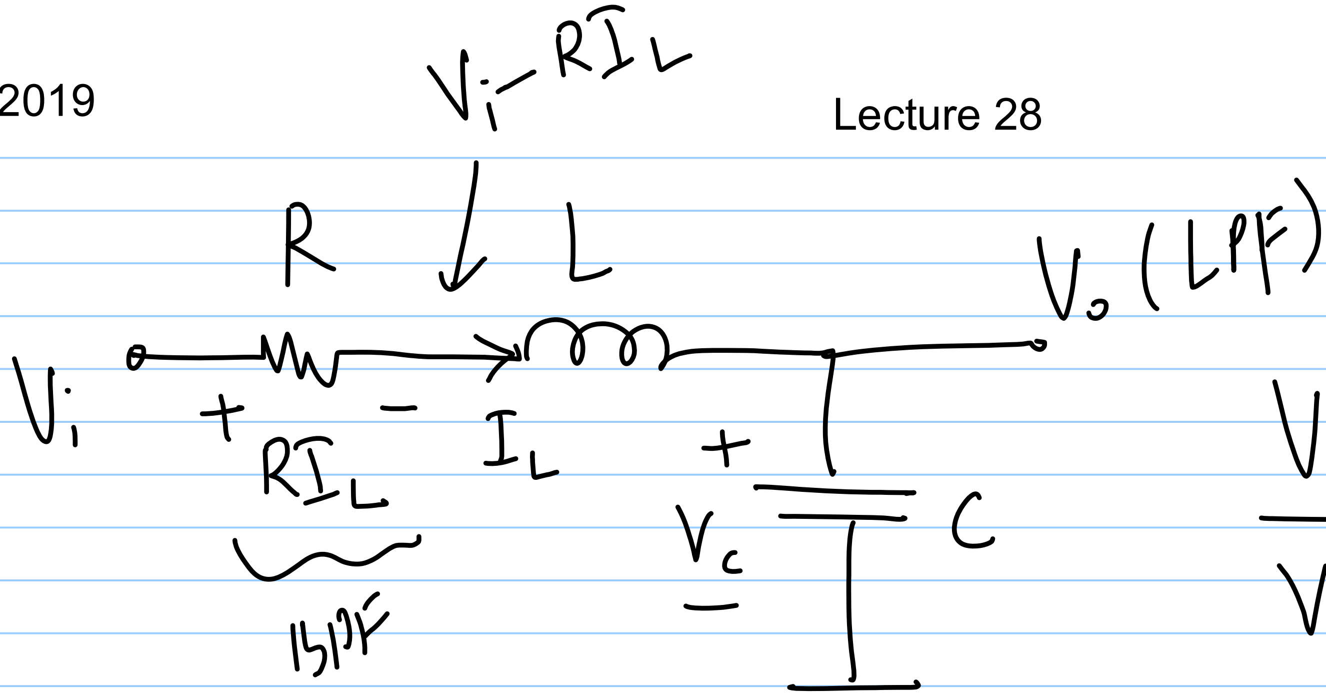


$$\frac{V_o(s)}{V_i(s)} = \frac{1}{1 + sCR + s^2LC}$$

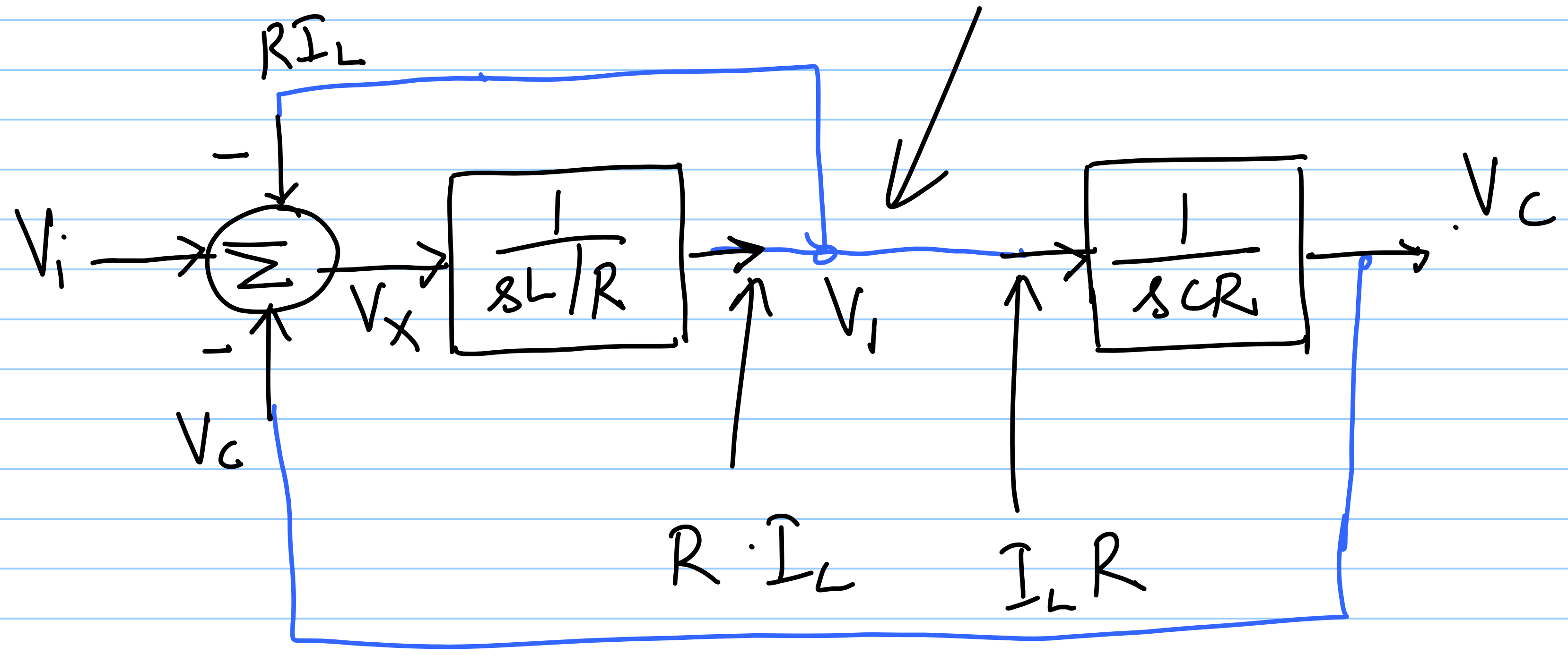
State variables of a network:

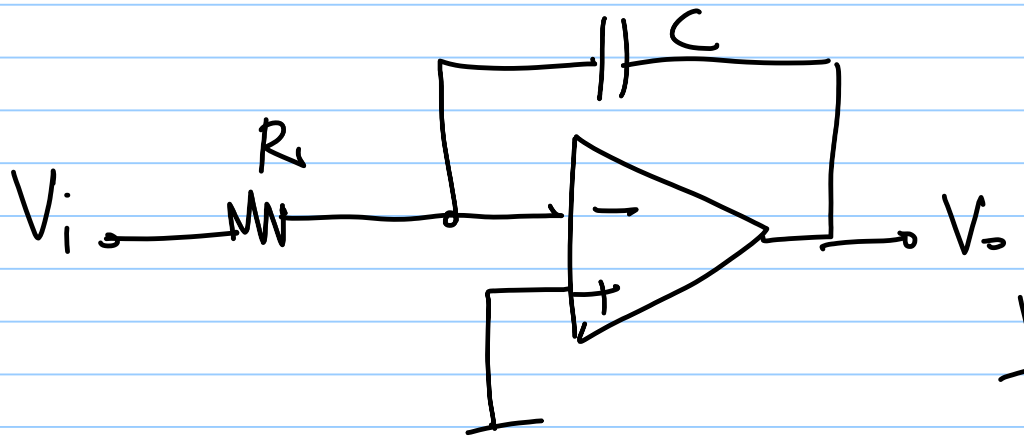
1) currents through inductors
2) voltages across the capacitors

$$V_c = \frac{I_c}{sC} = \cancel{\frac{V_i - V_c}{sCR}} \quad \frac{I_L}{sC} = \frac{I_L \cdot R}{sCR}$$

$$I_L = \frac{V_i - V_c}{R + sL} \checkmark \qquad \text{— (1)} \qquad \frac{(\ \ )}{s(\ \ )}$$

