CE

$$v_t = v_\pi + R_E i_E$$

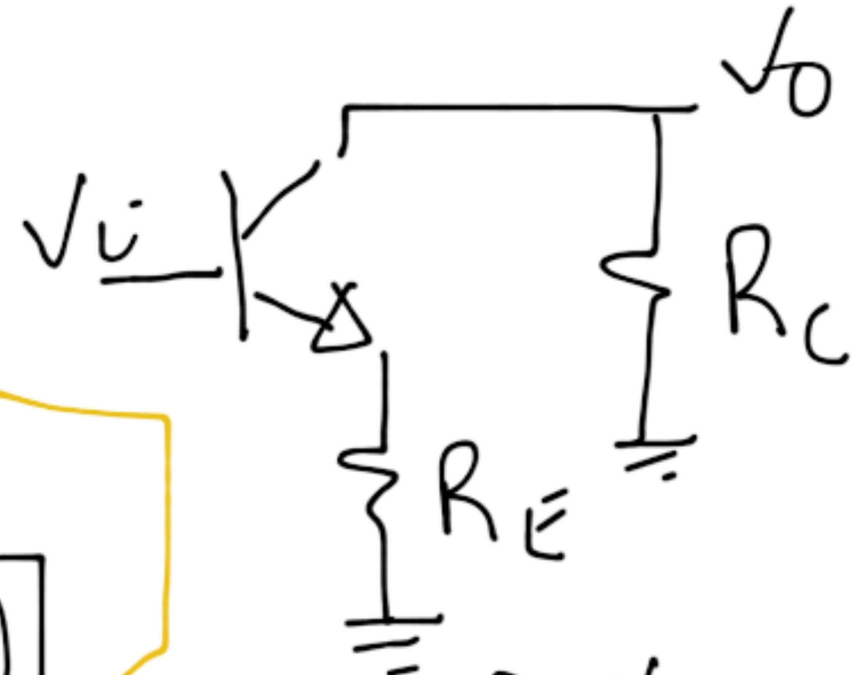
$$i_E = \frac{v_\pi}{r_\pi} + g_m v_\pi$$

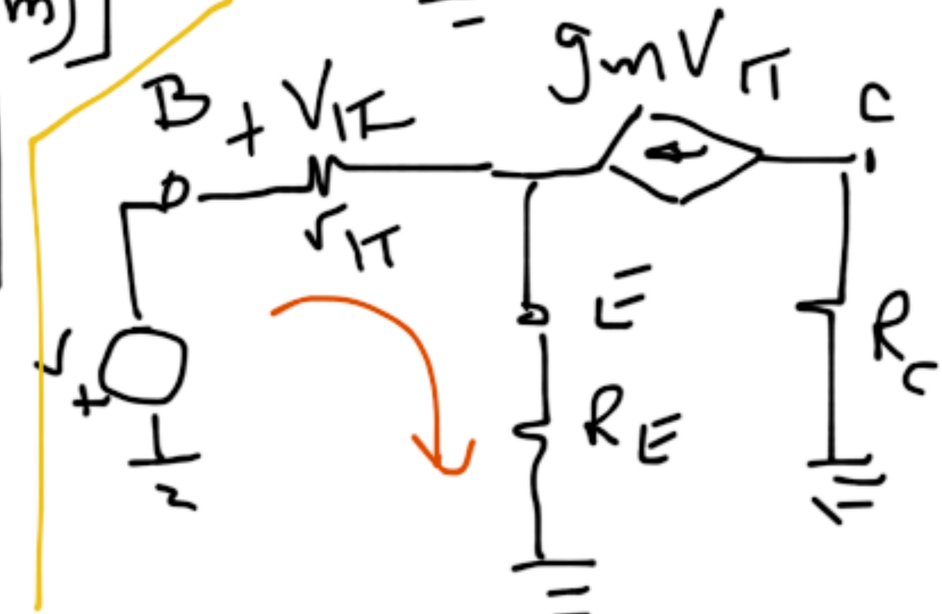
$$v_t = v_\pi \left[1 + R_E\left(\frac{1}{r_\pi} + g_m\right)\right]$$

