TOTAL: _____/10

ECE 651: Electronic Design II

Homework #3

Due: Monday, October 2nd, 2023

Student Name: _____

Note: Please use this as a cover page for your paper submission.

1. Build the following Common-Emitter amplifier on Multisim and simulate the circuit to find the overall voltage gain (G_v). For input signal (v_i), use a sinusoidal voltage source with a frequency of 1 kHz and a voltage amplitude of 1 mV. Choose all coupling and bypass capacitors to be 10 μF. For BJT, use the NPN silicon transistor (model: 2N2222A).

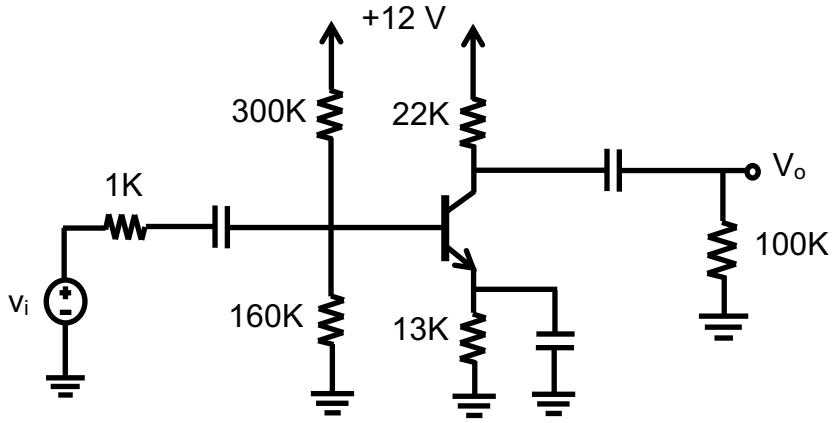


Figure 1. A Common-Emitter amplifier.

(a) Use the oscilloscope to display both input (v_i) and output (v_o) voltage waveforms. Make sure to use different colors for the plots so that the two waveforms are distinguishable. Use the waveforms to estimate the overall voltage gain ($G_v = v_o/v_i$).

(b) Use the AC sweep function to simulate the circuit with the frequency of input voltage (v_i) varying from 1 Hz to 100 MHz. Plot the gain (magnitude) of the amplifier as a function of frequency. In what frequency range is the amplifier gain the highest?

(c) What is the maximum amplitude of the input signal v_i (at 1 kHz) that can be amplified without signal distortion at the output (v_o)? Use the oscilloscope waveforms to support your answer.

2. Repeat Problem #1 for the following C-E amplifier circuit with an additional resistor at the emitter.

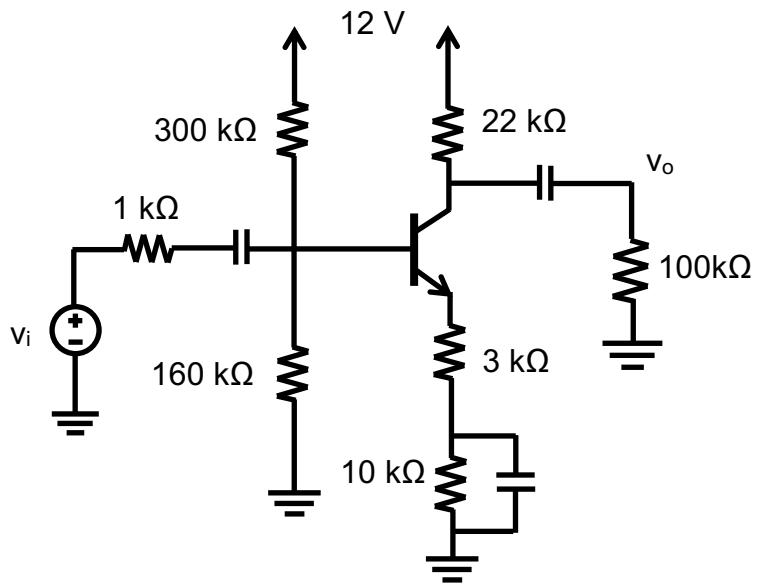


Figure 2. A C-E amplifier with an additional emitter resistor (R_e).

