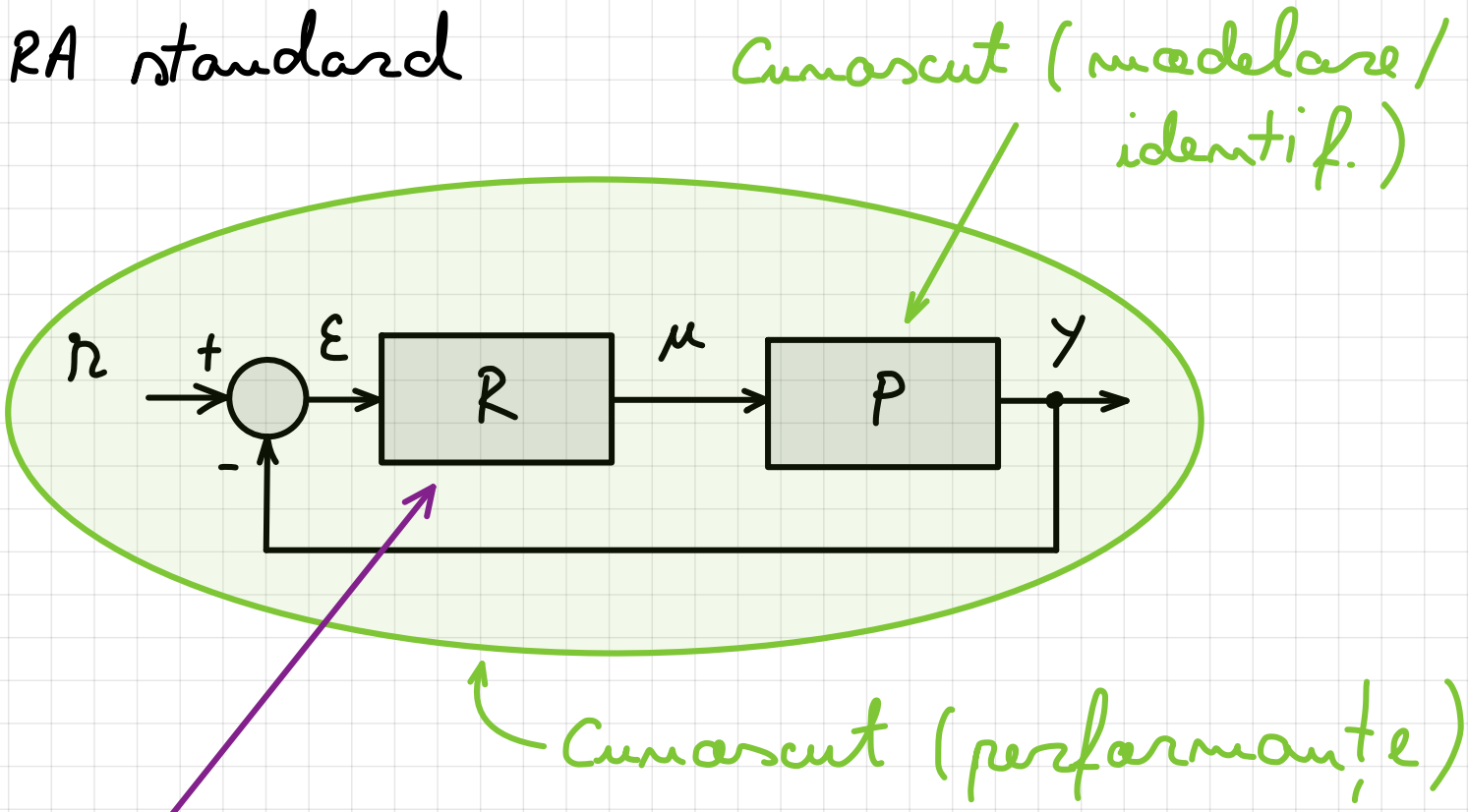
Criteriul modulului

SRA standard



PID: $K_R \left(1 + \frac{1}{T_i s} + T_d s\right)$

? ? ?

