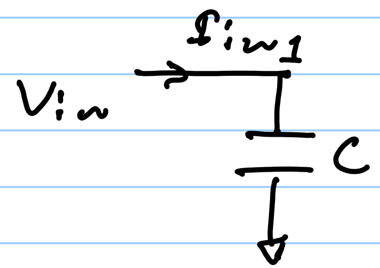
EE2019

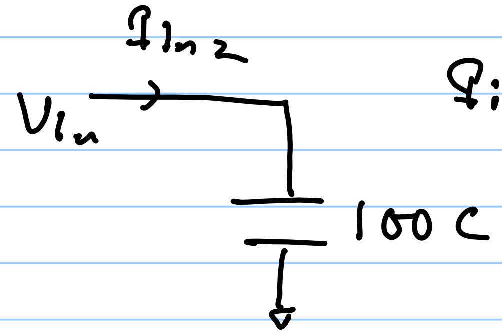
Note Title

2/27/2019

Miller Effect

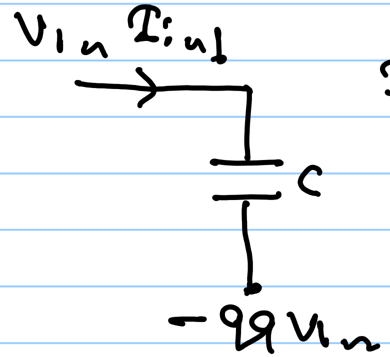


$I_{in1} = V_{in} sC$



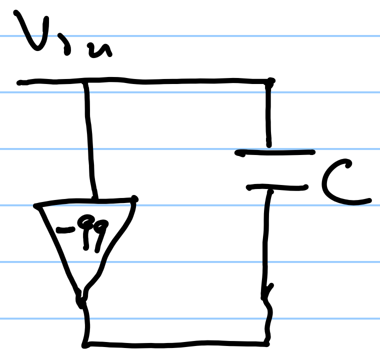
$I_{in2} = 100 V_{in} sC$

