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Reg. #	2019-EE-381,383
Marks	

Experiment # 4

Common Base Configuration

Objectives:

- 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.

Apparatus:

Transistor - 2N3904, Capacitors, Resistors, DMM, CRO, Function Generator, Jumpers, Connecting wires, bread board.

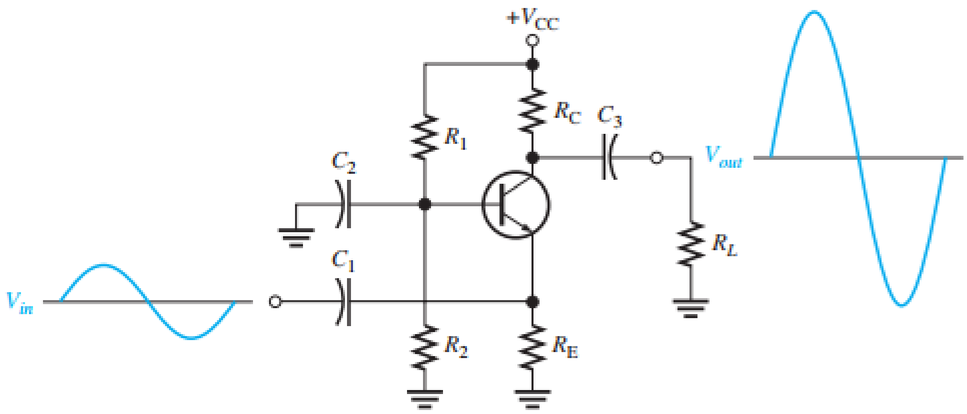
Theory:

In common base configuration, emitter is the input terminal, collector is the output terminal and base terminal is connected as a common terminal for both input and output. That means the emitter terminal and common base terminal are known as input terminals whereas the collector terminal and common base terminal are known as output terminals.

In common base configuration, the base terminal is grounded so the common base configuration is also known as grounded base configuration. Sometimes common base configuration is referred to as common base amplifier, CB amplifier, or CB configuration.

The input signal is applied between the emitter and base terminals while the corresponding output signal is taken across the collector and base terminals. Thus the base terminal of a transistor is common for both input and output terminals and hence it is named as common base configuration.

Fig 1 shows the circuit of a single stage CB amplifier using NPN transistor. In this diagram, V_{in} is the a.c. signal source, and R_L is the load. The capacitors C_1 and C_3 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.). Base is grounded using capacitor C_2. While R_1 and R_2 make a voltage divider bias circuit.



General Procedure:

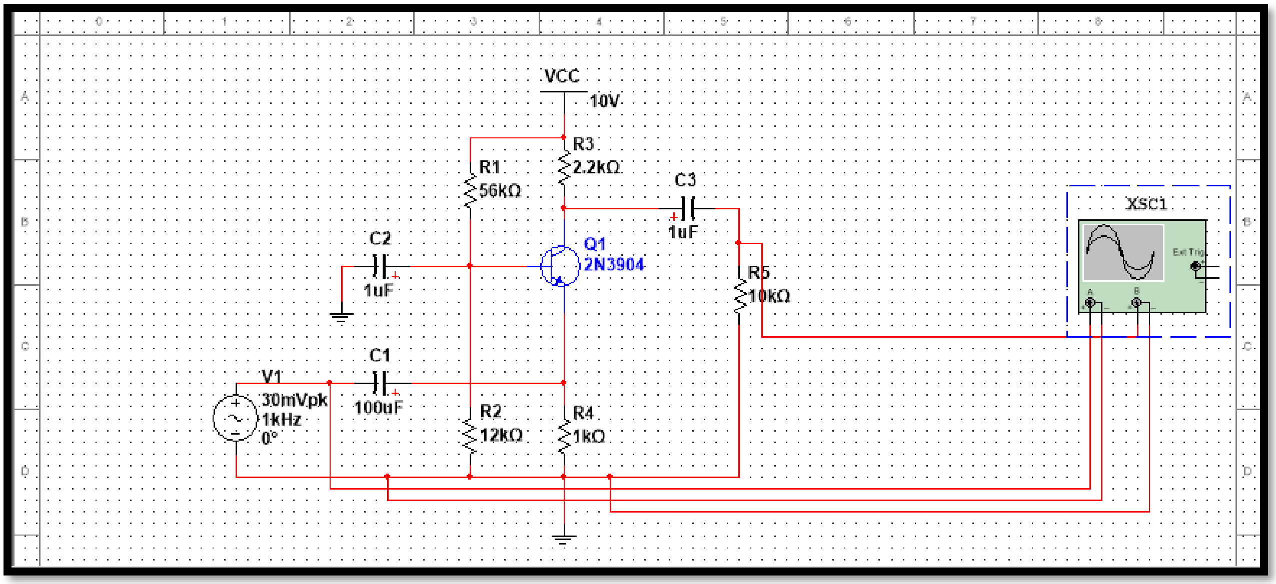
- Check all connection. Apply the VCC supply voltage to breadboard. With a multimeter, individually measure the transistor dc Emitter and Collector voltages with respect to Ground.
- Using the measured value for the dc Emitter voltage, calculate the dc quiescent Emitter current and the resultant transistor ac Emitter Resistance, ***r'e*** .
- Connect Channel 1 of your Oscilloscope to input-point (**V***in*) and Channel 2 to output-point (**V***out*).
- Then connect the Signal Generator to the circuit and adjust the sine wave output level of the Generator at 2V peak-to-peak at a frequency of 50Hz.
- Calculate the expected voltage gain from Emitter to Collector. Measure the actual voltage gain by dividing the peak-to-peak output voltage, **V***out* by the peak-to-peak input voltage, **V***in*.
- Remove $\mathbf{R_L}$ and determine the voltage gain by measuring **V***out* and **V***in*. Compare your measured result with the expected value.

Design:

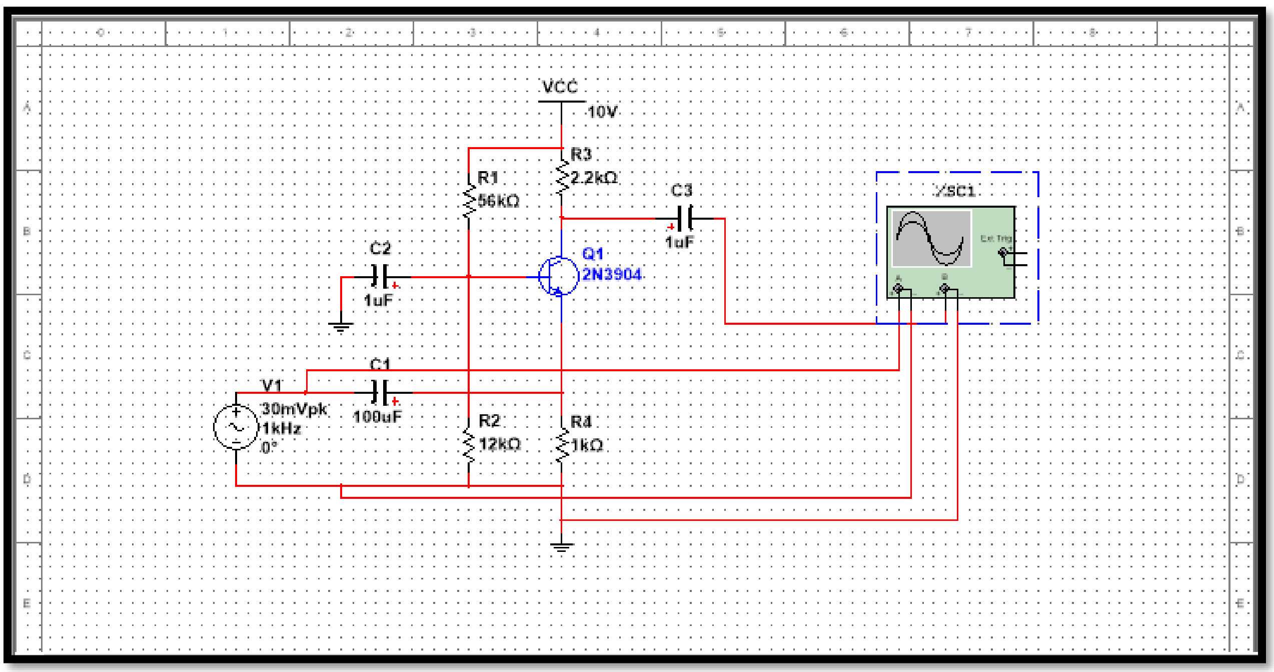
Design a small signal common base amplifier and find out its voltage gain with and without load resistance (Ref figure 6.32).

