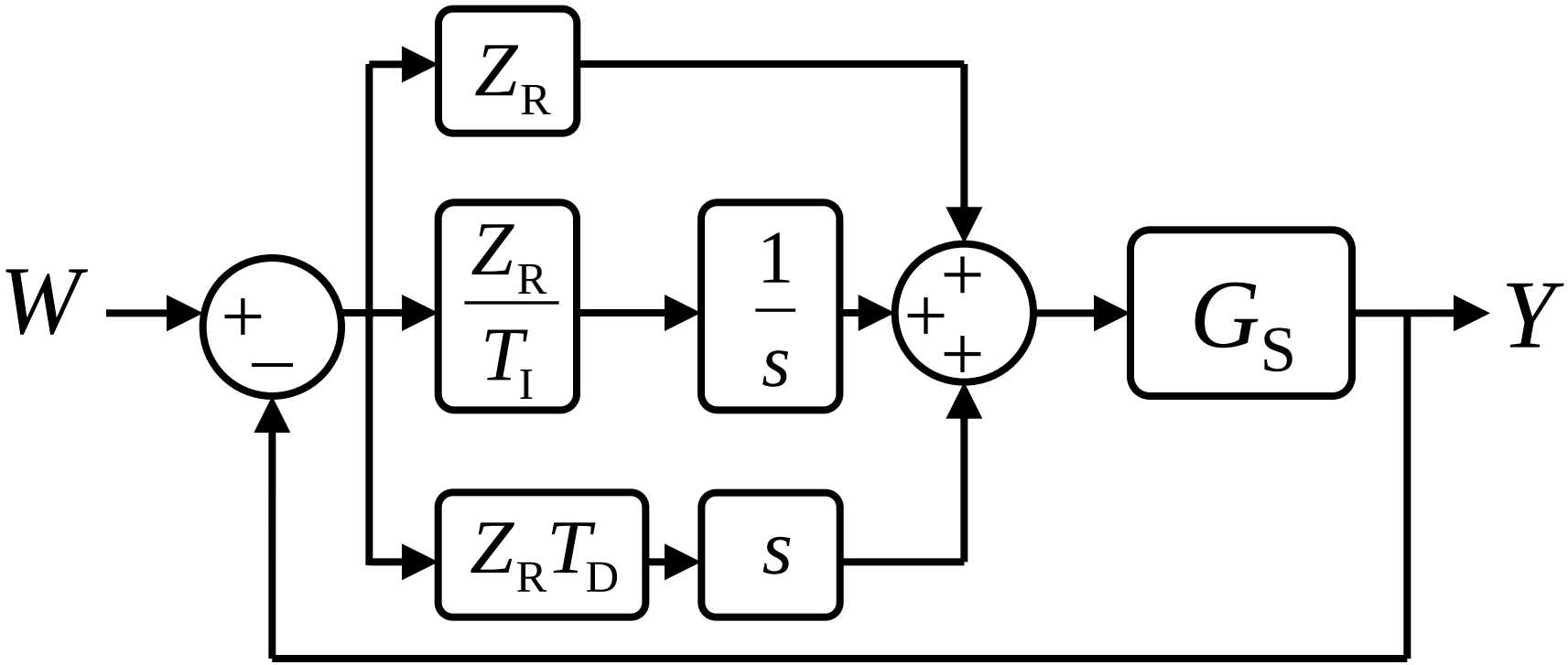
$T_{D,3} = 0{,}050$

$$\uparrow T_D \Rightarrow \uparrow t_{reg}\,, \downarrow \sigma_{max}$$

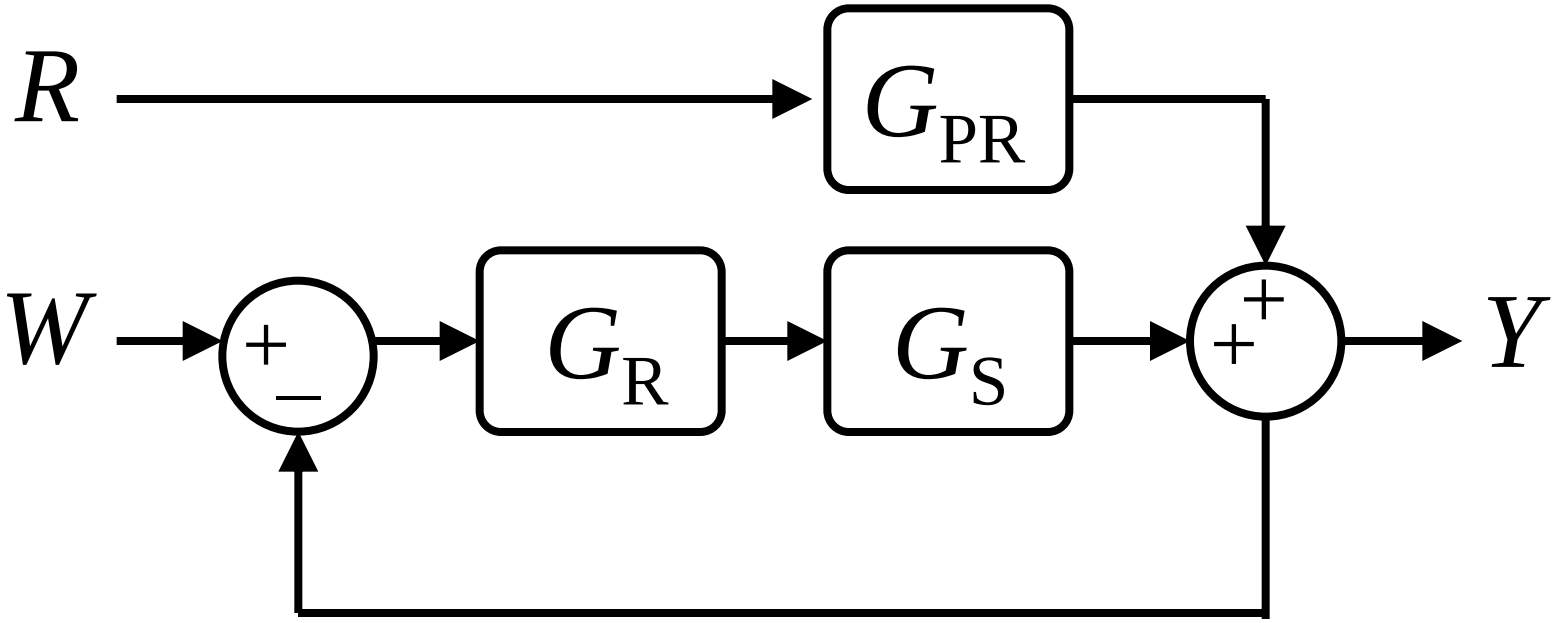
PID – regulátor

$$u(t) = u_{\mathrm{P}}(t) + u_{\mathrm{I}}(t) + u_{\mathrm{D}}(t)$$

$$u(t) = Z_{\mathrm{R}} e(t) + \frac{Z_{\mathrm{R}}}{T_{\mathrm{I}}} \int_0^t e(\tau)\,\mathrm{d}\tau + Z_{\mathrm{R}} T_{\mathrm{D}} \frac{\mathrm{d}e(t)}{\mathrm{dt}}$$