$\Downarrow$ 1:1

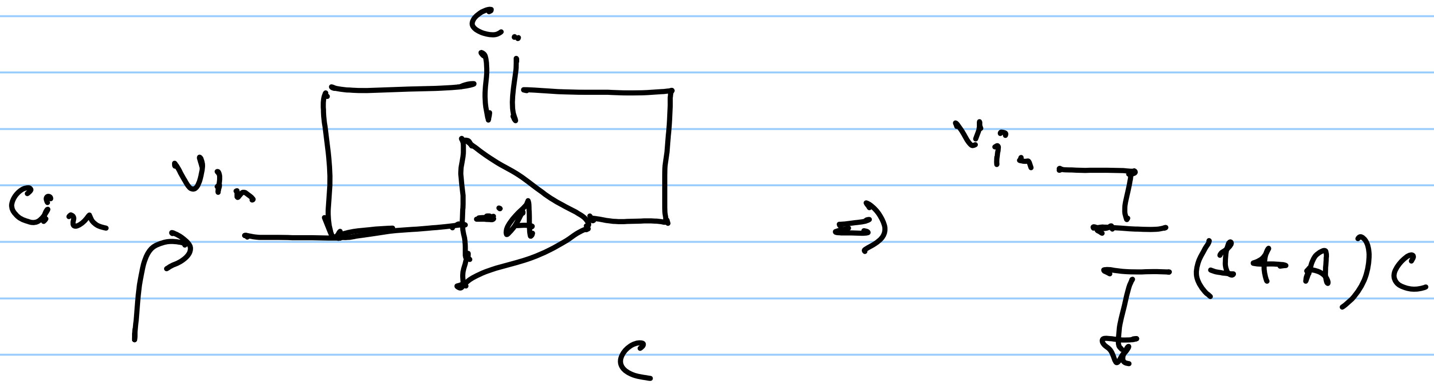


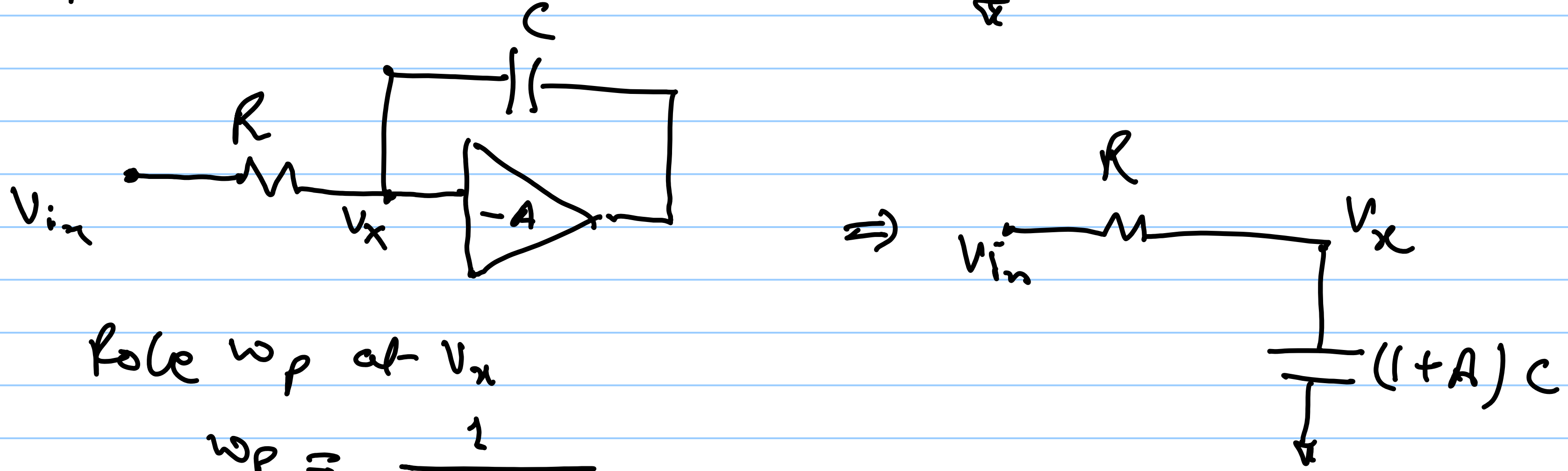
$I_{in1} = 100 V_{in} sC$

$\Rightarrow$



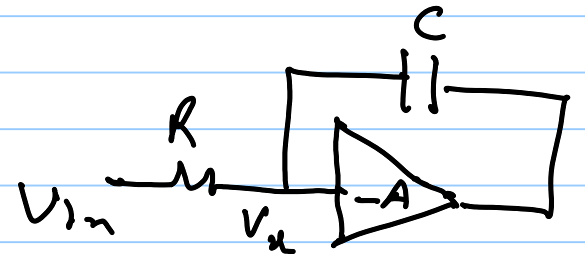
Note Title 2/27/2019



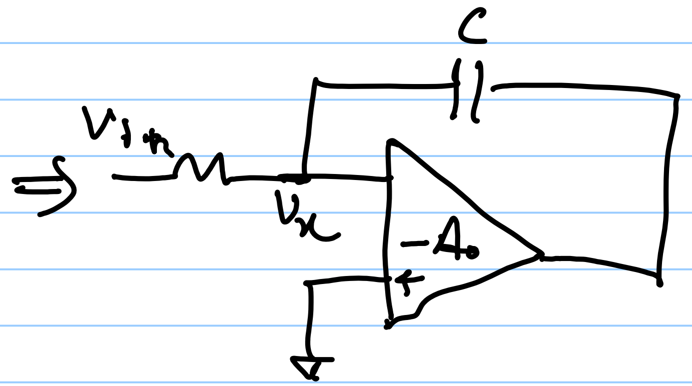


