AY-2025-2026
ODD SEM

Department of ECE

ANALOG ELECTRONIC CIRCUIT DESIGN

23EC2104

Topic:

DESIGN OF BJT AMPLIFIER

Session - 10

SESSION CONTENT

- Design of BJT amplifier

AIM OF THE SESSION

To understand the principles and steps involved in designing BJT amplifiers, and to apply design techniques to achieve desired amplifier specifications such as gain, bandwidth, and stability.

INSTRUCTIONAL OBJECTIVES

The Session is designed to:

1. Explain the general approach for designing a BJT amplifier.
2. Select appropriate biasing techniques to ensure proper Q-point operation.
3. Design small-signal equivalent models for amplifier analysis.

LEARNING OUTCOMES

At the end of this session, learners will be able to:

1. Design a BJT amplifier circuit to meet specified requirements.
2. Determine suitable biasing components for thermal and operating point stability.

CE Amplifier Circuit

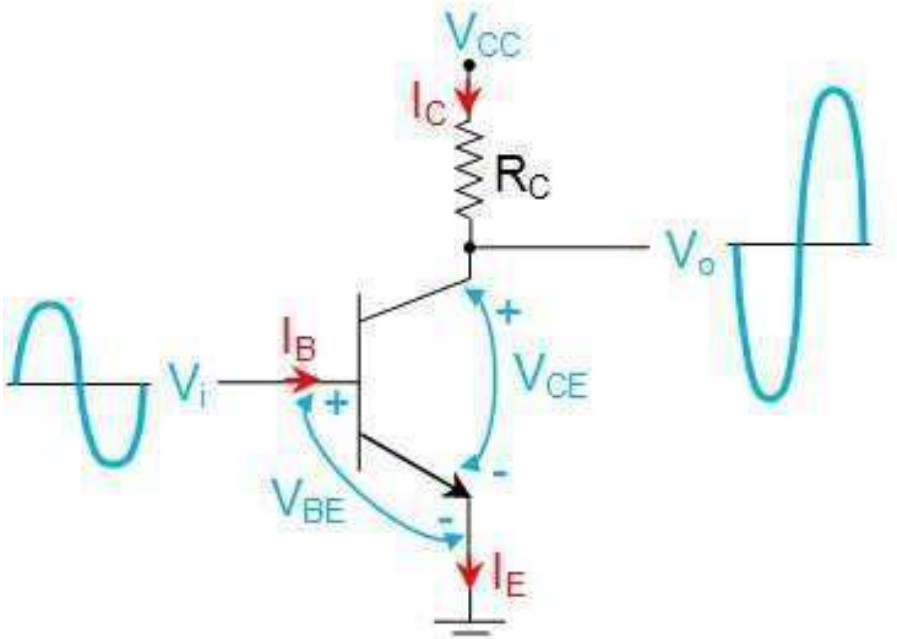


Figure 1 A Simple Common Emitter Amplifier

$$V_0 = V_{CC} - I_C R_C$$

- Collector terminal (output terminal) is connected to supply voltage V_{CC} through the collector resistor R_C.
- Base terminal is provided with the AC signal which needs to be amplified.
- Emitter terminal is grounded (hence also referred to as Grounded Emitter configuration).

