5. TO STUDY DC AND AC PERFORMANCE CE AMPLIFIER

1. Course, Subject & Experiment Details

Academic Year	2018 – 2019	Estimated Time	Experiment No.5 – 02 Hours
Course & Semester	S.E. (COMP) – Sem. III	Subject Name	Basic Electronics Lab
Chapter No. & Unit	01 – Unit 1.1 Mapped with CO-1	Chapter Title	Bipolar Junction Transistor
Experiment Type	Hardware (Bread Board)	Subject Code	CSL 302

2. Aim & Objective of Experiment

To design common emitter configuration BJT small signal amplifier according to the given performance specifications using the values as obtained from the device (BJT) datasheet & also to calculate the mid-band voltage gain (A_v) under normal operating conditions. This experiment also aims at understanding choice of components & analyzing if designed circuit meets the required specifications.

3. Expected Outcome of Experiment

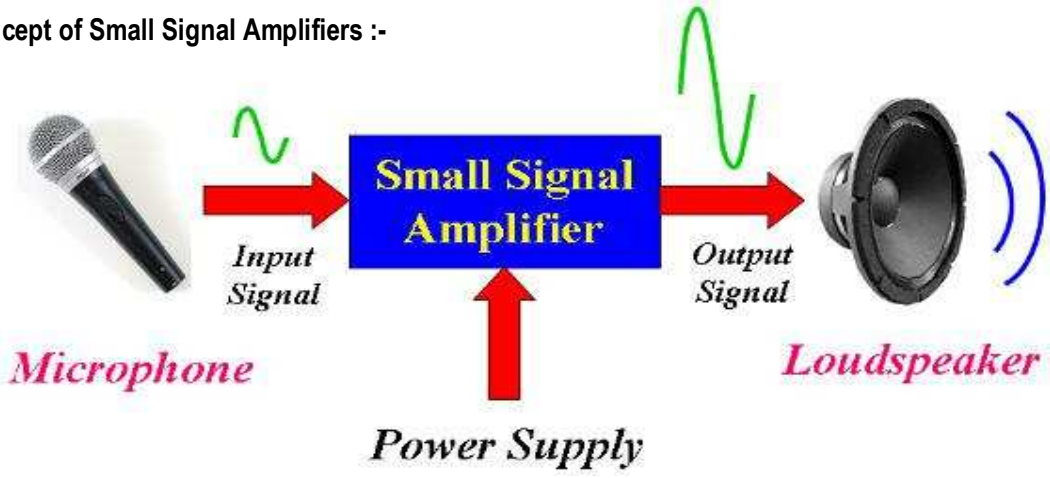
Being one of the major experiments in the curriculum, the expected outcome with the successful performance of this experiment is for the students to learn about the CE – BJT small signal amplifier designing procedures & to gain an insight into its operation. Computer simulation helps to verify the entire design process. Actually implementing will lead to an insight on how assumptions are made for it.

4. Problem Statement for Design

Design single stage CE – BJT amplifier to achieve a voltage gain of $|A_V| \geq 50$ to generate a peak output signal of $V_{out(peak)} = \pm 5$ V & employing BC 547B. Assume the lower cut-off frequency of f_L = 20 Hz & load resistance of R_L = 10 k8. Verify the designed & implement it.

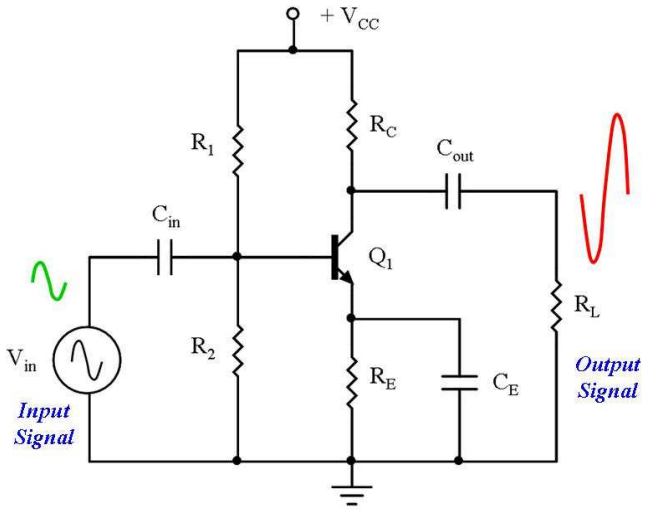
5. Brief Theoretical Description

(a) Concept of Small Signal Amplifiers :-



An electronic amplifier is an electronic device that increases the power of an input signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude. In this sense, an amplifier modulates the output of the power supply. Amplifiers are described according to their input & output properties. They exhibit the property of gain, or multiplication factor that relates the magnitude of the output signal to the input signal. The gain may be specified as the ratio of the output voltage to input voltage (voltage gain), output power to input power (power gain), or some combination of current (current gain). In many cases, with input and output in the same unit, gain is unit less or usually expressed in terms of decibels (dB).

