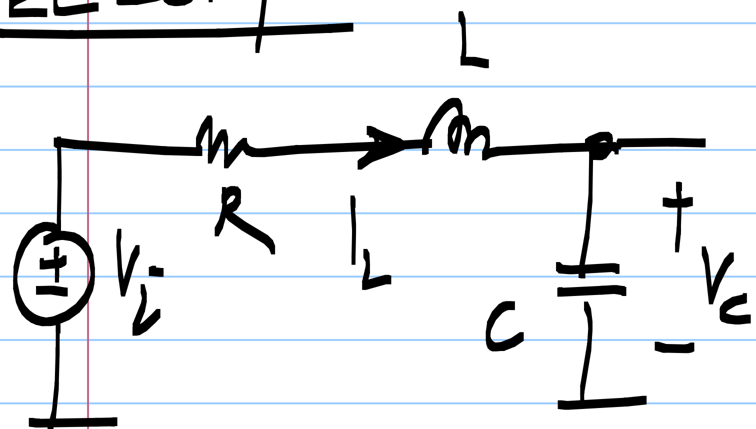
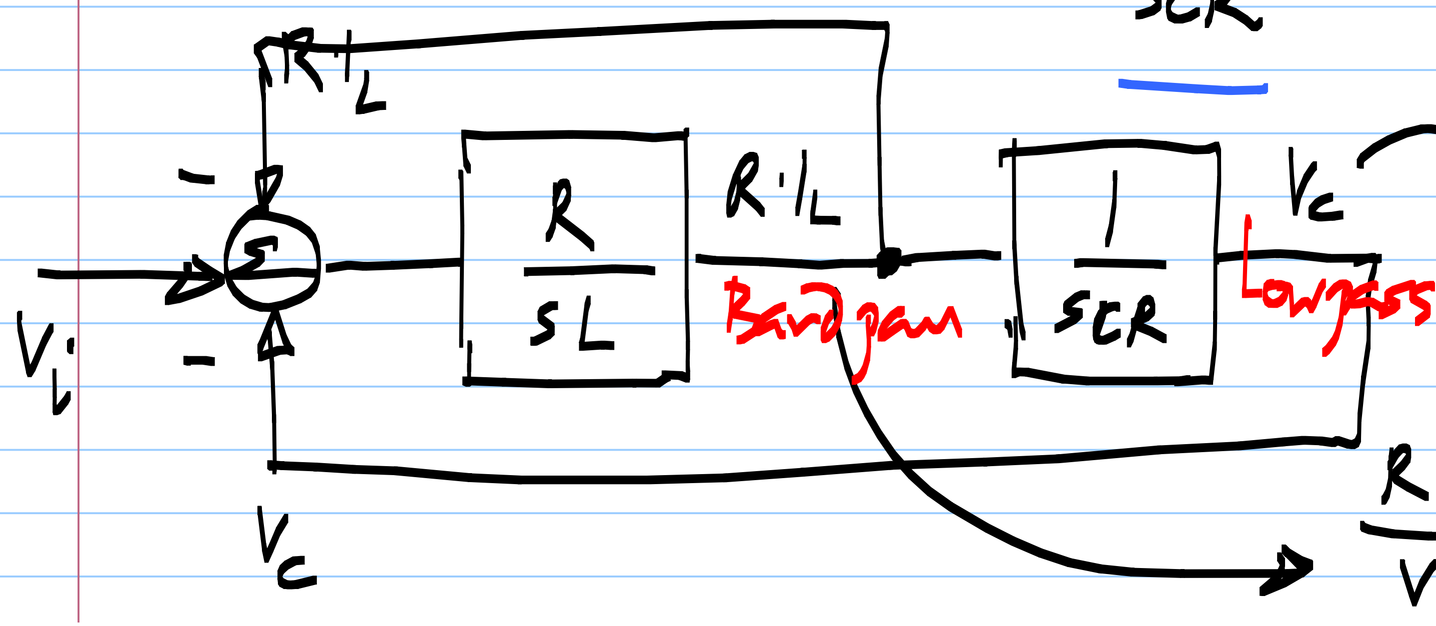
EE 2019