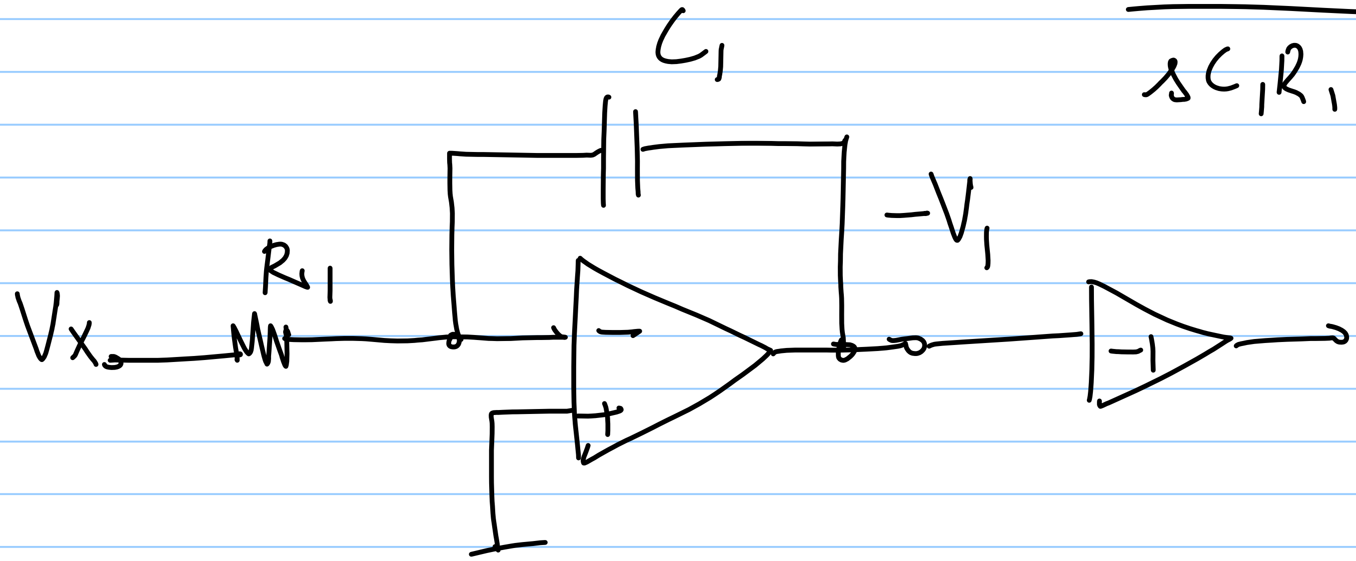
$$R I_L = \frac{V_i - R I_L - V_c}{sL/R} \qquad \text{— (2)}$$