(a) Use the oscilloscope to display both input (v_i) and output (v_o) voltage waveforms. Make sure to use different colors for the plots so that the two waveforms are distinguishable. Use the waveforms to estimate the overall voltage gain ($G_v = v_o/v_i$).

(b) Use the AC sweep function to simulate the circuit with the frequency of input voltage (v_i) varying from 1 Hz to 100 MHz. Plot the gain (magnitude) of the amplifier as a function of frequency. In what frequency range is the amplifier gain the highest?

(c) What is the maximum amplitude of the input signal v_i (at 1 kHz) that can be amplified without signal distortion at the output (v_o)? Use the oscilloscope waveforms to support your answer.

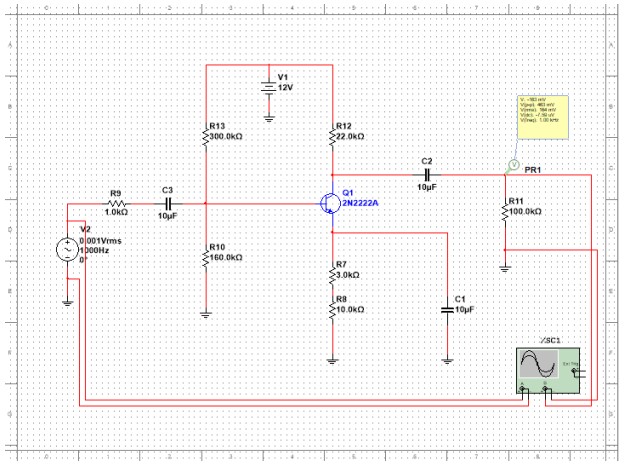
(d) Compare the gain of the two amplifiers in Figure 1 and Figure 2. Which amplifier has a higher gain?

(e) Compare the bandwidths of the two amplifiers. Which circuit has a broader bandwidth (the range of frequency with maximum gain)?

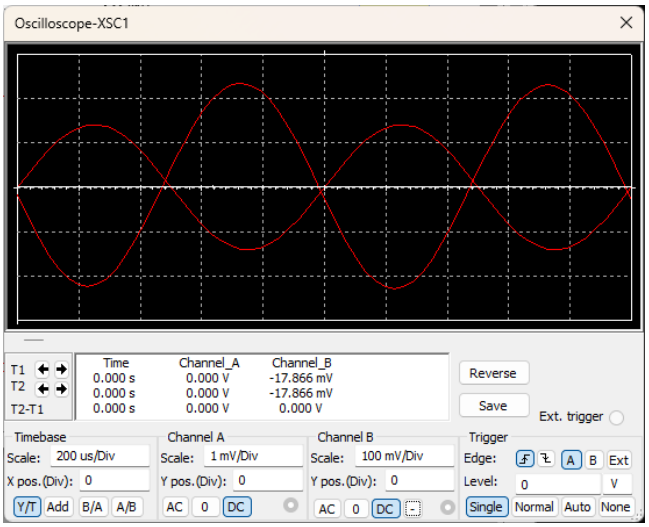
Note:

- All plots and waveforms must be properly labeled with units provided.
- For submission, convert all your worksheets (including this cover page with your name, all handwritten work, schematics, plots, etc.) into a PDF format and submit electronically on Canvas.
- Also, submit your Multisim files (file extension: .ms14) along with your PDF worksheets.

