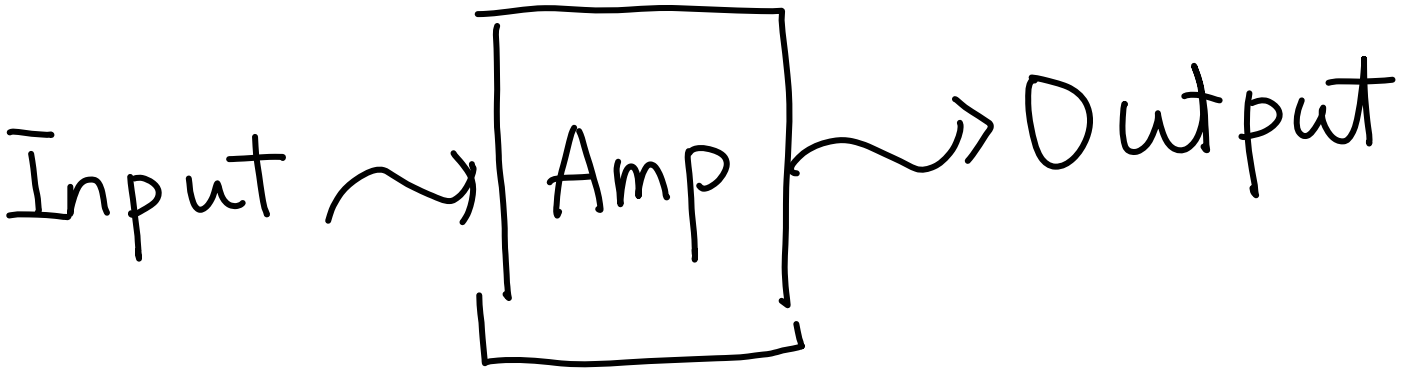
Lect. 13: BJT Amplifiers (CE)

What can we do with transistors?

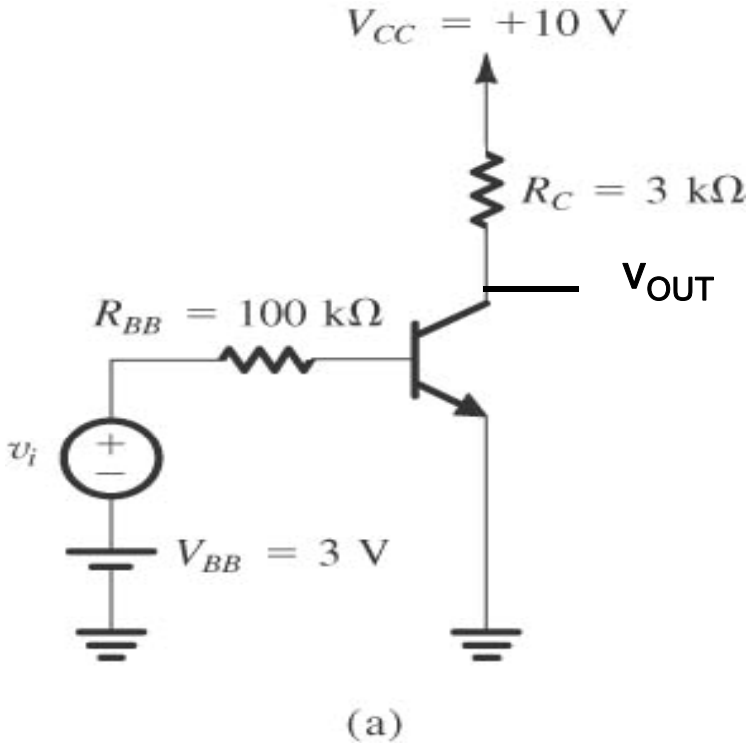
Amplifiers!



Output signal should be **faithful replica** of input signal
with desired amount of amplification

Lect. 13: BJT Amplifiers (CE)

How do we make amplifiers with BJT?



