INDIAN INSTITUTE OF TECHNOLOGY BHUBANESWAR

Introduction to Electronics Laboratory

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OBJECTIVES:

1. Bias a bipolar transistor using a potential-divider bias and measure the DC quantities.
2. Build the circuit of a common emitter (CE) amplifier using BJT and test its gain.
3. Measure the gain frequency response of this CE amplifier.
4. Build a modified CE amplifier with an emitter bypass technique and test its gain.
5. Measure the modified gain frequency response of this CE amplifier.
6. Extract important information from the measurements.

Part 1

DC Characteristics using Potential Divider Bias

Objective: Bias a bipolar transistor using a potential-divider bias and measure the DC quantities.

Theory Behind:

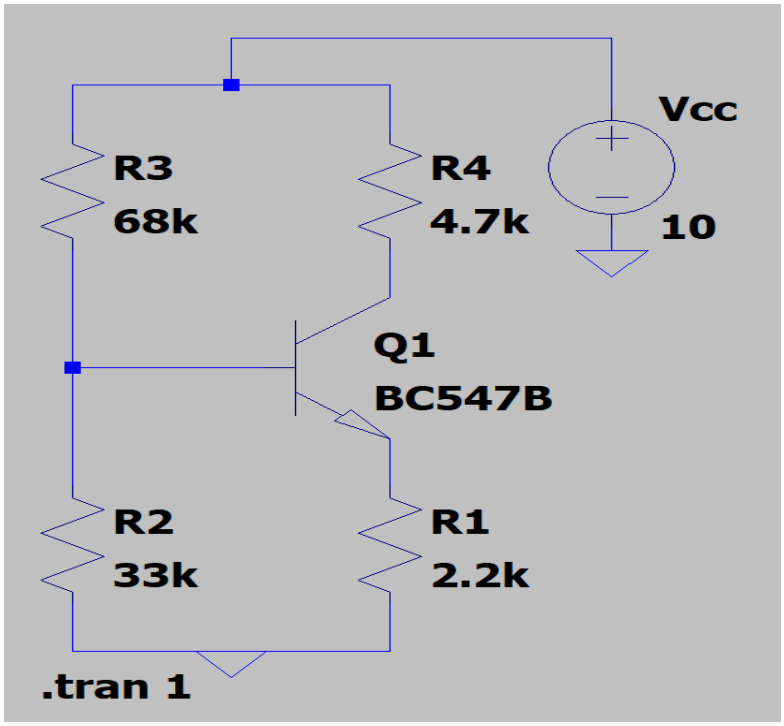
The Bipolar Junction Transistor is a semiconductor device which can be used for switching or amplification. The Transistor works under the following regions in the given stated conditions:

Active Region – the transistor operates as an amplifier and Ic = β*Ib.

Saturation – the transistor is "Fully-ON" operating as a switch and Ic = I(saturation).

Cut-off – the transistor is "Fully-OFF" operating as a switch and Ic = 0.

CIRCUIT DIAGRAM:



Observation Table:

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        --- Operating Point ---

V(c):           -5.87901        voltage
V(b):           -5.25308        voltage
V(e):           -1.73234        voltage
V(n001):        -10             voltage
Ic(Q1):         -0.000876806    device_current
Ib(Q1):         8.93666e-005    device_current
Ie(Q1):         0.00078743      device_current
I(R4):          -0.00078743     device_current
I(R3):          -0.000159184    device_current
I(R2):          -6.98076e-005   device_current
I(R1):          -0.000876806    device_current
I(Vcc):         -0.000946614    device_current
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RESULT:

From the results obtained from the simulation we will come to know

$V_{CE}= V_C – V_E =1.90256V$

$V_{BE} = V_B – V_E =0.62546V$

$I_C= 1.17mA$

$I_B=2.5327\mu A$

$V_{BC} = -1.2771V$ << Cut in voltage of the NP diode

Hence it Base collector junction is in reverse bias and Emitter base junction is in forward bias so it is in active region.

DISCUSSION:

Potential divider bias is a method used for the dc biasing of bipolar junction transistors (BJT) in a simple amplifier circuit. The above circuit is in active region as the Collector base junction is in reverse bias and Emitter Base junction is in forward bias.

