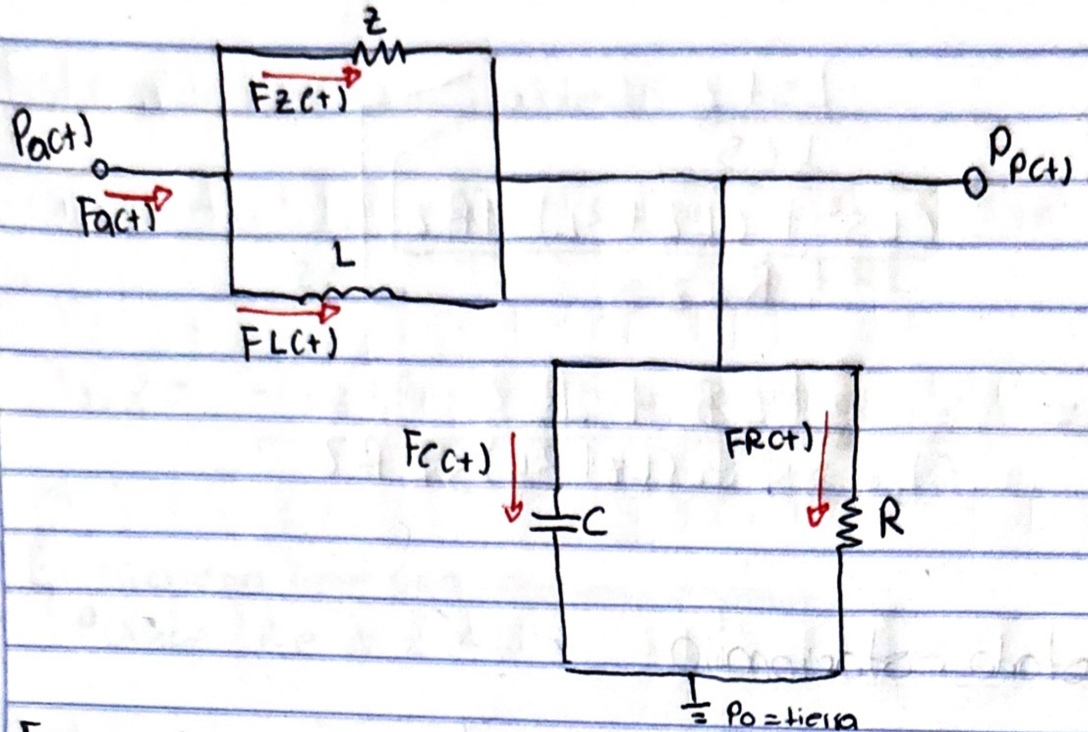
Practica 5.4 sistema cardiovascular



Ecuación Principal

$$F_a(t) = F_z(t) + F_L(t) = F_c(t) + F_R(t)$$

$$F_z(t) = \frac{P_a(t) - P_p(t)}{Z} \qquad F_c(t) = \frac{C\,dP_p(t)}{dt}$$

$$F_L(t) = \frac{1}{L}\int [P_a(t) - P_p(t)]\,dt \qquad F_R(t) = \frac{P_p(t)}{R}$$

Procedimiento algebraico

$$\frac{P_a(t)}{Z} - \frac{P_p(t)}{Z} + \frac{1}{L}\int [P_a(t) - P_p(t)]\,dt = \frac{C\,dP_p(t)}{dt} + \frac{P_p(t)}{R}$$

$$\frac{P_a(s)}{Z} - \frac{P_p(s)}{Z} + \frac{P_a(s) - P_p(s)}{Ls} = CsP_p(s) + \frac{P_p(s)}{R}$$

$$\left(\frac{1}{Z} + \frac{1}{Ls}\right)P_a(s) = \left(Cs + \frac{1}{R} + \frac{1}{Z} + \frac{1}{Ls}\right)P_p(s) \qquad RLZs$$

$$\left(\frac{Ls+Z}{LsZ}\right)P_a(s) = \frac{CRLZs^2 + LZs + RLs + RZ}{RLZs}\left(P_p(s)\right)$$

$$\left(\frac{Ls+Z}{LsZ}\right)P_a(s) =$$

$$\frac{P_p(s)}{P_a(s)} = \frac{\frac{Ls+Z}{LsZ}}{\left(\frac{RCLs^2Z + LZs + RLs + ZR}{RZLs}\right)}$$

$$\frac{P_P(s)}{P_a(s)} = \frac{\frac{Ls+Z}{LZs}}{\frac{CLs^2+(LZ+RL)s+RZ}{RLZs}}$$

$$= \frac{RLs+RZ}{CLRZs^2+(LZ+RL)s+RZ}$$

Error en estado estacionario

$$e(s) = \lim_{s\to\emptyset} s\, P_a(s)\left[1 - \frac{P_P(s)}{P_a(s)}\right]$$

$$= \lim_{s\to\emptyset} \cancel{s} \cdot \frac{1}{\cancel{s}}\left[1 - \frac{R\cancel{L}\cancel{s}+RZ}{\cancel{CLRZs^2}+\cancel{(CLZ+RL)s}+RZ}\right]$$

$$= 1 - \frac{RZ}{RZ} = \emptyset$$

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Estabilidad en lazo abierto

$$\lambda_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad a = CLRz \qquad C = Rz$$
$$b = Lz + RL$$

$$\lambda_{1,2} = \frac{-(Lz + RL) \pm \sqrt{(Lz + RL)^2 - 4(LR^2z^2}}{2CLRz} = \frac{(-)(\;)}{+}$$

El sistema tiene una respuesta estable porque $Re\,\lambda_{1,2} < \emptyset$

Modelo de ecuaciones integro-diferenciales

$$P_p(t)\left(\frac{1}{R} + \frac{1}{z}\right) = \frac{P_a(t)}{z} + \frac{1}{L}\int [P_a(t) - P_p(t)]\,dt - C\frac{dP_p(t)}{dt}$$

$$P_p(t) = \left(\frac{P_a(t)}{z} + \frac{1}{L}\left[\int (P_a(t) - P_p(t))\,dt - C\frac{dP_p(t)}{dt}\right]\right)\frac{zR}{z+R}$$