The goal of this lab is for you to measure the frequency response of all three types of single-transistor BJT amplifiers: CE, CC, and CB. For these experiments, it will be convenient to have a scope probe attached to the input node, as well as one on each terminal of the BJT. You’ll measure the magnitude and phase at the output node relative to the input sine wave. The instructions below are meant to guide you through this process, but you may need to be a little creative to get the data that you need, especially in the high-gain frequency range. Make sure that you get at least one measurement per decade, and one measurement at each pole or zero location (where you get 45 degrees of phase shift).

Build the common emitter amplifier above, with $R_C=10k$, $R_E=1k$, $R_2=100k$, and $V_{CC}=10V$, choosing $R_1$ such that the output bias voltage is roughly 5–6V.

1. Using the oscilloscope, measure the gain (attenuation) from $v_{in}$ to $v_b$ using a 100mV amplitude sine wave.
   a. Find the frequency at which the output $v_b$ has a 45 degree phase shift from the input. How does it compare to your calculated value for $\omega_{pin}$ from the prelab? What is the gain to $v_b$ at this frequency?

   b. Vary the DC bias of $v_{in}$. Does the DC bias have any impact on the gain, phase, or pole frequency? Why or why not?

   c. Measure the gain and phase shift for an input at 10 times your measured $\omega_{pin}$, and one tenth your measured $\omega_{pin}$. At each of these frequencies, measure the gain and phase shift from $v_{in}$ to $v_e$, and measure the gain and phase shift from $v_{in}$ to $v_c$. Plot these points.

   d. Over this range of frequencies, did the gain from $v_b$ to $v_c$ remain constant? Did the gain from $v_b$ to $v_e$ remain constant? Why?

   e. Have your TA look over your results, discuss any questions that you may have, and initial.
2. For frequencies above $\omega_{pin}$ there should be a relatively flat gain of roughly -10 (magnitude 10, phase -180) from $v_{in}$ to $v_{c}$.
   a. Find the frequency at which this gain increases in magnitude by $\sqrt{2}$, and measure the magnitude and phase at that frequency, and at ten times that frequency. How does this compare to $\omega_{PE}$ that you calculated in the prelab?

   b. Find the highest gain magnitude from input to collector. To do this, you may need to put a voltage divider on the output of your function generator. Find the lowest and highest frequencies at which the gain is within $\sqrt{2}$ of your maximum gain. How close are these to your prelab calculations for $\omega_{pGM}$ and $\omega_{pout}$?

   c. Measure the magnitude and phase of the gain at $10^8$ rad/sec. Did the gain fall by as much as you would expect ($10^8/\omega_{pout}$)

Discuss your results for part 2 with your TA, and get his initials.

3. Bode plot from $v_{in}$ to $v_{c}$ (common emitter)

   ![Bode plot diagram]

   TA initials
4. Bode plot from $v_{\text{in}}$ to $v_e$. (common collector or emitter follower)
5. Common base. Now hook the input up to the emitter, and set the offset voltage on the signal generator so that your bias point is around 5—6 V. Measure the magnitude and phase of the gain to the collector and plot.