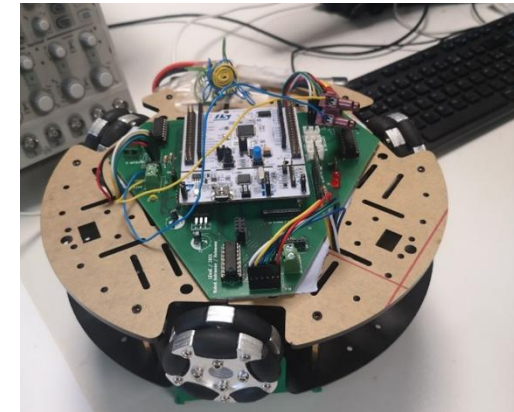
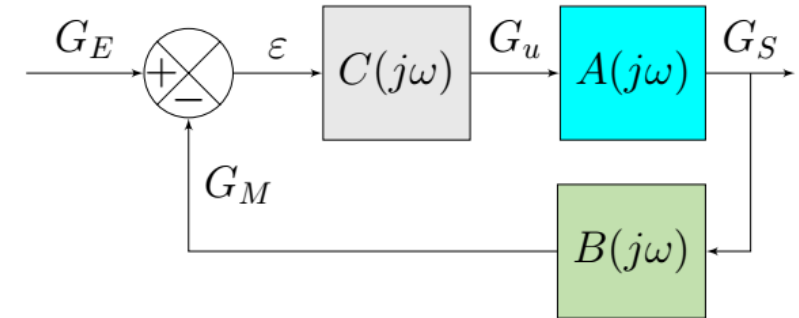
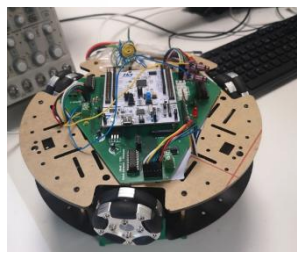


Automatique Systèmes asservis

TD Opto-Electronique

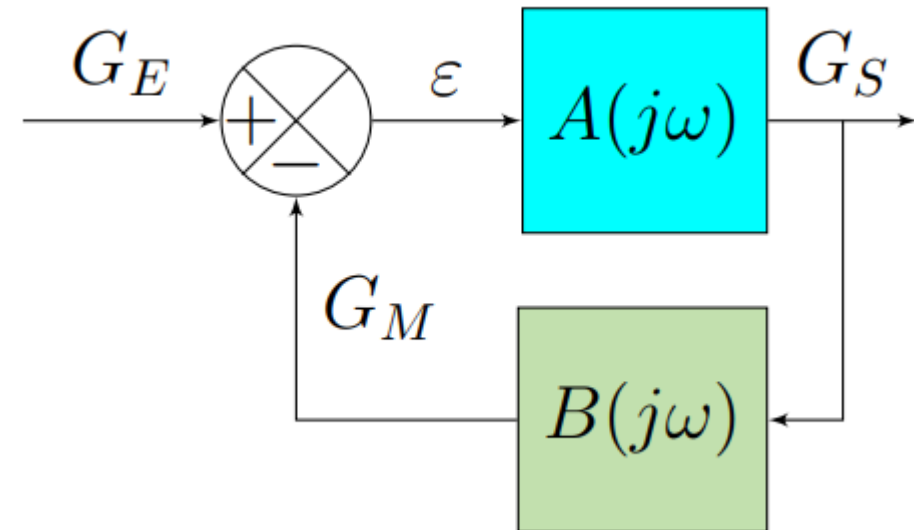
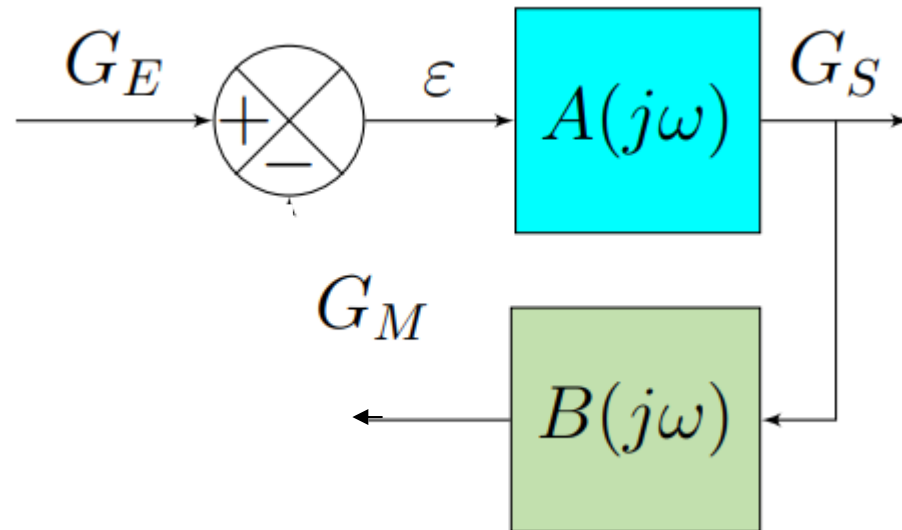
Julien VILLEMEJANE

