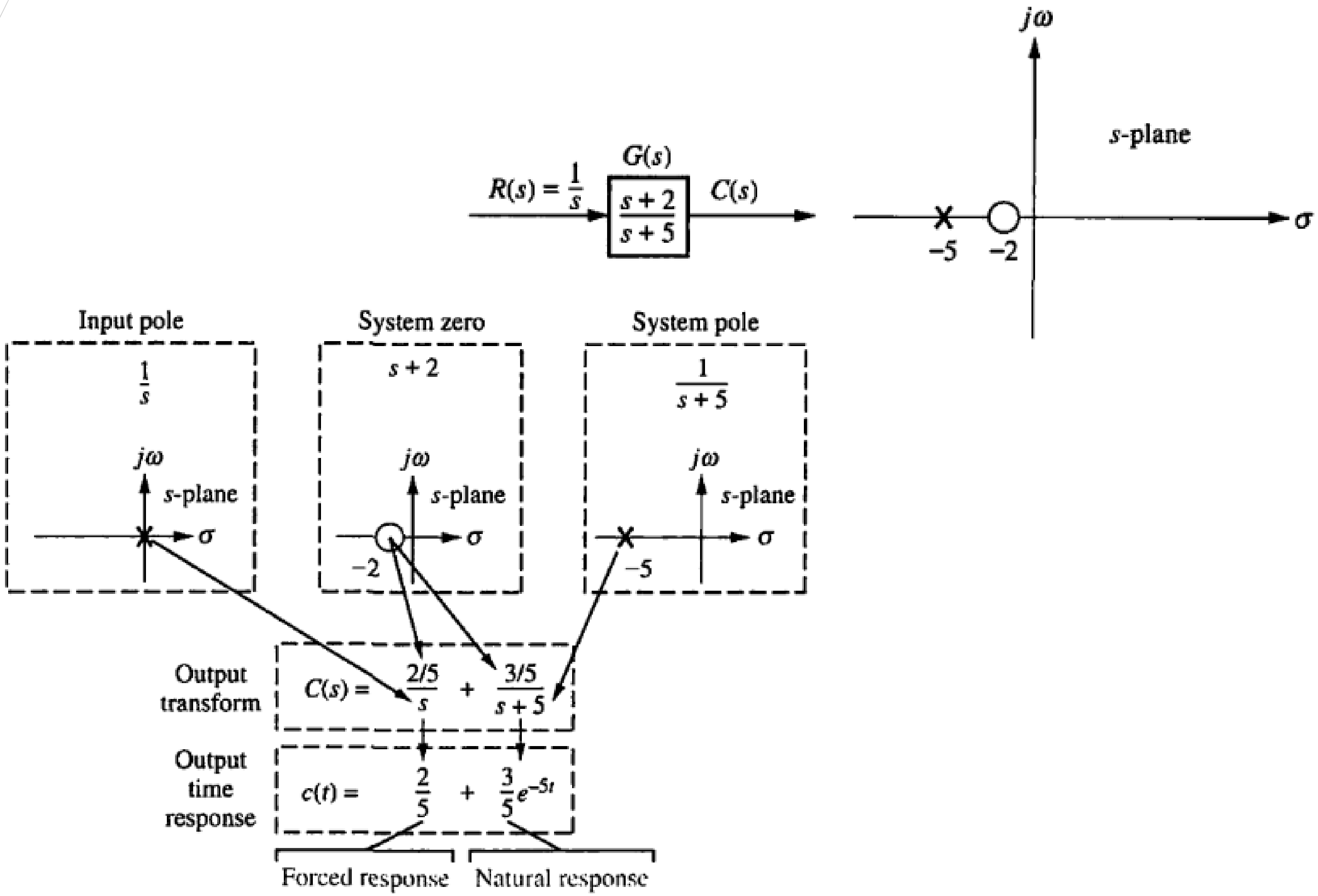
Respuesta en el tiempo

Modelado de sistemas – 2020

Ing. Camilo Sanabria

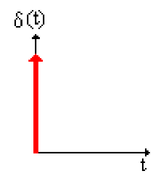
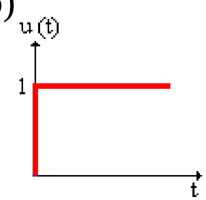
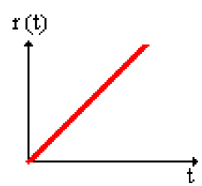
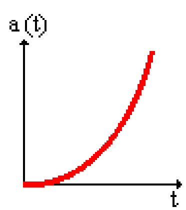
Pole and zero



