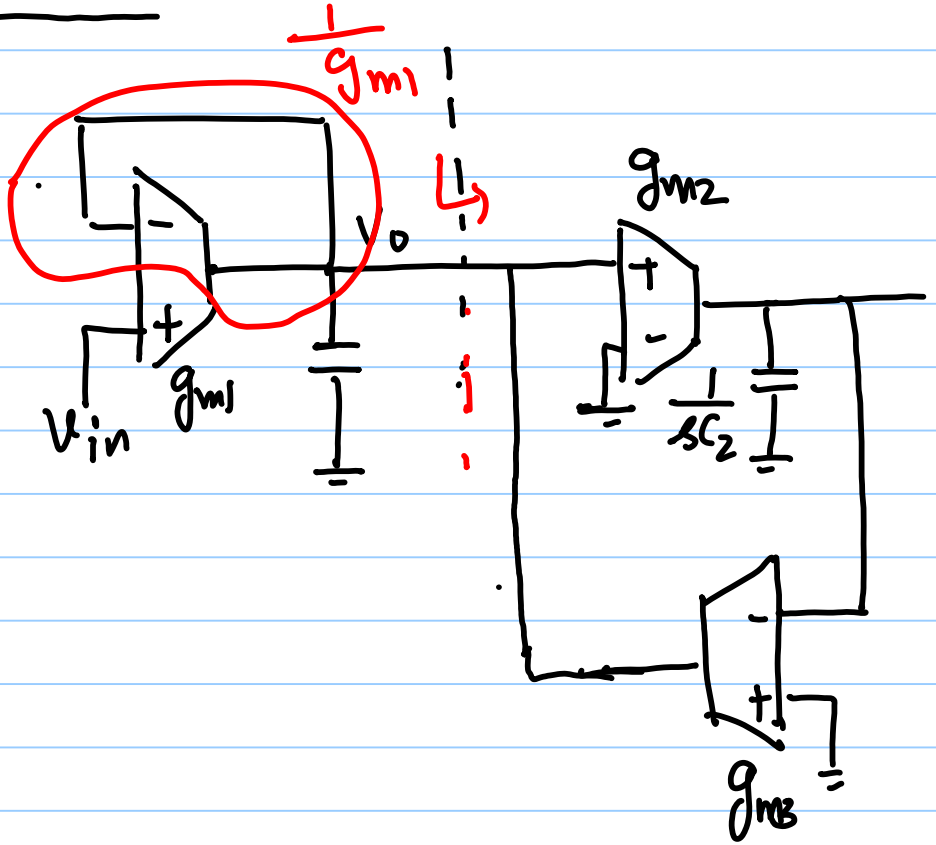
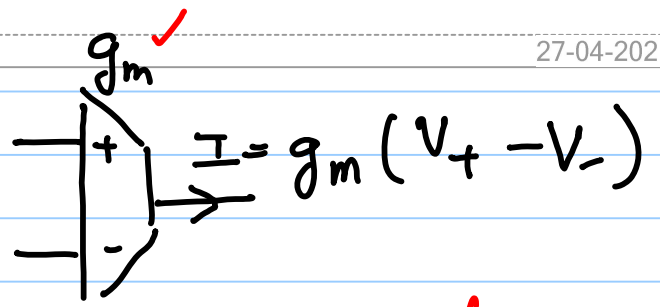
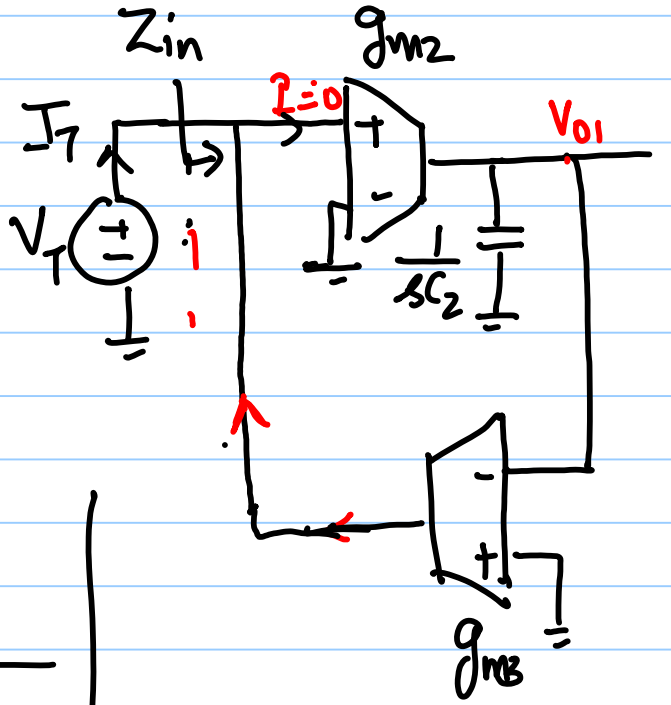
Lecture #39

