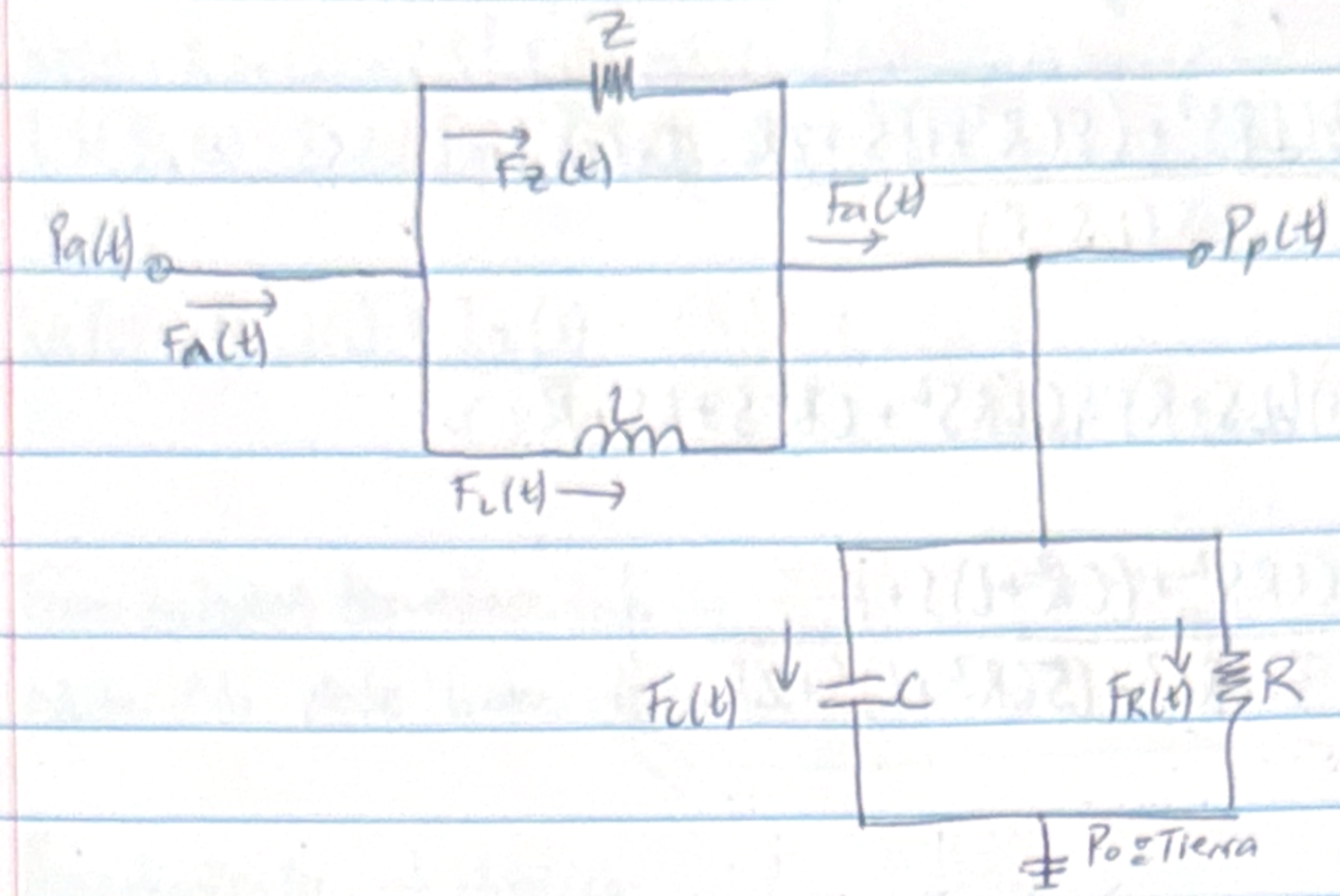
Práctica 5.4. Sistema cardiovascular



Ecuación principal

$$F_a(t) = F_Z(t) + F_L(t) = F_C(t) + F_R(t)$$

$$F_Z(t) = \frac{P_a(t) - P_p(t)}{Z} \qquad F_C(t) = C\frac{dP_p(t)}{dt}$$

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

Procedimiento algebraico (sustituir en ecuación principal)