(a)

$$\mathbf{A}_v = \frac{v_o}{v_i} = -g_m \frac{r_\pi}{r_\pi + R_{BB}} (R_C \,//\, r_o)$$

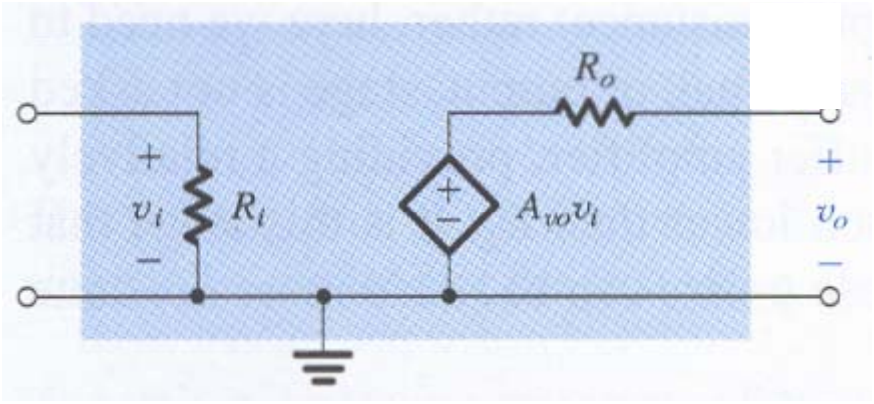
Amplification in small signal sense

There are many other types of amplifier circuits

Lect. 13: BJT Amplifiers (CE)

Various amplifier configurations

Voltage Amplifier



R_i: Input Resistance

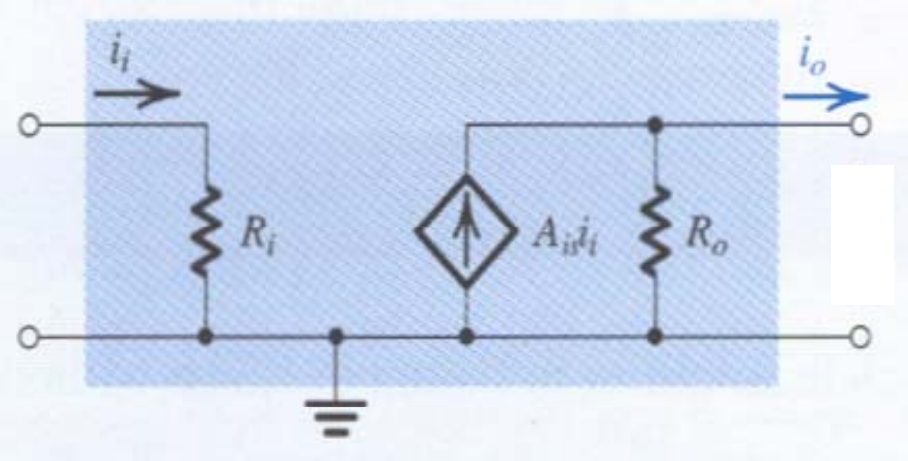
A_{vO}: Open-Circuit Voltage Gain

R_O: Output Resistance

Lect. 13: BJT Amplifiers (CE)