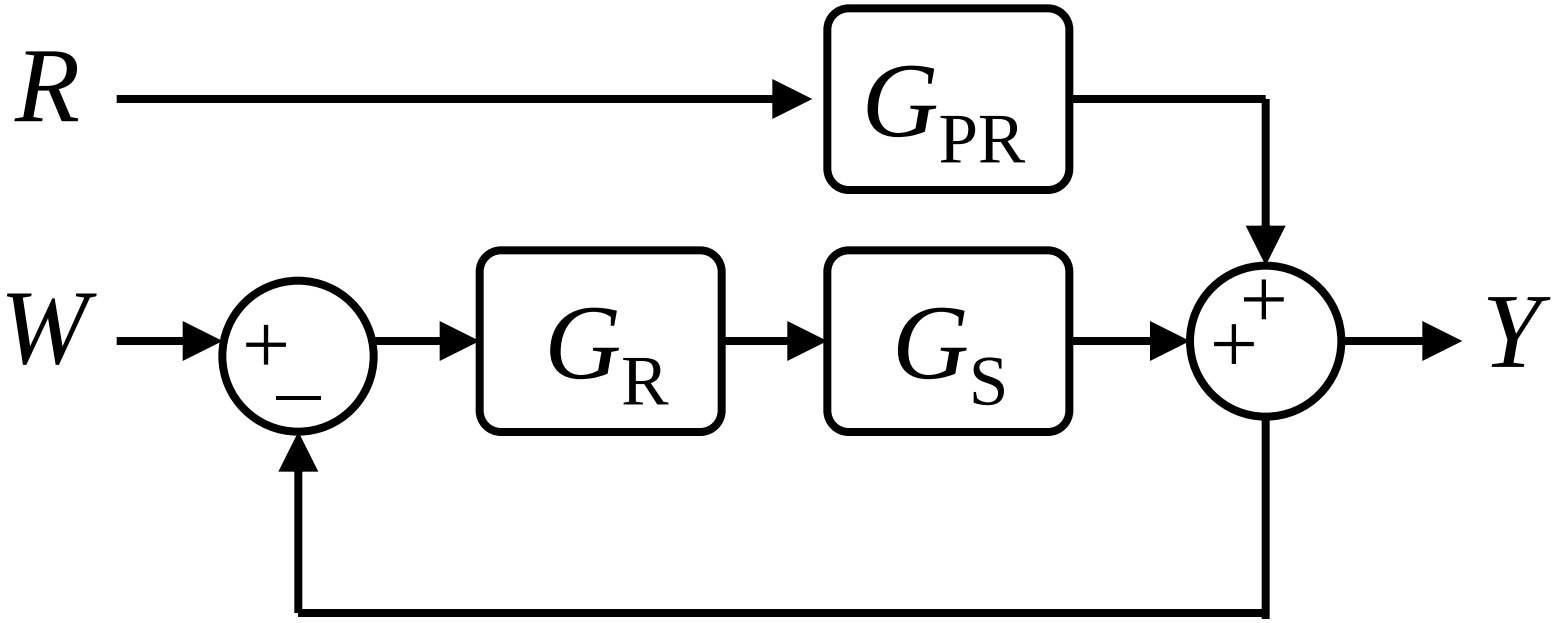
URO



Úloha sledovania

$W \neq 0$

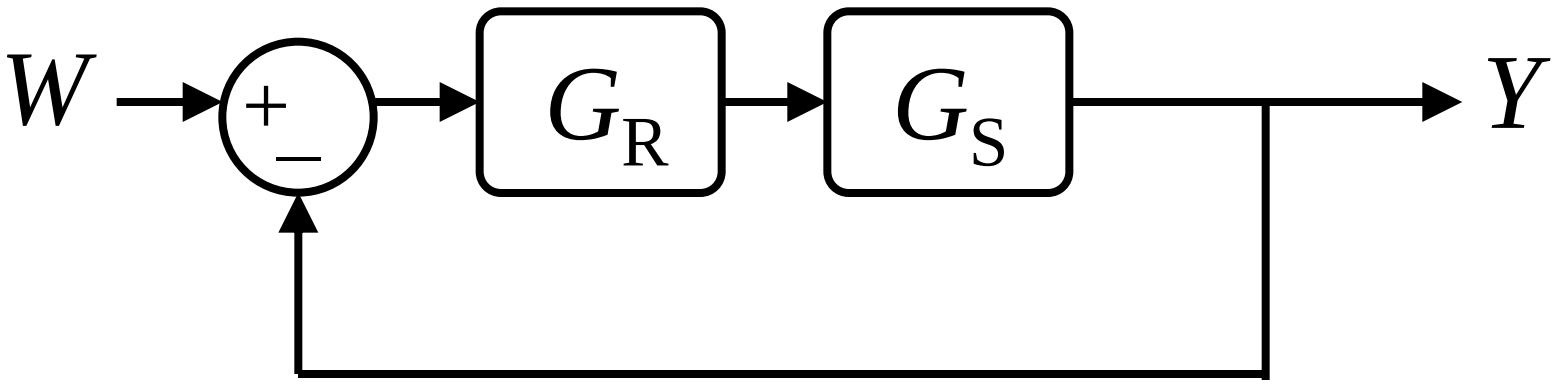
$R = 0$



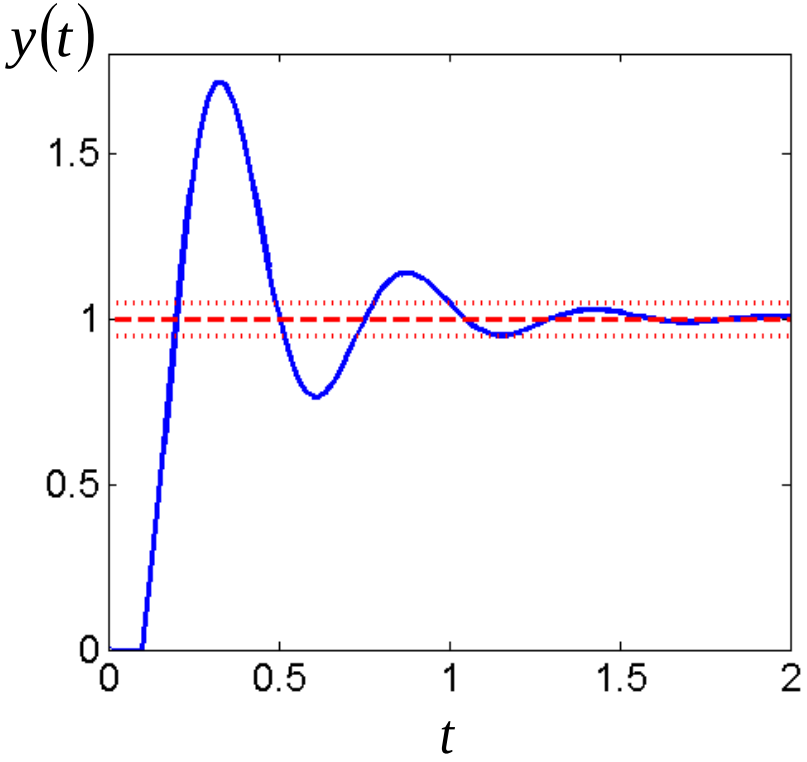
Úloha sledovania

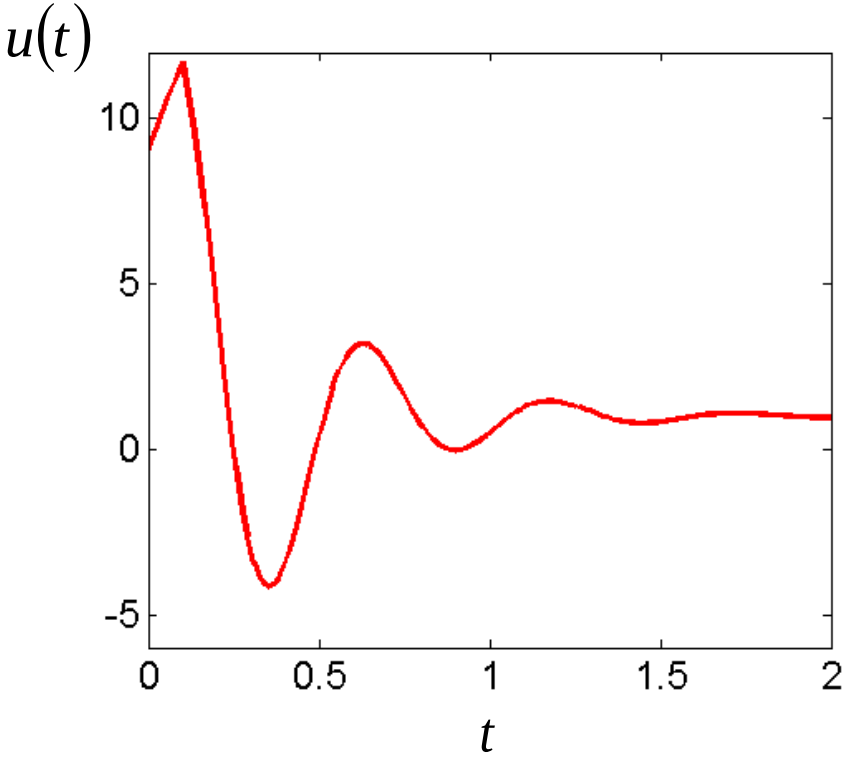
$$W \neq 0$$

$$R = 0$$

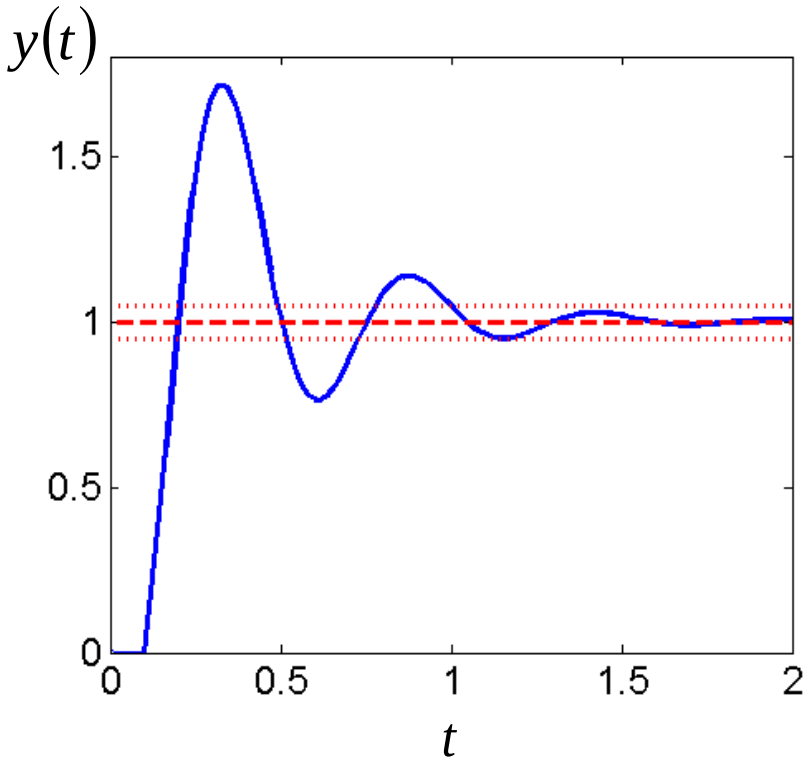


Úloha sledovania

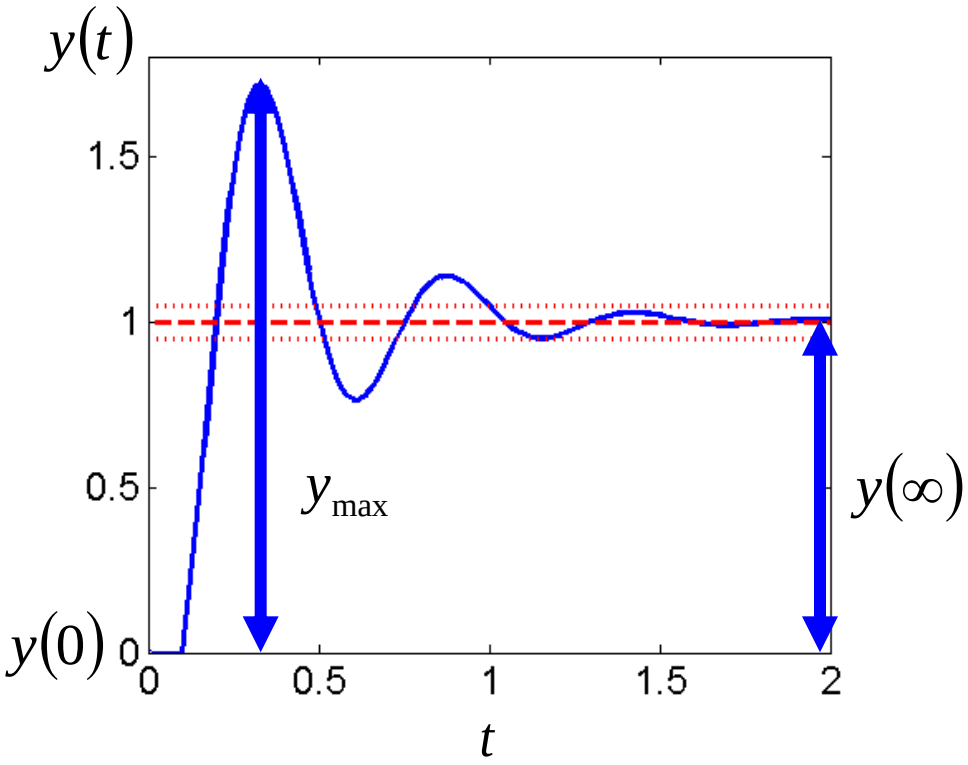




Kvalita riadenia – kritéria v časovej oblasti

