

EE112 - Fall 2016

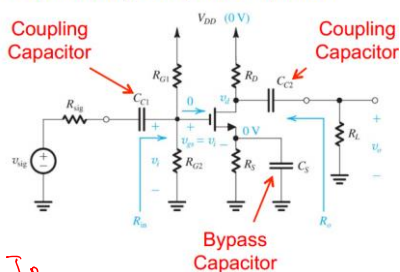
Analog Integrated Circuits I

Prof. Haoyu Wang
wanghy@shanghaitech.edu.cn
 5210 Research Bldg.

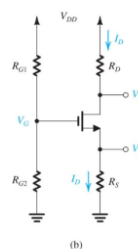
CS Amplifier with Bias Circuit

Both coupling and bypass capacitors are DC-open and AC-short

Capacitively Coupled Amplifier



DC:



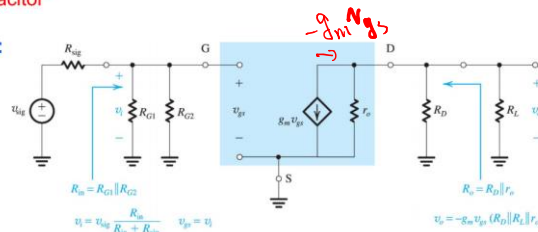
$$R_{in} = R_{G1} \parallel R_{G2}$$

$$R_o = R_D \parallel R_o$$

$$G_v = - \frac{R_{in}}{R_{sig} + R_{in}} g_m R_D \parallel R_L \parallel R_o$$

$$g_m = \frac{I_D}{V_{ov}/2}$$

AC:



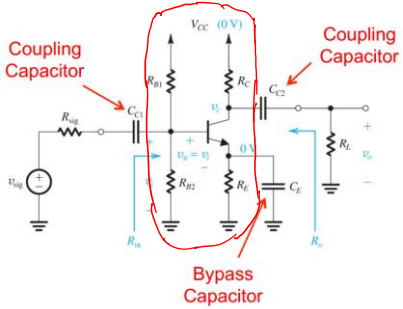
$$R_{in} = R_{G1} \parallel R_{G2}$$

$$v_i = v_{sig} \frac{R_{in}}{R_{in} + R_{sig}} \quad v_{gs} = v_i$$

$$v_o = -g_m v_{gs} (R_D \parallel R_L \parallel R_o)$$

CE Amplifier with Bias Circuit

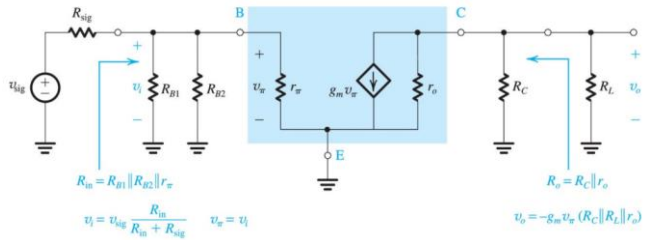
Both coupling and bypass capacitors are DC-open and AC-short



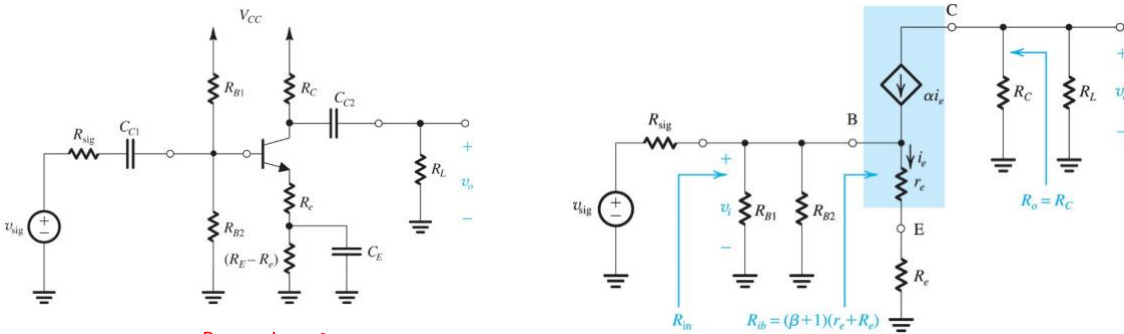
$$R_{in} = R_{B1} \parallel R_{B2} \parallel r_{\pi}$$

