

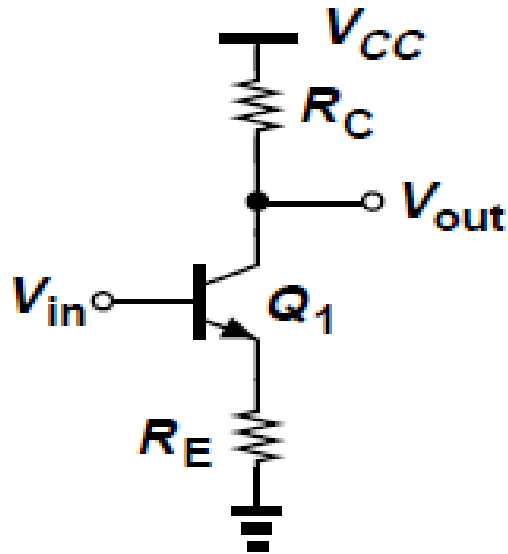
LESSON 20

LEC23

LEC24 beginning to 17min

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Properties of CE stage with degeneration



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

$$g_m = V_T / I_C$$

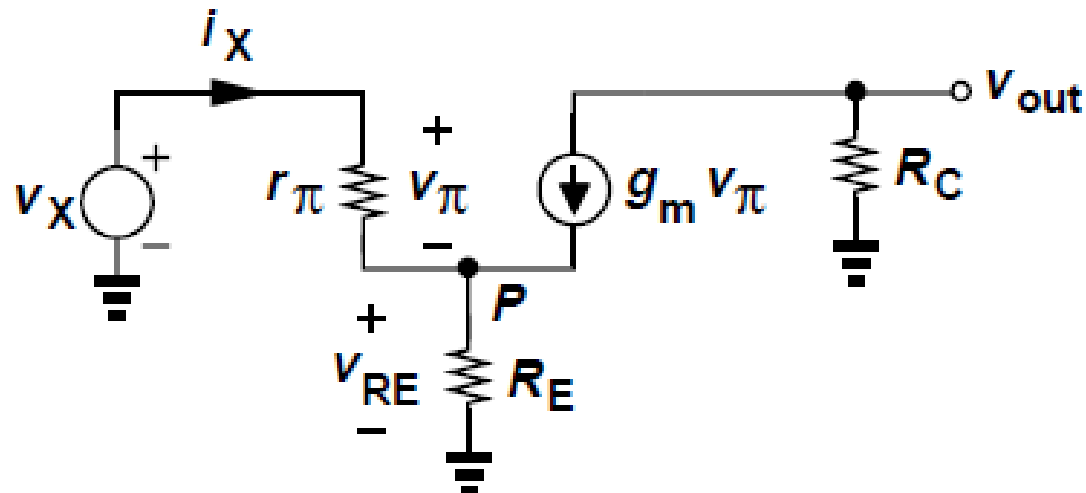
Gain is less sensitive to temperature and process variations and to signal amplitude.

R_C = Resistance tied between collector and GND

R_E = Resistance tied between emitter and GND

To minimize sensitivity to I_C -> pick $R_E \gg V_T / I_C$

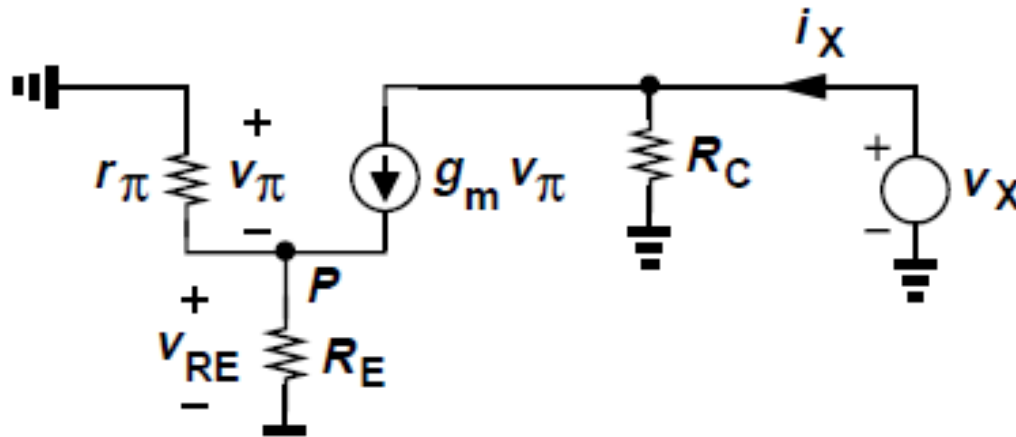
INPUT IMPEDANCE (NO EARLY EFFECT)



$$v_X = r_\pi i_X + R_E(1 + \beta)i_X,$$

$$\begin{aligned} R_{in} &= \frac{v_X}{i_X} \\ &= r_\pi + (\beta + 1)R_E. \end{aligned}$$

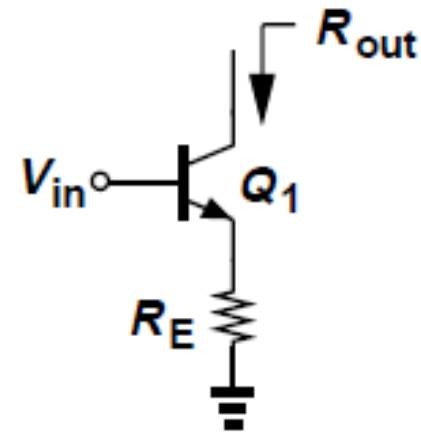
OUTPUT IMPEDANCE (NO EARLY EFFECT)



$$v_{in} = 0 = v_\pi + \left(\frac{v_\pi}{r_\pi} + g_m v_\pi \right) R_E,$$

$$\begin{aligned} R_{out} &= \frac{v_X}{i_X} \\ &= R_C, \end{aligned}$$

OUTPUT IMPEDANCE (EARLY EFFECT)



$$v_{\pi} = -i_X (R_E || r_{\pi}),$$

$$v_X = (i_X - g_m v_{\pi}) r_O - v_{\pi}$$

$$= [i_X + a_{\pi} i_X (R_E || r_{\pi})] r_O + i_X (R_E || r_{\pi}).$$

$$R_{out} = [1 + g_m (R_E || r_{\pi})] r_O + R_E || r_{\pi}$$

$$= r_O + (g_m r_O + 1) (R_E || r_{\pi}).$$