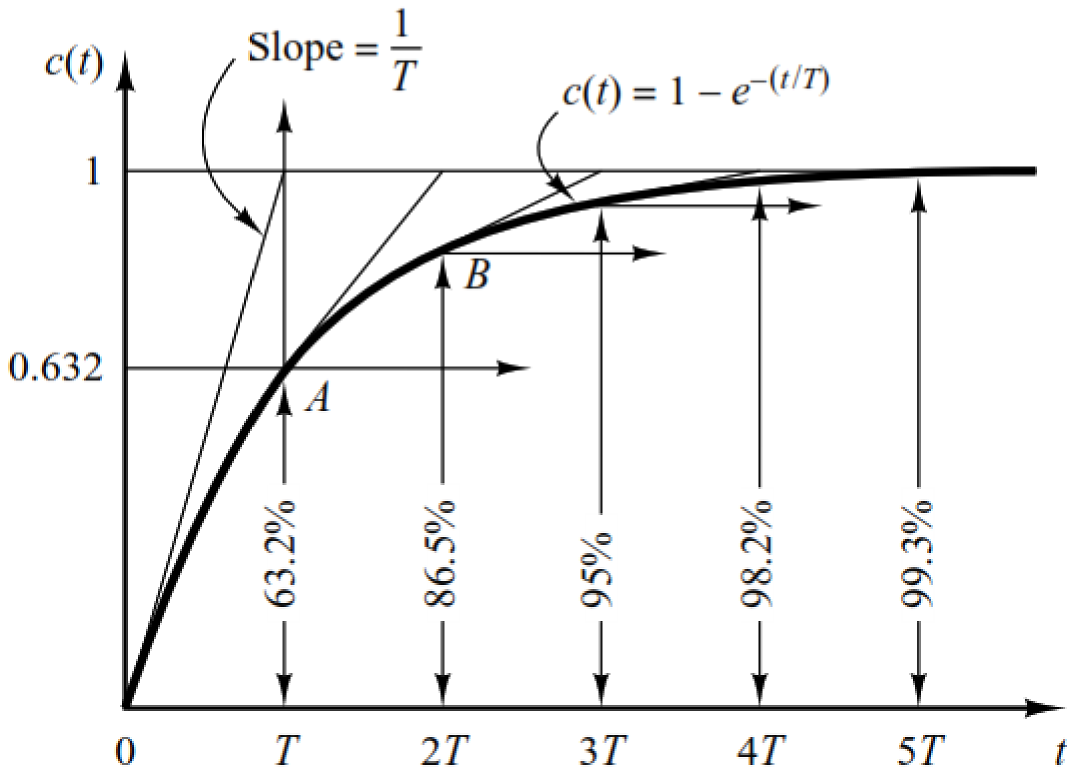
Source: Control systems Engineering – Norman Nise. 6ed

Time response

$$y(t) = \mathcal{L}^{-1}[G(s)U(s)]$$

Tipo de Señal	Definición en el dominio del tiempo	Transformada de Laplace
Impulso δ(t) 	$\delta(t) = \begin{cases} \alpha\ \forall t = 0 \\ 0\ \forall \text{otrocaso} \end{cases}$	1
Escalón (Paso) 	$u(t) = \begin{cases} 1 \forall t \geq 0 \\ 0\ \forall \text{otrocaso} \end{cases}$	$\frac{1}{s}$
Rampa 	$r(t) = \begin{cases} t\ \forall t \geq 0 \\ 0\ \forall \text{otrocaso} \end{cases}$	$\frac{1}{s^2}$
Parábola 	$a(t) = \begin{cases} \frac{t^2}{2}\ \forall t \geq 0 \\ 0\ \forall otrocaso \end{cases}$	$\frac{1}{s^3}$

