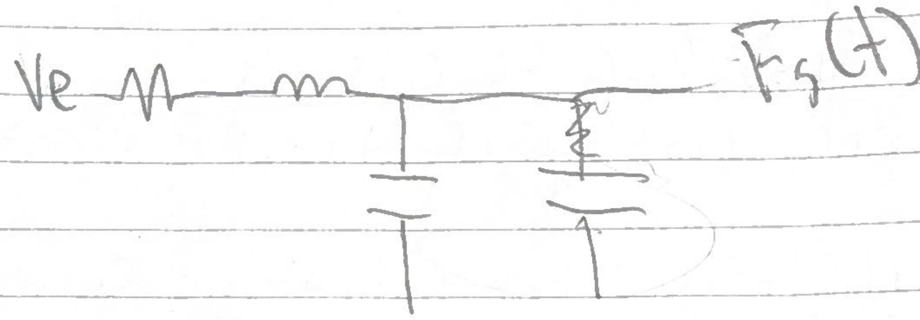


$$V_a = R I_1(t) + L\frac{d(I_1(t))}{dt} + \frac{1}{C}\int (I_1 - I_2)\,dt$$

$$\frac{1}{C_1}\int (I_1 - I_2)\,dt = \frac{1}{C_2}\int I_2(t)\,dt$$

$$V_e = \frac{1}{C_2}\int I_2(t)\,dt$$

Transformada

$$V_a = R I_1(S) + LS\,I_1(S) + \frac{I_1(S) - I_2(S)}{C_1 S}$$

$$\frac{I_1(S) - I_2(S)}{C_1 S} = \frac{I_2(S)}{C_2 S} + R_2 I_2(S)$$

$$V_e = \frac{I_2(S)}{C_2 S} + R_2 I_2(S)$$

$$\left(\frac{1}{C_1 S}\right) I_1(S) = \frac{I_2(S)}{C_2 S} + \frac{I_2(S)}{C_1 S}$$

$$I_1(S) = \frac{\left(\frac{1}{C_2 S} + \frac{1}{C_1 S} + R_2\right) I_2}{\frac{1}{C_1 S}}$$

$$V_a = \left(R_1 + L_1 S + \frac{1}{C_1 S}\right)\left(\frac{\left(\frac{1}{C_2 S} + \frac{1}{C_1 S} + R_2\right) I_2}{\frac{1}{C_1 S}}\right) - \frac{I_2(S)}{C_2 S}$$

$$V_a = \left(R_1 + LS + \frac{1}{C_1 S}\right)\left(\frac{C_1 \cancel{S}}{C_2 \cancel{S}} + 1 + R_2 C_1 S\right) I_2 - \frac{I_2(S)}{C_2 S}$$

$$I_2\left[\frac{R_1 C_1}{C_2} + \frac{L S C_1}{C_2} + \frac{\cancel{C_1}}{\cancel{C_1} C_2 S} + R_1 + LS + \frac{\cancel{1}}{\cancel{C_1 S}} + R_1 R_2 C_1 S + R_2 C_1 L S^2 + R_2 + \frac{1}{C_2 S}\right.$$

$$\frac{R_1 C_1 + L S C_1}{C_2} + \frac{1}{\cancel{C_2} S} + R_1 + LS + \frac{1}{C_1 S} + R_1 R_2 C_1 S + R_2 C_1 L S^2 + R_2 - \frac{\cancel{1}}{\cancel{C_2 S}}$$

$$\frac{R_1 C_1^2 S + L S C_1^2 S + R_1 C_1 C_2 S + C_1 C_2 L S^2 + 1 + C_1^2 C_2 R_1 R_2 S^2 + R_2 C_1^2 C_2 L S^3 + R_2 C_1 C_2 S}{C_2 C_1 S}$$

$$\frac{(R_1 C_1 S + C_1 L S^2 + R_1 C_2 S + C_2 L S^2 + \cancel{C_2} + C_1 C_2 R_1 R_2 S^2 + R_2 C_1 C_2 L S^3 + R_2 C_2 S)\cancel{C_1} + 1}{\cancel{C_1} C_2 S}$$

$$(C_1 C_2 R_2 L) S^3 + (C_2 L + C_1 C_2 R_1 R_2 + C_1 L) S^2 + (R_1 C_2 + R_2 C_2 + R_1 C_1) S + 1$$

$$\frac{\dfrac{1 + R_2 C_2 S}{\cancel{C_2 S}}}{\dfrac{(C_1 C_2 R_2 L) S^3 + (C_1 L + C_2 L + C_1 C_2 R_1 R_2) S^2 + (R_1 C_1 + R_1 C_2 + R_2 C_2) S + 1}{\cancel{C_2 S}}}$$

$$\frac{1 + R_2 C_2 S}{(C_1 C_2 R_2 L) S^3 + (C_1 L + C_2 L + C_1 C_2 R_1 R_2) S^2 + (R_1 C_1 + R_1 C_2 + R_2 C_2) S + 1}$$

