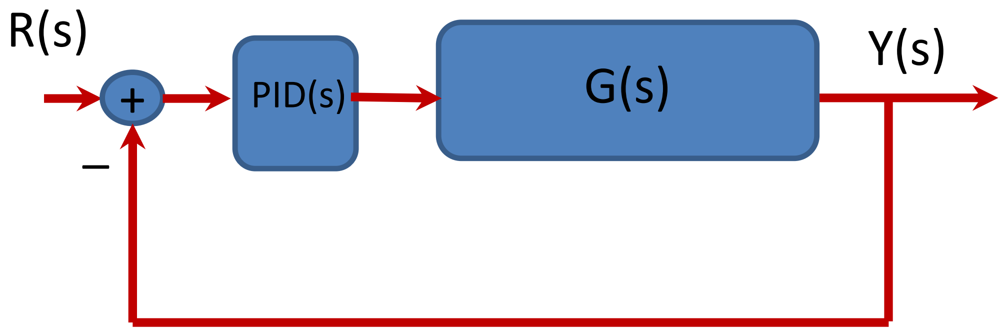
Control y Servomecanismos A

Control Automático I

Tema: Compensadores PID

Cursada Virtual 2020

Compensación PID



$$\mathrm{T}(s) = \frac{Y(s)}{R(s)} = \frac{PID(s)G(s)}{1+PID(s)G(s)}$$

$$PID(s) = Kp\left(1 + \frac{1}{T_i s} + T_d s\right) = \frac{K_p(T_i T_d s^2 + T_i s + 1)}{T_i s}$$

$$PID(s) = Kp\left(1 + \frac{1}{T_i s} + \frac{T_d s}{\left(\frac{s}{p_1} + 1\right)}\right)$$

K_p, T_i y T_d parámetros de sintonía del PID(s)

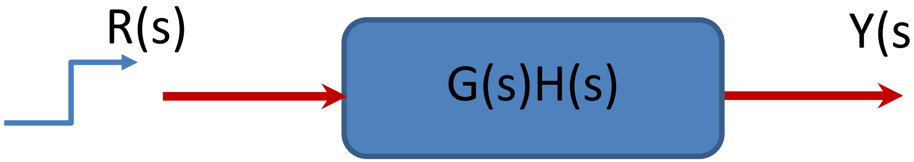
Acciones Especificas → Estáticas (errores EE)

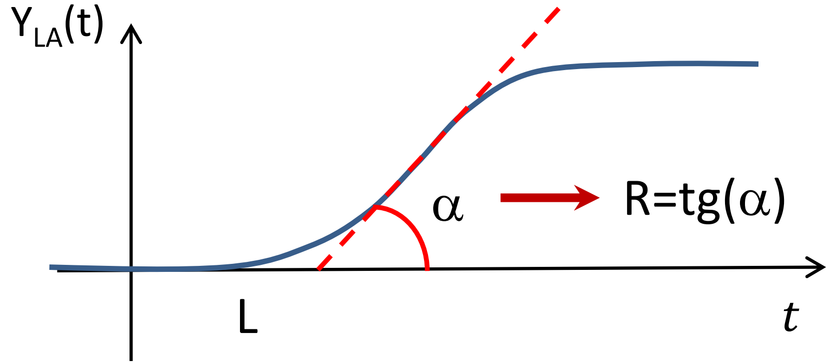
Estabilidad (MF)