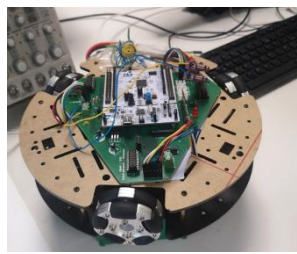




Boucle ouverte / Boucle fermée

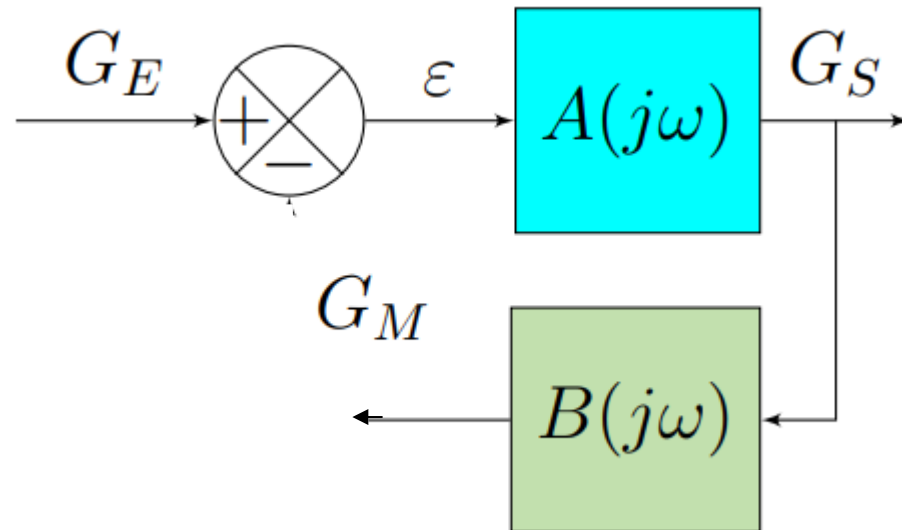
Systèmes asservis





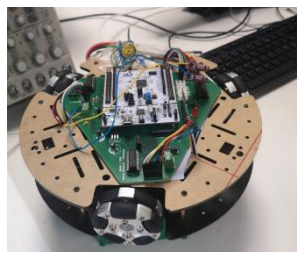
Boucle ouverte / Boucle fermée

Systèmes asservis



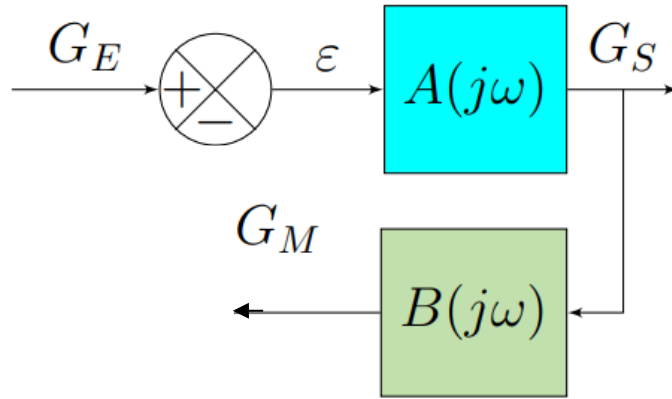
$$G_S = A(j\omega)G_E$$

$$G_M = A(j\omega)B(j\omega)G_E$$



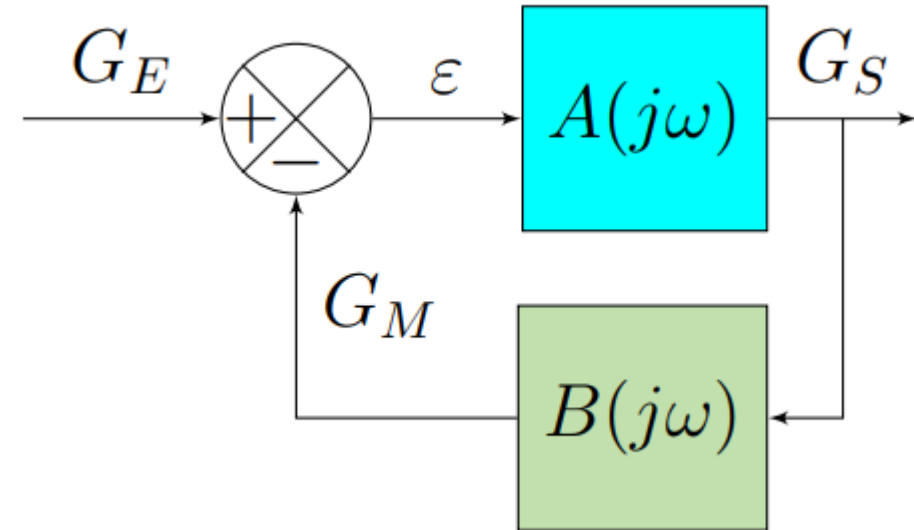
Boucle ouverte / Boucle fermée

Systèmes asservis



$$G_S = A(j\omega)G_E$$

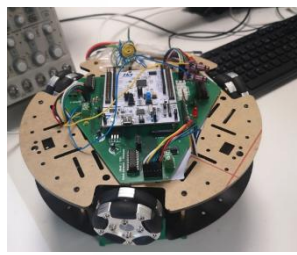
$$G_M = A(j\omega)B(j\omega)G_E$$



$$\varepsilon = G_E - G_M$$

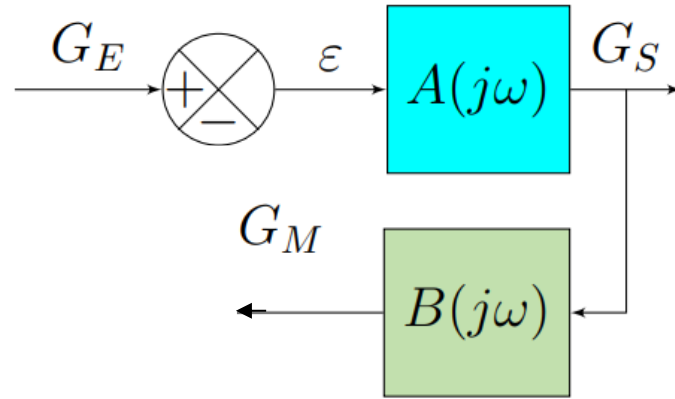
$$G_M = B(j\omega)G_S$$

$$G_S = A(j\omega)\varepsilon$$



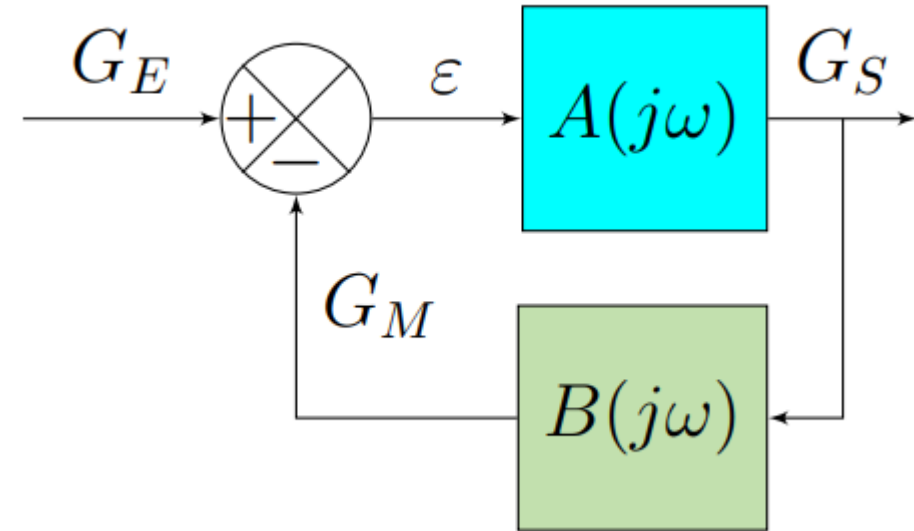
Boucle ouverte / Boucle fermée

Systèmes asservis



$$G_S = A(j\omega)G_E$$

$$G_M = A(j\omega)B(j\omega)G_E$$



$$\varepsilon = G_E - G_M$$

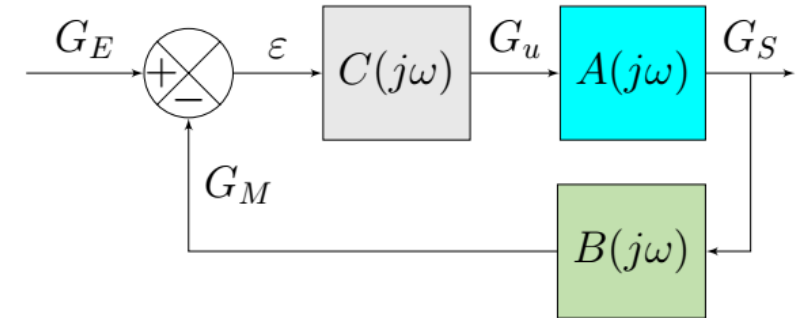
$$G_M = B(j\omega)G_S$$

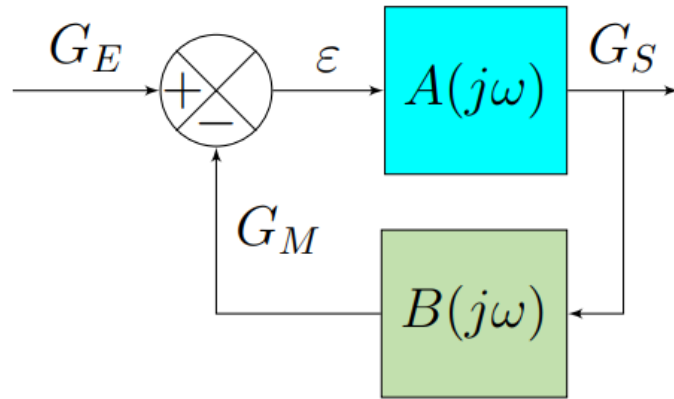
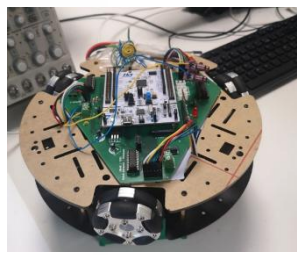
$$G_S = A(j\omega)\varepsilon$$

$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

Systeme A d'Ordre 1

Exercice 2





$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

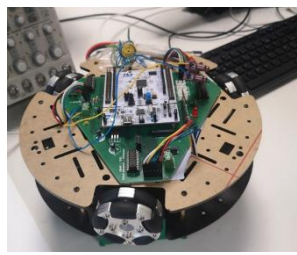
$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

Système A d'ordre 1

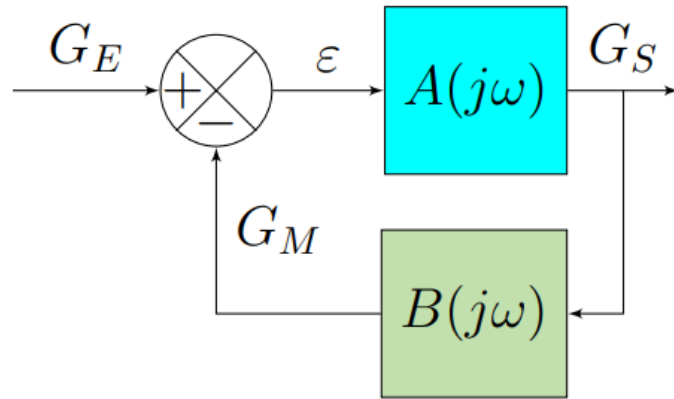
Systèmes asservis

$$H(j\omega) = \frac{K_A}{1 + K_A K_B + T_A j\omega}$$



Système A d'ordre 1

Systèmes asservis



$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

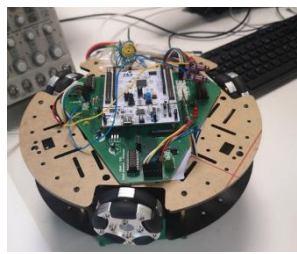
$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$H(j\omega) = \frac{K_A}{1 + K_A K_B + T_A j\omega}$$

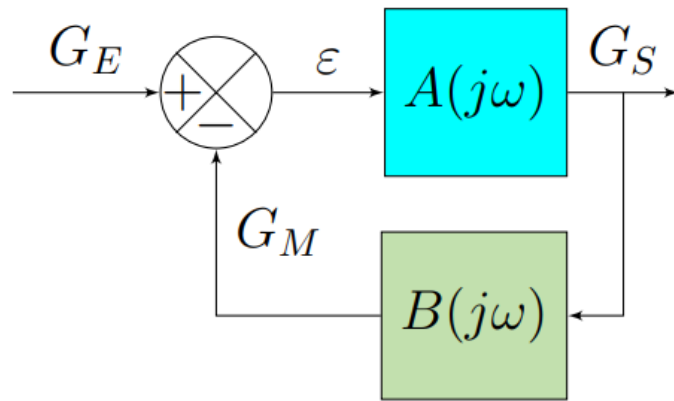
Forme Canonique → Système du premier ordre

$$H(j\omega) = \frac{K_A}{1 + K_A K_B} \frac{1}{1 + \frac{T_A}{1 + K_A K_B} j\omega}$$



Système A d'ordre 1

Systèmes asservis



$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$H(j\omega) = \frac{K_A}{1 + K_A K_B + T_A j\omega}$$

Forme Canonique → Système du premier ordre

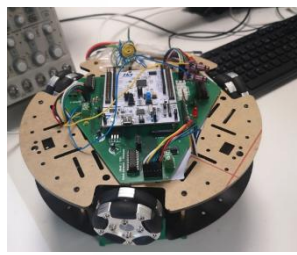
$$H(j\omega) = \frac{K_A}{1 + K_A K_B} \frac{1}{1 + \frac{T_A}{1 + K_A K_B} j\omega}$$

Gain statique

$$H_0 = \frac{K_A}{1 + K_A K_B}$$

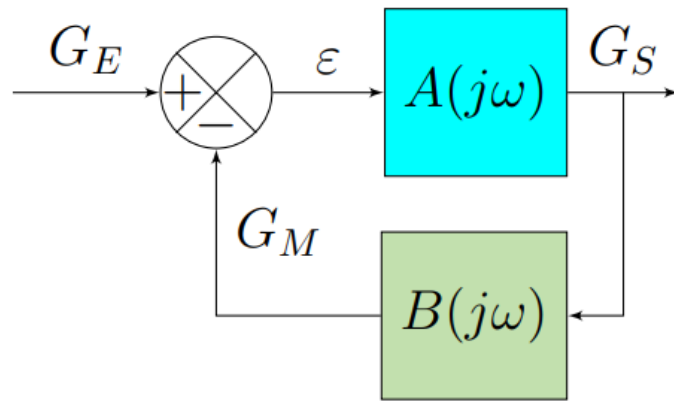
Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B}$$



