ELEC 313 Lab 9
Common Emitter Transistor Amplifier

REFERENCE: Appropriate chapters of ELEC 306 text.

OBJECTIVE: The objective of this experiment is to construct and observe the operation of a common emitter transistor amplifier.

EQUIPMENT: Transistor 2N2222A
Resistors 100K Ω , 20K Ω , 1K Ω , 470 Ω
Capacitor 10uF, 0.1uF
Power Supply (Vdc) , Function Generator
Multi Meter(s), Transistor tester, Oscilloscope

PRIOR PREPARATION (Pre-Lab):

The circuit below will be constructed and tested in this laboratory exercise.

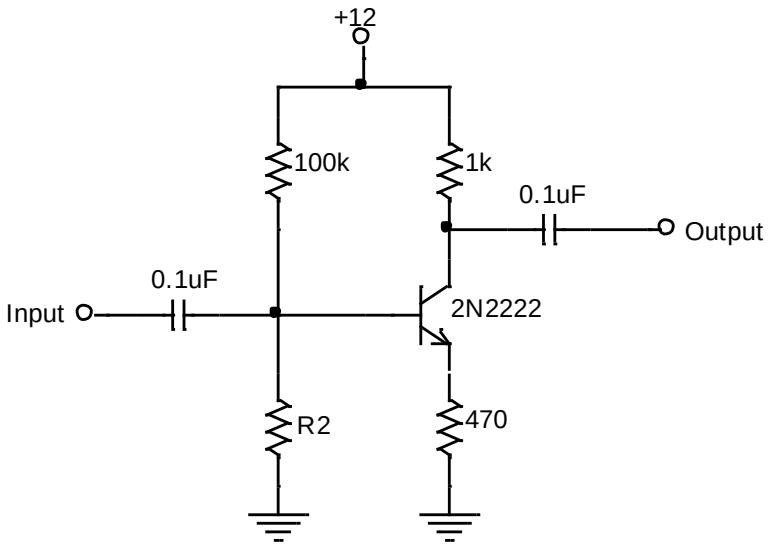

Figure 1. Common Emitter Transistor Amplifier (without the emitter bypass capacitor)

1. Referring to figure 1, compute the value of R_2 that causes 3mA to flow in the emitter of Q_1. Assume β=150.
2. Simulate the circuit in PSPICE. Apply a 50-mV AC source with a 50-Ω source impedance to the input of the circuit and a 1 MEG resistor from the output to ground. Use the AC SWEEP simulation facility to make a plot of the output voltage as the frequency is swept from 100 Hz to 1 MHz.
3. Add a 10μF capacitor from the emitter to ground and repeat the PSpice analysis.

EXPERIMENT

The following procedure will be used to evaluate the transistor amplifier of figure 1.

1) Construct the circuit of figure 1 without the emitter bypass capacitor.
2) Measure and record the dc voltage at the each terminal of the transistor.
3) Connect the output of the function generator to the input of the circuit. Set the function generator to a frequency of 30 kHz and select a sine wave.
4) Connect CHANNEL 1 of the oscilloscope to the input and CHANNEL 2 to the output.
5) Adjust the amplitude control on the function generator for a sinusoidal waveform that swings from -250mV to +250mV ($500mV_{pp}$) at the circuit input *as measured on the oscilloscope*.
6) Measure the peak-to-peak amplitude of the output waveform.
7) Compute the gain of the amplifier at this frequency and show your result to the instructor before proceeding.

Port Impedances

8) Connect the decade resistance box to the output. Adjust its resistance until the output voltage reads as one-half the open-circuit value measured in step 6 at 30 kHz. The displayed resistance value is equivalent to the output resistance of the circuit.
9) Disconnect the function generator from the circuit input and use the oscilloscope to measure the open-circuit voltage produced by the generator.
10) Remove the decade box from the output and reconnect it between the function generator and the circuit input, so that the signal travels from the function generator and through the resistance box on its way to the circuit input.
11) Adjust the decade resistance box so that the voltage measured at the circuit input is one-half the open circuit voltage measured in step 9. The displayed resistance value is 50 Ω less than the input resistance of the circuit.
12) Remove the decade resistance box and reconnect the function generator directly to the circuit input, leaving its frequency at 30 kHz.

Large-Signal Performance

13) Slowly increase the amplitude of the generator while observing the output waveform. At the point where clipping of the output waveform begins to occur, record the peak-to-peak voltage at the input.

Emitter bypass capacitor

14) Insert the 10uF emitter bypass capacitor.
15) Repeat steps 2 through 7, except reduce the input voltage until the waveform does not clip. Be sure the scope is triggering off of the output signal.

DATA ANALYSIS

1. Use the measured data to determine the input and output resistances
2. At 30 kHz, what is the maximum input signal level that avoids distortion?
3. What is the effect of the bypass capacitor on the dc voltages of the transistor?
4. What is the effect of the bypass capacitor on the small signal output voltage?
5. Calculate the theoretical small signal gains and input and output impedances of the circuits.

LAB REPORT

Your report should be completed in the format requested by the instructor. The lab report should be in standard format and include the following items:

1. Data Analysis items.
2. Comparison of measured data with theoretical results.