CE Amplifier Circuit

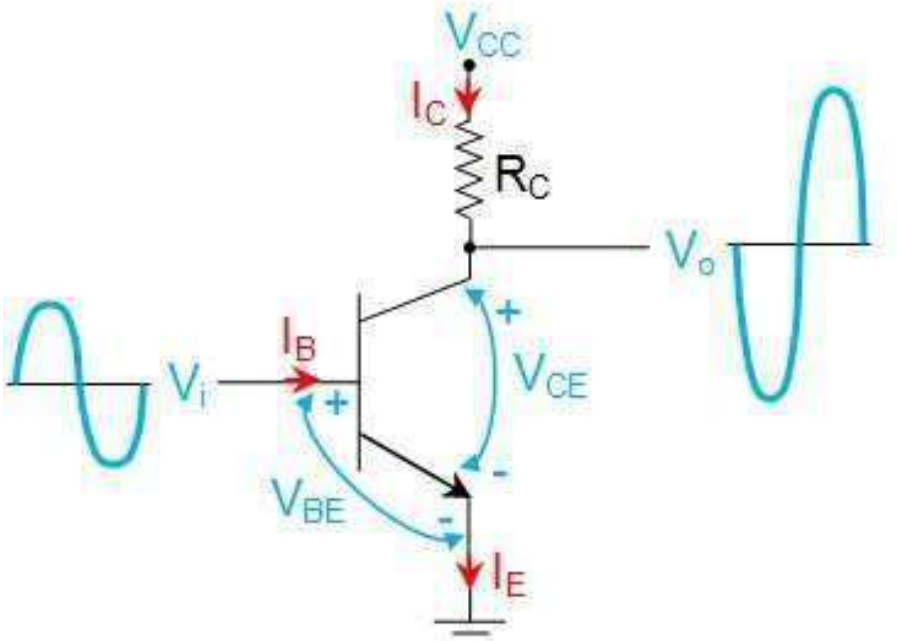


Figure 1 A Simple Common Emitter Amplifier

❖In this kind of arrangement, as the input voltage V_i increases, the base current I_B also increases which in turn increases the collector current I_C.

❖This causes an increase in the voltage drop across the collector resistor, R_C which results in a decreased output voltage V_0 as emphasized by the following relationship

