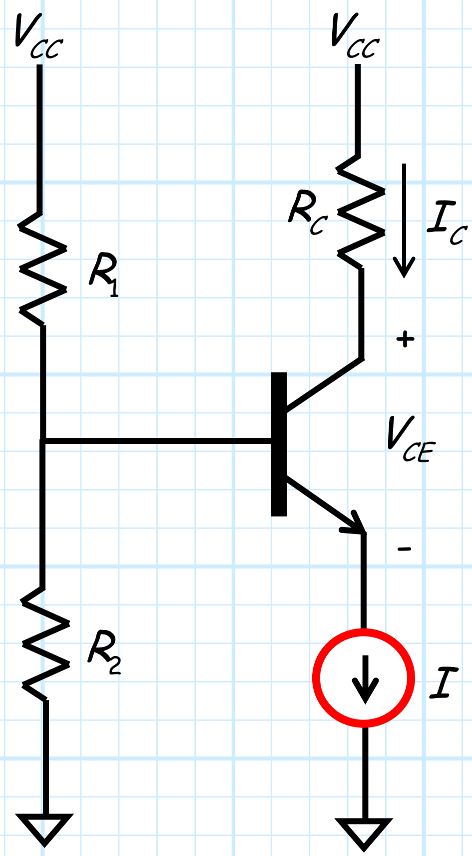
BJT Biasing using a Current Source

Another way to bias a BJT small signal amplifier is to use one voltage source and one **current source**. This biasing scheme has a number of **important advantages**:



1. The DC emitter current is **independent** of β or BJT temperature!

Therefore, the DC collector current $I_C = \alpha\, I_E \approx I_E$ is nearly independent of these parameters as well.

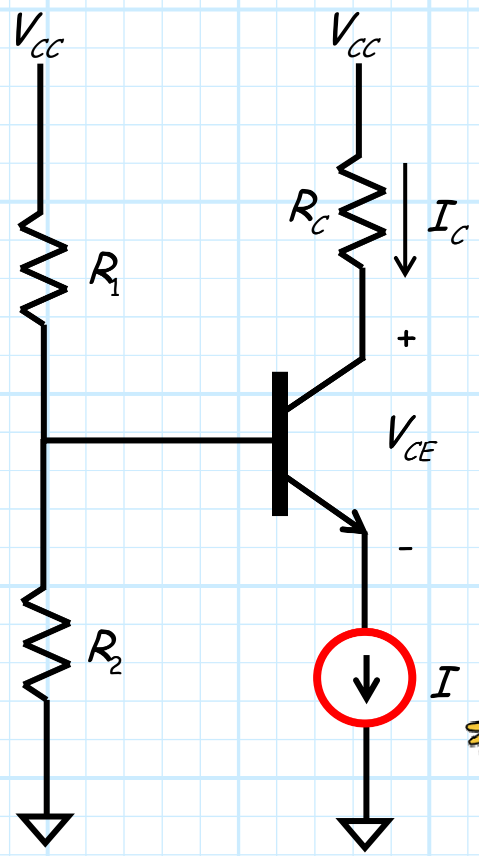
2. This means that the **emitter voltage** can be set at an arbitrarily low value!

Therefore, the output voltage swing can be much **larger** than an equivalent single-supply amplifier!

3. We can make resistors R_1 and R_2 **large** without making design sensitive to temperature and β.

The current source: not as easy as it appears

Note that **ideally**, we would set the emitter votage to **zero** ($V_E = 0$), and thus the collector voltage to $V_C = V_{CC}/2$ to **maximize** the output swing (i.e., maximize the largest possible **undistorted** output signal).



Q: *But, isn't it diddly darn difficult to actually build an **ideal** current source!?*

A: True! For reasons we shall study later, most current sources require a **minimum voltage** across them in order to operate properly.

Put collector voltage half way between floor and ceiling

Thus, our **bias rule** should be:

Make the DC emitter voltage V_E as ***small*** *as possible (and still have the current source work!).*

Then set the **current source** to a value equal to the desired DC collector current (i.e., $I_C \approx I_E$):

$$I = I_E \approx I_C$$

To maximize the output voltage swing, we still want to place the DC collector voltage V_C **half way** between V_{CC} and V_E.

$$V_C = \frac{V_{CC} + V_E}{2}$$

The **collector resistor** therefore should be:

$$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{V_{CC} - V_C}{I} = \frac{V_{CC} - V_E}{2I}$$

R_1 and R_2: same as before

The remaining resistors R_1 and R_2 are determined in the **same** manner as with the single-supply bias design, i.e.:

$$R_1 = \frac{V_{CC} - V_B}{I_1}$$

and

$$R_2 = \frac{V_B}{I_2} \approx \frac{V_B}{I_1}$$

where the base voltage is approximately:

$$V_B = 0.7 + V_E$$

and the current I_1 is any value in the range:

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

Just the kind of subtle topic I might put on an exam

For **example**, say we wish to design a biasing network where:

$$I_C = 2\,mA \qquad V_E \geq 2.0\,V \qquad V_{CC} = 15.0\,V \qquad I_1 = 0.5\,I_C$$

The result would be: