Bipolar Junction Transistor (BJT)

Module:3	Transistors	5 hours
Bipolar Junction Transistor (BJT) - Device structure and physical operation, Concept of CB, CE and CC Configuration, Transistor as a Switch, - Metal-Oxide Field Effect Transistor (MOSFET) - Device Structure, Mode of operation and Characteristics, MOSFET configurations (CS, CD and CG).		

https://www.youtube.com/watch?v=-VwPSDQmdjM

Bipolar Junction Transistor (BJT)

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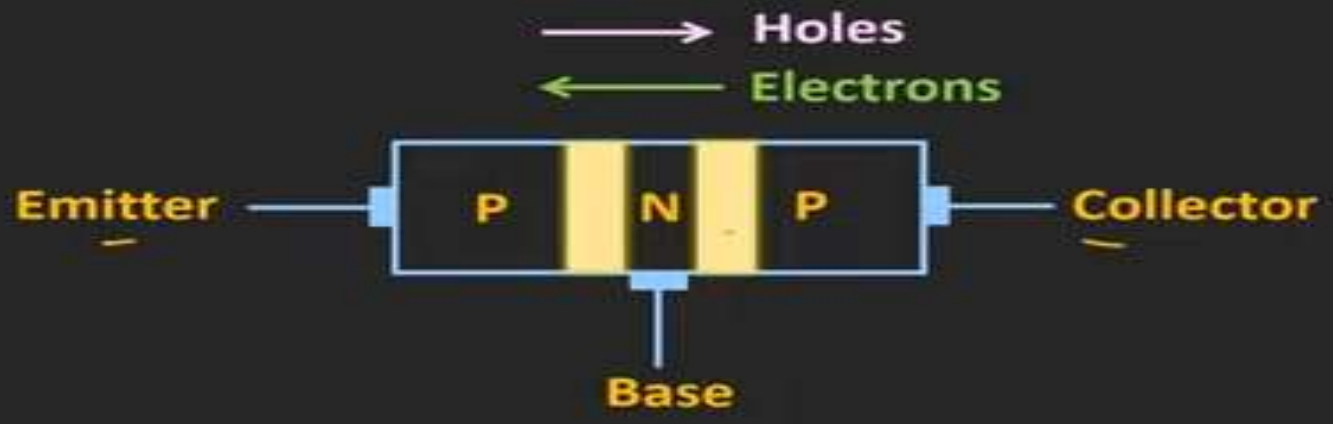
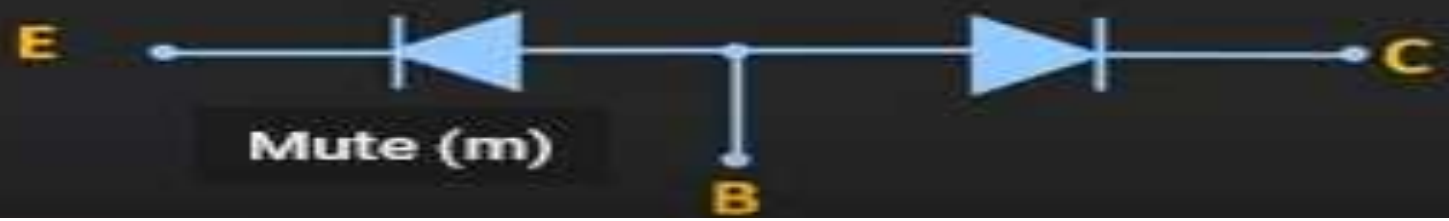
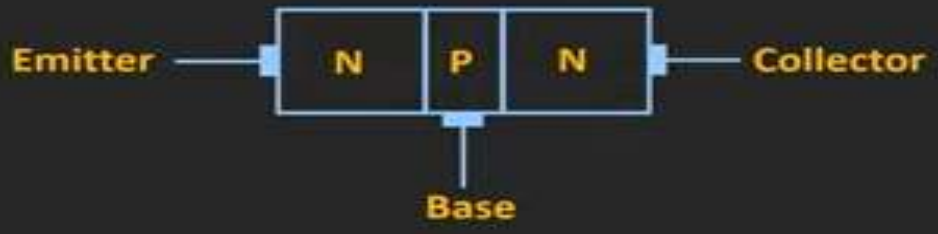




Bipolar Junction Transistor (BJT)



Emitter	Heavily Doped
Base	Lightly Doped
Collector	Moderately Doped

Base - Very Thin

Different Regions of Operation

Active Region

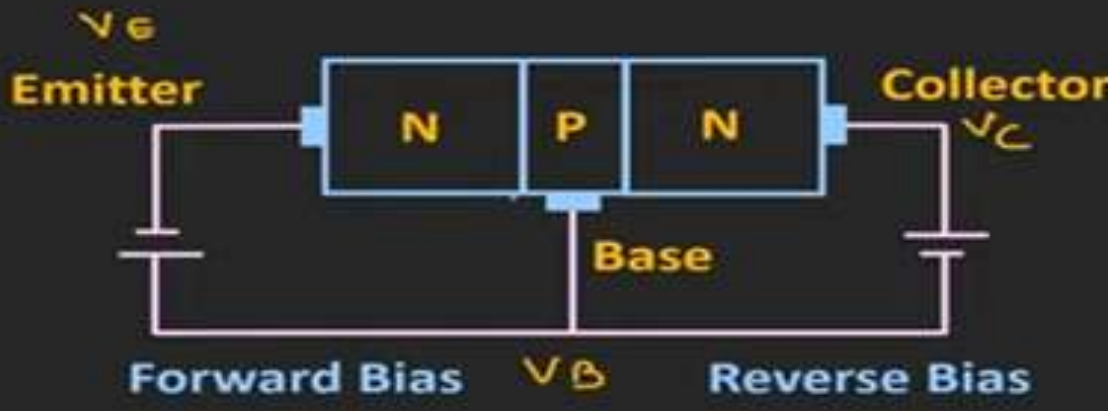
Cut-off Region

Saturation Region

Bipolar Junction Transistor (BJT)

Different Regions of Operation

Active Region

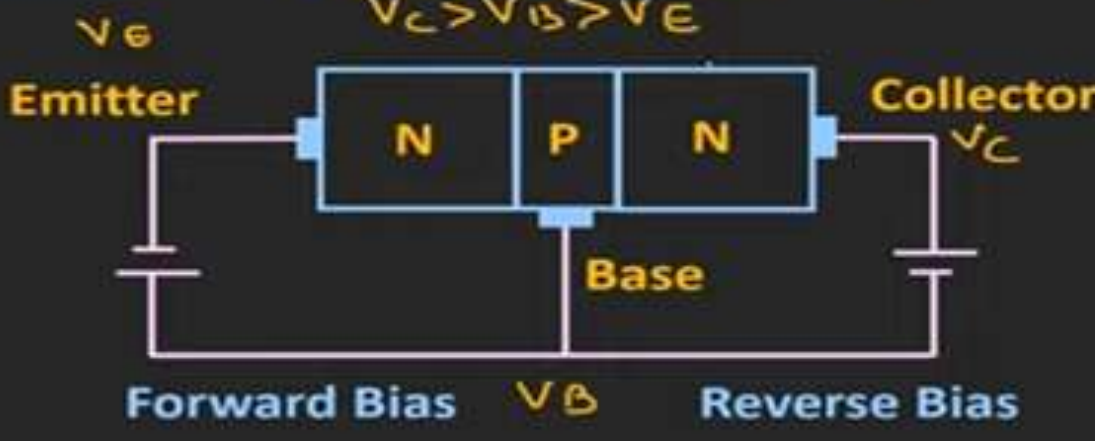


Different Regions of Operation

$V_B > V_E$ $V_C > V_B$

$V_C > V_B > V_E$

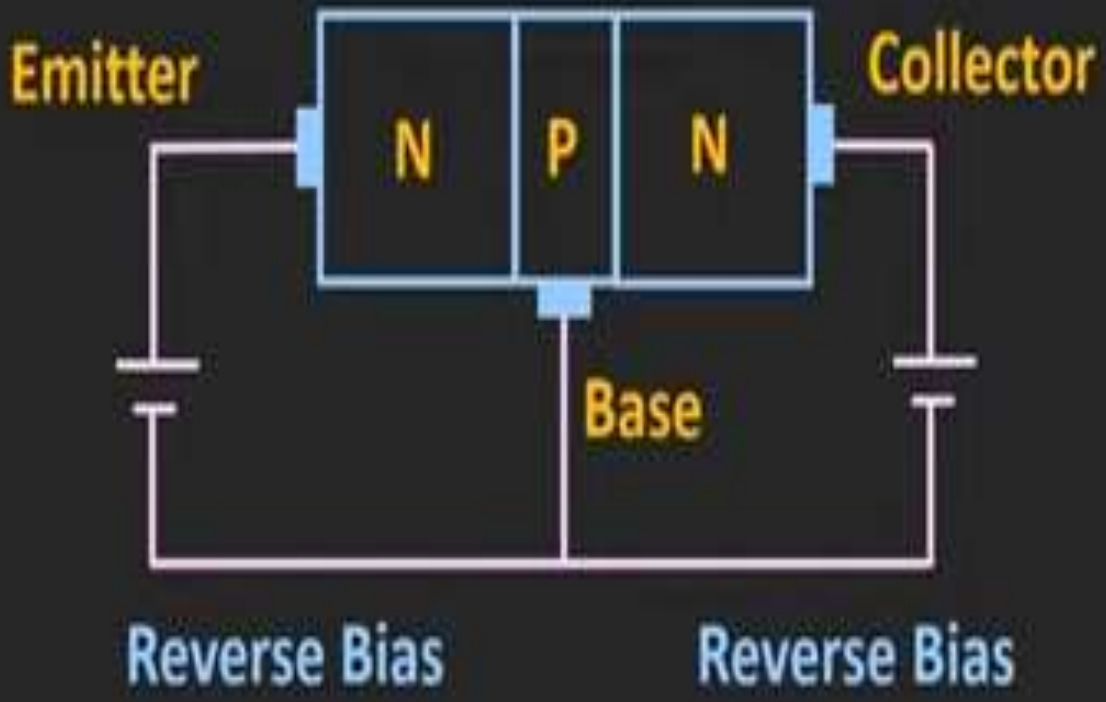
Active Region



Bipolar Junction Transistor (BJT)

Different Regions of Operation

$V_E > V_B$ $V_C > V_B$

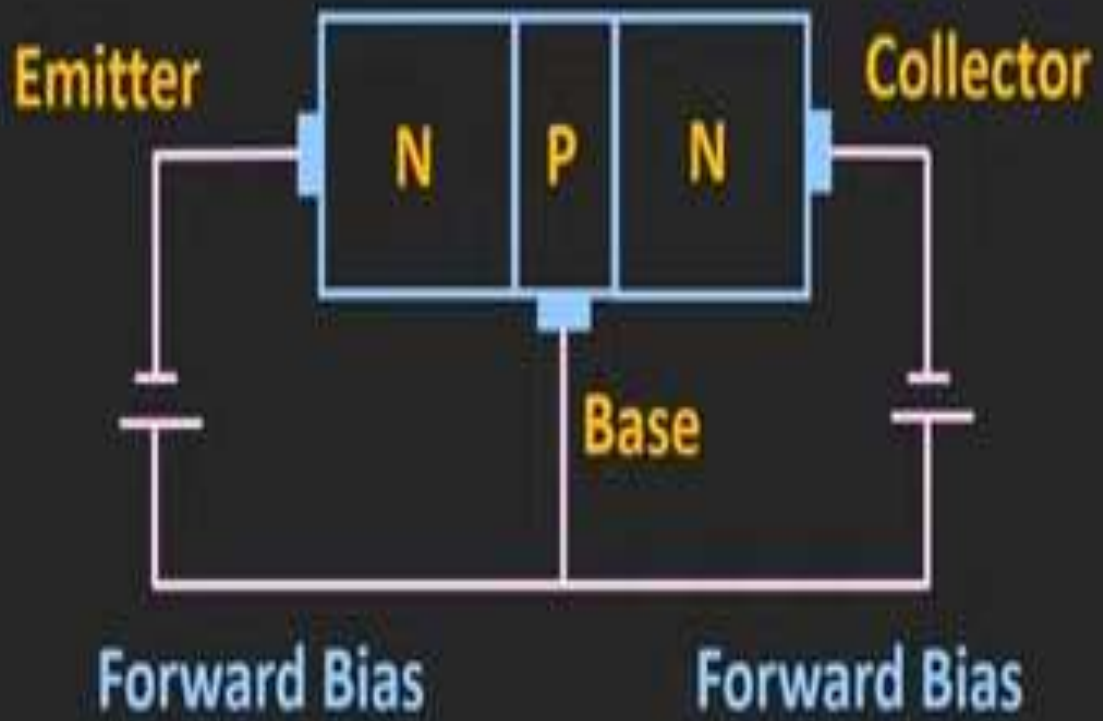


Cut-off Region

Bipolar Junction Transistor (BJT)