$$v_t = v_\pi \left[1 + \frac{R_E}{r_\pi}(1+\beta)\right]$$

$$v_o = -g_m v_\pi R_C$$

$$\frac{v_o}{v_t} = \frac{-g_m R_c}{1 + \frac{R_E}{r_\pi}(\beta+1)}$$





$$g_m r_\pi = \beta$$

$$\frac{V_o}{V_t} = \frac{-g_m R_c}{1 + \frac{R_E}{r_\pi}(\beta+1)} = A_v$$

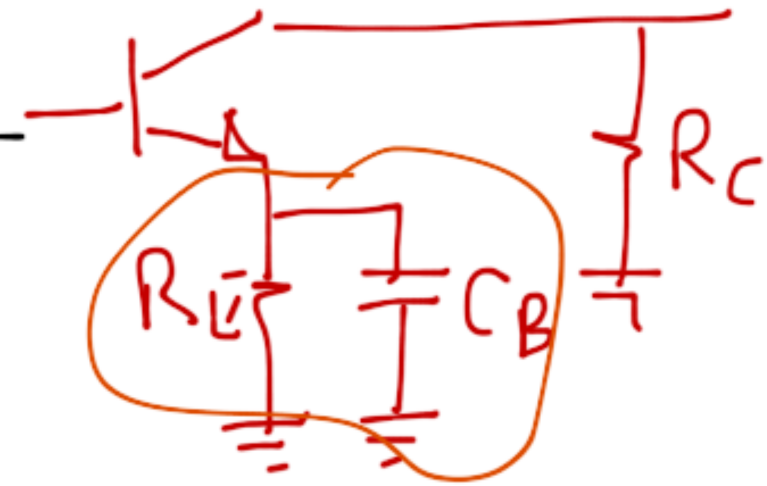
$$\beta = g_m r_\pi$$

$$\frac{\beta}{r_\pi} = g_m \cong \frac{\beta+1}{r_\pi}$$

$$\boxed{A_v = \frac{-\beta R_c}{r_\pi + R_E(\beta+1)}}$$

$$\boxed{A_v = \frac{-g_m R_c}{1 + g_m R_E}}$$

$$A_v = \frac{-g_m R_c}{1 + g_m R_E}$$



$$Z_E = R_E \,\|\, \frac{1}{sC_B}$$

$$Z_E = \frac{R_E}{sC_B R_E + 1}$$

$$A_v(s) = \frac{-g_m R_c}{1 + g_m R_E / [sC_B R_E + 1]}$$

$$= \frac{-g_m R_c \,(1 + sC_B R_E)}{1 + sC_B R_E + g_m R_E}$$

$$\frac{-g_m R_c\,(1 + sC_B R_E)}{1 + sC_B R_E + g_m R_E}$$

$$A_v(s) = \frac{-g_m R_c}{1 + g_m R_E} \cdot \frac{1 + sC_B R_E}{1 + \dfrac{sC_B R_E}{1 + g_m R_E}}$$

$$\frac{R_E}{1 + g_m R_E} = \frac{R_E\,(1/g_m)}{\dfrac{1}{g_m} + R_E} = R_E \,\|\, \frac{1}{g_m}$$

$$A_v(s) = \frac{-g_m R_c}{1+g_m R_E} \frac{1 + sC_B R_E}{1 + sC_B\left(R_E \| \frac{1}{g_m}\right)}$$