Note Title 27-04-2021

Gm-C filter



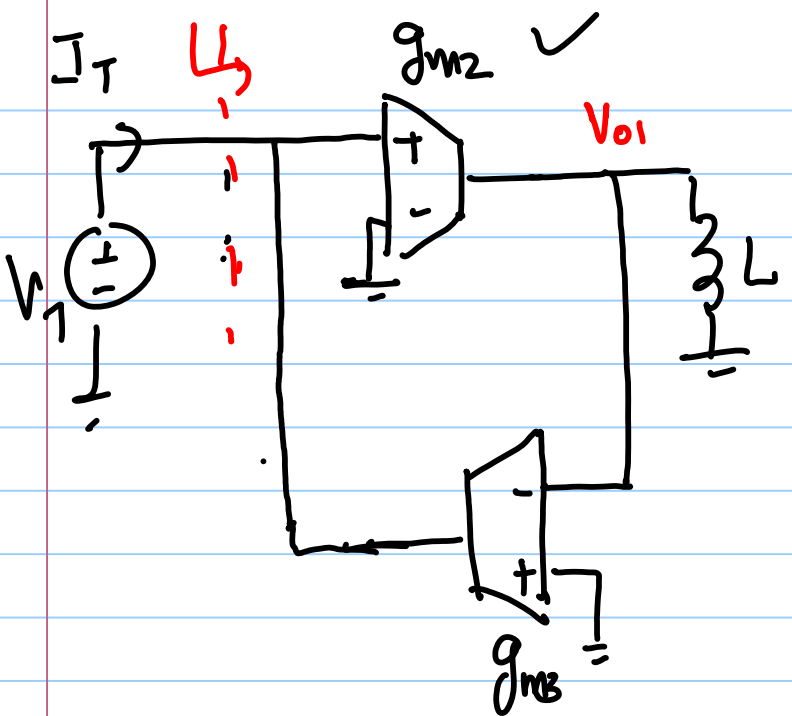




$$\frac{V_o(s)}{V_i(s)} = \frac{s(g_{m2}C_2)\,/\,g_{m2}g_{m3}}{\frac{s^2 C_1 C_2}{g_{m2}g_{m3}} + \frac{s\,g_{m1}C_2}{g_{m2}g_{m3}} + 1}$$

