**American International University- Bangladesh**
**Department of Electrical and Electronic Engineering**
EEE2104: Electronic Devices Laboratory

**Title:** Bipolar Junction Transistor (BJT): Study of Single Stage Transistor Common Emitter Amplifier

## Introduction:

The aim of the ac analysis is to determine the voltage amplification ($A_V$), current amplification (Ai), input impedance ($Z_i$), output impedance (Zo), and the phase relation between the input voltage (Vi) and the output voltage (Vo). After performing the dc analysis, we will now calculate the small signal parameters depending on the model being used, draw the small signal equivalent circuit and then perform the ac analysis.
The main objectives of this experiment are to-

- Trace the circuit diagram of a single stage transistor Amplifier;
- Measure Beta (β) of the transistor with multimeter.
- Measure the Q – Point.
- Measure the maximum signal that can be amplified with the amplifier without any distortion.
- Measure the voltage gain of the amplifier at 1KHz.
- Measure the voltage gain of the amplifier at different values of load resistance.

## Theoretical Background:

The analysis is done assuming that the signal frequency is sufficiently high. Subsequently it can be assumed that all the coupling capacitors (C1 and C2) and the bypass capacitor ($C_E$) act as perfect short circuits. Such a frequency is said to be in the mid band of the amplifier.
The hybrid-π model and T-model can be used for the ac analysis. Those models are valid only for small signals. The general forms of these models are shown in the following figures 1 and 2.

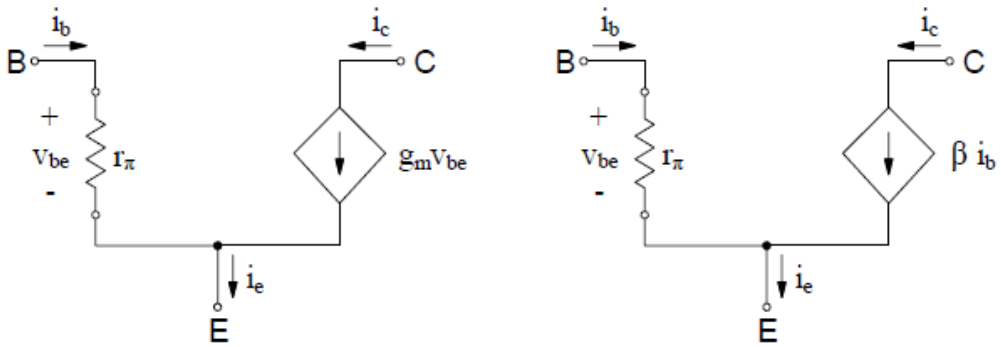


**Fig. 1: The Hybrid π-model**

Where, Transconductance

$$g_m = \frac{I_C}{V_T} \quad \text{and} \quad V_T = \frac{KT}{q}$$

Common emitter input resistance

$$r_\pi = \frac{\beta}{g_m}$$

Common base input resistance

$$r_e = \frac{\alpha}{g_m}$$

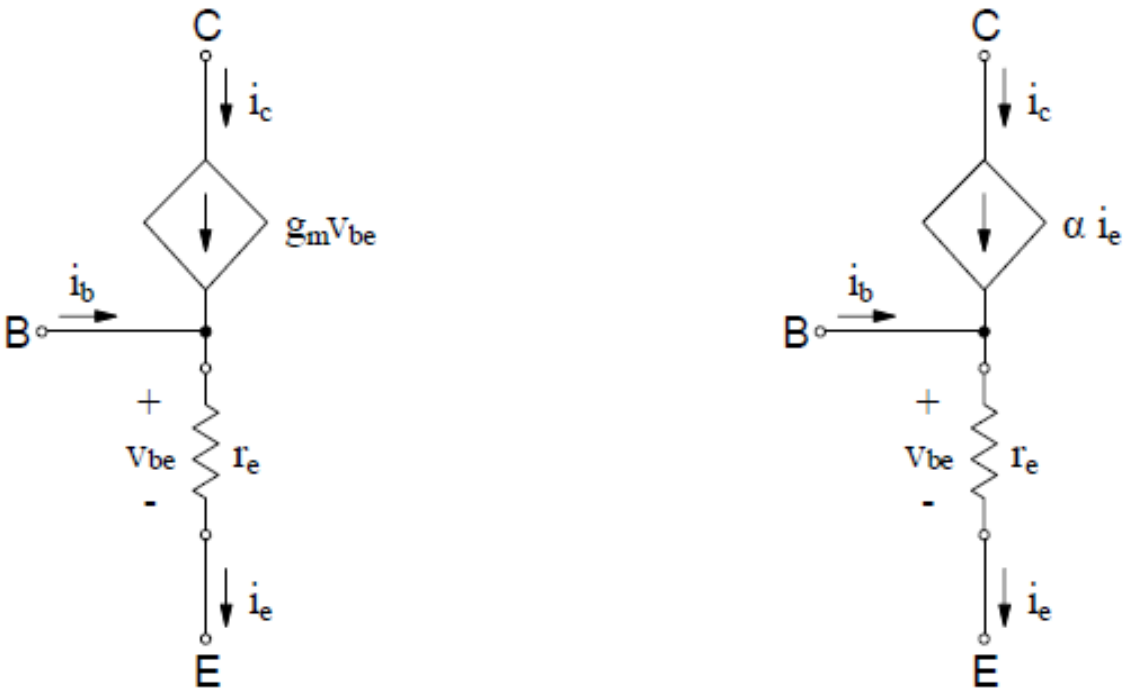


**Fig. 2: The T-model**

Since in this experiment we will mainly concentrate on single stage amplifier where most widely used single stage transistor amplifier in common emitter configuration is shown in the figure below.

