

N1

$$\frac{V_1 - V_1}{R_1} = \frac{V_1 - V_2}{R_2} + C_2 \frac{d(V_0 - V_1)}{dt}$$

$V_1 - V_0$

N2

$$\frac{V_1 - V_2}{R_2} = C_1 \frac{dV_2}{dt}$$

N3

$$\frac{V_0 - V_3}{R_4} = \frac{V_3 - V_0}{R_3}$$

V_1

Expandiendo C2

$$\frac{V_i - V_1}{R_1} = \frac{V_1 - V_2}{R_2} - C_2 \frac{dV_0}{dt} + C_2 \frac{dV_1}{dt}$$

$V_2 = V_3$

Despejando V_i

$$\frac{V_i}{R_1} - \frac{V_1}{R_1} = \frac{V_1}{R_2} - \frac{V_2}{R_2} + C_2 \frac{dV_0}{dt} - C_2 \frac{dV_1}{dt} \rightarrow \frac{V_i}{R_1} = \frac{V_1}{R_2} - \frac{V_2}{R_2} + C_2 \frac{dV_0}{dt} - C_2 \frac{dV_1}{dt} + \frac{V_1}{R_1}$$

$$\rightarrow V_i = \frac{R_1}{R_2} V_1 - \frac{R_1}{R_2} V_2 + R_1 C_2 \frac{dV_0}{dt} - R_1 C_2 \frac{dV_1}{dt} + V_1$$

Despejando V_3 de N3

$$\frac{V_0}{R_4} - \frac{V_3}{R_4} = \frac{V_3}{R_3}$$

$$\left(\frac{V_0}{R_4} = \frac{V_3}{R_3} + \frac{V_3}{R_4} \right) R_4 R_3$$

$$R_3 V_0 = V_3 R_4 + V_3 R_3$$

$$R_3 V_0 = (R_4 + R_3) V_3$$

$$\rightarrow \frac{R_3}{(R_4 + R_3)} V_0 = V_3$$

$$i_3 = \frac{R_3}{(R_4 + R_3)} \frac{dV_0}{dt}$$

$$V_3 = V_2 \rightarrow \text{Por el op ideal}$$

Despejando V_1 de N2

$$\frac{V_1}{R_2} - \frac{V_2}{R_2} = C_1 \frac{dV_2}{dt}$$

$$\left(\frac{V_1}{R_2} = C_1 \frac{dV_2}{dt} + \frac{V_2}{R_2} \right) R_2$$

$$V_1 = C_1 R_2 \frac{dV_2}{dt} + V_2$$

Sustituyendo V_3 en V_2

$$V_1 = C_1 R_2 \left(\frac{R_3}{(R_4 + R_3)} \frac{dV_0}{dt} \right) + \frac{R_3}{(R_4 + R_3)} V_0$$

$$V_1 = C_1 R_2 \left(\frac{R_3}{(R_4 + R_3)} \frac{d^2 V_0}{dt^2} \right) + \frac{R_3}{(R_4 + R_3)} \frac{dV_0}{dt}$$

$$V_i = \underbrace{\frac{R_1}{R_2} V_1 - \frac{R_1}{R_2} V_2}_{\text{Yellow bracket}} + R_1 C_2 \frac{dV_0}{dt} - R_1 C_2 \frac{dV_1}{dt} + V_1$$

$$V_i = V_1 + \frac{R_1}{R_2} (V_1 - V_2) - R_1 C_2 \ddot{V}_0 + R_1 C_2 \ddot{V}_1$$