27/3/2018



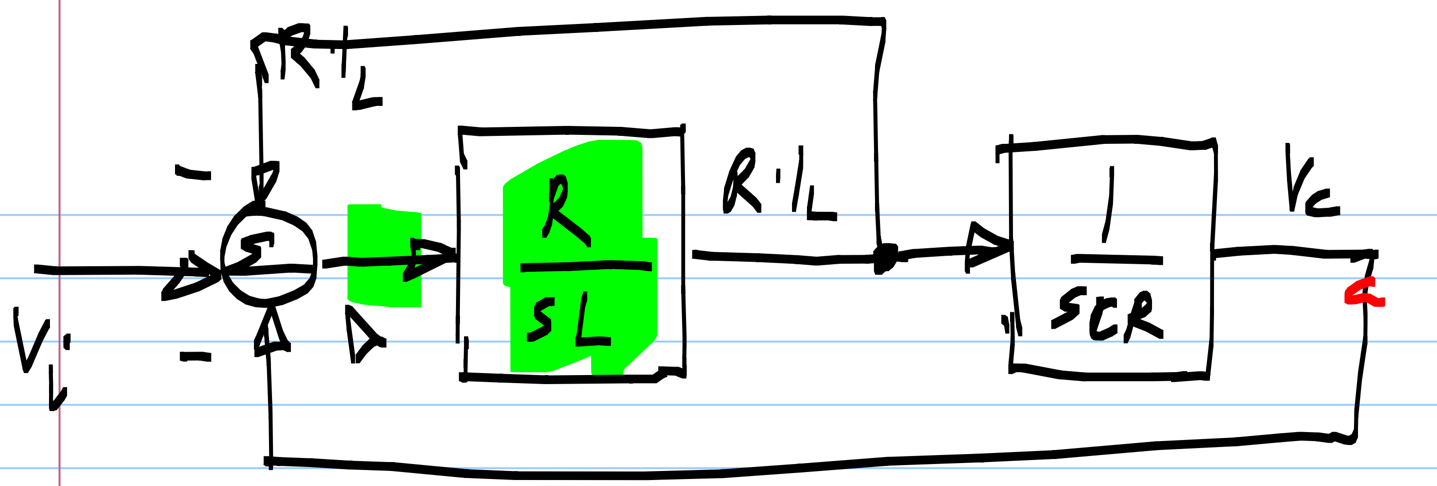

$$R \cdot I_L = \frac{R}{sL}\left(V_i - I_L \cdot R - V_c\right)$$

$$V_c = \frac{1}{sCR} \cdot \left(I_L \cdot R\right)$$

