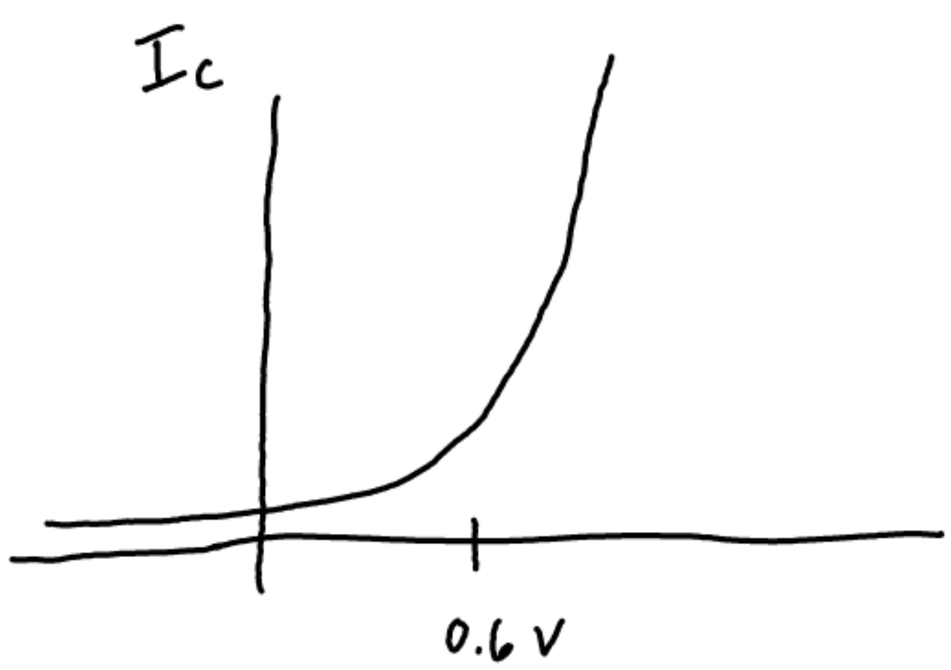
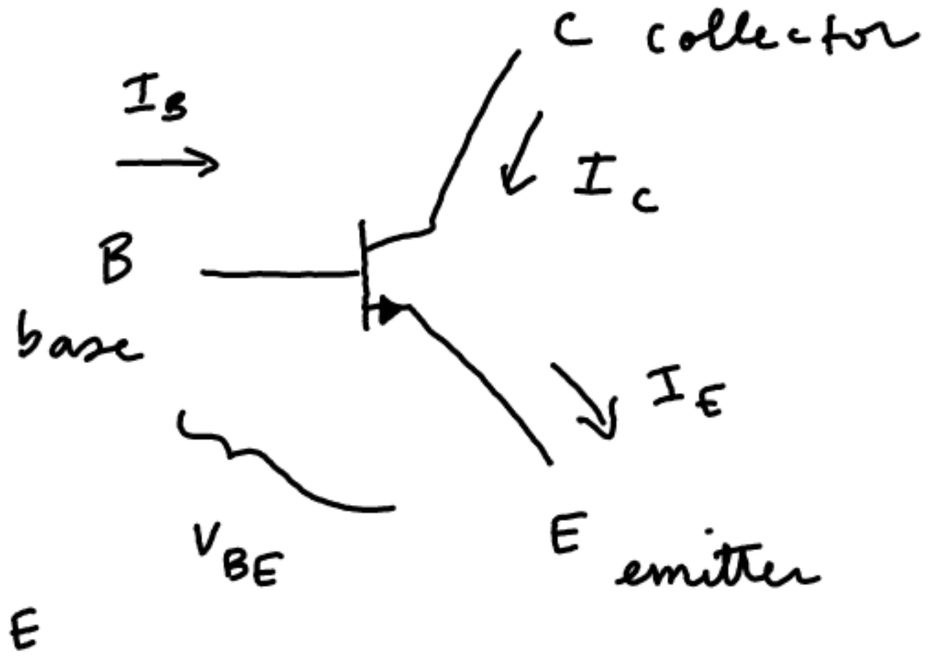
Transistors

