

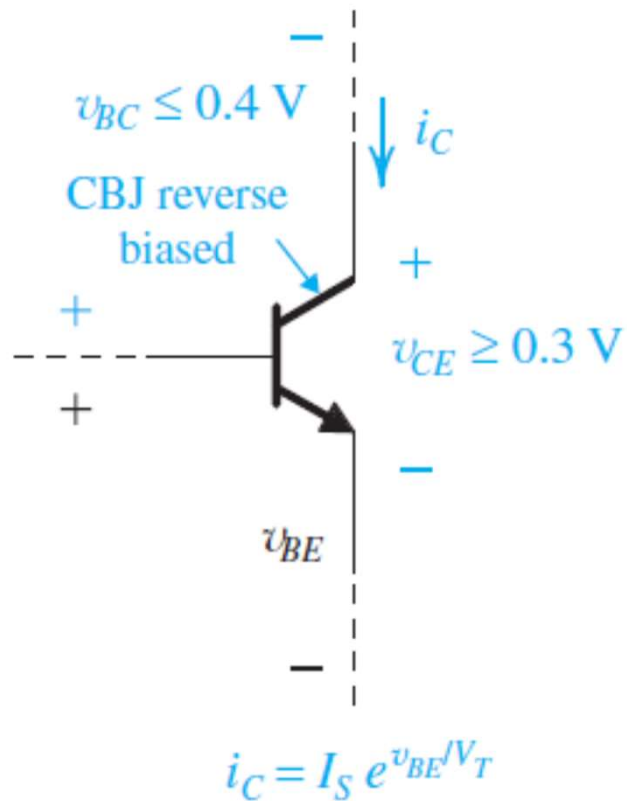
BASIC ELECTRONIC CIRCUITS

Amplifiers, and Op-Amps

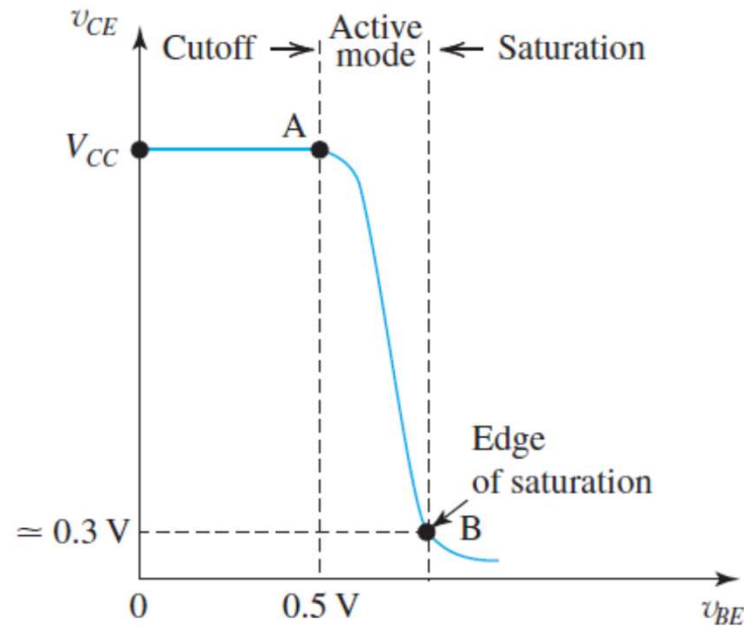
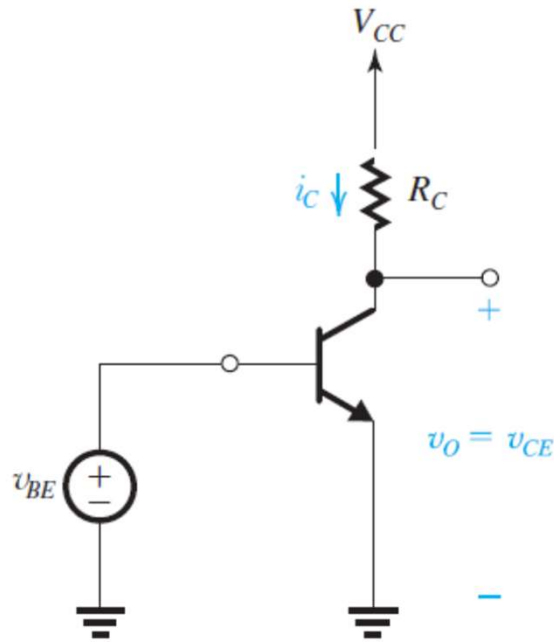
Content

