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 100KΩ, 20KΩ, 1KΩ, 470Ω
Capacitor 10uF, 1µF, 0.1µF
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.

1. Referring to figure 1, compute the value of $R_2$ that causes 3 mA to flow in the emitter of $Q_1$.
2. Assuming mid-band operation (modeling the capacitors as short circuits), compute the voltage gain and both the input resistance and the output resistance.
3. Add a 10 uF emitter bypass capacitor to the circuit shown in figure 1. Compute the mid-band voltage gain and both the input and output resistances of the circuit.
4. In PSPICE, apply a 50-mV AC source with a 50-Ω source impedance to the input of each circuit. 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 for each circuit. When simulating, attach a 1 MEG resistor from the output to ground.
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 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 waveform that swings from -75 mV to +75 mV (150 mVpp) 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) Adjust the amplitude of the function generator back to 150 mVpp as measured on the oscilloscope.
14) 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.

Small-Signal Amplitude Response

15) Set the frequency of the function generator to 100 Hz.
16) Adjust the amplitude of the function generator to obtain a 500 mVpp sine wave as measured at the output. Measure on CHANNEL 1 of the oscilloscope the peak-to-peak value of the input waveform. Compute the voltage gain of the amplifier at this frequency. (Note: At some frequencies, and 100 Hz may be one of them, the amplifier may not have enough gain to produce 500 mVpp at the output. In this case, set the output voltage to whatever value can be obtained, measure the input voltage, and compute the gain.)
17) Adjust the frequency of the function generator in the following sequence of values, {200, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 MHz}, and repeat step 16 for each.

Emitter bypass capacitor

18) Repeat steps 2 through 7 after inserting the 10uF emitter bypass capacitor.
DATA ANALYSIS
1. Make a semi-log plot of the voltage gain versus frequency.
2. Use the measured data to determine the input and output resistances
3. At 30 kHz, what is the maximum input signal level that avoids distortion?
4. What is the effect of the bypass capacitor on the dc voltages of the transistor?
5. What is the effect of the bypass capacitor on the small signal output voltage?

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 additional items:

1) Data Analysis items.
2) Comparison of measured data with pre-lab results.