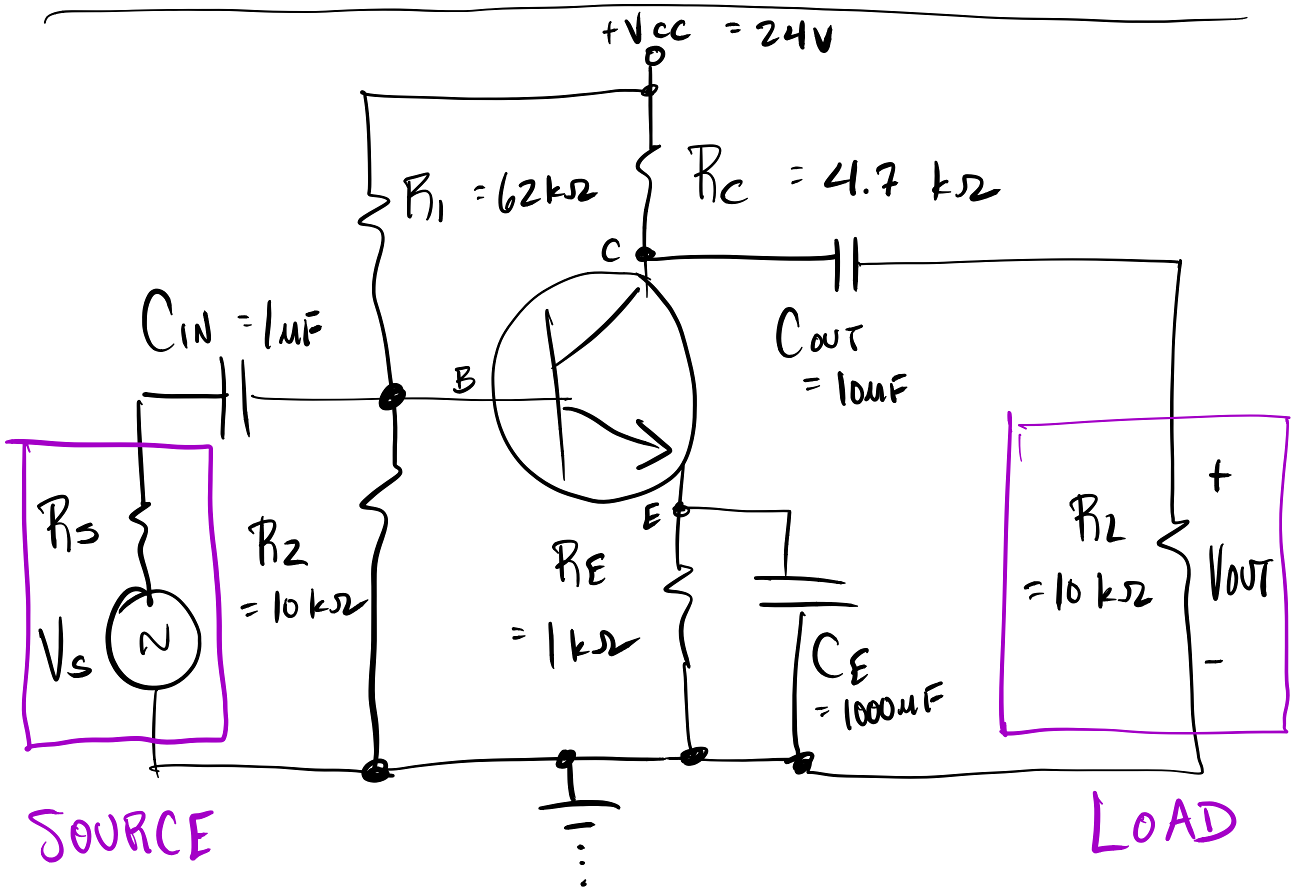
Common-Emitter Voltage Amplifier



Common emitter: because the large capacitor C_E has a sufficiently low impedance at most frequencies that the emitter is effectively <u>grounded</u> for AC signals.

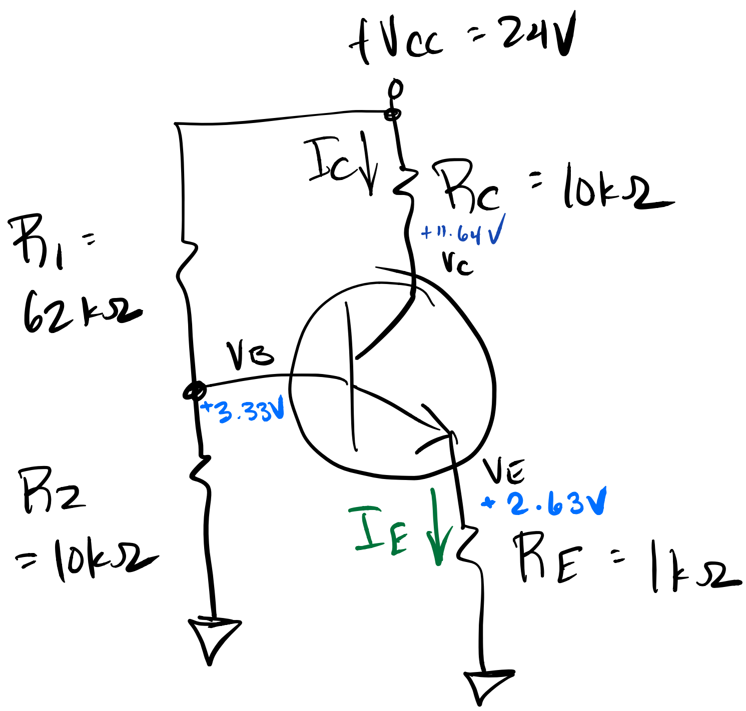
- input signal (source) is connected to the base (via C_{IN}, R_1, & R_2)
- output signal (load) emanates from the collector (via. R_C and C_{OUT})

- analyze this circuit in stages.

