Common Base Amplifier

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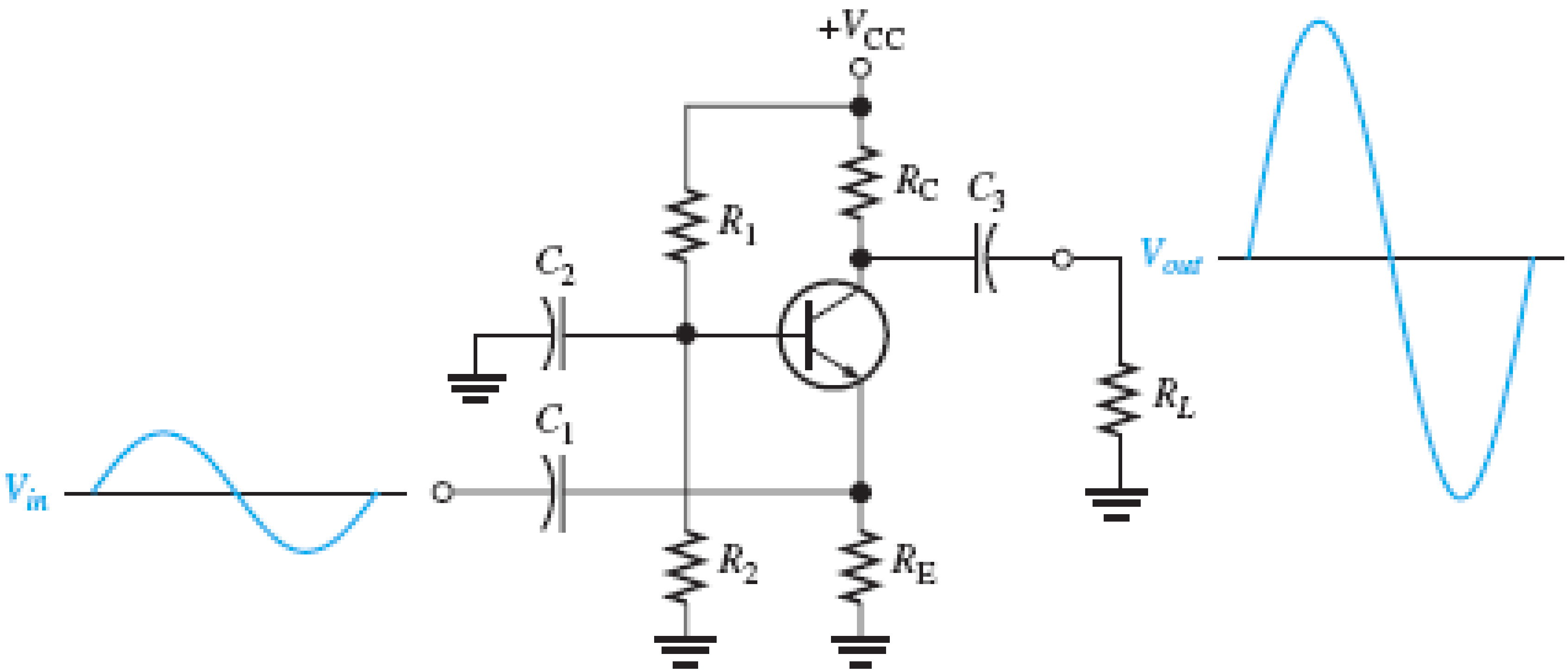
THE COMMON-BASE AMPLIFIER

The base is the common terminal and is at ac ground because of capacitor C_2.
The input signal is capacitively coupled to the emitter.
The output is capacitively coupled from the collector to a load resistor.



Voltage Gain

$$Av = V_{out} / V_{in}$$

$$= \frac{V_c}{V_e}$$

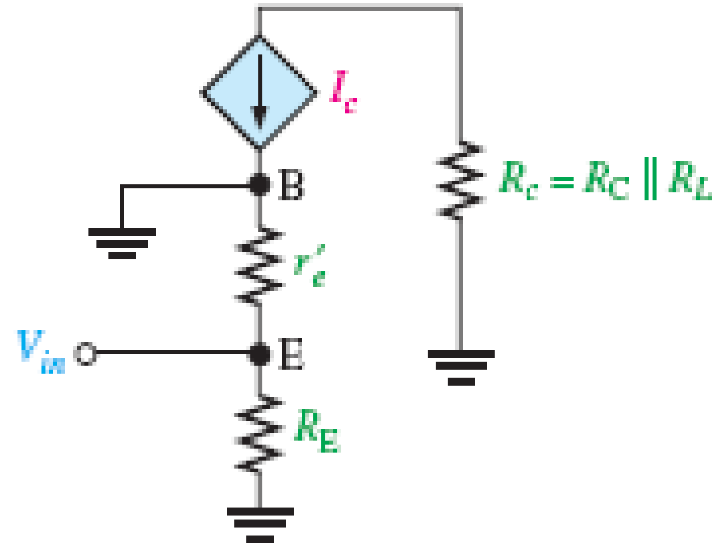
$$= \frac{I_c R_c}{I_e(r'_e \parallel R_E)}$$

$$\cong \frac{I_c R_c}{I_e(r'_e \parallel R_E)}$$

If $R_E >> r'_e$, then

$$A_v \cong \frac{R_c}{r'_e}$$

where $R_c = R_C \parallel R_L$.