zero at $1/C_B R_E$

pole at $\dfrac{1}{C_B\left(R_E \| 1/g_m\right)}$

At low f $\rightarrow s = 0$

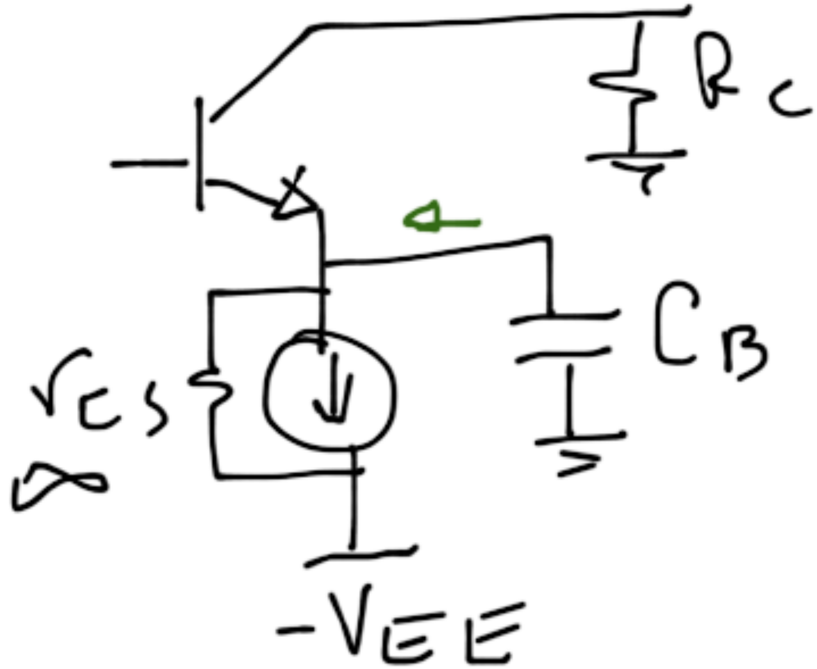
$$A_v(0) = \frac{-g_m R_c}{1+g_m R_E}$$

at mid-freq $\rightarrow s = \infty$

$$A_v(s) = \frac{-g_m R_c}{1 + g_m R_E} \; \frac{\cancel{1} + s\cancel{C_B} R_E}{\cancel{1} + s\cancel{C_B}\left(R_E \,\|\, \frac{1}{g_m}\right)}$$

$$A_v(\infty) = \frac{-g_m R_c}{\cancel{1 + g_m R_E}} \; \frac{\cancel{R_E}}{\dfrac{\cancel{R_E}\left(\cancel{1/g_m}\right)}{\cancel{R_E + 1/g_m}}}$$

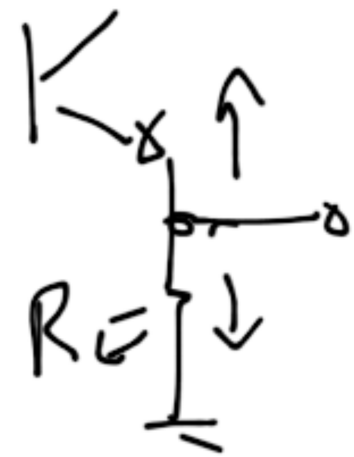
Biasing with C.S.



zero at $\cancel{1/C_B R_E} \to 0$

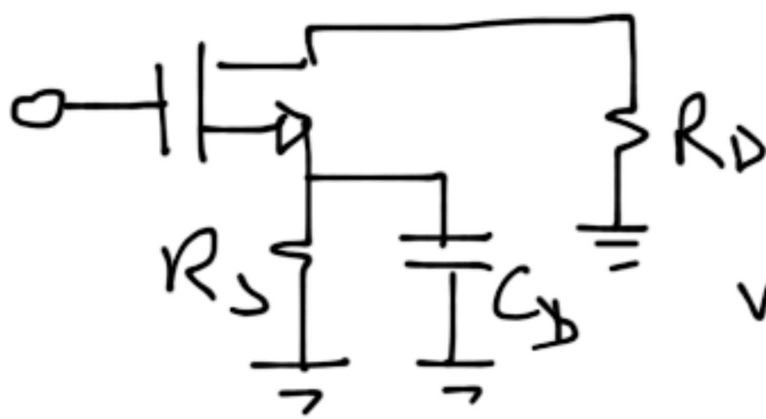
pole at $\dfrac{1}{C_B(\cancel{R_E \|}\, 1/g_m)}$