CONCLUSION:

We have analyzed DC characteristics of the circuit using Potential divider bias. We also found that the circuit is in active region by finding VBC and it is less than cut-in voltage, hence, it is active region.

Part 2

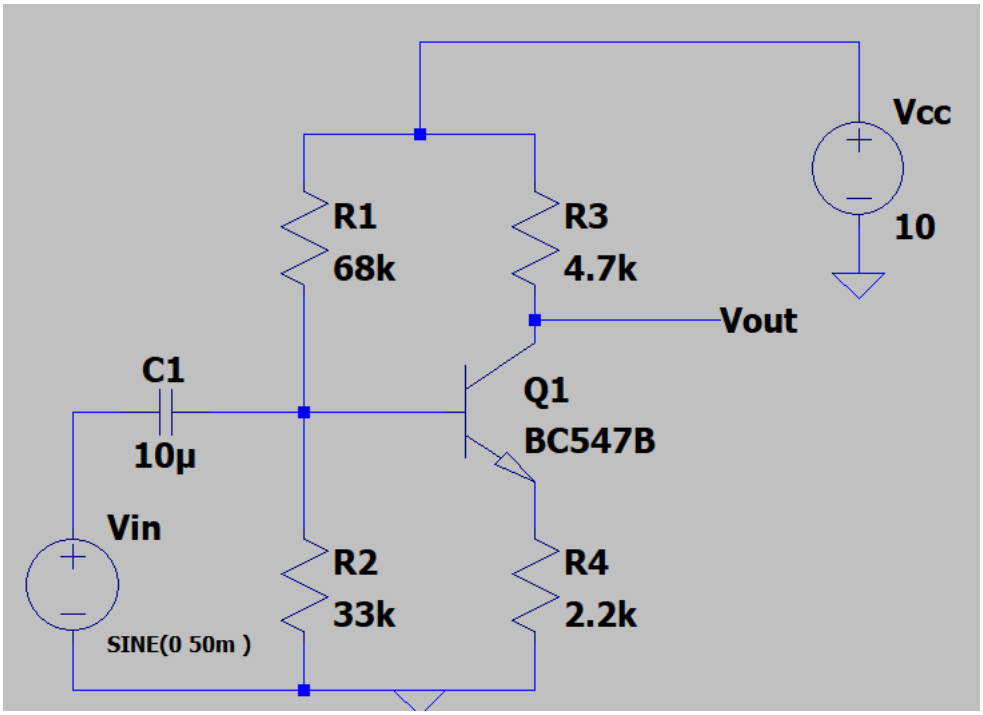
Common Emitter (CE) Amplifier

Objective: Build a Common Emitter amplifier (CE) using BJT and measure its gain.

Theory Behind:

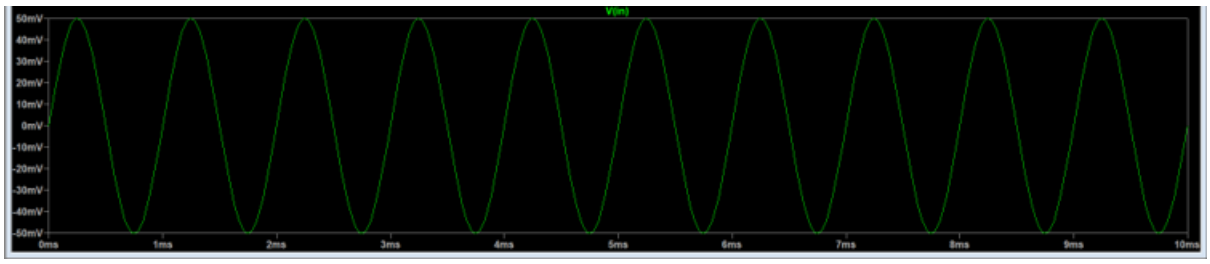
In electronics, a common-emitter amplifier is one of three basic single-stage bipolar-junction-transistor (BJT) amplifier topologies, typically used as the voltage amplifier, where the voltage gain Avo is defined as Vout/Vin. A CE amplifier has a similar sort of usage like a transformer where it helps to achieve a higher Vout by amplification of Vin, in addition to some benefits like Current gain that it offers.