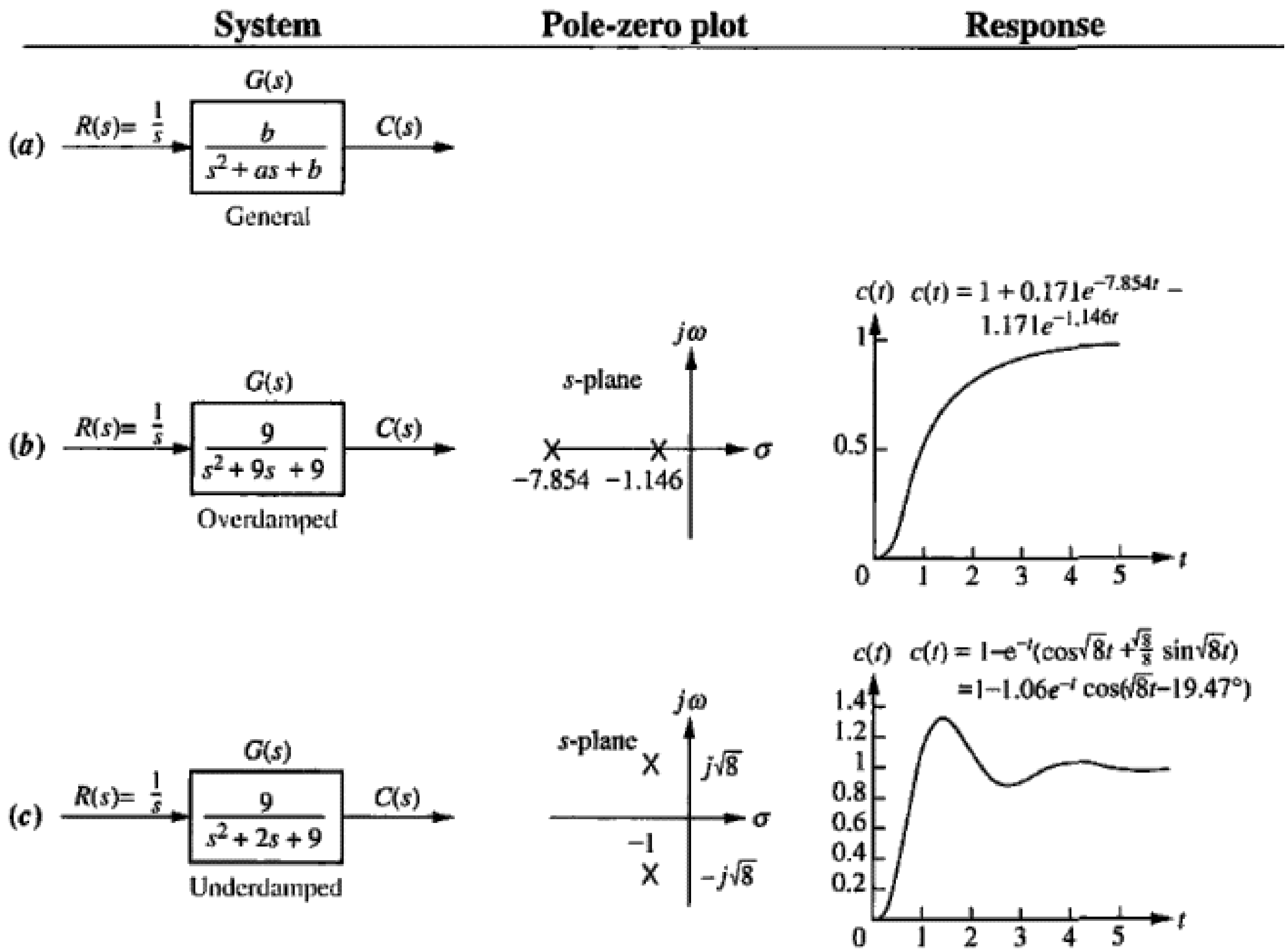
First order systems



$$\frac{C(s)}{R(s)} = \frac{1}{Ts+1}$$

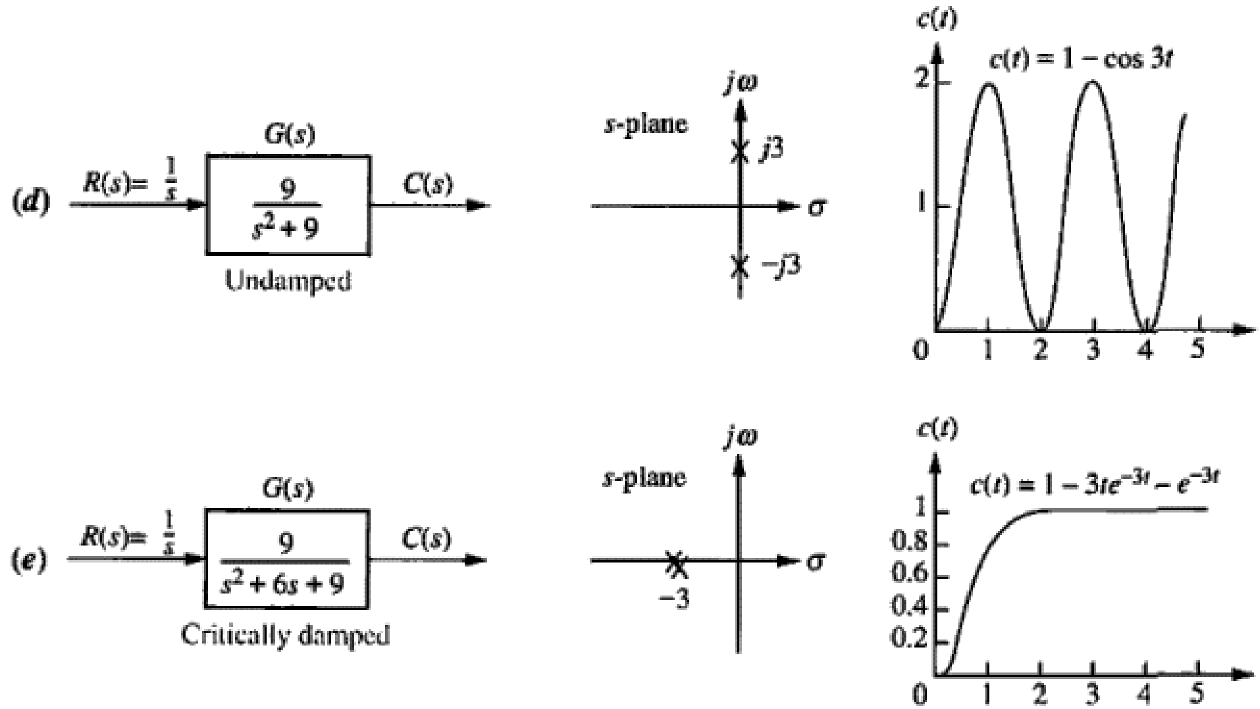
Source: Modern control engineering– Katsuhiko Ogata. 5ed

