Roll No	2019-EE(381,383)
Marks	

Experiment # 02

Common Emitter Amplifier Configuration

Objectives:

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

Apparatus:

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

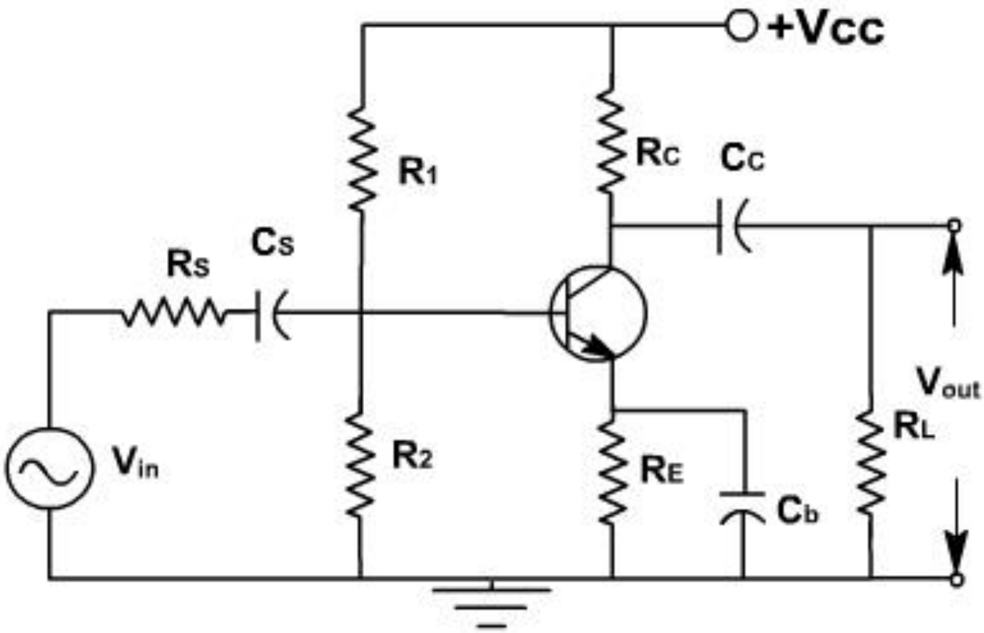
Theory:

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 1, 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.

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.).



General Procedure:

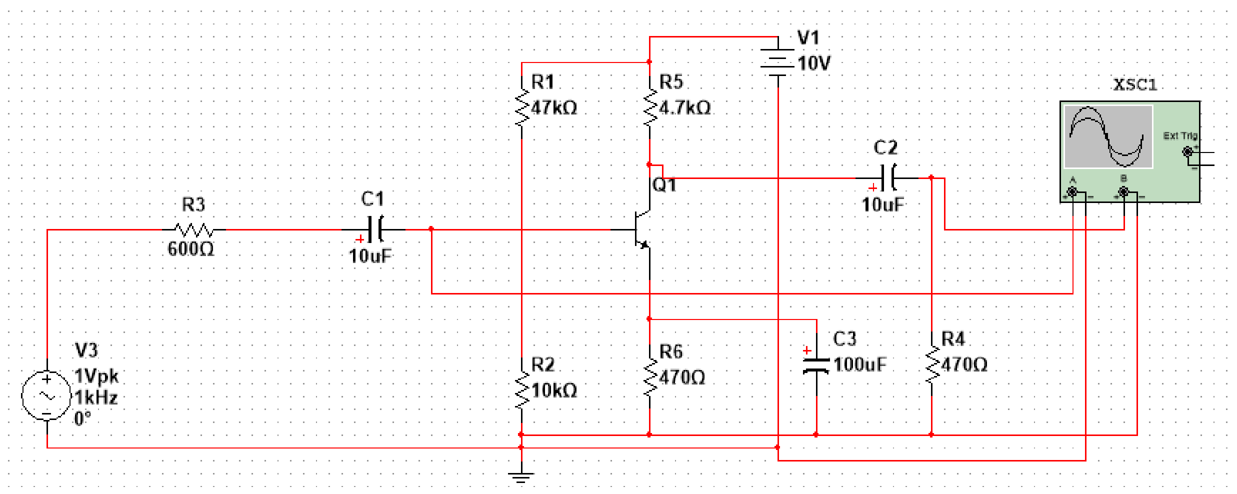
- Apply a sine wave and measure the output voltage using the double beam oscilloscope.
- Display both input and output signals on the oscilloscope and observe the phase shift. Measure the output voltage and compute the voltage gain. (Avoid using Auto set of the oscilloscope, adjust manually, if the display is distorted due to the use of the 20dB attenuator)
- You must observe that the output signal level (V_{out}) is greater the input signal level (Vs). 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.
- Connect aresistance (R_S) in series with the source and calculate the voltage gain. Use the value obtained in step 2 with the one obtained here to calculate the input resistance.
- Remove the load resistance and calculate the voltage gain.