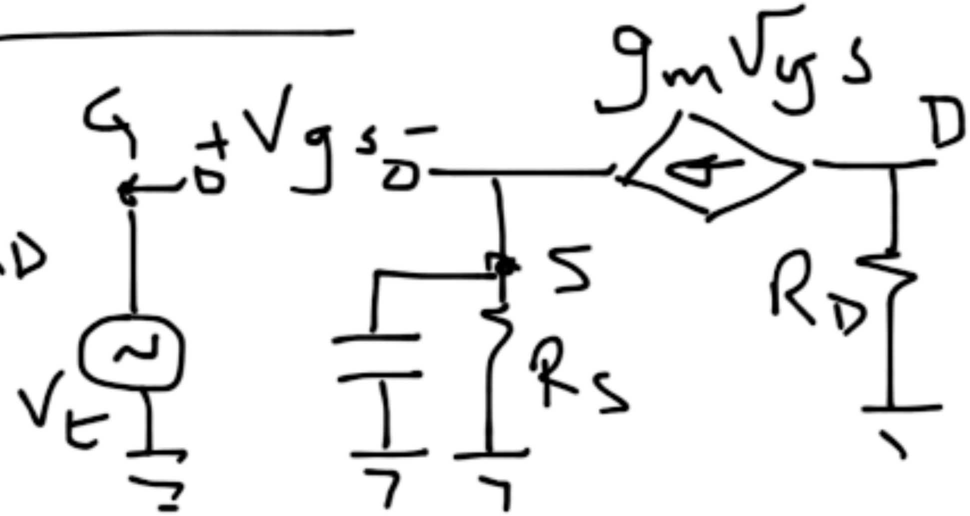
R_{eq} seen by C_B

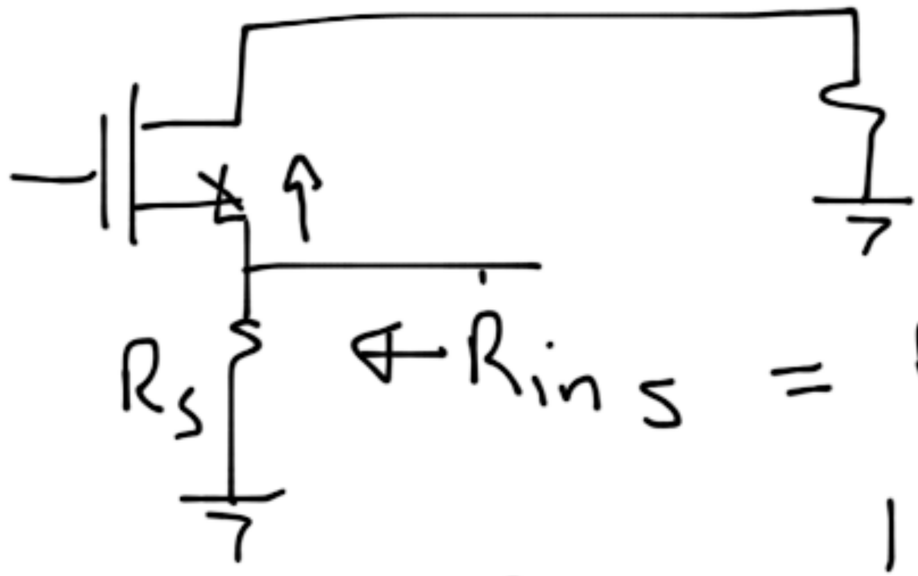


looking into base

$= 1/g_m$



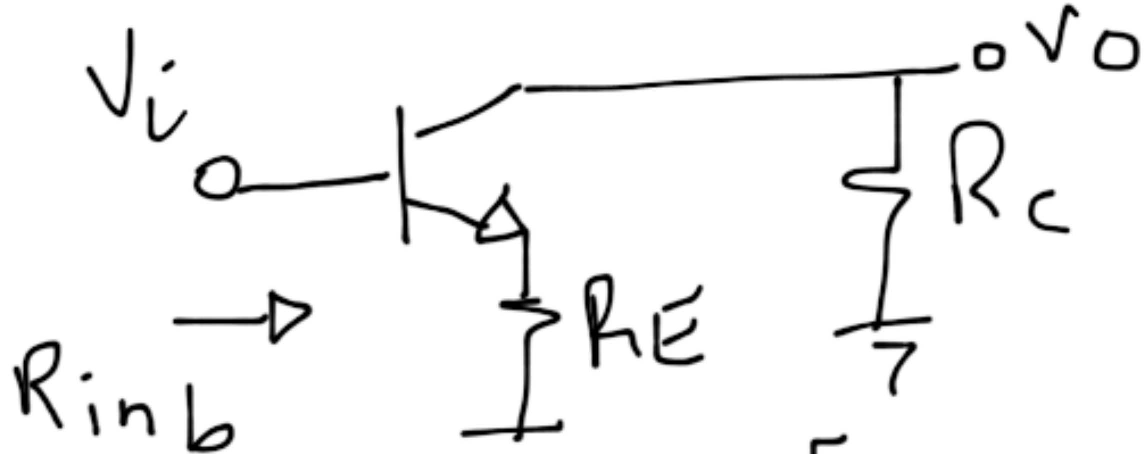