Système A d'ordre 1

Systèmes asservis



$K_A = 1$; $K_B = 1$; $T_A = 100$ ms

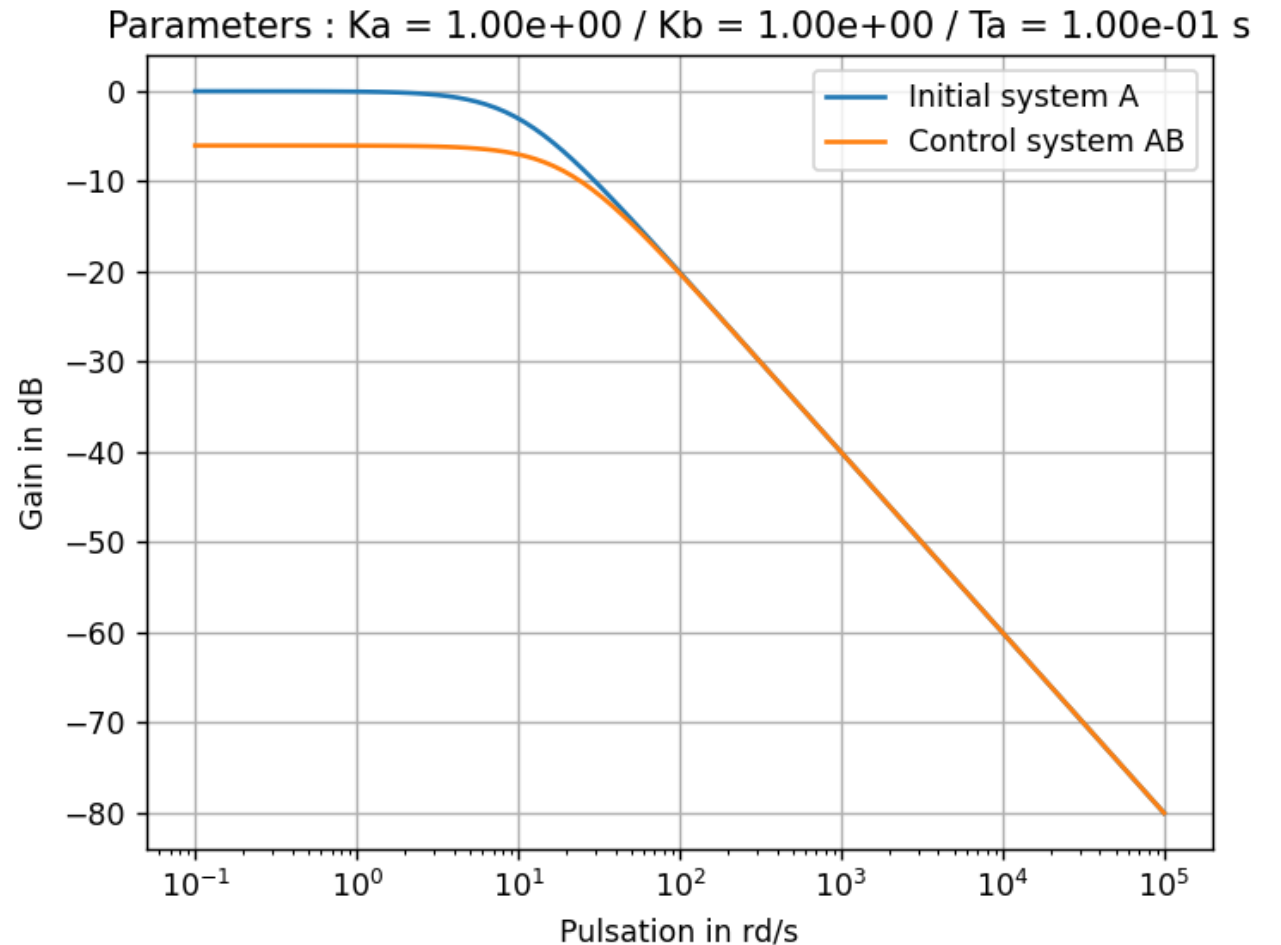
Système du premier ordre

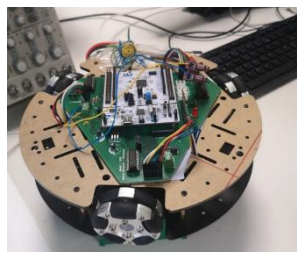
Gain statique

$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

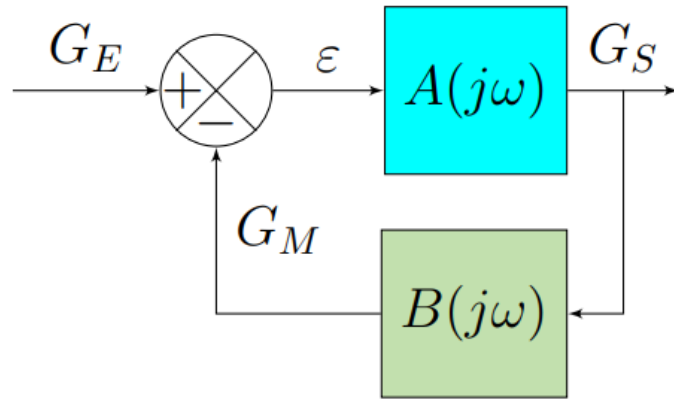
$$T_H = \frac{T_A}{1 + K_A K_B}$$





Système A d'ordre 1

Systèmes asservis



$K_A = 10$; $K_B = 1$; $T_A = 100$ ms

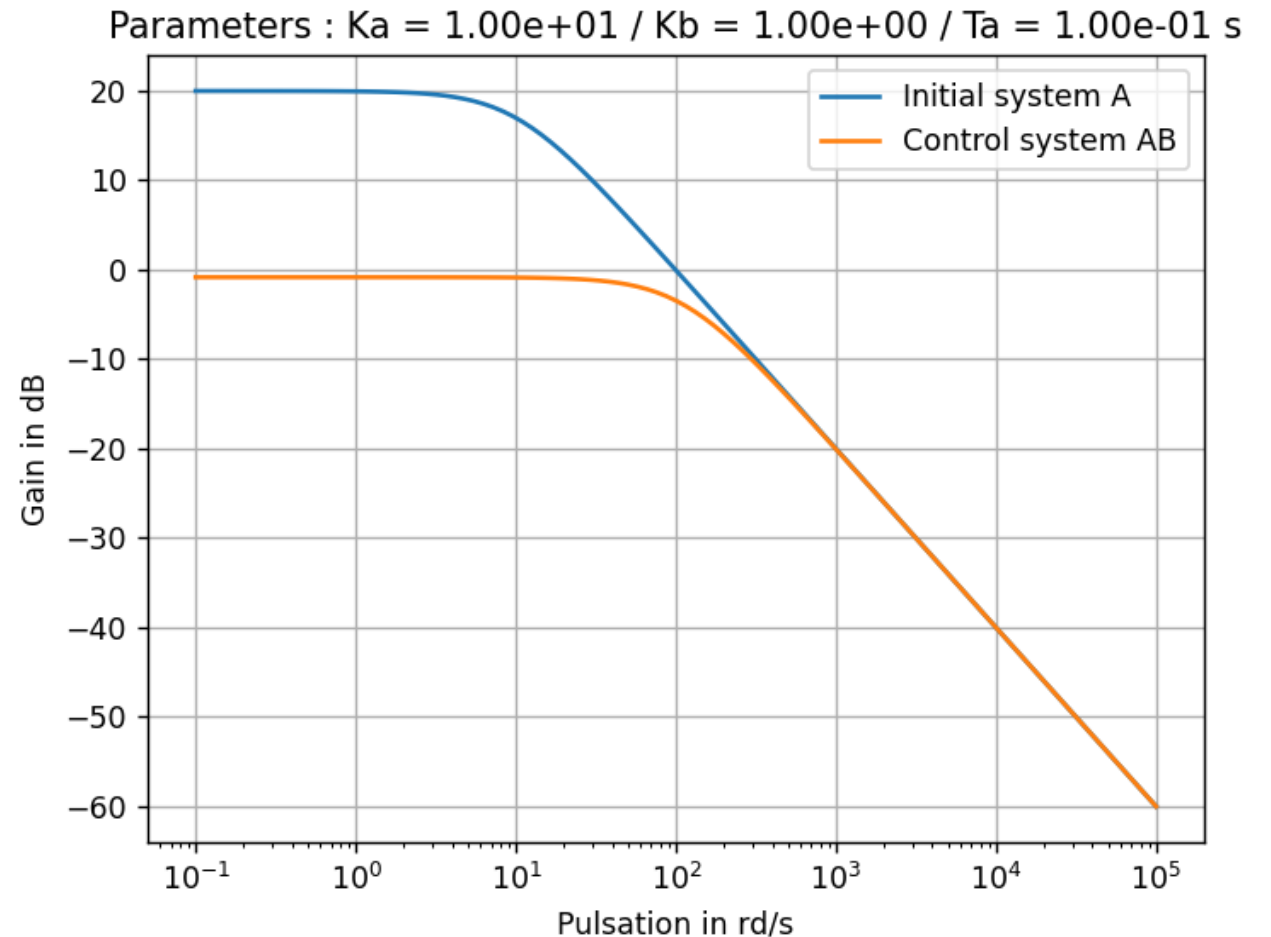
Système du premier ordre

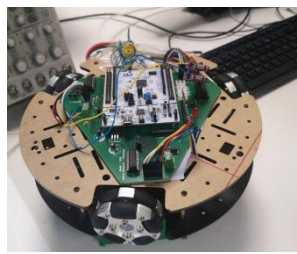
Gain statique

$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

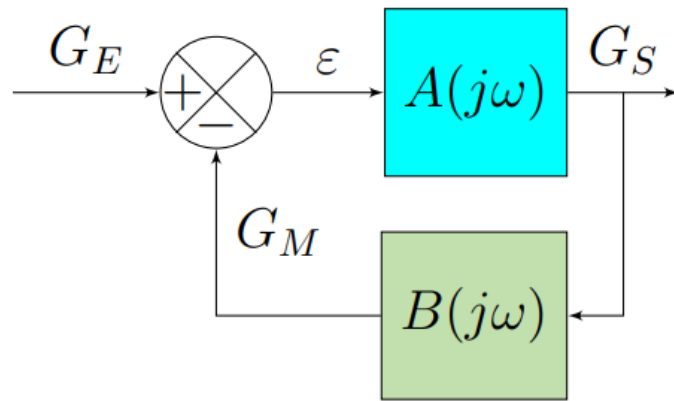
$$T_H = \frac{T_A}{1 + K_A K_B}$$





Système A d'ordre 1

Systèmes asservis



$$K_A = 10^7 ; K_B = 10^{-4} ; T_A = 100 \text{ ms}$$

Système du premier ordre

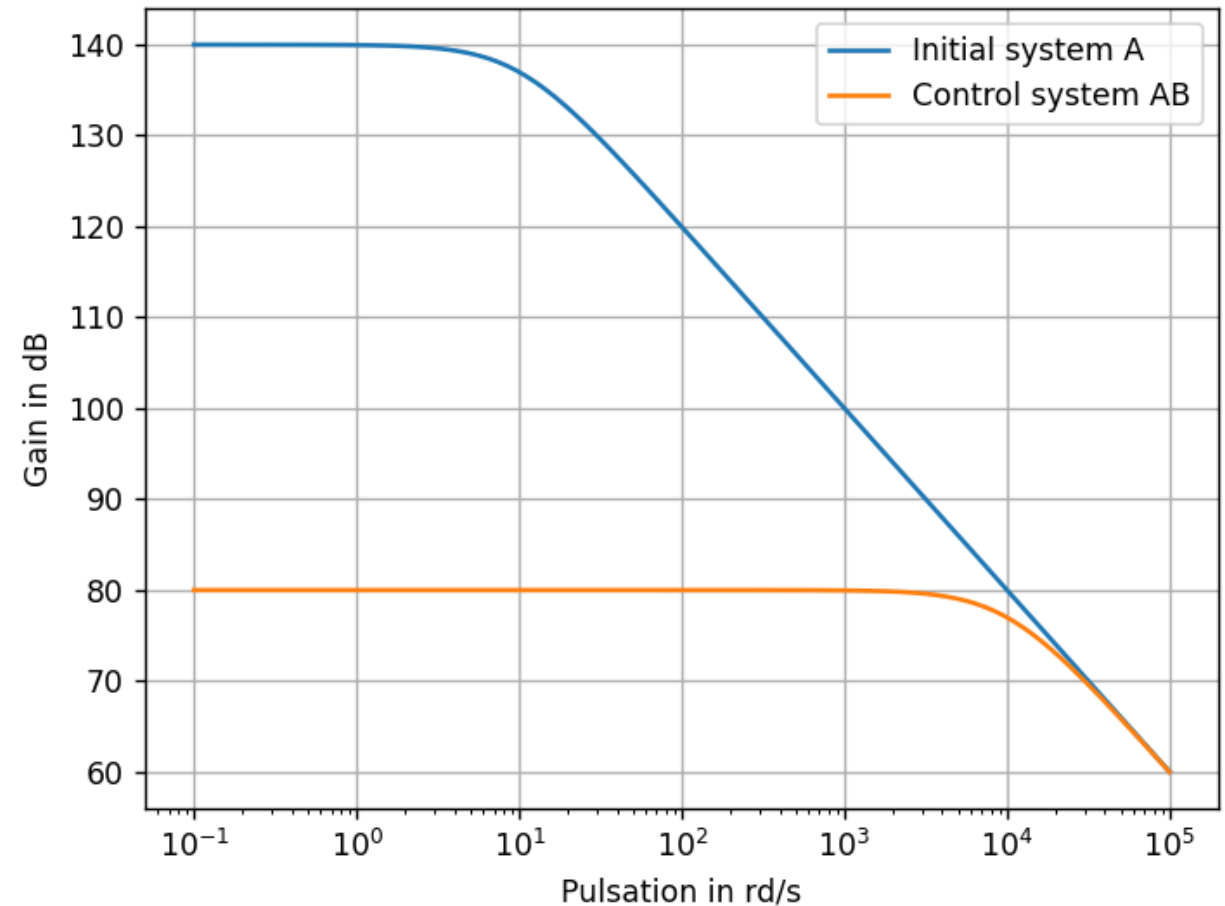
Gain statique

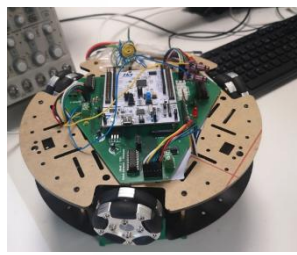
$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B}$$

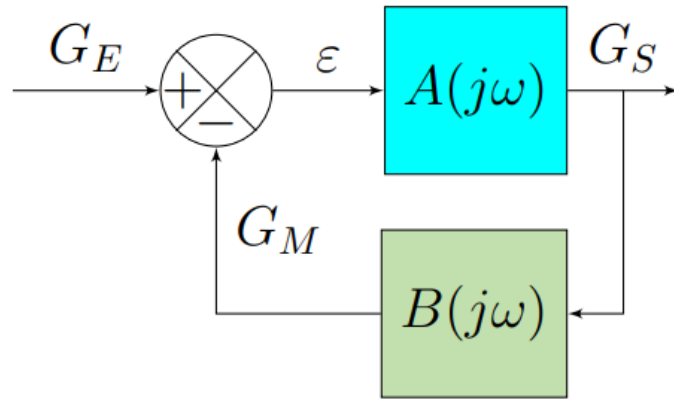
Parameters : $K_a = 1.00\text{e}+07$ / $K_b = 1.00\text{e}-04$ / $T_a = 1.00\text{e}-01$ s





Système A d'ordre 1

Systèmes asservis



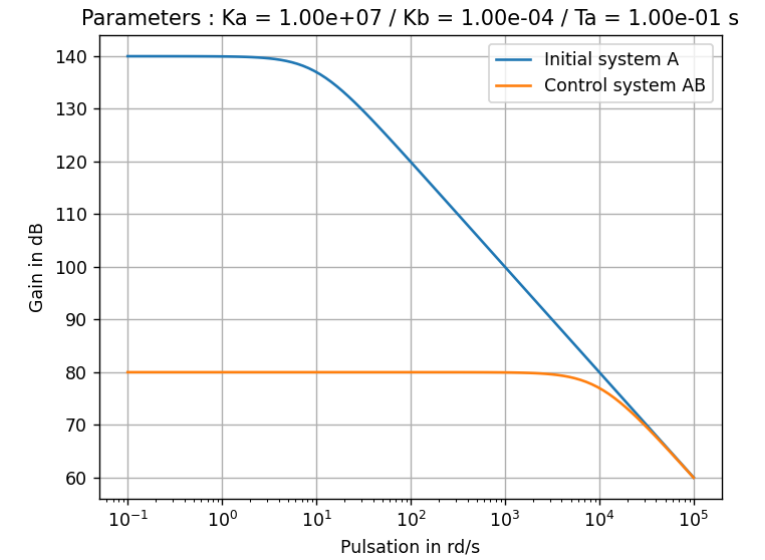
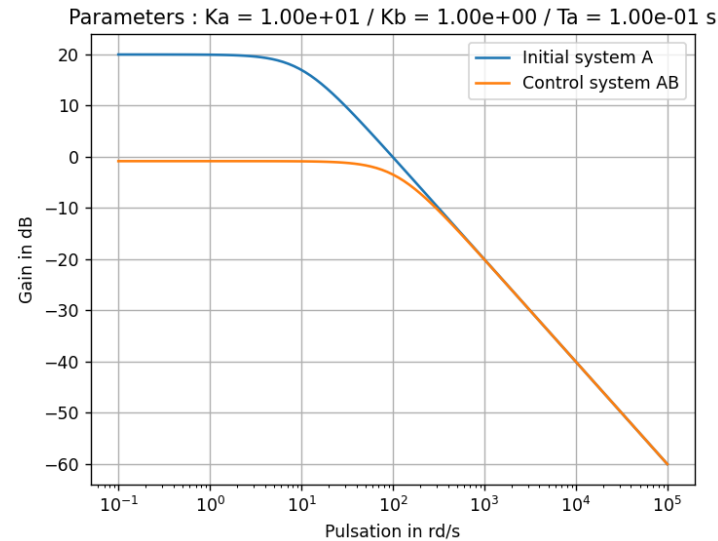
Système du premier ordre

Gain statique

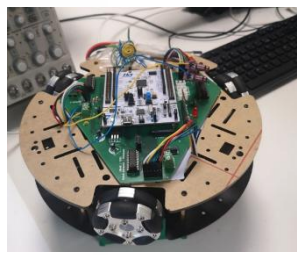
$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B}$$