Performance

Compensación PID

Sintonía Empírica (método 1)
Ensayo Lazo Abierto

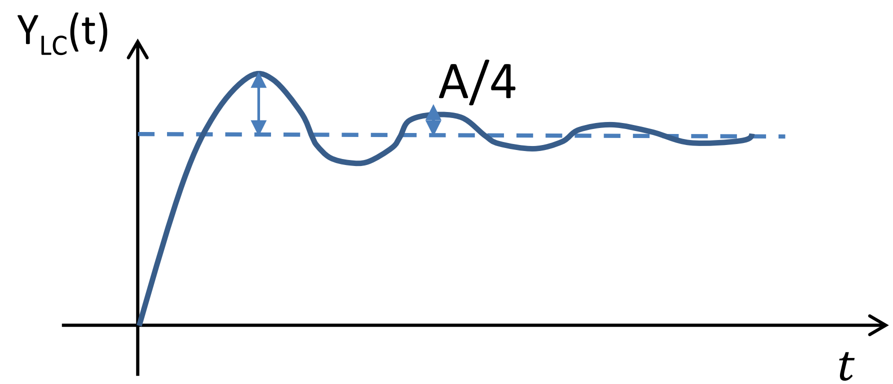




Ziegler-Nichols
(Control Optimo)

$$min \int_0^{t_s} |e(t)|dt$$

Respuesta "quater decay"