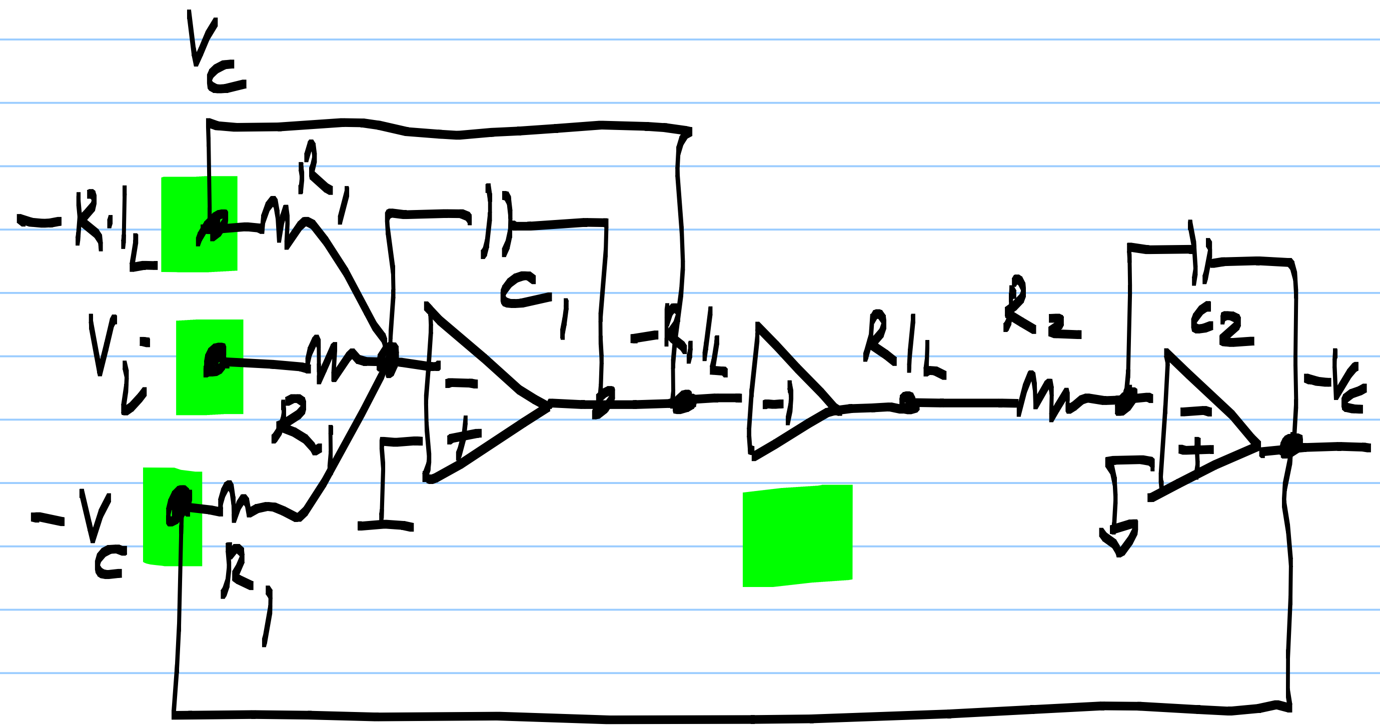



$$\frac{V_c}{V_i} = \frac{1}{s^2LC + sCR + 1}$$

$$\frac{R I_L}{V_i} = \frac{sCR}{s^2LC + sCR + 1}$$

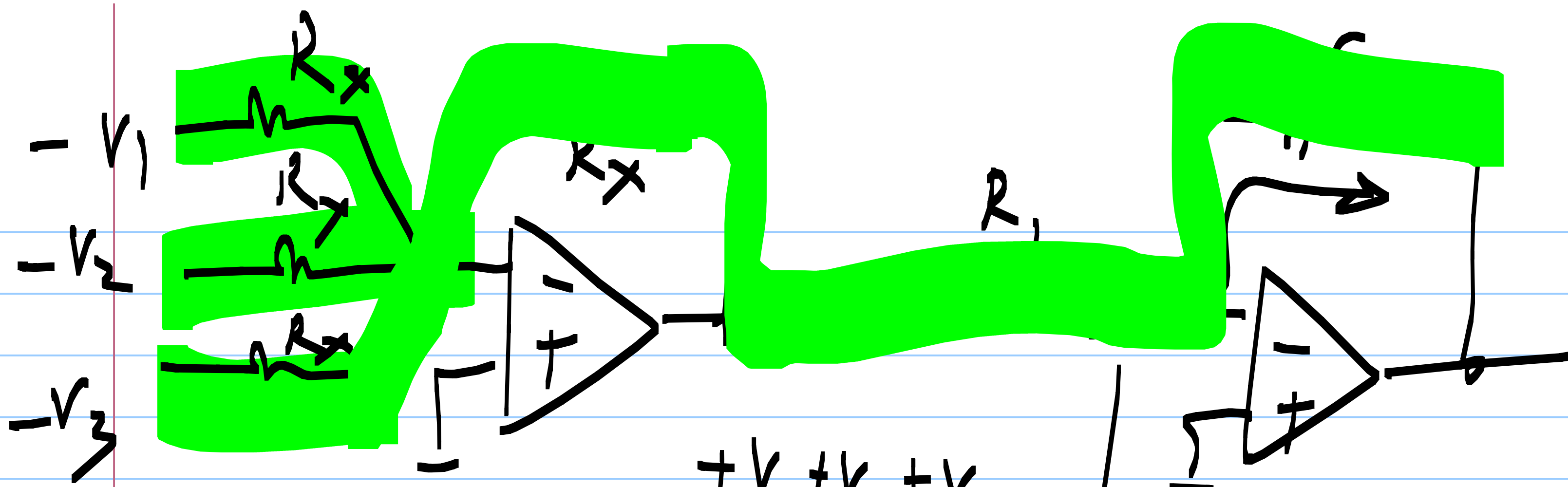