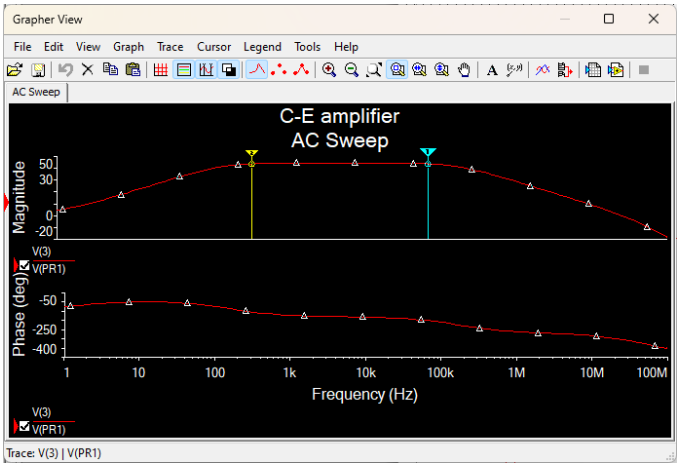
1) Figure 1



a) Vin = 1.41mV, Vout = -220m, Gain = Vout/Vin = -156

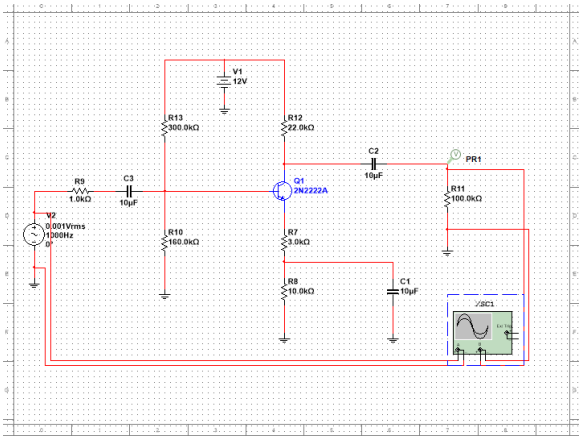


b) Highest magnitude from 300Hz to 300kHz

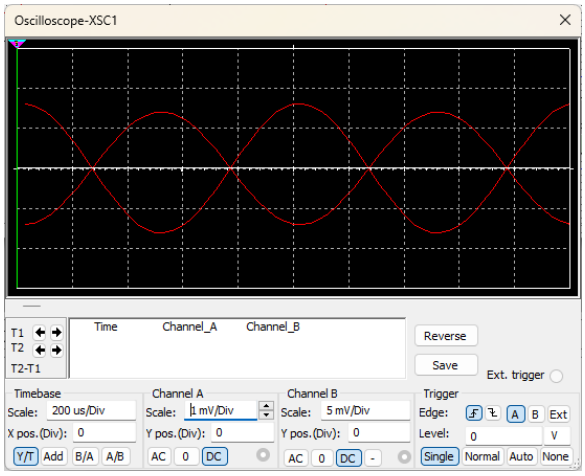


c)

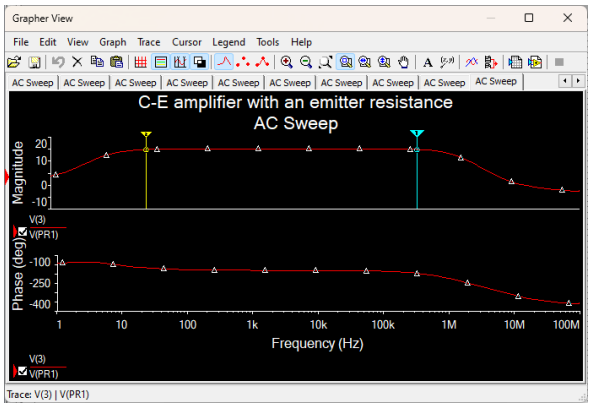
2) Figure 2



a) Vin = ~1.41mV, Vout = ~-8m, Gain = Vout/Vin = ~-5.7



b) Highest magnitude from about 11Hz to 500kHz



c)

d) Figure 1 has a higher gain than Figure 2.

e) Figure 2 has a wider bandwidth than Figure 1.