CIRCUIT DIAGRAM:

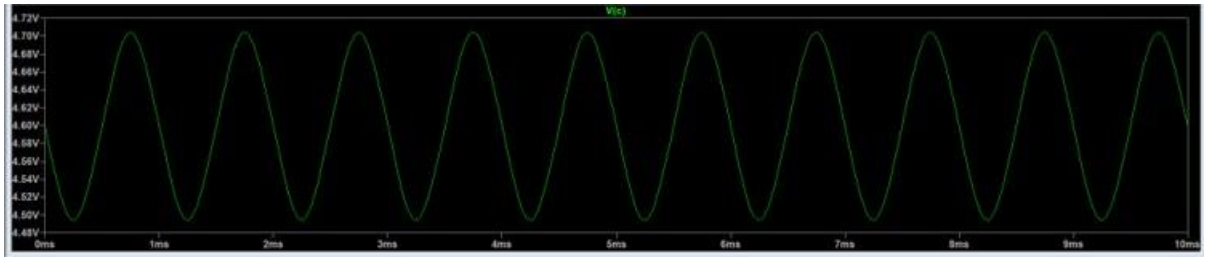


Graphs:

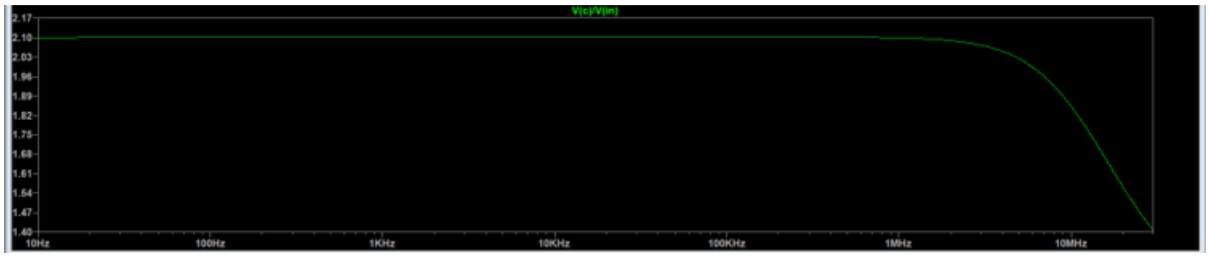
Vin vs time:



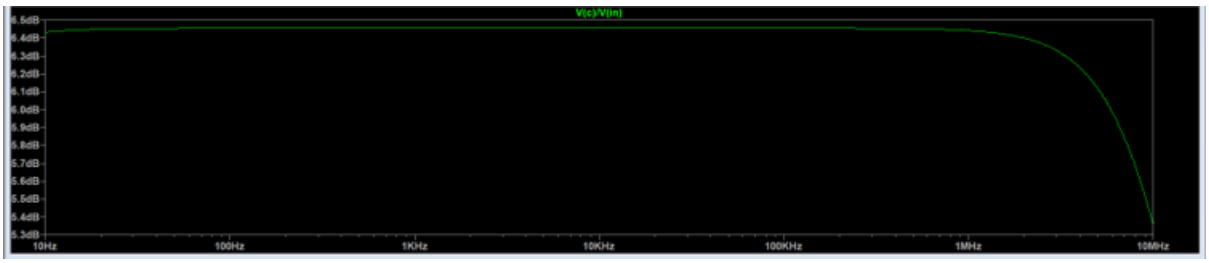
Vout vs time:



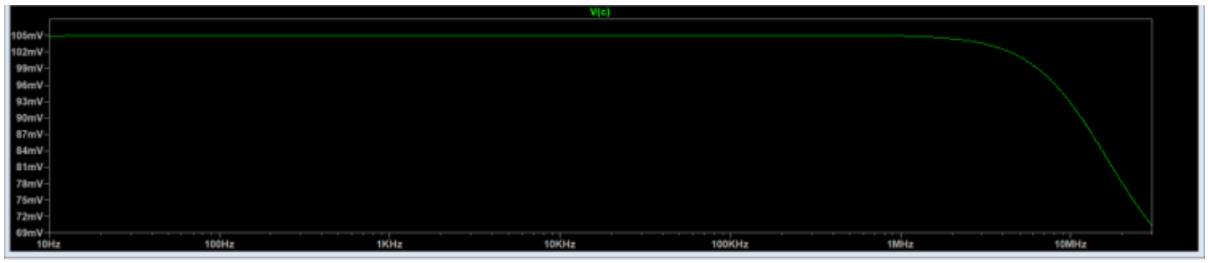
Gain vs Frequency (Vin=100mVpp):