Different Regions of Operation

$V_B > V_E$ $V_B > V_C$



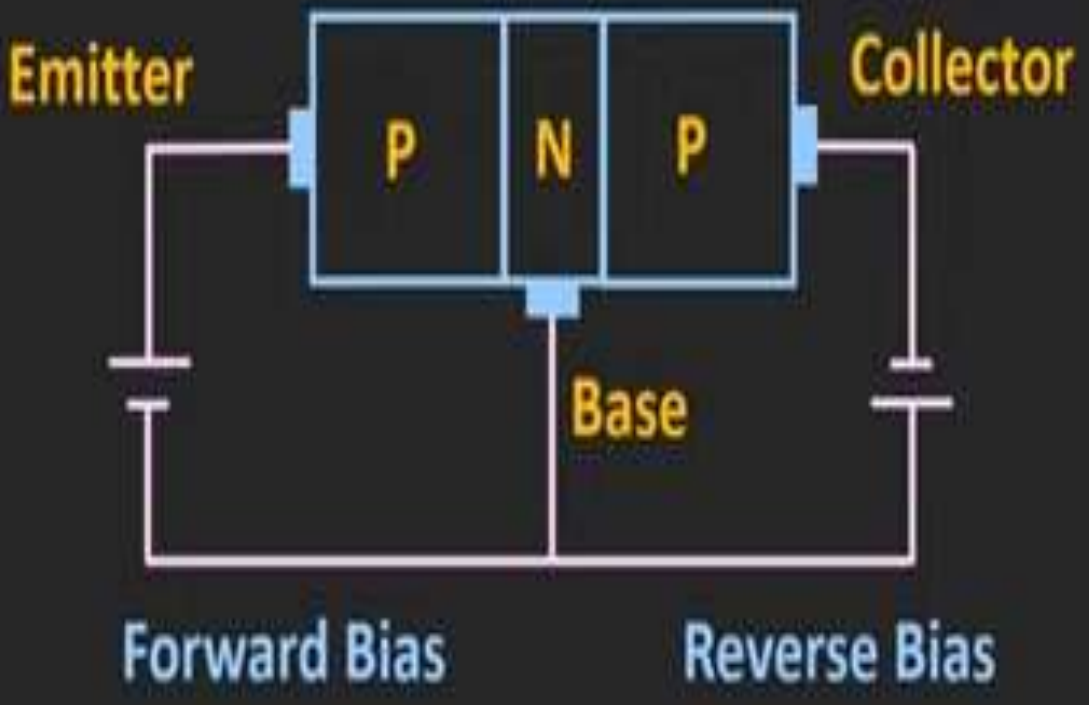
Saturation Region

Bipolar Junction Transistor (BJT)

Different Regions of Operation

$V_E > V_B$ $V_B > V_C$

Active Region



$V_E > V_B > V_C$

Bipolar Junction Transistor (BJT)

Different Regions of Operation

Active Region — Amplification

Cut-off Region

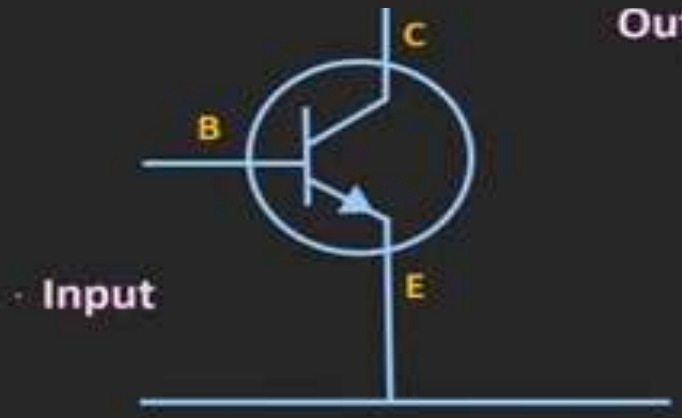
Saturation Region — Switching

Bipolar Junction Transistor (BJT)

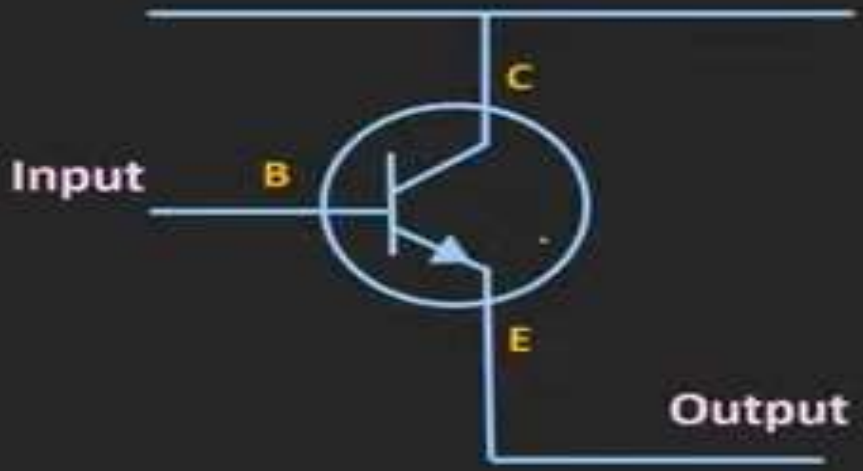
Bipolar Junction Transistor (BJT)