$$\frac{N_2(s)}{D_2(s)}$$

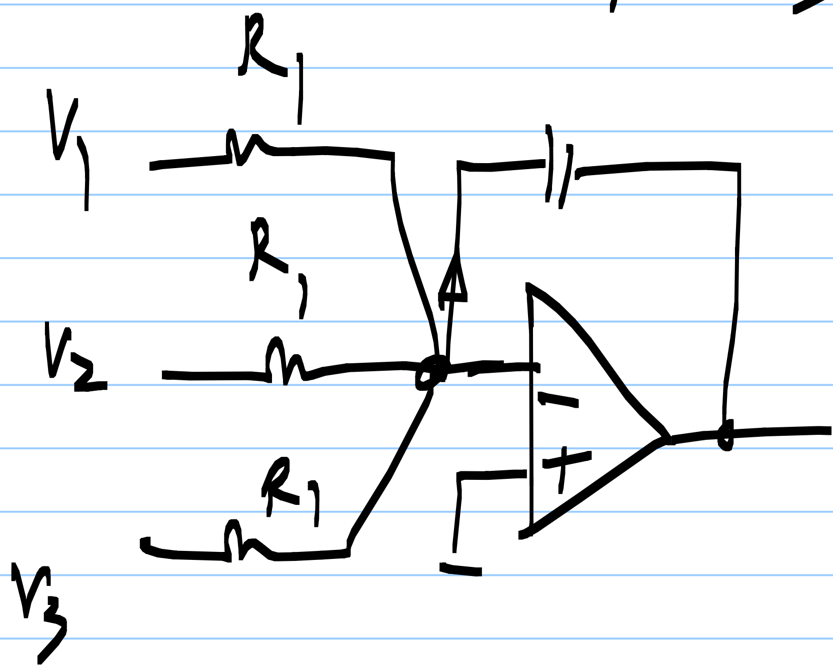



State-variable biquadratic filter

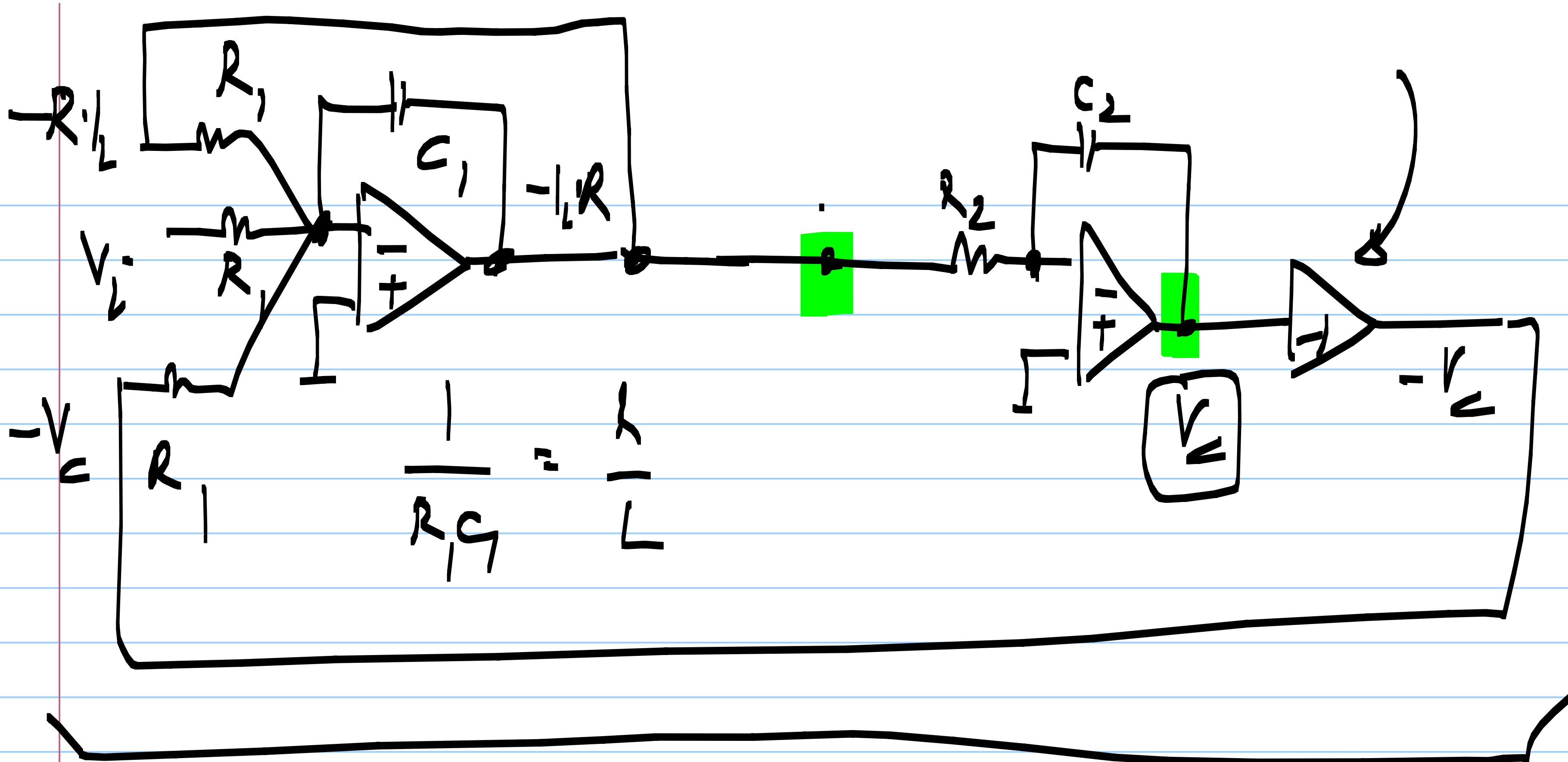
Tow-Thomas filter (biquad)