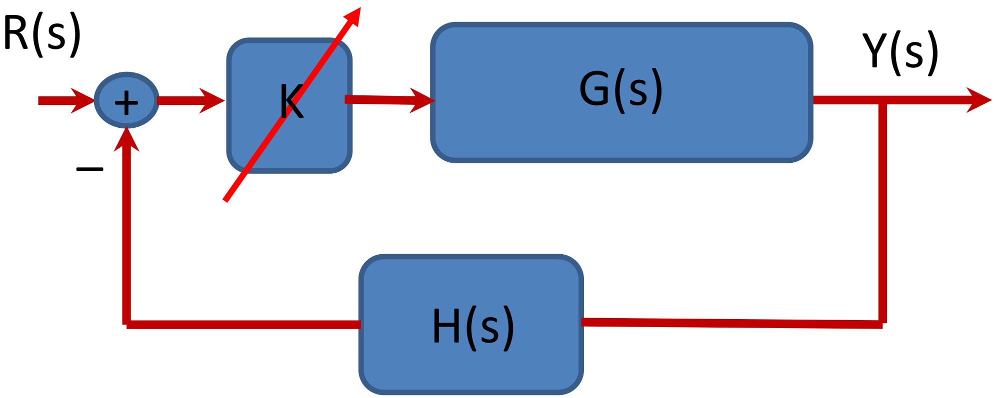
Sintonía

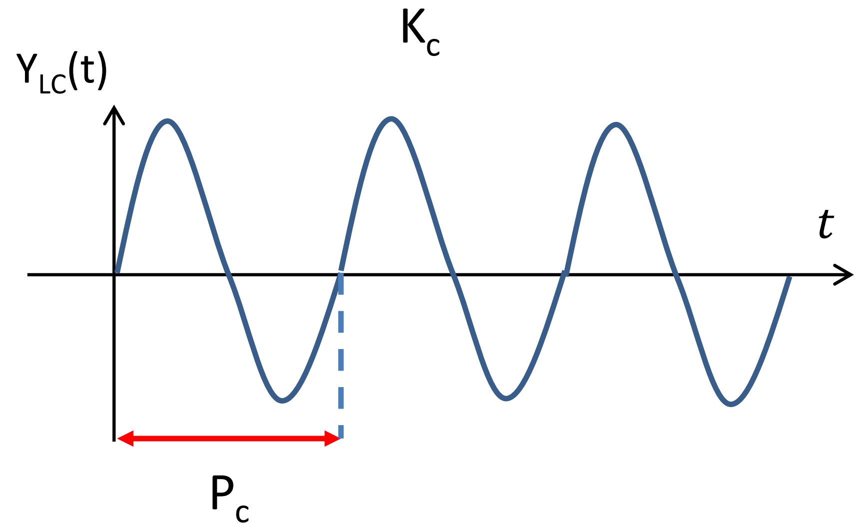
Kp = 1,2/ (R.L)
Ti = 2L
Td = 0,5L

Ti = 4Td

Compensación PID

Sintonía Empírica (método 2)
Ensayo Lazo Cerrado

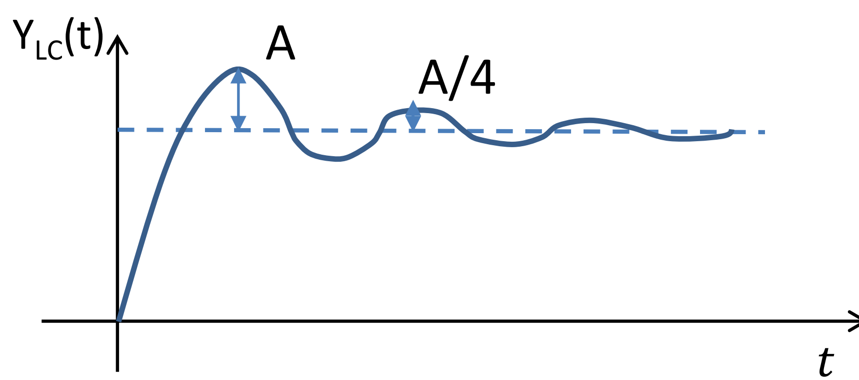




Ziegler-Nichols
(Control Optimo)

$$min \int_0^{t_s} |e(t)|dt$$

Respuesta “quater decay”



Sintonía

Kp = 0,6 Kc
Ti = 0,5 Pc