Clasificare procese

1) Procese rapide / procese lente

$$H_p(s) = \frac{K_P}{\prod_{k=1}^{n} (T_k s + 1)}$$

! → T_k ct. timp

Def: Proces rapid

$\forall T_k \leq 10$ sec.

Def: Proces lent

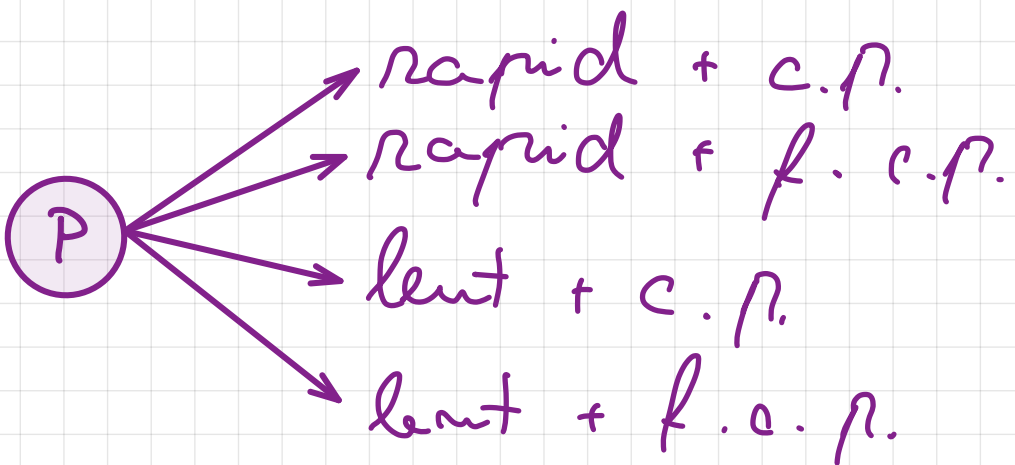
$\exists T_k \geq 10$ sec.

2) Ct. de timp parazite $\rightarrow$ DA / NU

$$H_p(s) = \frac{K_p}{(T_\Sigma s + 1) \cdot \prod_{k=1}^{m} (T_k s + 1)}$$

Def: T_Σ - ct. de timp parazită

$$T_\Sigma \leq 0,1 \cdot \min_k (T_k)$$



Obs:

1) $T_{\Sigma_1}, T_{\Sigma_2}, \dots \approx T_\Sigma$

$$T_\Sigma = T_{\Sigma_1} + T_{\Sigma_2} + \dots$$

ex.

$$\frac{K_p}{(T_{\Sigma_1} s + 1)(T_{\Sigma_2} s + 1) \prod_k (T_k s + 1)} \approx$$

$$\approx \frac{K_p}{(T_\Sigma s + 1) \prod_k (T_k s + 1)}, \quad T_\Sigma = T_{\Sigma_1} + T_{\Sigma_2}$$

$$T_{\Sigma_1} \cdot T_{\Sigma_2} \cdot s^2 + (T_{\Sigma_1} + T_{\Sigma_2}) s + 1$$

$T_{\Sigma_1} \cdot T_{\Sigma_2} \approx 0$

$T_{\Sigma_1} + T_{\Sigma_2} \approx T_\Sigma$

2) P. lent + c. p. $\approx$ P. lent

ex. $\frac{5}{(40s+1)(s+1)} \simeq \frac{5}{40s+1}$

Criteriul modulului

!!! Procese rapide + c.p.

$$H_p = \frac{K_p}{(T_\Sigma s+1)\prod_K (T_K s+1)}$$

$\forall T_K \leq 10\ sec \rightarrow$ ct. rapide

$T_\Sigma \leq 0,1 \cdot \min_K T_K$

$$H_R(s) = \frac{\prod_K T_K s+1}{2K_p \cdot T_\Sigma \cdot s} \rightarrow \begin{cases} \sigma = 4,3\% \\ t_t = 8 \cdot T_\Sigma \\ \varepsilon_{st} = 0 \\ \varepsilon_v = 2 \cdot T_\Sigma \end{cases}$$