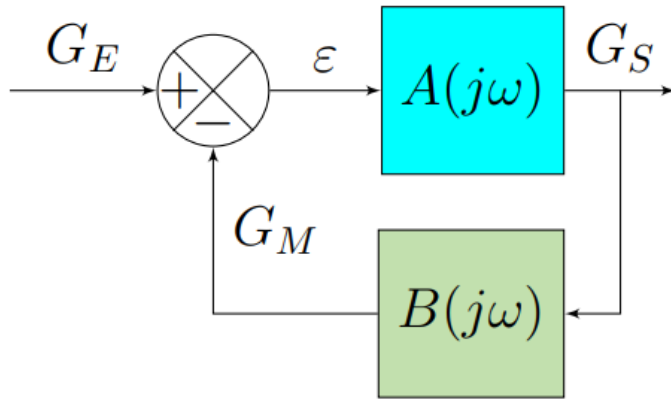


Produit gain / bande-passante = cte



Système A d'ordre 1

Systèmes asservis



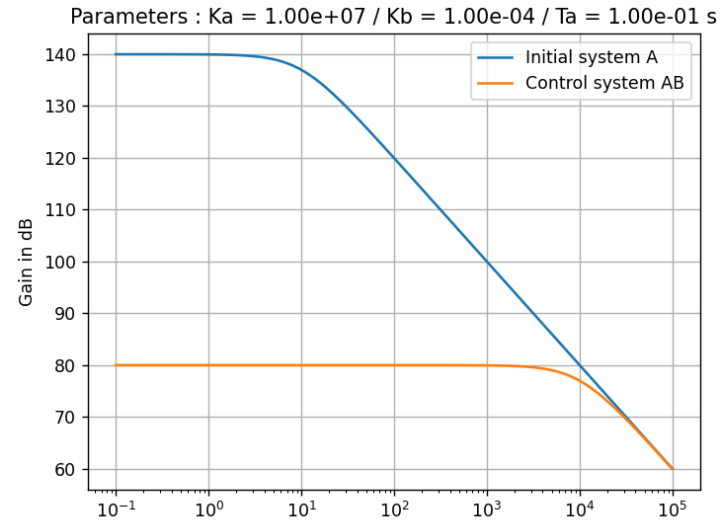
Système du premier ordre

Gain statique

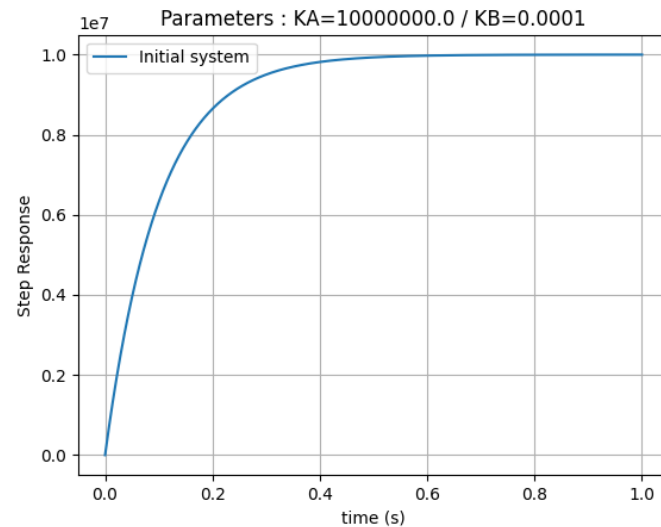
$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

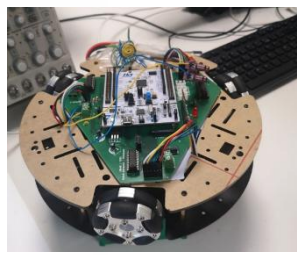
$$T_H = \frac{T_A}{1 + K_A K_B}$$



Réponse fréquentielle (Bode)

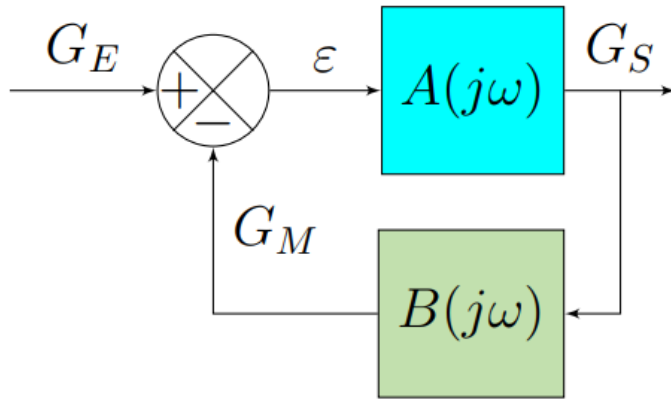


Réponse indicielle (échelon)



Système A d'ordre 1

Systèmes asservis



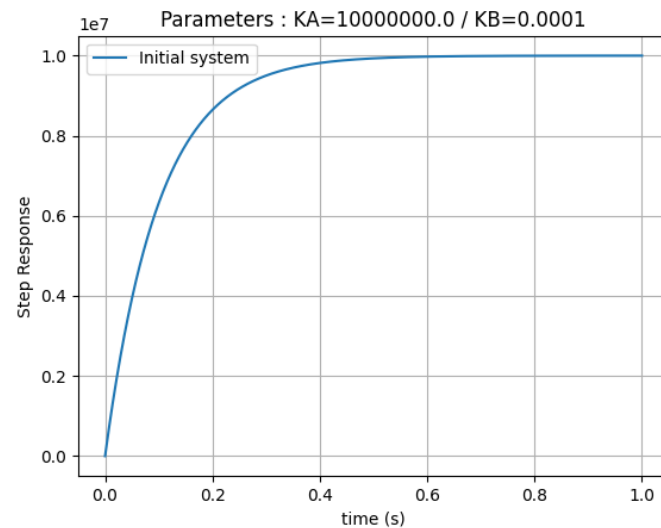
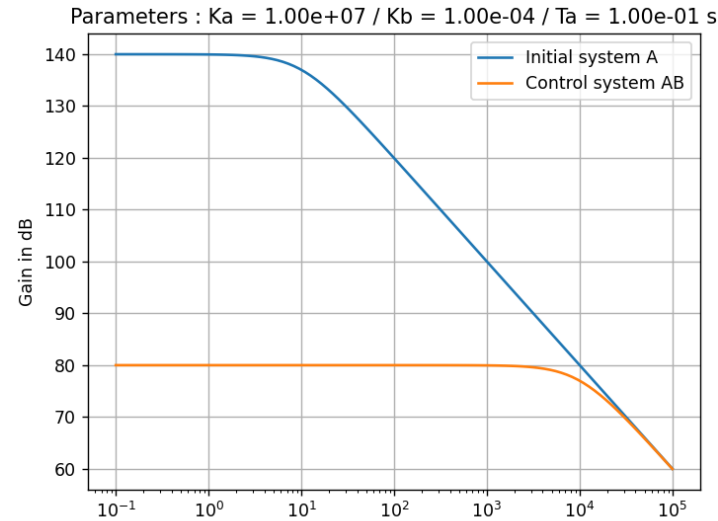
Système du premier ordre

Gain statique

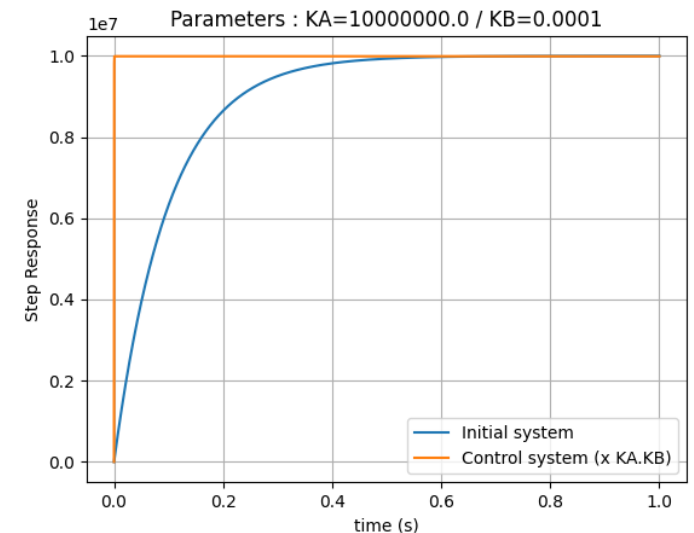
$$H_0 = \frac{K_A}{1 + K_A K_B}$$

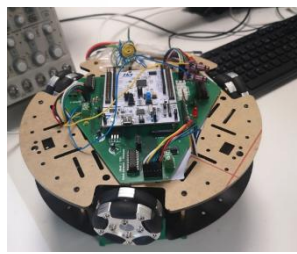
Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B}$$



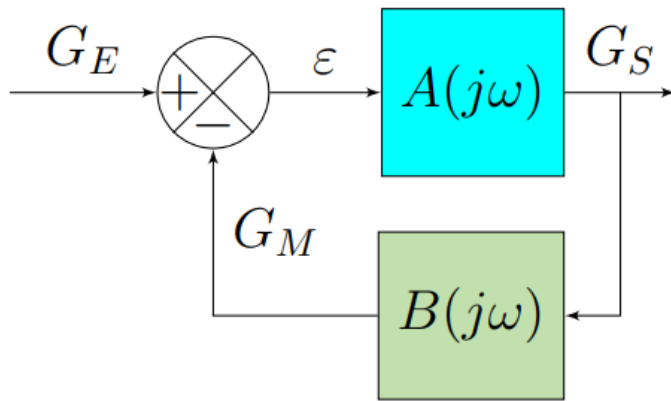
Réponse indicielle





Système A d'ordre 1

Systèmes asservis



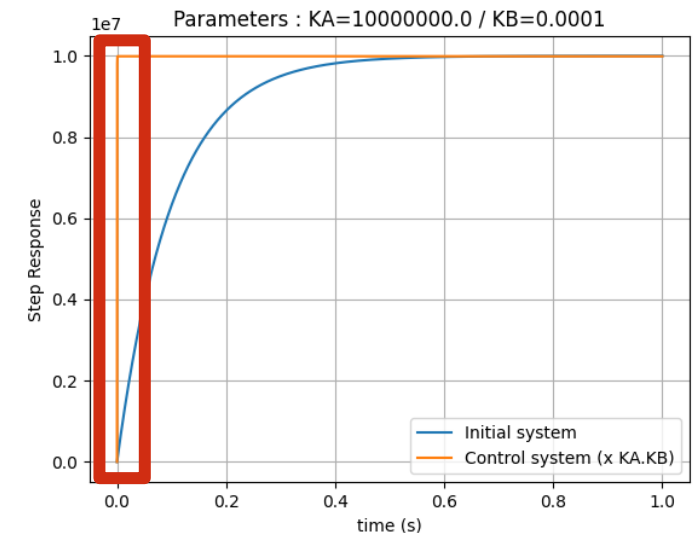
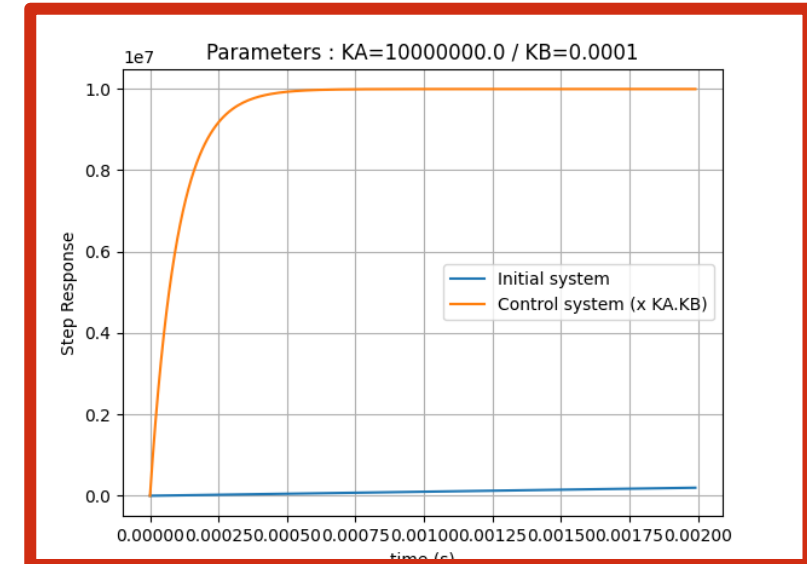
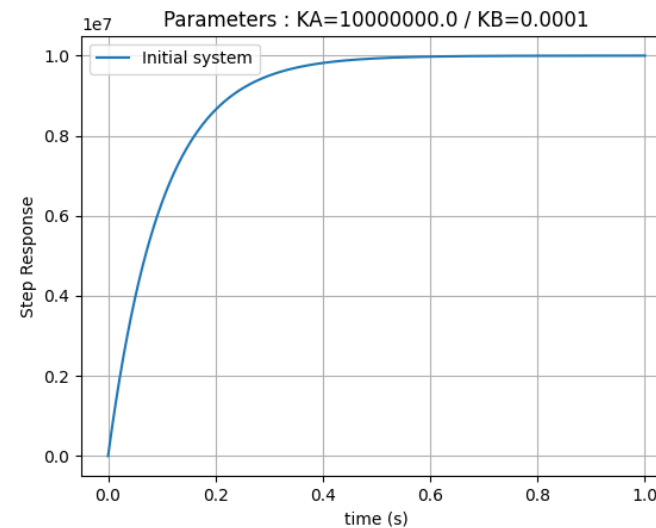
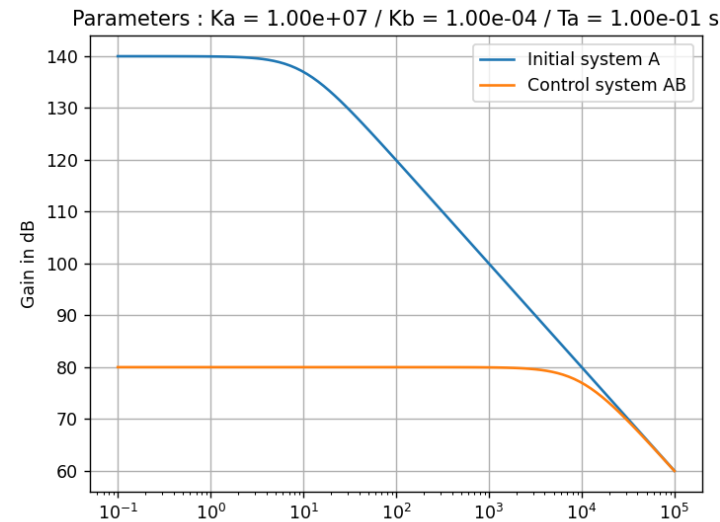
Système du premier ordre

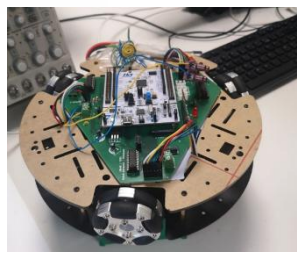
Gain statique

$$H_0 = \frac{K_A}{1 + K_A K_B}$$

Constante de temps

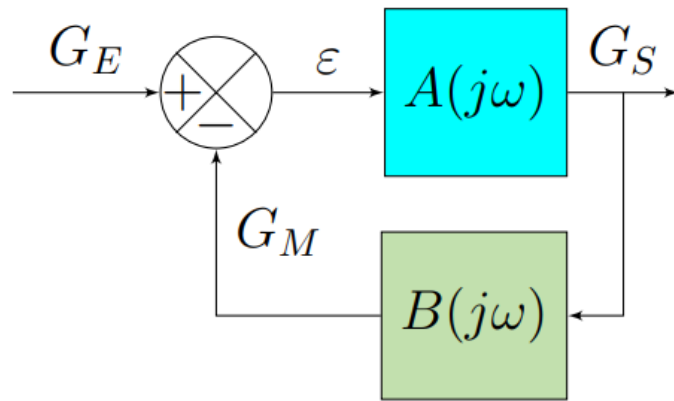
$$T_H = \frac{T_A}{1 + K_A K_B}$$





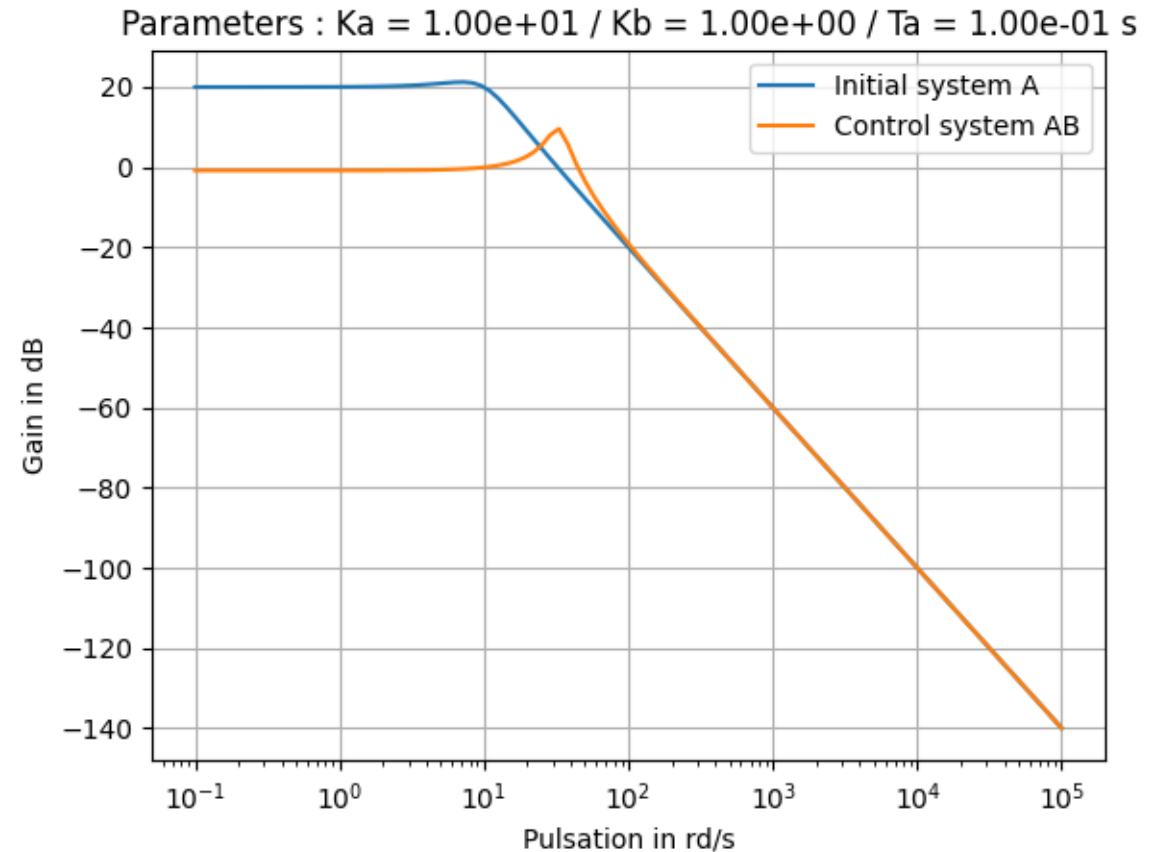
Système A d'ordre 2

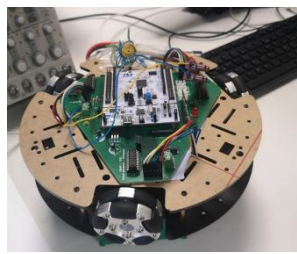
Systèmes asservis



$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

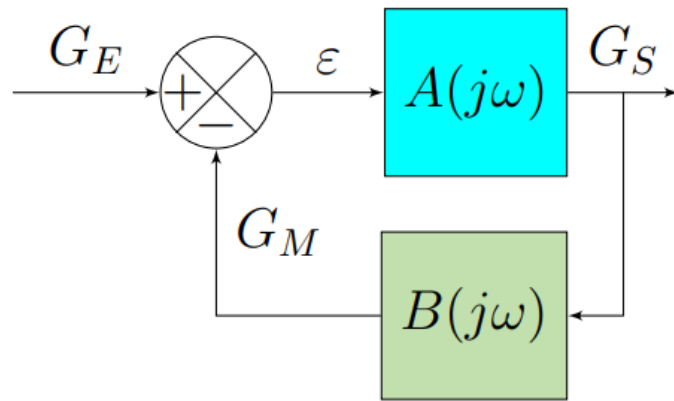
Et si A est
d'ordre 2 ?





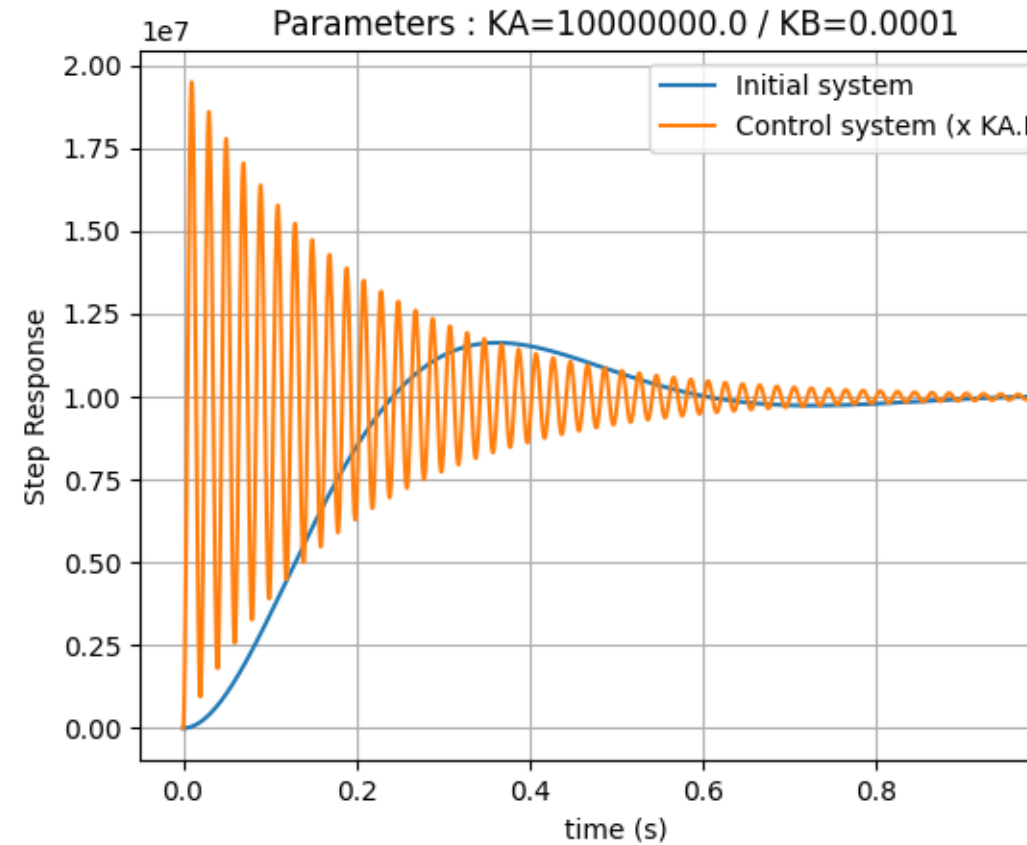
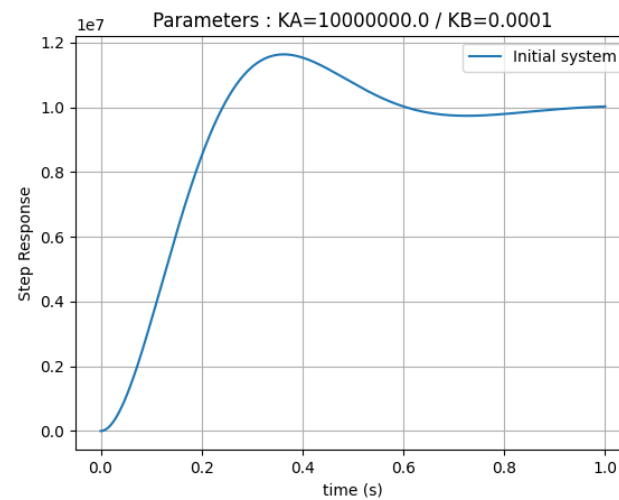
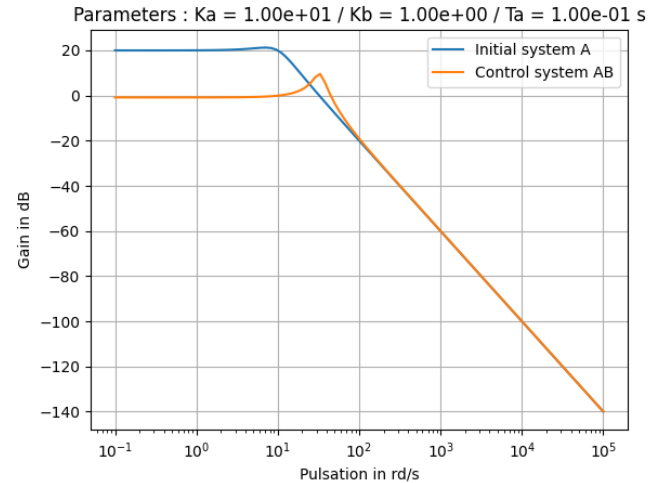
Système A d'ordre 2

Systèmes asservis



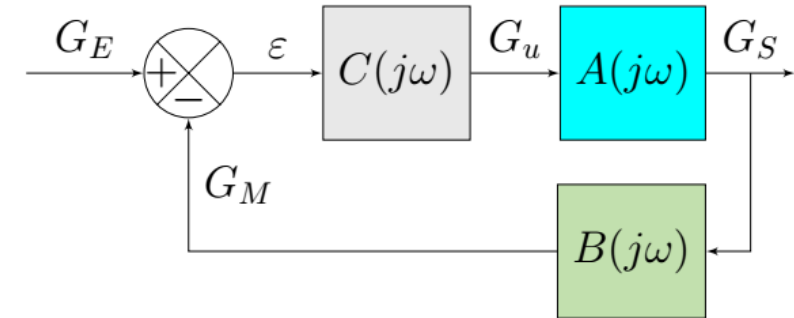
$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

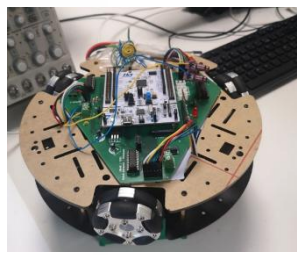
Et si A est
d'ordre 2 ?



