LECTURE 15

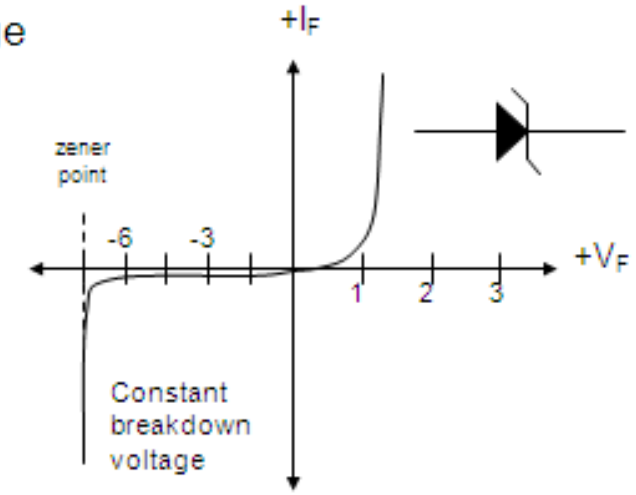
-Zener Diode

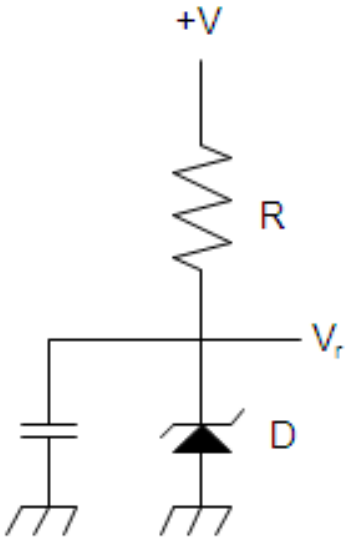
Topics to be covered

- Zener Diode
- Transistor

The Zener Diode

The zener diode exhibits a constant voltage drop when sufficiently reversed-biased. This property allows the use of the zener diode as a simple voltage regulator.



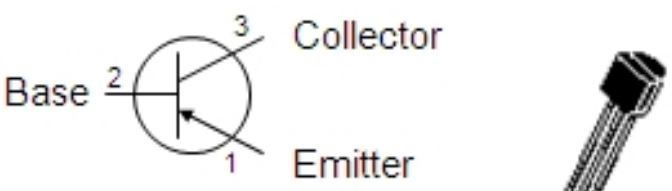


Here, V_r will be equal to the reverse breakdown voltage of the zener diode and should be constant. What is the purpose of the resistor in this circuit? Its job is to limit the current flowing through the zener diode:

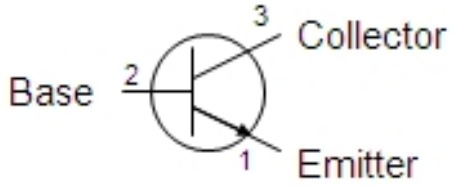
$$I = \frac{V - V_r}{R}$$

The Bipolar Junction Transistor

The transistor is a versatile device usually configured to perform as a switch or as an amplifier. The bipolar junction transistor (BJT) is the most common type and has three leads:



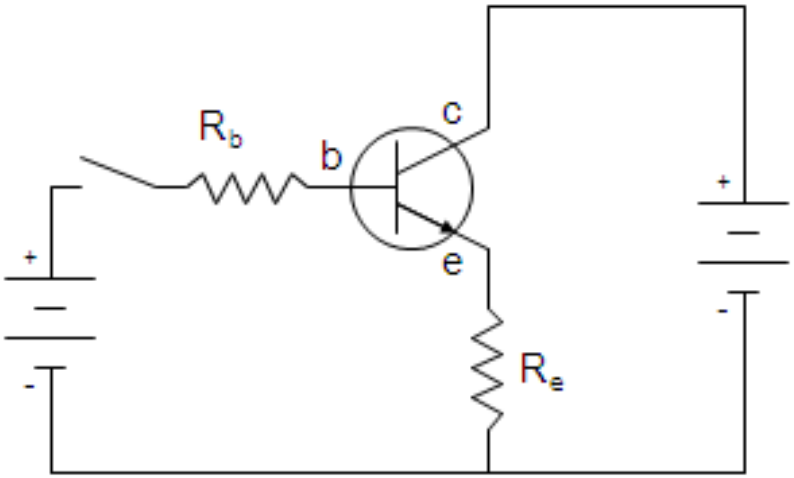
PNP Transistor



NPN Transistor

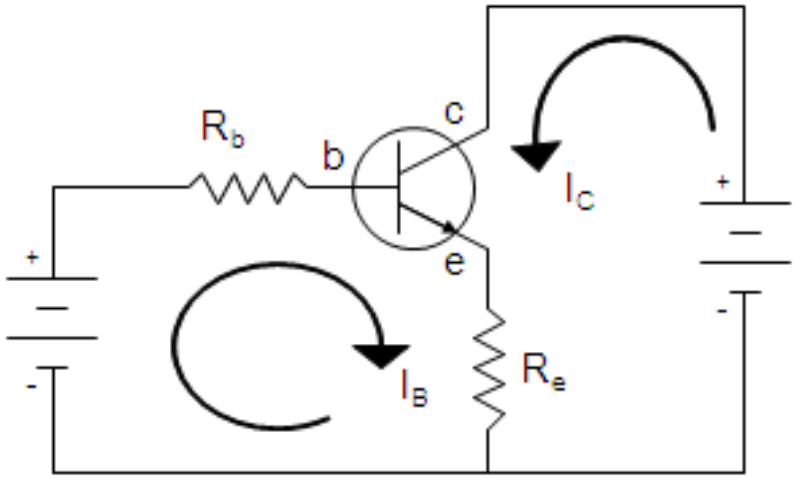
In a transistor, the flow of current from the collector to the emitter is controlled by the amount of current flowing into the base of the transistor. If no current flows into the base, no current will flow from the collector to the emitter (it acts like an open switch). If current flows into the base, then a proportional amount of current flows from the collector to the emitter (somewhat like a closed switch).

The NPN Transistor



No current flows from base to emitter, so the transistor acts like an open switch and no current flows from collector to emitter.

(Note: current never flows from base to collector or vice versa, regardless of the base current.)



Current now flows through the transistor from base to emitter. This causes the transistor to allow current to flow from the collector to the emitter. The size of the collector current depends on the size of the base current and the beta β of the transistor:

$$\beta = I_C / I_B$$

A typical transistor has a beta of about 100.

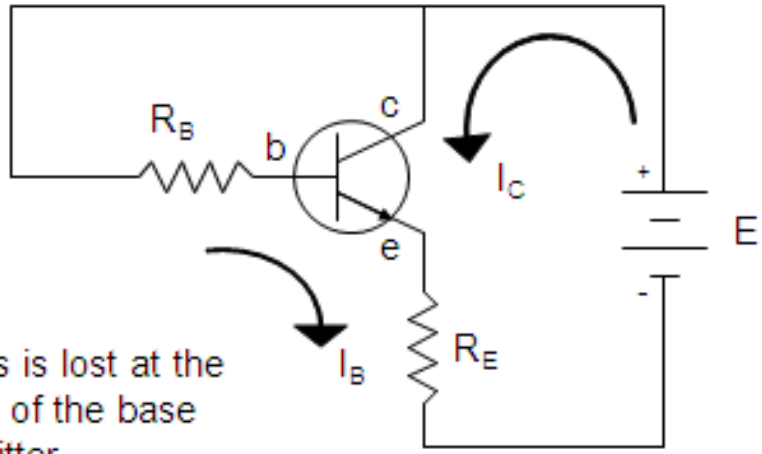
Base and Collector Currents

What's the base current I_B? Use Kirchhoff's voltage law:

$$E = I_B R_B + I_B R_E + 0.7\text{V}$$

$$E = I_B (R_B + R_E) + 0.7\text{V}$$

$$I_B = \frac{E - 0.7\text{V}}{R_B + R_E}$$



0.7 volts is lost at the junction of the base and emitter

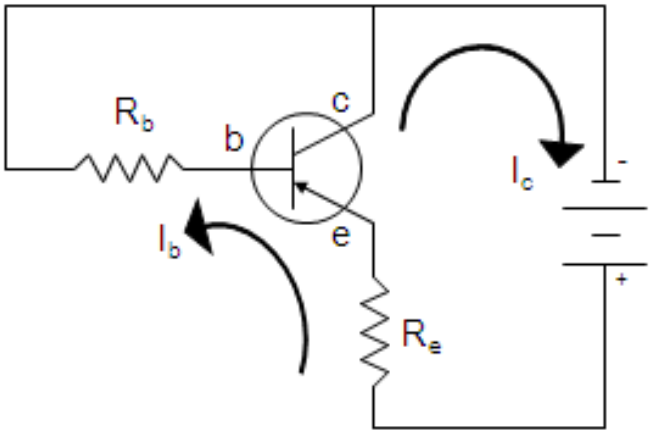
Now find the collector current I_C:

$$I_C = \beta \cdot I_B$$

What's the maximum value for the collector current?

$$I_C = \frac{E}{R_E}$$

The PNP Transistor



The PNP transistor behaves identically to the NPN transistor, except that all polarities are reversed. The voltages are applied with opposite polarity, and the currents run opposite to those in the NPN transistor, but all other behaviors are the same.