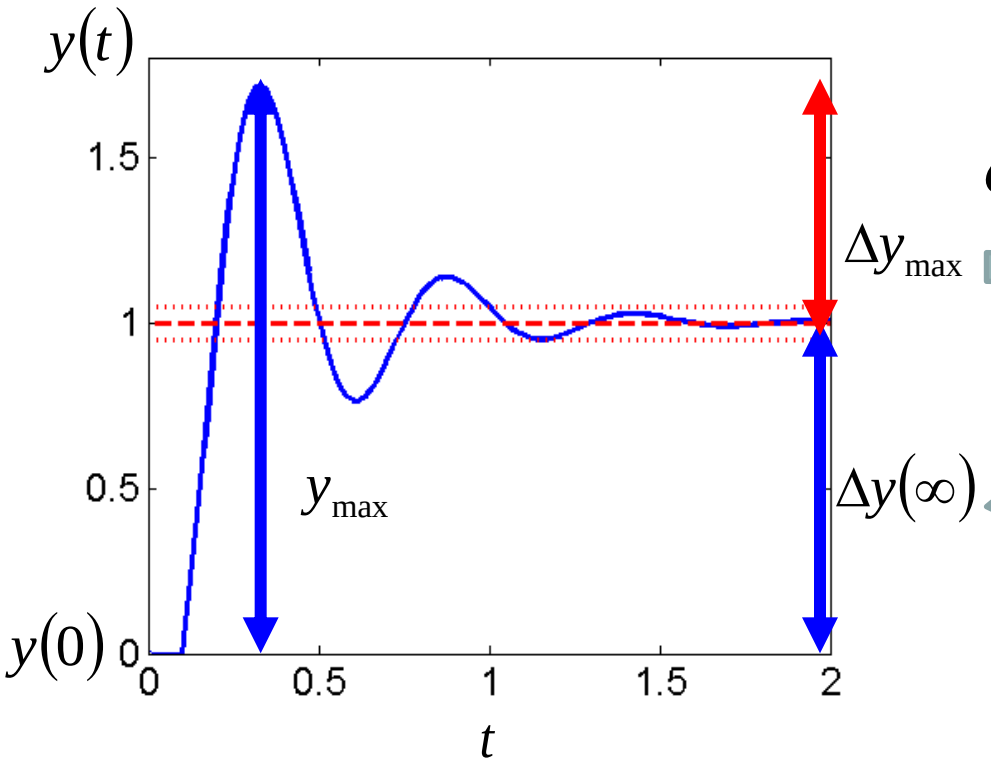


Kvalita riadenia – maximálne prereguľovanie



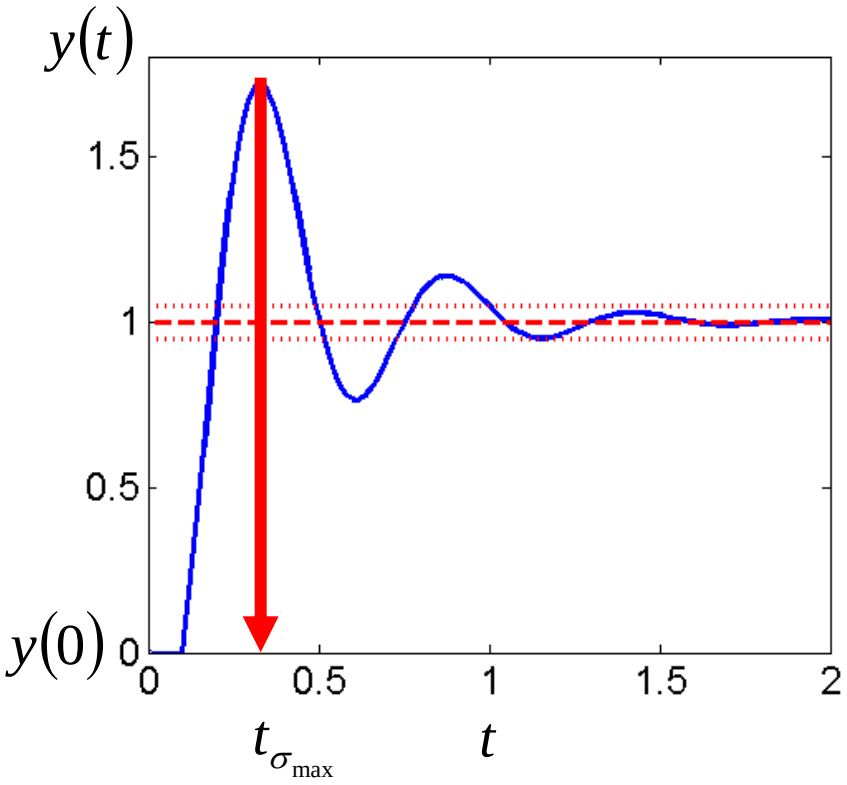
$$\sigma_{\max} = \frac{y_{\max} - y(0)}{y(\infty) - y(0)} \times 100\%$$

Kvalita riadenia – maximálne prereguluvanie



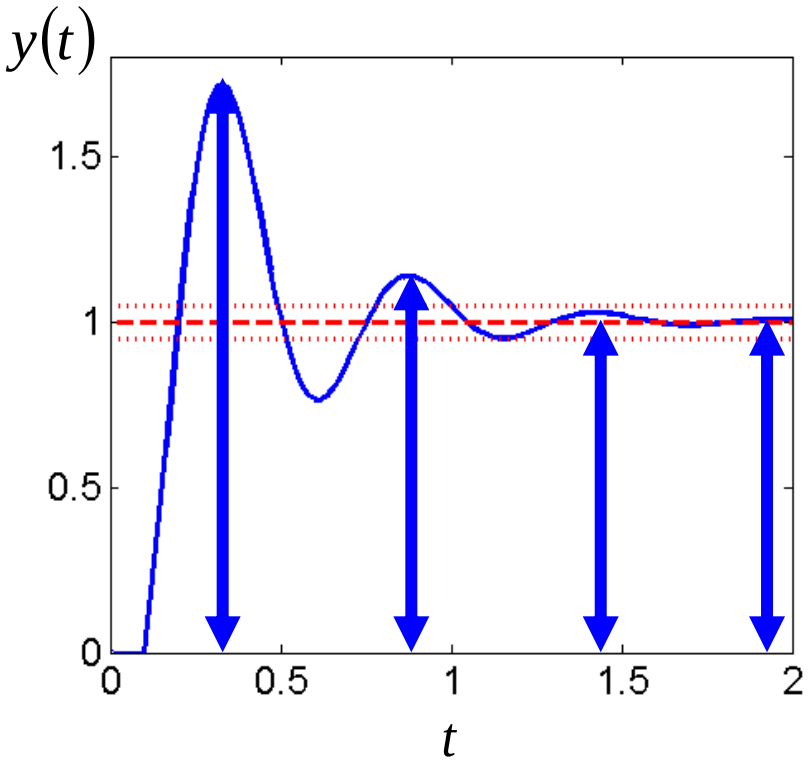
$$\sigma_{\max} = \frac{\Delta y_{\max}}{\Delta y(\infty)} \times 100\%$$