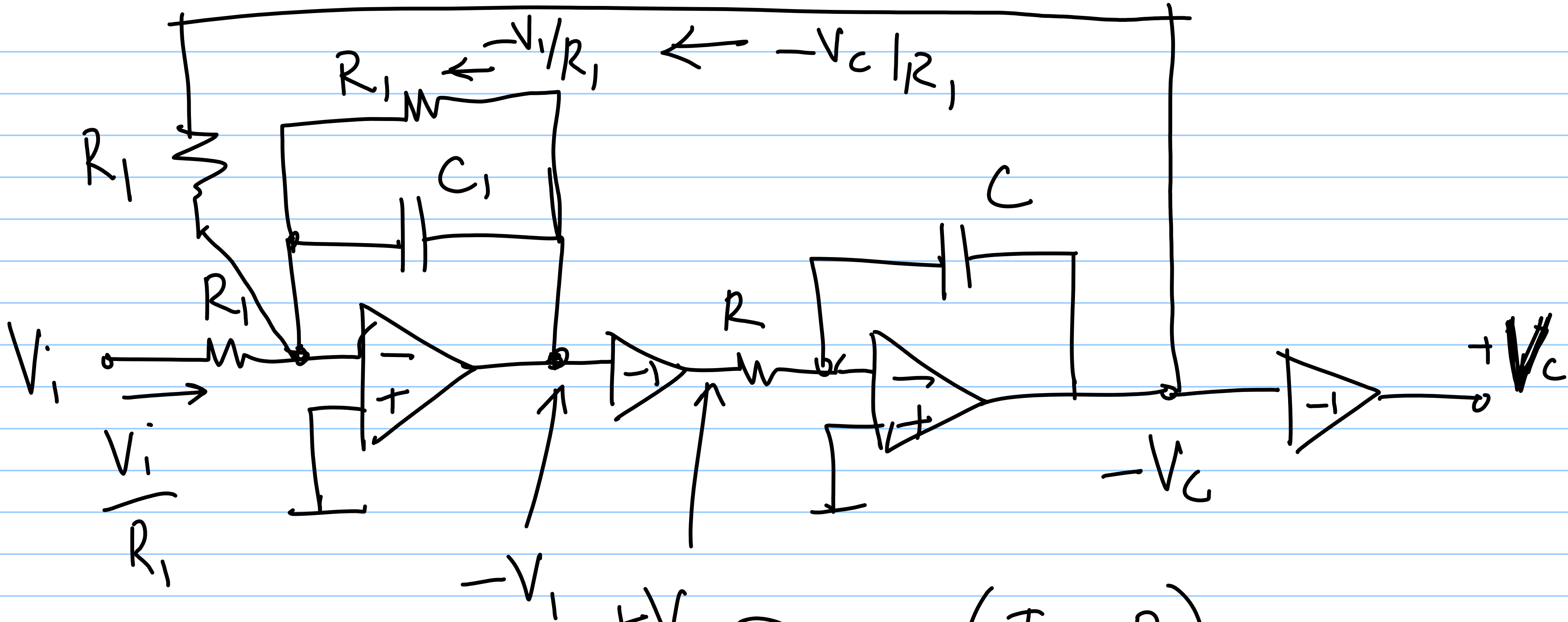
Integrator

$$\frac{V_o}{V_i} = \frac{-1}{sCR}.$$



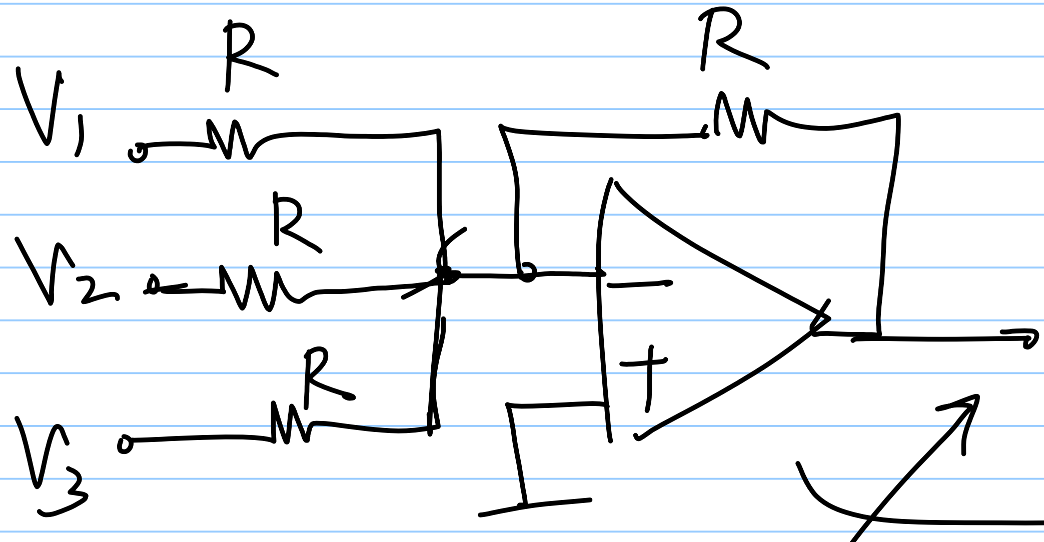
$$\frac{1}{sC_1R_1} = \frac{1}{sL/R}$$

$$\boxed{R_1C_1 = \frac{L}{R}}$$