Second-order systems



Source: Control systems Engineering – Norman Nise. 6ed

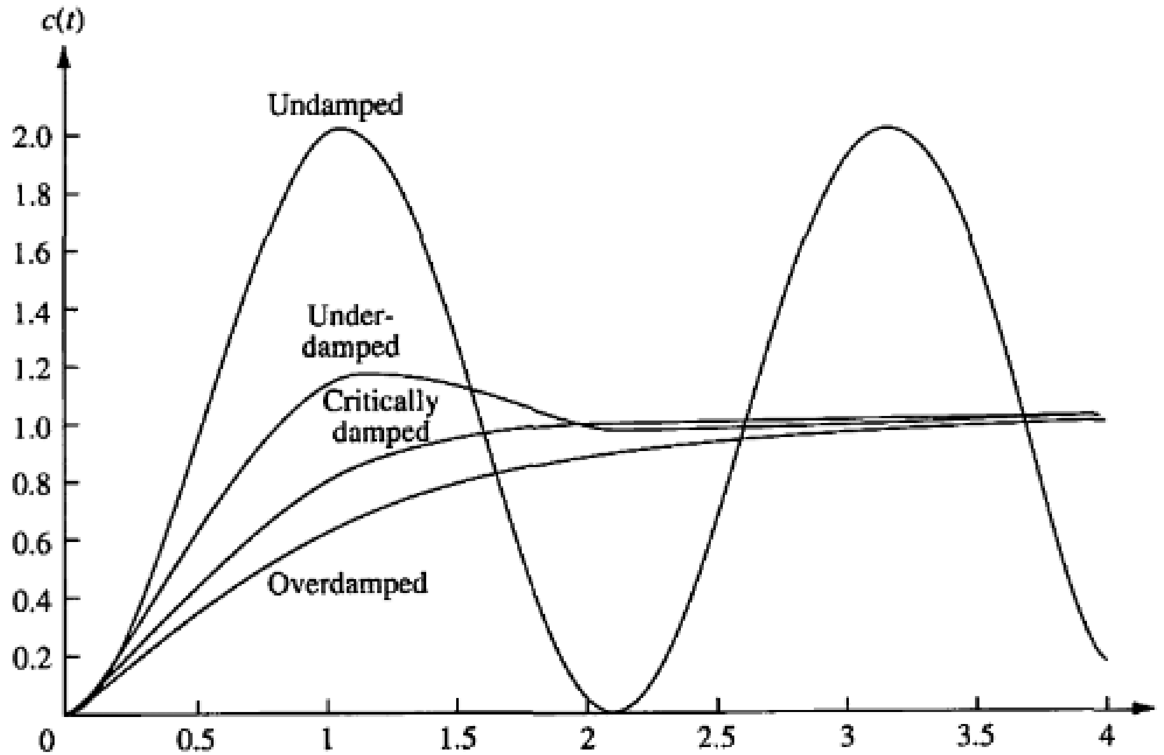
Second-order systems



Source: Control systems Engineering – Norman Nise. 6ed

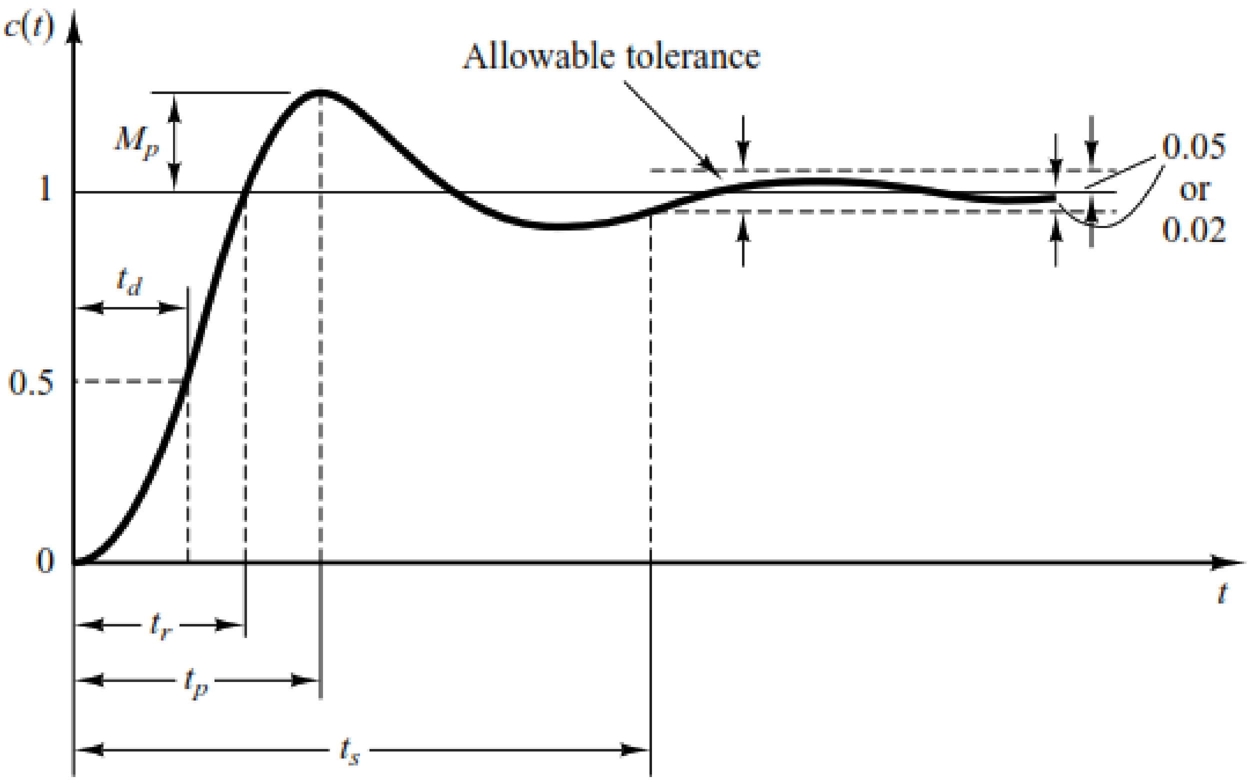
Second-order systems