$$R_o = r_o \parallel R_C$$

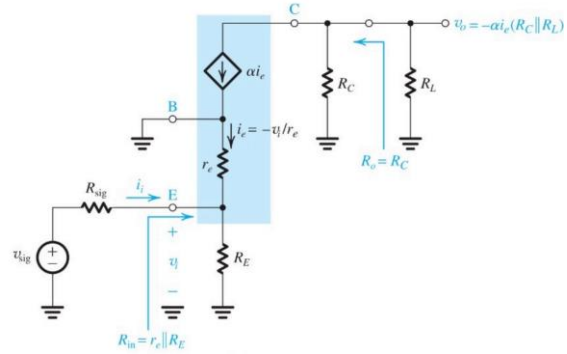
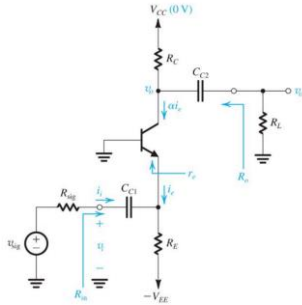
$$G_v = - \frac{R_{in}}{R_{sig} + R_{in}} \cdot g_m (R_o \parallel R_L)$$



Emitter-Degenerated CE Amplifier with Bias Circuit



CB Amplifier with Bias Circuit

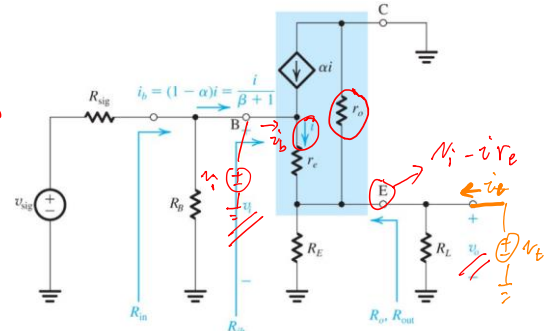
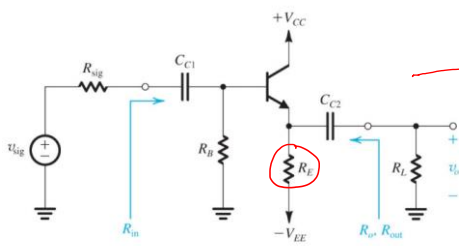


$$R_{in} = 1/g_m \parallel R_E \approx \frac{1}{g_m}$$

$$R_o = R_C$$

$$G_v = \frac{R_{in}}{R_{sig} + R_{in}} \cdot \left[\frac{R_C \parallel R_L}{1/g_m} \right] = \frac{R_{in}}{R_{sig} + R_{in}} g_m (R_C \parallel R_L)$$

Emitter Follower with Bias Circuit



$$R_{in} = R_B \parallel R_{iB} = R_B \parallel (1+\beta) \left(\frac{1}{g_m} + R_E \parallel R_L \right)$$

$$R_o = R_E \parallel R_L \parallel \left(\frac{1}{g_m} + \frac{R_B \parallel R_{sig}}{1+\beta} \right)$$

$$G_v = \frac{R_{in}}{R_{sig} + R_{in}} \cdot \frac{R_E \parallel R_L \parallel R_L}{1/g_m + R_E \parallel R_L}$$

$$\begin{cases} v_o = \frac{i}{\beta+1} \Rightarrow v_o = (1+\beta) v_b \\ i = \frac{v_i - v_o}{R_E \parallel R_L \parallel R_o} \end{cases} \quad \left[\begin{matrix} v_i \\ v_o \end{matrix} \right]$$

$$R_{iB} = \frac{v_i}{i_b} = (1+\beta) (r_o + R_E \parallel R_L)$$

Typical Frequency Response of Capacitively Coupled CE Amplifier