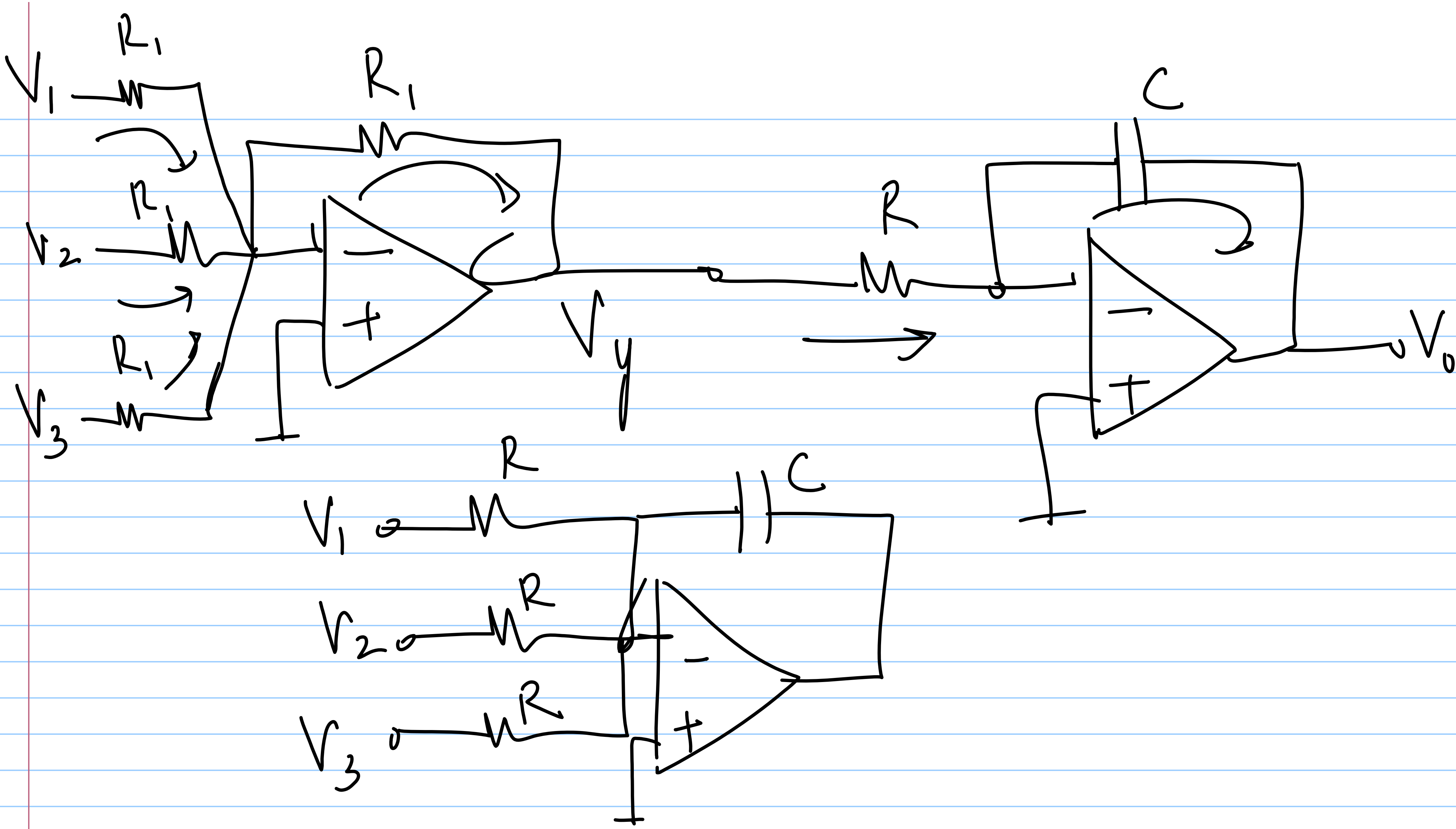
$+V_1 \longrightarrow (I_2 \cdot R)$

$$\left(\frac{V_i}{R_1} - \frac{V_c}{R_1} - \frac{V_1}{R_1}\right) \times \frac{-1}{sC_1} = -V_1$$



