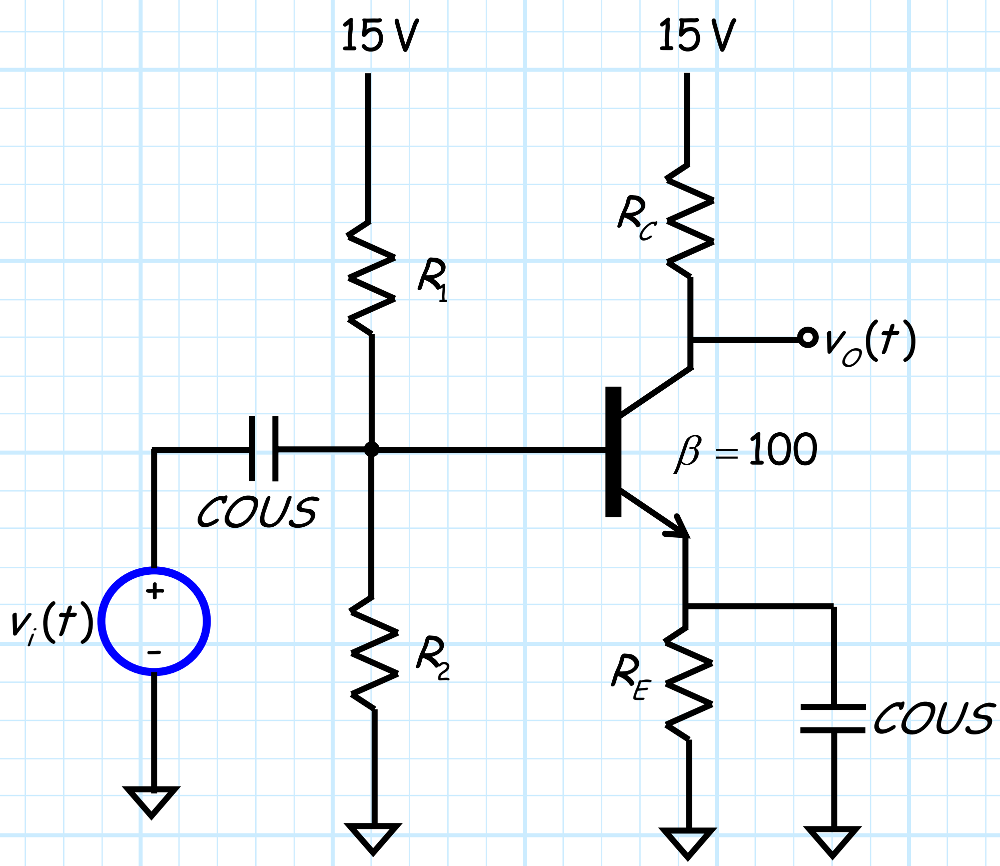
Example: Single-Supply DC Bias

Consider this small-signal amplifier:

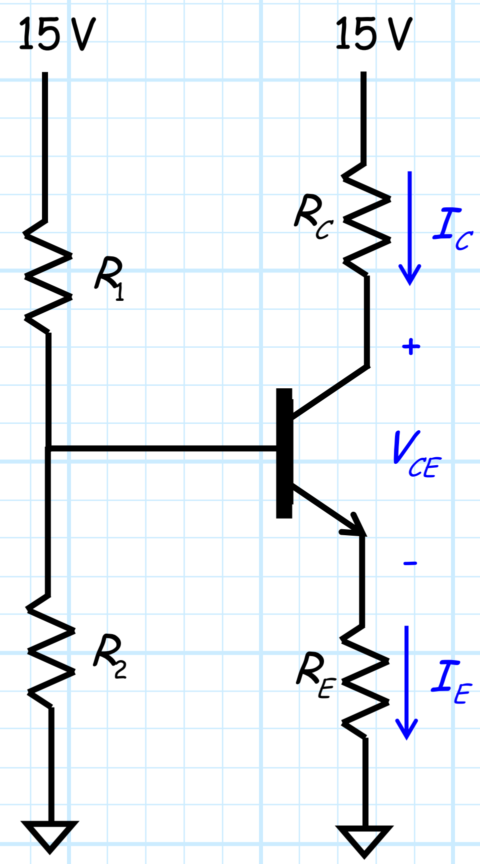


Say we decide that the **DC collector current** should be $I_C = 5\text{mA}$.