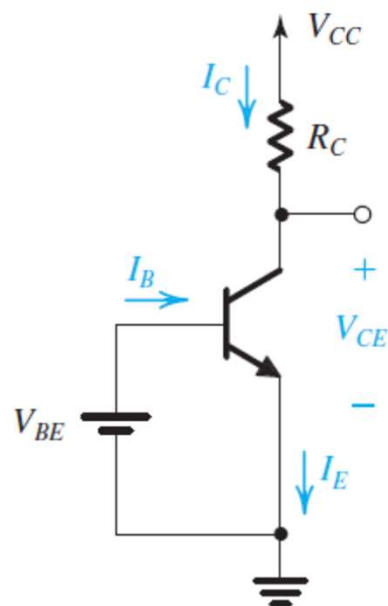
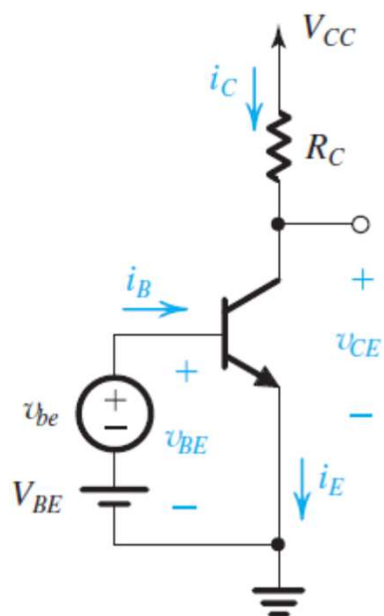
- Amplifiers
- Amplifier Parameters
- Amplifier types
- Operational Amplifiers
- Basic characteristics
- Configurations: Inverting, noninverting etc.

The basis for Amplifier Operation



Npn amplifier and Voltage-Transfer Characteristics





$$I_C = I_S e^{V_{BE}/V_T}$$

$$I_E = I_C / \alpha$$

$$I_B = I_C / \beta$$

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

$$v_{BE} = V_{BE} + v_{be}$$

$$\begin{aligned} i_C &= I_S e^{v_{BE}/V_T} = I_S e^{(V_{BE} + v_{be})/V_T} \\ &= I_S e^{V_{BE}/V_T} e^{v_{be}/V_T} \end{aligned}$$