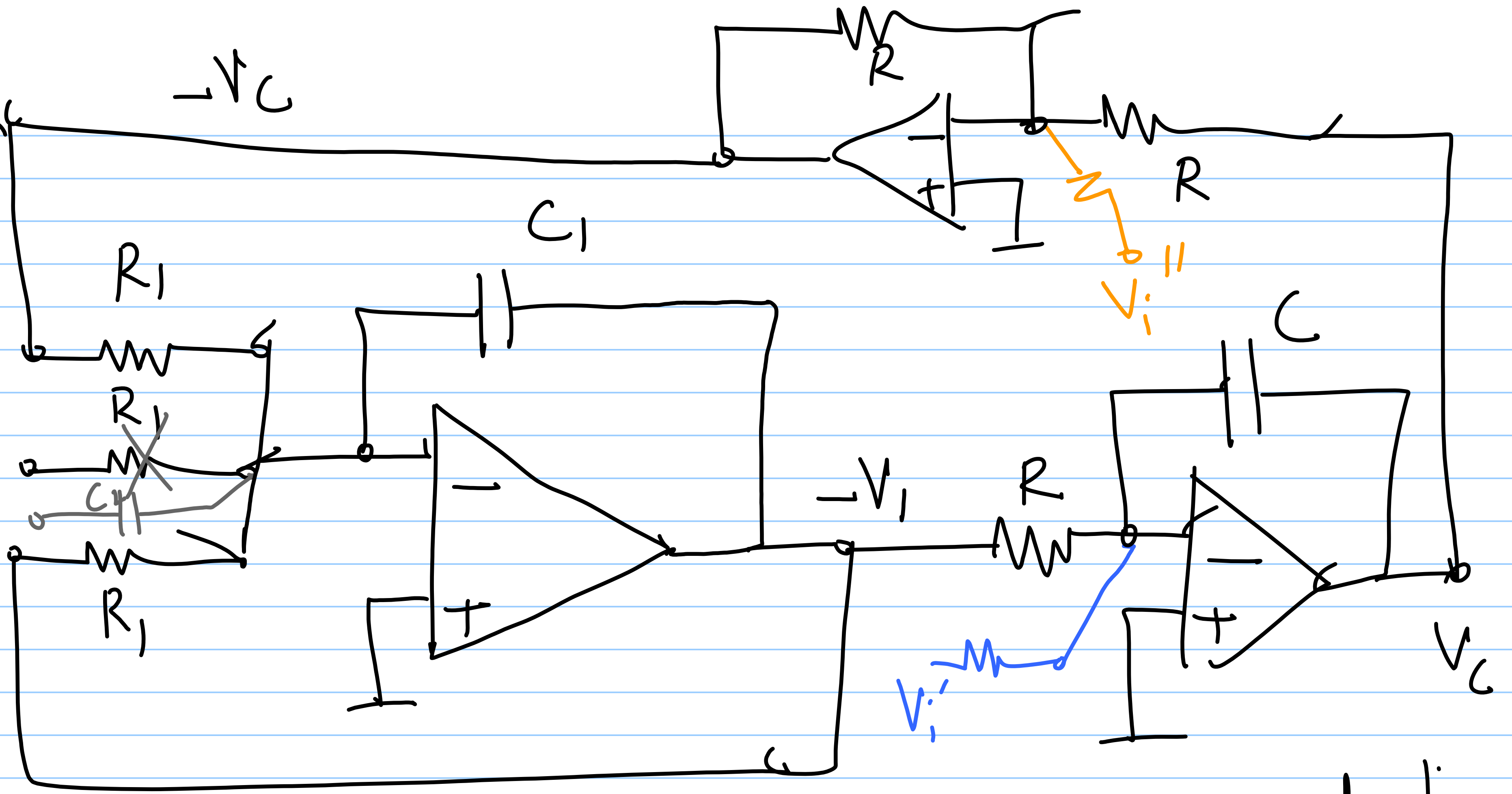
$$V_0 = -(V_1 + V_2 + V_3)$$

Summer



R_1
V_1
R_1
R_1
V_2
R_1
V_3
V_y
R
C
V_0
R
C
V_1
R
V_2
R
V_3

State Variable Biquadratic filter



Tow-Thomas Biquad filter

$$V_C = \frac{V_1}{sCR} = -\left(\frac{-V_1}{sCR}\right)$$

Biquadratic filter $\frac{N_2(s)}{D_2(s)}$