Design:

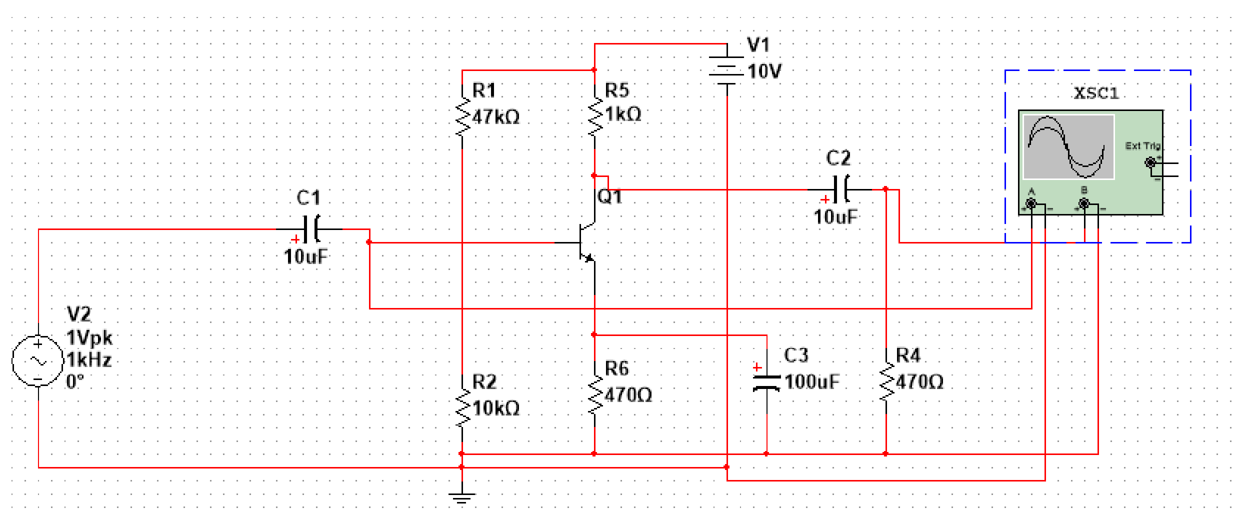
Design a small signal common emitter amplifier and find out its voltage gain with source resistance and without source resistance. (Use circuit 6.20 in Floyd book)

Circuit:

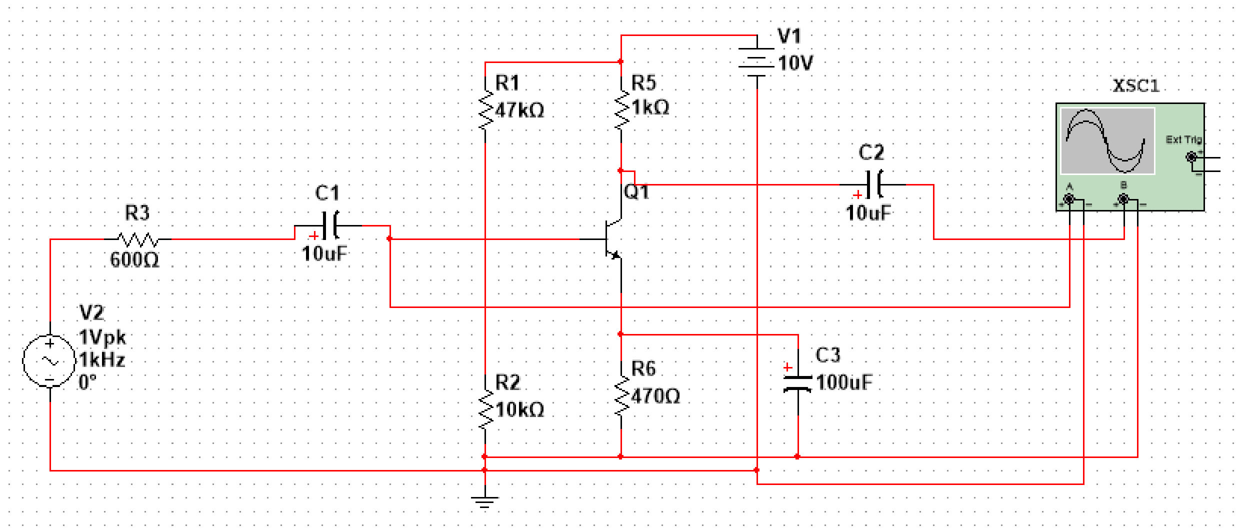
(With source resistance and load resistance)



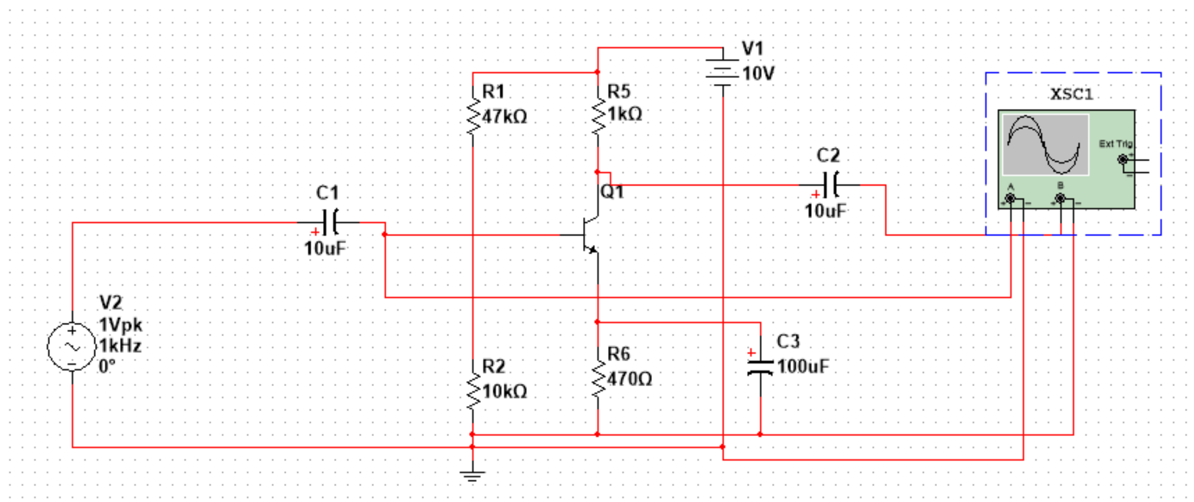
(with no source resistance)



(with no load resistance)



(with no source and no load resistance)



Calculations:

Calculation :-

$\beta_{DC} = 150$, $\beta_{ac} = 175$

(a)

$R_{th} = \frac{R_1 R_2}{R_1 + R_2} = \frac{(47)(10)}{47+10}$

$\boxed{R_{th} = 8.25 K\Omega}$

$V_{th} = \left(\frac{R_2}{R_1+R_2}\right) V_{CC}$

$V_{th} = \left(\frac{10}{47+10}\right) 10 \Rightarrow \boxed{V_{th} = 1.75V}$

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

$= \frac{1.75 - 0.7}{940 + 55} \Rightarrow \boxed{I_E = 1.06mA}$

$I_C \approx I_E = 1.06 mA$

$V_E = I_E (R_{E_1} + R_{E_2})$

$= (1.06)(940)$

$\boxed{V_E = 1V}$

$V_B = V_E + 0.7V$

$1 - 0.7v \Rightarrow \boxed{0.3V = V_B}$

$V_C = V_{CC} - I_C R_C = 10 - (1.06)(4.7)$

$\boxed{V_C = 5.02V}$

(b)

