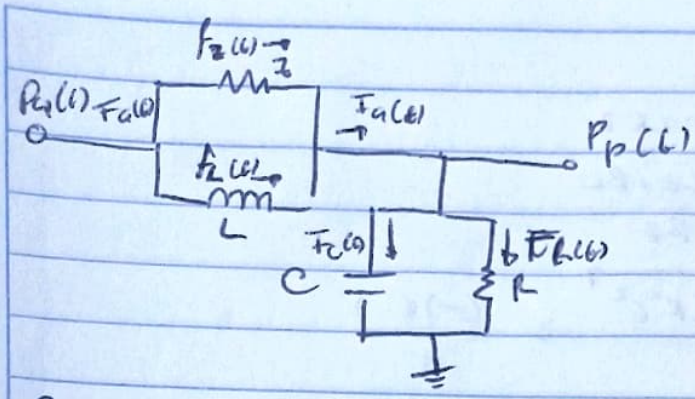
Practica 5.4: Sistema Cardiovascular



A Ecuaciones Principales

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

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

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

$$F_R(t) = \frac{P_p(t)}{R}$$

Procedimiento Algebraico

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

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

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

Función de transferencia

$$\frac{Ls + Z}{LZs} = \frac{CLs^2 + LZs + RLs + RZ}{LZs}\, P_p(s)$$

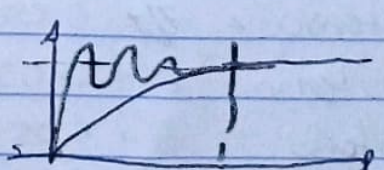
$$\frac{P_p(s)}{P_a(s)} = \frac{\frac{Ls + Z}{LZs}}{\frac{CLs^2 + (LZ + RL)s + RZ}{RLZs}} = \frac{RLs + RZ}{CLRZs^2 + (LZ + RL)s + RZ}$$

Error en estado estacionario

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

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

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



Estable pq $Re\ \lambda_{1,2} < 0$

Estabilidad en lazo abierto

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

$a = CLR^2$

$b = L^2 + RL$

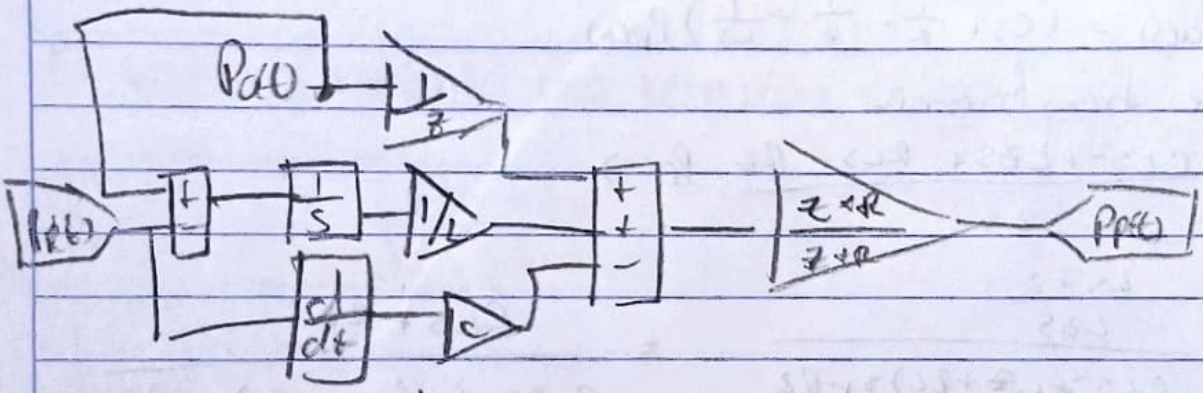
$c = R^2$

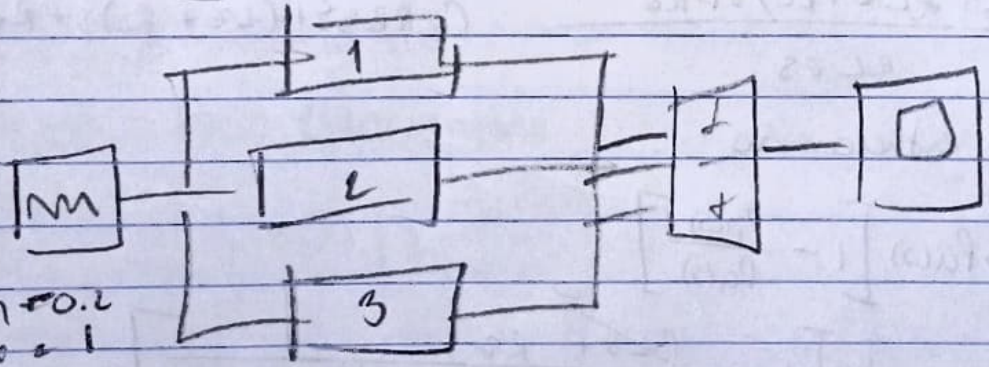
$$\lambda_{1,2} = \frac{-(L^2+RL) \pm \sqrt{(L^2+RL)^2 - 4CLR^2R^2}}{2CLR^2} = \frac{(-)(-)}{+}$$

Modelo de ELF

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

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





min = 0.2
max = 1
sucl = 100 sample = 0.5

1 Hipotenso	$t = 0.02$	$L = 0.005$	$C = 0.25$	$R = 0.6$
2 Normotenso	$t = 0.033$	$L = 0.01$	$C = 1.5$	$R = 0.95$
3 Hipertenso	$t = 0.05$	$L = 0.02$	$C = 2.5$	$R = 1.4$