Systeme B d'Ordre 1

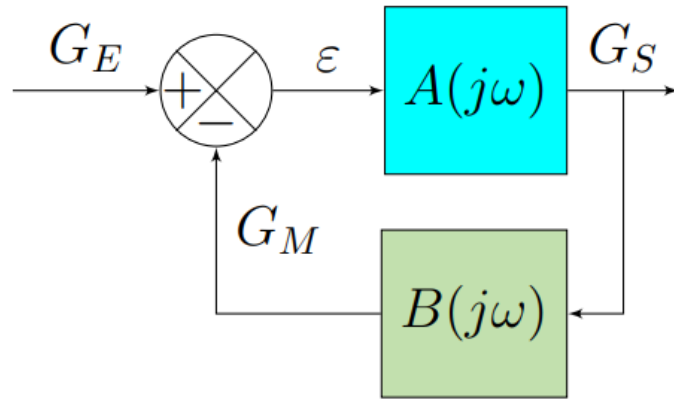
Exercice 3





Système B d'ordre 1

Systèmes asservis



$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

$$A(j\omega) = K_A$$

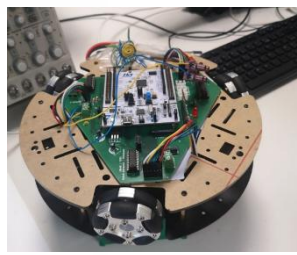
$$B(j\omega) = \frac{K_B}{1 + T_B j\omega}$$

$$H(j\omega) = \frac{K_A}{1 + K_A K_B} \cdot \frac{1 + T_B j\omega}{1 + \frac{T_B}{1 + K_A K_B} j\omega}$$

Gain statique

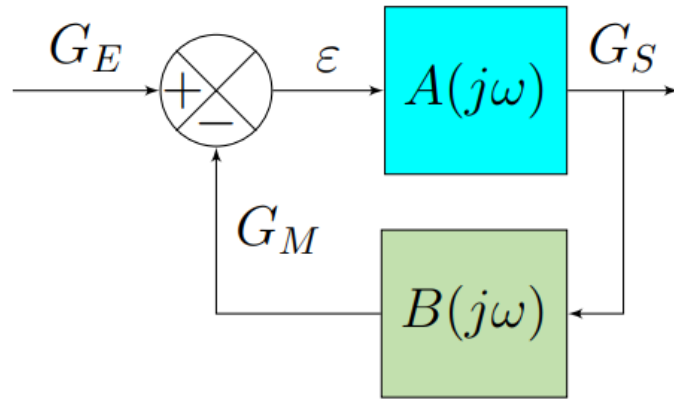
$$H_0 = \frac{K_A}{1 + K_A K_B}$$

$$R = \frac{\frac{T_B}{1 + K_A K_B}}{T_B} = \frac{1}{1 + K_A K_B}$$



Système B d'ordre 2

Systèmes asservis



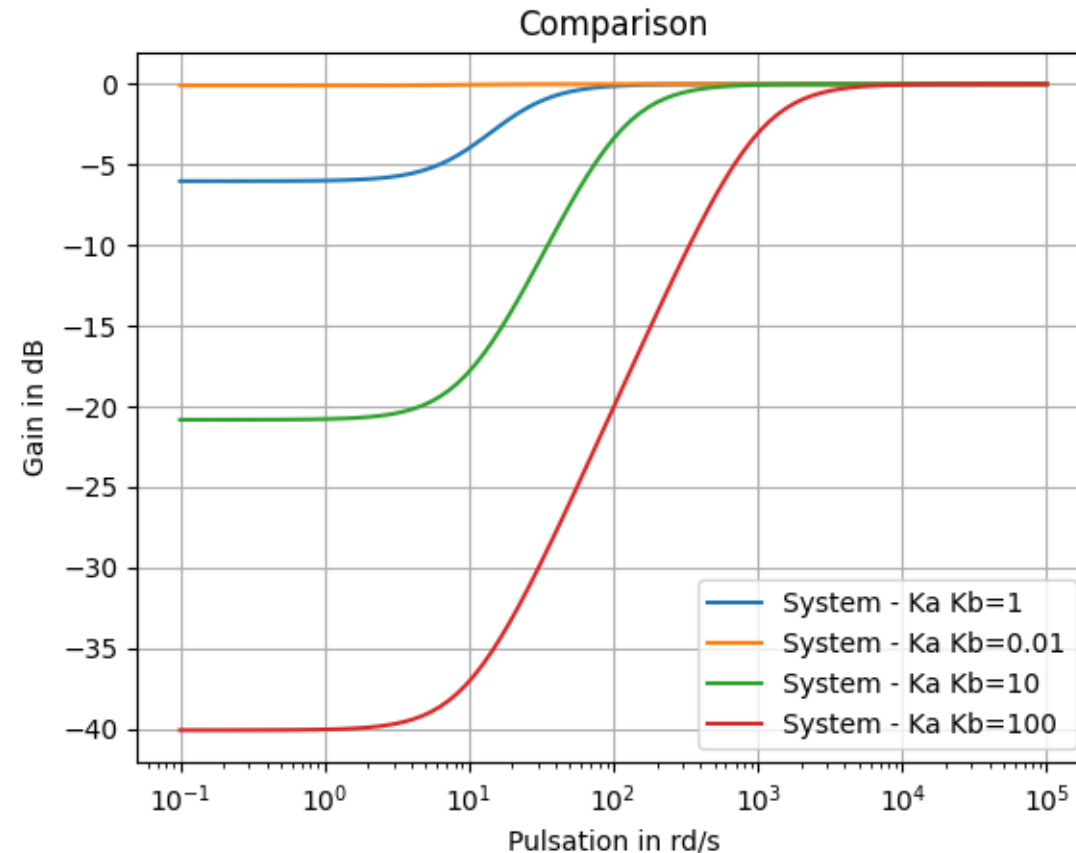
$$H(j\omega) = \frac{A(j\omega)}{1 + A(j\omega)B(j\omega)}$$

Gain statique

$$H_0 = \frac{K_A}{1 + K_A K_B}$$

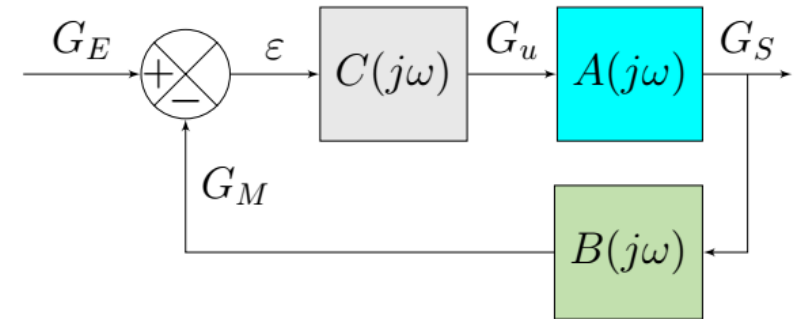
Rapport constante de temps

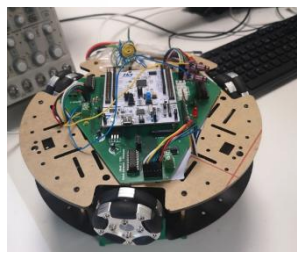
$$R = \frac{\frac{T_B}{1 + K_A K_B}}{T_B} = \frac{1}{1 + K_A K_B}$$



Correcteur P

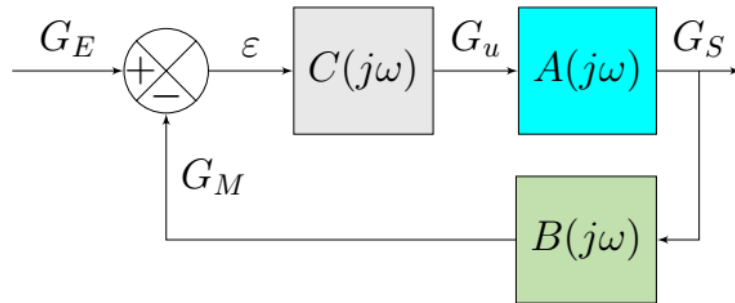
Exercice 4





Correcteur Proportionnel

Systèmes asservis



$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C$$

$$H(j\omega) = \frac{K_A K_C}{1 + K_A K_B K_C + T_A j\omega}$$

Forme Canonique → Système du premier ordre

$$H(j\omega) = \frac{K_A K_C}{1 + K_A K_B K_C} \frac{1}{1 + \frac{T_A}{1 + K_A K_B K_C} j\omega}$$

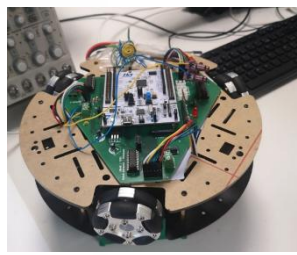
$$H(j\omega) = \frac{A(j\omega)C(j\omega)}{1 + A(j\omega)B(j\omega)C(j\omega)}$$

Gain statique

$$H_0 = \frac{K_A K_C}{1 + K_A K_B K_C}$$

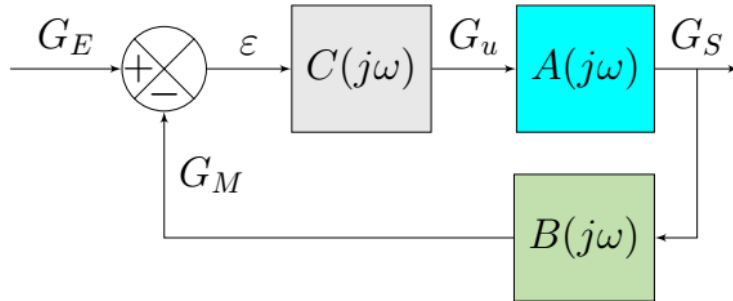
Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B K_C}$$



