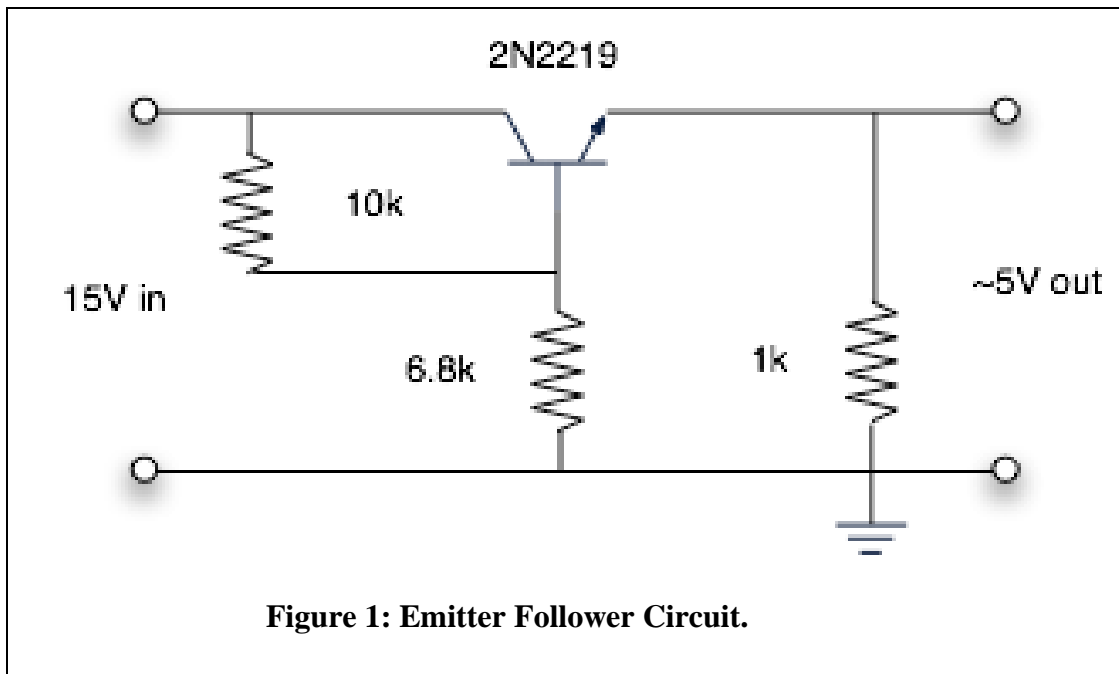


## **Bipolar Transistors II**

Transistor circuits can be used to obtain stable sources of constant voltage. The following sections trace the development of a simple voltage source using a single transistor. Items marked with an asterisk (\*) should be done before coming to lab.

### **The pass transistor**

Build the emitter follower circuit below, called the “pass-transistor” circuit.