Estabilidad en lazo abierto de control

$$\frac{1 + R_2 C_2 s}{\underbrace{(C_1 C_2 R_2 L)}_{A} s^3 + \underbrace{(C_1 L + C_2 L + C_1 C_2 R_1 R_2)}_{B} s^2 + \underbrace{(R_1 C_1 + R_1 C_2 + R_2 C_2)}_{C} s + \underbrace{1}_{D}}$$

$R_1 = 4700$
$R_2 = 2000$
$L = 100e-6$
$C_T = 33e-6$
$C_2 = 33e-6$

$a = (33e-6)(33e-6)(2000)(100e-6) = 2.178 \times 10^{-10}$
$b = ((33e-6)(100e-6) + (33e-6)(33e-6)(4700)(2000) = 0.0102$
$c = (4700)(33e-6) + (4700)(33e-6) + (2000)(33e-6) = 0.3762$
$d = 1$

$\lambda_1 = -46999978.4$
$\lambda_2 = -2.88$
$\lambda_3 = -33.86$

Es estable

Estabilidad en lazo abierto caso

$R_1 = 2000$
$R_2 = 2000$
$L = 100e-6$
$C_T = 33e-6$
$C_2 = 33e-6$
$a = (33e-6)(33e-6)(2000)(100e-6) = 2.178 \times 10^{-10}$
$b = ((33e-6)(100e-6) + (33e-6)(33e-6)(2000)(2000) = 4.3560 \times 10^{-3}$
$c = (2000)(33e-6) + (2000)(33e-6) + (2000)(33e6) = 0.198$
$d = 1$

$\lambda_1 = -19999969.7$
$\lambda_2 = -5.7873$
$\lambda_3 = -39.6672.$

Es estable

Integro dif.

1ª $V_e = R I_1(t) + L \frac{d(I(t))}{dt} + \frac{1}{C}\int (I_1(t) - I_2(t))\,dt$

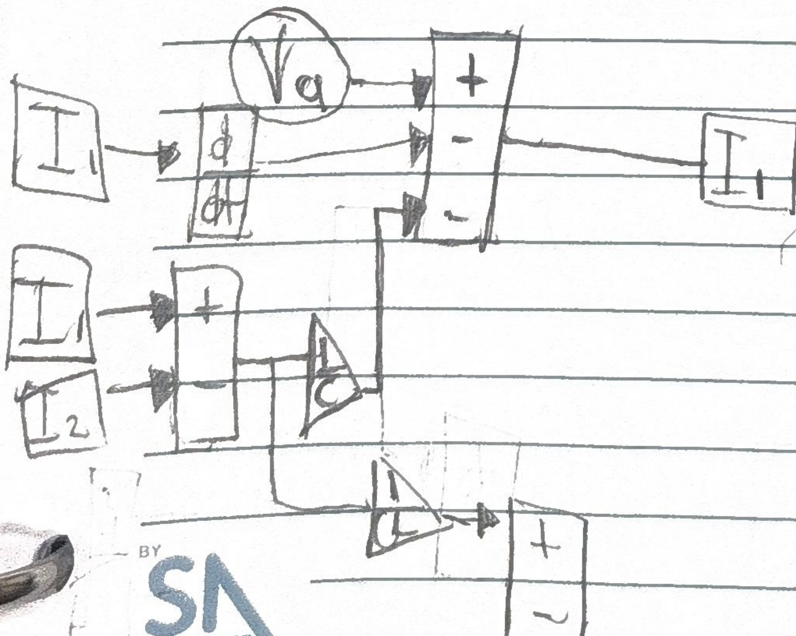
- $I_1 = \left[V_a - L\frac{d(I_1(t))}{dt} - \frac{1}{C}\int I_1(t) - I_2(t)\,dt\right] 1/R$

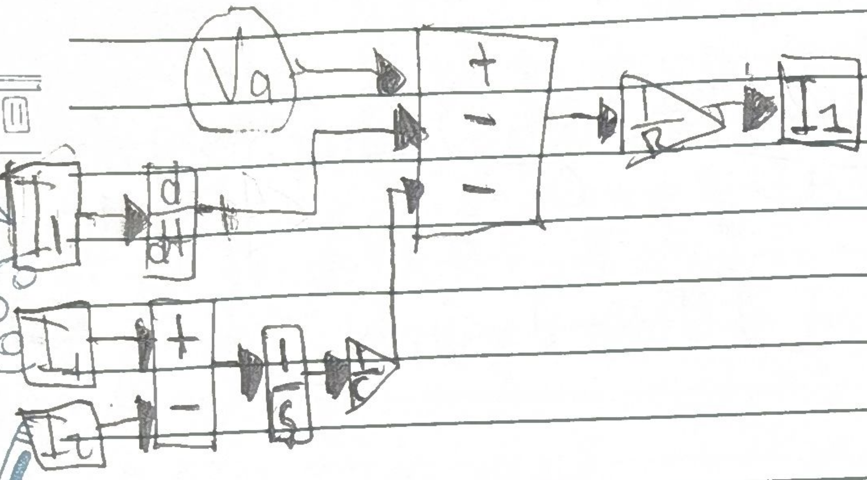
3ª $V_s = R_T I_2 + \frac{1}{C_T}\int I_2(t)\,dt$