$$-V_1 = -\left[\frac{V_i - V_1 - V_c}{sC_1R_1}\right] \qquad \pm H(n)$$

$$= \frac{-1}{sC_1R_1}\left[+V_i - V_1 - V_c\right]$$

$$-V_i \longrightarrow \boxed{+H(n)} \longrightarrow V_o$$

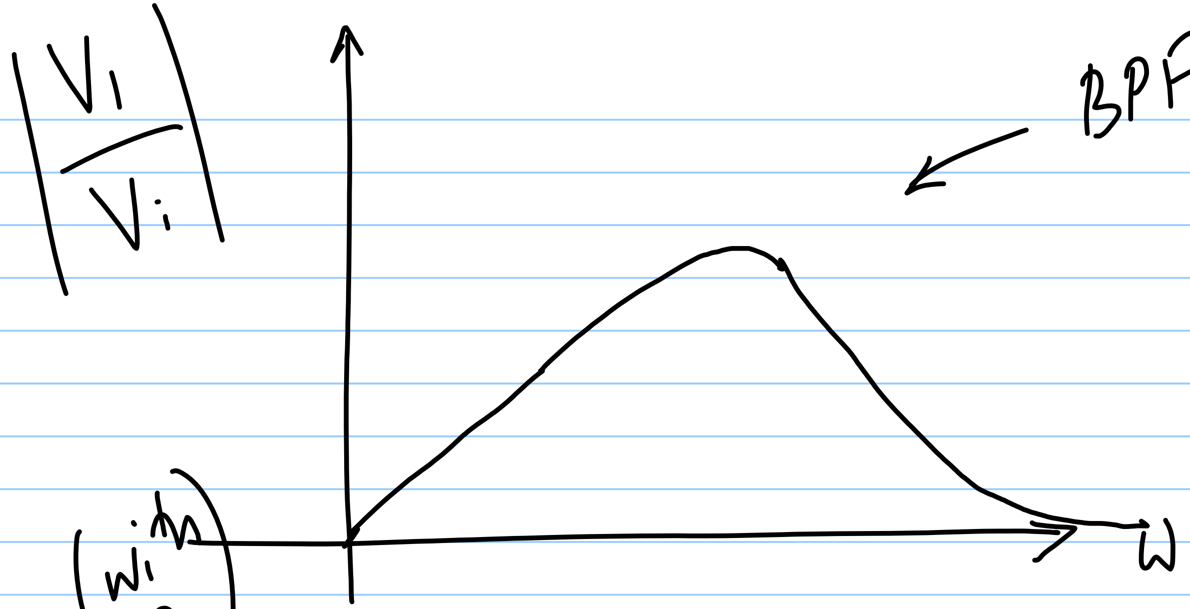
$$\frac{V_c(s)}{V_i(s)} = \frac{1}{1 + sCR + s^2LC}$$ Lowpass filter