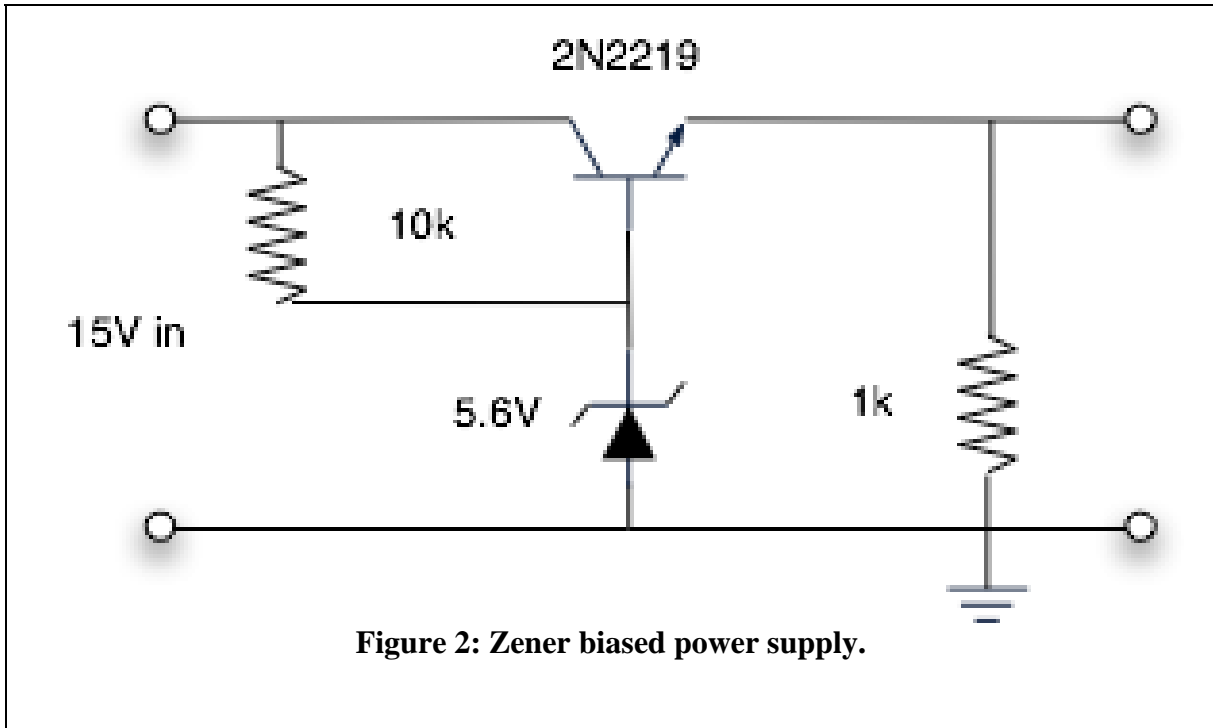


- (a) \*Calculate the output impedance. Assume  $\beta=200$ . (Hint: It is approximately equal to the output impedance of the circuit that supplies the base current divided by  $\beta$ .)
- (b) Measure the output impedance by finding the change in voltage when the circuit is loaded by 150 ohms.
- (c) Reduce the input voltage from 15 volts to 10 volts, a 33% change. What is the percentage change in the output voltage?

### **The Zener-regulated pass transistor**

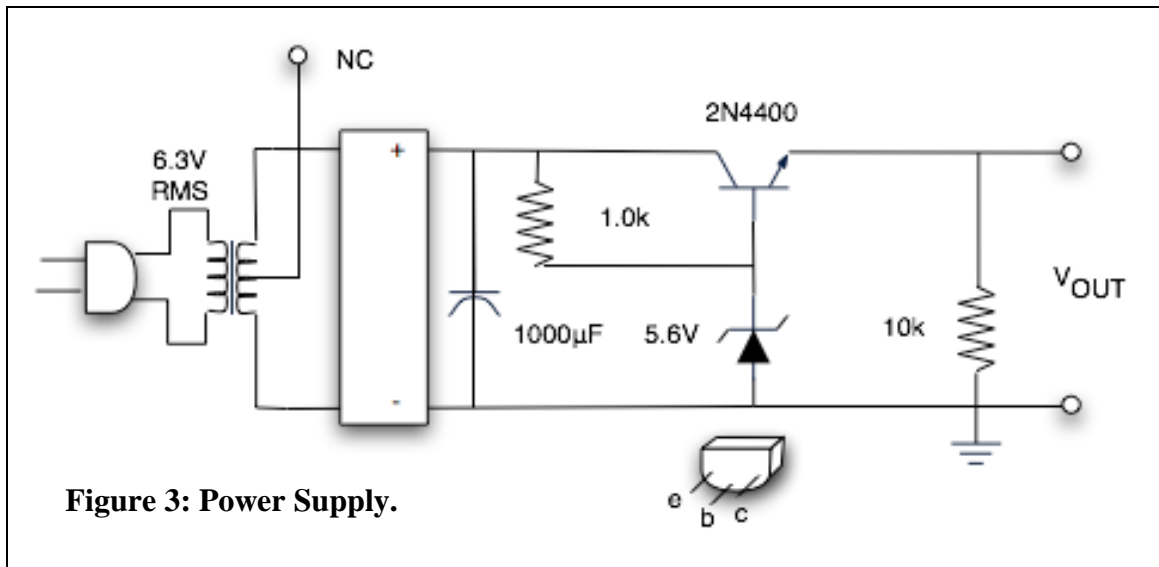
Replace the 6.8k resistor by a reverse-biased 5.6 volt Zener diode (Fig. 2).

- (a) Measure the output impedance as above.
- (b) Find the change in output voltage when the input voltage changes from 15 to 10 volts.



