Transformada de Laplace

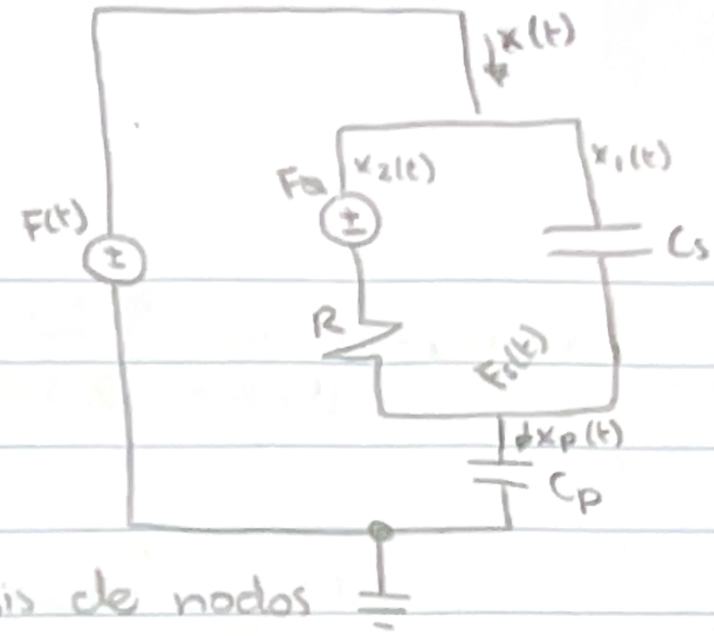
Derivadas → multiplicación por s

Sistema musculoesquelético

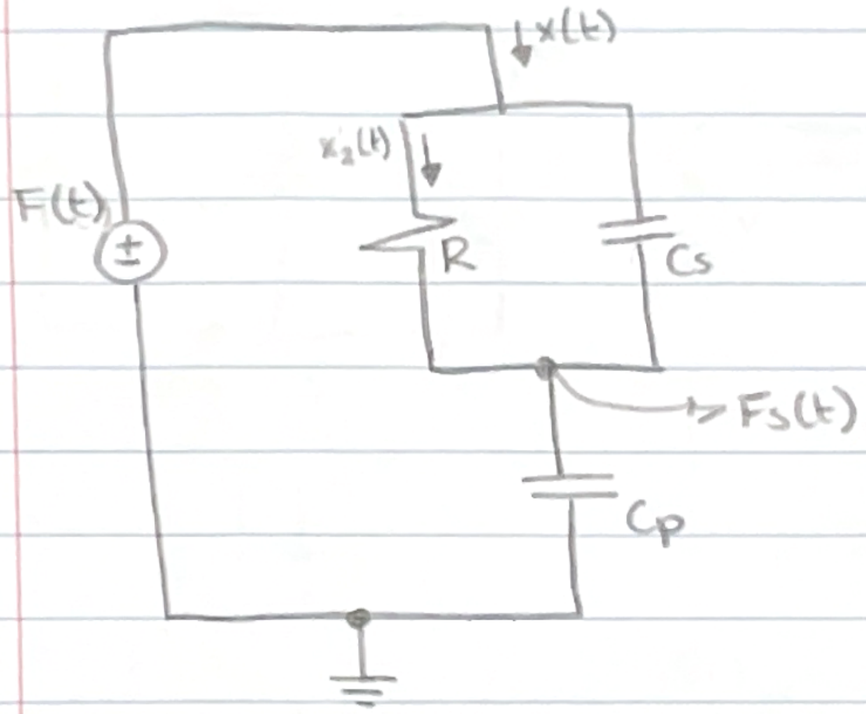
Función de transferencia

- Análisis por superposición

Circuito eléctrico



- Análisis de nodos



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

$$x(t) = C_p \frac{dF_s(t)}{dt}$$

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

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

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

$$\frac{F_s(s)}{F(s)}$$

Transformada de Laplace

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

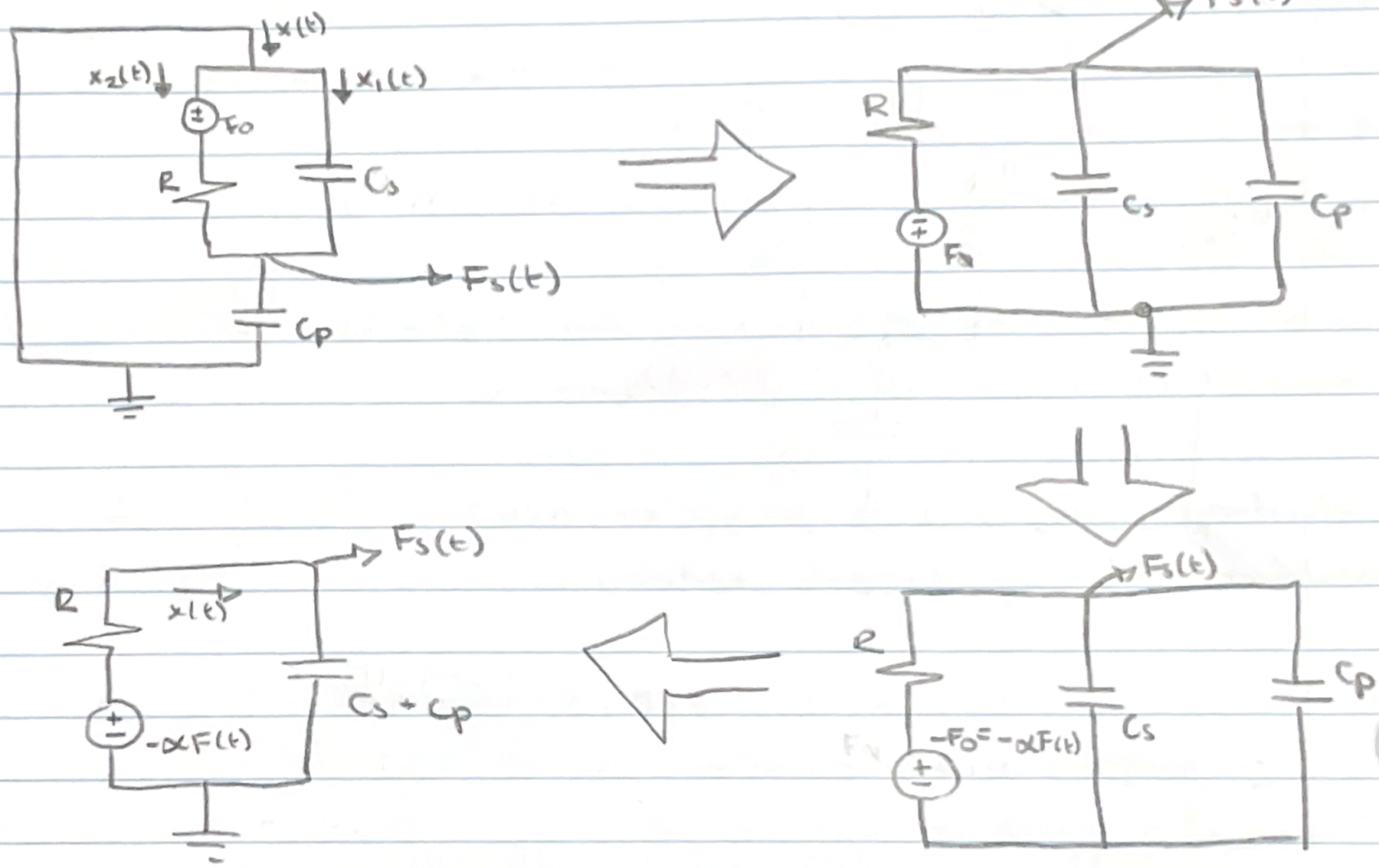
$$C_p s F_s = C_s s F_s - C_s s F_s(s) + \frac{F(s)}{R} - \frac{F_s(s)}{R}$$

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

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

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

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



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

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

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

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