BJT Configuration

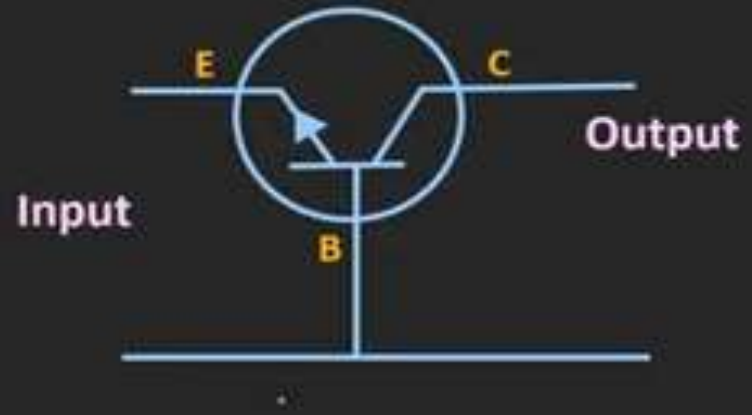
Common Emitter



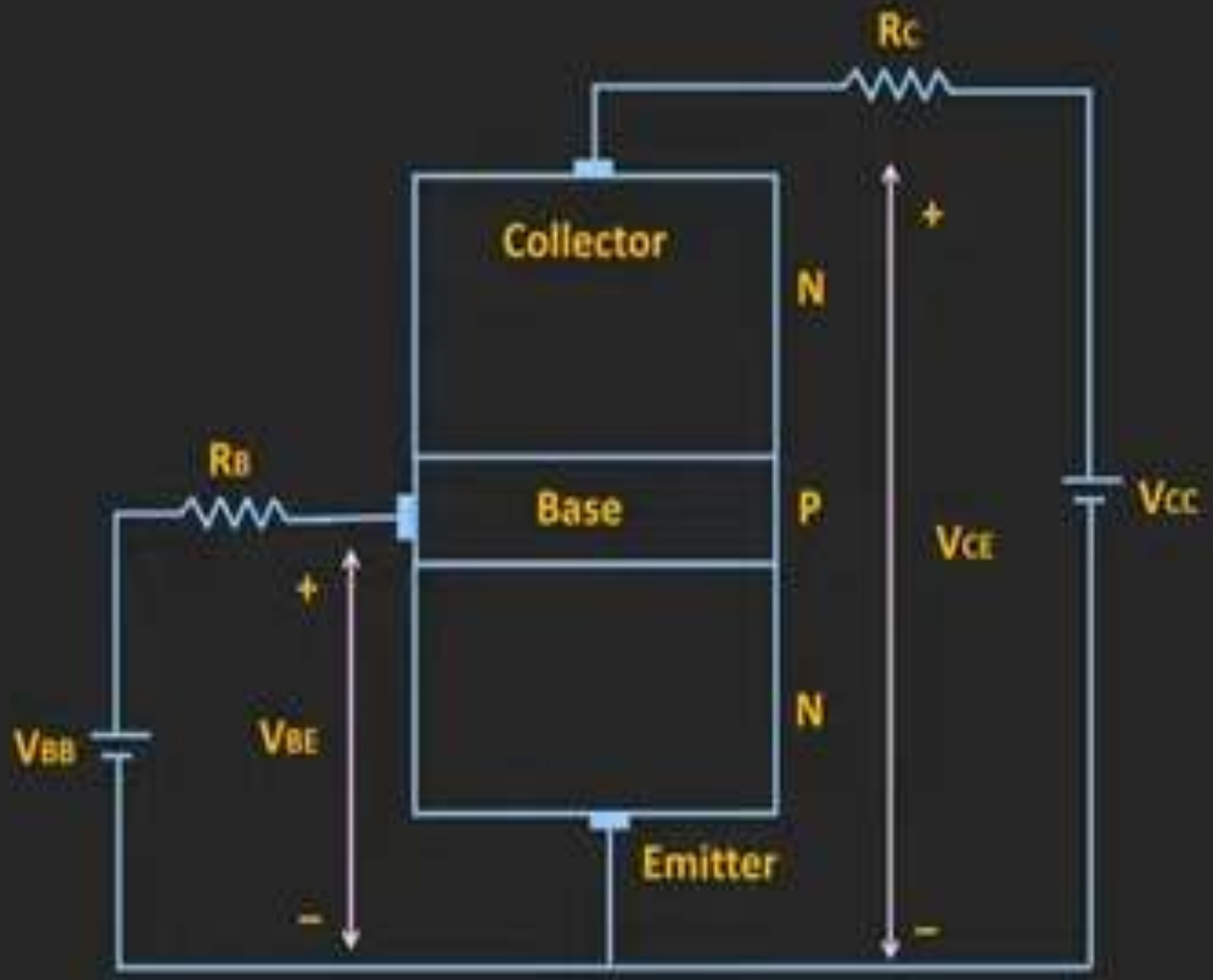
Common Collector



Common Base



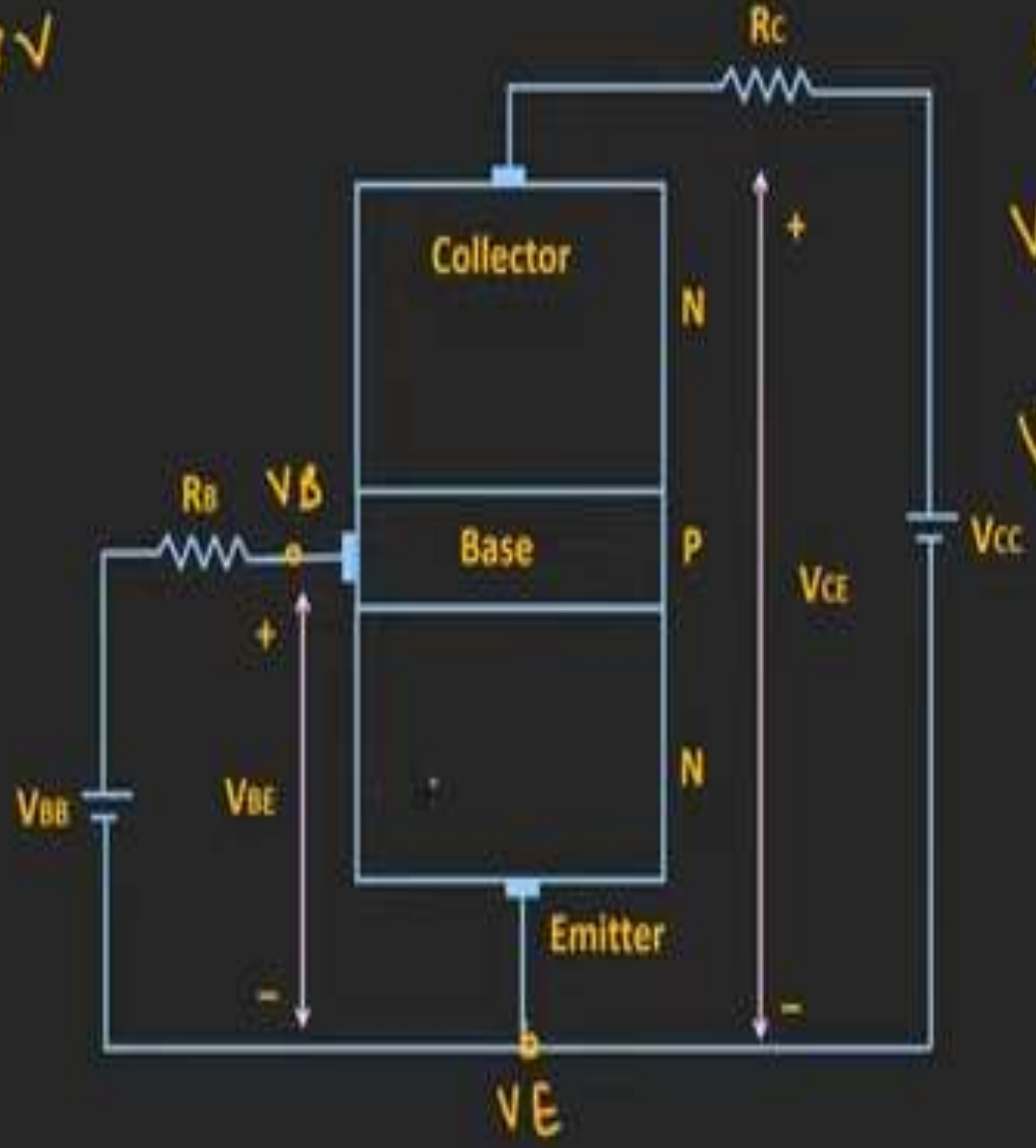
Working of BJT



Working of BJT

$V_{BE} \sim 0.7V$

V_{CB}



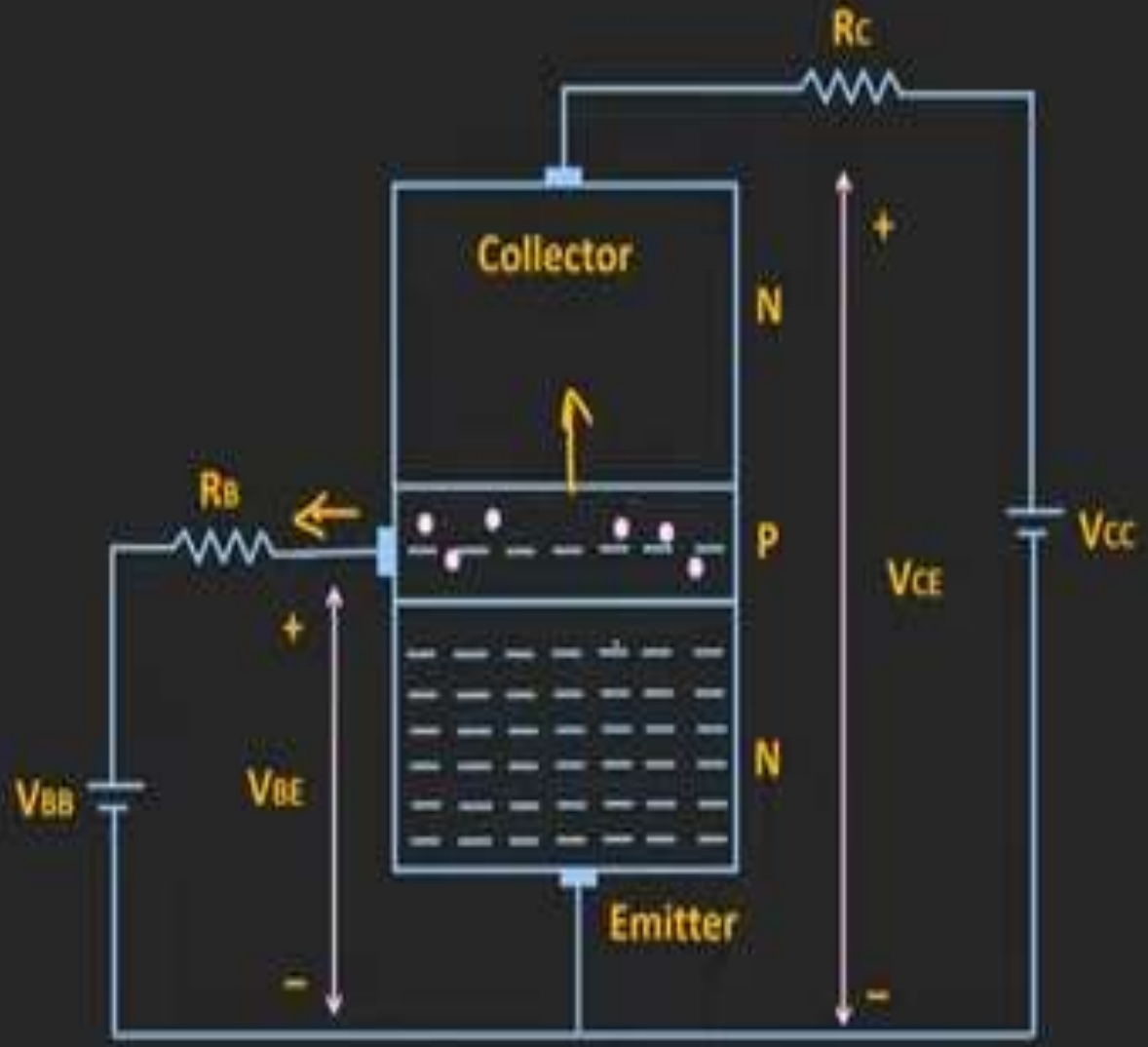
$V_{BE} = V_B - V_E$

$V_{CE} = V_C - V_E$

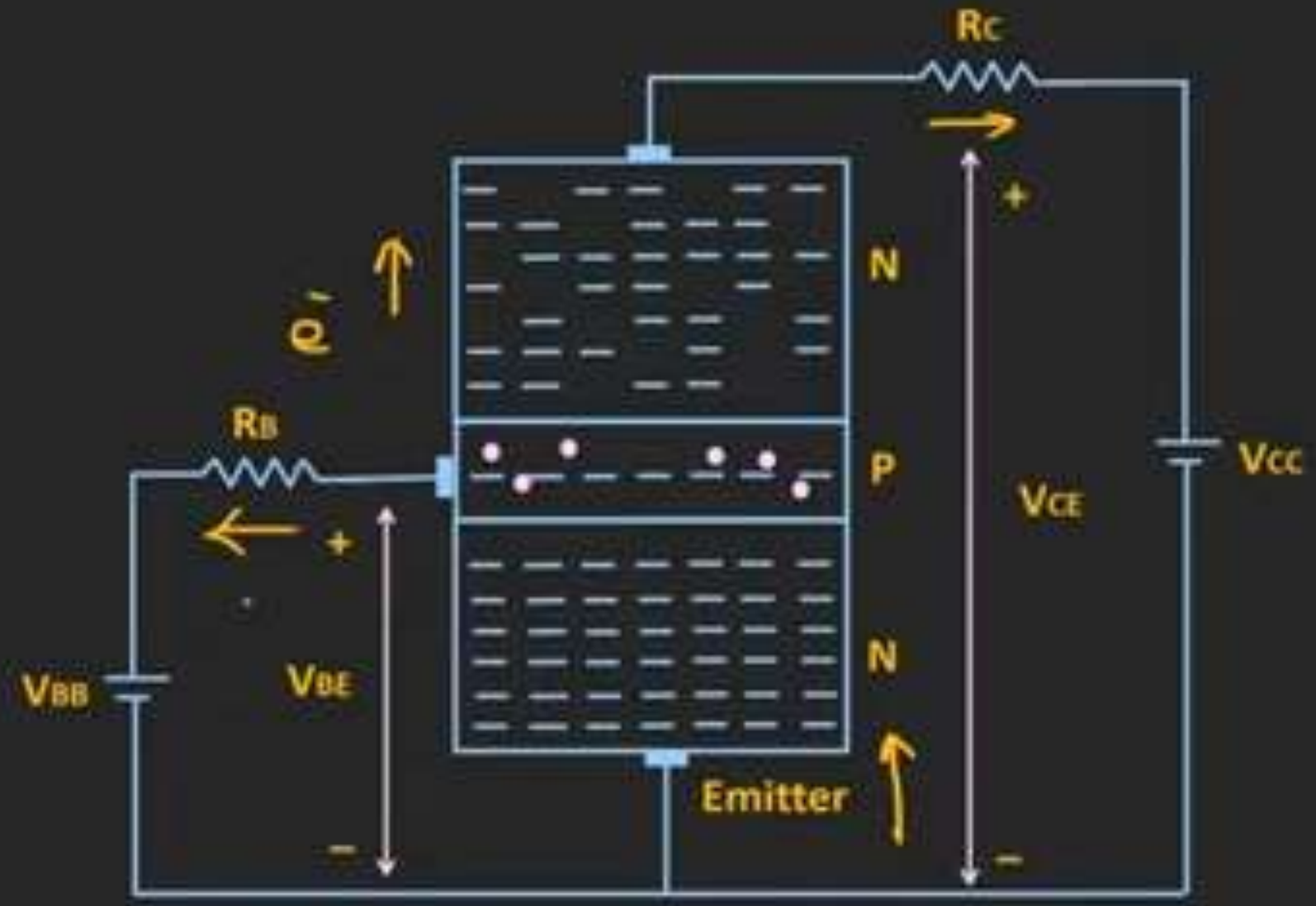
$V_{EB} = V_E - V_B$

$= -V_{BE}$

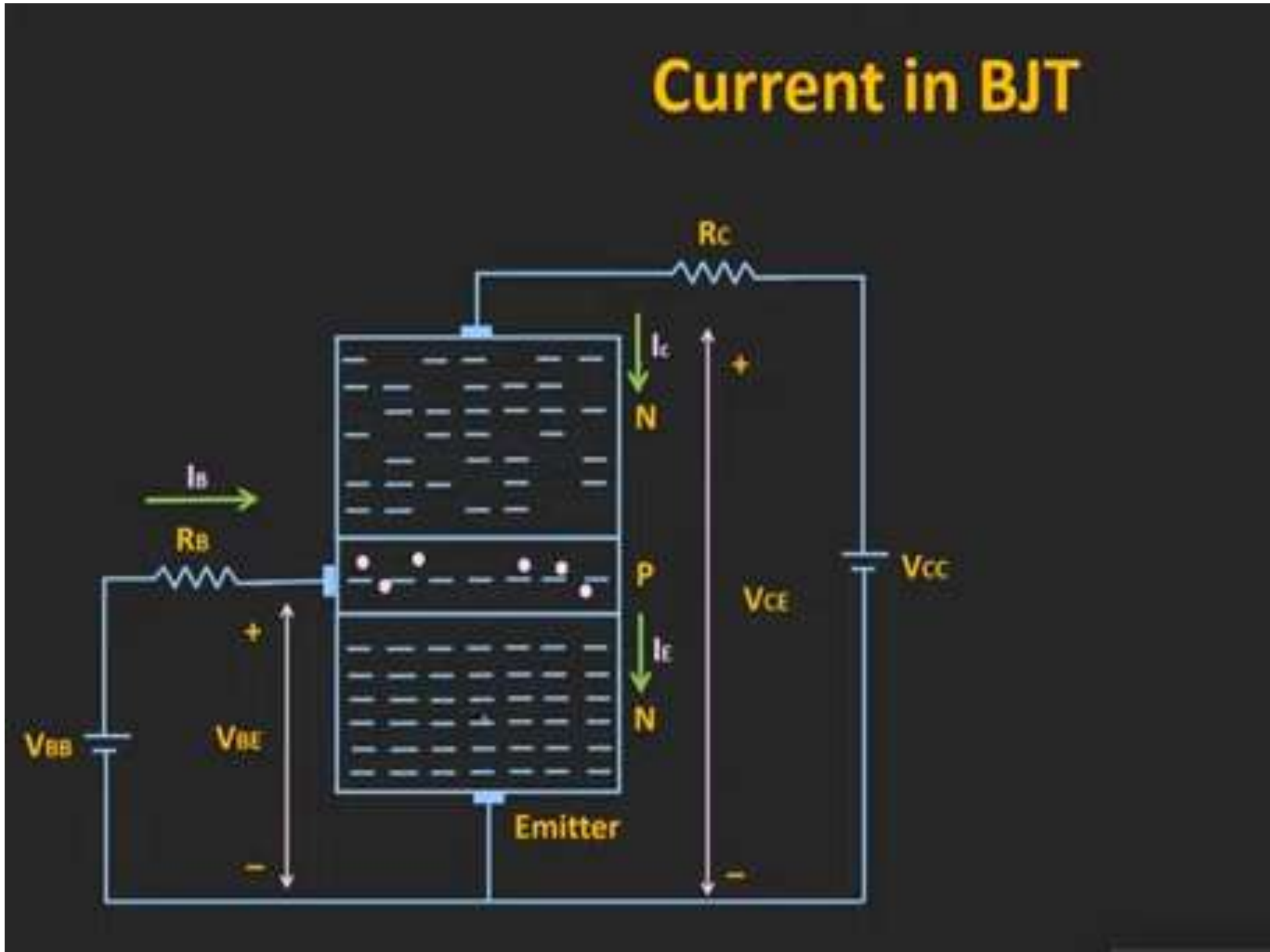
Working of BJT



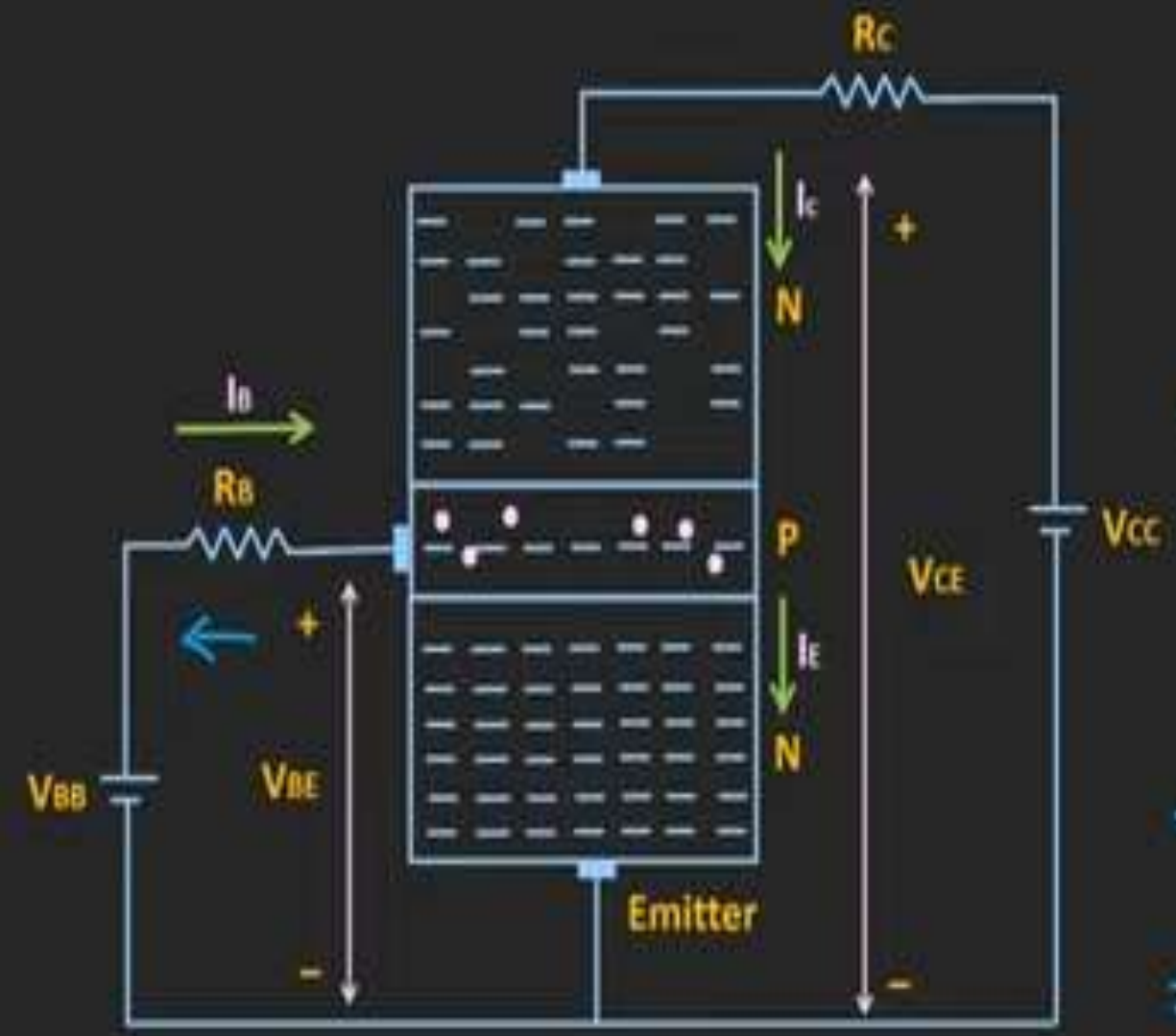