$$r_e' \approx \frac{25mV}{I_E} = \frac{25mV}{1.06mA}$$

$\boxed{r_e' = 23.6\Omega}$

total $\underline{R_{in}}$ is

$R_{in(total)} = R_1 \| R_2 \| R_{in(base)}$

$R_{in(base)} = \beta_{ac}(r_e' + R_{E1})$

$175(494)$

$\boxed{R_{in(base)} = 86.5k\Omega}$

therefore

$R_{in(total)} = 47k\Omega \| 10k\Omega \| 86.5k\Omega = 7.53k\Omega$

(c)

$$\text{Attenuation} = \frac{V_s}{V_b} = \frac{R_s + R_{in(tot)}}{R_{in(tot)}}$$

$$= \frac{600 + 7.53K\Omega}{7.53K\Omega}$$

$$\boxed{\text{Attenuation} = 1.08}$$

$$R_c = \frac{R_c R_L}{R_L + R_c} = \frac{(4.7)(47)}{(4.7)+(47)}$$

$$\boxed{R_c = 4.27K\Omega}$$

$$A_V \cong \frac{R_c}{R_{E_1}} = \frac{4.27}{470} = 9.09$$

overall voltage gain

$$A_V' = \left(\frac{V_b}{V_s}\right) A_v = (0.93)(9.09)$$

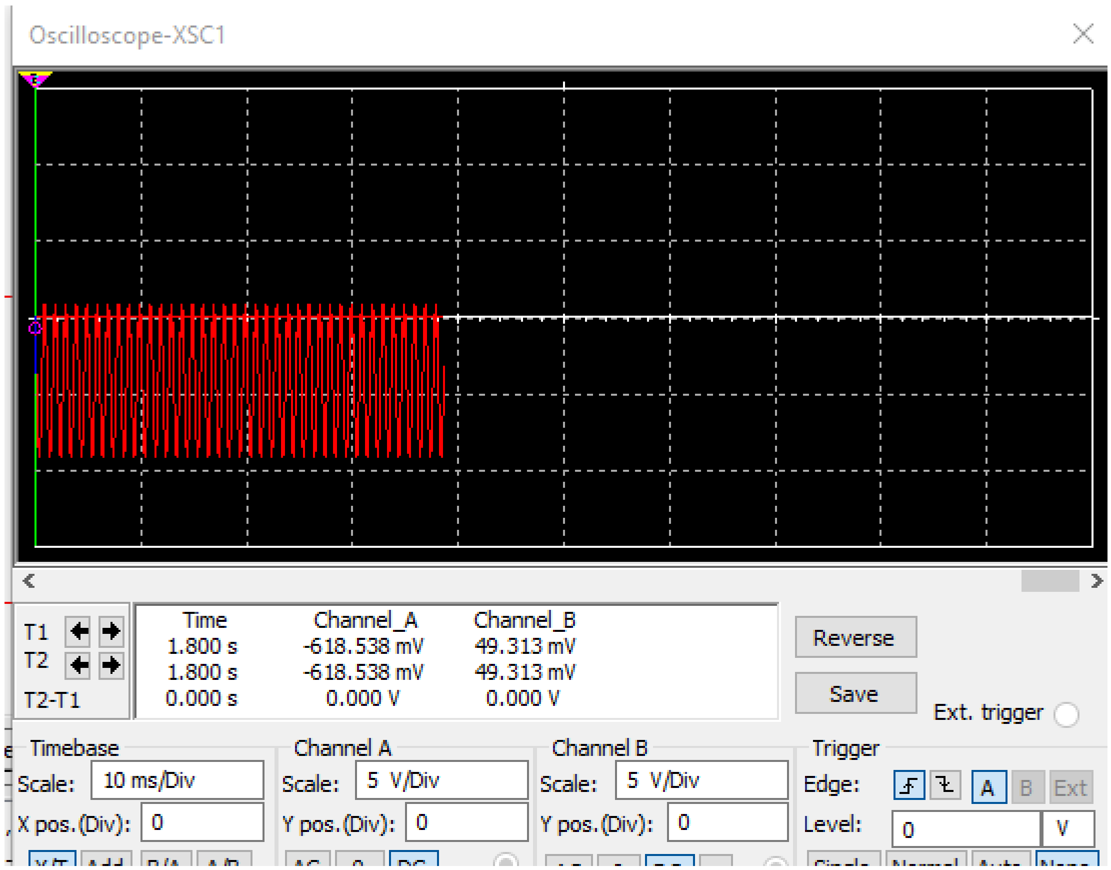
$$A_V' = \left(\frac{V_b}{V_s}\right) A_v = 8.45$$

