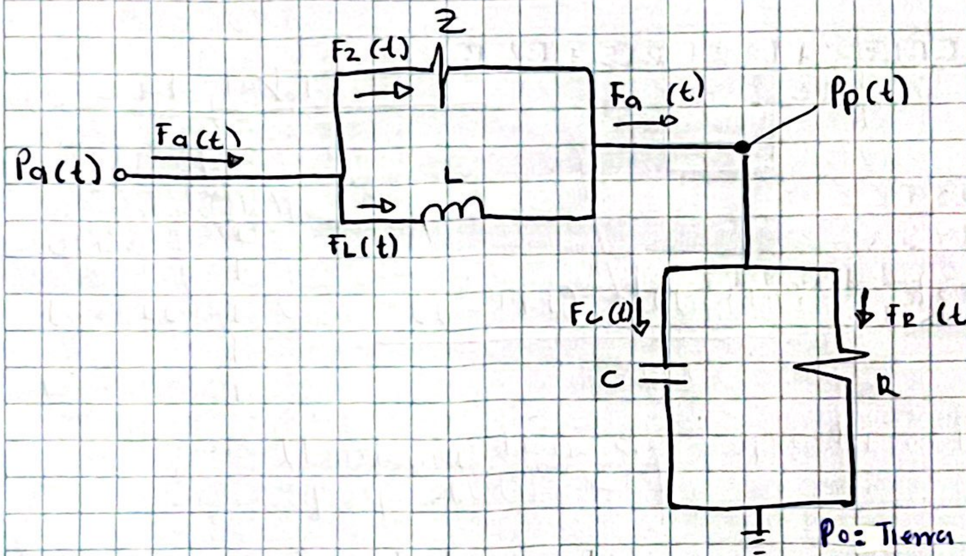
Práctica 5.4. **Sistema cardiovascular**

viernes 10 de octubre de 2025



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.

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

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

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

$$RLZS\left(\frac{1}{R}\right) \quad \frac{RLZS}{\cancel{R}}$$

$$\frac{LS+Z}{LZS}\,Pa(s)=\frac{CRLZS^2+LZS+RLS+RZ}{RZLS}\,Pp(s)$$

$$RLZS\left(\frac{1}{Z}\right)=\frac{RLZS}{\cancel{Z}}$$

$$RLZS\left(\frac{1}{LS}\right)=\frac{RLZS}{LS}$$

$$\frac{Pp(s)}{Pa(s)}=\frac{\dfrac{LS+Z}{LZS}}{\dfrac{CRLZS^2+LZS+RLS+RZ}{RZLS}}$$

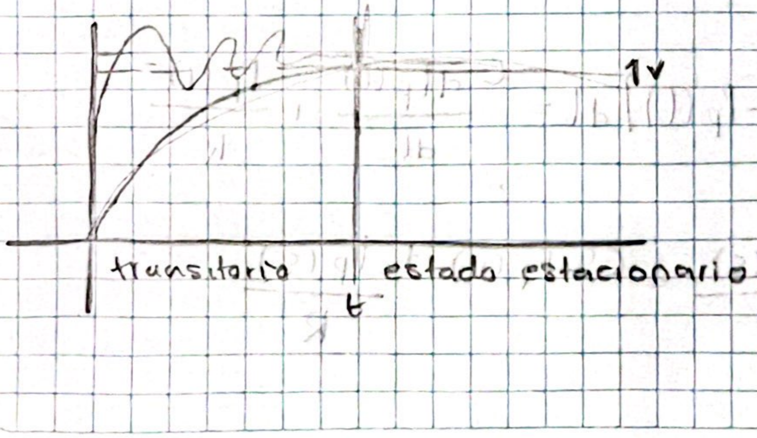
$$\frac{Pp(s)}{Pa(s)}=\frac{RLS+RZ}{CLRZS^2+(LZ+RL)S+RZ}$$ Función de transferencia.

Error en estado estacionario.

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

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

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



Estabilidad en lazo abierto.