Sustituyendo V_1 y \dot{V}_1 en V_i

$$V_i = \underbrace{\frac{C_1 R_2 R_3}{R_4 + R_3} \ddot{V}_0 + \frac{R_3}{R_4 + R_3} V_0}_{V_1} +$$

$$\frac{R_1}{R_2} \left[\left(\frac{C_1 R_2 R_3}{R_4 + R_3} \ddot{V}_0 + \frac{R_3}{R_4 + R_3} V_0 \right) - \frac{R_3}{R_4 + R_3} V_0 \right] - R_1 C_2 \ddot{V}_0 \\ + R_1 C_2 \left[\frac{C_1 R_2 R_3}{R_4 + R_3} \ddot{V}_0 + \frac{R_3}{R_4 + R_3} \ddot{V}_0 \right]$$

Eliminando y agrupando

$$V_i = \frac{C_1 R_2 R_3}{R_4 + R_3} \ddot{V}_0 + \frac{R_3}{R_4 + R_3} V_0 + \frac{R_1 R_3 C_1}{R_4 + R_3} \ddot{V}_0 - R_1 C_2 \ddot{V}_0$$

$$+ \frac{R_1 R_2 R_3 C_1 C_2}{R_4 + R_3} \ddot{V}_0 + \frac{R_1 R_3 C_2}{R_4 + R_3} \ddot{V}_0$$

Terminos semejantes $\frac{R_3}{R_4 + R_3} = A$

$$V_i = \underbrace{C_1 R_2 A \ddot{V}_0}_{\text{Green bracket}} + A V_0 + \underbrace{R_1 C_1 A \ddot{V}_0}_{\text{Green bracket}} - \underbrace{B_1 C_2 \ddot{V}_0}_{\text{Green bracket}} + R_1 R_2 C_1 C_2 A \ddot{V}_0 \\ + R_1 C_2 A \ddot{V}_0$$

Despejando \ddot{V}_o

$$R_1 R_2 C_1 C_2 A \ddot{V}_o = V_i - C_1 R_2 A \dot{V}_o - A V_o - R_1 C_1 A \dot{V}_o + R_1 C_2 \dot{V}_o - R_1 C_2 A V_o$$

$$\begin{aligned} \ddot{V}_o &= \frac{1}{R_1 R_2 C_1 C_2 A} \left[V_i - C_1 R_2 A \dot{V}_o - A V_o - R_1 C_1 A \dot{V}_o + R_1 C_2 \dot{V}_o - R_1 C_2 A V_o \right] \\ &= \frac{V_i}{R_1 R_2 C_1 C_2 A} - \frac{\dot{V}_o}{R_1 C_2} - \frac{V_o}{R_1 R_2 C_1 C_2} - \frac{\dot{V}_o}{R_2 C_2} + \frac{\dot{V}_o}{R_2 C_1 A} - \frac{V_o}{R_2 C_1} \end{aligned}$$

Agrupando

$$V_i = R_1 R_2 C_1 C_2 A \ddot{V}_o + (C_1 R_2 A + R_1 C_1 A - R_1 C_2 + R_1 C_2 A) \dot{V}_o + A V_o$$

Despejando

$$\ddot{V}_o R_1 R_2 C_1 C_2 A = V_i - (C_1 R_2 A + R_1 C_1 A - R_1 C_2 + R_1 C_2 A) \dot{V}_o - A V_o$$

$$\ddot{V}_o = \frac{V_i}{R_1 R_2 C_1 C_2 A} - \frac{(C_1 R_2 A + R_1 C_1 A - R_1 C_2 + R_1 C_2 A) \dot{V}_o}{R_1 R_2 C_1 C_2 A} - \frac{1}{R_1 R_2 C_1 C_2} V_o$$

Esp. estado

$$x_1 = V_o$$

$$\dot{x}_1 = \dot{V}_o$$

$$x_2 = \dot{V}_o$$

$$\dot{x}_2 = \ddot{V}_o =$$

$$\frac{V_i}{R_1 R_2 C_1 C_2 A} - \frac{(C_1 R_2 A + R_1 C_1 A - R_1 C_2 + R_1 C_2 A) \dot{V}_o}{R_1 R_2 C_1 C_2 A} - \frac{1}{R_1 R_2 C_1 C_2} V_o$$