Bipolar - junction

Transistors behave a lot like diodes,

but with one key difference:





the base voltage controls the current

through a different terminal of the device!

result: current-controlled current valve

I_B is some small non-zero signal

$I_C \sim 100\, I_B$

current flows between E and C $\underline{\text{IF}}$ $V_{BE} > 0.6\,V$

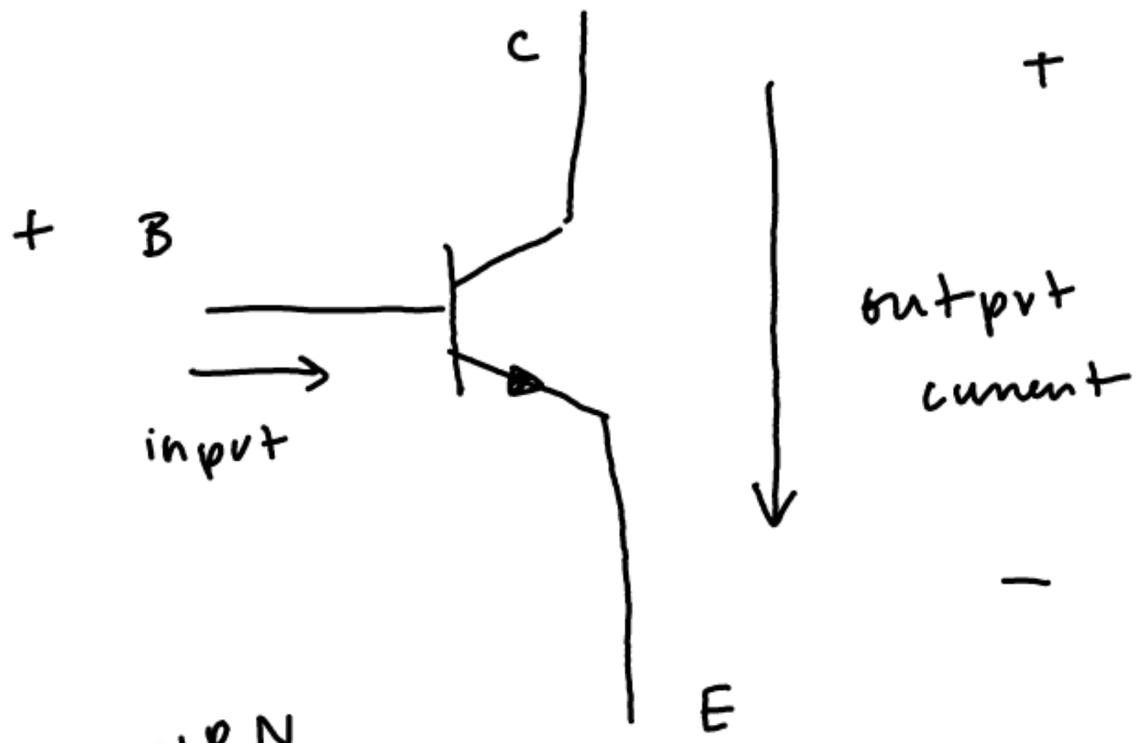
↖ controlled by B

one-direction only: shown by arrow

npn C → E

pnp E → C

Simple Model for BJT



NPN

IF $V_{CE} \geq 0.2V$

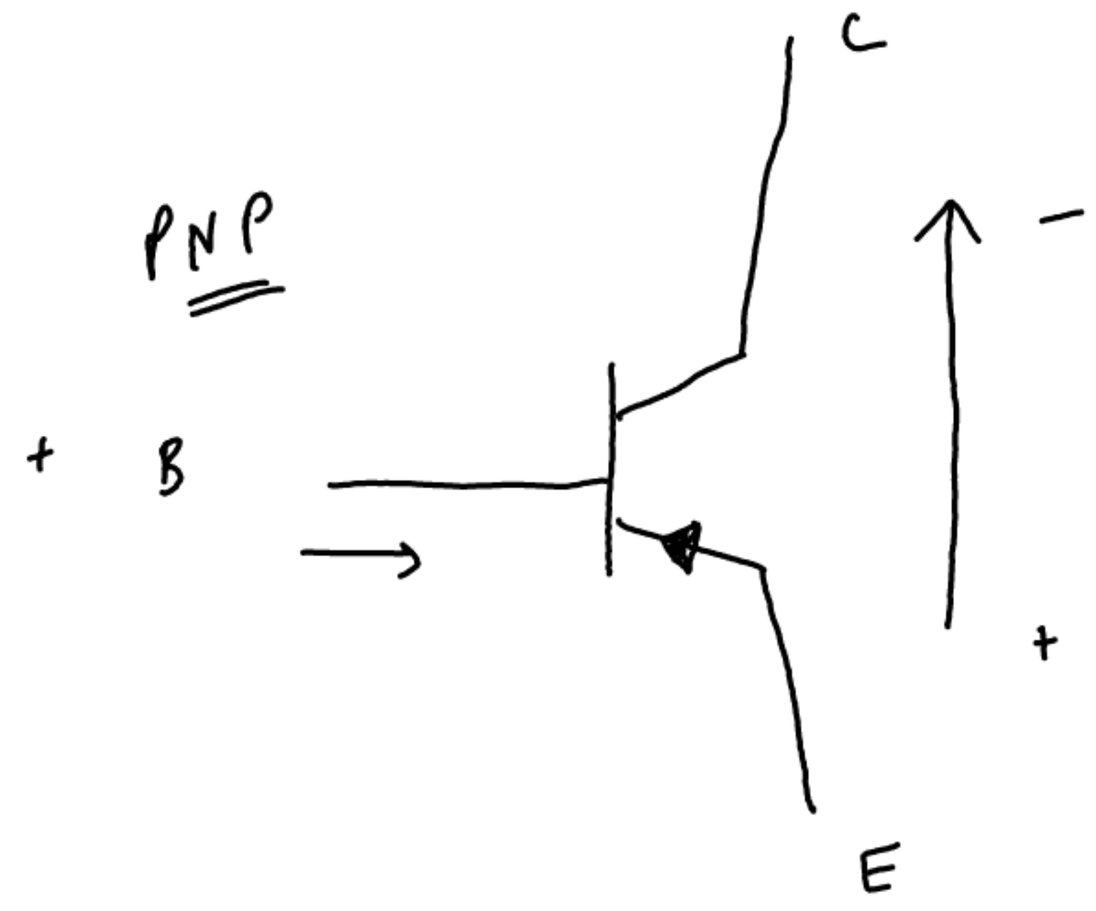
AND $V_{BE} \sim 0.6V$

then $I_c \sim I_E$

$I_E = I_c + I_B$

$= I_c + \frac{I_c}{100} \sim I_c$

Voltage at emitter is always ~0.6 V lower than voltage at base for current to flow



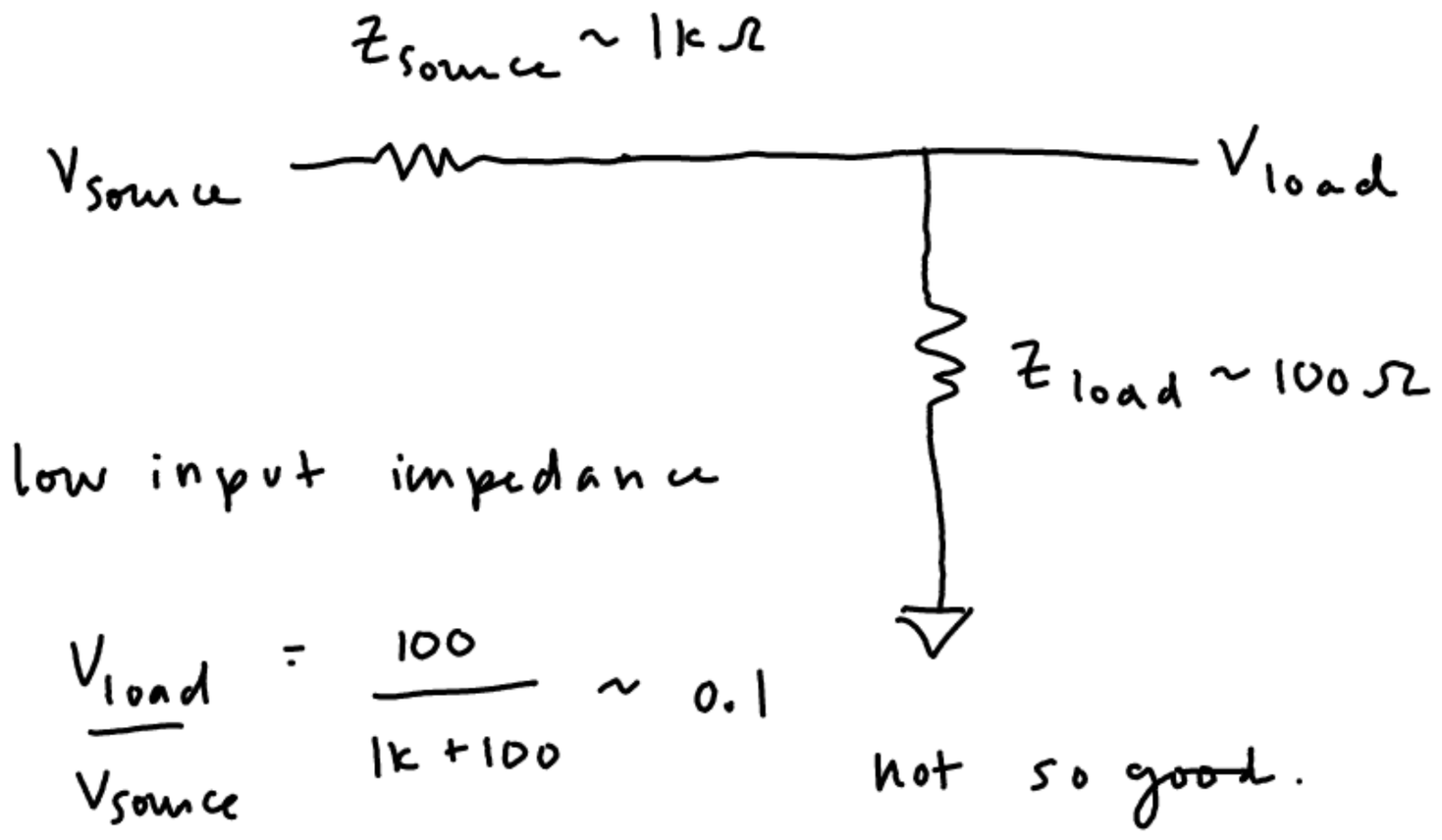
voltage at emitter is ~0.6V higher than at base for current to flow

Utility: output current is not limited by input current

↓

effective super high input impedance

example:



low input impedance

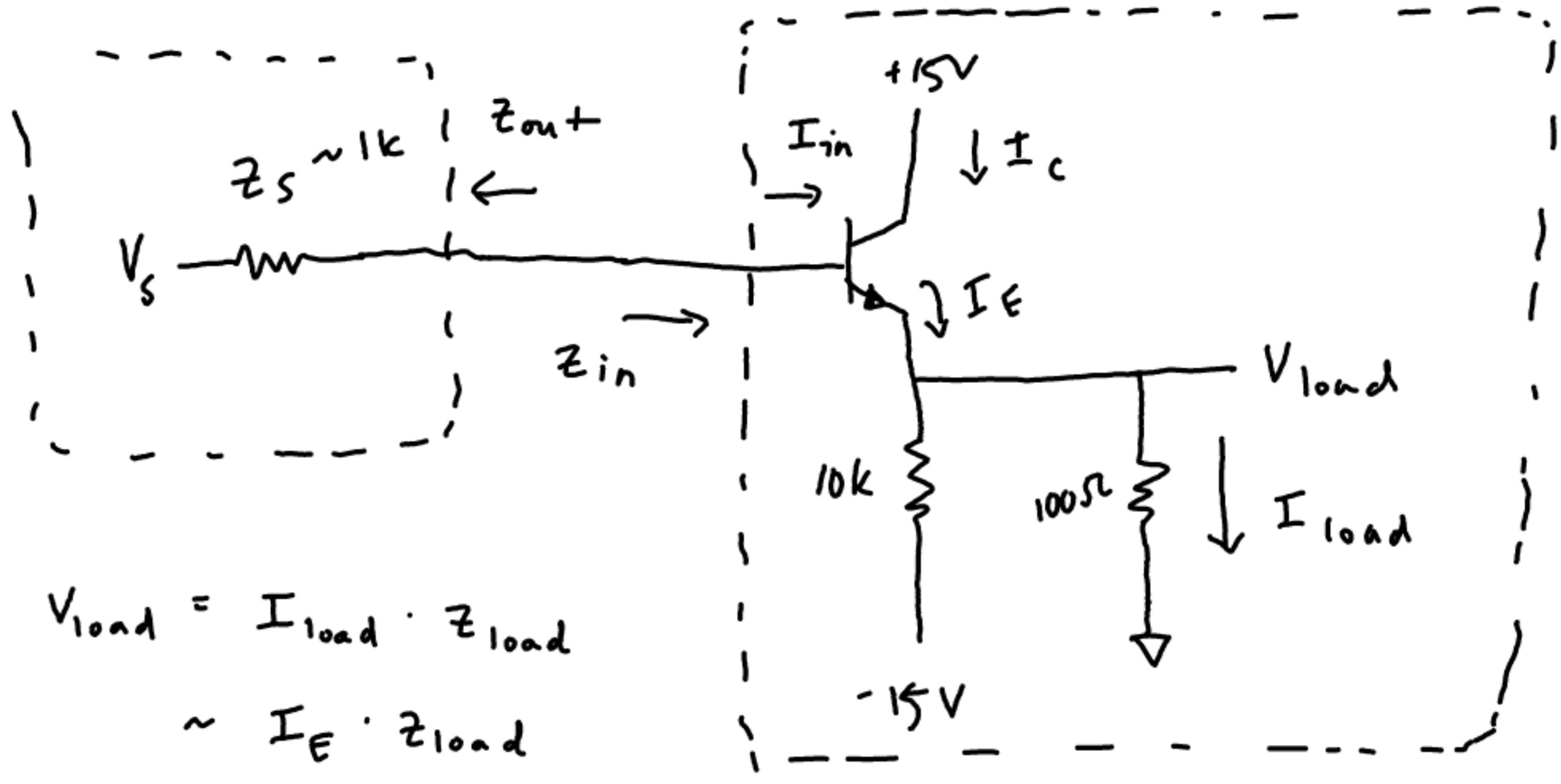
$$\frac{V_{load}}{V_{source}} = \frac{100}{1k+100} \sim 0.1$$

not so good.

Adding a transistor will improve both

Z_{in} and Z_{out}

Improve z_{in}:



$$V_{load} = I_{load} \cdot z_{load}$$

$$\sim I_E \cdot z_{load}$$

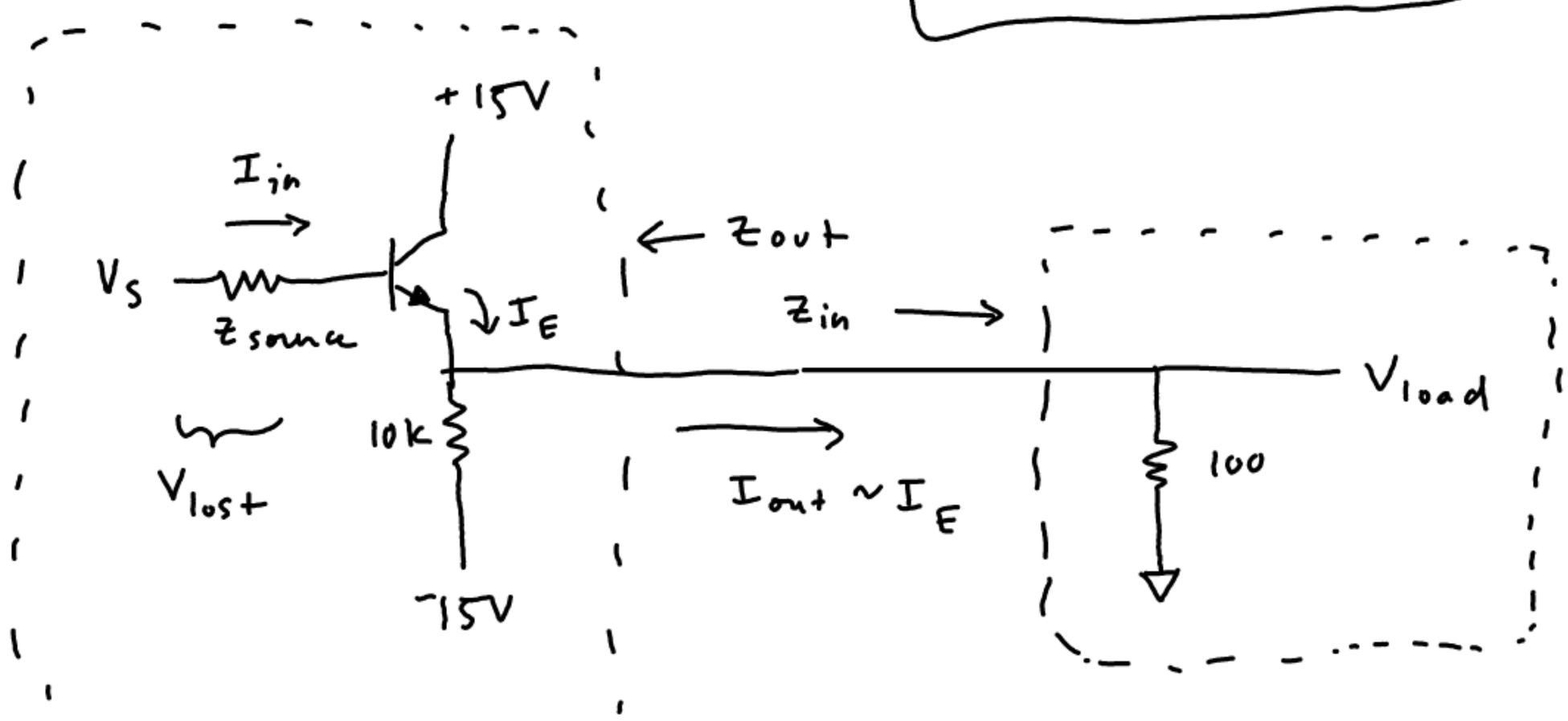
$$= \beta I_{in} \cdot z_{load}$$

$$z_{in} = \frac{V_{load}}{I_{in}} = \frac{\beta I_{in} z_{load}}{I_{in}} = \beta z_{load}$$

$\beta \approx 100$ so that's a big improvement!

Improve z_{out}

* emitter-follower



input voltage drops over z_{source}

$$V_{lost} = I_B z_{source}$$

$$= \frac{I_{out}}{\beta} z_{source} \rightarrow z_{out} = \frac{V_{lost}}{I_{out}} = z_{source}/\beta$$