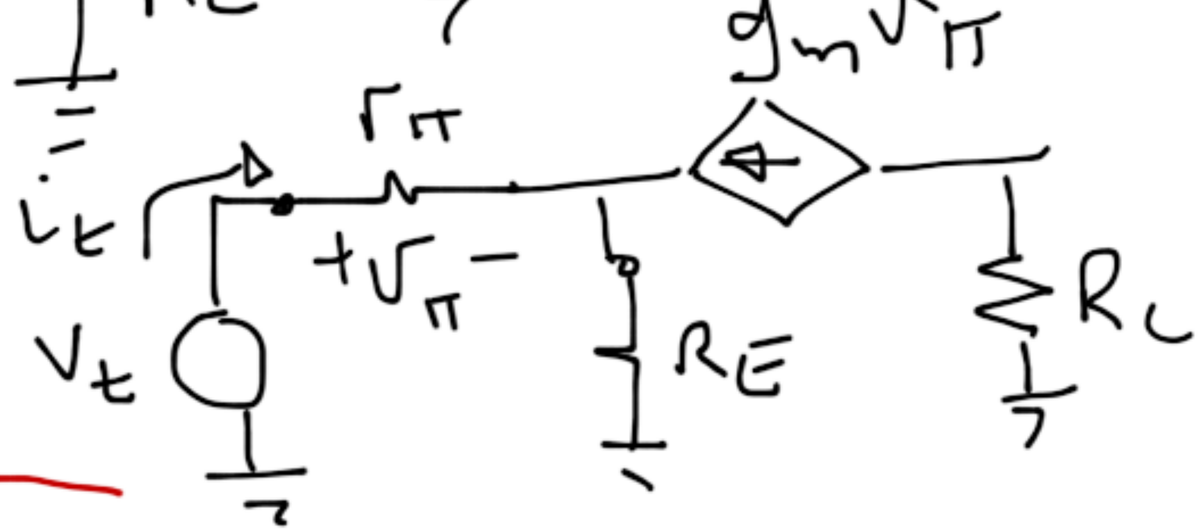


$$\leftarrow R_{in_S} = R_s \,||\, 1/g_m$$

$$\text{pole} \rightarrow f_p = \frac{1}{2\pi C_B \left(R_s \,||\, \frac{1}{g_m}\right)}$$

$$\text{zero} \rightarrow f_Z = \frac{1}{2\pi C_B R_S}$$



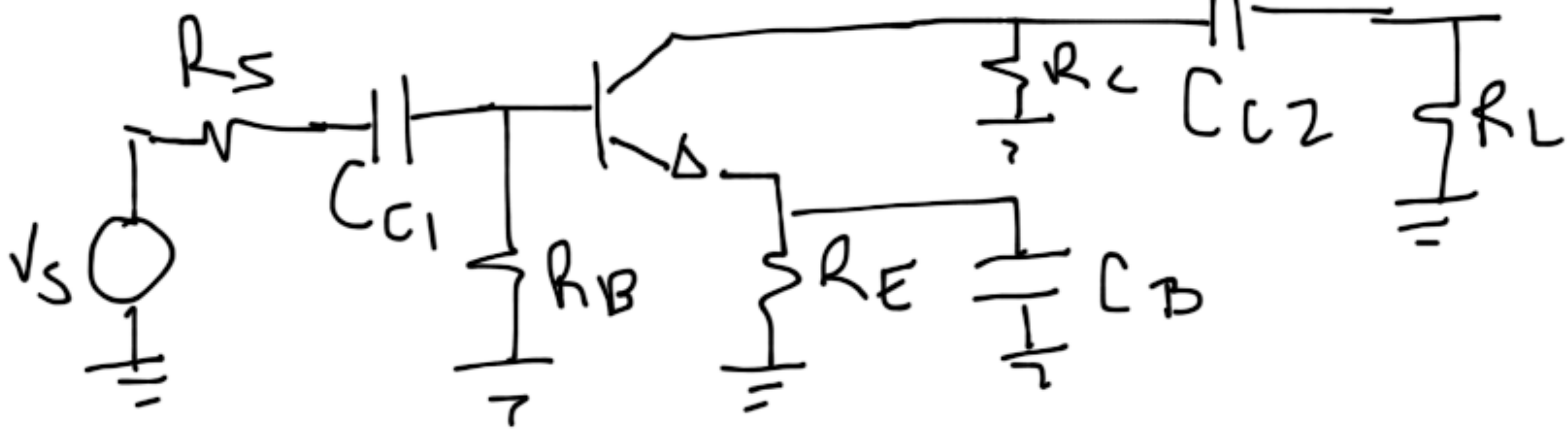


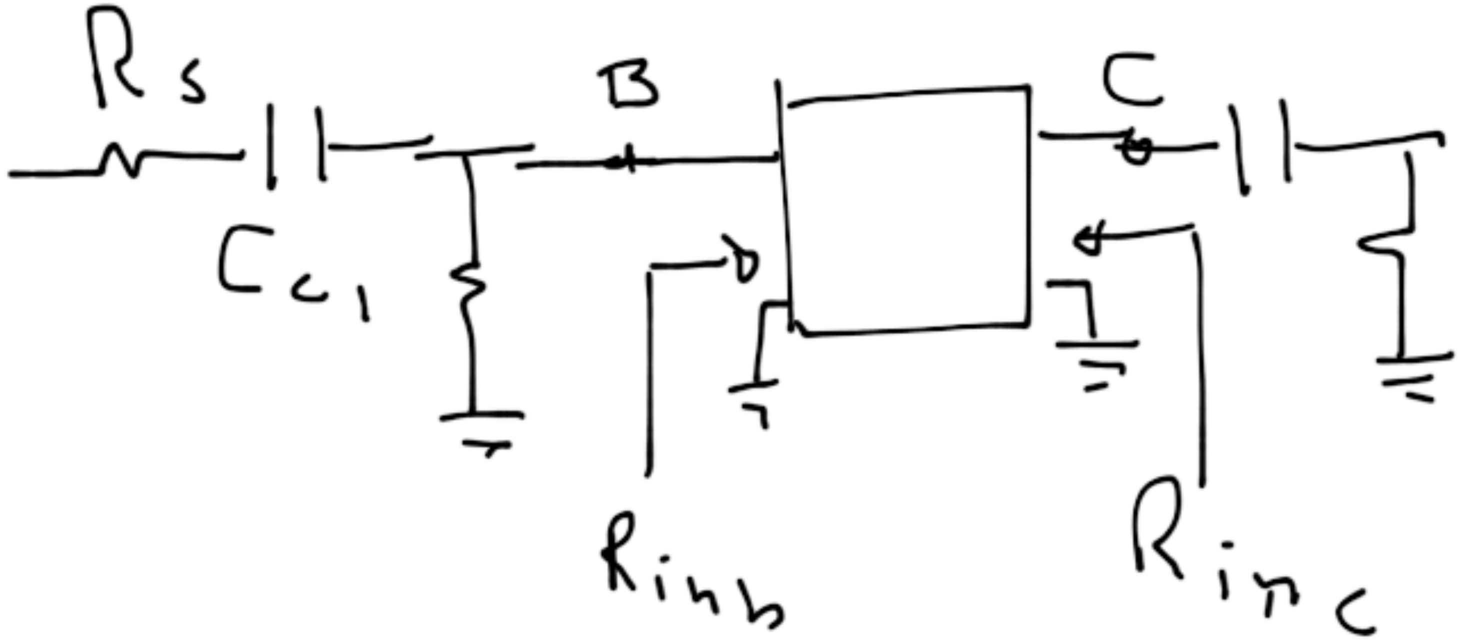
$$R_{in_b} = \frac{v_t}{i_t}$$

$$v_t = i_t r_\pi \left[1 + R_E\left(\frac{1}{r_\pi} + g_m\right)\right]$$

$$R_{in_b} = r_\pi \left[1 + R_E\left(\frac{1}{r_\pi} + g_m\right)\right]$$

$$= r_\pi + (\beta + 1) R_E$$