Gain vs Frequency (in dB) (Vin=100mVpp):



Vout(Amplitude) vs Frequency(Vin=100mVpp):



RESULT:

From the above obtained plots from the simulation we get AV(Vout/Vin) as 187.72 3dB frequencies obtained are 295.02Hz

DISCUSSION:

When the base current/voltage is increased collector current increases and will cause the voltage drop in collector resistor to increase. Because of this the collector to emitter voltage decreases. Similarly decrease in base current/ voltage and in collector current will increase the collector to emitter voltage. When base voltage & collector/base current are zero collector to emitter voltage is maximum. When base voltage & collector/base current are at their maximum collector to emitter voltage is at its minimum. It means output voltage is out of phase.That is why CE amplifier gives 180 phase shift (in output voltage)

Part 3

Common Emitter (CE) Amplifier with Emitter Bypass

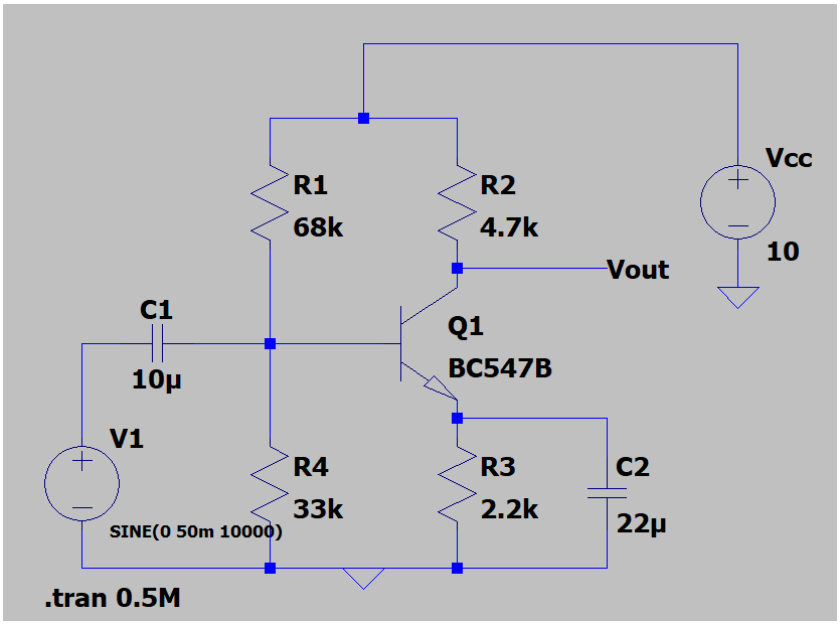
Objective:

Measuring the Gain and Gain frequency response of a CE amplifier with a bypassed Emitter.

Theory Behind:

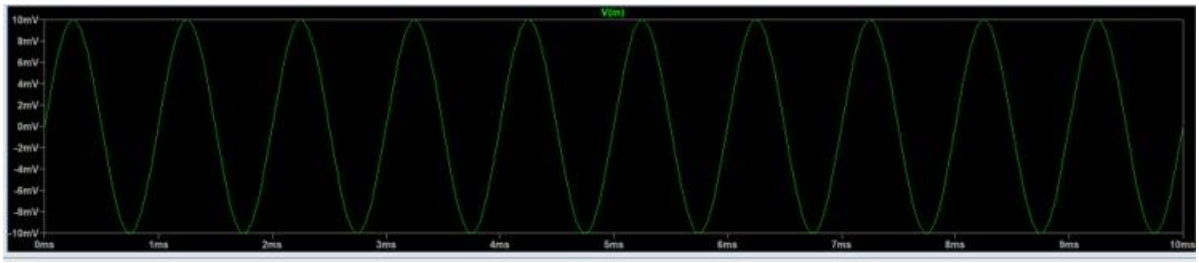
In a CE amplifier, with a bypassed emitter, the emitter resistor Re is bypassed by a capacitor connected in parallel(as shown in the above Circuit Diagram),thereby reducing the effective loss that may have occurred across Re, helping to obtain a greater Gain as compared to the amplifier in part 2,thereby ensuring a considerably larger amplification of Vin and a significantly larger value of Vout compared to part 2.