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

$a = CLRZ$

$b = LZ + RL$

$c = RZ$

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

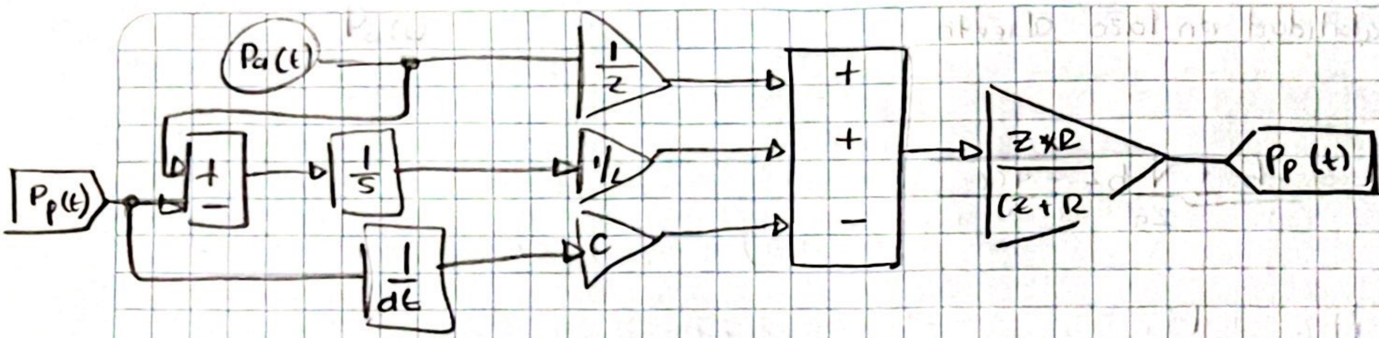
El sistema tiene una respuesta estable porque $Re\lambda_{1,2} < 0$

Modelo de ecuaciones integro-diferenciales

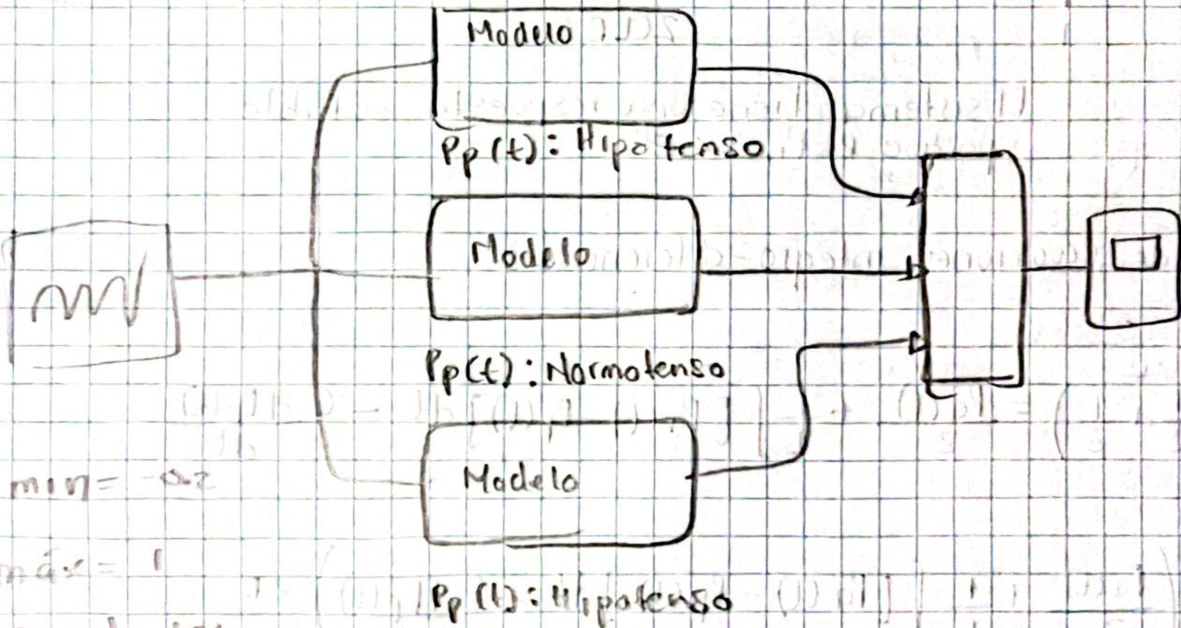
$$P_p(t)\underbrace{\left(\frac{1}{R} + \frac{1}{Z}\right)}^{\frac{Z+R}{ZR}} = \frac{P_a(t)}{Z} + \frac{1}{L}\int [P_a(t) - P_p(t)]\,dt - C\frac{dP_p(t)}{dt}$$

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

Scanned with CamScanner



Lazo Abierto.



min = -0.2

máx = 1

seed = 106