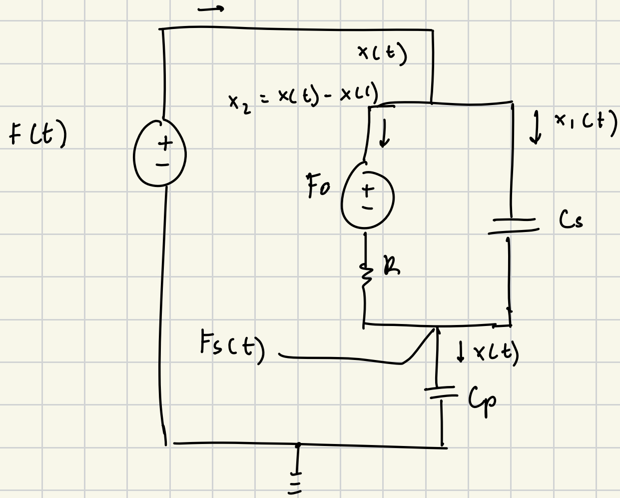
23/10/25

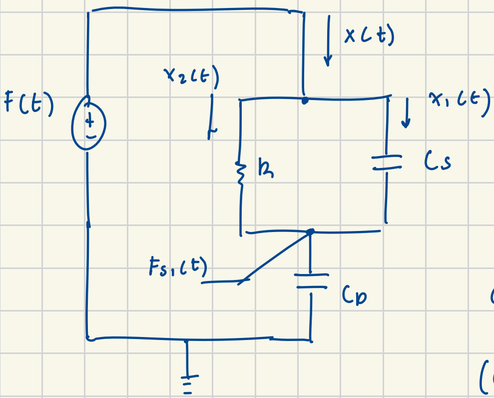
Circuito eléctrico



$$x(t) = x_1(t) + x_2(t)$$

Función de transferencia

Análisis apagando Fo



$$x(t) = x_1(t) + x_2(t)$$

$$x(t) = \frac{d\left[F_s(t)\right]}{dt} \cdot C_p$$

$$x_2(t) = \frac{F(t) - F_s(t)}{R}$$

$$x_1(t) = C_s \frac{d\left[F(t) - F_s(t)\right]}{dt}$$

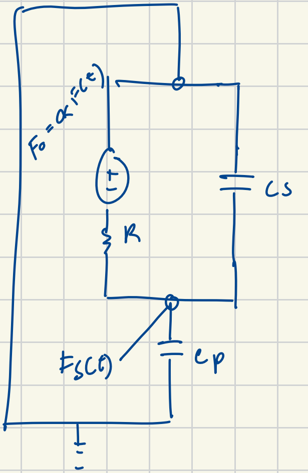
$$C_p \frac{dF_s(t)}{dt} = C_s \frac{d\left[F(t) - F_s(t)\right]}{dt} + \frac{F(t) - F_s(t)}{R}$$

$$C_p\, s\, F_s(s) = C_s\, s\left[F(s) - F_s(s)\right] + \frac{F(s) - F_s(s)}{R}$$

$$\left(C_p s + C_s s + \frac{1}{R}\right) F_s(s) = \left(C_s s + \frac{1}{R}\right) F(s)$$

$$\frac{F_s(s)}{F(s)} = \frac{\left(C_s s + \frac{1}{R}\right)}{\left(C_p s + C_s s + \frac{1}{R}\right)}$$

