KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DEPARTMENT OF ELECTRICAL ENGINEERING
Electronic Circuits I - EE203

Experiment # 6

BJT CE Amplifier

OBJECTIVE

The purpose of this experiment is to**:**

- Demonstrate the operation and characteristics of the small signal CE amplifier.
- Determine the maximum output available from a basic common-emitter amplifier.
- Calculate voltage gain, input, and output resistance experimentally**.**

COMPONENTS REQUIRED

- Transistor - 2N3904
- Capacitors - $22\mu F$ (2No's), 100 μ F
- Resistors - 50kΩ, 22kΩ, 3.3kΩ (2No's),2.2k

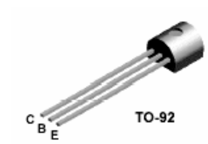

Figure 1 2N3904 Pin configuration

PRELAB

1. For the circuit shown in Figure 2 consider β=75. Calculate the dc components I_{BQ} and $I_{CQ,}$ V_{CEQ}.
2. Draw the small signal equivalent circuit.
3. Calculate the voltage gain for the circuit (v_o/v_s).
4. Remove C_E and calculate the voltage gain.
5. Connect a resistance of 2kΩ in series with the source in the presence of C_E and calculate the new voltage gain.
6. From 3 and 5 calculate input resistance of the amplifier.
7. Remove the load resistance R_L and calculate the voltage gain (in the presence of C_E).
8. From 3 and 7 calculate the output resistance seen by the load

SUMMARY OF THEORY

In a common-emitter (CE) amplifier, the input signal is applied between the base and emitter and output signal is developed between the collector and emitter. The transistor's *emitter* is common to both the input and output circuits, hence the term common emitter. The input and out signal gives 180^o phase shift.

To amplify ac signal, the base-emitter junction must be forward biased and the base-collector junction must be reverse-biased. The bias establishes and maintains the proper dc operating conditions for the transistor. After analyzing the dc conditions, the ac parameters for the amplifier can be evaluated.

Figure 2, below shows the transistor configured as a common emitter amplifier. In this diagram, V_S is the a.c. signal source, and R_L is the load. V_{CC} is a power supply, which provides the transistor with the necessary power to amplify the a.c. signal. Resistors R_1 and R_2 are used to establish the correct voltage at the base of the transistor. (See the text for more details.)

The capacitors C_1 and C_2 serve to isolate the signal source and load from the voltage source V_{CC}. (The capacitors are called "blocking capacitors" or "coupling capacitors", since they block the d.c. voltage but act like a short to the a.c. signal.)

EXPERIMENTAL WORK

Before you connect the circuit test the transistor using DMM and curve Tracer, instructor will examine you procedure.

DC analysis

1. Wire the circuit as shown in Figure 2. The pin diagram for the 2N3904 transistor is shown in Figure 1.
2. After you have checked all connections, apply the 10V supply voltage (you have to adjust the supply of 5-15V variable from beardboard to 10V using multimeter).

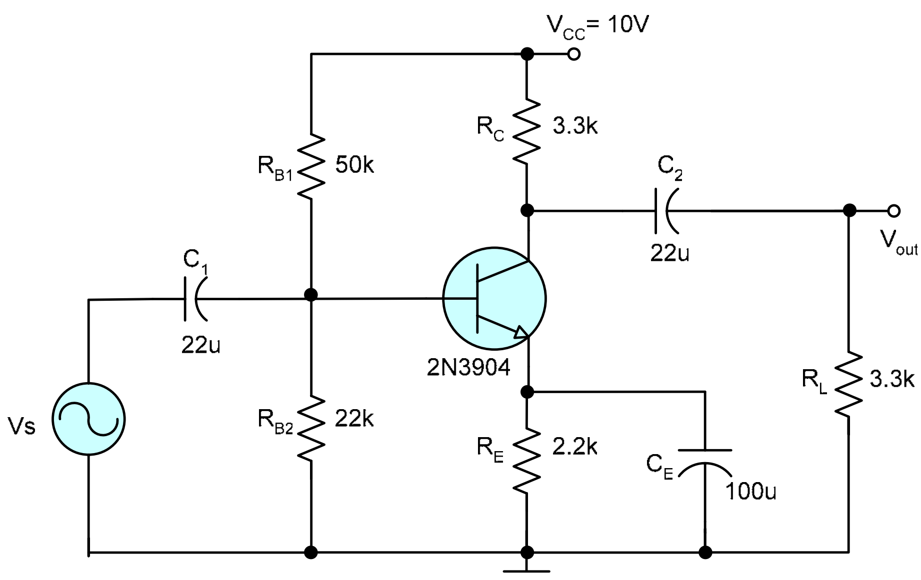

Figure 2

3. With a multimeter, individually measure the transistor dc base, emitter and collector voltages and currents, record you results in table1. Findβ. Make sure

your transistor is biased in the active mode for amplifier application. Record your results in Table 1.

Parameters	Measured Value	Theoritical Value	Simulation Value
V_B			
V_E			
V_C			
I_B			
I_E			
I_C			

Table1

Small Signal Analysis

4. Apply a sine wave (10mV, 100 kHz) and measure the output voltage using the double beam oscilloscope. Display both input and output signals on the oscilloscope and observe the phase shift. Measure the output voltage and compute the voltage gain. **(Avoid using Autoset of the oscilloscope, adjust manually, if the display is distorted due to the use of the 20dB attenuator)**
5. You must observe that the output signal level (V_{out}) is greater the input signal level (V_s). In addition, V_{out} is inverted or 180 degree out-of-phase, with respect to the input. Those points are two major characteristics of a common-emitter amplifier.
6. Remove C_E and calculate the voltage gain.
7. Reconnect C_E. Connect a 2kΩ resistance (R_S) in series with the source and calculate the voltage gain in the presence of C_E. Use the value obtained in step 2 with the one obtained here to calculate the input resistance.
8. Remove the load resistance and calculate the voltage gain with C_E connected. Summarize your results in Table 2.
9. Compare results to the theoretical calculations and PSPICE simulation. Find the error percentages and discuss the factors that caused these errors.
10. Attach theoretical and Pspice results with the report.
11. Input and Output resistance can be calculated using.

$R_i / (R_i+Rs) = A_3/A_1$	R_i---Input Resistance
$R_L/ (R_L+R_O) = A_1/A_4$	R_O ---Output Resistance

Record all your observations in table 2.

C_E	Rs	R_L	Vs(p-p)	V_{out}(p-p)	Measured Gain	Theoretical gain	Simulation gain
$100\mu F$	Without	3.3K	20mV		A_1=	A_1=	
Without	Without	3.3K	20mV		A2=	A2=	
$100\mu F$	2K	3.3K	20mV		A_3=	A_3=	
$100\mu F$	Without	Without	20mV		A_4=	A_4=	

Table 2

PSPICE WORK

BIAS POINT DETAIL SIMULATION

Use Schematics to connect the circuit shown in Figure 2. Analyze the circuit by choosing *Analysis* → *Setup* → *Bias Point*. Run the simulation by choosing *Simulate* from the *Analysis* menu (See the results from examine output choosing from file Menu). Write all the results in the following table.

Vcc	V_B	V_E	V_C	I_B	I_E	I_C	β	α

SMALL SIGNAL ANALYSIS

Use Schematics to draw the amplifier circuit in Figure 2. For source *Vs* use *VSIN* from the *Get New Part* Menu. Double click the source and enter the values of peak voltage and frequency of 10mV and 1 kHz. Exactly follow the same procedure used in Lab. Write all the results in Table 2.