take C_B as a short

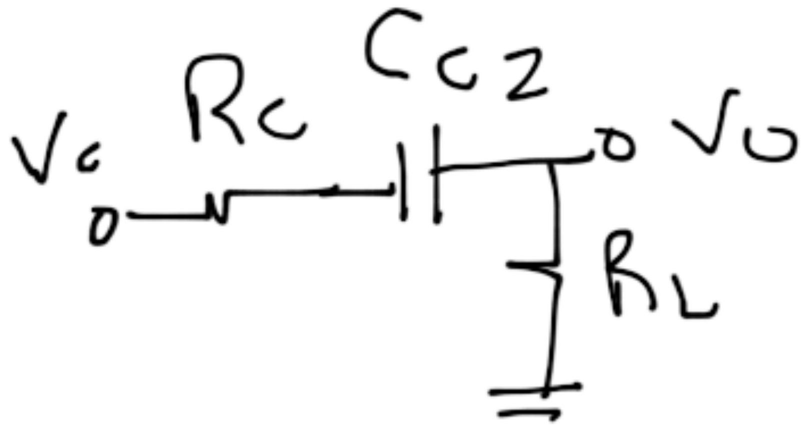
$$Z_S = R_S + \frac{1}{sC_{C1}} = \frac{sC_{C1}R_S + 1}{sC_{C1}}$$

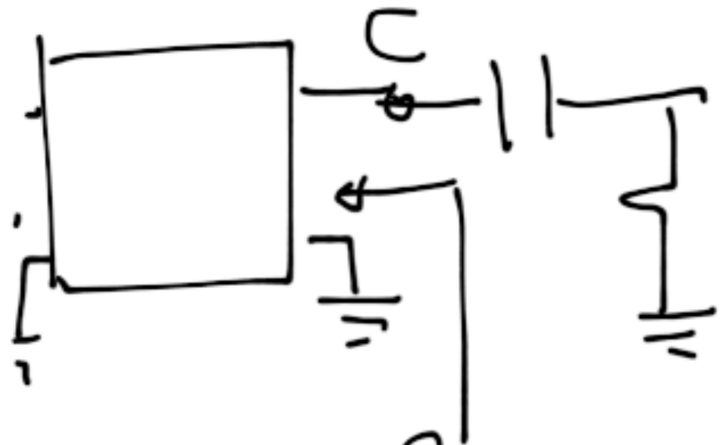
overall gain

$$A_V = \left(\frac{V_O}{V_C}\right)\left(\frac{V_C}{V_B}\right)\frac{V_B}{V_S}$$

$$\frac{V_B}{V_S} = \frac{R_B'}{R_B' + Z_S} = \frac{sC_{C1}R_B}{sC_{C1}(R_B' + R_S) + 1}$$