Kvalita riadenia – čas maximálneho prereguloványia

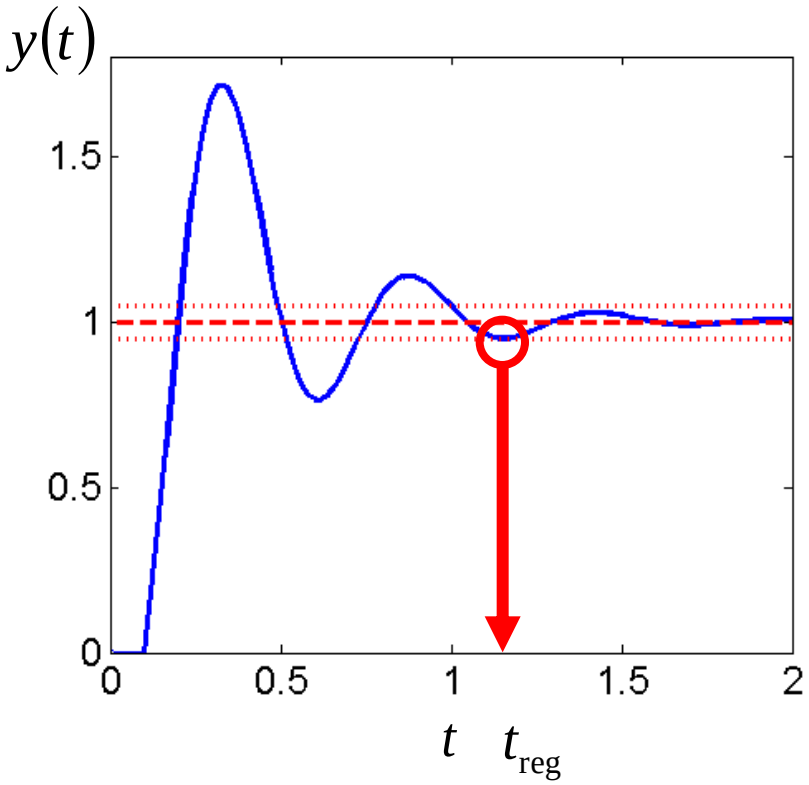


$$t_{\sigma_{\max}} = \{t : y(t) = y_{\max}\}$$

Kvalita riadenia – počet preregulovaní

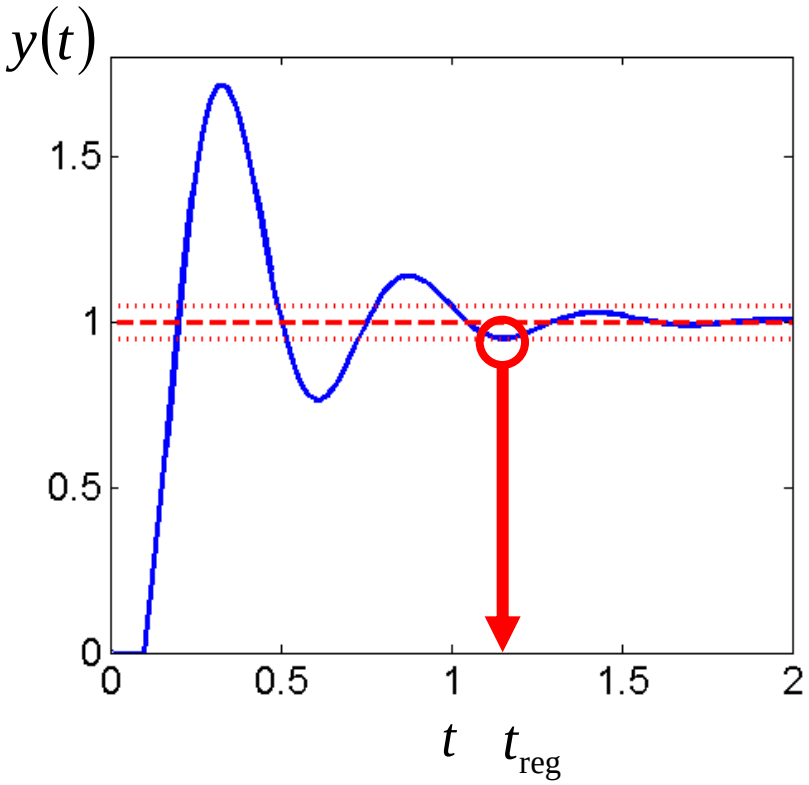


Kvalita riadenia – čas regulácie

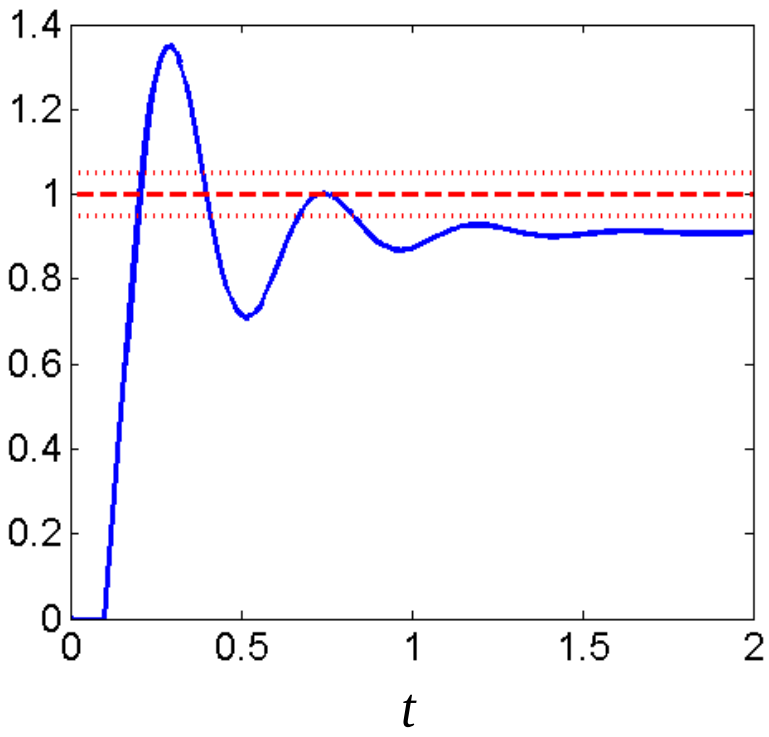


$$y(t) \in \langle w-\delta, w+\delta \rangle \quad t > t_{reg}$$

Kvalita riadenia – čas regulácie



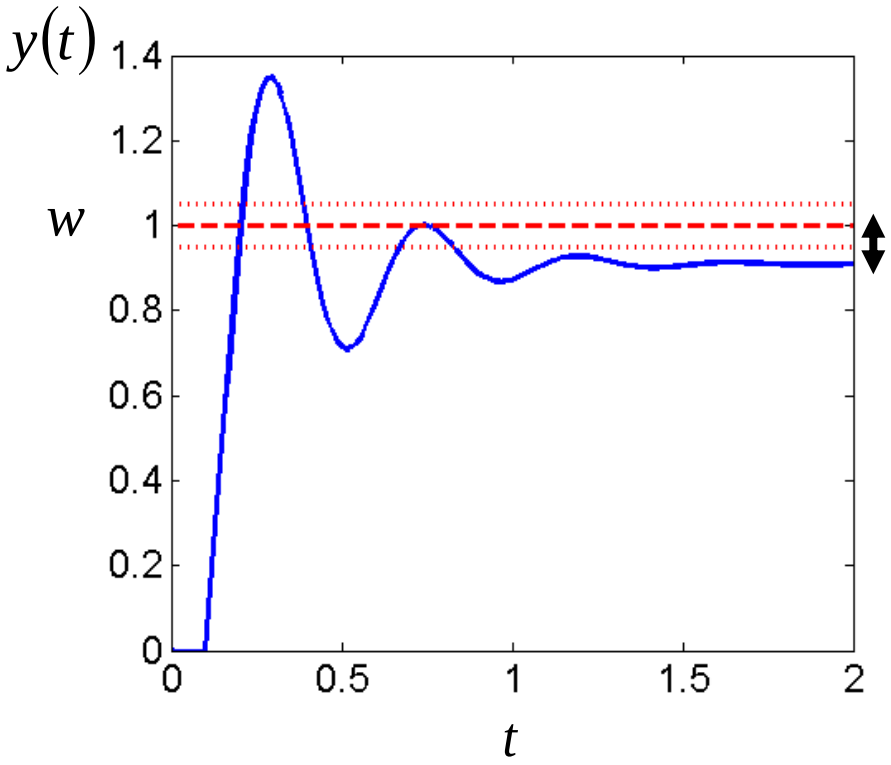
nie je



