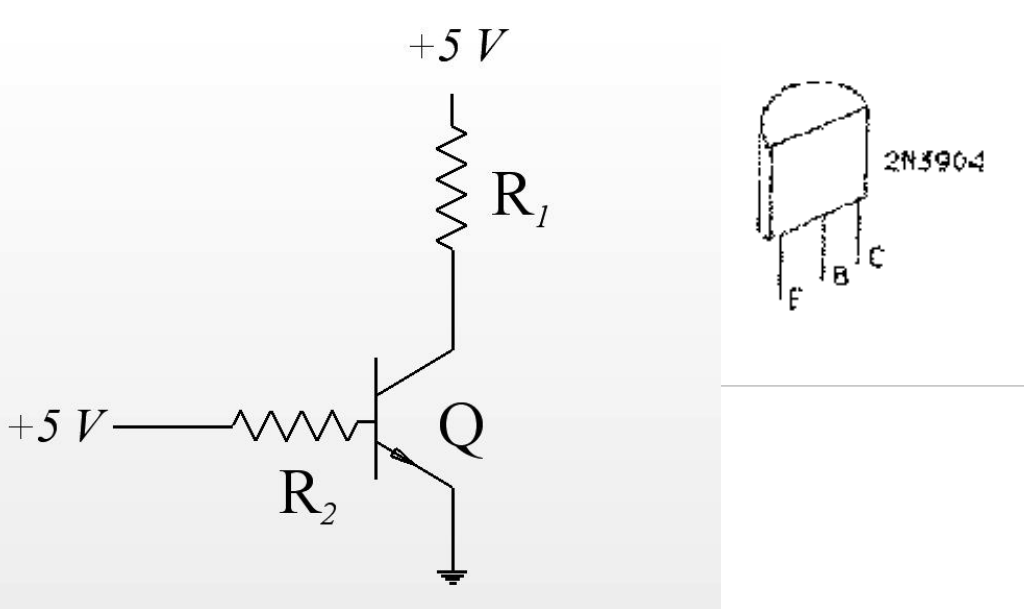


Physics 517/617 Experiment 4

Basic Experiment - Physics 517/617

1) Build the following circuit. Use a $100\ \Omega$ resistor for R_1 . Vary R_2 between $500\ \Omega$ and $50\ \text{k}\Omega$ (using a resistor box if possible). Measure V_{BE} and I_C . Determine β (h_{fe}) for each of your measurements. Plot I_B vs I_C . What is the saturation current and voltage (V_{CE})? For what values of R would this circuit make a good switch?

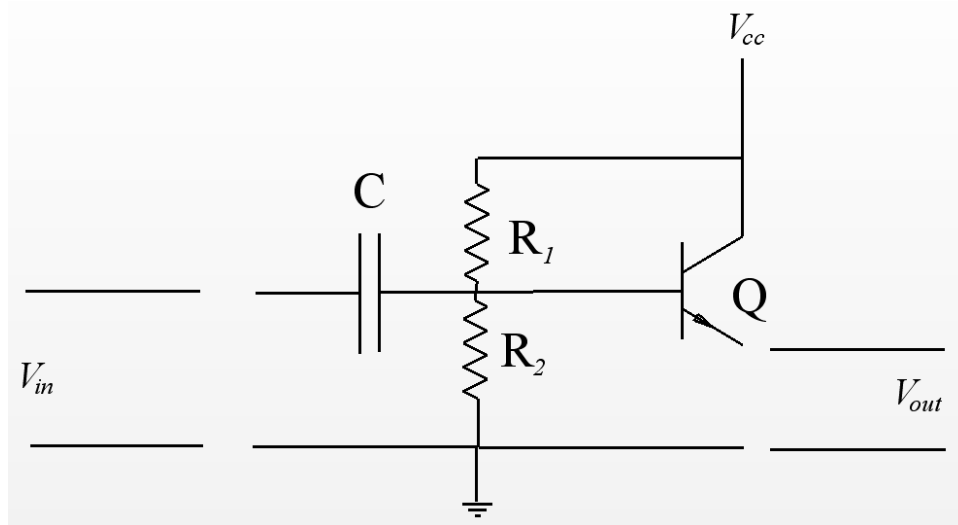


2) This project will study an emitter follower similar to that shown below (Fig. 4.57 of *Practical Electronics for Inventors*). Emitter followers allow low impedance loads to be driven by high impedance sources. Use a function generator with $600\ \Omega$ output impedance for this project. You will use this to drive a loudspeaker with nominal impedance of $8\ \Omega$. While it is disconnected from the circuit, set the function generator to produce a 1 V peak-to-peak sine wave at 1 kHz . *Don't change the function generator settings in what follows.*

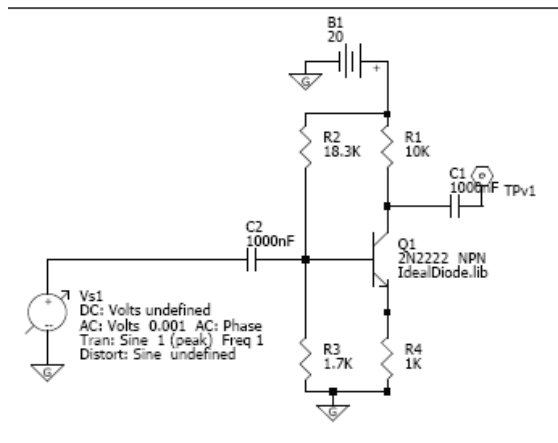
a) Hook the function generator directly to the speaker. Note the sound and measure the amplitude of the function generator output/speaker input. In your write up explain your observations.

b) Construct the emitter follower circuit below. Initially connect a small load across the output (say $1\ \text{k}\Omega$ or so). Set $V_{cc} = 5\text{ V}$. Note: ideally to minimize the load on the function generator, the current gain of the transistor, β multiplied by the impedance of the load (speaker) should be much larger than the output impedance of the drive (function generator). Also, ideally, to minimize the load on the function generator, the bias resistors should be much larger than its output impedance. On the other hand, to provide a reliable operating point, the bias resistors should be much *smaller* than β times the load impedance. For the transistor you are using β is about 100 and these conditions

require some compromising. Take $R_1 = R_2$ between $1\text{ k}\Omega$ and $2\text{ k}\Omega$. The value of the capacitor just needs to be large, $RC \gg \frac{1}{2\pi f}$. Connect the function generator to the input and measure voltages at V_{in} , V_{out} , and the base of the transistor with and without the speaker connected to the output. Use your measurements to find the output impedance of the emitter follower circuit. Study as a function of frequency.



3) Build the following single stage common emitter amplifier (with emitter degeneration).



- First build the circuit without the capacitors or sinusoidal source.
- Check the V_{BE} is .7 volts
- Add the capacitor and sinusoidal generator to your circuit.

Measure the following properties of your amplifier and compare them to what you expect theoretically:

- operating point (V_{CE} , I_C with no input signal).
- Small signal gain: make a bode plot for frequencies 100 Hz – 1 MHz
- response to large signals

In your write-up explain the biasing of the transistor and the requirements on the resistors connected to the transistor's base.

4) Add a bypass capacitor across the emitter resistor such that $RC < 1$ kHz and make bode plots of the gain and phase shift of output of the transistor. Explain the function of the bypass capacitor.

No additional work is required for Physics 617