Step response for second-order system damping cases



Source: Control systems Engineering – Norman Nise. 6ed

Second-order systems



$$\frac{K\omega_n^2}{s^2 + 2\rho\omega_n s + \omega_n^2}$$

$$\omega_d = \omega_n\sqrt{1-\rho^2}$$

$$\sigma = \rho\omega_n$$

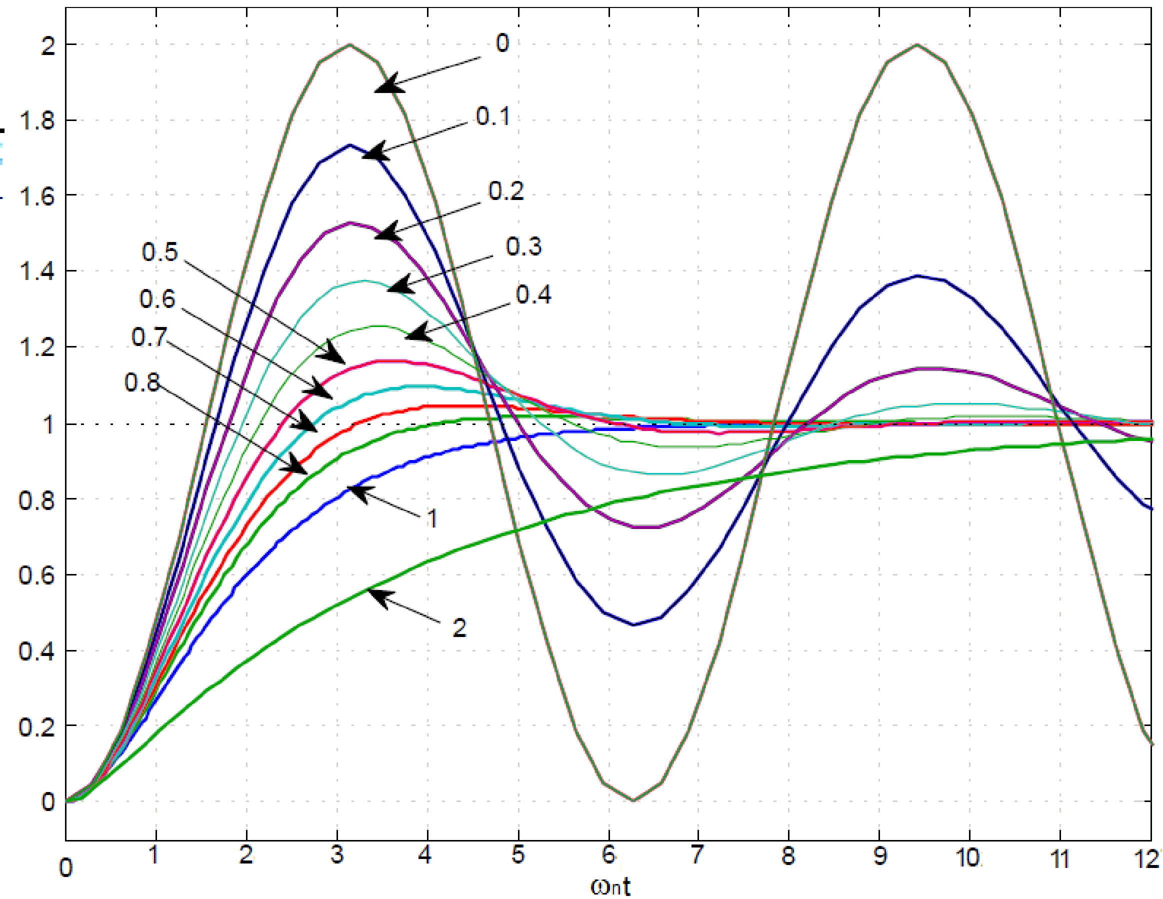
$$t_r = \frac{1}{\omega_d} tan^{-1}\left(\frac{\omega_d}{-\sigma}\right)$$

$$M_p = e^{-\left(\frac{\rho}{\sqrt{1-\rho^2}}\right)\pi}$$

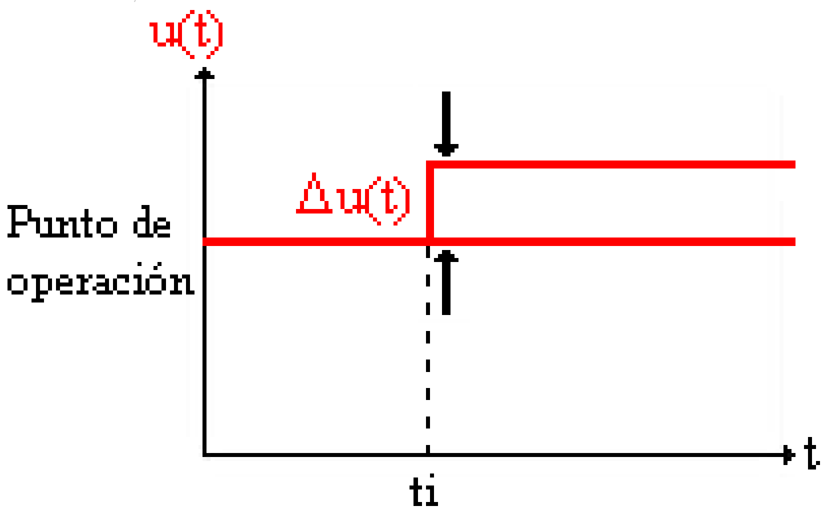
$$t_p = \frac{\pi}{\omega_d} \qquad t_s = \frac{4}{\rho\omega_n}$$

