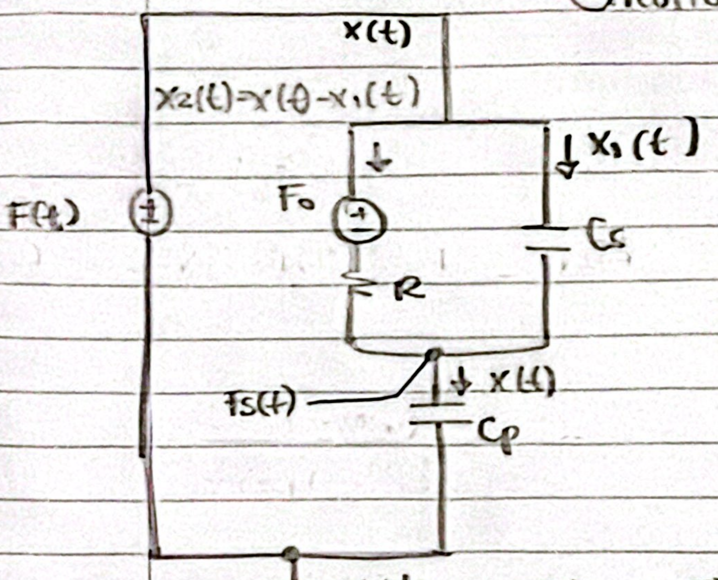
modelado de sistemas fisiológicos — 23 oct 2025

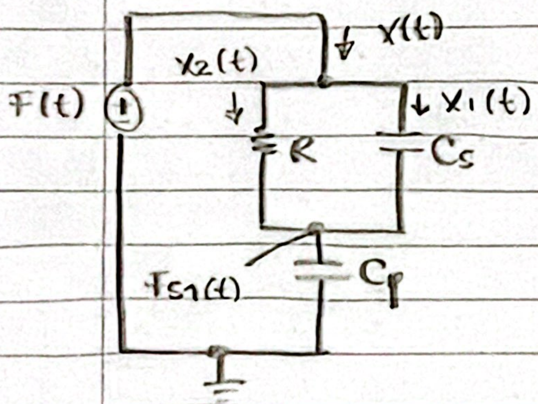
Circuito eléctrico.



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

Función de transferencia

Análisis apagando Fo



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

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

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

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

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

Hacemos la transformada de laplace.

$$C_p S F_s(S) = C_s S [F(S) - F_s(S)] + \frac{F(S) - F_s(S)}{R}$$

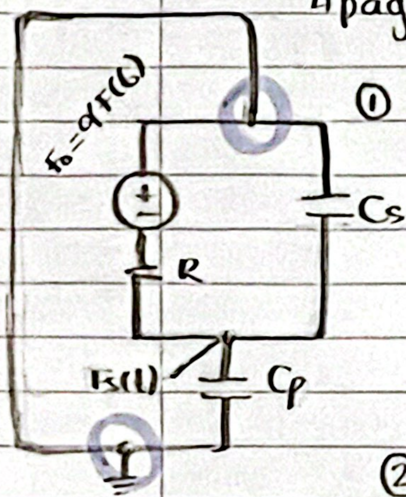
$$\left(C_p S + C_s S + \frac{1}{R}\right) F_s(S) = \left(C_s S + \frac{1}{R}\right) F(S)$$

23 oct 2025.

$$\frac{F_s(S)}{F(S)} = \frac{?}{?}$$

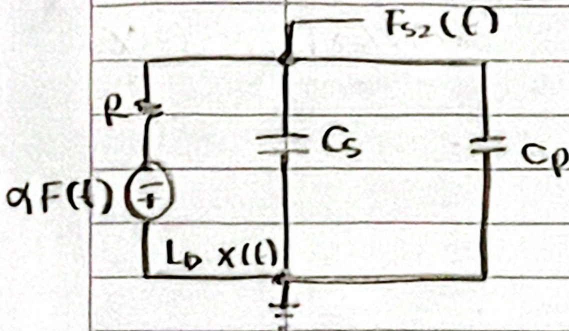
$$\frac{F_s(S)}{F(S)} = \frac{C_s S + \frac{1}{R}}{C_p S + C_s S + \frac{1}{R}} = \frac{\frac{RC_sS+1}{R}}{\frac{RC_pS + RC_sS+1}{R}} = \frac{RC_sS+1}{RC_pS + RC_sS+1}$$

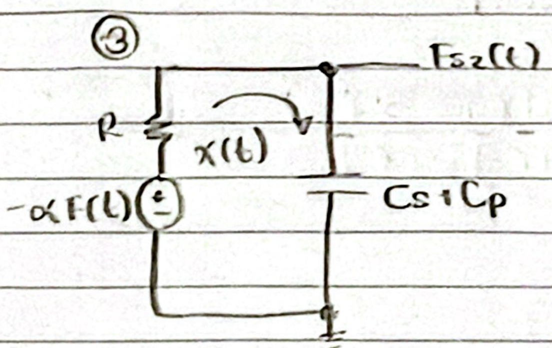
Apagando F_s



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

$$F_{s1}(s) = \frac{(C_sRS+1)F(S)}{R(C_s+C_p)S+1}$$





$$-\alpha F(t) = Rx(t) + \frac{1}{C_s+C_p}\int x(t) \qquad F_{s2} = -\frac{1}{C_s+C_p}X(S)$$

$$-\alpha F(S) = RX(S) + \frac{X(S)}{C_s+C_p} \qquad \frac{F_s(S)}{F(S)} =$$

$$-\alpha F(S) = \left(R + \frac{1}{C_s+C_p}\right)X(S)$$

$$F(S) = -\frac{1}{\alpha}\left(R + \frac{1}{C_s+C_p}\right)X(S)$$

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

- error estado estacionario
- estabilidad en lazo abierto.

$$F_s(S) = \frac{X(S)}{(C_s+C_p)S}$$

$$F(S) = -\frac{R(C_s+C_p)S+1}{\alpha(C_s+C_p)S}\,X(S)$$

$$\frac{F_s(S)}{F(S)} = -\frac{\frac{\cancel{X(S)}}{(C_s+C_p)S}}{\frac{R(C_s+C_p)S+1}{\alpha(C_s+C_p)S}\,X(S)} = -\frac{\alpha}{R(C_s+C_p)S+1}$$

$$F_{S2}(S) = -\frac{\alpha F(S)}{R(C_s+C_p)S+1}$$

$$F_s(S) = F_{S1}(S) + F_{S2}(S)$$

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

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

Parámetro	Control	Caso
$F(t)$	1V	1V
α	0.25	0.25
C_s	10 µF	10 µF
C_p	100 µF	100 µF
R	100 Ω	10 kΩ

Tarea 24 oct 2025

Error en estado estacionario

①

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

②

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

③

$$e(s) = 1 - \frac{1-\alpha}{1} = 1 - 1 + \alpha = \alpha \; // \quad e(s) = \alpha \; ; \; e(t) = \alpha V = 0.25V$$

Estabilidad en lazo abierto

Sistema de 1er orden: tiene una sola raiz.

$$R(C_s + C_p)s + 1 = 0 \qquad \lambda = -\frac{1}{R(C_s + C_p)}$$

$Re \; \lambda < 0 \; \therefore$ El sistema es estable

Resultado: la respuesta del sistema es estable. La respuesta es asintóticamente estable.