Working of BJT



Current in BJT



Current in BJT



$$I_B + I_C = I_E$$

$$I_C \simeq I_E$$

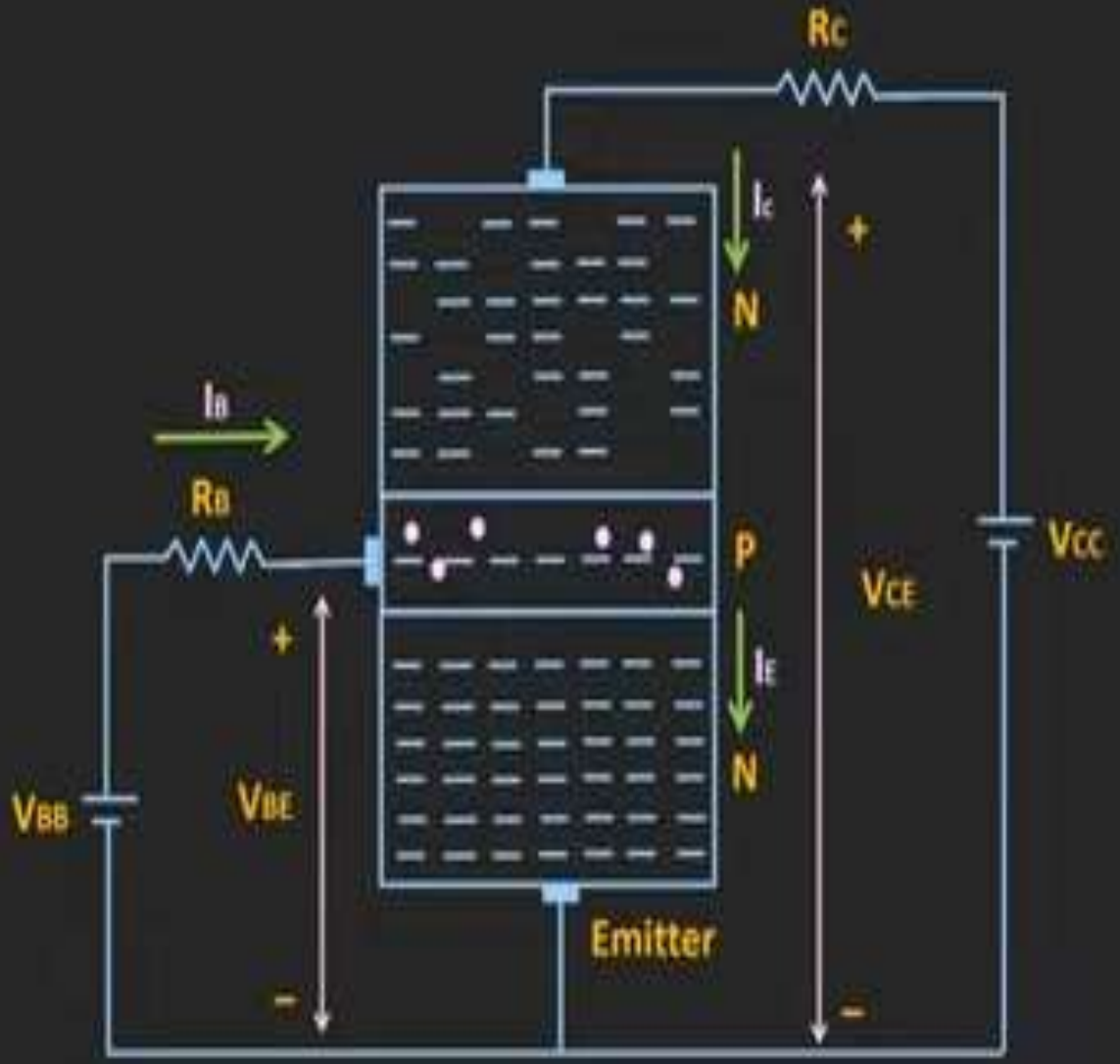
$$\Rightarrow I_C = \alpha I_E$$

$$I_B + \alpha I_E = I_E$$

$$\Rightarrow I_B = (1-\alpha) I_E$$

$$\Rightarrow I_B = (1-\alpha) \times \frac{I_C}{\alpha}$$

Current in BJT



$$I_B = \frac{1-\alpha}{\alpha} \times I_C$$

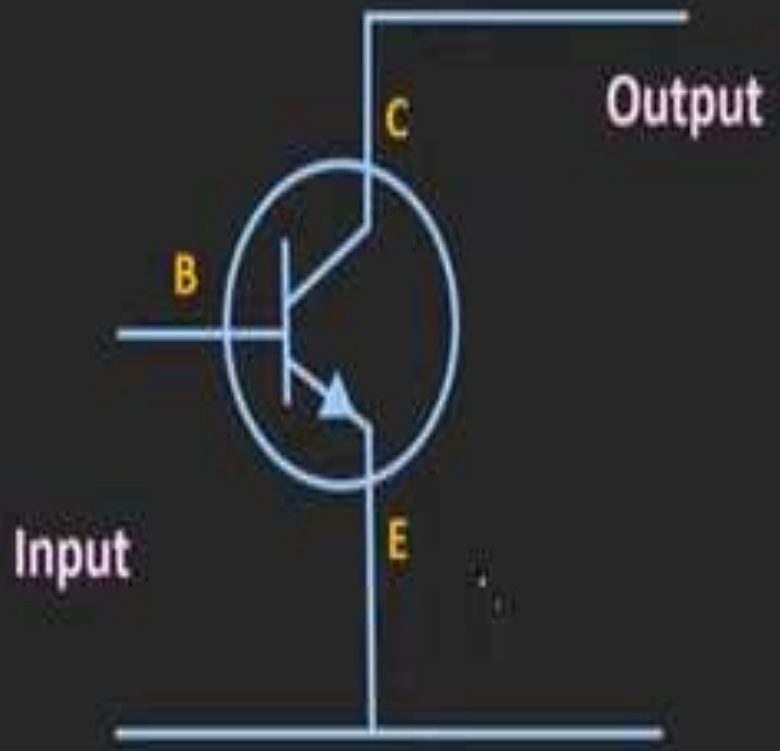
$$\Rightarrow I_C = \frac{\alpha}{\underbrace{1-\alpha}_{\beta}} \times I_B$$