$$I_T = -g_{m3}\left(0 - g_{m2}\frac{V_T}{sC_2}\right)$$

$$\frac{V_T}{I_T} = sL = s\,\frac{C_2}{g_{m2}g_{m3}}$$

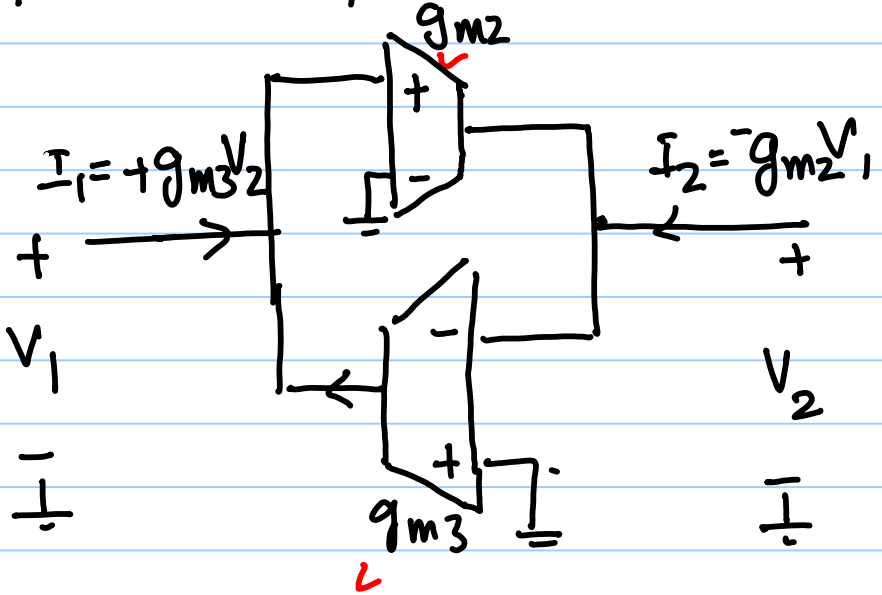


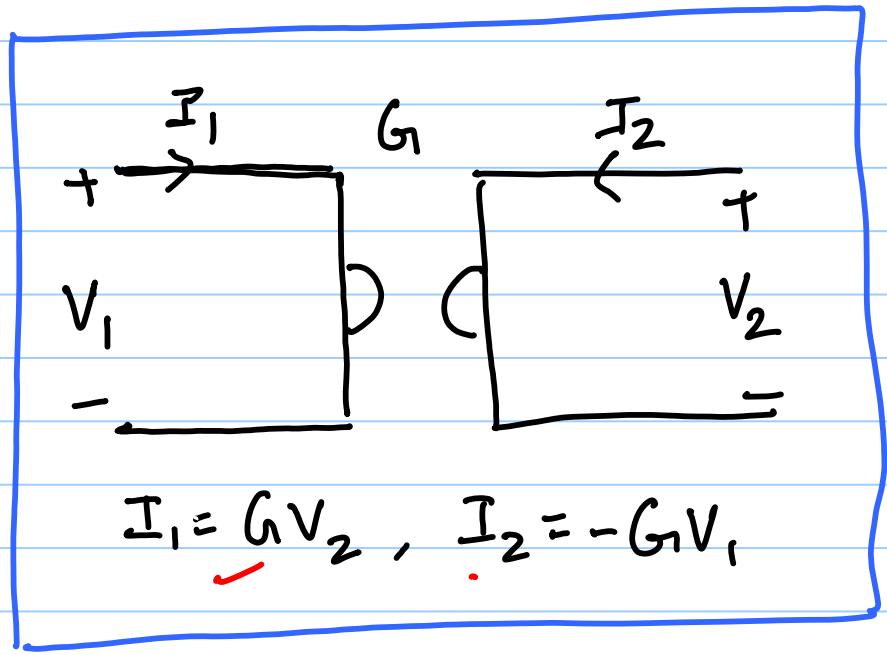
$$\frac{V_0}{V_i} = \frac{s(R \| L) \times g_{m2}/g_{m1}}{s^2 LC_1 + s\frac{L}{R} + 1}$$

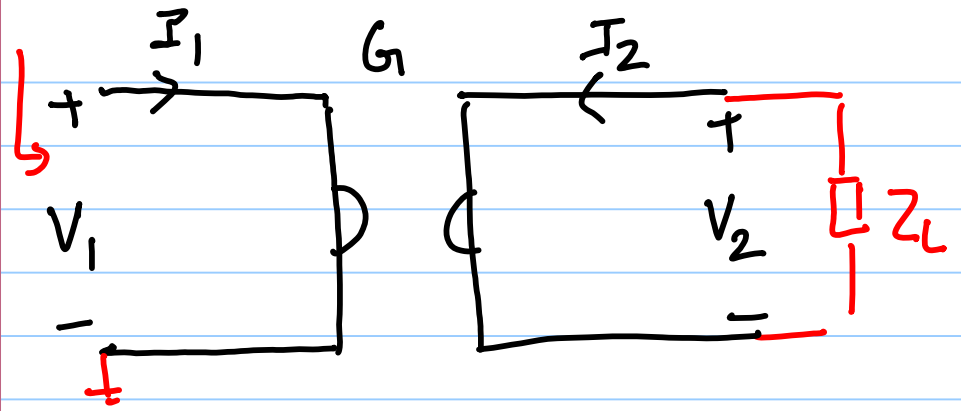
$$I_T = -g_{m3}(0 - g_{m2} V_1 \cdot sL)$$