f_Z at origin, $f_P = \dfrac{1}{2\pi C_{C1}(R_S + R_B')}$





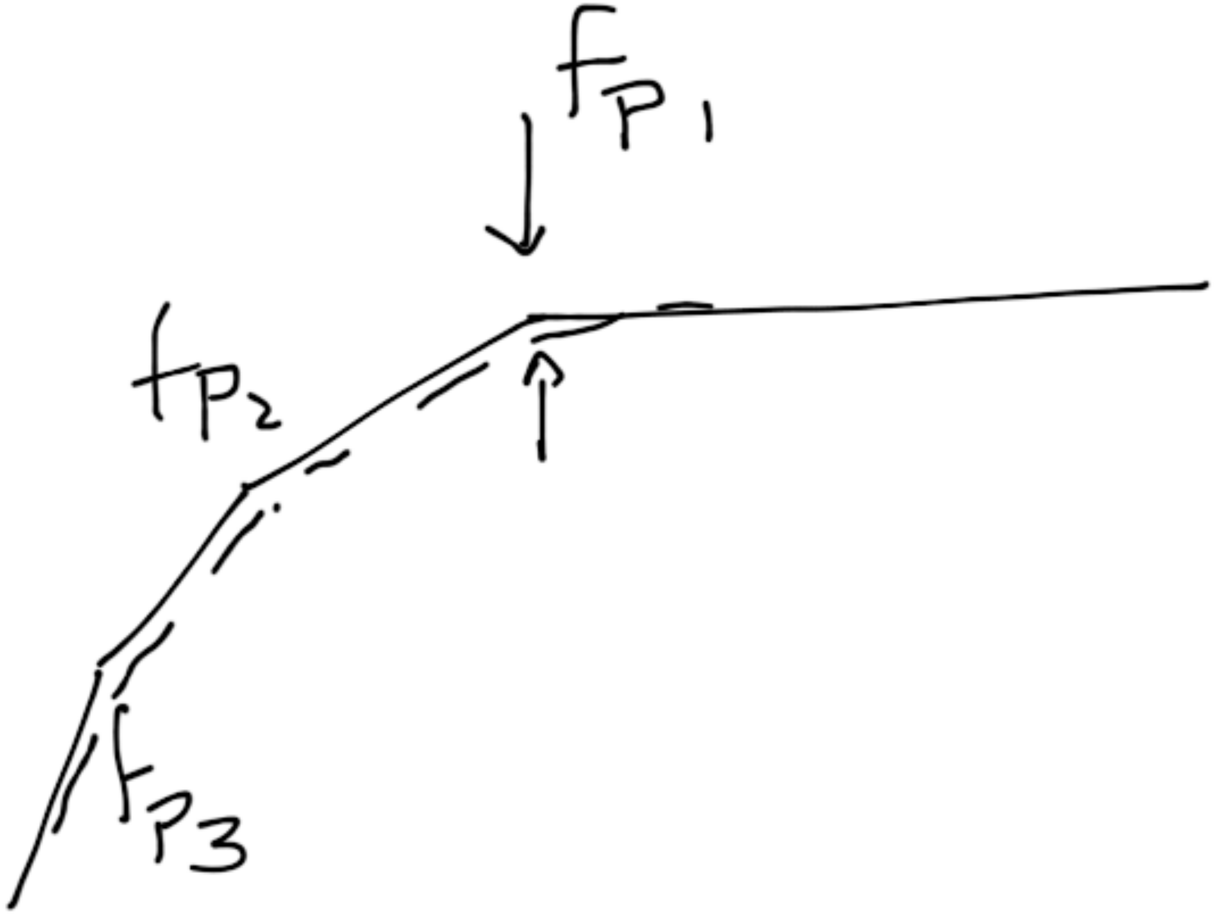
$R_{in_C} = R_C$

$$\frac{V_o}{V_c} = \frac{R_L}{R_L + R_C + 1/sC_{c2}}$$

$$= \frac{sC_{c2} R_L}{1 + sC_{c2}(R_L + R_C)}$$

zero at orijin

pole at $f_p = \dfrac{1}{2\pi C_{c2}(R_L + R_C)}$



f_{P_1}
f_{P_2}
f_{P_3}