(b) The CE – BJT Small Signal Amplifier:-

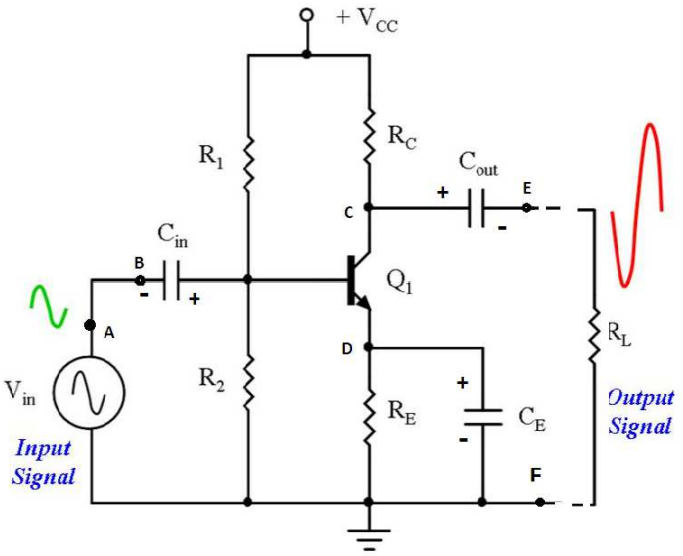


To obtain low distortion when used as an amplifier the operating quiescent point needs to be correctly selected. This is in fact the DC operating point of the amplifier and its position may be established at any point along the load line by a suitable biasing arrangement. The best possible position for this the Q-point is as close to the centre position of the load line as reasonably possible, thereby producing a Class A type amplifier operation, V_{CE} = ½ V_{CC}. Consider the common emitter amplifier circuit shown above. The single stage common emitter amplifier circuit shown above uses what is commonly called voltage divider biasing. This type of biasing arrangement uses two resistors as a potential divider network across the supply with their center point supplying the required base bias voltage to the transistor. Voltage divider biasing is commonly used in the design of bipolar transistor amplifier circuits.

In common emitter amplifier circuits, capacitors C_{in} & C_{out} are used as coupling capacitors to separate the AC signals from the DC biasing voltage. This ensures that the bias condition set up for the circuit to operate correctly is not affected by any additional amplifier stages, as the capacitors will only pass AC signals and block any DC component. The output AC signal is then superimposed on the biasing of the following stages. Also a bypass capacitor, C_E is included in the emitter terminal connection.

This capacitor is an open circuit component for DC bias meaning that the biasing currents and voltages are not affected by the addition of the capacitor maintaining a good Q-point stability. However, this bypass capacitor short circuits the emitter resistor at high frequency signals and only R_L plus a very small internal resistance acts as the transistors load increasing the voltage gain to its maximum. Generally, the value of the bypass capacitor, C_E is chosen to provide a reactance of at most, $1/10^{th}$ the value of R_E at the lowest operating signal frequency.

6. Circuit Diagram & Experimental Setup



7. Apparatus Required

(a) Software :-,MultiSim 10 by National Instruments (NI) OR CircuitMaker 2000 Professional Edition

(b) Components :-

Type of Component	Symbolic Notation	Component Value & Specification
Resistors	R_1	68 K, ¼ W
	R_2	12 K, ¼ W
	R_C	4.7K, ¼ W
	R_E	1.2K, ¼ W
Capacitors	C_{in}	1 µF, 63 V
	C_{out}	1 µF, 63 V
	C_E	100 µF, 63 V
BJT	Q_1	BC 547B
Resistor		1K
Potentiometer		10K

(c) Instruments :-

- Single DC Power Supply : 0-30 V
- Digital Multimeter (DMM)
- Function Generator: 0-10 MHz, 20 Vpp Max.
- Cathode Ray Oscilloscope (CRO) : 0-30 MHz
- Bread Board & Connecting Wires

8. Designing Steps & Procedure

Students should systematically explain the entire design procedure in this section, thereby justifying the selection of different component values according to given design specifications & draw circuit diagram

9. Experimental Procedure

1. Arrange designed circuit on bread board & give DC power supply of + 12V.
2. Give peak to peak input signal of around V_{in} = 50 mV, 10 kHz.
3. Measure the peak to peak output signal (V_{out}) on the CRO screen.
4. Measure Vc(at point C), V_{E}(at point D), and calculate Q point of the Amplifier.
5. Calculate the overall amplifier system voltage gain $|A_V| = V_{out} / V_{in}$
6. To calculate the current gain, connect 1k resistor in series with the input signal (i.e. between pint A &B) and measure voltage (**vi'**) at point B.
7. To calculate input impedance Ri, connect 10K Potentiometer (POT) in series with input signal (i.e. between pint A &B). And adjust POT accordingly so that you will get output voltage (Vo/2) half of the original output voltage. After this, remove POT and check resistor value of the POT on multimeter.
8. To calculate output impedance Ro, connect 10K Potentiometer (POT) between point (C and F). And adjust POT accordingly so that you will get output voltage (Vo/2) half of the original output voltage. After this, remove POT and check resistor value of the POT on multimeter.
9. For measuring frequency response, connect circuit as per original diagram and vary input frequency (from 20 Hz – 1 MHz) and measure output voltage.

10. Observation Table

1. Q Point of the Amplifier

Vcc	Vc	VE	**Ic= Vcc-Vc/Rc**	**V_{CE} = Vc- V_E**

Q point = (VcE, Ic)

2. Voltage gain :

Vin= , Vo= , Av = Vo/Vin

3.Current gain :

Ii = (Vi-Vi')/1k, Io= V0/Rc , Ai = Io/ Ii

4.Input impedance Ri= , **Output impedance** Ro=

5. Frequency response curve:

Input voltage, Vi= 50mV

Frequency	Vo	Gain = Vo/ Vin	Gain in db

11. Conclusions & Inferences

Students should explain in brief the concluded outcome from the experiment & its inference, as obtained from the observation table & nature of the graph which explains the circuit behavior as per the conditions

12. Practical & Real Life Applications

- Public Address Systems (PAS)
- Audio & Music Equipment
- CD & Cassette Players
- Microphone Pre-amplification Stage
- TV & Radio Receivers
- Communication Systems & Equipment

13. Post Lab Questions

1. Draw DC load line & locate Q – point for the designed circuit by performing DC analysis.
2. Perform small signal (AC) analysis on the designed amplifier (Calculate A_v, R_i or Z_i & R_o or Z_o).
3. Systematically compare & tabulate all different BJT amplifier configurations (CB, CE & CC).

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