Let's find the **resistor** values for R_1, R_2, R_C and R_E that properly **bias** this amplifier!

Step 1: *Write the DC Circuit Schematic*

After all, we are designing the **DC** bias!



Step 2: *Enforce the design goals for V_E and V_C*

Recall that our DC bias "rule-of -thumb" was to divide the V_{CC} voltage into "thirds" so that:

$$V_E = V_{CC}/3 = 5.0 \quad V$$

and

$$V_C = 2V_{CC}/3 = 10.0 \quad V$$

Since we want $I_C = 5\,mA$, we find that the **collector resistor** must be:

$$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{15 - 10}{5} = 1K$$

Likewise, the **emitter resistor** is:

$$R_E = \frac{V_E}{I_E} = \frac{\alpha}{I_C} V_E = \frac{5.0}{5.05} = 0.99K \cong 1K$$

Step 3: *Choose I_1 and find R_1 and R_2*

Recall our "**rule-of-thumb**" for the current I_1 is:

$$0.1\, I_C < I_1 < I_C$$

Let's pick a value in the middle, i.e.:

$$I_1 = 0.5\, I_C = 2.5\,mA$$

Since we know that that the **base voltage** is approximately:

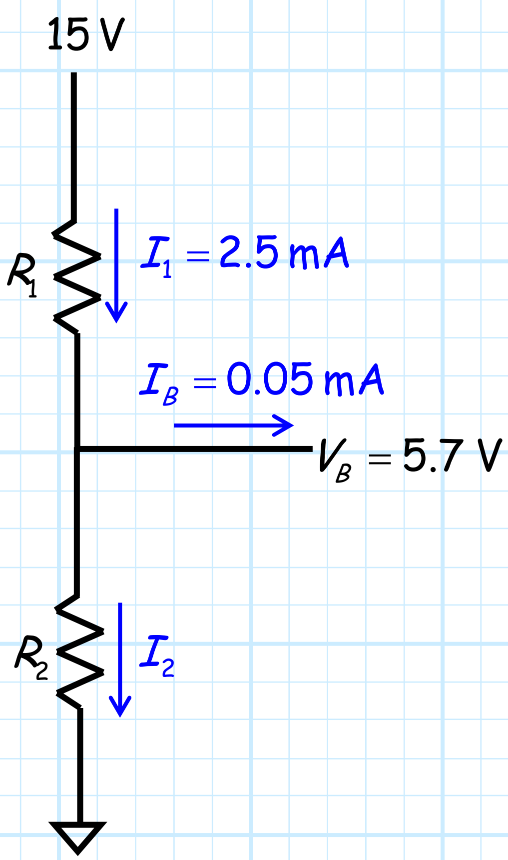
$$V_B \approx 0.7 + V_E = 5.7\text{ V}$$

and we know that the **base current** is:

$$I_B = \frac{I_C}{\beta} = \frac{5.0}{100} = 0.05\text{ mA}$$

we can thus determine resistor R_1:

$$R_1 = \frac{15.0 - V_B}{I_1} = \frac{15.0 - 5.7}{2.5} = 3.72\text{ K}$$



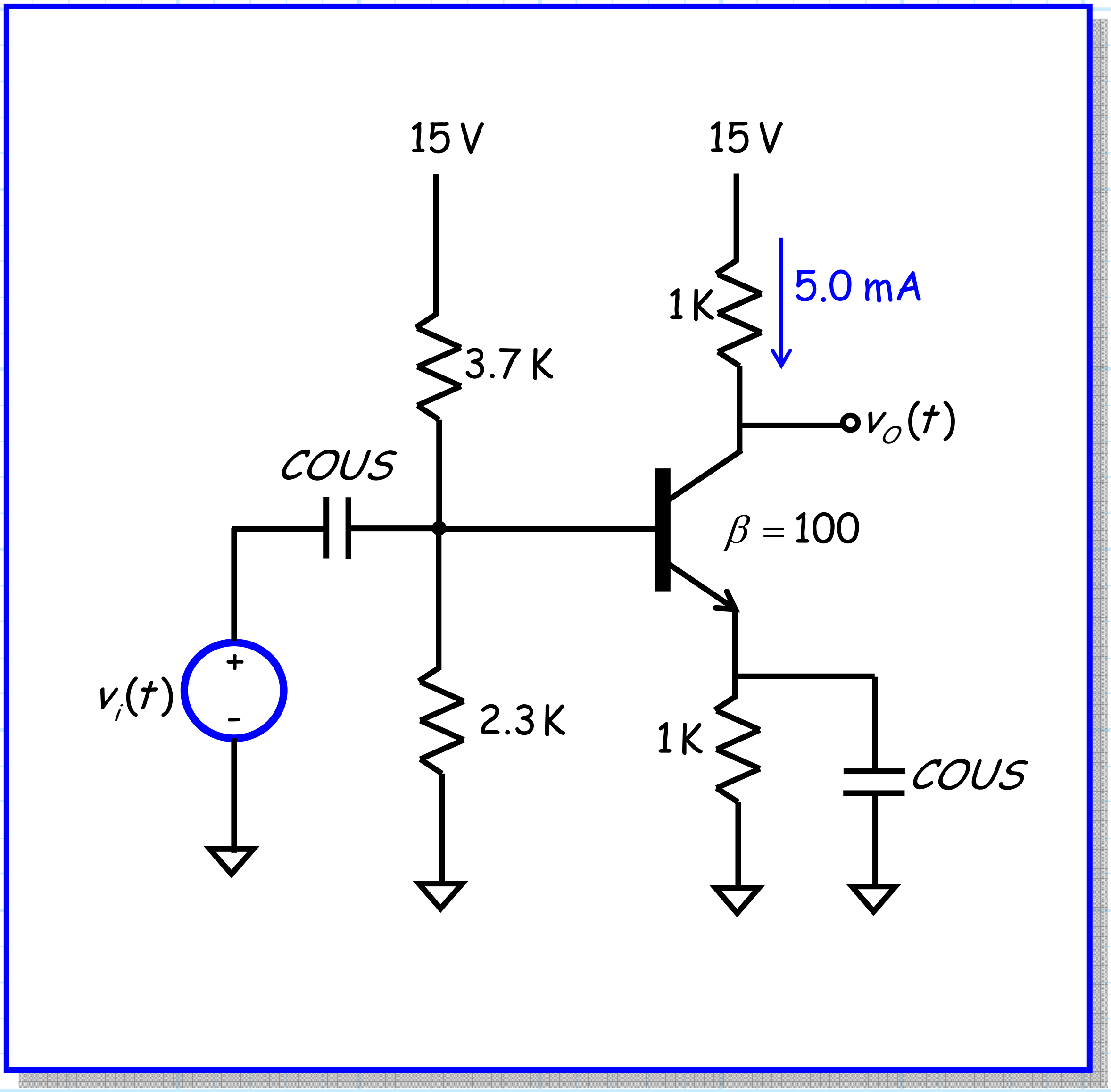
Likewise, since we know that the current I_2 is:

$$I_2 = I_1 - I_B = 2.5 - 0.05 \approx 2.5\text{ mA}$$

we can find the second resistor R_2:

$$R_2 = \frac{V_B}{I_2} = \frac{5.7}{2.5} = 2.28\text{ K}$$

Therefore, our completed **amplifier design** is:


15 V
15 V
3.7 K
1 K
5.0 mA
$v_o(t)$
COUS
$\beta = 100$
$v_i(t)$
+
-
2.3 K
1 K
COUS