$$V_c = A_V' V_s \Rightarrow (8.45)(10mV)$$

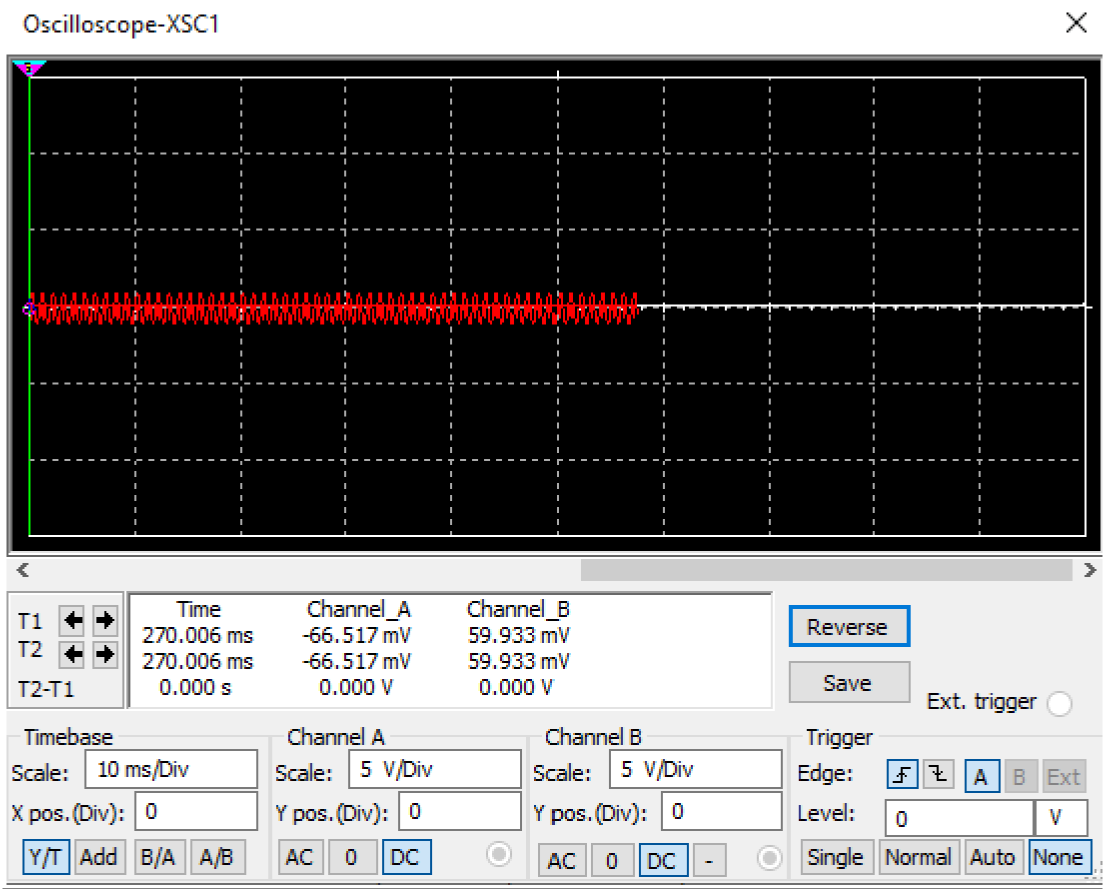
$$\boxed{V_c = 84.5mV}$$

Input and output Waveform:

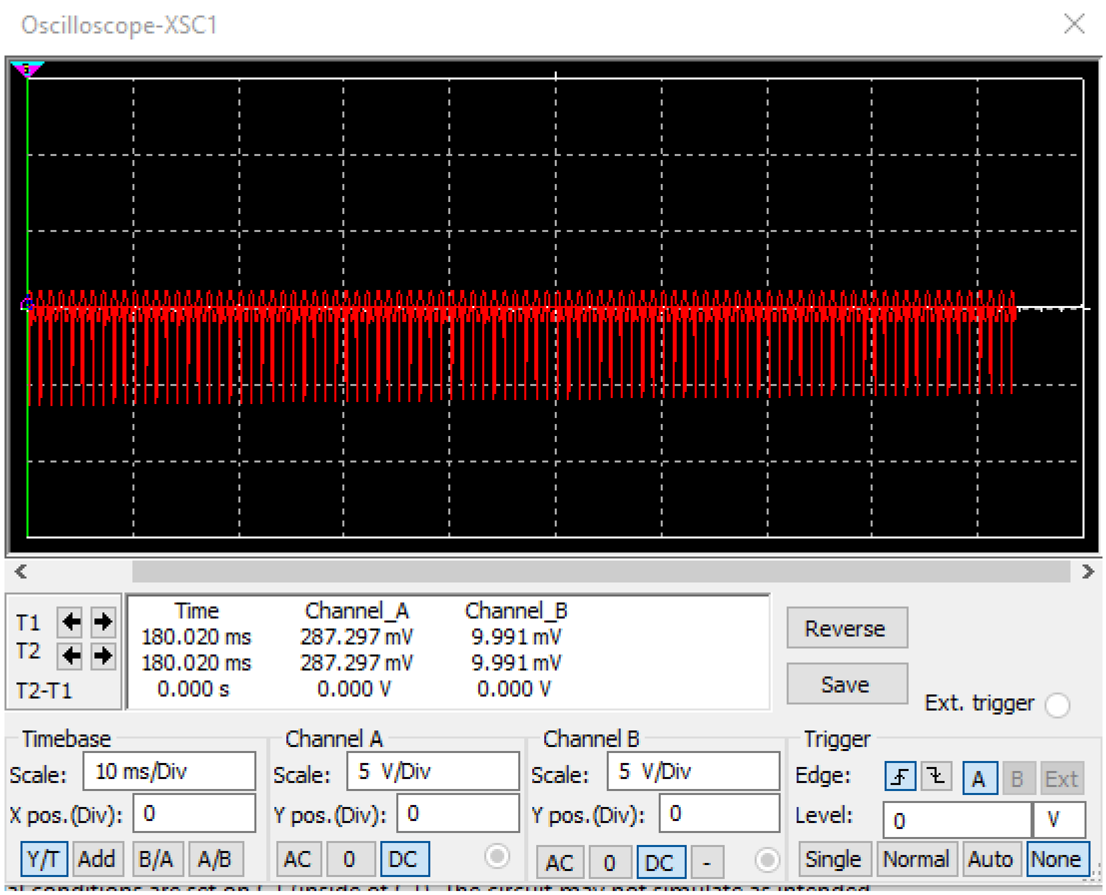
(With source resistance and load resistance)