Notice that the gain expression is the same as for the common-emitter amplifier. However, there is no phase inversion from emitter to collector.

Input Resistance

The resistance, looking in at the emitter, is

$$R_{in(emitter)} = \frac{V_{in}}{I_{in}} = \frac{V_e}{I_e} = \frac{I_e(r'_e \parallel R_E)}{I_e}$$

If $R_E >> r'_e$, then

$$R_{in(emitter)} \cong r'_e$$

R_E is typically much greater than r'_e, so the assumption that $r'_e \parallel R_E \cong r'_e$ is usually valid.

Output Resistance

Looking into the collector, the ac collector resistance, r'_c, appears in parallel with R_C. As you have previously seen in connection with the CE amplifier, r'_c is typically much larger than R_C, so a good approximation for the output resistance is

$$R_{out} \cong R_C$$

Current Gain

The current gain is the output current divided by the input current. I_c is the ac output current, and I_e is the ac input current. Since $I_c \cong I_e$, the current gain is approximately 1.

$$A_i \cong 1$$

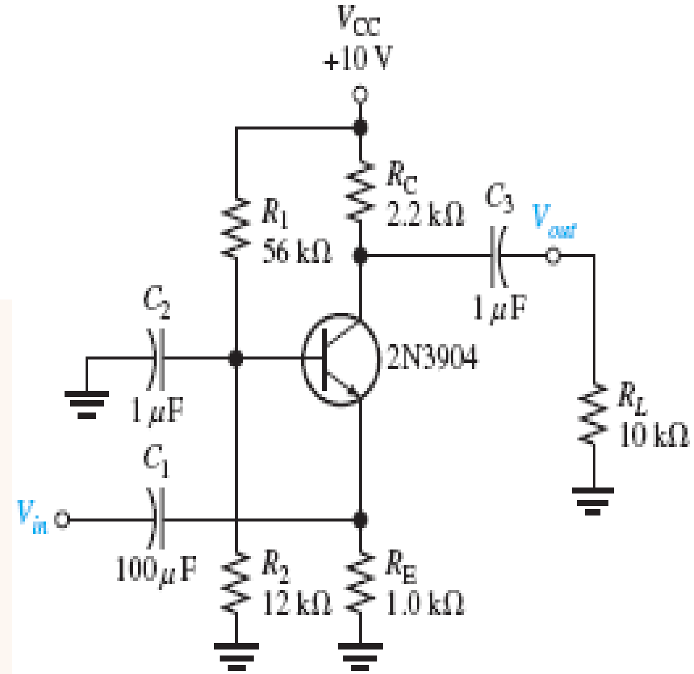
Power Gain

Since the current gain is approximately 1 for the common-base amplifier and $A_p = A_v A_i$, the power gain is approximately equal to the voltage gain.

$$A_p \cong A_v$$

Example

Find the input resistance, voltage gain, current gain, and power gain for the amplifier in Figure. β_{DC} = 250.



First, find I_E so that you can determine r'_e. Then $R_{in} \cong r'_e$.

$$R_{TH} = \frac{R_1 R_2}{R_1 + R_2} = \frac{(56\,\text{k}\Omega)(12\,\text{k}\Omega)}{56\,\text{k}\Omega + 12\,\text{k}\Omega} = 9.88\,\text{k}\Omega$$

$$V_{TH} = \left(\frac{R_2}{R_1 + R_2}\right)V_{CC} = \left(\frac{12\,\text{k}\Omega}{56\,\text{k}\Omega + 12\,\text{k}\Omega}\right)10\text{ V} = 1.76\text{ V}$$

$$I_E = \frac{V_{TH} - V_{BE}}{R_E + R_{TH}/\beta_{DC}} = \frac{1.76\text{ V} - 0.7\text{ V}}{1.0\,\text{k}\Omega + 39.5\,\Omega} = 1.02\text{ mA}$$

Therefore,

$$R_{in} \cong r'_e = \frac{25\text{ mV}}{I_E} = \frac{25\text{ mV}}{1.02\text{ mA}} = \mathbf{24.5\,\Omega}$$

Calculate the voltage gain as follows:

$$R_c = R_C \| R_L = 2.2\,\text{k}\Omega \| 10\,\text{k}\Omega = 1.8\,\text{k}\Omega$$

$$A_v = \frac{R_c}{r'_e} = \frac{1.8\,\text{k}\Omega}{24.5\,\Omega} = \mathbf{73.5}$$

Also, $A_i \cong 1$ and $A_p \cong A_v = \mathbf{76.3}$.