- $V_s = R_T I_2 + \frac{1}{C_T}\int I_2(t)\,dt$

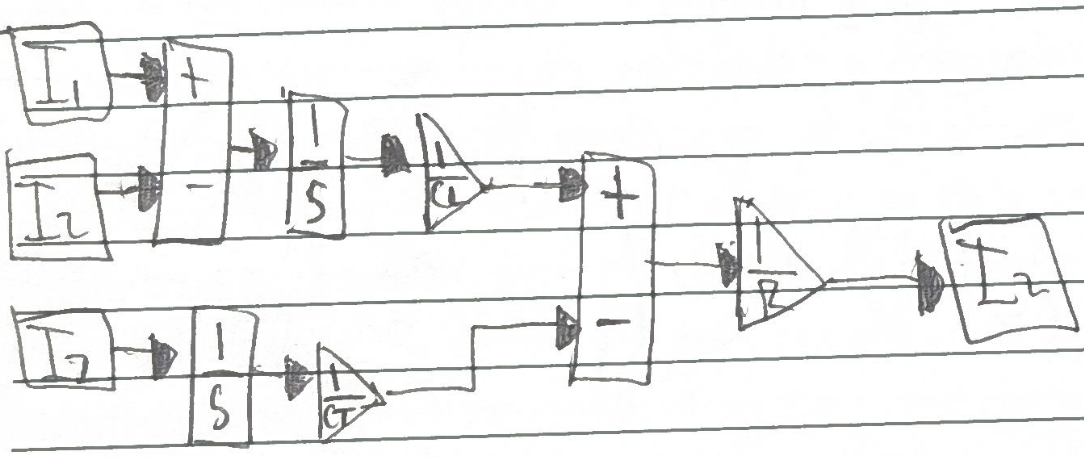
2ª $\frac{1}{C_L}\int I_1(t) - I_2(t)\,dt = R_T I_2 + \frac{1}{C_T}\int I_2(t)\,dt$

- $I_2 = \left[\frac{1}{C_L}\int I_1(t) + I_2(t)\,dt - \frac{1}{C_T}\int I_2(t)\,dt\right] 1/R$

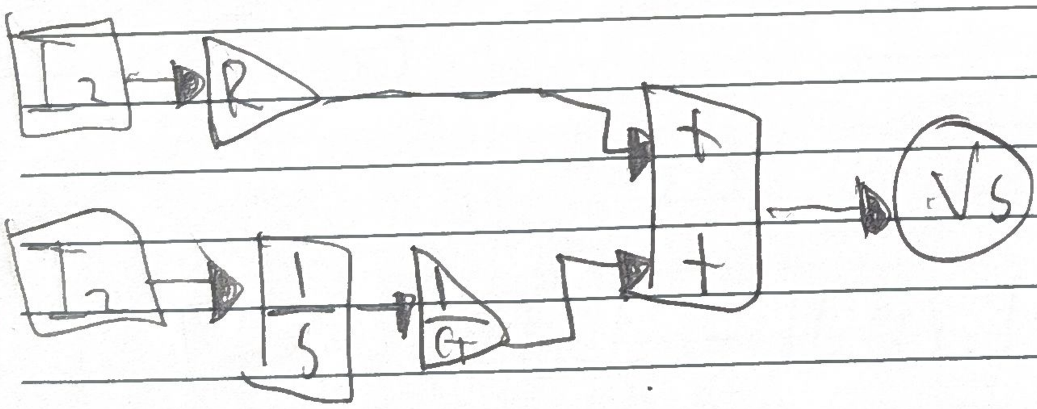




Va
+
-
-
1/R
I1
I1
d/dt
I1
I2
+
-
1/s
1/C



I1
I2
+
-
1/s
1/C
+
-
1/R
I2
I2
1/s
1/C



I2
R
+
+
Vs
I2
1/s
1/C

$Va(s)\ 1+s(R(C_1+C_2)+R_2C_2)+s^2(L(C_1+C_2)+RR_2C_1C_2)+s^3(LR_2C_1C_2)$

$$e(s)=\lim_{s\to 0} Pa(s)\left[\frac{Ve(s)}{Va(s)}\right]$$

$$e(s)\lim_{s\to 0} \cancel{s} * \frac{1}{\cancel{s}}\left[\frac{Ve(s)}{Va(s)}\right]$$

$$e(s)=\frac{1}{1} \quad , \quad e(s)=1-1=\emptyset$$