CIRCUIT DIAGRAM:

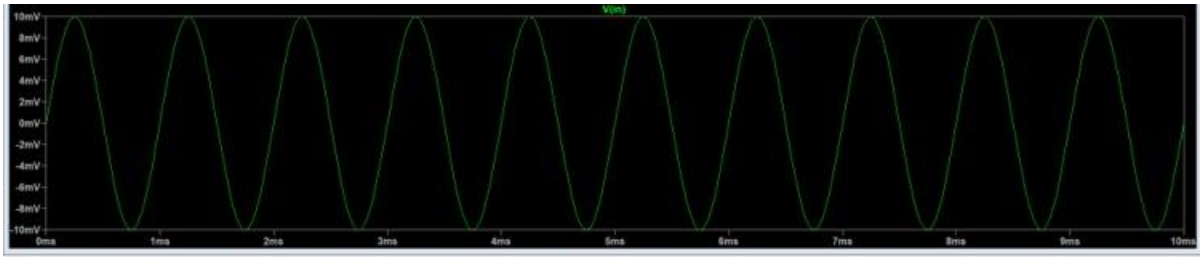


Graphs:

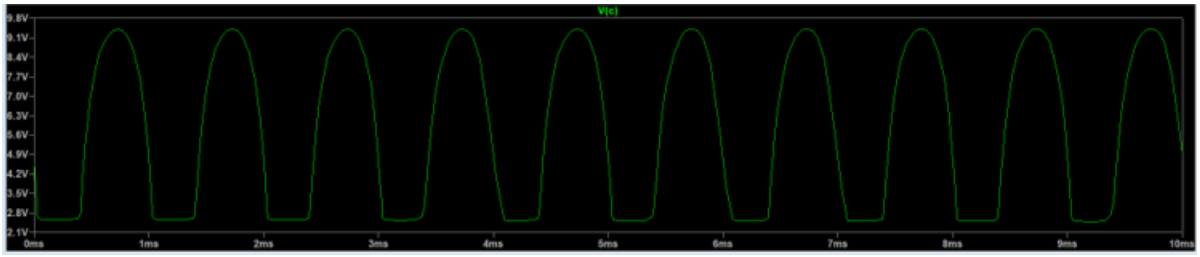
Vin vs time (Vin=20mVpp):



Vout vs time (Vin=20mVpp):



Vout vs time (Vin=100mVpp):



Gain vs Frequency (Vin=20mVpp):

Gain vs Frequency (in dB)(Vin=20mVpp):

Vout(Amplitude) vs Frequency(Vin=20mVpp):

RESULT:

From the above obtained plots from the simulation we get

$A_V(V_{out}/V_{in})$ as 187.72 3dB

frequencies obtained are 295.02Hz

DISCUSSION:

Common emitter amplifier is the circuit which amplifies voltage especially for low frequencies. Here the voltage gain AVo is defined as V_{Out}/V_{In}. We have analyzed the common emitter amplifier in the presence of the Emitter bypass and absence of it.

As in presence of the Emitter bypass the impedance of it is very small, hence we short circuit the capacitor. Therefore, in the final circuit of the amplifier is the emitter resistor is absent in the circuit consisting Emitter bypass capacitor.

In the above the 3dB frequency is measured when the gain becomes 3dB below max gain(dB). We can see that the gain is nearly constant in low frequencies.

CONCLUSION:

We have analyzed the Common emitter amplifier in presence and absence in bypass emitter capacitor. We also observed that in presence of bypass emitter the gain is very high compared to the absence of bypass emitter. CE amplifier uses the potential divider Bias.