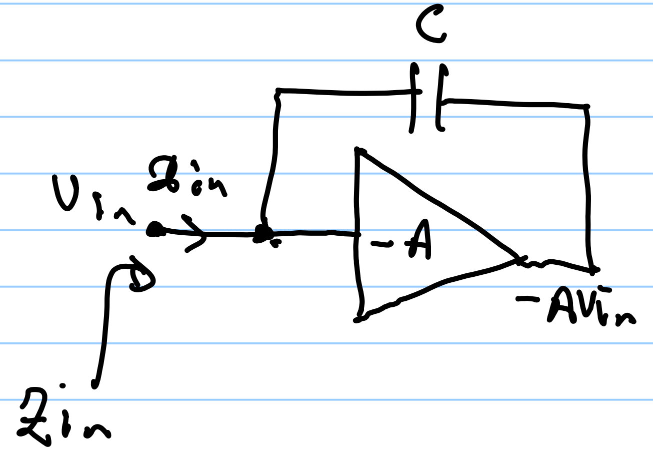
Pole ω_p at V_x

$$\omega_p = \frac{1}{R(1+A)C}$$



$\Rightarrow$





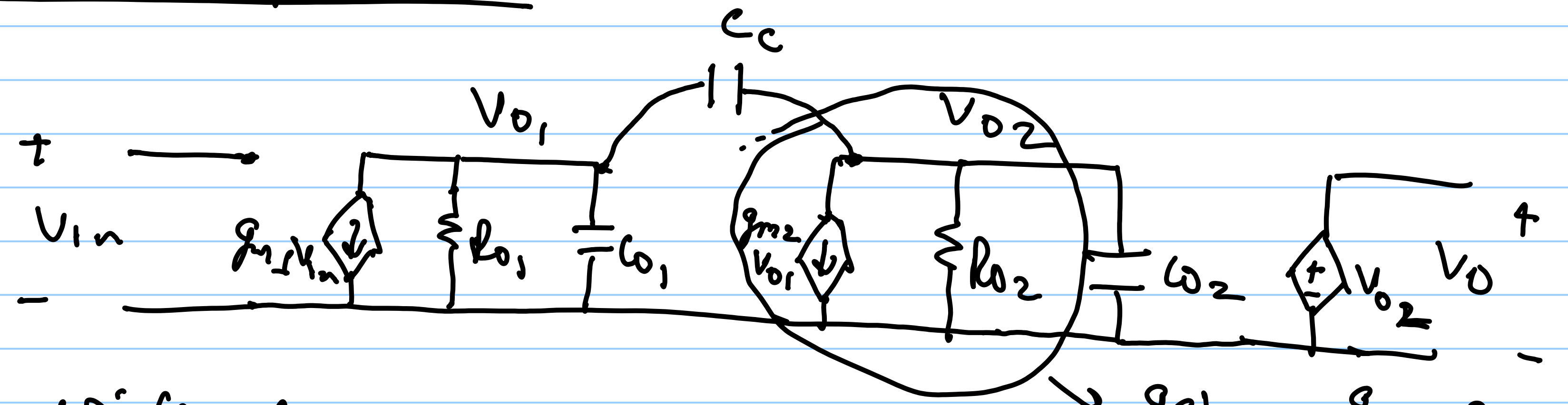
$$Z_{in} = \frac{V_{in}}{I_{in}}$$

$$I_{in} = (V_{in} + AV_{in})\, sC \Rightarrow \frac{V_{in}}{I_{in}} = \frac{1}{s(1+A)C}$$