$$\Rightarrow I_C = \beta I_B$$

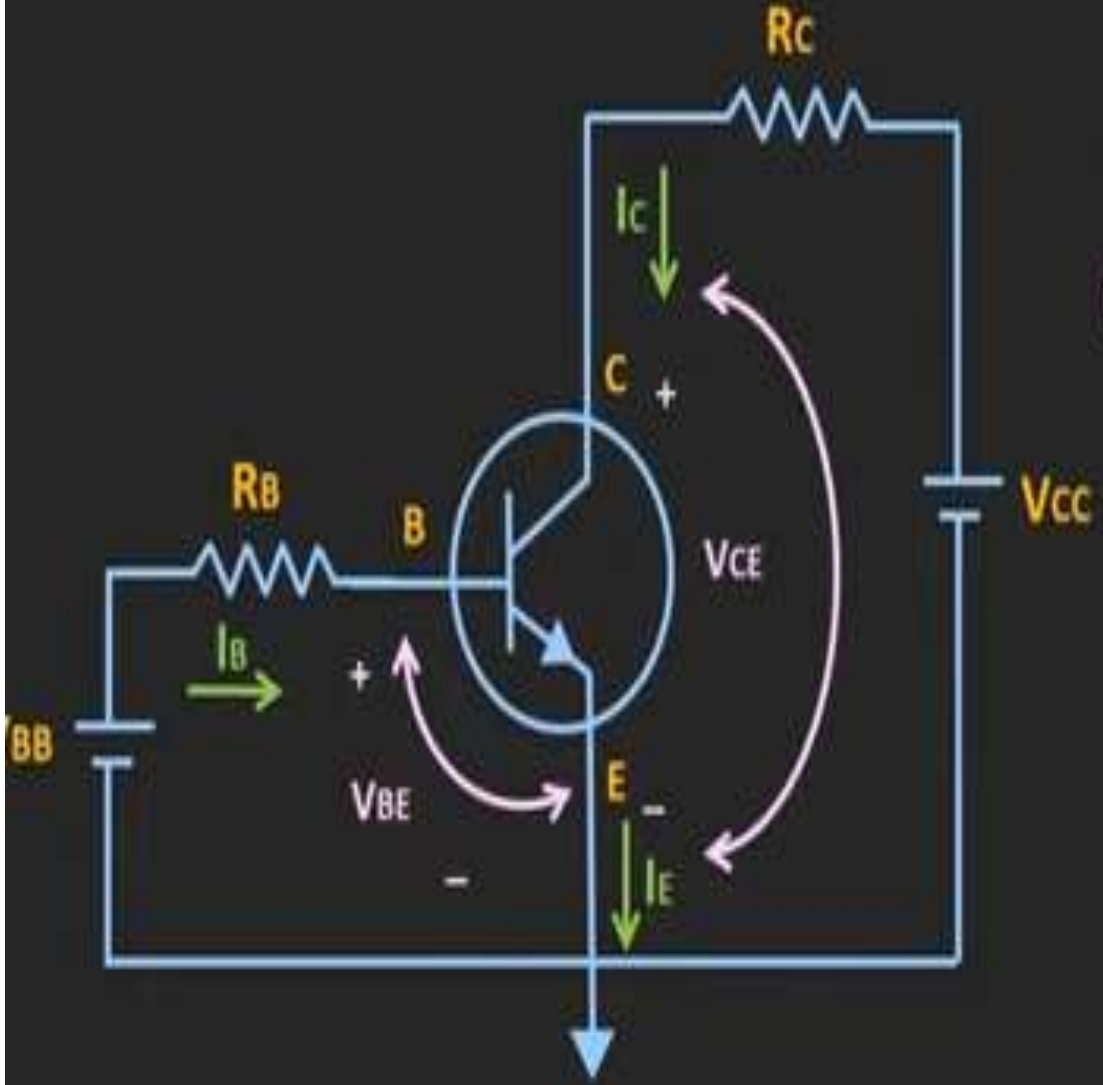
BJT
Common Emitter Configuration

https://www.youtube.com/watch?v=KynKHr2cXgk

Common Emitter (CE) Configuration



Common Emitter (CE) Configuration



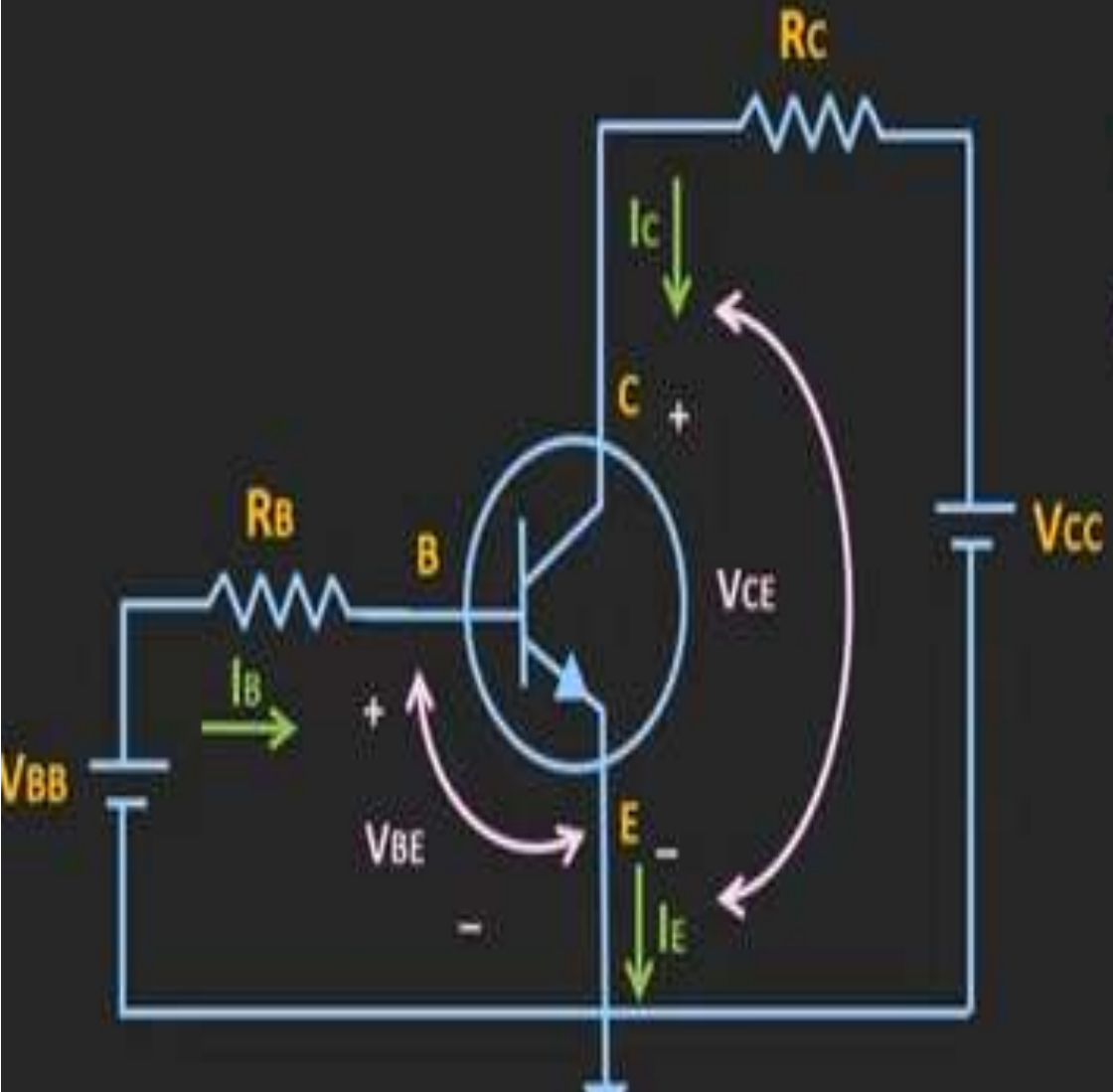
Base- Emitter Junction - Forward Bias

Collector- Base Junction - Reverse Bias

I_B,

I_C

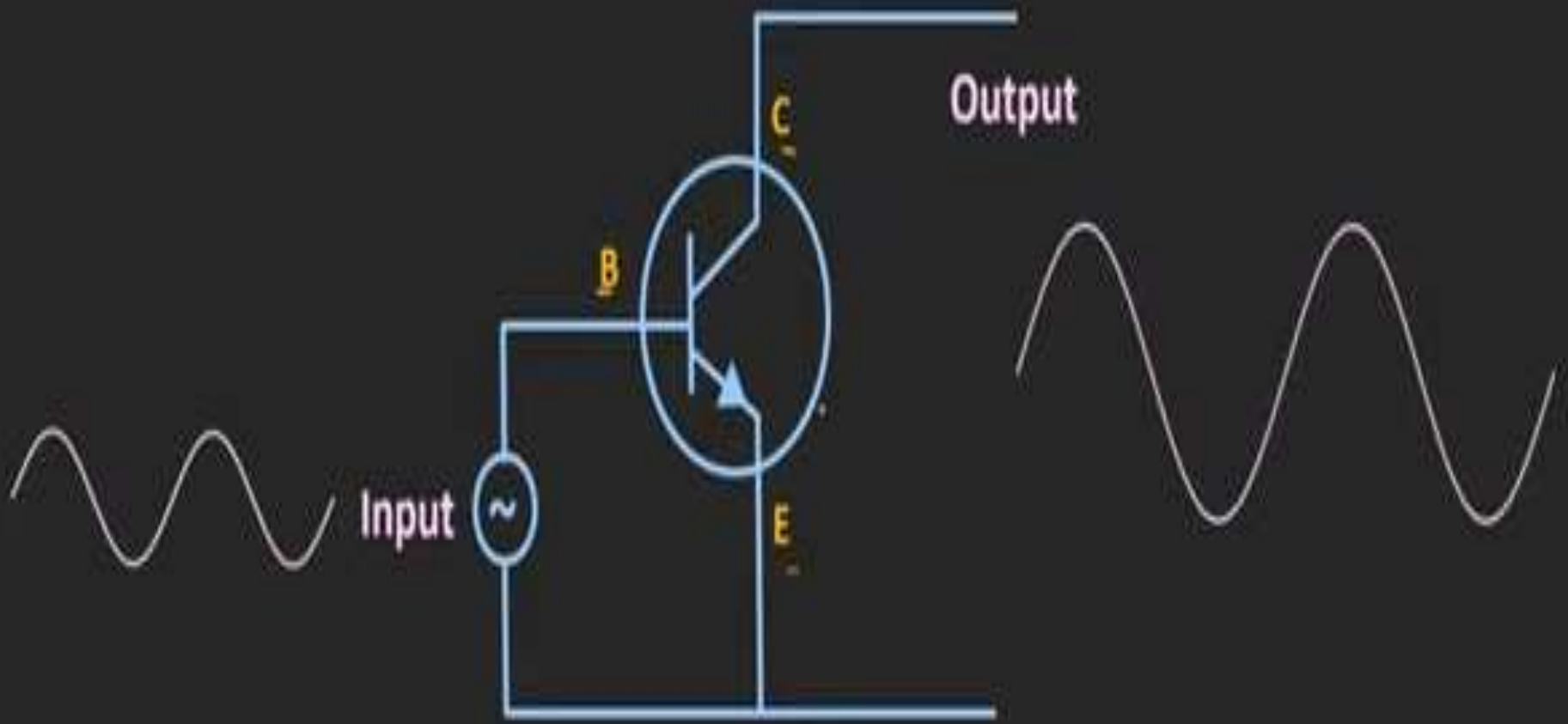