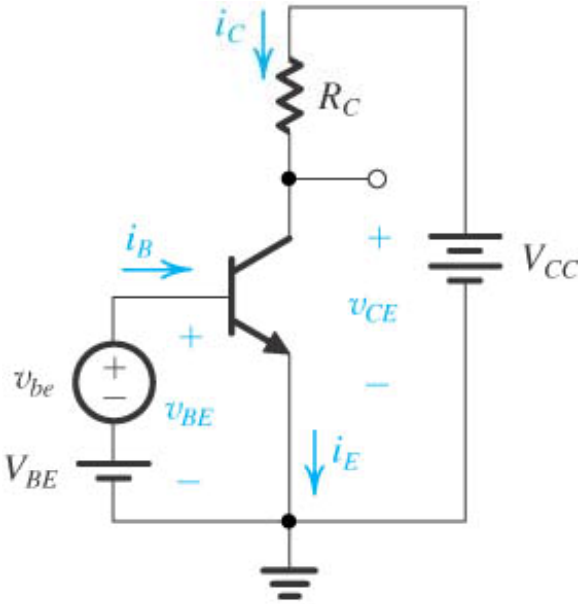
Various amplifier configuraitons

Current Amplifier



A_{is}: Short-Circuit Current Gain

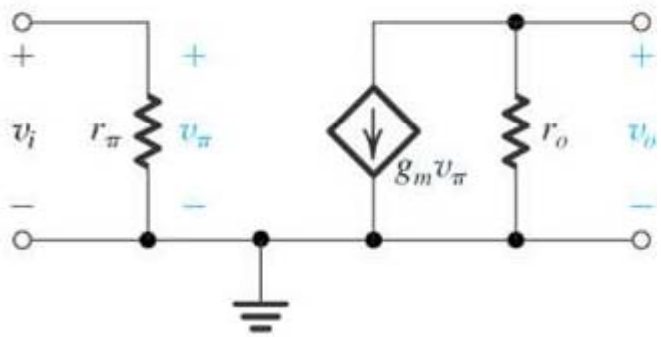
Lect. 13: BJT Amplifiers (CE)



(a)

Common-Emitter Configuration

Small signal model



R_i: r_π

R_O: $r_O \,||\, R_C$

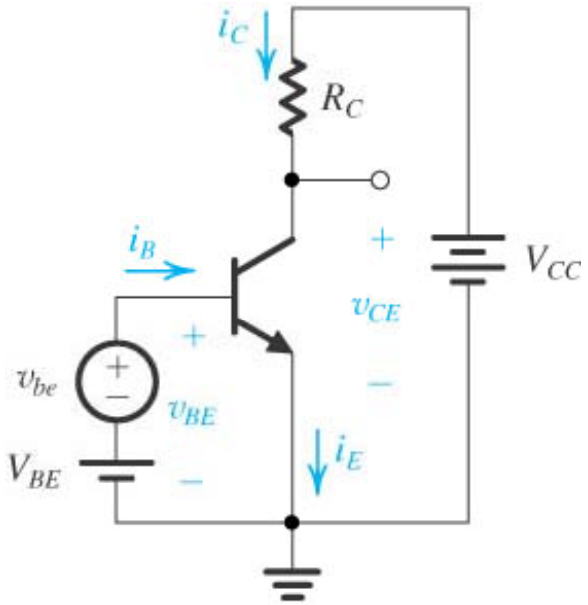
A_{vO}: $-g_m (r_O||R_C)$

A_{is}: $-\beta$

Large voltage gain? Large g_m, Large R_C,

Lect. 13: BJT Amplifiers (CE)

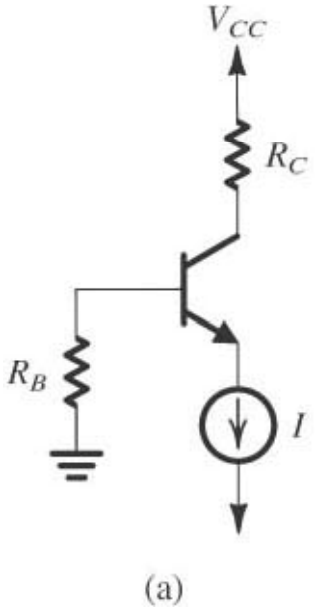
Common-Emitter Configuration



Can we eliminate V_{BE}?

➔ Many BJT bias techniques (5.2 in Razavi)

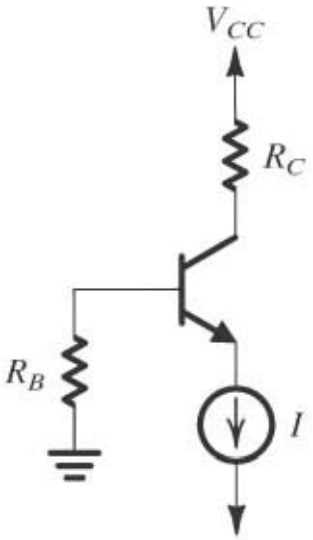
Current source biasing



How can we make the current source?