$C_{in} = (1+A)C$ This is called Miller Effect

Note Title 2/27/2019

Miller compensation

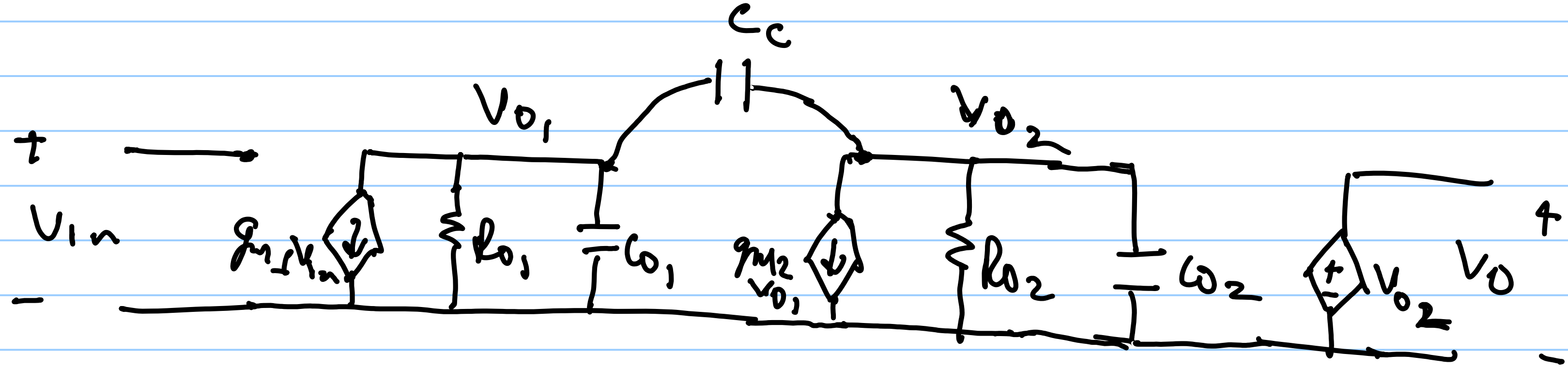


→ gain $= -g_{m2}R_{o2}$

without C_c. poles are at

$$\omega_{p_1} = \frac{1}{R_{o1}C_{o1}} \quad \& \quad \omega_{p_2} = \frac{1}{R_{o2}C_{o2}}$$

Note Title 2/27/2019



Apply KCL at V_{o1}

$$G_{o1} = \frac{1}{R_{o1}} \quad \& \quad G_{o2} = \frac{1}{R_{o2}}$$

$$g_{m1} V_{in} + V_{o1} G_{o1} + V_{o1}\, s C_{o1} + (V_{o1} - V_{o2})\, s C_c = 0$$

$$g_{m1} V_{in} + V_{o1}\left[G_{o1} + s(C_{o1} + C_c)\right] - V_{o2}\, s C_c = 0$$

Note Title 2/27/2019

$$V_{o1} = \frac{V_{o2}\, s C_c - g_{m1} V_{in}}{G_{o1} + s(C_{o1} + C_c)} \longrightarrow (1)$$

Apply KCL at V_{o2}

$$g_{m2} V_{o1} + G_{o2} V_{o2} + s C_{o2} V_{o2} + (V_{o2} - V_{o1})(s C_c) = 0$$

$$V_{o2}\left[G_{o2} + s(C_{o2} + C_c)\right] + V_{o1}(g_{m2} - s C_c) = 0$$

$$V_{o2}\left[G_{o2} + s(C_{o2} + C_c)\right] = V_{o1}(s C_c - g_{m2})$$

substitute V_{o1} from (1)

$$V_{o1} = \frac{V_{o2}\, s C_c - g_{m1} V_{in}}{G_{o1} + s(C_{o1} + C_c)}$$

$$V_{o2}\left(G_{o2} + s(C_{o2} + C_c)\right] = \frac{V_{o2}\, s C_c - g_{m1} V_{in}}{G_{o1} + s(C_{o1} + C_c)} (s C_c - g_{m2})$$

$$V_{o2}\left[G_{o2} + s(C_{o2} + C_c)\right]\left[G_{o1} + s(C_{o1} + C_c)\right] = (V_{o2}\, s C_c - g_{m1} V_{in})(s C_c - g_{m2})$$

$$V_{o2}\left[G_{o2} + s(C_{o2} + C_c)\right]\left[G_{o1} + s(C_{o1} + C_c)\right] = V_{o2}\, s C_c (s C_c - g_{m2}) + V_{in} g_{m1} (g_{m2} - s C_c)$$

$$V_{o2}\left[G_{o2}+s(C_{o2}+C_c)\right]\left[G_{o1}+s(C_{o1}+C_c)\right]+V_{o2}\,sC_c\,(g_{m2}-sC_c)$$

$$= V_{in}\,g_{m1}\,(g_{m2}-sC_c)$$

$$V_{o2}\Big[G_{o1}G_{o2}+G_{o2}(C_{o1}+C_c)s+G_{o1}(C_{o2}+C_c)s+s^2(C_{o2}+C_c)(C_{o1}+C_c)$$

$$+\,\underline{s}\,C_c\,g_{m2}-s^2C_c^2\Big] = V_{in}\,g_{m1}\,(g_{m2}-sC_c)$$

$$V_{o2}\Big[G_{o1}G_{o2}+s\big[G_{o2}(C_{o1}+C_c)+G_{o1}(C_{o2}+C_c)+C_c\,g_{m2}\big]+s^2\big\{C_{o1}C_{o2}+\cancel{C_c^2}+C_c(C_{o1}+C_{o2})\cancel{-C_c^2}\big\}\Big]$$

$$= V_{in}\,g_{m1}\,(g_{m2}-sC_c)$$