Common Emitter (CE) Configuration



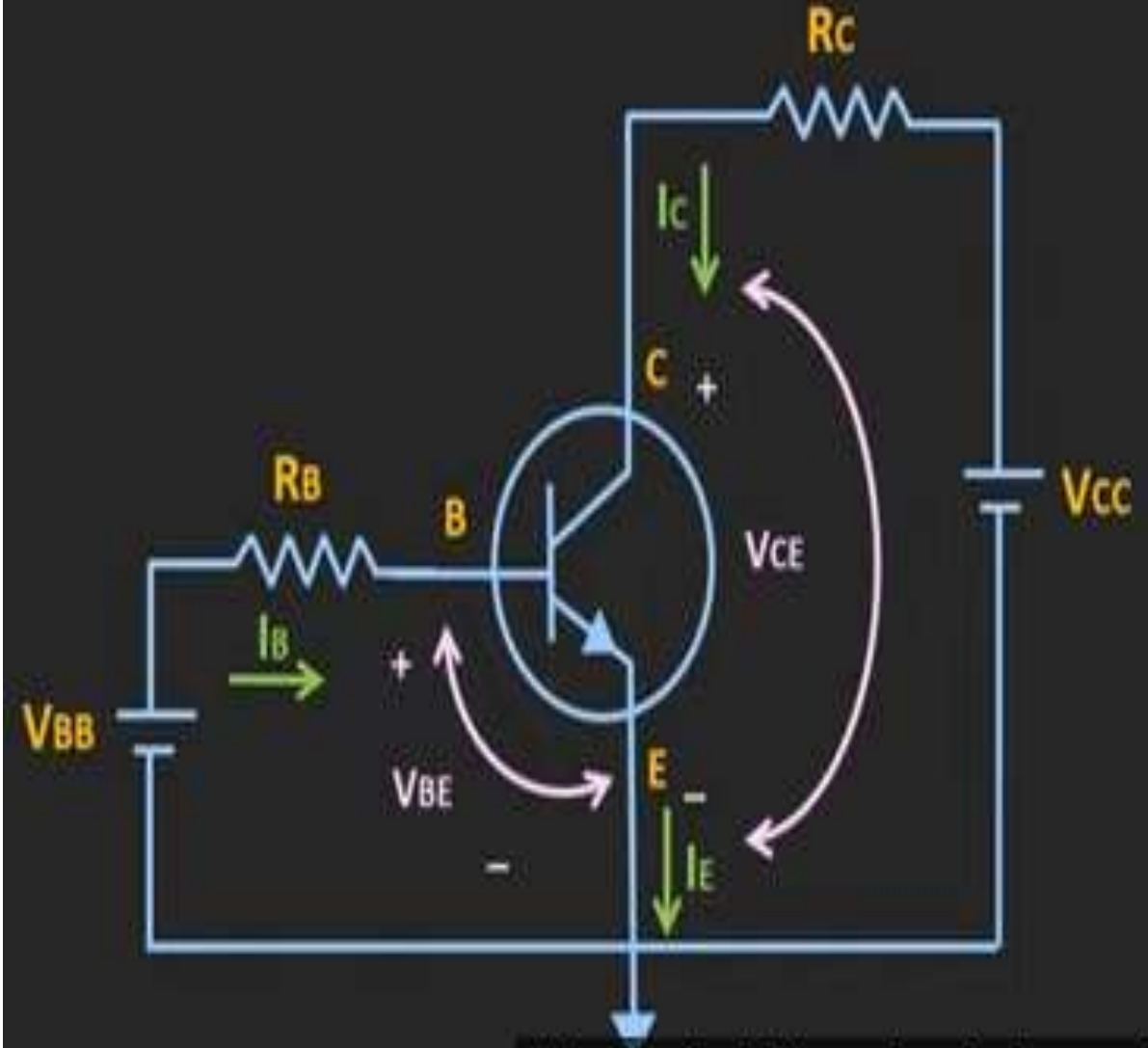
Base- Emitter Junction - Forward Bias

Collector- Base Junction - Reverse Bias

Common Emitter (CE) Configuration



Common Emitter (CE) Configuration



Input Characteristics

V_{BE}, I_B

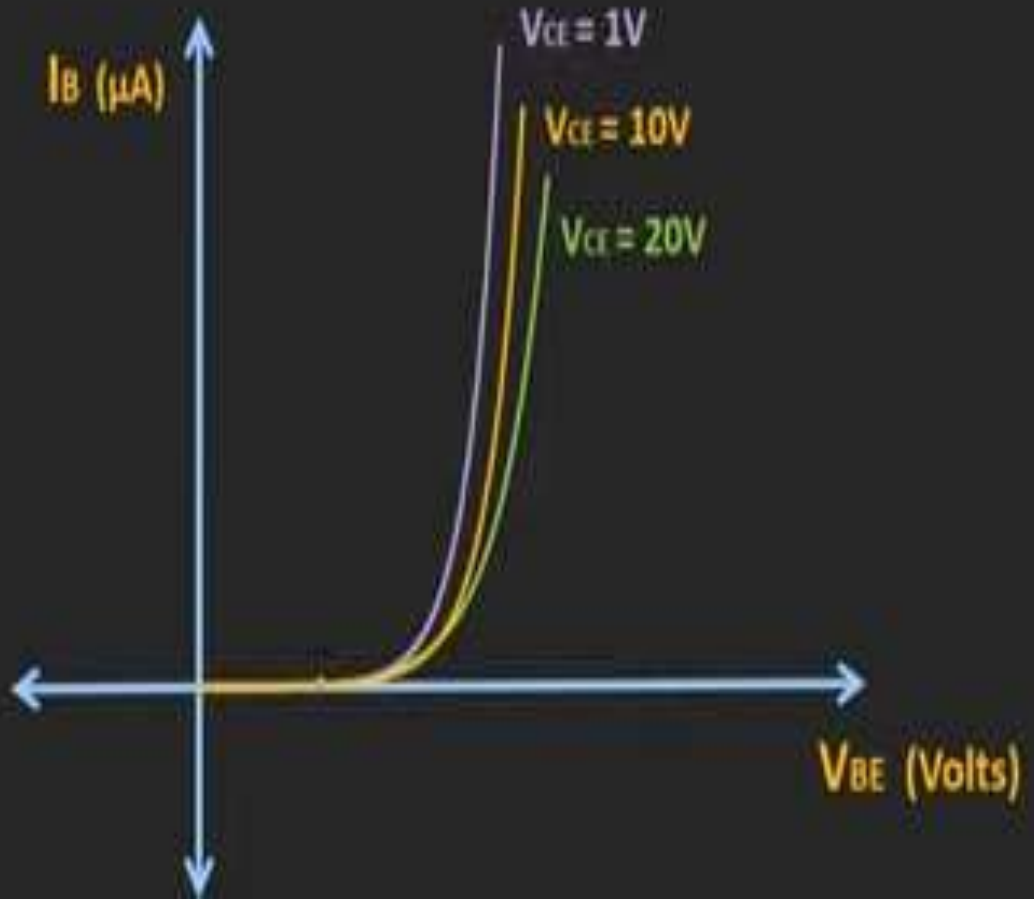
Output Characteristics

V_{CE}, I_C

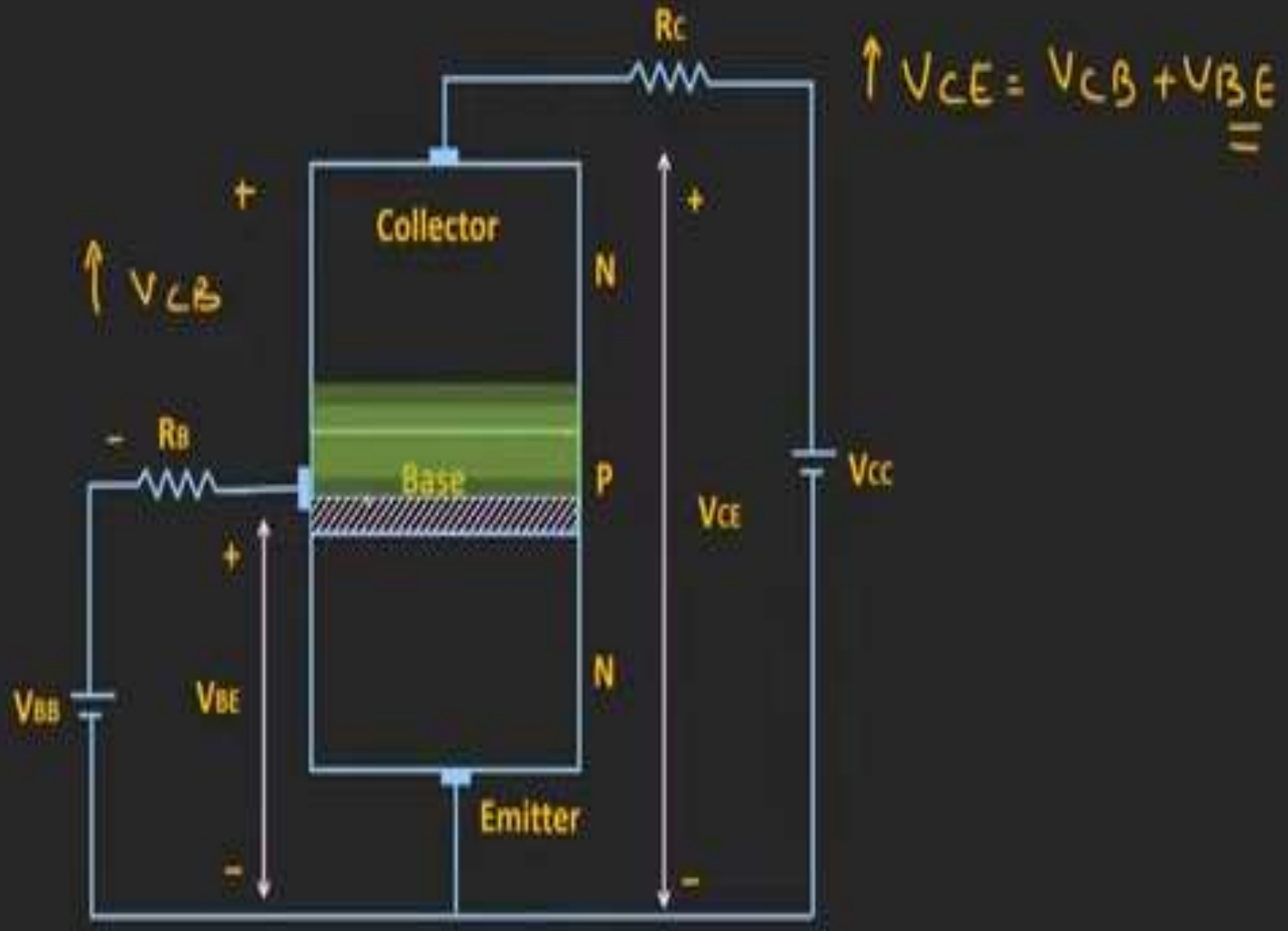
Similarly this output characteristic defines