$$F(s) = \frac{R(C_s + C_p)s + 1}{(C_s + C_p)s} \cdot \frac{x(s)}{-\propto}$$

$$\frac{F_s(s)}{F(s)} = \frac{\frac{x(s)}{(C_s + C_p)s}}{\frac{R(C_s + C_p)s + 1}{(C_s + C_p)s} \cdot \frac{x(s)}{-\propto}} \rightarrow \frac{\frac{x(s)}{(C_s + C_p)s}}{\frac{R(C_s + C_p)s + 1}{-\propto (C_s + C_p)s} x(s)}$$

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

$$F_{s_2}(s) = \frac{-\alpha F(s)}{R(C_s+C_p)s+1}$$

$$F(t) = F_{s_1}(s) + F_{s_2}(s)$$

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

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

Función de transferencia

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

	Control	Caso
C_s	$10\mu F$	$10\mu F$
C_p	$100\mu F$	$100\mu F$
R	100Ω	$10K\Omega$
α	0.25	0.25
F(t)	1V	1V

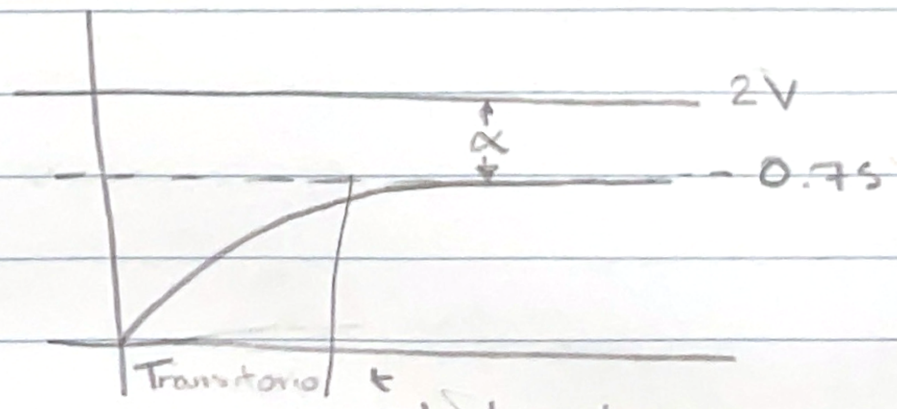
Error en estado estacionario

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

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

$e(s) = \alpha$

$e(t) = \alpha V$



Estabilidad en lazo abierto

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

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

$Re\lambda < 0$ → El sistema presenta una respuesta estable