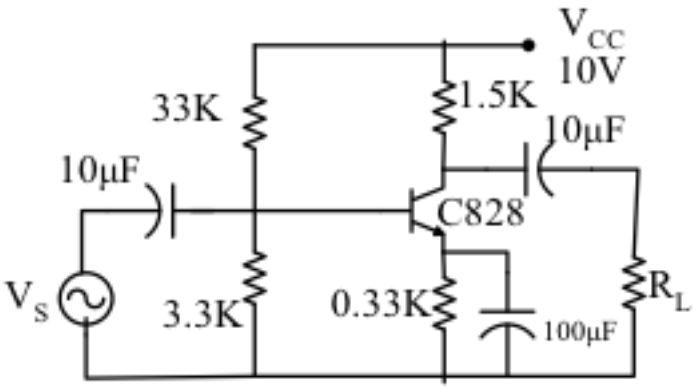


**Fig. 3: Single Stage CE Amplifier**

**Pre-lab Homework:**

Read about single stage transistor amplifier and their equivalent models from "Microelectronic Circuits" by A.S. Sedra, K.C. Smith and use Pspice to generate the output of the circuits provided in this lab sheet. Compare the graphs given in the textbook with your results. Save the simulation results and bring it to the lab.

In order to analyze the single stage CE amplifier, consider the circuit described in the above figure 3. Hence do the following:

- Use "Pspice" to implement the above circuit using 2N2222 transistor.
- Determine the DC operation point values for $V_B$, $V_C$, $V_{CE}$, $V_E$, $I_C$, and $I_B$
- Perform a transient analysis of a sinusoidal input signal. The input signal $V_S$ exhibits a frequency of 1 KHz and an amplitude 10 mV peak. Display the input voltage and the voltage across load resistance $R_L$ together to see the transistor amplification characteristics. Also display the base voltage $V_B$.

**Apparatus:**

| No. | Apparatus | Quantity |
|---|---|---|
| 1 | Transistor (C828) | 1 |
| 2 | 33k, 10k, 4.7k, 1k, 3.3k, 1.5k, 330Ω Resistance | 1 for each |
| 3 | Project Board | 1 |
| 4 | Cathode Ray Oscilloscope (CRO) | 1 |
| 5 | Multimeter | 1 |
| 6 | Signal Generator | 1 |
| 7 | 100μF Capacitor | 1 |
| 8 | Probes | 2 |
| 9 | Power Supply Cable | 2 |

**Precaution:**

Transistors are sensitive to be damaged by electrical overloads, heat, humidity, and radiation. Damage of this nature often occurs by applying the incorrect polarity voltage to the collector circuit or excessive voltage to the input circuit. One of the most frequent causes of damage to a transistor is the electrostatic discharge from the human body when the device is handled.

**Experimental Procedure:**

1. Measure β of the transistor with multimeter.
2. Calculate DC operating point of the transistor circuit.
3. Implement the circuit as shown in the figure.
4. Measure the operating point with the help of table: 1 and compare with your calculated value.
5. Feed ac Signal of 1 kHz at the input and observe the input and output on the CRO.
6. Increase the input signal till the output wave shape starts getting distorted. Measure this input signal. This is the maximum input signal that the amplifier can amplify without any distortion.
7. Now feed an ac signal that is less than the maximum signal handling capacity of the amplifier. Fix the input signal frequency at 1 KHz, Draw the input and output voltage wave shape and calculate gain.

**8.** Connect different load resistors and find the voltage gain of the amplifier for each.

Observations:

**1.** Q – Point of the amplifier.

| $V_{CC}$ | $V_C$ | $V_{CC} - V_C$ | $I_C = (V_{CC}-V_C) / R_C$ | $V_{CE}$ |
|---|---|---|---|---|
| | | | | |

**2.** Maximum signal that can be handled by the amplifier without introducing distortion = ……..V and Operating frequency = ……KHz

**3.** Voltage Gain of the amplifier:

| Load Resistor | Input voltage | Output Voltage | Gain |
|---|---|---|---|
| 1K | | | |
| 4.7K | | | |
| 10K | | | |
| 100K | | | |

**Simulation and Measurement:**

Compare the simulation results with your experimental data/ wave shapes and comment on the differences (if any).

**Discussion and Conclusion:**

Interpret the data/findings and determine the extent to which the experiment was successful in complying with the goal that was initially set. Discuss any mistake you might have made while conducting the investigation and describe ways the study could have been improved.

**Report:**

1. Show all the experimental data and calculations in your report.
2. Why do we need all of the capacitors and resistors shown in the circuit?
3. Discuss the experiment as a whole.

**References:**

1. American International University–Bangladesh (AIUB) Electronic Devices Lab Manual.
2. A.S. Sedra, K.C. Smith, “Microelectronic Circuits,” Oxford University Press (1998).
3. J. Keown, ORCAD PSpice and Circuit Analysis, Prentice Hall Press (2001)
4. P. Horowitz, W. Hill, “The Art of Electronics,” Cambridge University Press (1989).

**Thank you!**