Circuit:

- **For Resistance at Load:**



- **For No Resistance at load:**



Calculations:

$$R_{Th} = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{(56k\Omega)(12k\Omega)}{56k\Omega + 12k\Omega}$$

$$= 9.88k\Omega$$

$$V_{Th} = \left(\frac{R_2}{R_1 + R_2}\right) V_{CC} \Rightarrow = \left(\frac{12k\Omega}{56k\Omega + 12k\Omega}\right)(10)$$

$$V_{Th} = 1.76V$$

$$I_E = \frac{V_{Th} - V_{BE}}{R_E + R_{Th}/\beta_{DC}}$$

$$= \frac{1.76 - 0.7}{1k\Omega + 39.5\Omega} = 1.02mA$$

$$R_{Th} \cong r_e' = \frac{25mV}{I_E} = \frac{25mV}{1.02mA}$$

$$= 24.5\Omega$$

$$R_c = R_C \| R_L$$

$$= 2.2k\Omega \| 10k\Omega = 1.8k\Omega$$

$$A_v = \frac{R_c}{r_e'} = \frac{1.8k\Omega}{24.5\Omega} = 73.5$$

$A_i \cong 1$ and $A_p \cong A_v = 76.3$

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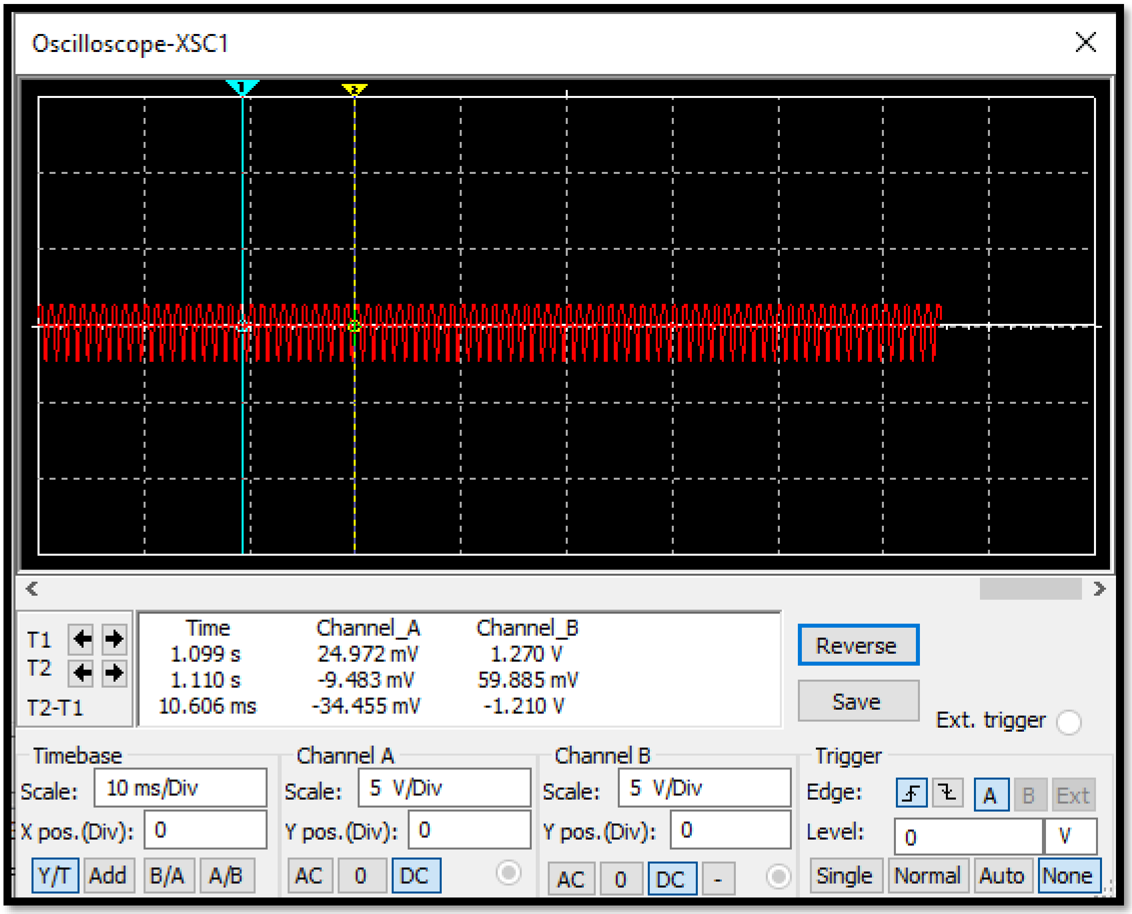
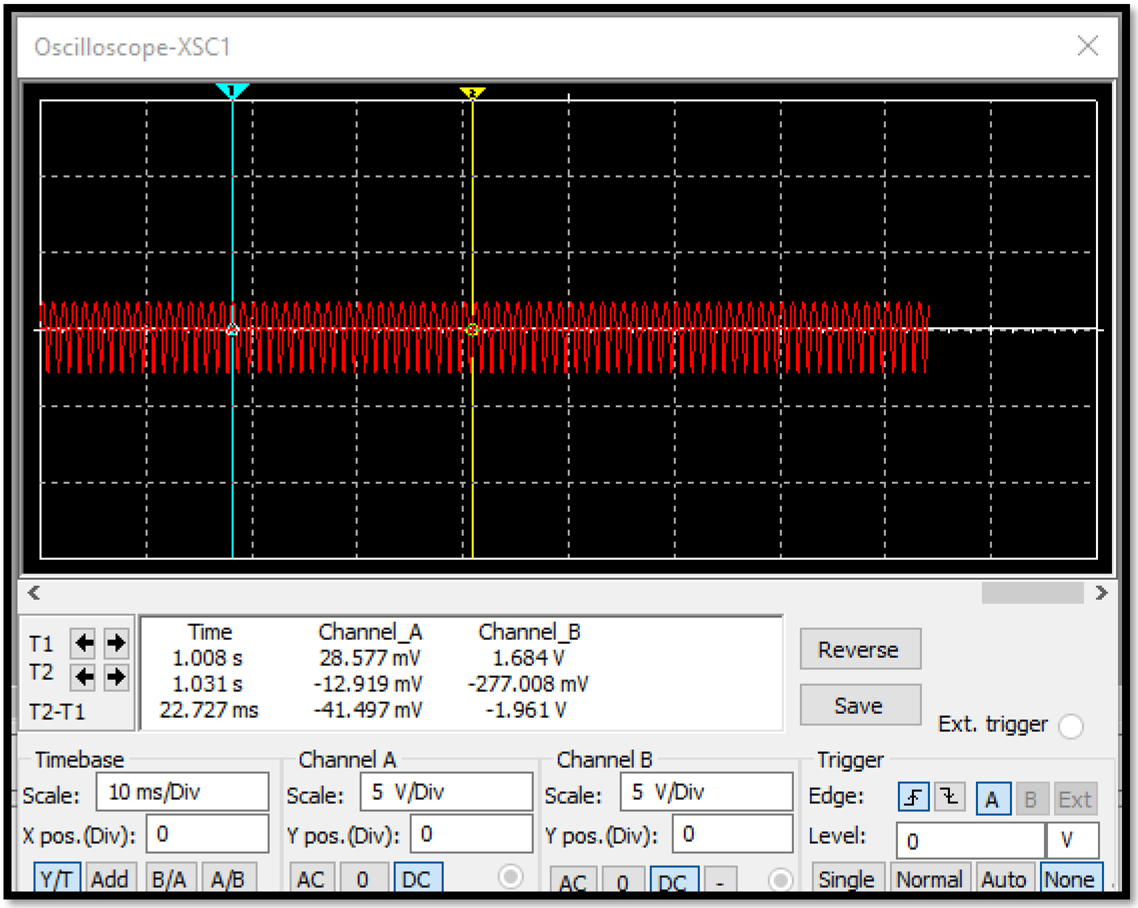
- **<u>Output for Load Resistance:</u>**