$$y(t) \in \langle w-\delta, w+\delta \rangle \quad t > t_{reg}$$

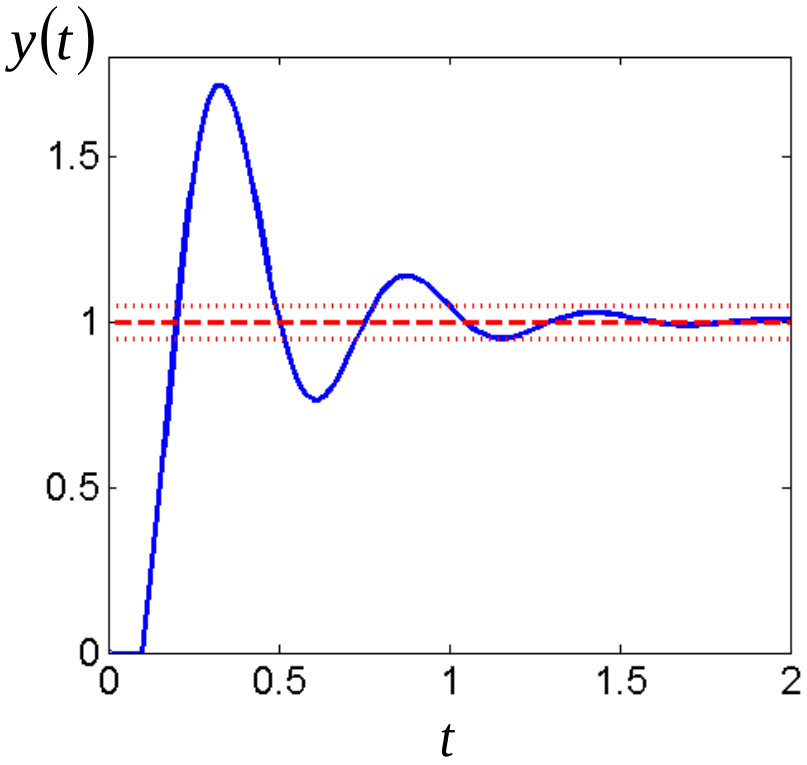
$$y(\infty) \notin \langle w-\delta, w+\delta \rangle$$

Kvalita riadenia – trvalá regulačná odchýlka

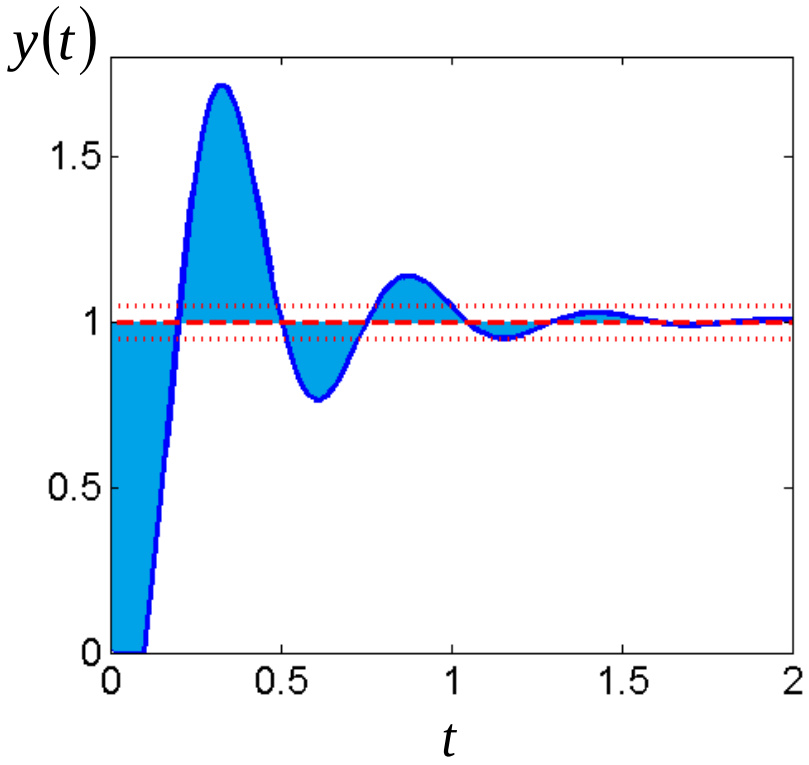


$$e(\infty) = w - y(\infty)$$

Kvalita riadenia – integrálne kritéria

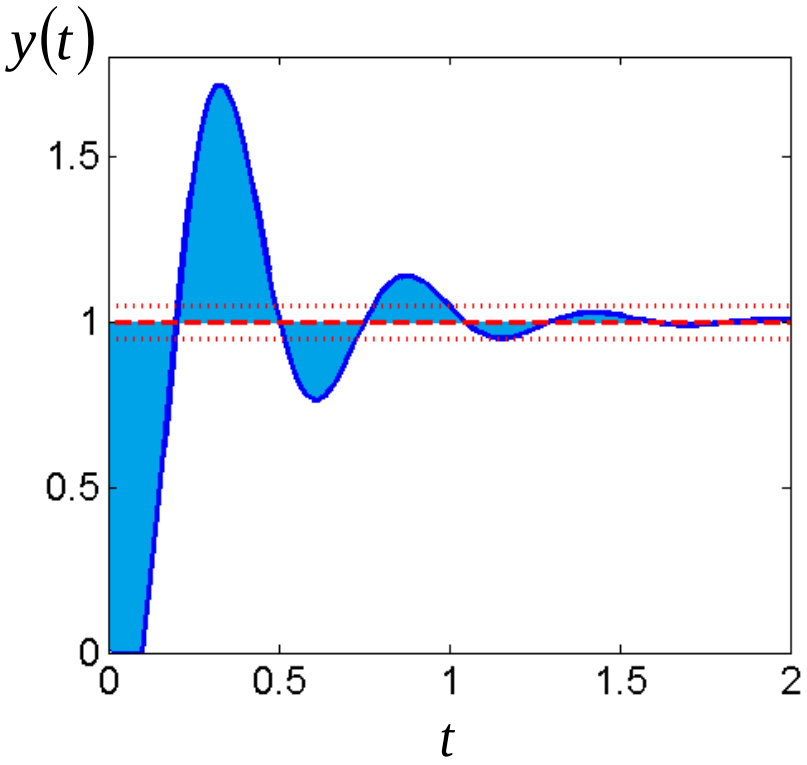


Kvalita riadenia – IAE



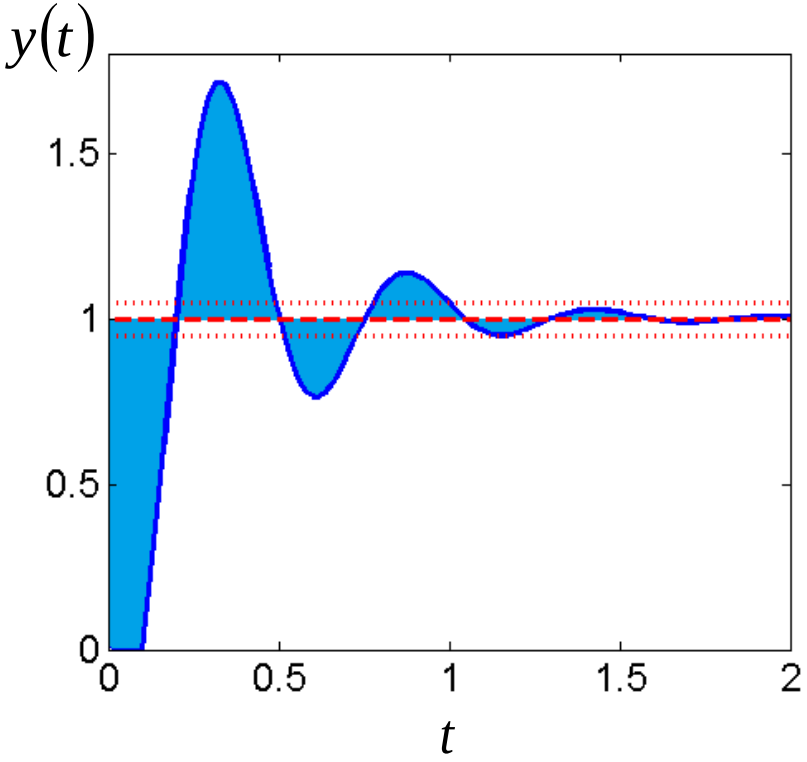
$$IAE = \int_0^{\infty} |e(t)| \mathrm{d}t$$