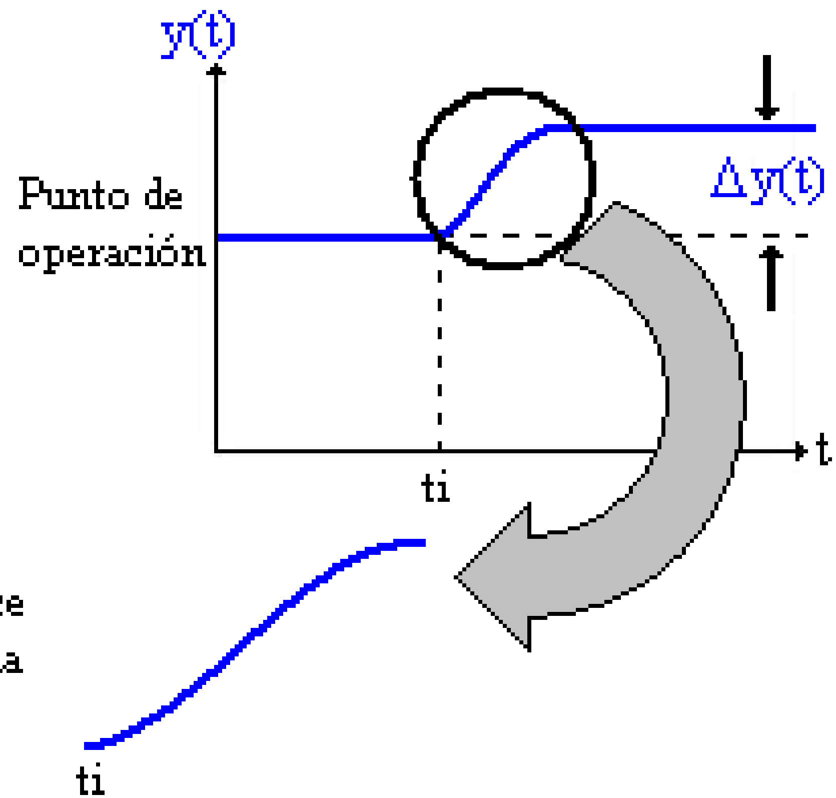
Second order response

$$\frac{K\omega_n^2}{s^2 + 2\rho\omega_n s + \omega_n^2}$$



Reaction curve



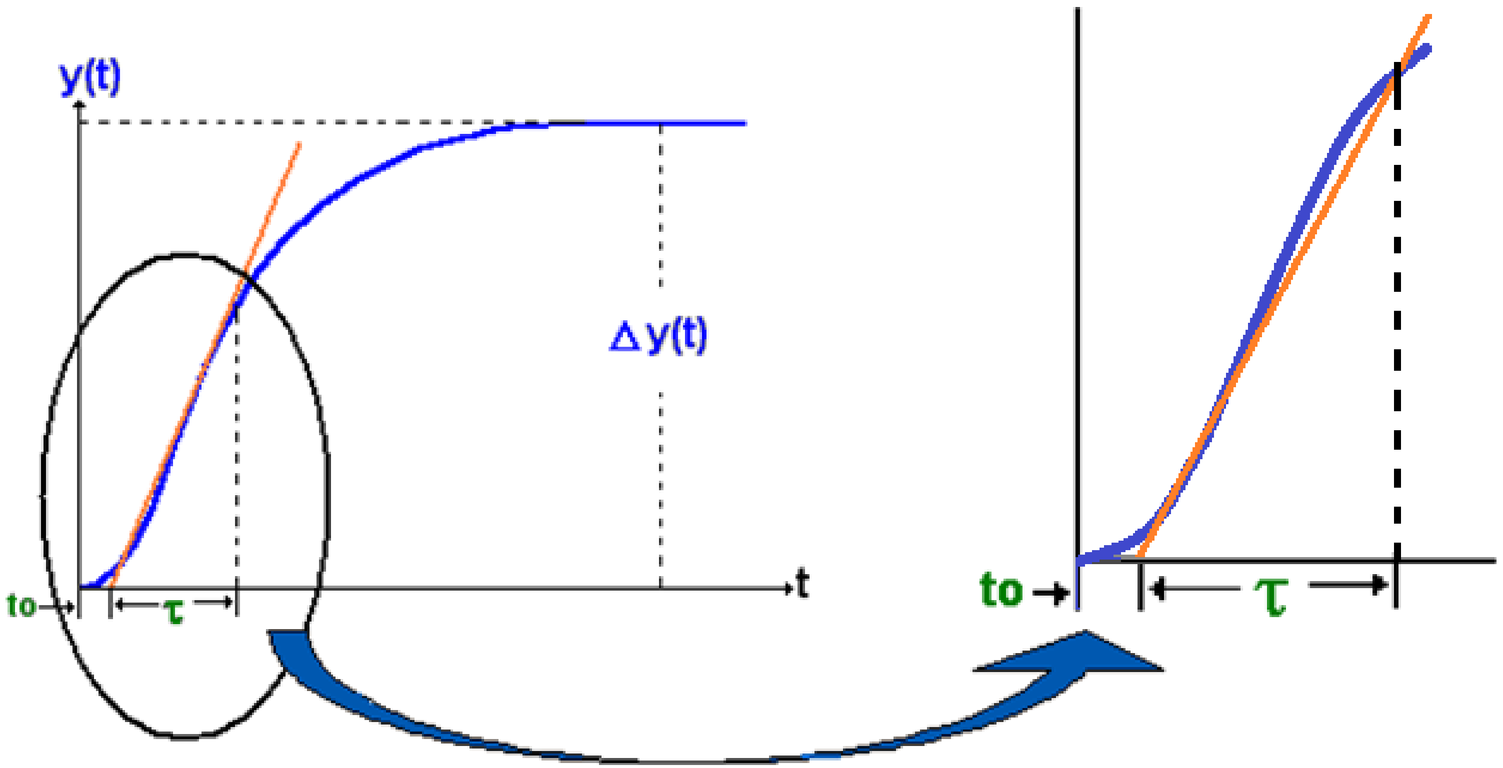


El análisis para hallar el modelo se hace sobre esta zona de la gráfica conocida como: ***curva de reacción***

$$G(s) = \frac{Ke^{-t_o s}}{\tau s + 1}$$