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

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

$$\frac{P_p(s)}{P_a(s)} = \frac{?}{?}$$

$$\left(\frac{1}{Z} + \frac{1}{LS}\right)P_a(s) = \left(CS + \frac{1}{R} + \frac{1}{Z} + \frac{1}{LS}\right)P_p(s)$$

$$P_p(s)\left(\frac{1}{Z} + \frac{1}{LS}\right)\frac{CZLS + Z}{(+ZLS+)}\,P_a(s) \qquad P_p(s)\left(CS + \frac{1}{R} + \frac{1}{Z} + \frac{1}{LS}\right) = P_p(s)\left(CSRZLS\right.$$

$$P_p(s)\left(CS+\frac{1}{R}+\frac{1}{Z}+\frac{1}{LS}\right)=P_p$$

$$P_p(s)\left(\frac{CS(LSRZ)+ZLS+RLS+RZ}{RZLS}\right)=P_p(s)\left(\frac{CLRZS^2+ZLS+RLS+RZ}{RZLS}\right)$$

$$\frac{Pa(s)}{}\left(\frac{LS+Z}{ZLS}\right)=P_p(s)\left(\frac{CLRZS^2+ZLS+RLS+RZ}{RZLS}\right)$$

$$\frac{\left(\frac{LS+Z}{ZLS}\right)}{\left(\frac{CLRZS^2+(ZL+RL)S+RZ}{RZLS}\right)}=\frac{P_p(s)}{Pa(s)}$$

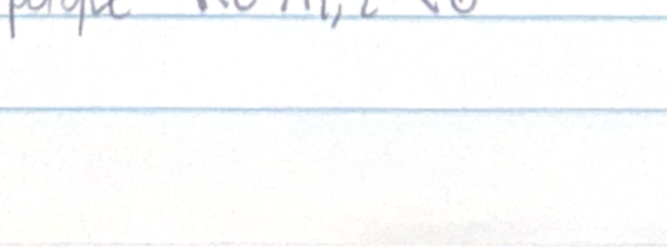
$$\frac{P_p(s)}{Pa(s)}=\frac{LS+RLS+RZ}{CLRZS^2+(LZ+RL)S+RZ}$$

Estado: Error en estado estacionario

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

$$=\lim_{s\to 0} s*\frac{1}{s}\left[1-\frac{RLS+RZ}{CLRZS^2+(LZ+RL)S+RZ}\right]$$

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



Estabilidad en lazo abierto

$$\lambda_{1,2}=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$\lambda_{1,2}=\frac{-(LZ+RL)\pm\sqrt{(LZ+RL)^2-4CLR^2Z^2}}{2CLRZ}$$

más grande

$a=CLRZ$

$b=LZ+RL$

$C=RZ$

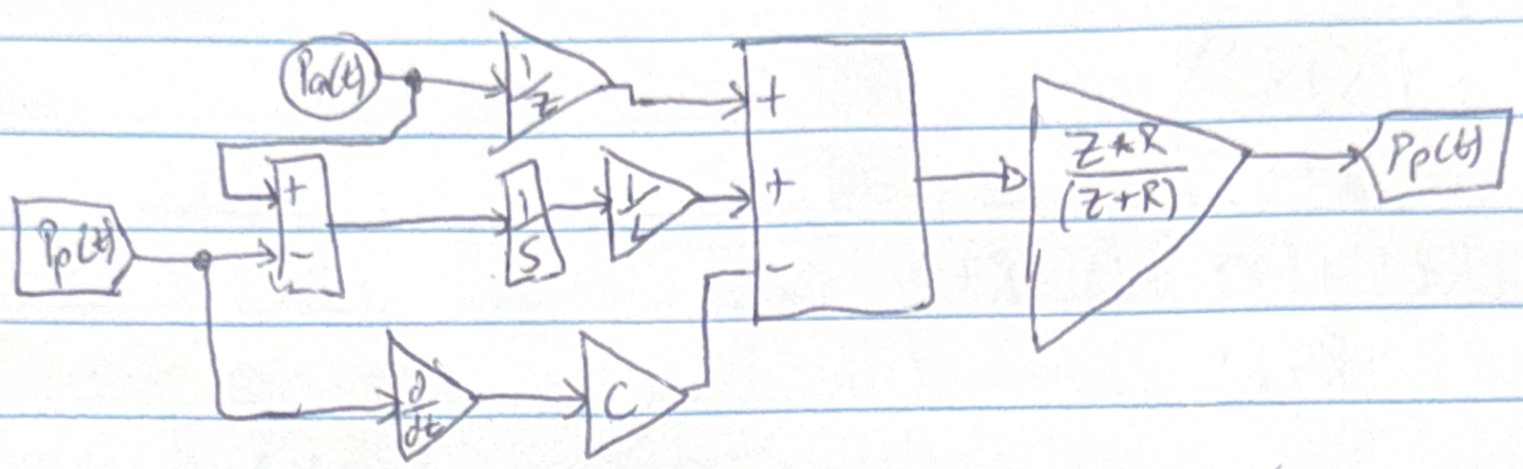
el sistema tiene una respuesta estable porque $Re\,\lambda_{1,2}<0$

Modelo de ecuaciones integro-diferenciales

*No conocemos $P_p(t)$, se despeja

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

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



min = -0.2

max = 1

seed = 106