$$\frac{V_T}{I_T} = \frac{1}{s(g_{m2} g_{m3} L)} = \frac{1}{sC}$$

Gyrator or Impedance inverter

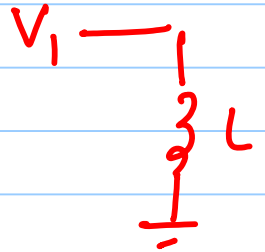




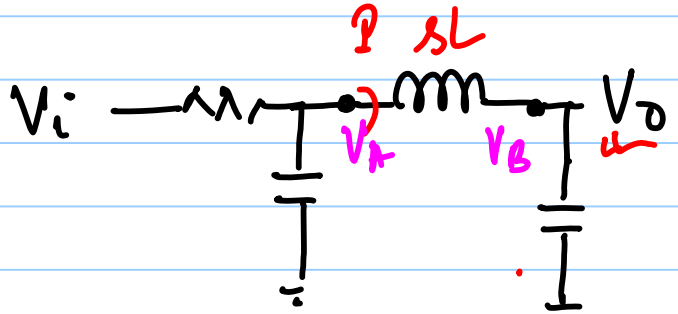


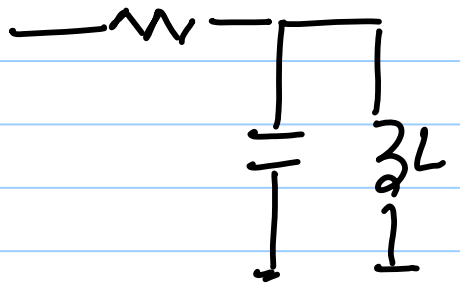
if $Z_L = 1/sC$

$$Z_{in} = \frac{1/sC}{a^2} = sL$$

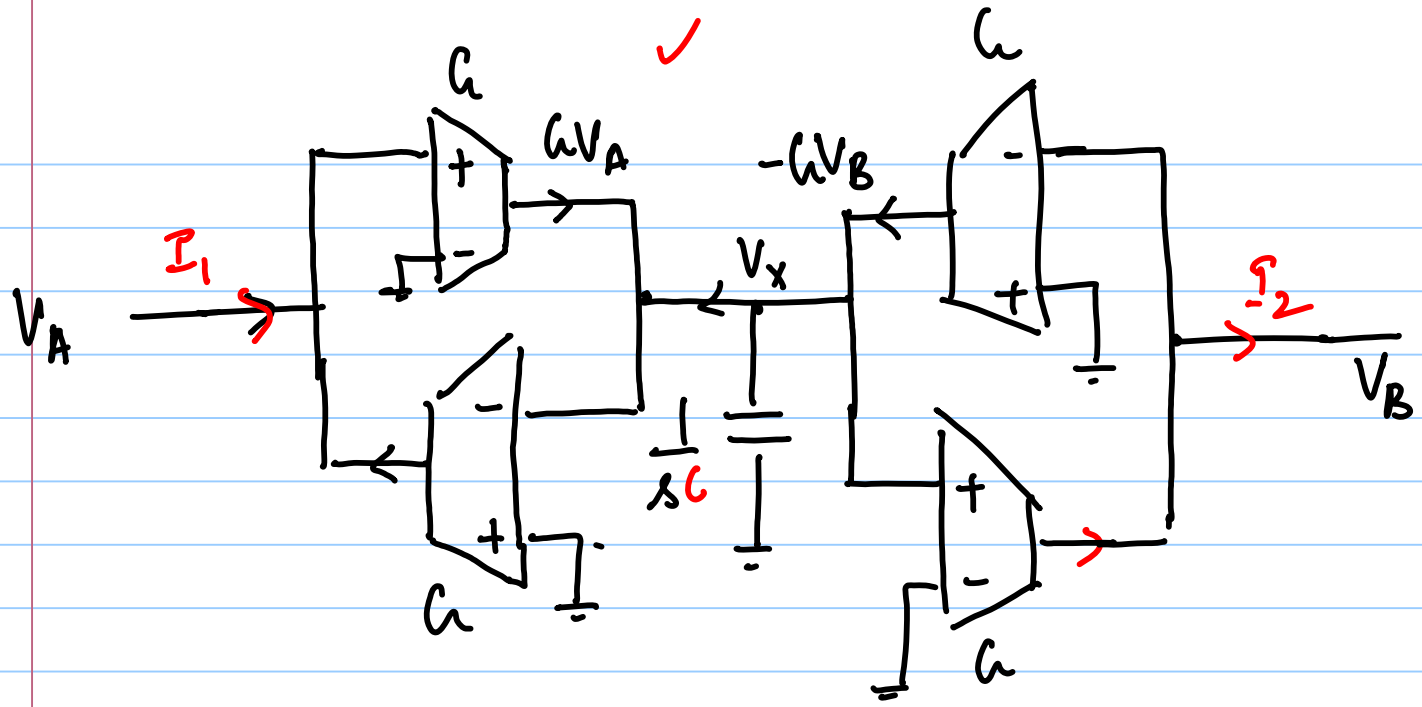


$$\frac{V_1}{I_1} = \frac{V_1}{aV_2} = \frac{V_1}{a(-I_2 Z_L)} = \frac{V_1}{aZ_L(aV_1)} = \frac{1}{a^2 Z_L}$$