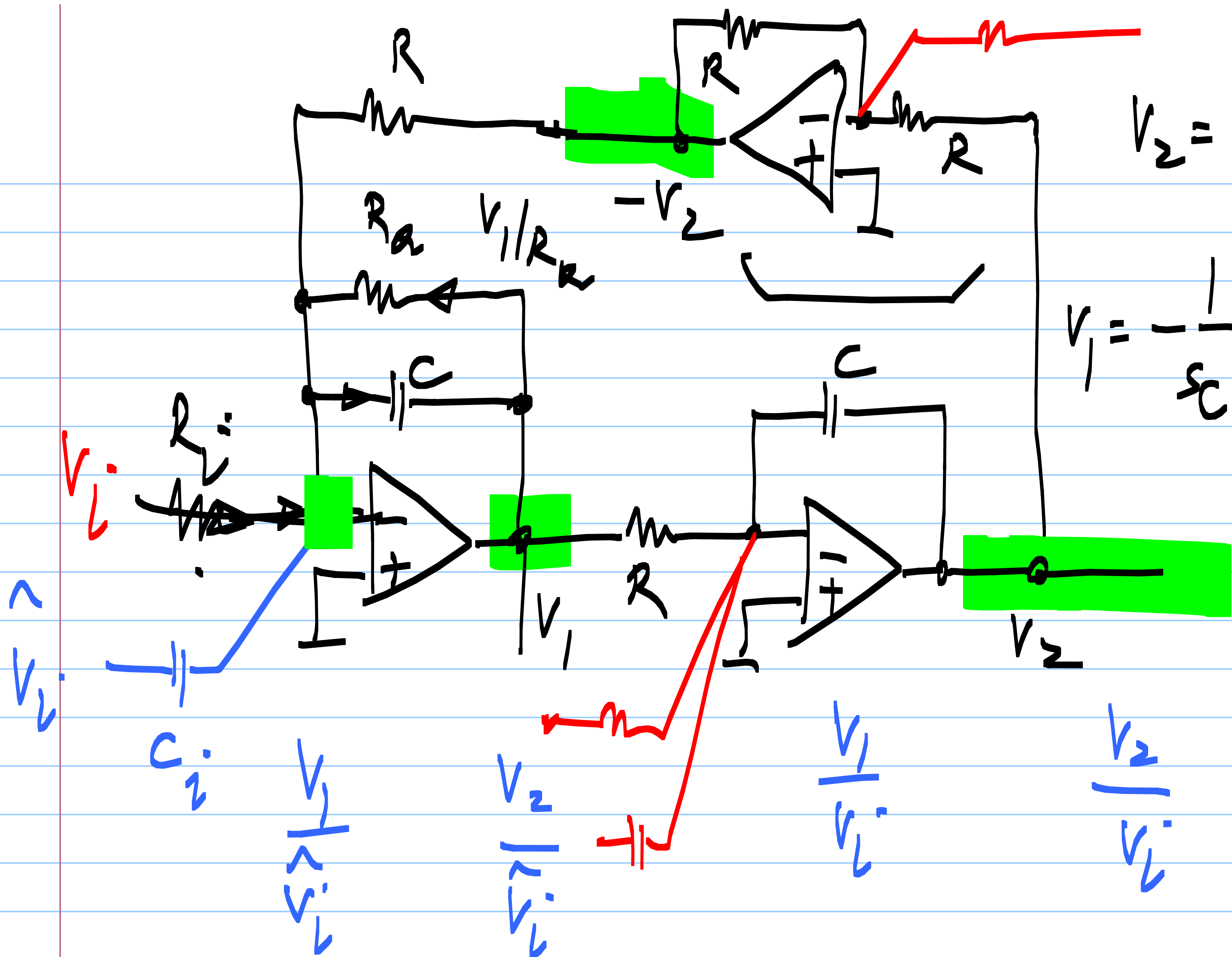

$+V_1 + V_2 + V_3$




$\frac{V_1}{R_1} + \frac{V_2}{R_f} + \frac{V_3}{R_f}$




$$\frac{1}{R_1 C_1} = \frac{R}{L}$$




$$V_2 = -\frac{V_1}{sCR}$$

$$V_1 = -\frac{1}{sC}\left(\frac{V_i}{R_i} + \frac{V_1}{R_Q} - \frac{V_2}{R}\right)$$

$$V_2 = -\frac{V_1}{sCR} \qquad sCR \cdot V_2 = -V_1$$

$$V_1 = -\frac{1}{sC}\left(\frac{V_i}{R_i} + \frac{V_1}{R_Q} - \frac{V_2}{R}\right)$$

$$sCR \cdot V_1 = -V_i \cdot \frac{R}{R_i} - V_1 \cdot \frac{R}{R_Q} + V_2$$

$$-(sCR)^2 \cdot V_2 = -V_i \cdot \frac{R}{R_i} + (sCR)\frac{R}{R_Q} \cdot V_2 + V_2$$

$$\frac{V_1}{V_i} = \frac{-\frac{R}{R_i} \cdot (sCR)}{(sCR)^2 + sCR \cdot \frac{R}{R_Q} + 1}$$

$$\boxed{\frac{V_2}{V_i} = \frac{R/R_i}{(sCR)^2 + sCR \cdot \frac{R}{R_Q} + 1}}$$

$$\frac{V_2}{V_i} = \frac{R/[illegible]}{(s[illegible])^2 + sCR \cdot \frac{R}{R_Q} + 1}$$

$1/Q$

$$\frac{1}{s^2LC + sL/R + 1}$$

$$\frac{V_1}{V_i} = - \frac{R/\ \cdot (sCR)}{(sCR)^2 + sCR \cdot \frac{R}{R_a} + 1} \quad ] \quad D_2(s)$$

$$\frac{V_2}{V_i} = \frac{R/R_i}{(sCR)^2 + (sCR)\frac{R}{R_a} + 1}$$

$$\frac{V_1}{\hat{V}_i} = \frac{-(sCR)^2 \cdot \frac{C_i}{C}}{D_2(s)} \ ; \ \frac{V_2}{\hat{V}_i} = \frac{(sCR) \quad C_i/C}{D_2(s)}$$