$$\frac{F_s(s)}{F(s)} = \frac{C_s s + \frac{1}{R}}{(C_p + C_s)s + \frac{1}{R}}$$

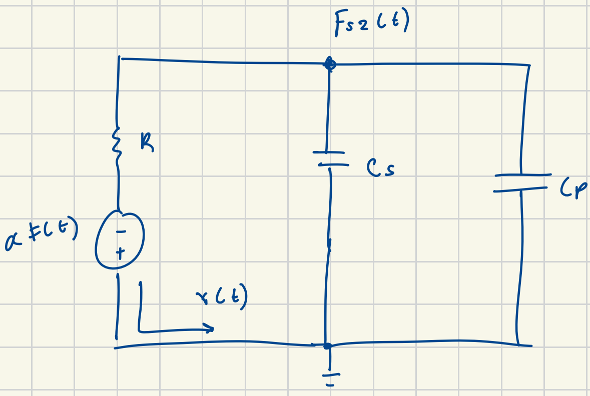


$$= \frac{\frac{C_s R s}{R} + \frac{1}{R}}{\frac{(C_p + C_s) R s}{R} + \frac{1}{R}}$$

$$= \frac{\frac{C_s R s + 1}{\cancel{R}}}{\frac{(C_p + C_s) R s + 1}{\cancel{R}}}$$

$$\frac{F_s(s)}{F(s)} = \frac{C_s R s + 1}{R(C_p + C_s) s + 1}$$

$$\boxed{F_{s_1}(s) = \frac{(C_s R s + 1) F_s(s)}{R(C_s + C_p) s + 1}}$$

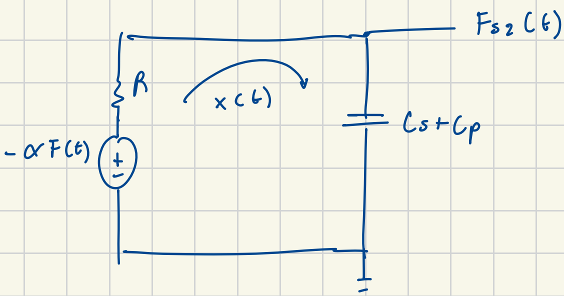


$$-\alpha F(t) = R\, x(t) + \frac{1}{C_s + C_p} \int x(t)\, dt$$

$$F_s(t) = \frac{1}{C_s + C_p} \int x(t)\, dt$$

$$-\alpha F(s) = R\, x(s) + \frac{x(s)}{(C_s + C_p) s}$$

$$F_s(s) = \frac{x(s)}{(C_s + C_p) s}$$



$$F_s(s) = -\frac{R(C_s + C_p) s + 1}{\alpha (C_s + C_p) s}\, x(s)$$

$$\frac{F_s(s)}{F(s)} = -\frac{\frac{\cancel{x(s)}}{\cancel{(C_s + C_p)} s}}{\frac{R(C_s + C_p) s + 1}{\alpha \cancel{(C_s + C_p)} s} \cancel{x(s)}}$$

$$\frac{F_s(s)}{F(s)} = -\frac{\alpha}{R(C_s + C_p) s + 1}$$

$$F_{s2}(s) = -\frac{\alpha F(s)}{R(C_s + C_p) s + 1}$$

$$F_s(s) = F_{s_1}(s) + F_{s2}(s)$$

$$F_s(s) = \frac{(C_s R s + 1) F(s) - \alpha F(s)}{R(C_p + C_s) s + 1}$$

$$\frac{F_s(s)}{F(s)} = \frac{C_s R s + 1 - \alpha}{R(C_p + C_s) s + 1}$$

Error en estado estacionario

$$e(s) = \lim_{s \to 0} s \quad F(s) \left[1 - \frac{F_s(s)}{F(s)} \right]$$

$$= \lim_{s \to 0} \cancel{s} \cdot \frac{1}{\cancel{s}} \left[1 - \frac{\cancel{C_s R s}^{0} + 1 - \alpha}{\cancel{R(C_p + C_s) s}^{0} + 1} \right]$$

$$= 1 - \frac{1 - \alpha}{1}$$

$$= \cancel{1} - \cancel{1} + \alpha$$

$$= \underline{\alpha \quad \cancel{1}} = \alpha V = 0.25 \ V$$

Estabilidad en lazo abierto

$$R(C_p + C_s) s + 1 = 0$$

$$s = - \frac{1}{R(C_p + C_s)} < 0 \quad \therefore \quad \text{es estable, asintóticamente estable.}$$