$$I = \frac{V_A - V_B}{sL}$$



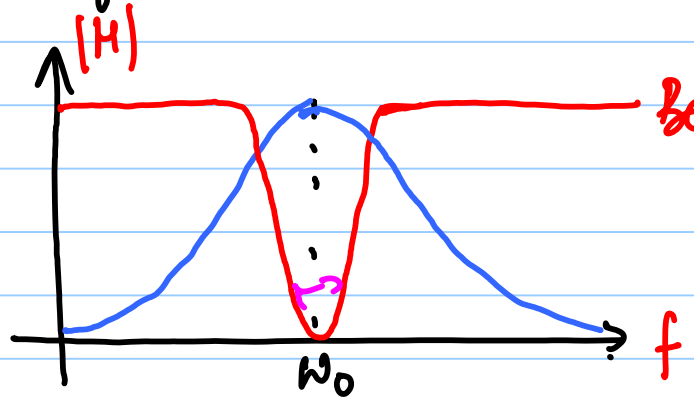
$$V_x = G(V_A - V_B)\frac{1}{sC}$$

$$I_1 = -G(0 - V_x) = \frac{G^2}{sC}(V_A - V_B)$$

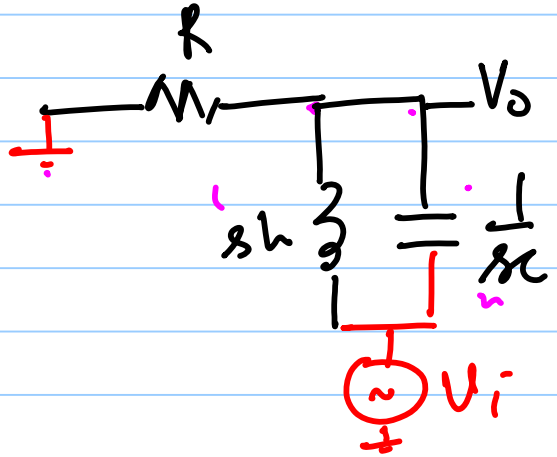
$$I_2 = GV_x = \frac{G^2}{sC}(V_A - V_B)$$

$$\frac{V_A - V_B}{I} = \frac{1}{G^2(1/sC)} = s\left(\frac{C}{G^2}\right) = sL$$

Band Reject Filter

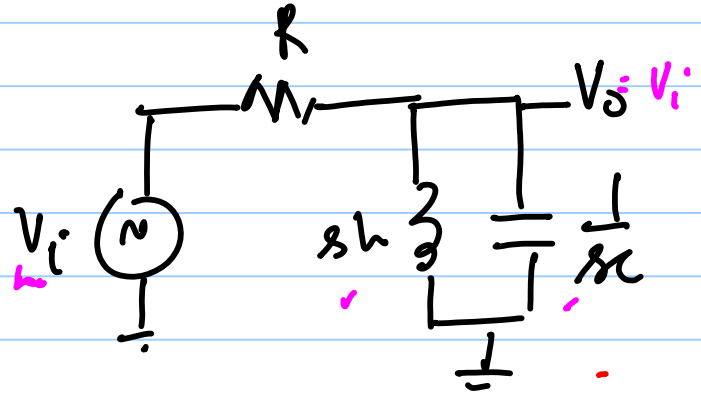


Band Reject filter ✓



$$\frac{V_o}{V_i} = \frac{s/\omega_0 Q_p}{1 + \frac{s}{\omega_0 Q_p} + \frac{s^2}{\omega_0^2}}$$

$$H_{BRF} = 1 - H_{BPF}$$



$$\frac{V_o}{V_i} = \frac{s/\omega_0 Q_p}{1 + \frac{s}{\omega_0 Q_p} + \frac{s^2}{\omega_0^2}}$$

$$H_{BRF} = 1 - \frac{s/\omega_0 Q_p}{1 + s/\omega_0 Q_p + s/\omega_0^2} = \frac{1 + s^2/\omega_0^2}{1 + \frac{s}{\omega_0 Q_p} + \frac{s^2}{\omega_0^2}} = \frac{V_o}{V_i}$$

$$\frac{V_o}{V_i} = \frac{1 + s^2/\omega_0^2}{1 + \frac{s}{\omega_0 Q_p} + \frac{s^2}{\omega_0^2}} = \frac{1 + \omega_0^2/s^2}{1 + \frac{\omega_0}{s} \cdot \frac{1}{Q_p} + \frac{\omega_0^2}{s^2}}$$

$$V_o \left(1 + \frac{\omega_0}{s} \frac{1}{Q_p} + \frac{\omega_0^2}{s^2}\right) = V_i \left(1 + \frac{\omega_0^2}{s^2}\right)$$

$$(V_o - V_i) \frac{\omega_0^2}{s^2} + V_o \frac{\omega_0}{s} \frac{1}{Q_p} + (V_o - V_i) = 0$$

$$+\left\{(-V_o + V_i)\frac{\omega_0}{s} - V_o\frac{1}{Q_p}\right\}\frac{\omega_0}{s} + V_i = +V_o$$