$$i_C = I_C e^{v_{be}/V_T}$$

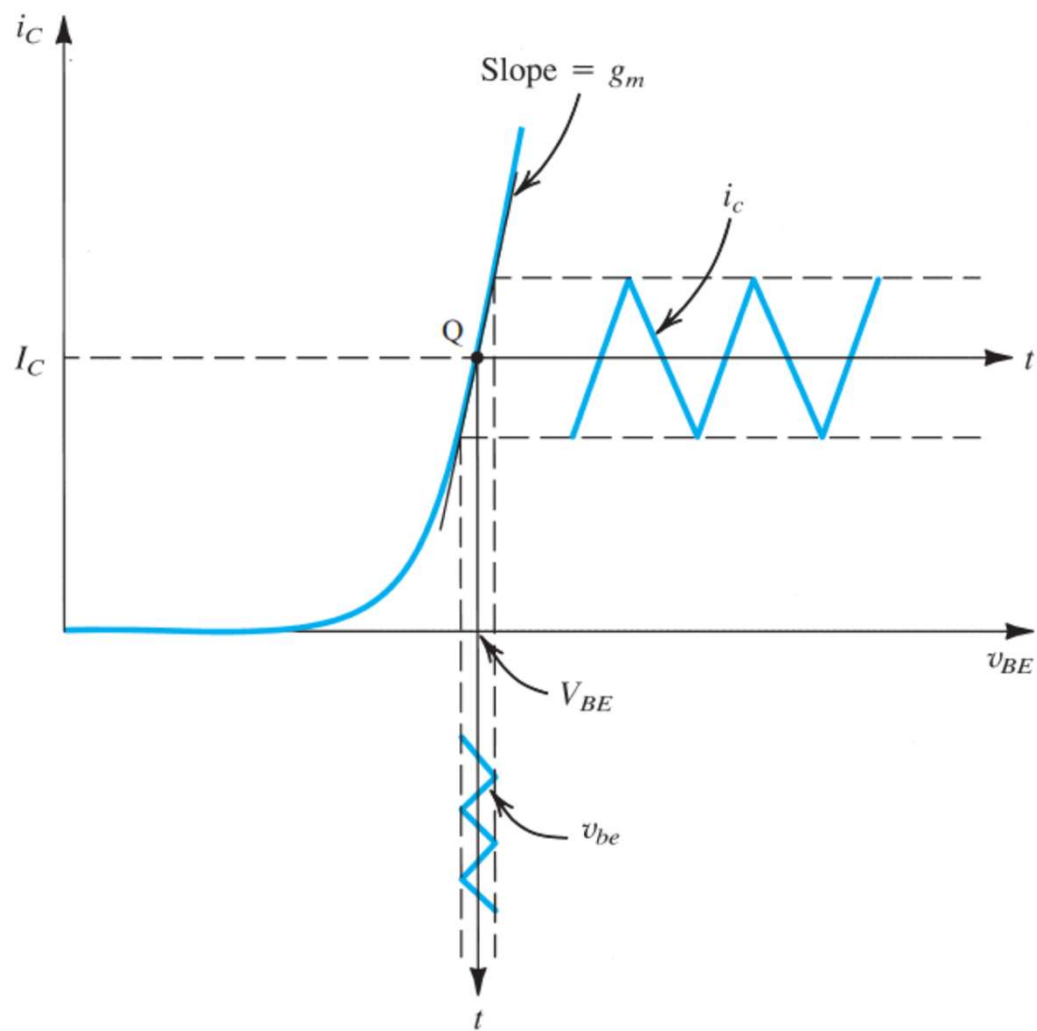
$$i_C \simeq I_C \left(1 + \frac{v_{be}}{V_T} \right)$$

$$i_c = \frac{I_C}{V_T} v_{be}$$

$$i_c = g_m v_{be}$$

$$g_m = \frac{I_C}{V_T}$$

$$v_{be} \ll V_T$$



Amplifiers

- **Signal Amplification:**
 - Increase the amplitude of the signal without changing the other parameters.
- Why the signal amplification is needed?
 - The weak signal are too small for reliable processing
- **Linearity:** it is essential to make sure that the information contained in the signal is not changed and no new information is introduced. Then the output signal will be exact replica of that at the input.
- Any changes in waveform is considered to be distortion and is obviously undesirable.
- Ex: Voltage amplifier, Power Amplifier.

Amplifier parameters

- Gain
- Frequency response
- Bandwidth
- Input impedance
- Output impedance

Gain

- Measure of the amplification of an amplifier
- Ratio of the output signal amplitude to input signal amplitude
- Symbol - A
- Voltage gain (A_V), Current gain (A_i), power gain (A_P)

$$A_V = \frac{V_{out}}{V_{in}}$$

$$A_I = \frac{I_{out}}{I_{in}}$$

$$A_P = \frac{P_{out}}{P_{in}}$$

Voltage Gain in dB= $20 \log |A_V|$

Current Gain in dB= $20 \log |A_i|$

Power Gain in dB= $10 \log A_P$

Input and output Impedance

- Input impedance: impedance experienced as the amount of current able flow into the input terminals
- Depends upon, frequency of the signal, gain of the amplifier, and load connected at the output terminals.
- Output impedance: responsible for the fall in signal voltage at the output terminals, when current is drawn from the output terminals.