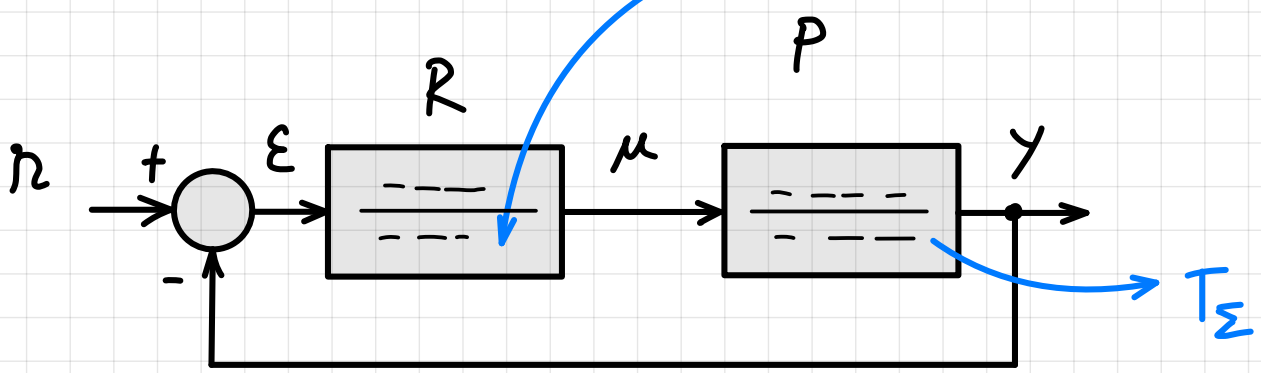
- Implementabilitatea fizică a reg.

$$\ell_{H_R} \geq 0$$

Obs: Procesul > 1 ct. timp dominantă (2, 3, 4, ...), at. Reg. nu este impl. fizic

=> Filtrare

$$H_R(\Lambda) = \frac{\prod_k T_k \Lambda + 1}{2 K_P \cdot T_\Sigma \cdot \Lambda \prod_i (T_{F_i} \Lambda + 1)}$$



$$T_\Sigma' = T_\Sigma + T_{F_1} + T_{F_2} + \dots$$

!!! $t_t = 8 \cdot T_\Sigma'$

$\varepsilon_v = 2 \cdot T_\Sigma'$

Trebuie să impunem ca adăugarea ct. de filtrare să nu ducă la încălcarea constr. de performanță impuse

(P1)

$$H_p(s) = \frac{100}{(0,1s+1)(2s+1)(8s+1)}$$

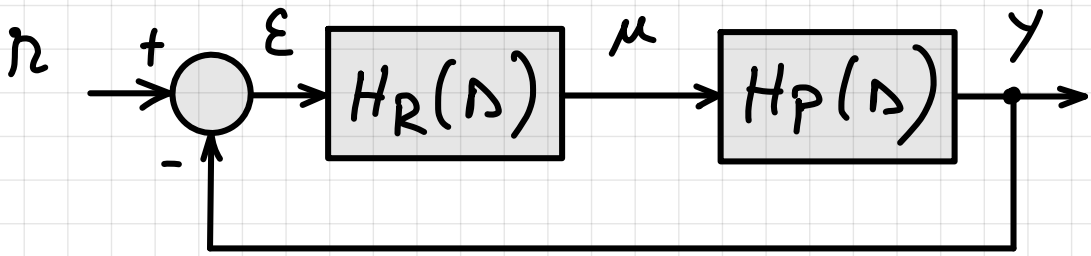
a) Structura SRA care asigură urmărirea referinței și rejecția perturbațiilor

b) Alg. de reglare care asigură

$$\begin{cases} \sigma \leq 5\% \\ t_t \leq 1{,}2 \text{ sec.} \\ \varepsilon_{sT} = 0 \\ \varepsilon_v \leq 0{,}3 \text{ sec.} \end{cases}$$