$$V_0 = V_{CC} - I_C R_C$$

CE Amplifier Circuit

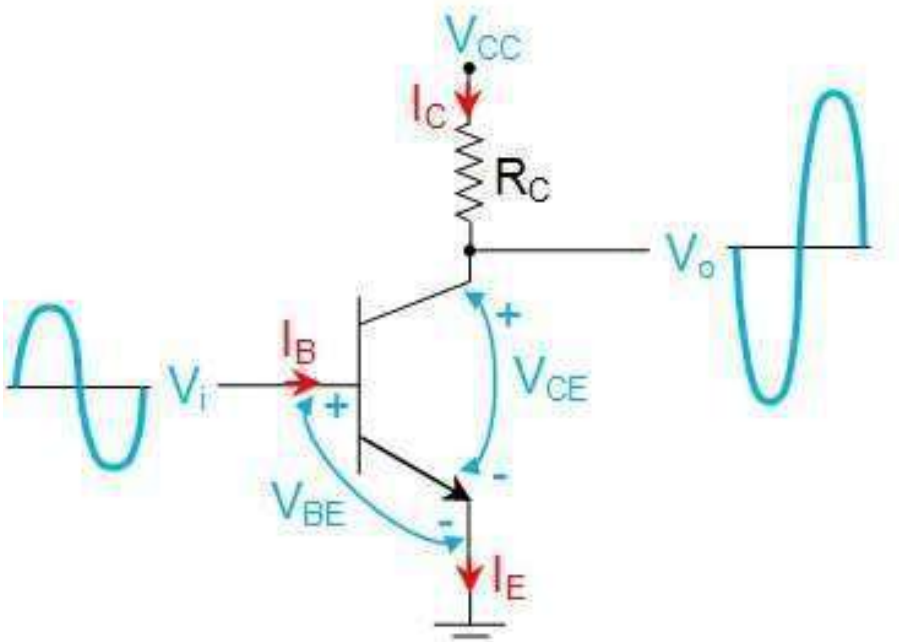
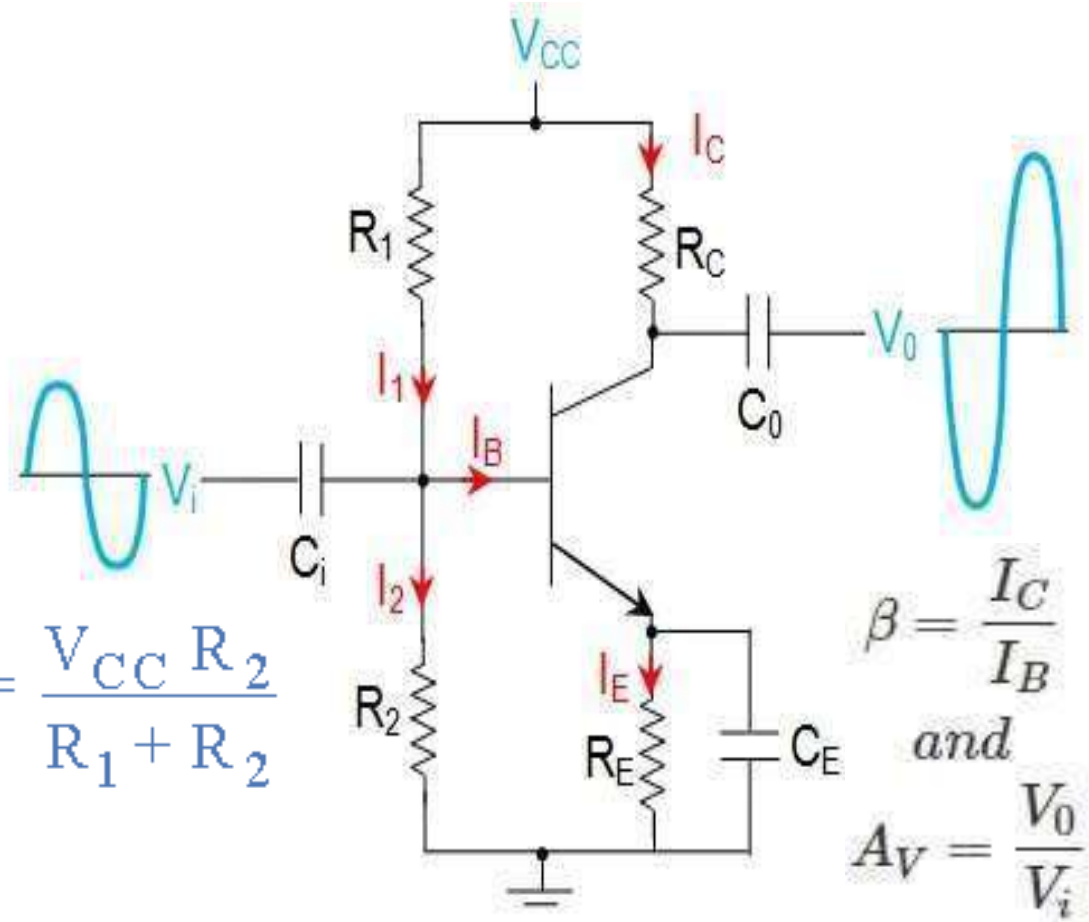


Figure 1 A Simple Common Emitter Amplifier

$$V_0 = V_{CC} - I_C R_C$$

- Similarly as the input voltage goes on decreasing, I_B and hence I_C decrease, due to which the voltage drop across R_C also decreases thereby increasing the output voltage.
- This indicates that for the positive half-cycle of the input waveform, one would get amplified negative half-cycle while for the negative input pulse, the output would be a amplified positive pulse. Hence there exists a phase-shift of 180^o between the input and the output waveforms of the **common emitter amplifier** for which it is also referred to as Inverting Amplifier.