$$= \frac{1}{1+sCR+s^2C\cdot C_1RR_1}$$

$$\frac{L}{R} = R_1C_1 \Rightarrow L = RR_1C_1$$

Bandpass response

$$\frac{V_1(s)}{V_i(s)} = \frac{V_c}{V_i}\cdot sCR = \frac{sCR}{1+sCR+s^2LC}$$



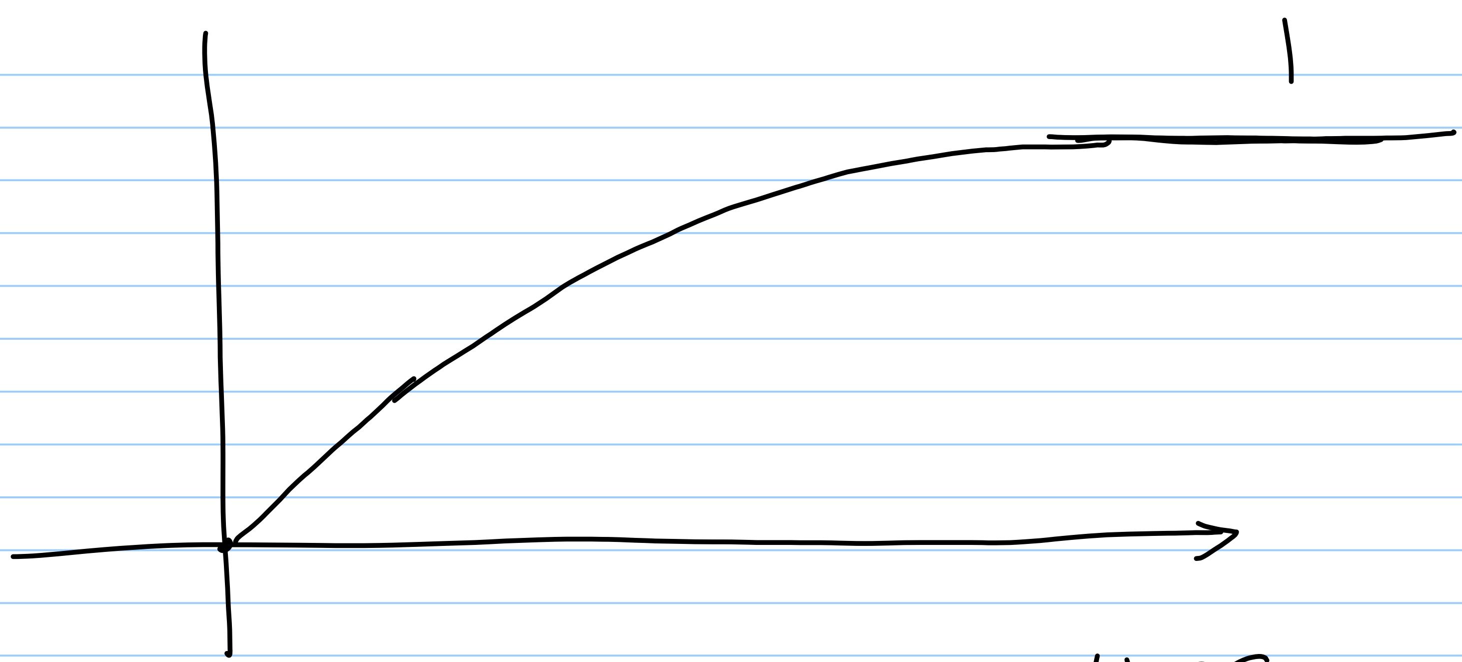
New V_i (with C_2)

$$\frac{V_c(s)}{I_i(s)}$$

$$\frac{V_c(s)}{\cancel{sC_2}\left(\frac{V_i(s)}{\cancel{R}_1}\right)} = \frac{sC_2R_1}{1+sCR+s^2LC}$$

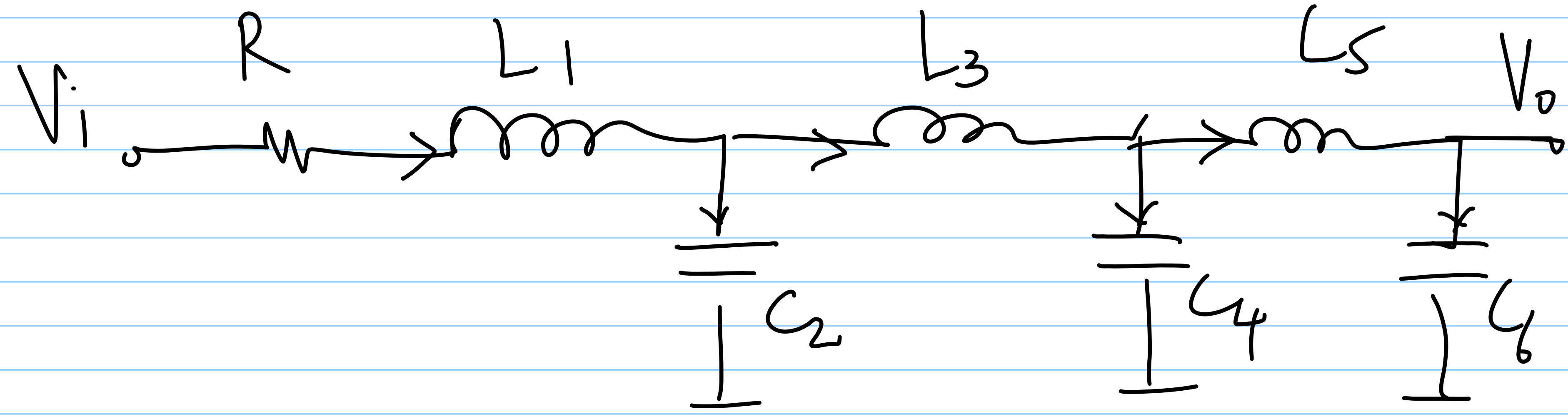
$$V_1/V_i\,(s) = \frac{s^2C_2R_1CR}{1+sCR+s^2LC}$$

$\left|\frac{V_1}{V_i}\right|$



$C_2 = C_1$

HPF



Vi
R
L1
L3
L5
Vo
C2
C4
C6