Rezolvare

a) SRA standard cu un grad de libertate



b)

1) Analiza proces

$$\left.\begin{array}{l} T_1 = 0{,}1 \text{ sec.} \\ T_2 = 2 \text{ sec} \\ T_3 = 8 \text{ sec} \end{array}\right\} \rightarrow T_1, T_2, T_3 \leq 10 \text{ sec}$$

=> Proces rapid

$T_1 \leq 0{,}1 \cdot \min(T_2, T_3)$

=> T_1 - ct. parazită

2) Verif. performanțelor (oferite de crit. modulului)

- $\sigma = 4{,}3\% < 5\%$ ✓
- $t_t = 8 \cdot T_\Sigma = 0{,}8 < 1{,}2$ sec ✓
- $\varepsilon_{ST} = 0$ ✓
- $\varepsilon_v = 2 \cdot T_\Sigma = 0{,}2 < 0{,}3$ ✓

crit. modulului — constrângeri din cerință

=> OK → pot aplica crit. modulului

3) Proiectare

$$H_R(s) = \frac{(2s+1)(8s+1)}{2 \cdot 100 \cdot 0{,}1 \cdot s} =$$

$$= \frac{(2s+1)(8s+1)}{20s}$$ → mai este imp.

↓ Trebuie pus sub forma unui reg. PID (PID nefiltrat în acest caz)

$$\underbrace{K_R}_{?}\left(1 + \frac{1}{\underbrace{T_i}_{?} s} + \underbrace{T_d}_{?} s\right) =$$

$$= K_R + \frac{K_R}{T_i s} + K_R T_d s =$$

$$= \frac{K_R T_i s + K_R + K_R T_i T_d s^2}{T_i s} =$$

$$= \frac{16s^2 + 10s + 1}{20s}$$

$$16 T_i s^2 + 10 T_i s + T_i = 20 K_R T_i s +$$

$$+ 20 K_R + 20 K_R T_i T_d s^2$$

$20 K_R = T_i \Rightarrow$ **$T_i = 10$ sec.**

$10 \cancel{T_i} = 20 K_R \cancel{T_i} \Rightarrow$ **$K_R = 0{,}5$**

$16 \cancel{T_i} = 20 K_R \cancel{T_i} T_d \iff$

$\iff 16 = 10 T_d \Rightarrow$ **$T_d = 1{,}6$ sec**

PID: $0{,}5 \left(1 + \frac{1}{10 s} + 1{,}6 s \right)$

4) Filtrare

PID_f: $0{,}5 \left(1 + \frac{1}{10 s} + \underbrace{\frac{1{,}6 s}{T_F s + 1}}_{?} \right)$

Verificăm constr. de performanță

$T_\Sigma = 0,1$

$$\begin{cases} t_t \leq 1,2 \text{ sec} \\ \varepsilon_v \leq 0,3 \text{ sec} \end{cases}$$

$$\begin{cases} t_t : & 8 \cdot (T_F + T_\Sigma) \leq 1,2 \text{ sec} \\ \varepsilon_v : & 2 \cdot (T_F + T_\Sigma) \leq 0,3 \text{ sec} \end{cases}$$

$\rightarrow \quad 8 \cdot T_F + 0,8 \leq 1,2 \iff 8 \cdot T_F \leq 0,4 \text{ sec}$

$\Rightarrow \quad \boxed{T_F \leq 0,05 \text{ sec}}$

$\rightarrow \quad 2 \cdot T_F + 0,2 \leq 0,3 \iff 2 \cdot T_F \leq 0,1 \text{ sec}$

$\Rightarrow \quad \boxed{T_F \leq 0,05 \text{ sec}}$

$\Rightarrow$ Spre ex. aleg $T_F = 0,03 \text{ sec}$

$$\boxed{PID_f : \; 0,5 \left(1 + \frac{1}{10\Delta} + \frac{1,6\Delta}{0,03\Delta + 1} \right)}$$