- **<u>Output for no Load Resistance:</u>**

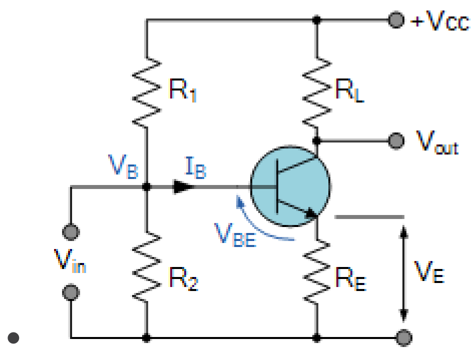


Result:

Sr. #	**With & without Load Resistance**	**Input Voltage**	**Output Voltage**	**$A_{V(Theoretical)}$**	**$A_{V(Practical)}$**
01	Without load Resistance	28.577mV	1.684V	76.3	58.92
02	With load Resistance	24.972mV	1.270V	76.3	50.86

Questions:

- **What is the effect of r_e on amplifier?**



- The amplifiers bias voltage can be stabilized by placing a single resistor in the transistors emitter circuit as shown. This resistance is known as the Emitter Resistance, R_E. The addition of this *emitter resistor* means that the transistors emitter terminal is no longer grounded or at zero volt potential but sits at a small potential above it given by the Ohms Law equation of: $V_E = I_E \times R_E$. Where: I_E is the actual emitter current.
- The aim of an AC signal amplifier circuit is to stabilize the DC biased input voltage to the amplifier and thus only amplify the required AC signal. This stabilization is achieved by the use of an Emitter Resistance which provides the required amount of automatic biasing needed for a common emitter amplifier.

- **What is the maximum current gain in common base amplifier?**

The current gain for the common-base configuration is defined as the change in collector current divided by the change in emitter current when the base-to-collector voltage is constant. Typical common-base current gain in a well-designed bipolar transistor is very close to unity.

- **Can the same voltage gain is achieved with a common base as with common emitter amplifier?**

Yes, almost same**(HIGH)** voltage gain is achieved in both common emitter and common Base amplifier.

The voltage gain is a function of input and output resistances, and also the internal resistance of the emitter-base junction, which is subject to change with variations in DC bias voltage.

$$Av=Vout/Vin$$

And in common emitter amplifiers the voltage gain is defined as the product of the current gain and the ratio of the output resistance of the collector to the input resistance of the base circuits.

$$\beta = \Delta Ic/ \Delta Ib$$
$$Av = \beta\ Rc/Rb$$