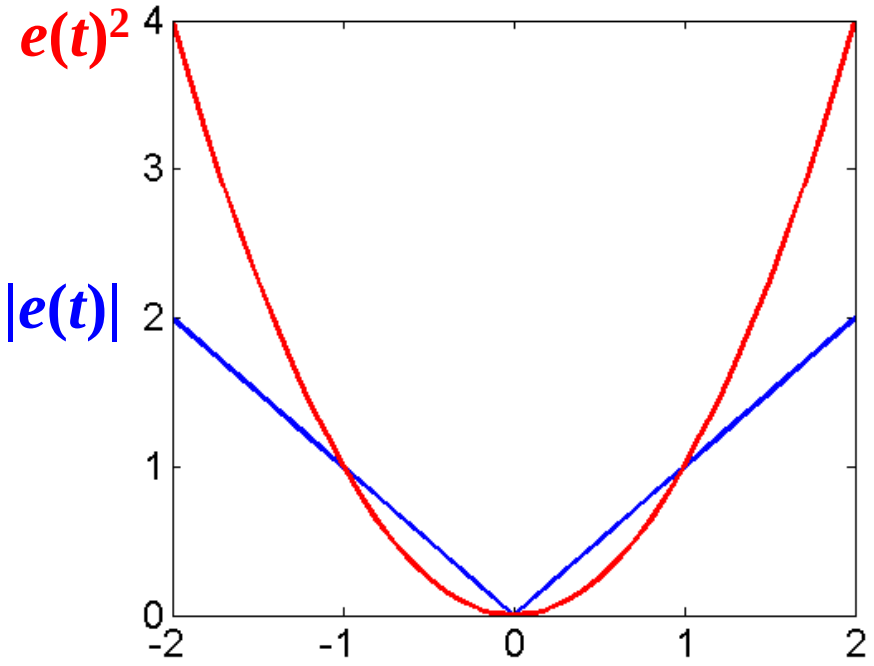
Kvalita riadenia – ISE



$$ISE = \int_0^\infty e(t)^2 \, \mathrm{d}t$$

Kvalita riadenia – IAE vs. ISE

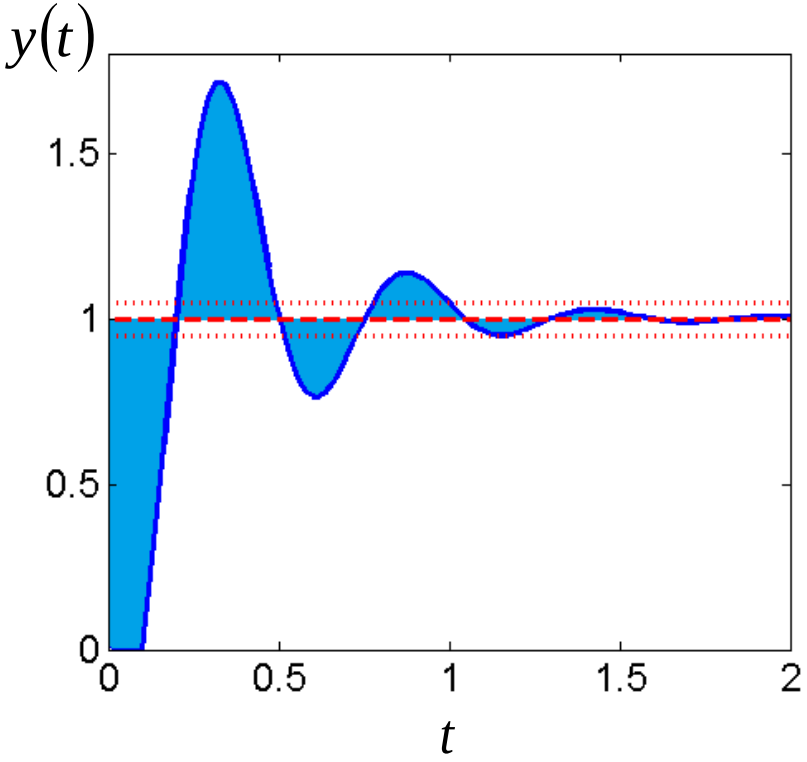


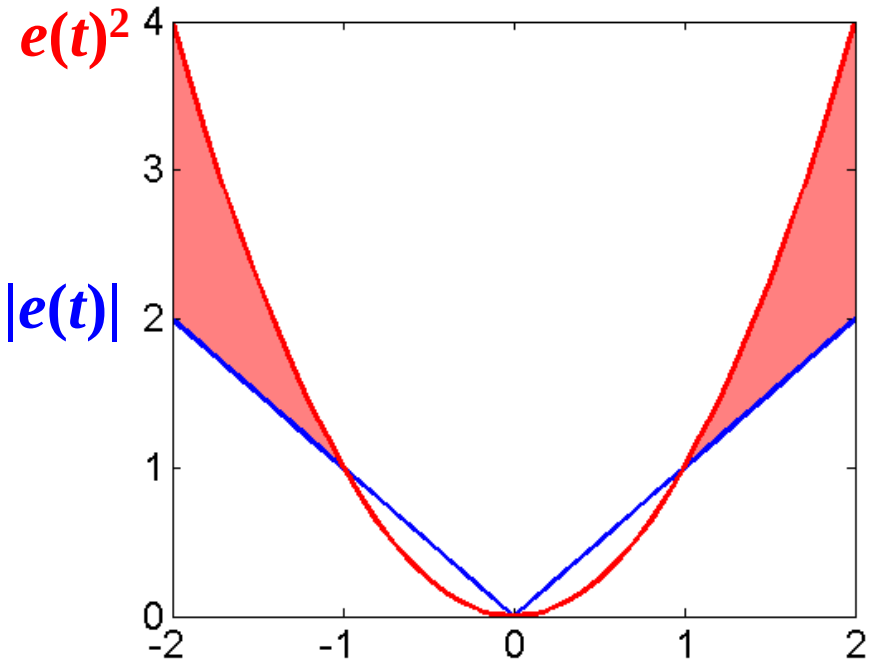


$$IAE = \int_0^\infty |e(t)| \mathrm{d}t$$

$$ISE = \int_0^\infty e(t)^2 \mathrm{d}t$$

Kvalita riadenia – IAE vs. ISE

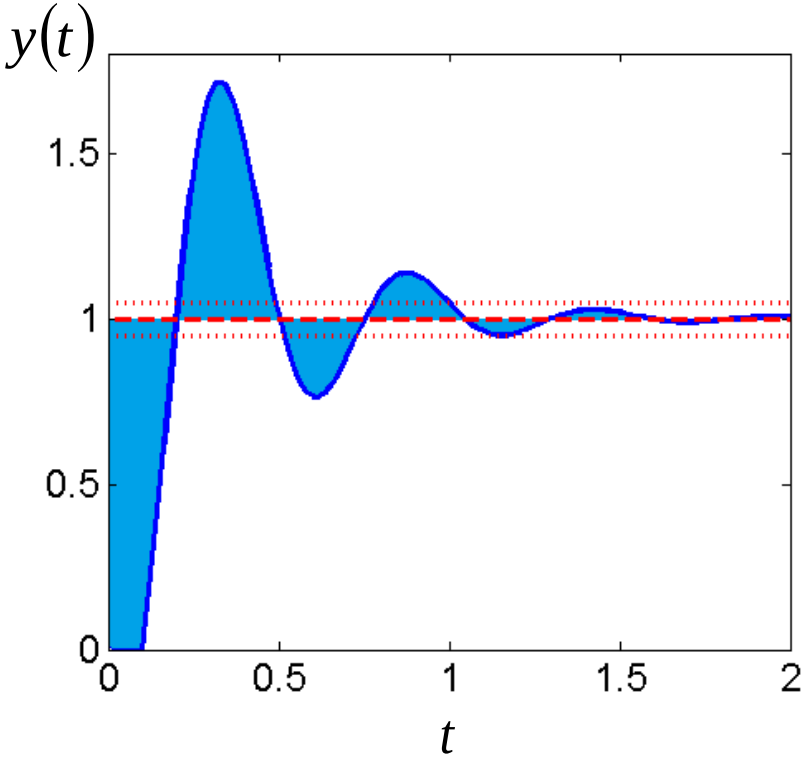


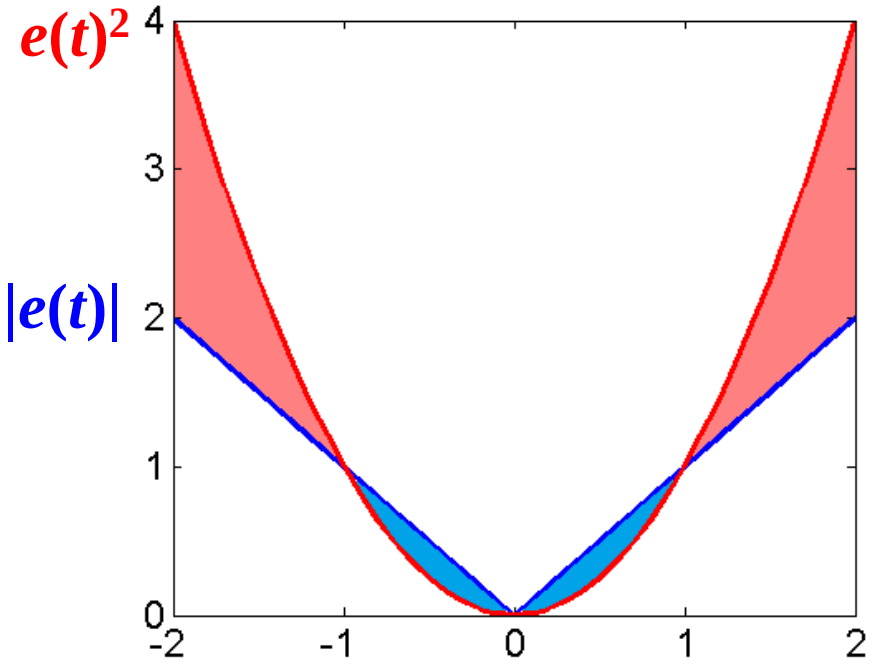


