L ABORATORY EXERCISE NO.8

COMMON BASE AMPLIFIER

OBJECTIVE

1. To investigate the common-base amplifier using voltage divider bias.
2. To measure the open-circuit voltage gain, loaded voltage gain, input resistance, and output resistance of the common-base amplifier.
3. To evaluate the common-base amplifier using the small-signal equivalent mode

INTRODUCTION

Although it has a small input resistance, the common base amplifier can be used in some applications requiring high voltage gain. As will be demonstrated in this experiment, the common base amplifier is also used in conjunction with FET amplifiers for high frequency amplification. When used as a small-signal amplifier, the Input and output voltages and currents vary over a small range of the a small signal am transistor's characteristic curves. In this situation, the amplifier is said to be operating in its linear region, i.e. the gain of the amplifier is the same for all amplitude variations at the input and output.

Small signal-amplifiers are often analyzed using ac equivalent circuits. Figure 8-A shows the small-signal ac equivalent circuits of the common base amplifier in Figure 8-2. Notice that no capacitors or dc voltage sources appear in the equivalent circuit, because they are assumed to be short-circuited to the signal. R1 and R2 in Figure 8-2 are similarly shorted to ac ground.

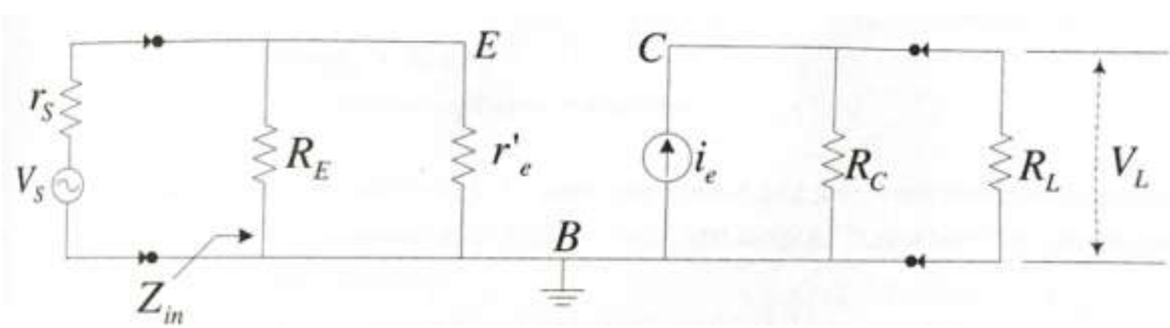

Figure 8-A. Common base amplifier ac equivalent circuit

The ratio of the output to input voltage when the amplifier is not loaded (R_L=∞ or open) is called the open-circuit voltage gain. The open circuit voltage gain of the common base amplifier can be calculated using the following equations.

$$\boldsymbol{Av = \frac{Vo}{Vin} = \frac{Rc}{r'_e}}$$

Where:

R_C is the external collector resistor

r_C is the internal collector resistance

R_E is the external emitter resistor

r'_e is internal emitter resistance

$$r'_e = \frac{0.026}{I_E}$$

Where:

IE is the dc emitter current

The input impedance, Z_{in}, of the common base amplifier is the ac resistance looking into the input of the amplifier stage. As can be seen in Figure 8-A.

$$Z_{in} = r'_e || R_E \approx r'_e$$

The output impedance, Z_{out}, of the common base amplifier is the ac resistance looking back into the output stage, as can be noted in Figure 8-A.

$$Z_{out} = r_c$$

Where: rc = Rc||RL

rc = ac collector resistance

When a load resistor R_L is connected across the output and a real signal source is connected to the input, voltage divisions take place at both the input and output. Therefore, the voltage gain from source to load is calculated as follows.

$$A_v = \frac{V_L}{V_S} = \frac{Z_{out}}{r_s + Z_{in}} = \frac{r_c}{r_s + Z_{in}} = \frac{R_c || R_L}{r_s + r'_e}$$

where: r_s is the internal resistance of the signal source

MATERIALS AND EQUIPMENT

Equipment	Resistors	Potentiometers	Capacitors	Transistors	Miscellaneous
1-Power Supply	1- 82 kΩ	1- 10 kΩ	3 - 22µF,25 V Electrolytic	1- PNP transistor 2N3906	1-Long Nose
1- Multitester	2- 10 kΩ	1-200 Ω		1- 2N2222	Wire Stripper
1-Oscilliscope	1-5.6 kΩ				Connecting Wires
1-Signal Generator	1-1 K Ω				Breadboard

PROCEDURES

STEP 1

To measure the open-circuit voltage gain, Av, and the impedance, Z_o, of a common-base amplifier, connect the circuit in Figure 8-1. Measure the DC voltage (V_E) across R_E. This value will be used to determine the bias current, $I_E = V_E / R_E$, and the internal emitter resistance, $r'_e = 0.026 / I_E$.

