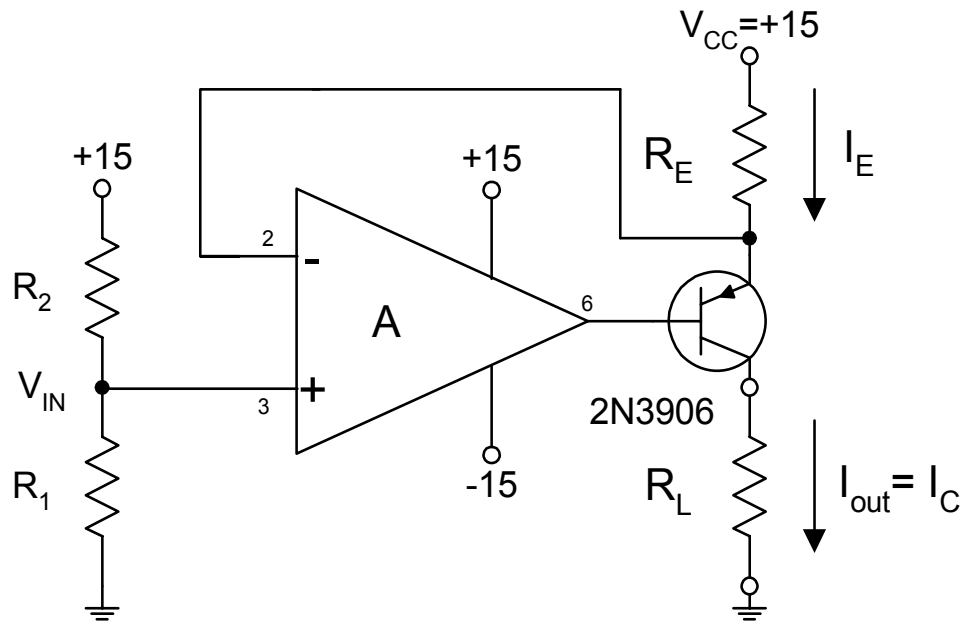# VOLTAGE-CONTROLLED CURRENT SOURCE
[VCCS]

1. Feedback forces $[+15V - V_{IN}]$ across R_E, because V_+ must equal V_-

2. If we ignore any offset voltage at the output of the op-amp, the only error comes from the emitter current not quite being equal to the collector current [due to I_B]. One can use a Darlington transistor or a JFET to reduce or remove this error.

3. This version of the VCCS does not work if V_{IN} is an external voltage not referenced to V_{CC}.

4. Example: $R_E = 100\Omega$, $\beta_F = 100$, $V_{IN} = 5$ V, 10 V, and 14 V:

   $[15V-5V] / 100\Omega = 100$ mA for I_E; $I_C = 99$ mA.

   $[15V-10V] / 100\Omega = 50$ mA for I_E; $I_C = 49.5$ mA.

   $[15V-14V] / 100\Omega = 10$ mA for I_E; $I_C = 9.9$ mA.

5. $R_1 - R_2$ can of course be a potentiometer for ease of adjustment!