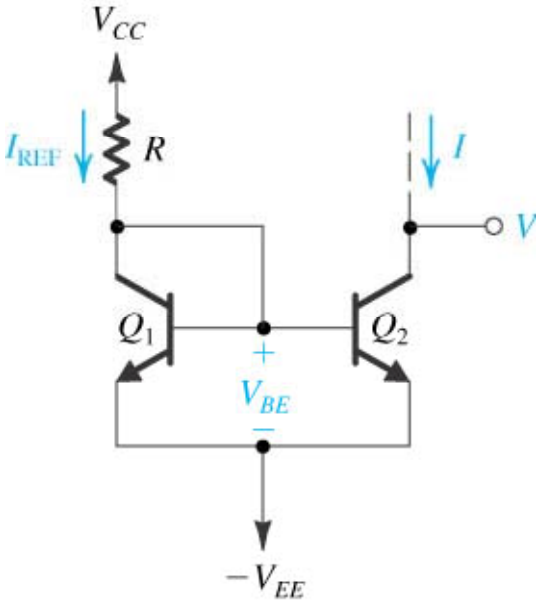
Lect. 13: BJT Amplifiers (CE)

Current source biasing



(a)

BJT current souce



(b)

$$I = I_{C1}$$

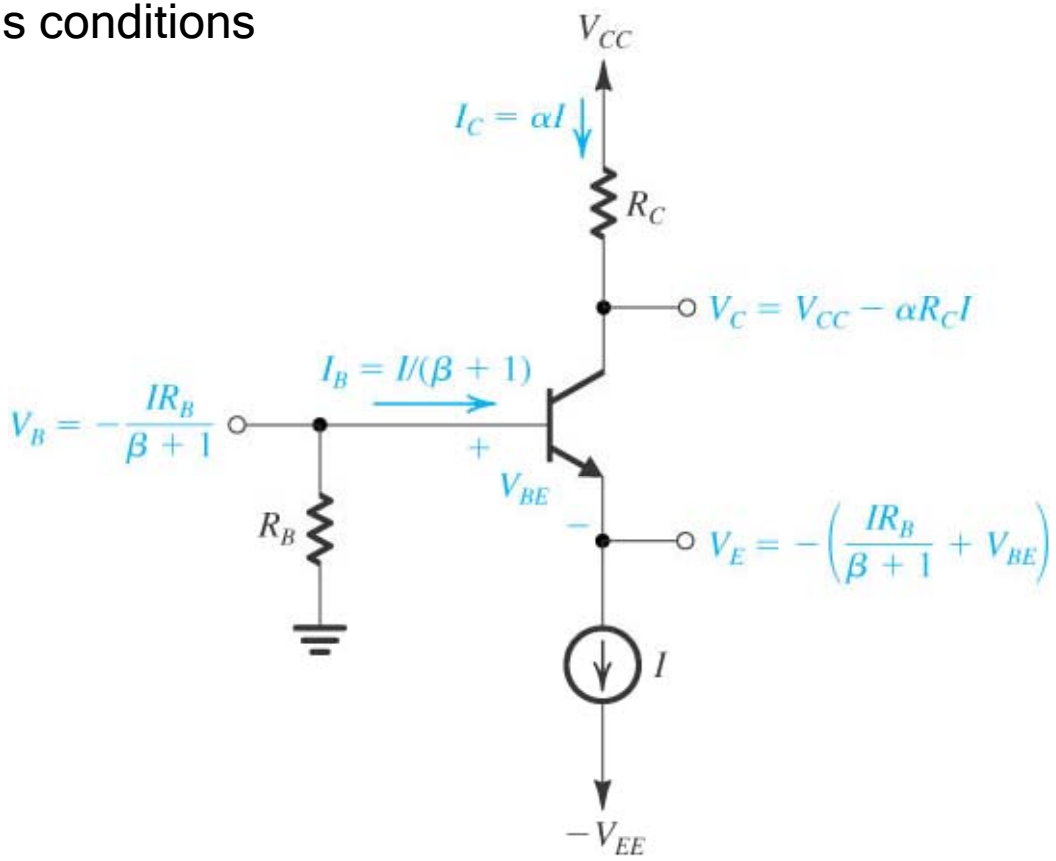
$$I_{REF} = I_{C1} + 2I_B$$

$$= I_{C1} + 2\frac{I_{C1}}{\beta} \sim I_{C1}$$