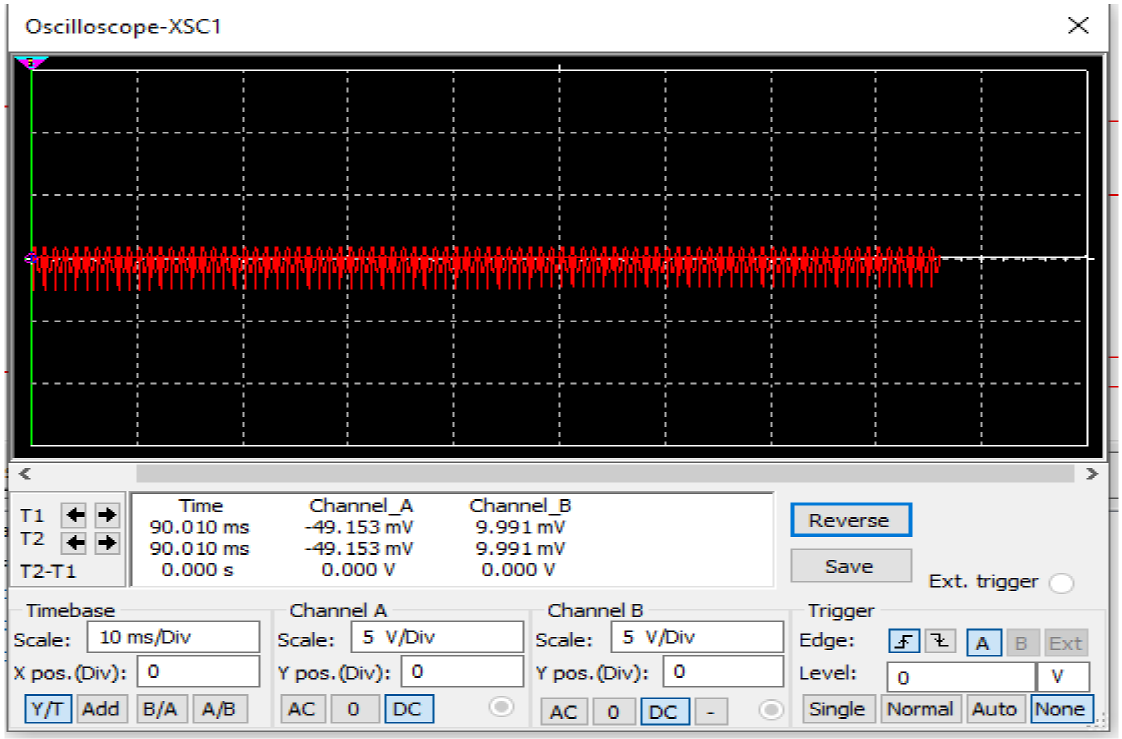
(with no source resistance)


Oscilloscope-XSC1
T1
T2
T2-T1
Time
270.006 ms
270.006 ms
0.000 s
Channel_A
-66.517 mV
-66.517 mV
0.000 V
Channel_B
59.933 mV
59.933 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 10 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None

(with no load resistance)



(with no source and no load resistance)



Result:

Sr. #	**Source Resistance**	**Input Voltage**	**Output Voltage**	**Av(Theoretical)**	**Av(Practical)**
01	With source Resistance	***-618.538mV***	***49.313mV***	***-0.07***	
02	Without source Resistance	***-66.517mV***	***59.933mV***	***-0.901***	
03	With load resistance	-618.538mV	49.313mV	-o.07	
04	Without load resis	287.297mV	9.991mV	0.035	

Questions:

- **Among BJT amplifiers, common-emitter amplifier is most favored. Give two reasons.**

The CE configuration provides both High Current and Voltage gain unlike other configurations like CC (High current gain but voltage gain less than unity i.e 1) and CB (High voltage gain but current gain less than unity). Thus CE configuration is best for amplification because of its high power gain (due to its both high voltage and current gain) and hence most widely used.

- **What is the advantage of biasing using two resistors as a potential divider network at the base of CE amplifier?**

The steady state operation of a transistor depends a great deal on its base current, collector voltage, and collector current values and therefore, if the transistor is to operate correctly as a linear amplifier, it must be properly biased around its operating point.

Establishing the correct operating point requires the selection of bias resistors and load resistors to provide the appropriate input current and collector voltage conditions. The correct biasing point for a bipolar transistor, either NPN or PNP, generally lies somewhere between the two extremes of operation with respect to it being either “fully-ON” or “fully-OFF” along its DC load line. This central operating point is called the “Quiescent Operating Point”, or **Q-point** for short.

- **Describe any three steps required for ac analysis**.

  AC Analysis is used to calculate the small-signal response of a circuit. In **AC Analysis**, the DC operating point is first calculated to obtain linear, small-signal models for all nonlinear components. Then, the equivalent circuit is analyzed from a start to a stop frequency.