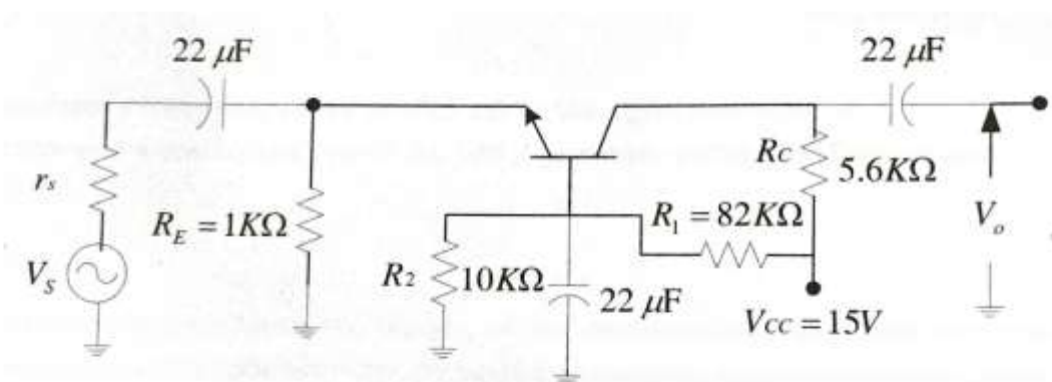

Figure 8-1. Common base amplifier with voltage divider bias

Using the measurement made, calculate the quiescent current, I_E, and the ac emitter resistance, r'_e

STEP 2

With the signal generator's frequency set to 10 kHz, adjust the signal generator until V_o = 3Vp-p. Measure and record the input voltage V_{in} (including the phase relationship between V_{in} and V_o). The open-circuit Voltage gain A_{Vo} is V_o/V_{in}.

STEP 3

To measure the output impedance, Z_o, of the common-base amplifier, connect a 10 kΩ potentiometer connected as a rheostat between the output coupling capacitor and ground. Adjust this potentiometer until V_o is 1.5 $V_{p\text{-}p}$ (one-half of the previous 3 V output). Remove the potentiometer and measure its resistance. By voltage divider formula, this resistance equals the output resistance of the common-base amplifier.

STEP 4

To measure common the output loaded voltage gain from source-to-load, V_L/V_S, and the input impedance, Z_{in}, of the common base amplifier, connect the circuit shown in Figure 8-2

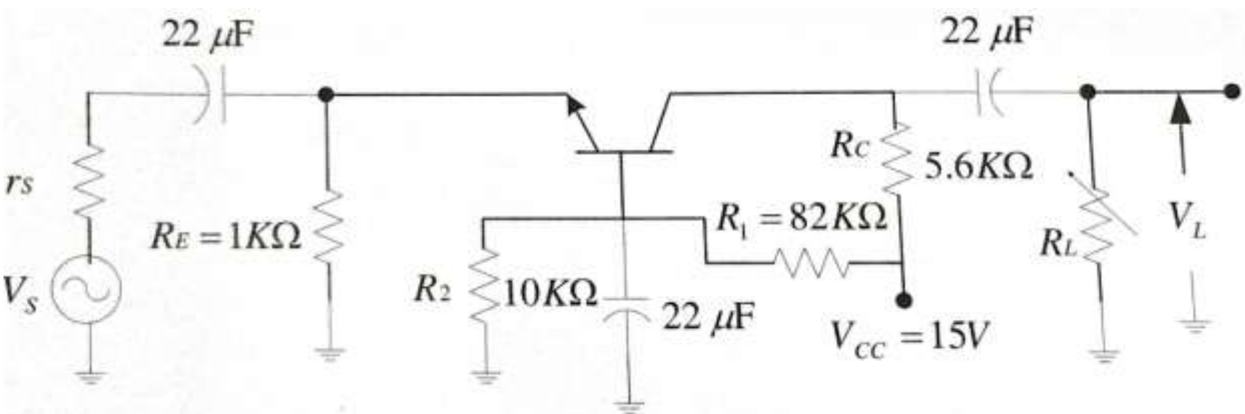

Figure 8-2. Common base amplifier circuit with load

STEP 5

With the generator's frequency set to 10 KHz, adjust the signal generator until V_L = 3Vp-p. Remove the signal generator and measure and record the signal generator voltage V_S. The voltage gain from source to load is V_L/V_S.

STEP6

To measure the input impedance, Z_{IN} (stage), of the common base amplifier, reconnect the signal generator and insert 200Ω potentiometer connected as rheostat between (in series with) the input of coupling capacitor and the signal generator.

Adjust the potentiometer until V_L = 1.5V_{p-p} (one-half of the previous 3V output). Remove the potentiometer and measure its resistance. By voltage divider rule, this resistance, less the signal generator r_s internal resistance, equals the input impedance of the common base amplifier.

If the output resistance, r_s, of the signal generator is unknown, it can be determined as follows. With no load connected across the signal generator terminals (open-circuited output), adjust the terminal voltage to 1V_{p-p}, then connect a potentiometer (rheostat) across the terminals. Adjust the resistance voltage across it is 0.5V_{p-p}. The resistance of the rheostat is then equal r_s.

STEP7

Reconnect the circuit of Figure 8-2. Now increase the amplitude of the signal source until the output voltage V_L starts to distort. Measure the peak to peak value of the output voltage at the point where it just starts to distort.