Common-Collector Design Example

Typical Specs

$\beta = 150$

$R_L = 100\,\Omega$

$V_{cc} = 10V$

$v_{o\,max} = 1V$ ($2V_{pp}$)

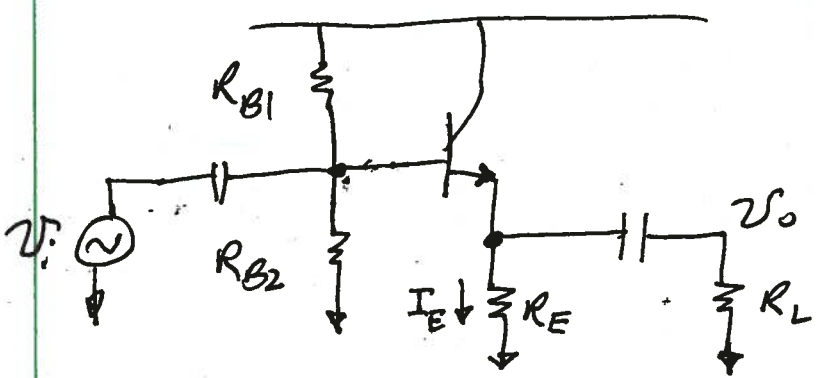
$R_{in} \geq 5k\Omega$

$A_V \geq 0.95\ V/V$

Design Guidlines:

Set $R_E = R_L$

Set $V_{EQ} = \frac{V_{cc}}{3}$



Set $R_E = R_L = 100\Omega$, $V_E = \frac{10V}{3} \simeq 3.3V$

$$I_E = \frac{3.3V}{100\Omega} = 33mA$$

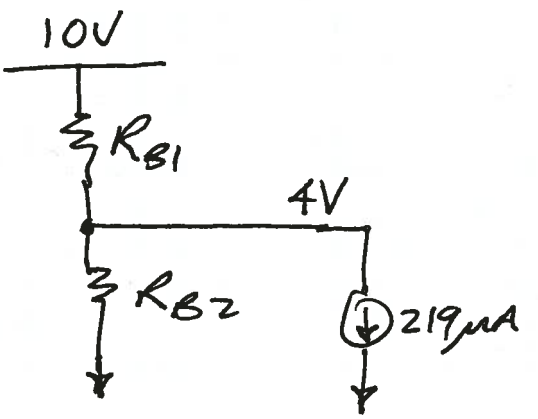
$$\Rightarrow I_c = \frac{\beta}{\beta+1} I_E = 32.8mA$$

$$I_B = \frac{I_E}{\beta+1} = 219\mu A$$

We want to design R_B such that it doesn't have a major impact on R_{in}

$$R_{in} \simeq \beta(R_E \| R_L) = 150\left(\frac{100\Omega \| 100\Omega}{}\right) = 7.5k\Omega$$

Designing R_{B1}, R_{B2}



$$R_{B1} = \frac{R_{B2}[V_{cc} - V_B]}{V_B + I_B R_{B2}}$$

Set $R_{B2} >> R_{in} \Rightarrow R_{B2} = 100k\Omega$

$$R_{B1} = \frac{100k\Omega[10V - 4V]}{4V + 219\mu A(100k\Omega)} = 23.2\,k\Omega$$

$$R_B = R_{B1} \| R_{B2} = 100k \| 23.2k\Omega = 18.8k\Omega$$

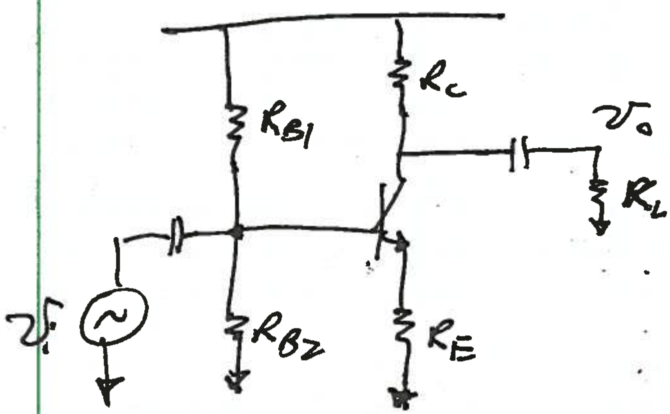
$$A_V = \frac{R_E \| R_L}{r_e + R_E \| R_L} \qquad r_e = \frac{V_{th}}{I_E} = \frac{25.9mV}{33mA} = 0.78\Omega$$

$$= \frac{100 \| 100}{0.78 + 100 \| 100} = 0.985\ V/V$$

$$R_{in} = R_B \| [r_\pi + (\beta+1)(R_E \| R_L)] \qquad r_\pi = \frac{V_{th}}{I_B} = \frac{25.9mV}{219\mu A} = 118\Omega$$

$$= 18.8k\Omega \| [118\Omega + 151(50\Omega)] = 5.45k\Omega$$

Common-Emitter Design Example



Typical Specs

$\beta = 150$

$R_L = 5K\Omega$

$V_{CC} = 10V$

$v_{omax} = 1V \ (2v_{pp})$

$R_{in} \geq 10K\Omega$

$|A_v| \geq 10 \ V/V$

Design Guidelines:

~~Set $V_E = V_{RC} = \frac{V_{cc}}{3}$ approximately~~

Set R_E based on R_{in} Spec

Set R_C based on A_V Spec

Set $V_{RC} = \frac{V_{cc}}{3}$ approximately, check A_V

$$R_{in} \simeq \beta R_E \geq 10k\Omega$$

$$\text{Set} \quad R_E = \frac{2(R_{in}\ \text{Spec})}{\beta} = \frac{2(10k\Omega)}{150} = 133\Omega$$

$$A_V \simeq \frac{R_C \| R_L}{R_E} \Longrightarrow R_C \geq \frac{1}{\frac{1}{R_E A_{Vspec}} - \frac{1}{R_L}}$$

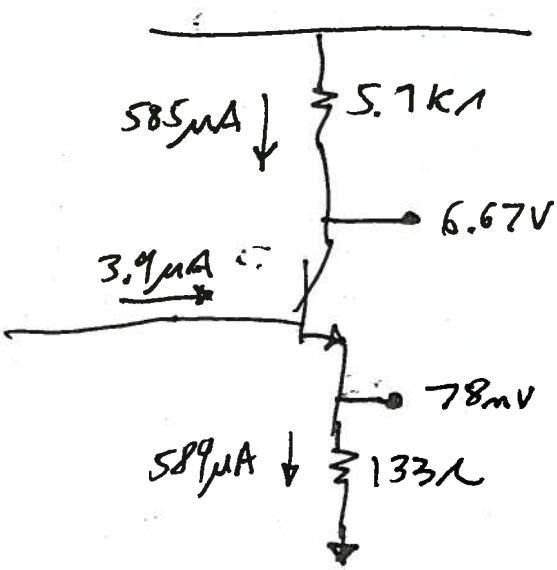
$$\text{Set} \quad R_C = \frac{1}{R_E(2A_{Vspec}) - \frac{1}{R_L}} = \frac{1}{133(2)(10) - \frac{1}{5K}} = 5.7K\Omega$$

$$I_C = \frac{V_{cc}}{3R_C} = \frac{10V}{3(5.7K\Omega)} = 585\mu A$$

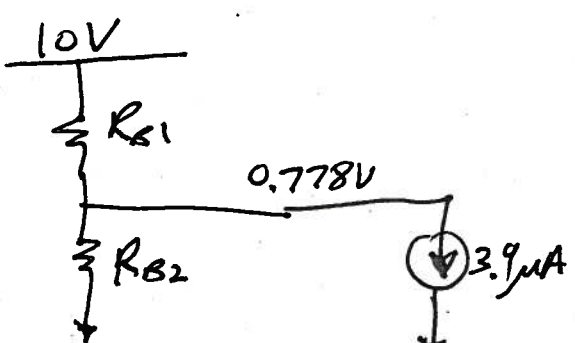
$$g_m = \frac{I_C}{V_{th}} = \frac{585\mu A}{25.9mV} = 22.6\ mA/V$$

$$A_V = -\frac{g_m(R_C \| R_L)}{1 + \frac{g_m R_{E1}}{\alpha}}$$

$$= -\frac{22.6\ mA/V\ (5.7k \| 5k)}{1 + \frac{22.6\ mA/V\ (133)}{0.993}} = 14.9\ V/V$$



Designing R_{B1}, R_{B2}



$$R_{B1} = \frac{R_{B2}[V_{cc} - V_B]}{V_B + I_B R_{B2}}$$

Set $R_{B2} \gg R_{in} \Rightarrow$

$R_{B2} = 100K\Omega$

$$R_{B1} = \frac{100K[10V - 0.778V]}{0.778V + (3.9\mu A)(100K\Omega)} = 790K\Omega$$

$$R_B = R_{B1} \| R_{B2} = 790k \| 100k = 88.8k\Omega$$

$$R_{in} = R_B \| [r_\pi + (\beta+1) R_E]$$

$$r_\pi = \frac{V_{th}}{I_B} = \frac{25.9mV}{3.9\mu A} = 6.6k\Omega$$

$$R_{in} = 88.8k \| [6.6k + (151)(133)]$$

$$= 20.5k\Omega$$