Td = 0,125 Pc

Ti = 4Td

Compensación PID

Sintonía Analítica (método 3)
Corrige E_{ee} y MF

$$PID(s) = K_p\left(1 + \frac{1}{T_i s} + T_d s\right) = \frac{K_p(T_i T_d s^2 + T_i s + 1)}{T_i s}$$

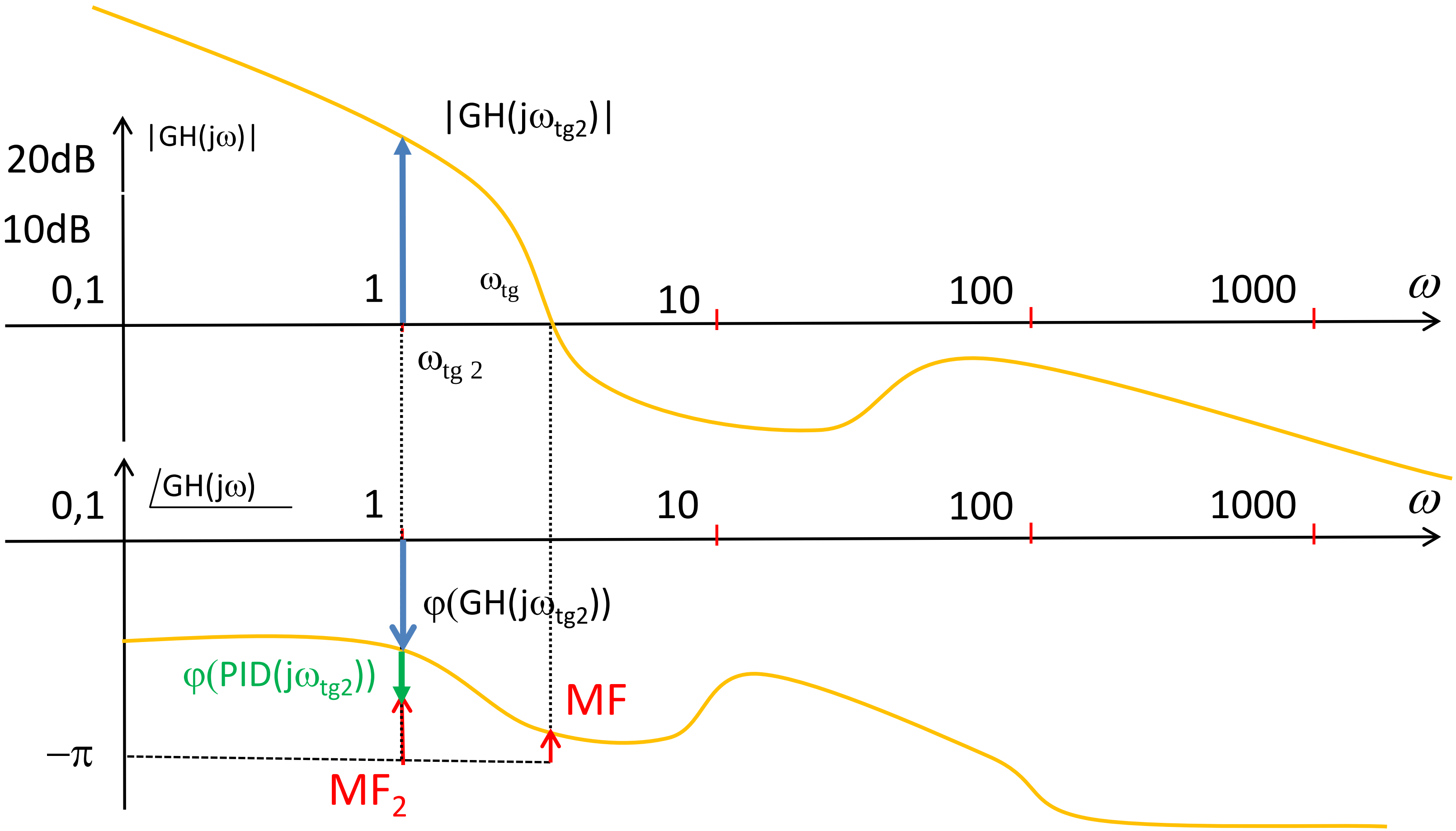
$$PID(j\omega) = K_p\left(1 + \frac{1}{jT_i\omega} + jT_d\omega\right) = K_p + jK_p\left(T_d\omega - \frac{1}{T_i\omega}\right)$$