$$I_{REF} = \frac{V_{CC} + V_{EE} - V_{BE}}{R}$$

Lect. 13: BJT Amplifiers (CE)

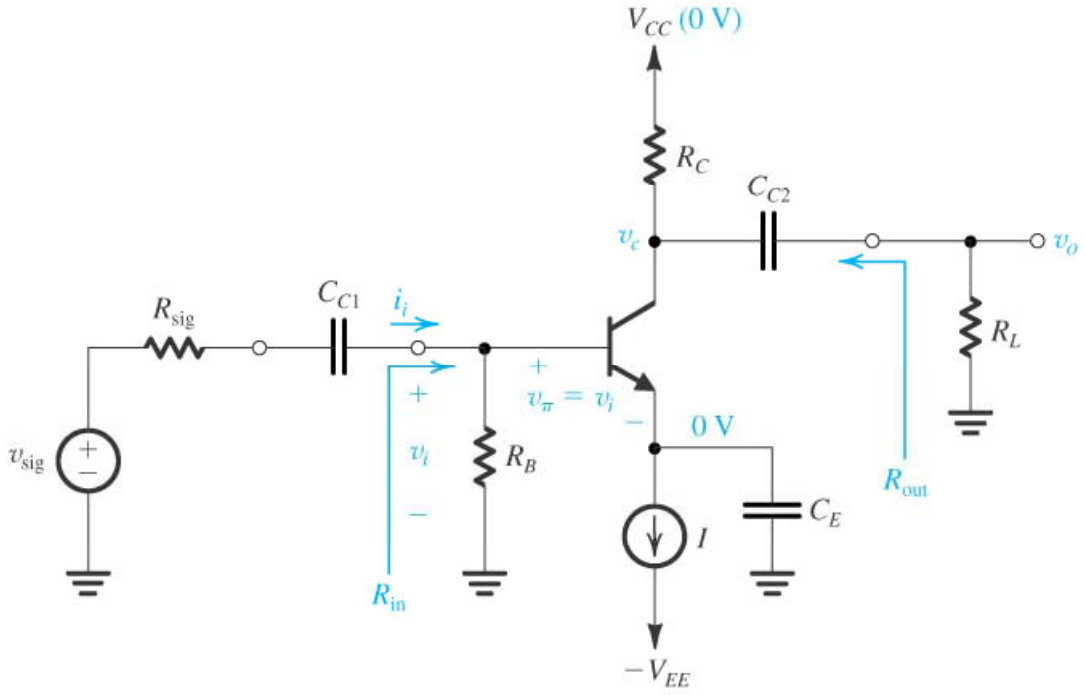
Bias conditions



Apply this to **Common-Emitter** configuration

Lect. 13: BJT Amplifiers (CE)