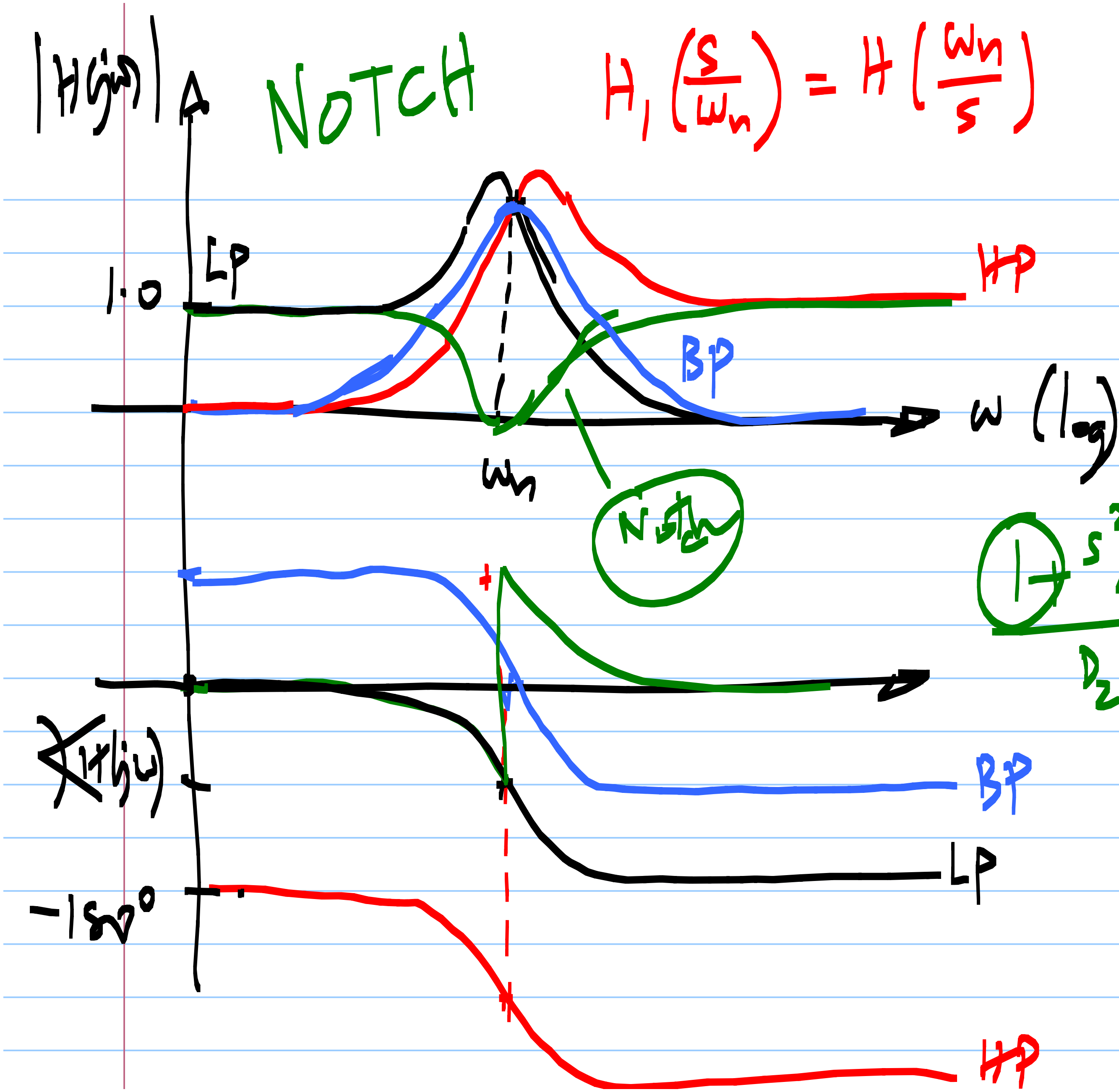
## $2^{nd}$ order transfer fn.

$$H(s) = \frac{1}{\frac{s^2}{\omega_n^2} + \frac{s}{Q\omega_n} + 1}$$

$Q$

$s = j\omega_n$

$$H_1\left(\frac{s}{\omega_n}\right) = H\left(\frac{\omega_n}{s}\right)$$




$$\frac{1 + s^2/\omega_n^2}{D_2(s)}$$

$$H_1(s) = \frac{s^2/\omega_n^2}{D_2(s)}$$

$$H_3(s) = \frac{s/\omega_n}{D_2(s)}$$

$$1 + s^2/\omega_n^2$$