DC Circuit

$$Z_C = \frac{1}{j\omega C}$$

- at D.C., all three capacitors have infinite Z and therefore disappear
- redraw!



∴ assume β is "sufficiently high" that $I_B \to 0$

$$\therefore V_B = V_{CC}\left[\frac{R_2}{R_1 + R_2}\right]$$

$$= 24\left[\frac{10}{10 + 62}\right]$$

$$V_B = 3.33\ ✓$$

∴ for NPN Si transistor, ON and operating in active region: $V_{BE} = 0.7\,V$

∴ $V_{BE} = V_B - V_E$

$\longrightarrow V_E = V_B - 0.7$

$= 3.33 - 0.7$

$V_E = 2.63\,V$

∴ then $I_E = \dfrac{V_E}{R_E} = \dfrac{2.63}{1k} = 2.63\,mA$

∴ "high β" means $I_C = I_E = 2.63\,mA$

$V_C = V_{CC} - I_C R_C$

$= 24 - 2.63\cancel{m} \cdot 4.7\cancel{k}$

$V_C = 11.64\,V$

∴ finally, we need V_{CE};

$$V_{CE} = V_C - V_E$$
$$= 11.64 - 2.63 \cong 9V$$

$$I_C = 2.63\,mA$$
$$V_{CE} = 9V$$

quiescent or operating point

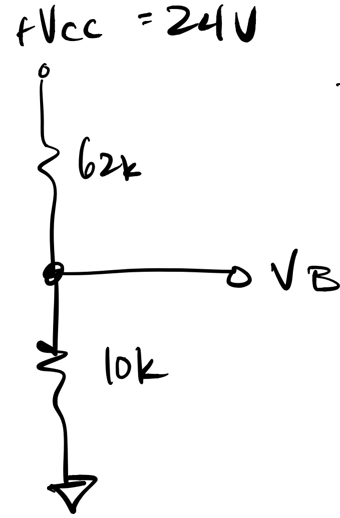
↓

"idle", meaning not 'wiggling' (yet)

∴ to ensure "wiggle room" when applying the AC signal we wish to amplify, V_{CE} shouldn't be too close to either V_{CC} nor ground

∴ also good to ensure $R_e < \frac{1}{2} R_L$

- Check "high-β" assumption!
  - current in input voltage divider:



$$I_{divide} = \frac{24\text{ V}}{10k + 62k}$$

$$= \underline{0.333 \text{ mA}}$$

- say $\beta = 200$;

then $I_B = \frac{I_C}{\beta} \approx \frac{2.63}{200} = 0.01315 \text{ mA}$

$I_{divide} > 25\, I_B$

$\therefore$ yes, we can ignore base current!

- we're done w/ D.C. analysis, nothing new here!

Mid-Frequency AC Circuit

∴ the purpose of C_E is to "ground" the emitter at "most" frequencies

∴ the purpose of C_{IN} is to protect V_S from the 3.33V needed at the base of the transistor to get it into the active region!

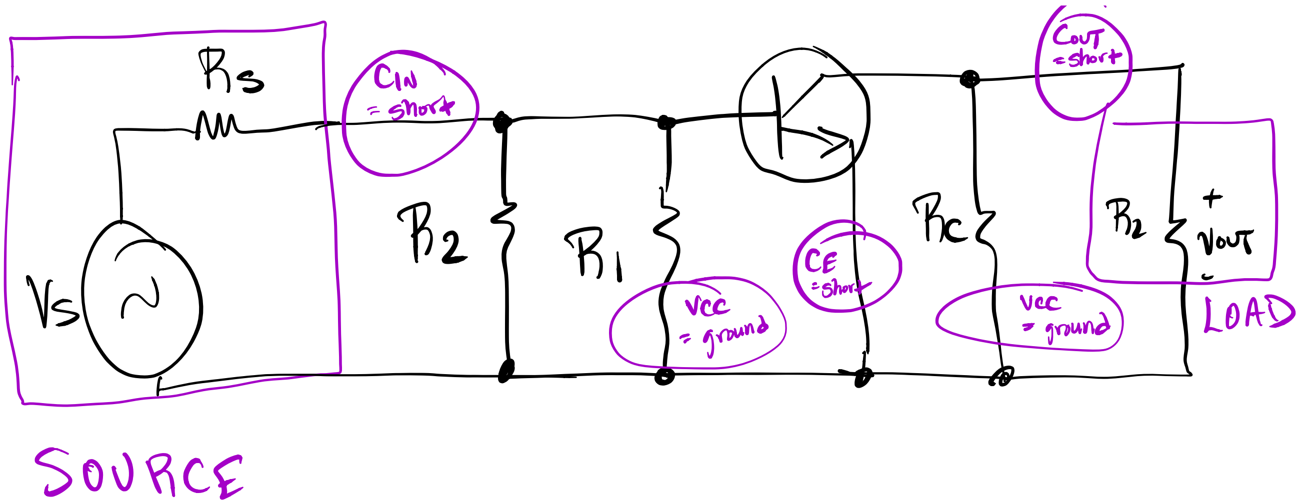
∴ often called "bias" voltage

∴ ...but still get "useful" frequencies through

∴ the purpose of C_{OUT} is to protect the load from the 11.64V collector voltage, but get the "useful" frequencies into it

∴ a "perfect" power supply looks like "ground" for all AC signals!!! All DC, no wiggling allowed!!!

∴ at "middle" frequencies, the circuit looks like this:



∴ the next thing we want to know:
the mid-frequency AC gain of the circuit