$$IAE = \int_0^\infty |e(t)| \mathrm{d}t$$

$$ISE = \int_0^\infty e(t)^2 \mathrm{d}t$$

Kvalita riadenia – IAE vs. ISE

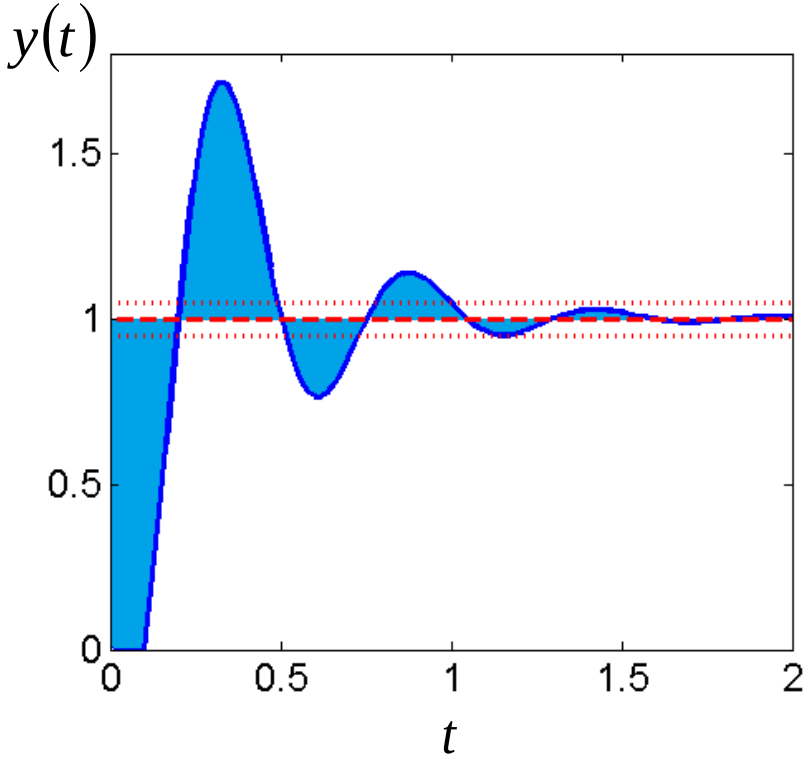




$$IAE = \int_0^\infty |e(t)| \mathrm{d}t$$

$$ISE = \int_0^\infty e(t)^2 \mathrm{d}t$$

Kvalita riadenia – ITAE, ITSE, ISTSE

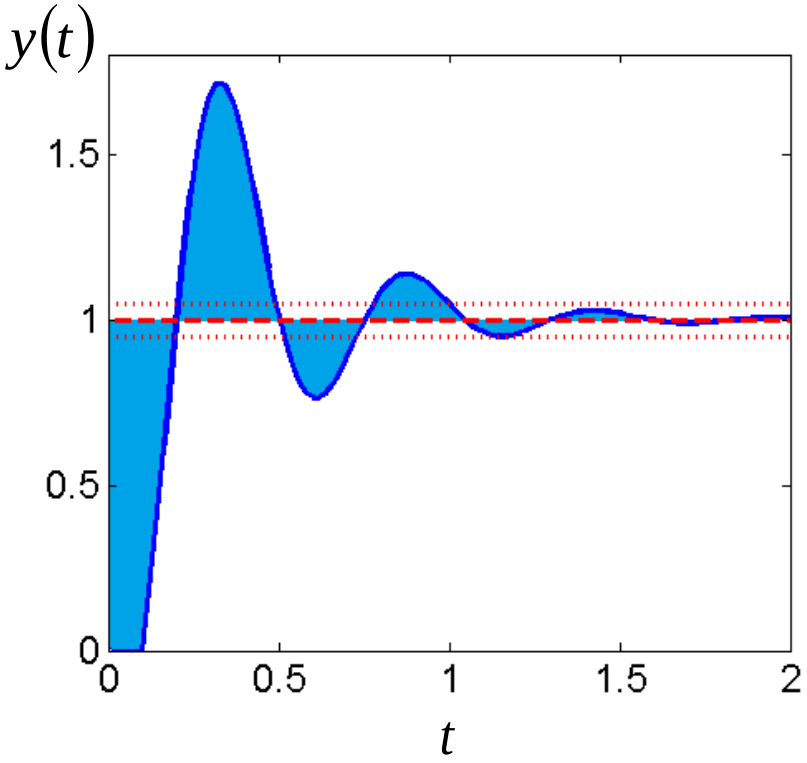


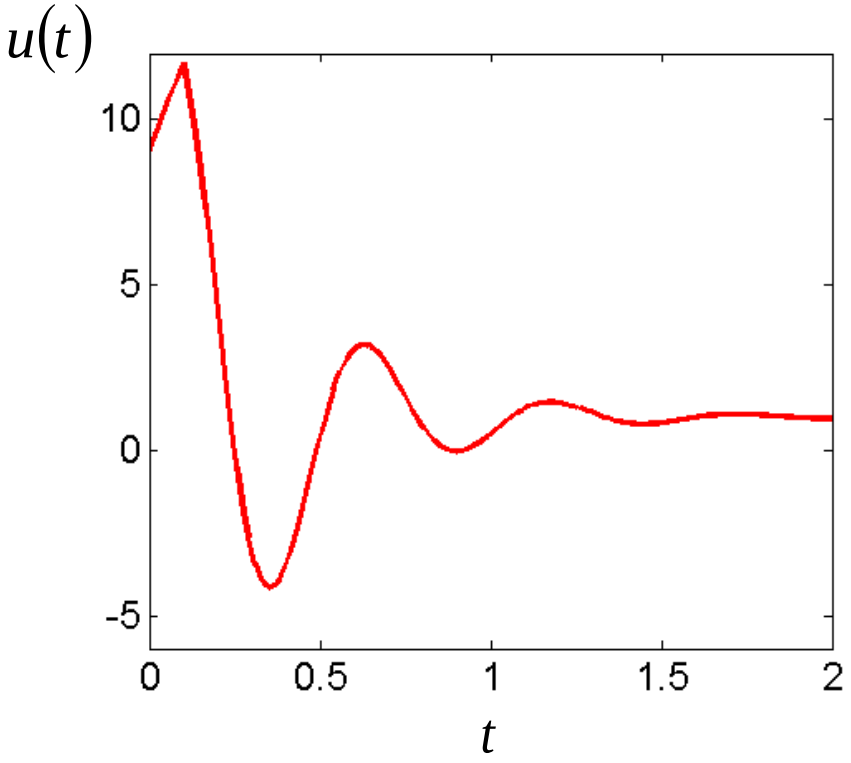
$$ITAE = \int_0^\infty t|e(t)|\mathrm{d}t$$

