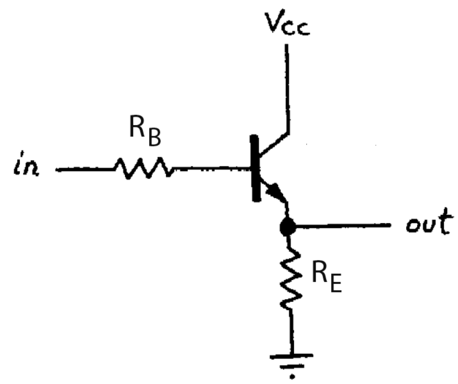
**Physics 120 - David Kleinfeld Spring 2016**

**Sketch of the emitter-follower, a unity gain impedance buffer**




This circuit can be understood by applying Kirchhoff's voltage law to the left-hand loop. We have:

$-V_{in} + I_B R_B + V_{BE} + I_E R_E = 0.$

In the linear regime, $I_E = (1+\beta) I_B$ so:

$V_{out} = I_E R_E = (V_{in} - V_{BE})\, R_E / [R_E + R_B / (1+\beta)] \approx V_{in} - V_{BE}$

since $\beta >> 1$. To within an offset of $V_{BE}$, the magnitude of output is the same as the input.

The input resistance, found by opening the dependent current source Ic and shorting the voltage drop $V_{BE}$, is just:

$R_{in} = V_B / I_B = I_E R_E / I_B = (1+\beta) R_E.$

So we see that the emitter-follower functions as a high impedance input.

The output resistance, found similarly by opening the dependent current source Ic and shorting the voltage sources $V_{BE}$ and $V_{in}$, is just

$R_{out} = V_E / I_E = I_B R_B / I_E = R_B / (1+\beta).$

This is just the resistance of the source divided by the gain.

Both relations generalize to

$Z_{in} = (1+\beta) Z_E$ and $Z_{out} = Z_{source} / (1+\beta).$