Reaction curve

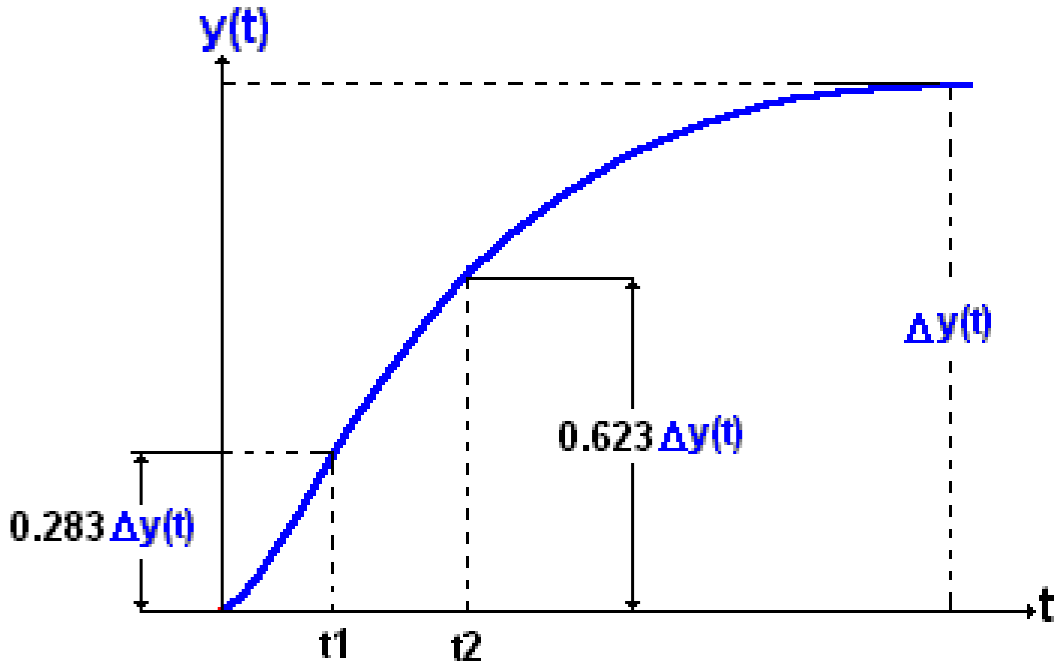
Método de la tangente



$$G(s) = \frac{Ke^{-t_o s}}{\tau s + 1}$$

Reaction curve

Método de dos puntos (Smith)



$$\tau = \tfrac{3}{2}(t_2 - t_1)$$

$$t_o = t_2 - \tau$$

$$G(s) = \frac{Ke^{-t_o s}}{\tau s + 1}$$

$$e^{-t_o s} = \frac{1 - \frac{t_o}{2}s}{1 + \frac{t_o}{2}s}$$