$$ITSE = \int_0^\infty te(t)^2\,\mathrm{d}t$$

$$ISTSE = \int_0^\infty t^2e(t)^2\,\mathrm{d}t$$

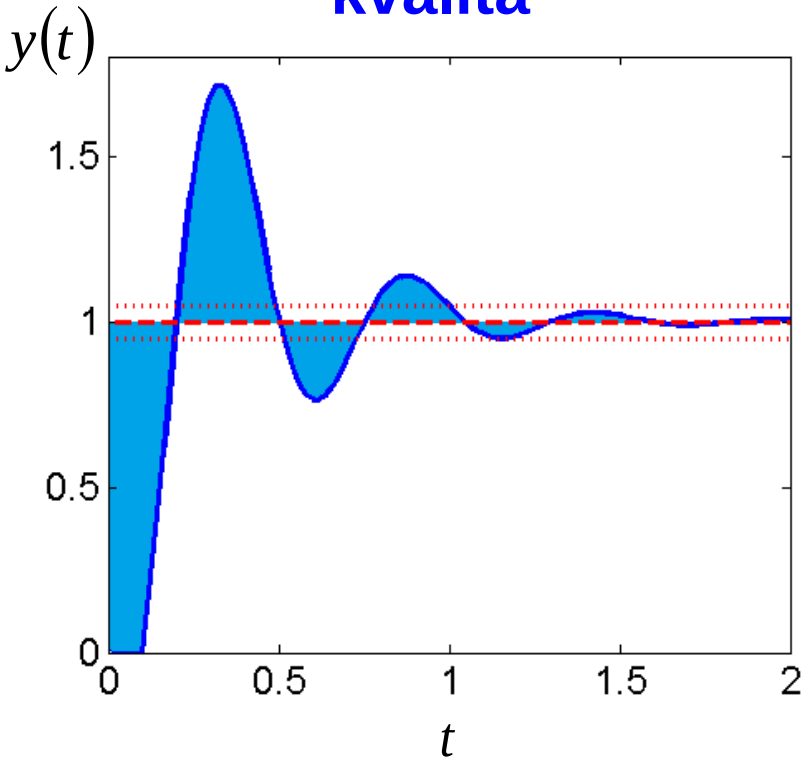
Kvalita riadenia – komplexné kritérium



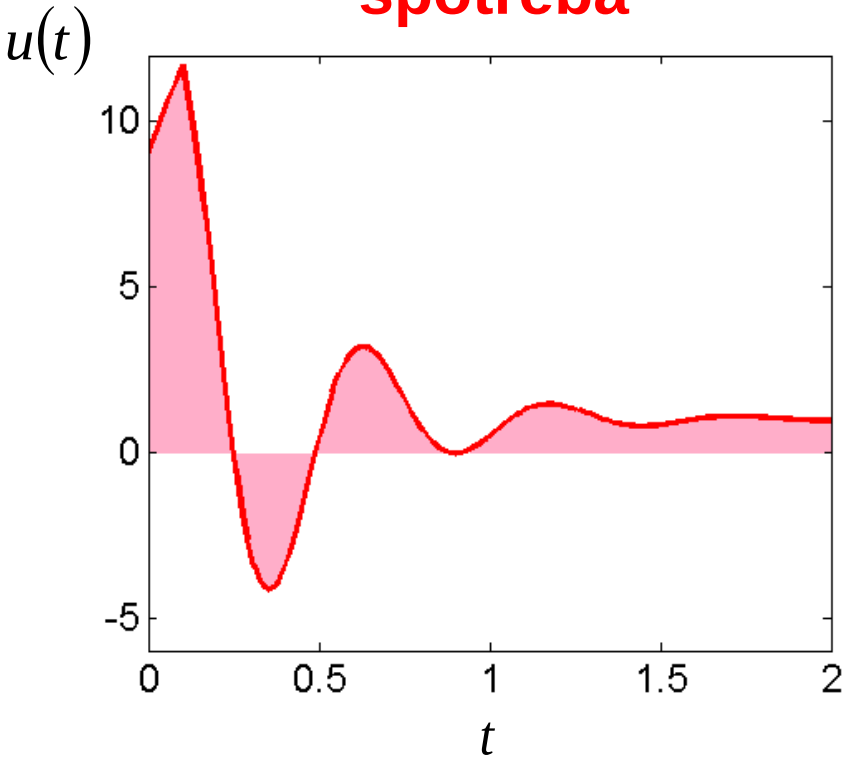


Kvalita riadenia – komplexné kritérium

kvalita



spotreba

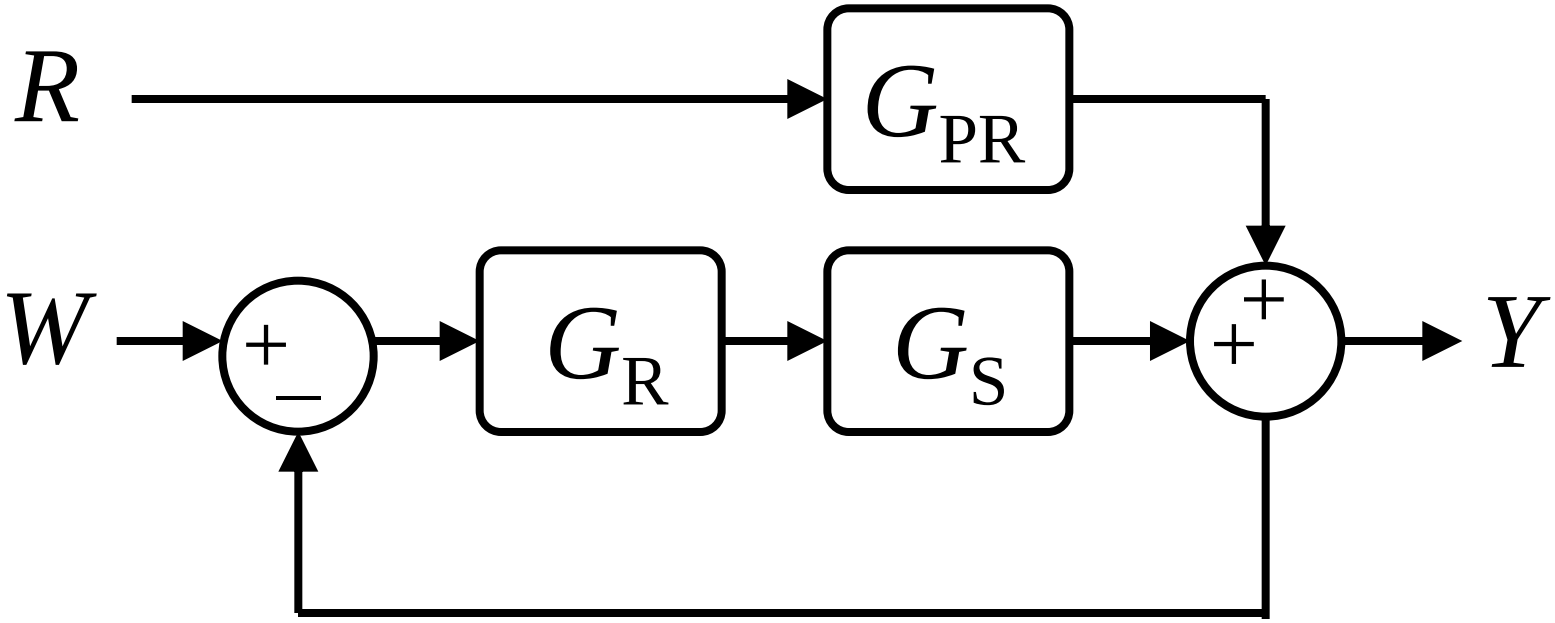


$$J = \int_0^{\infty} \left(Qe(t)^2 + Ru(t)^2 \right) \mathrm{d}t$$

Úloha regulácie

$W = 0$

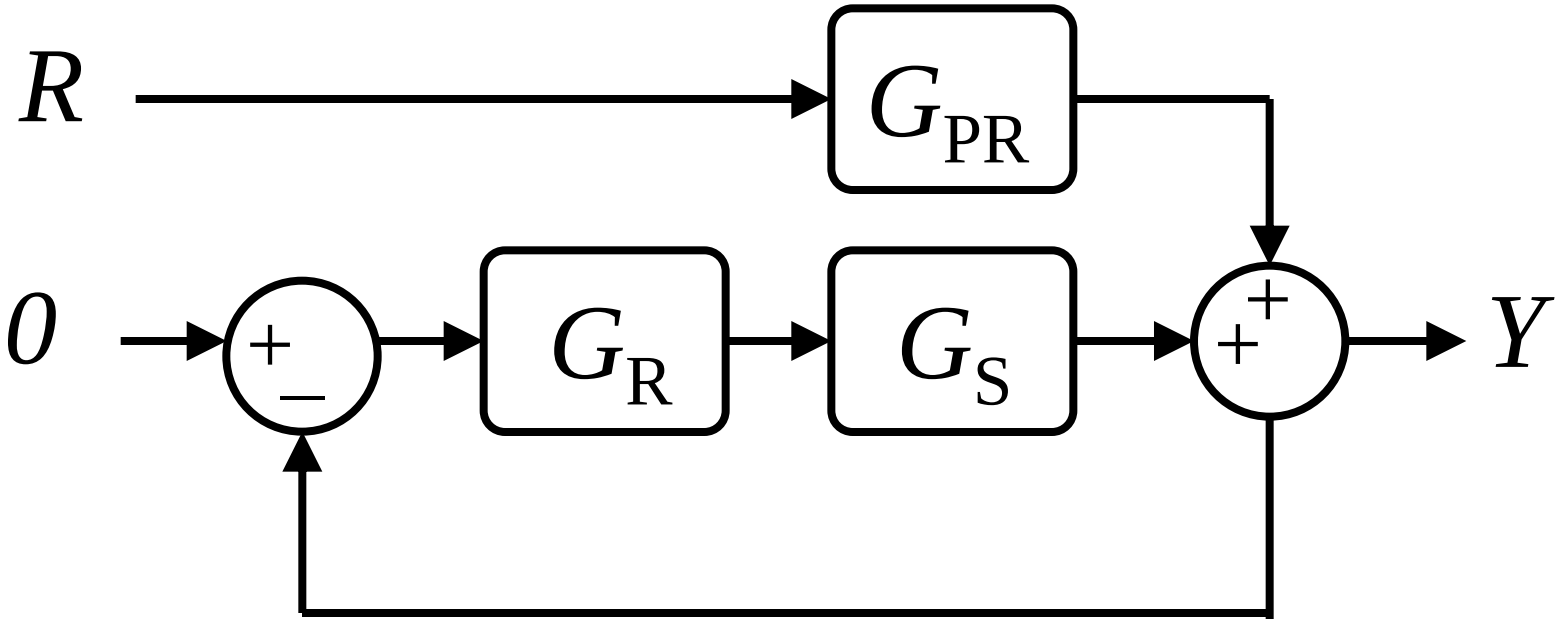
$R \neq 0$



Úloha regulácie

$W = 0$

$R \neq 0$



Úloha regulácie