Correcteur Proportionnel

Systèmes asservis



$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C$$

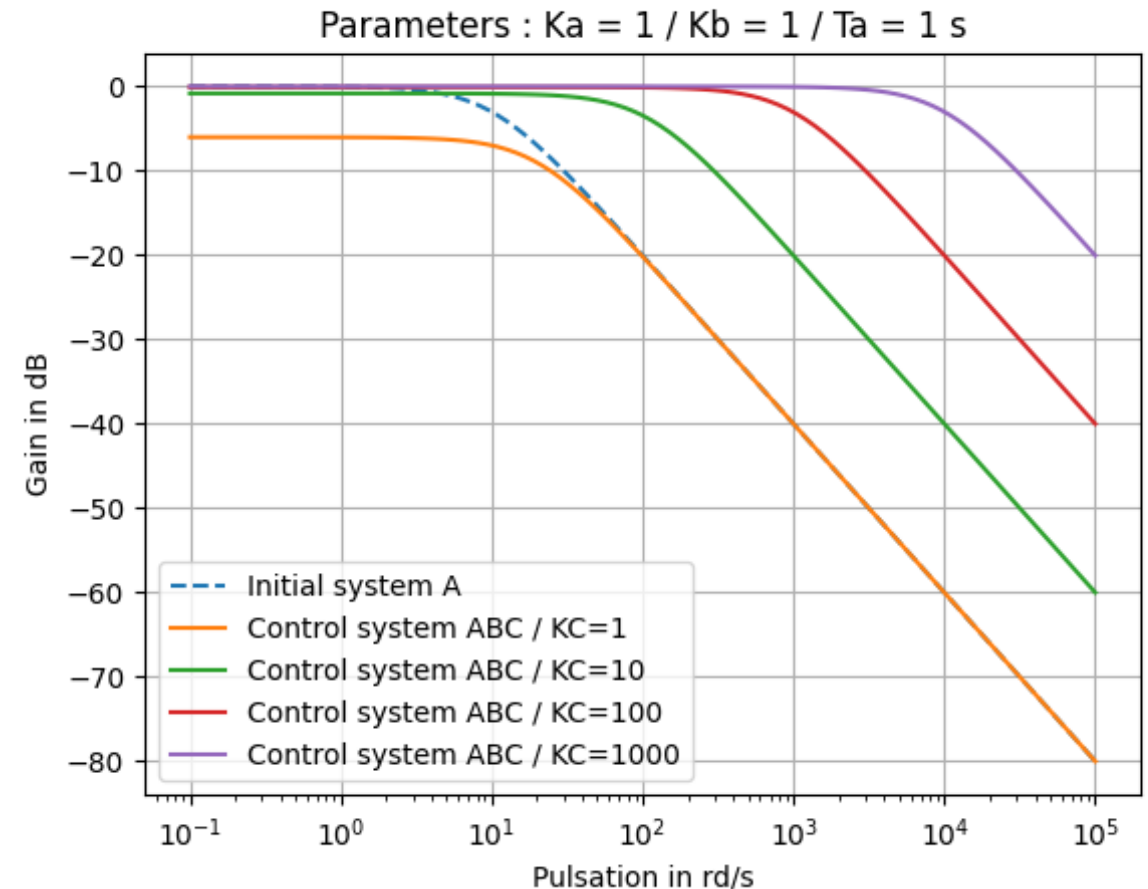
Système du premier ordre

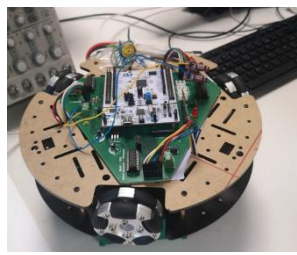
Gain statique

$$H_0 = \frac{K_A K_C}{1 + K_A K_B K_C}$$

Constante de temps

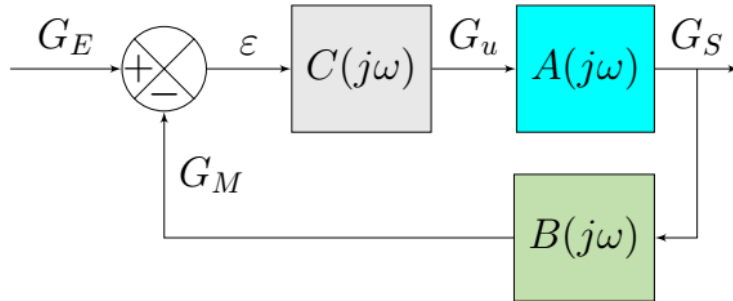
$$T_H = \frac{T_A}{1 + K_A K_B K_C}$$





Correcteur Proportionnel

Systèmes asservis



$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C$$

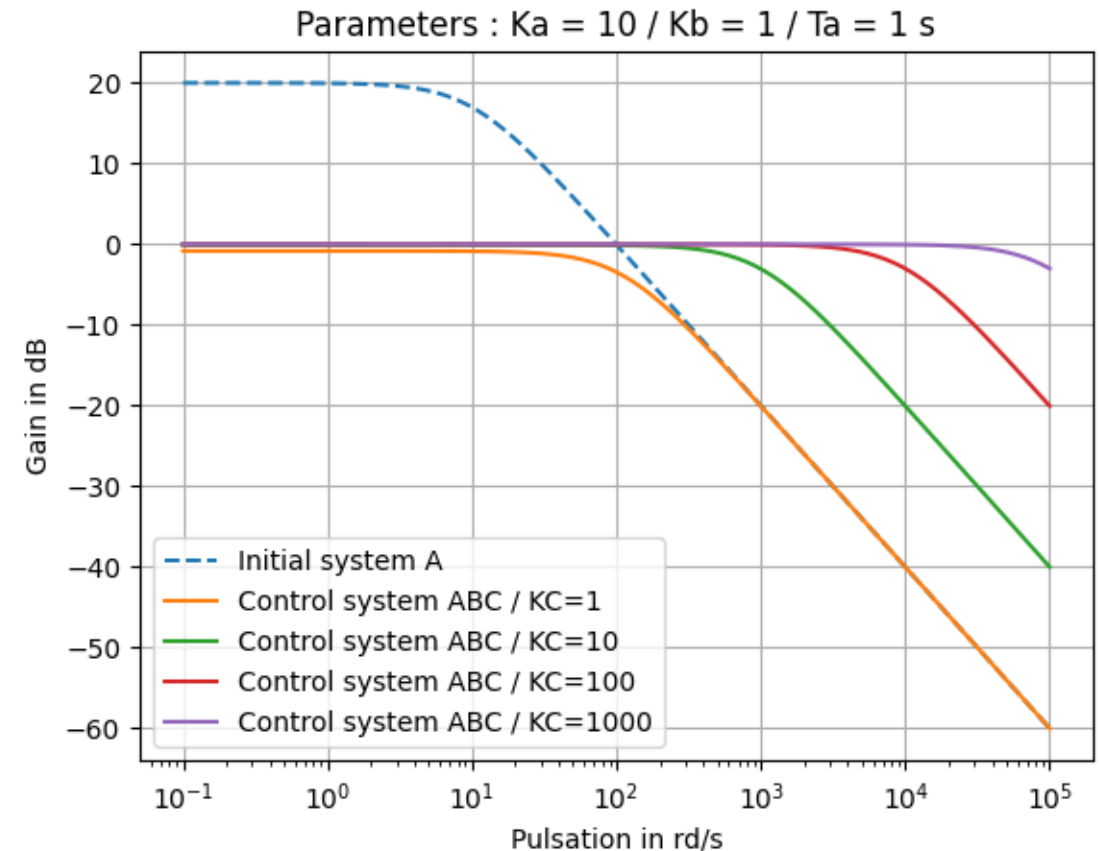
Système du premier ordre

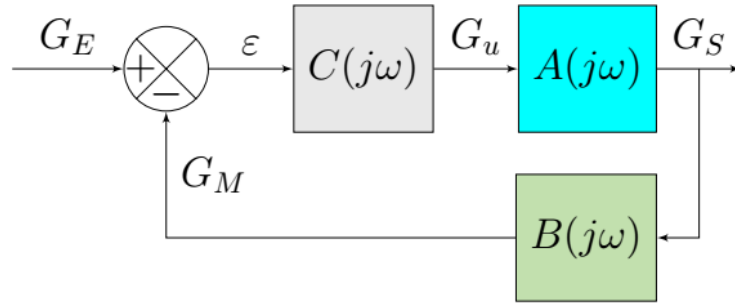
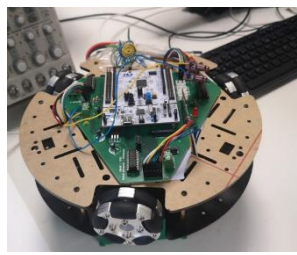
Gain statique

$$H_0 = \frac{K_A K_C}{1 + K_A K_B K_C}$$

Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B K_C}$$





$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C$$

Système du premier ordre

Gain statique

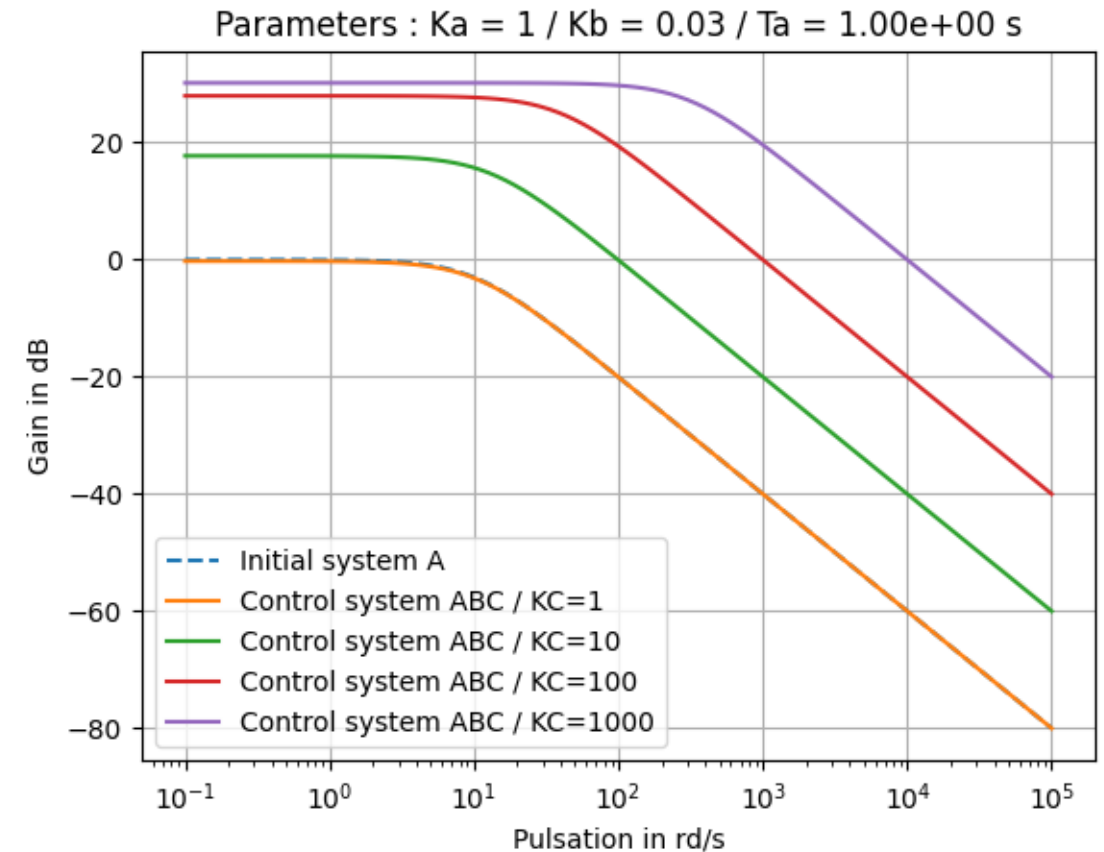
$$H_0 = \frac{K_A K_C}{1 + K_A K_B K_C}$$

Constante de temps

$$T_H = \frac{T_A}{1 + K_A K_B K_C}$$

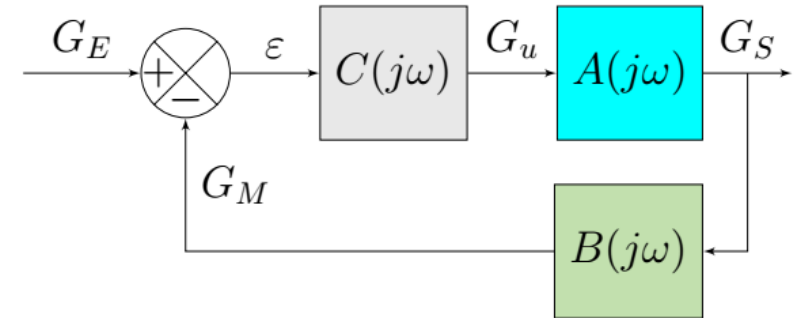
Correcteur Proportionnel

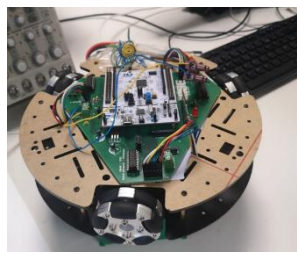
Systèmes asservis



Correcteur PI

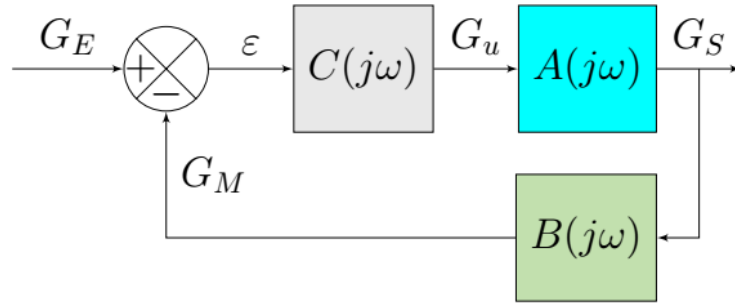
Exercice 5





Correcteur Prop. et Intégral

Systèmes asservis

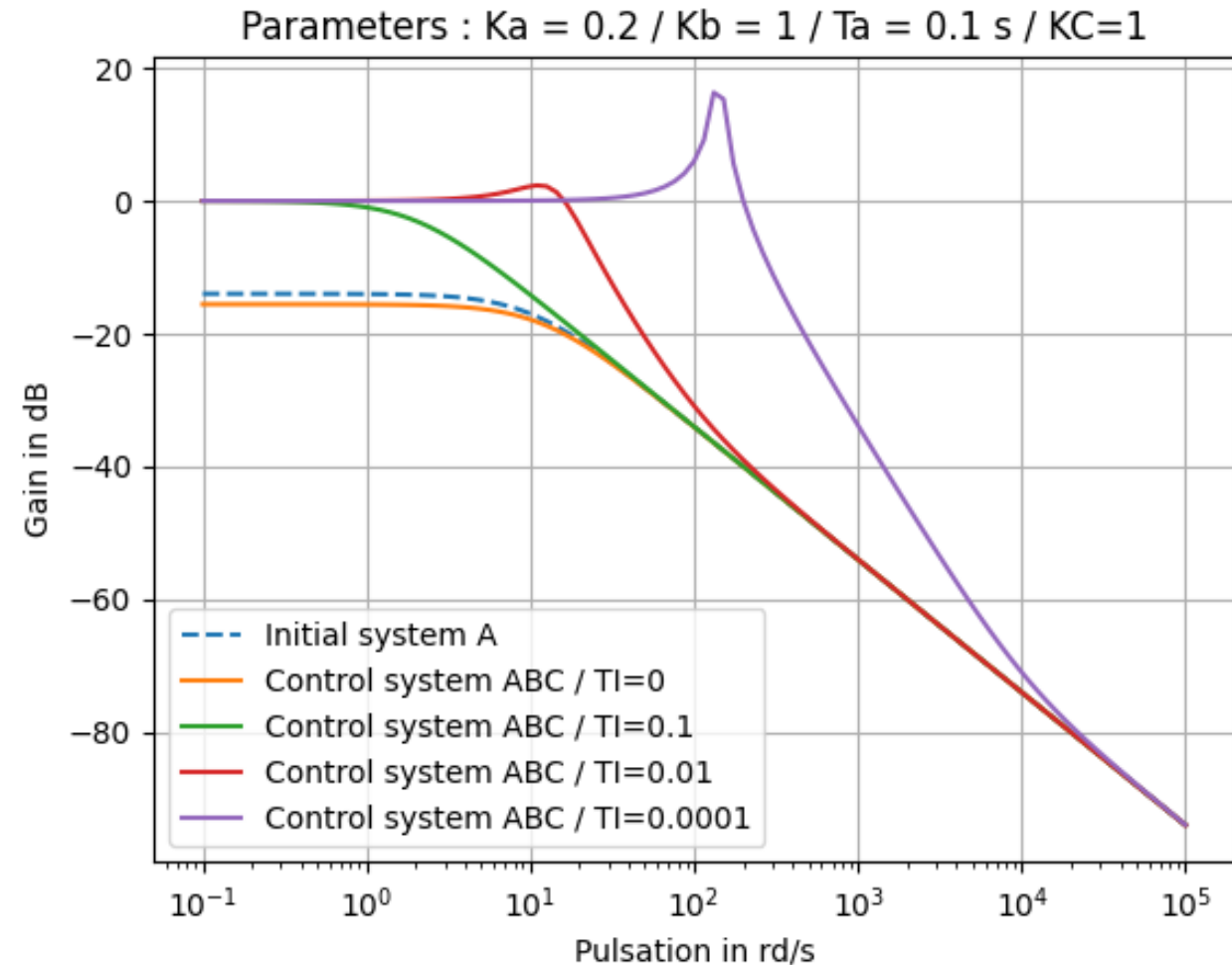


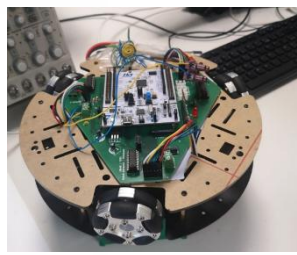
$$H(j\omega) = \frac{A(j\omega)C(j\omega)}{1 + A(j\omega)B(j\omega)C(j\omega)}$$