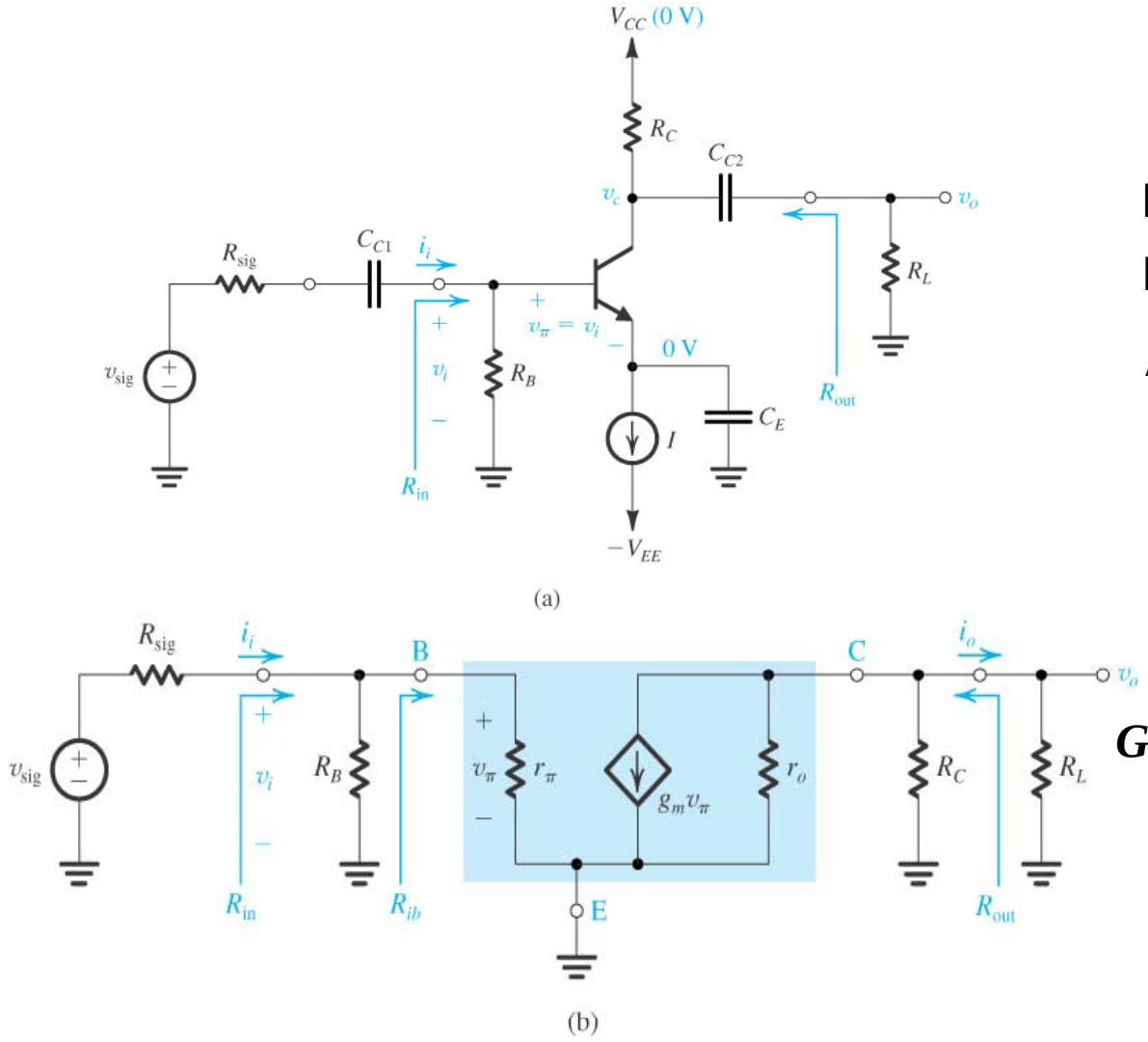
Common-Emitter with bypass capacitors



(a)

Bypass capacitors: Open for DC, Short for small-signal AC

Lect. 13: BJT Amplifiers (CE)



R_{in}: $R_B \parallel r_\pi$

R_{out}: $R_C \parallel r_O$

A_{vo}: $-g_m(R_C \parallel r_O)$

Including R_L: $\mathbf{A}_v = \mathbf{A}_{vo}\dfrac{\boldsymbol{R_L}}{\boldsymbol{R_L + R_o}}$

Overall voltage gain (v_{out}/v_{sig})

$$\boldsymbol{G_v = -\frac{(R_B \parallel r_\pi)}{(R_B \parallel r_\pi) + R_{sig}} g_m (r_o \parallel R_C \parallel R_L)}$$