CE Amplifier Circuit



$$V_B = \frac{V_{CC} R_2}{R_1 + R_2}$$

$$\beta = \frac{I_C}{I_B}$$

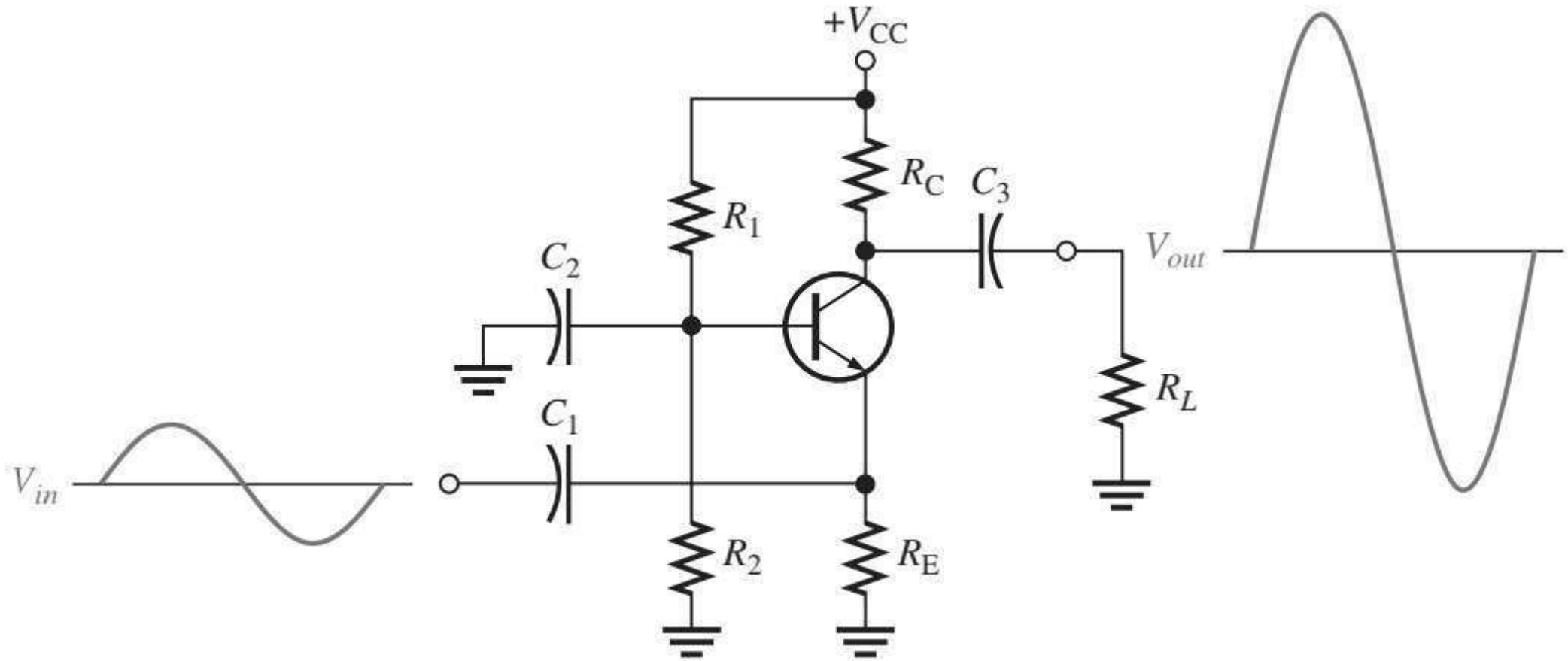
and

$$A_V = \frac{V_0}{V_i} = -\frac{R_C}{R_E}$$

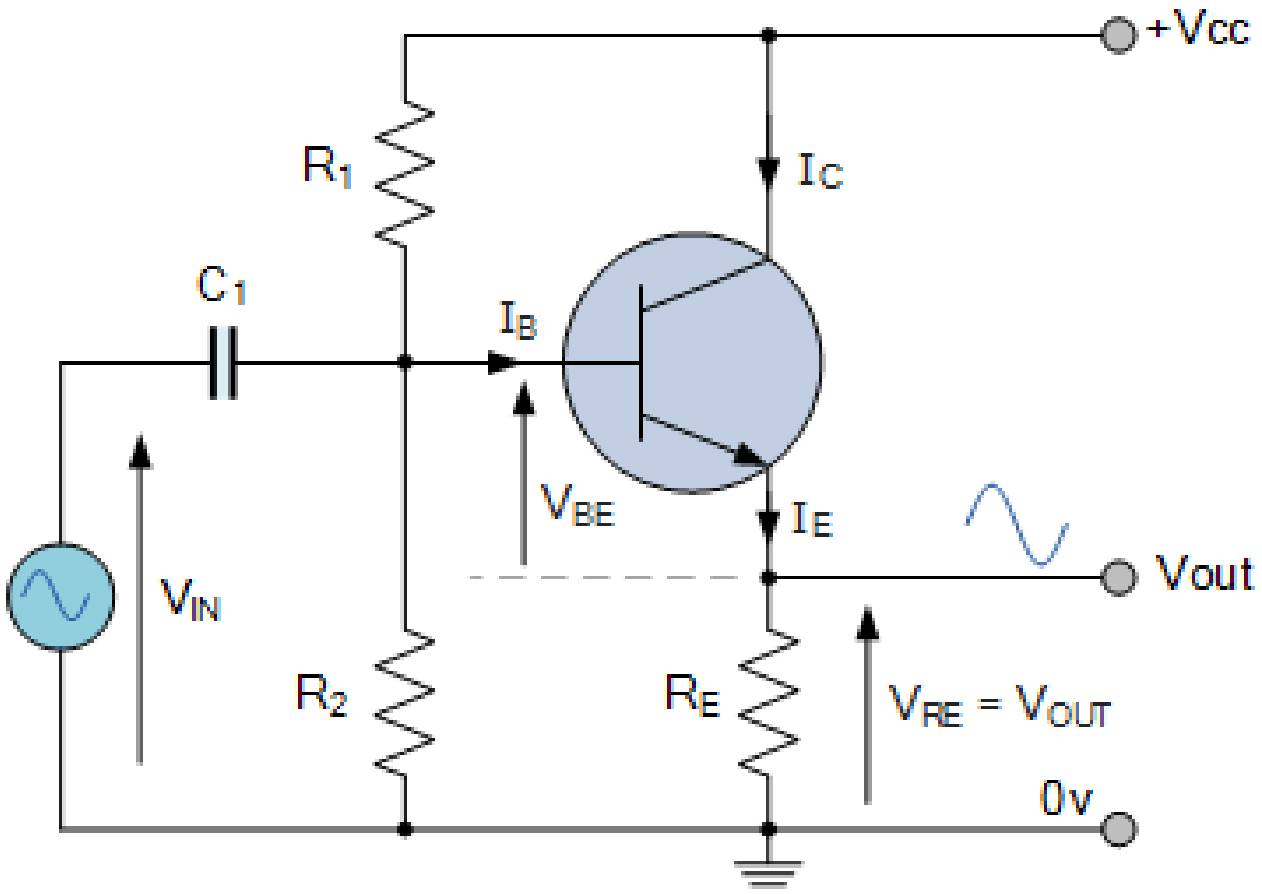
Figure 2 Common Emitter Amplifier with Biasing and Decoupling Details

- **R1** and **R2**-Voltage Divider Bias
- Ci and Co-Coupling Capacitor for blocks any DC Components and passes AC Signal for Amplification
- Rc for Controlling Ic and Provide Output Voltage.
- RE provides biasing stabilization.
- CE provides low reactance path to the amplified AC signal.