$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

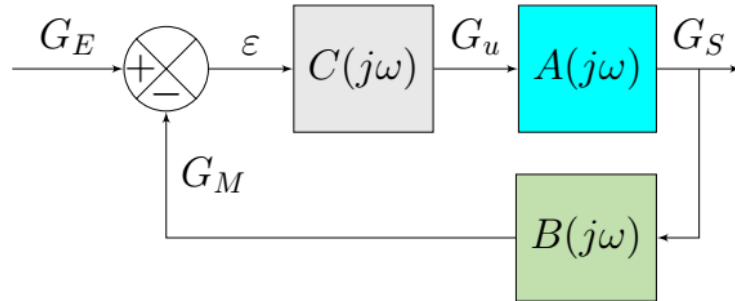
$$C(j\omega) = K_C + \frac{1}{T_I j\omega}$$





Correcteur Prop. et Intégral

Systèmes asservis



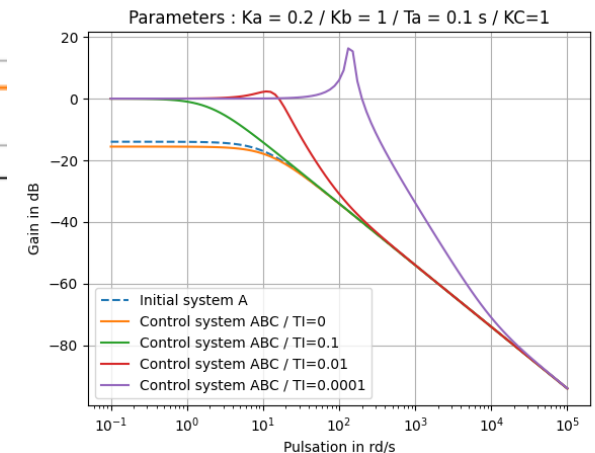
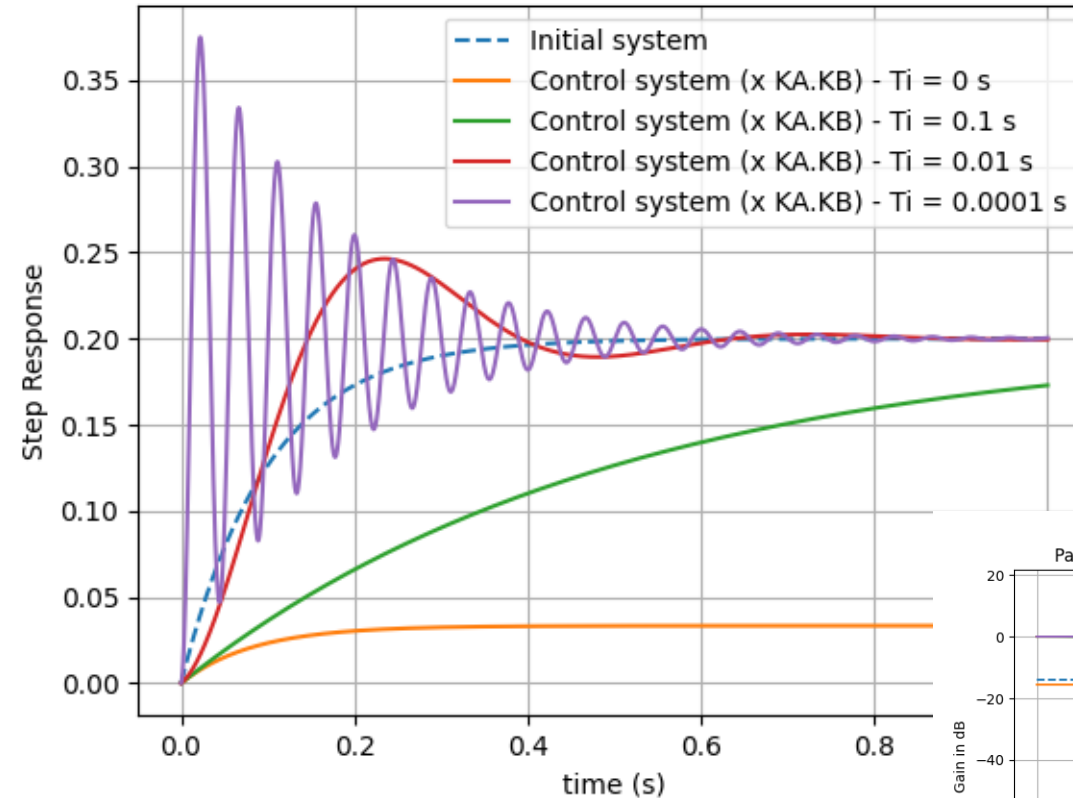
$$H(j\omega) = \frac{A(j\omega)C(j\omega)}{1 + A(j\omega)B(j\omega)C(j\omega)}$$

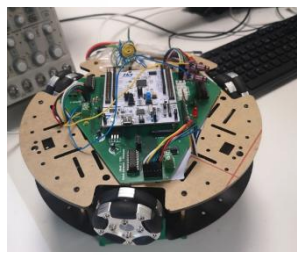
$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C + \frac{1}{T_I j\omega}$$

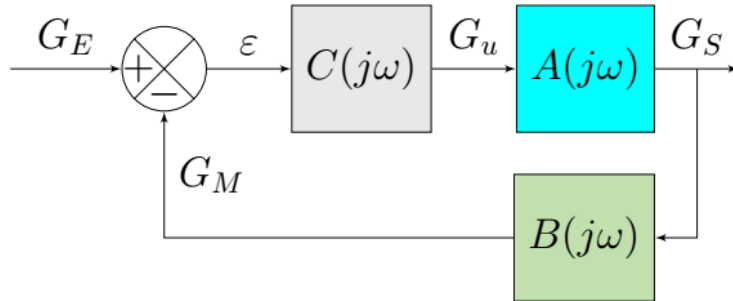
Parameters : $K_A=0.2$ / $K_B=1$





Correcteur Prop. et Intégral

Systèmes asservis

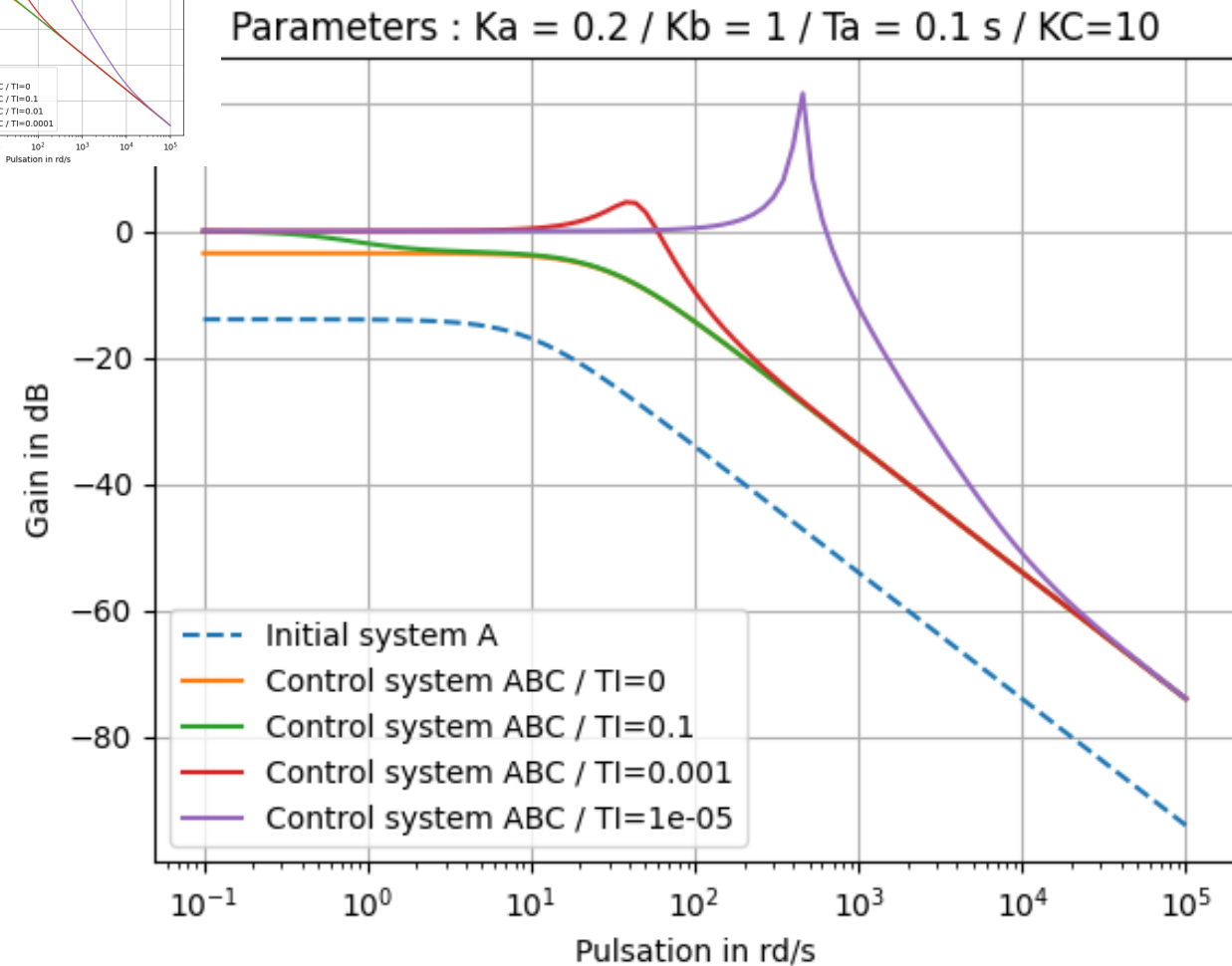
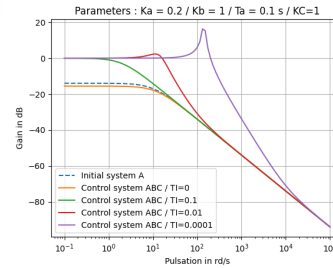


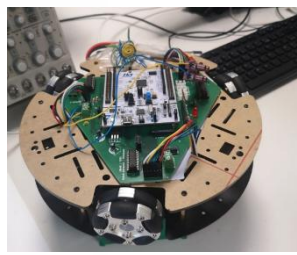
$$H(j\omega) = \frac{A(j\omega)C(j\omega)}{1 + A(j\omega)B(j\omega)C(j\omega)}$$

$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

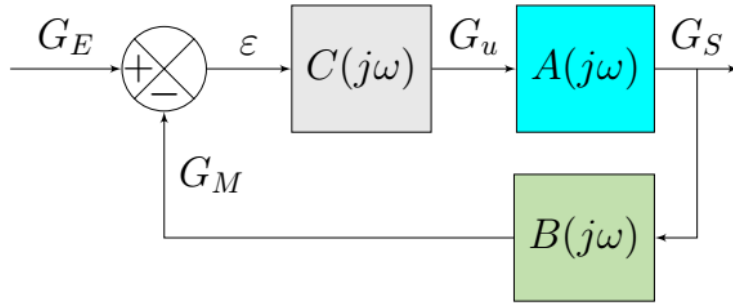
$$C(j\omega) = K_C + \frac{1}{T_I j\omega}$$





Correcteur Prop. et Intégral

Systèmes asservis



$$H(j\omega) = \frac{A(j\omega)C(j\omega)}{1 + A(j\omega)B(j\omega)C(j\omega)}$$

$$A(j\omega) = \frac{K_A}{1 + T_A j\omega}$$

$$B(j\omega) = K_B$$

$$C(j\omega) = K_C + \frac{1}{T_I j\omega}$$