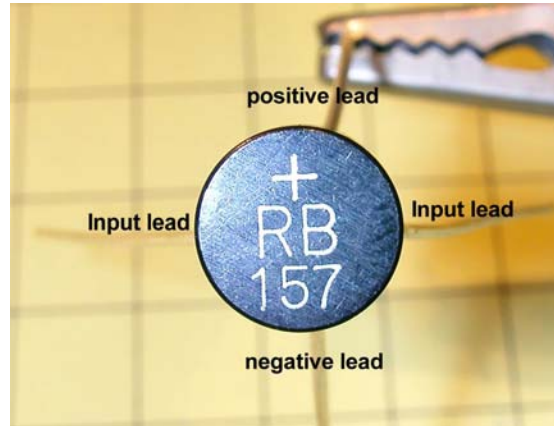
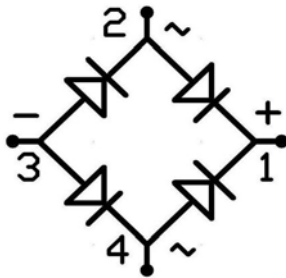
**Construction of a power supply**

On a piece of perforated board solder together the following circuit:



The rectangular box refers to the full-wave rectifier WL02F (alternatively RB152) and “NC” means no connections to the center tap on the transformer. The output should be about 5 volts. *Note:* A commercial full-wave rectifier bridge has 4 leads, two for AC

inputs (opposite of each other unless otherwise marked) and two for DC outputs (+ and – opposite of each other unless otherwise marked).

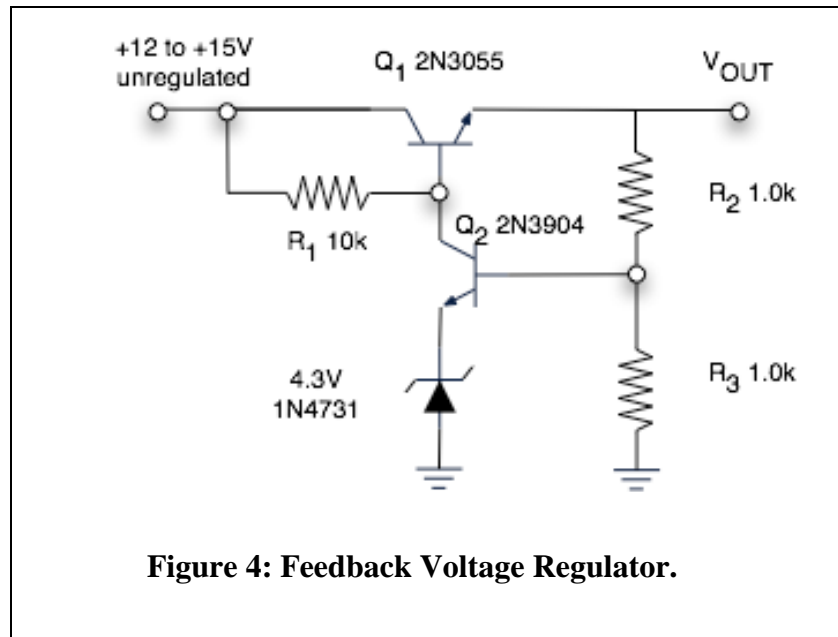


At times polarity of components may be marked with the length of the leads: a longer lead represents '+’.

*Soldering tips:* 1) Soldered junctions (leads of components, wire ends, terminal posts, PCB pads) need to be free from any contaminants – solder rosin core and/or soldering paste serve to remove grease and oxidation. Clean the iron tip by rubbing it against a wet sponge. 2) It is advisable to tin the junctions separately by solder, before soldering them together. The tip of the iron should be kept tinned and shiny at all times. 3) When applying solder to a junction, the junction should be kept at a high temperature, just as the solder. One way to ensure that is by touching the junction, instead of the solder, with the iron tip and to melt the solder only through the heat coming from the junction. 4) Tweezers or pliers can be used to secure parts in place during soldering and to protect both the fingers and components from excessive heat.

Present the completed power supply to your instructor. Plot V vs. I for your supply by loading it. Choose several load resistors from 2k $\Omega$  to 100 $\Omega$ . As the current increases do you note any qualitative change in the curve? If yes, comment on possible reasons.

**Note:** The zener-regulated pass transistor developed in this lab is an acceptable source of stable voltage to be used when circumstances are not demanding. Transistorized power supplies with two or three transistors in a fast negative feedback circuit are used when the



load conditions are variable. These can give output impedances less than an ohm and high stability against temperature variation. Figure 4 is a common example of a negative-feedback circuit. Transistor  $Q_1$  is normally conducting because of the bias current through  $R_1$ . When the output voltage reaches 10 volts,  $Q_2$  begins to conduct, shunting current away from the base of  $Q_1$  and preventing further rise of the output voltage. \*Explain why this happens.