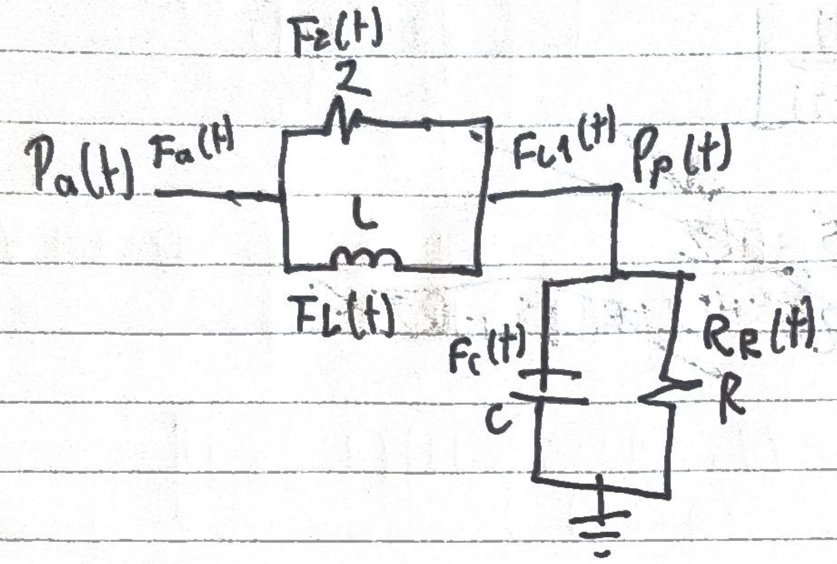
Practica 6.4 Sistema cardiovascular



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

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

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

Procedimiento algebraico

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

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

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

$$P_a(s)\left[\frac{Ls + Z}{LsZ}\right] = \frac{CLs^2RZ + ZLs + RLs + RZ}{RZLs}\,P_p(s)$$

$$\frac{P_p(s)}{P_a(s)} = \frac{\frac{Ls+Z}{LsZ}}{\frac{CLs^2RZ + ZLs + RLs + RZ}{RZLs}}$$

Error de estado estacionario

$$e(s) = \lim_{s\to 0} s P_a(s)\left[1 - \frac{P_p(s)}{P_a(s)}\right]$$

$$\lim_{s\to 0} \cancel{s}\frac{1}{\cancel{s}}\left[1 - \frac{\cancel{RLs} + RZ}{\cancel{CLRZs^2} + \cancel{(LZ+RL)s} + RZ}\right]$$

$$1 - \frac{RZ}{RZ} = 0$$

Estabilidad en lazo abierto

Este es más grande

$$\lambda_{1,2} = \frac{-b \pm \sqrt{b^2-4ac}}{2a} \qquad a = CLRZ \quad b = LZ+RL \quad c = RZ$$

$$\frac{-(LZ+RL) \pm \sqrt{(LZ+RL)^2 - 4(CLRZ^2)}}{CLRZ}$$

$$= \frac{(-)(\;)}{+}$$

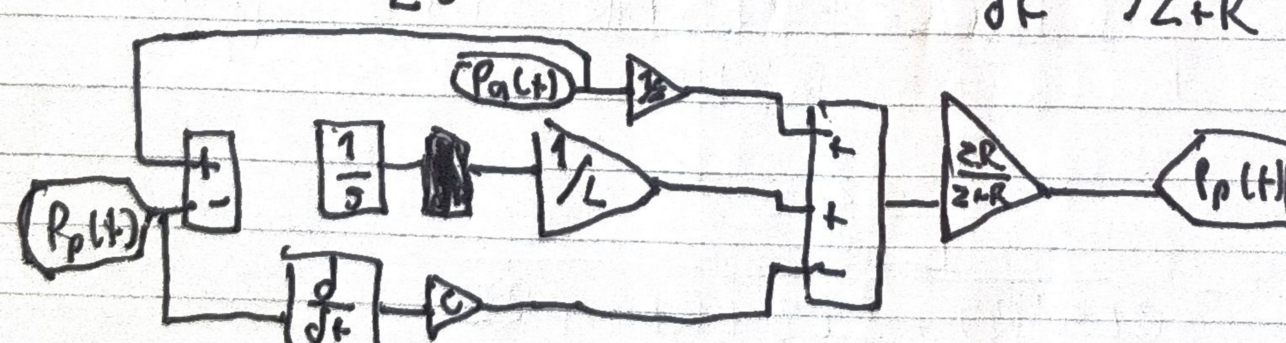
El sistema tiene una respuesta estable porque $\mathrm{Re}\,\lambda_{1,2} < 0$

Modelo de ecuaciones integro-diferenciales

$$\cancel{P_p(t) = \left(\frac{1}{R} + \frac{1}{Z}\right) = \frac{P_a(t)}{Z}}$$

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

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



Funcion de transferencia

$$\frac{P_p(t)}{P_a(t)} = \frac{[Ls + Z]R}{CLS^2RZ + ZLS + RLS + RZ}$$

$$= \frac{RLS + RZ}{CLRZS^2 + (ZL + RL)S + RZ}$$