$$Re\{PID(j\omega)\} = K_p$$

$$\mathrm{Im}\{PID(j\omega)\} = K_p\left(T_d\omega - \frac{1}{T_i\omega}\right)$$

Compensación PID

Especificaciones : E_{ee} =0 y MF=xx° en $\omega=\omega_{tg\ 2}$



$$|PID(j\omega_{\text{tg }2})| = 1/|GH(j\omega_{\text{tg }2})|$$

$$\varphi\left(PID(j\omega_{\text{tg }2})\right) = -180^{\circ} + MF_2 - \varphi\left(GH(j\omega_{\text{tg }2})\right)$$

Compensación PID

$$Re\{PID(j\omega)\} = K_p$$

$$\mathrm{Im}\{PID(j\omega)\} = K_p\left(T_d\omega - \frac{1}{T_i\omega}\right)$$

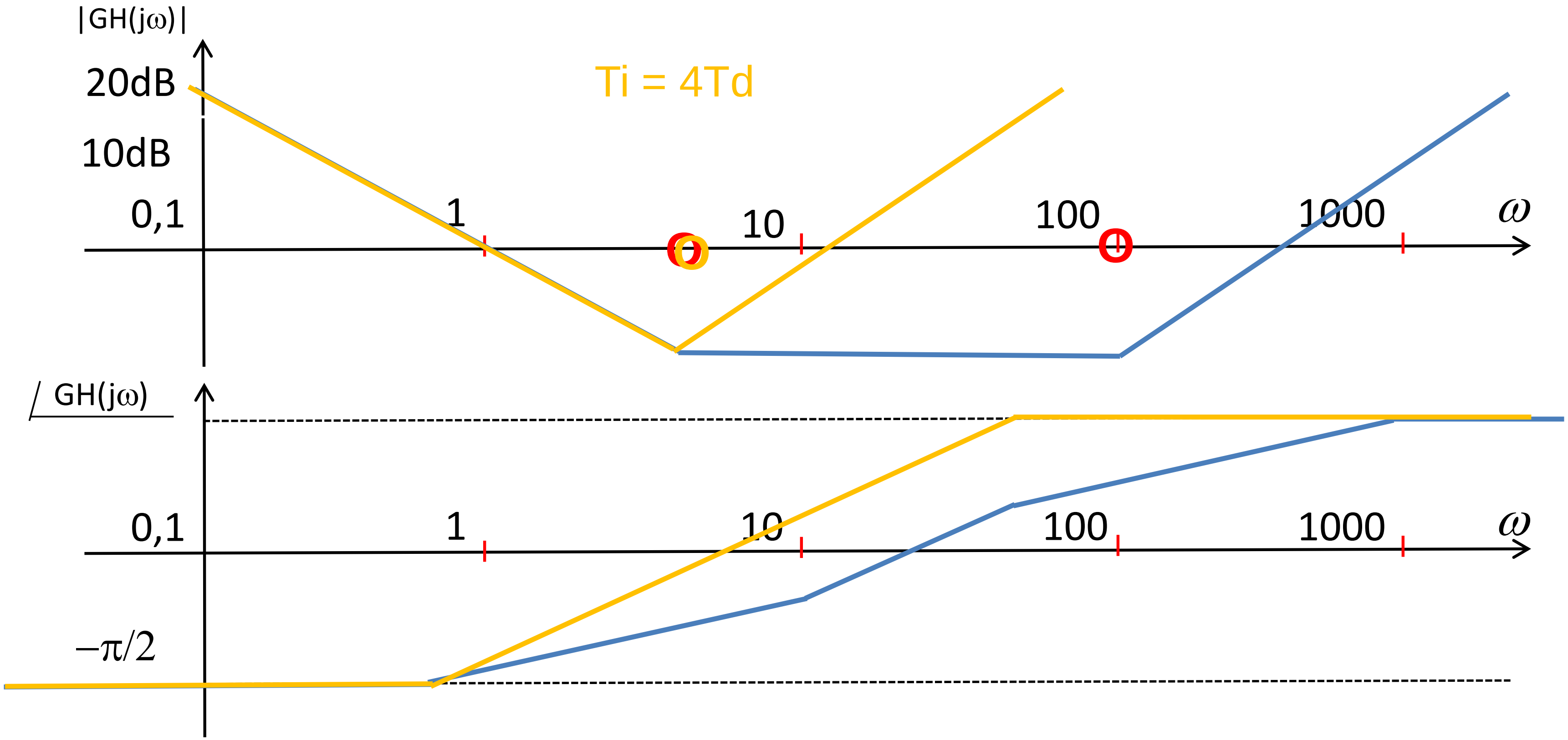
Requerimientos para el PID (obtención gráfica o analítica)

$$\left|PID\left(j\omega_{\mathrm{tg}\,2}\right)\right| = 1/\left|GH(j\omega_{\mathrm{tg}\,2})\right|$$
$$\varphi\left(PID\left(j\omega_{\mathrm{tg}\,2}\right)\right) = -180^{\circ} + MF_2 - \varphi\left(GH(j\omega_{\mathrm{tg}\,2}\right)$$

$$K_p = \frac{\cos\left(\varphi\left(PID\left(j\omega_{\mathrm{tg}\,2}\right)\right)\right)}{\left|GH(j\omega_{\mathrm{tg}\,2})\right|}$$

$$K_p\left(T_d\omega_{\mathrm{tg}\,2} - \frac{1}{T_i\omega_{\mathrm{tg}\,2}}\right) = \frac{\mathrm{sen}\left(\varphi\left(PID\left(j\omega_{\mathrm{tg}\,2}\right)\right)\right)}{\left|GH(j\omega_{\mathrm{tg}\,2})\right|} \longrightarrow \text{Ti = 4Td}$$

Compensación PID



El compensador puede aportar modulo y fase con distintas combinaciones de signos (fase<0 y módulo >1, fase>0 y módulo<1, fase<0 y modulo<1, etc.)