CB Amplifier Circuit

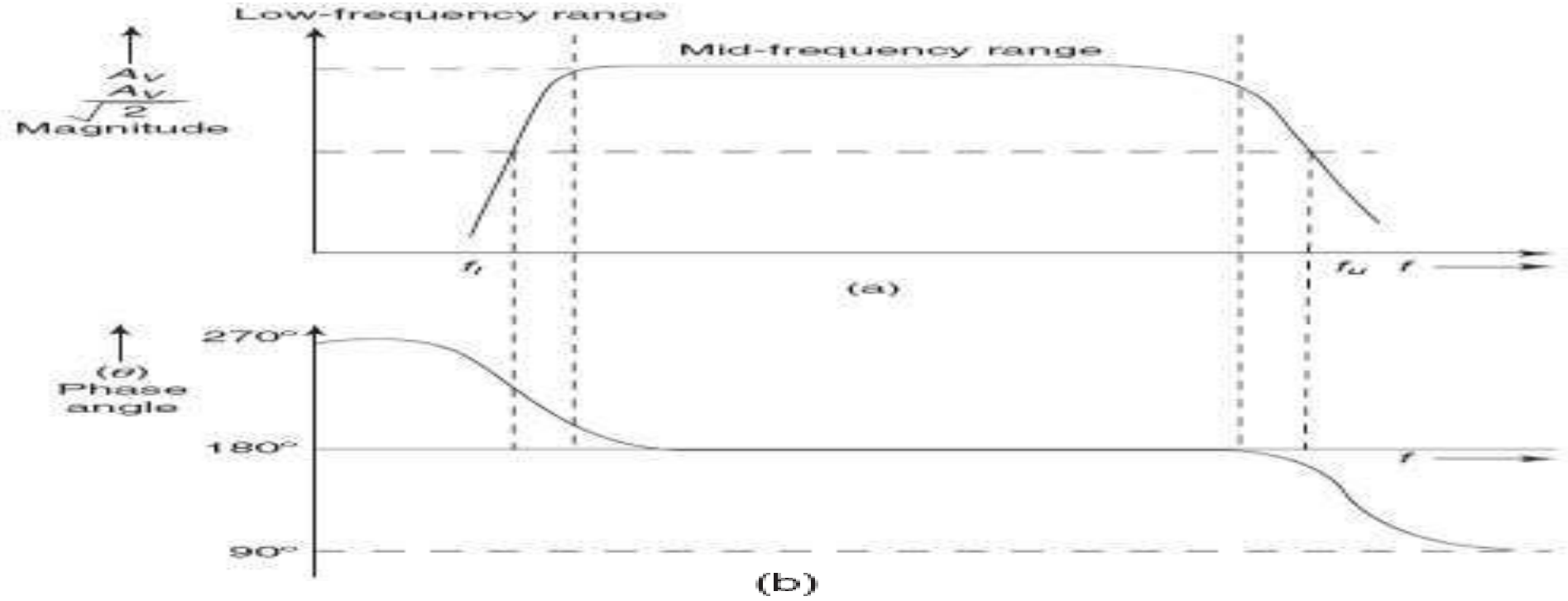


CC Amplifier Circuit(Emitter Follower)



FREQUENCY RESPONSE FOR CE AMPLIFIER WITH AND WITHOUTSOURCE IMPEDANCE

At different frequencies of the input signal, the performance of the device is different. The analysis till now has been limited to the mid-frequency spectrum. Frequency response of an amplifier refers to the variation of the magnitude and phase of the amplifier with frequency.



(a) Gain vs. frequency for a CE amplifier

(b) Phase angle vs. frequency for a CE amplifier

Comparison of BJT Amplifier

Characteristics	**CE Amplifier**	**CB Amplifier**	**CC amplifier (Emitter Follower)**
Current Gain	High	Less Than Unity	High
Voltage Gain	High	High	Less Than Unity
Input Resistance	Medium	Lowest	Highest
Output Resistance	Moderately High	Highest	Lowest
Phase Shift between Input and Output	180 °	0°	0°
Application	For Audio Frequency Applications	For High Frequency Applications	For Impedance Matching

Table Characteristics of the three BJT amplifier configurations

Configuration	Voltage gain	Current gain	Input resistance	Output resistance
Common emitter	$A_v > 1$	$A_i > 1$	Moderate	Moderate to high
Emitter follower	$A_v \cong 1$	$A_i > 1$	High	Low
Common base	$A_v > 1$	$A_i \cong 1$	Low	Moderate to high