Common Emitter (CE) Configuration

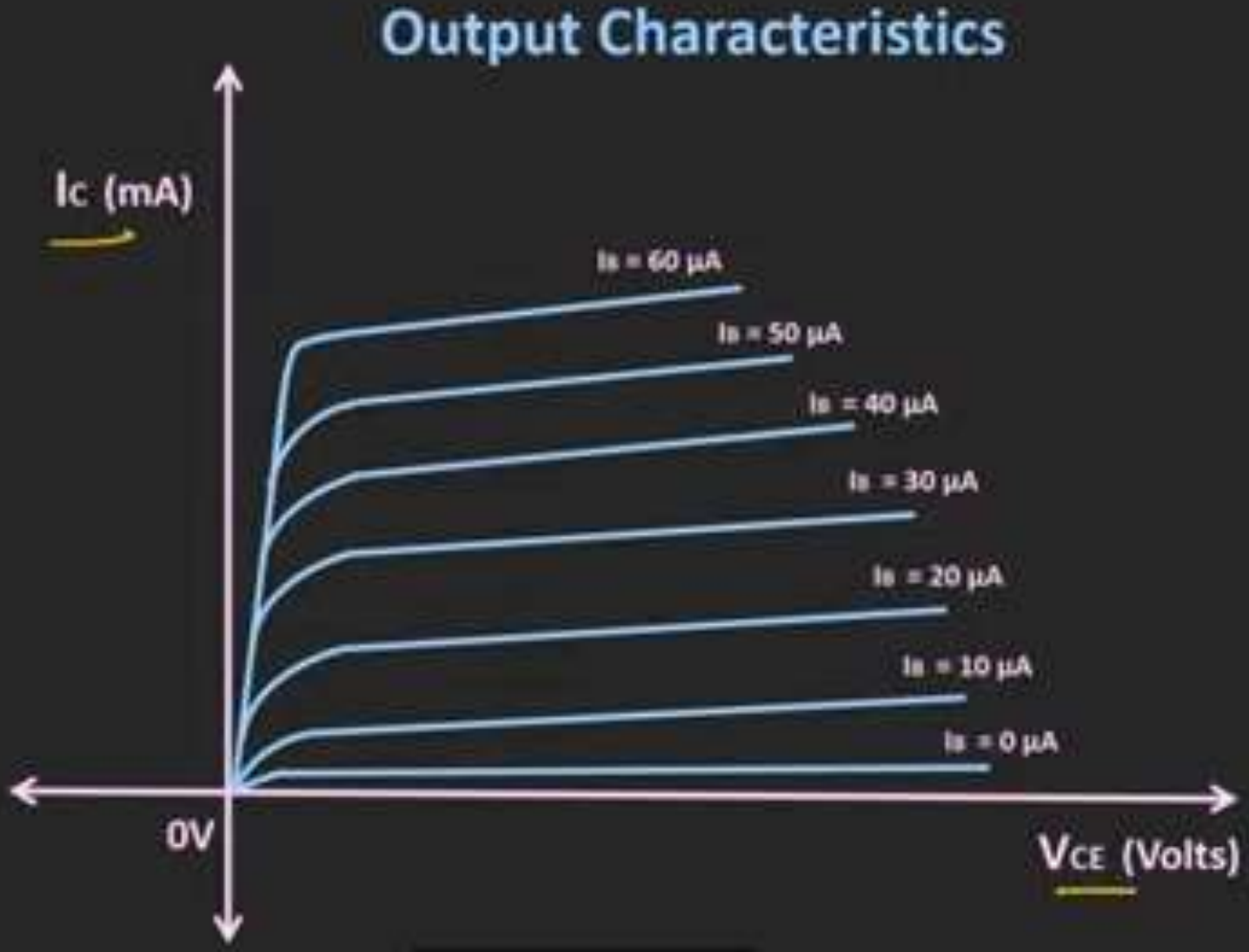
Input Characteristics



Common Emitter (CE) Configuration

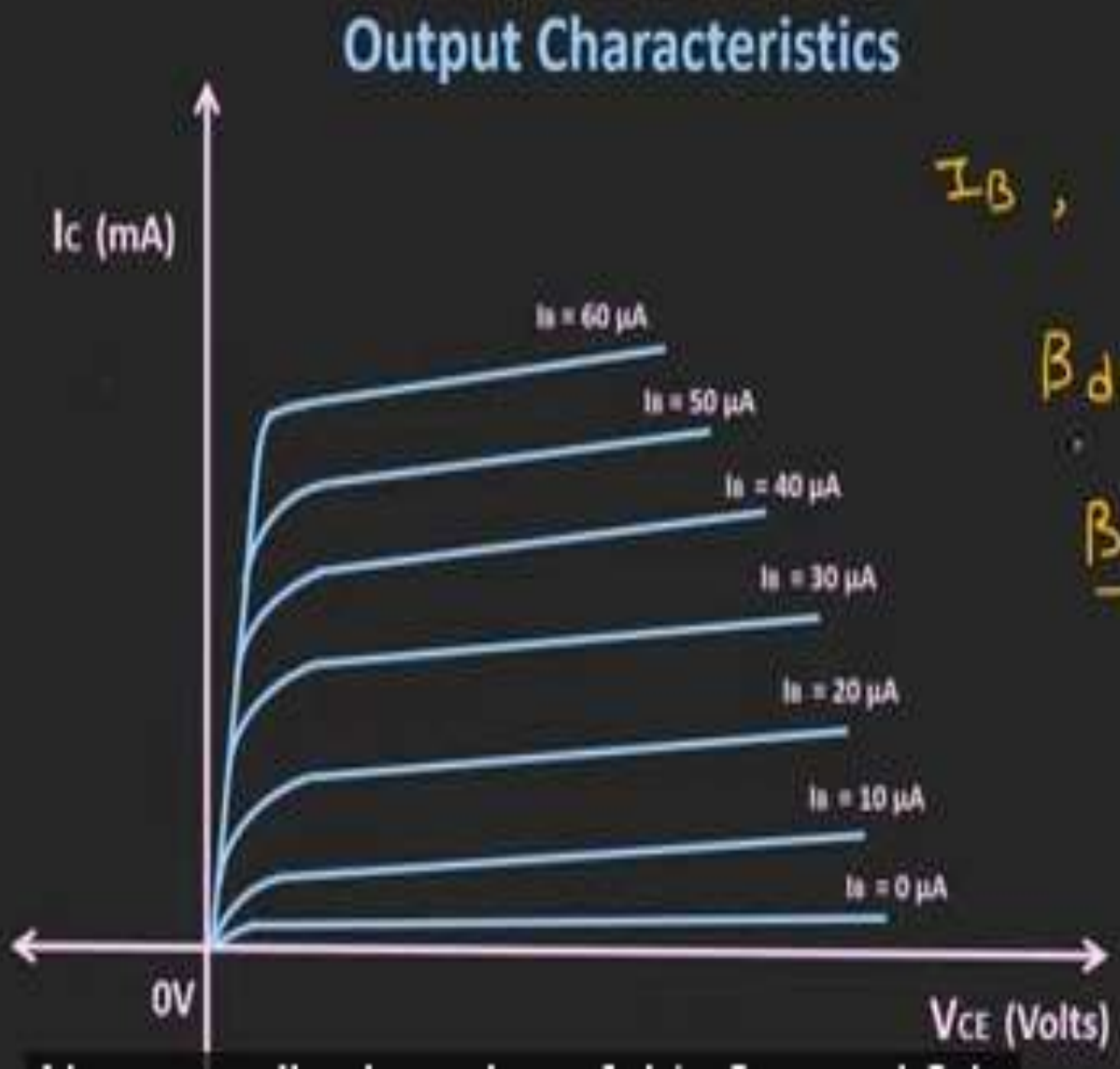


Common Emitter (CE) Configuration



voltage Vce.

Common Emitter (CE) Configuration

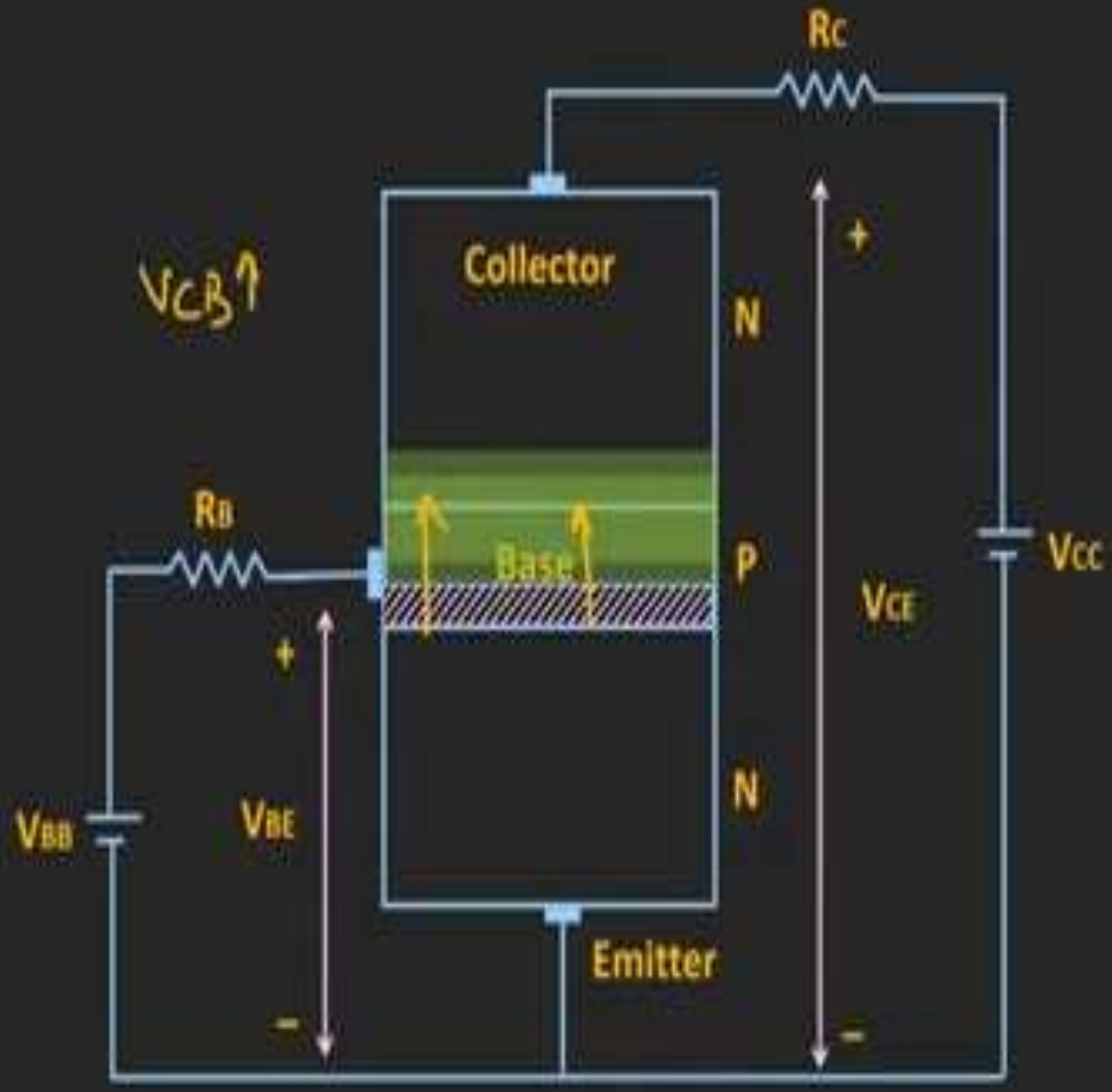


I_B , $I_C = \beta I_B$

β_{dc}

$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$

Common Emitter (CE) Configuration

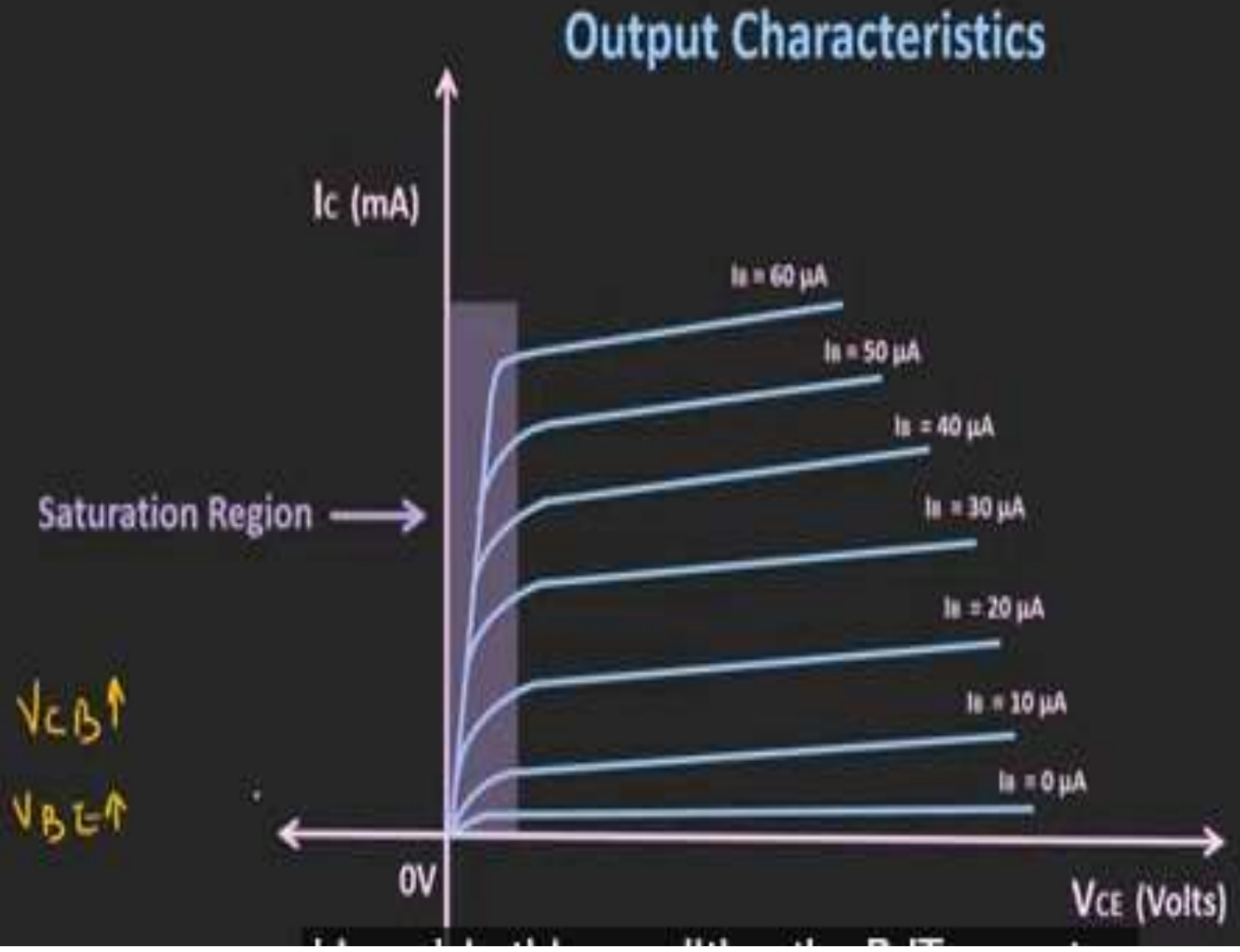


$V_{CE}\uparrow$

$V_{CE} = V_{CB} + V_{BE}$

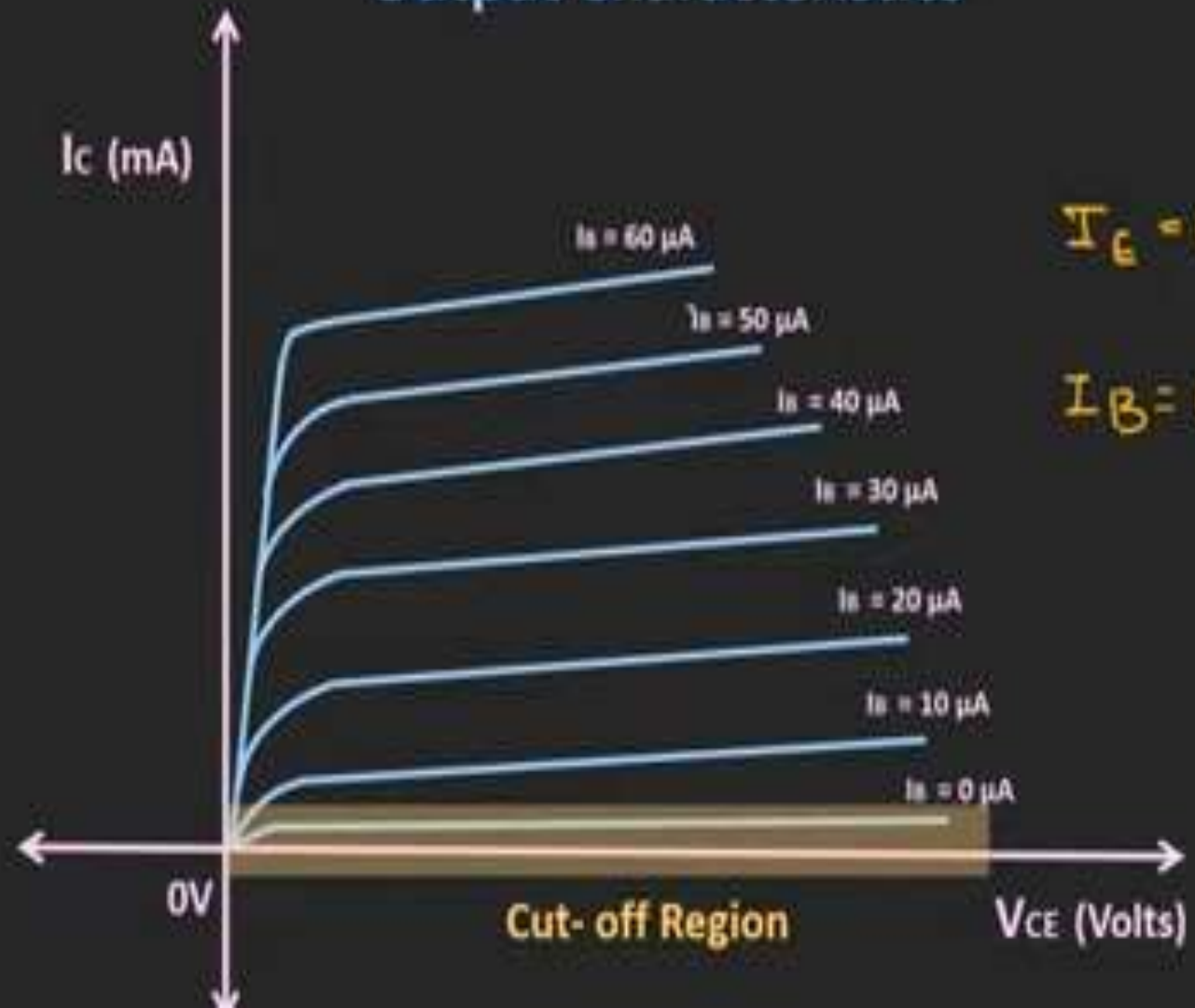
$V_{CE}\uparrow,\ I_C\uparrow$

Common Emitter (CE) Configuration



Common Emitter (CE) Configuration

Output Characteristics



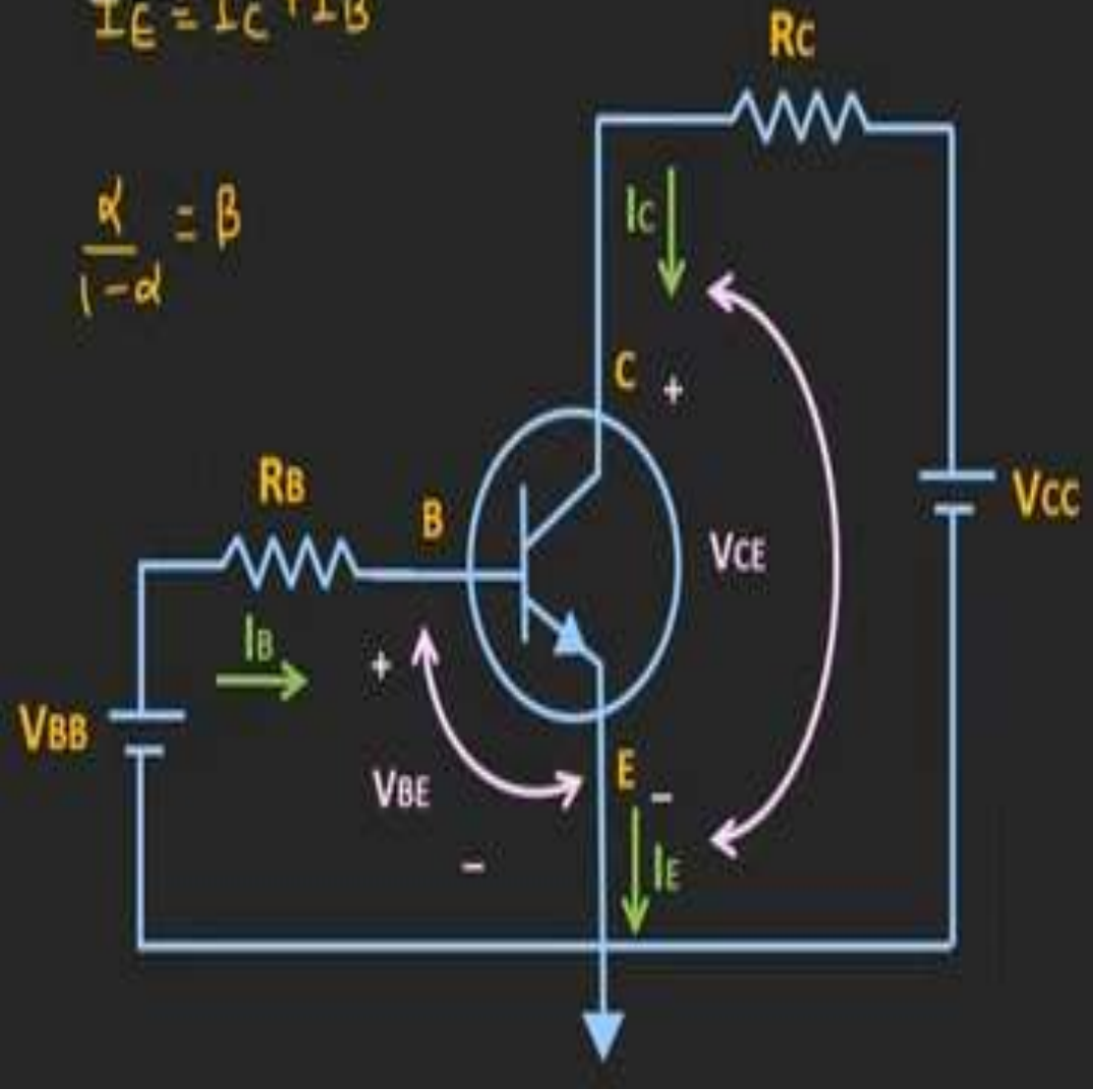
$I_E = 0 \Rightarrow I_{CBO}$

$I_B = 0 \Rightarrow$ ___

Common Emitter (CE) Configuration

$I_E = I_C + I_B$

$\frac{\alpha}{1-\alpha} = \beta$



$I_C = \alpha I_E + I_{CBO}$

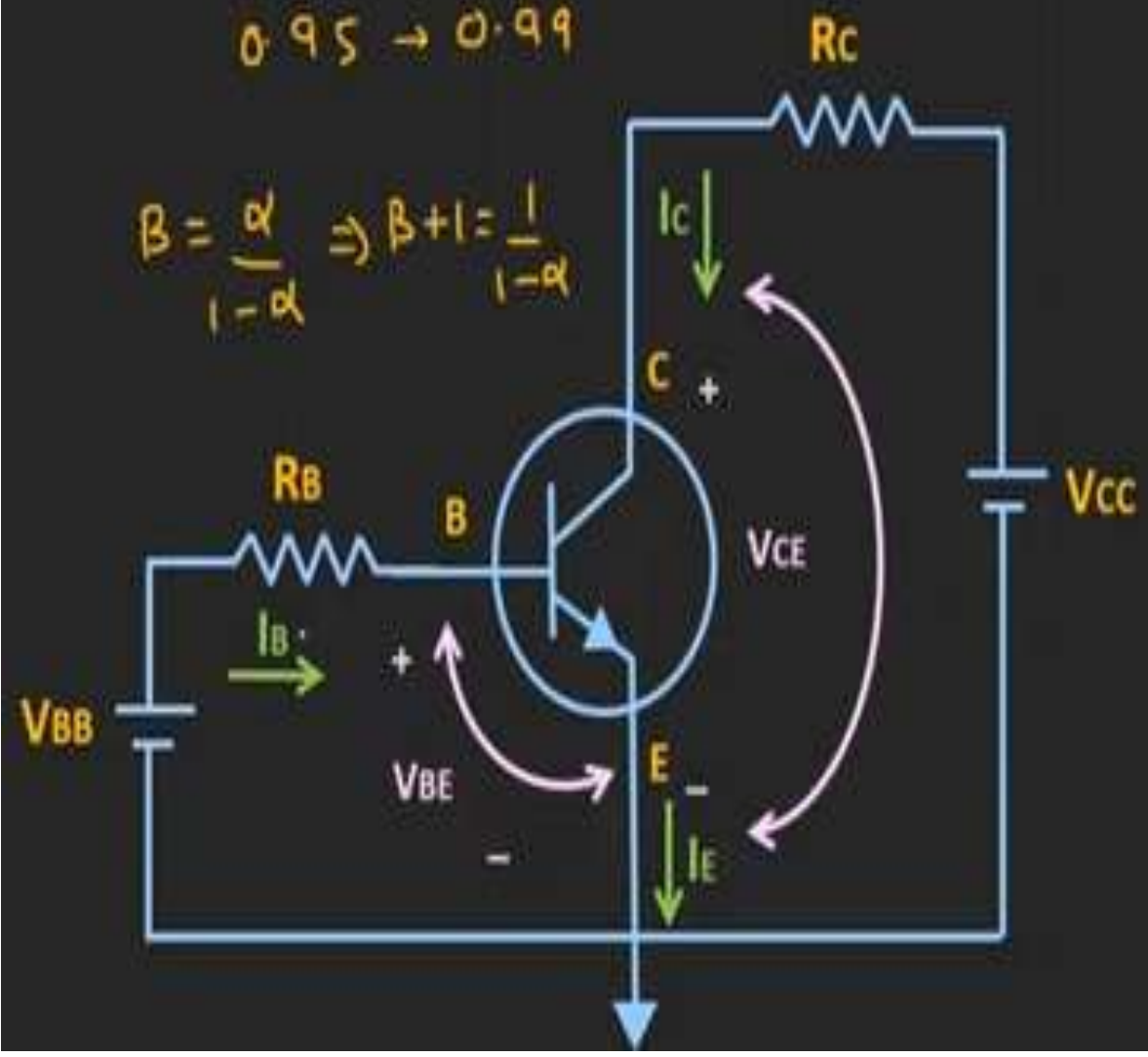
$\Rightarrow I_C = \alpha (I_C + I_B) + I_{CBO}$

$\Rightarrow (1-\alpha) I_C = \alpha I_B + I_{CBO}$

$\Rightarrow I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$

$\Rightarrow I_C = \beta I_B + \frac{1}{1-\alpha} I_{CBO}$

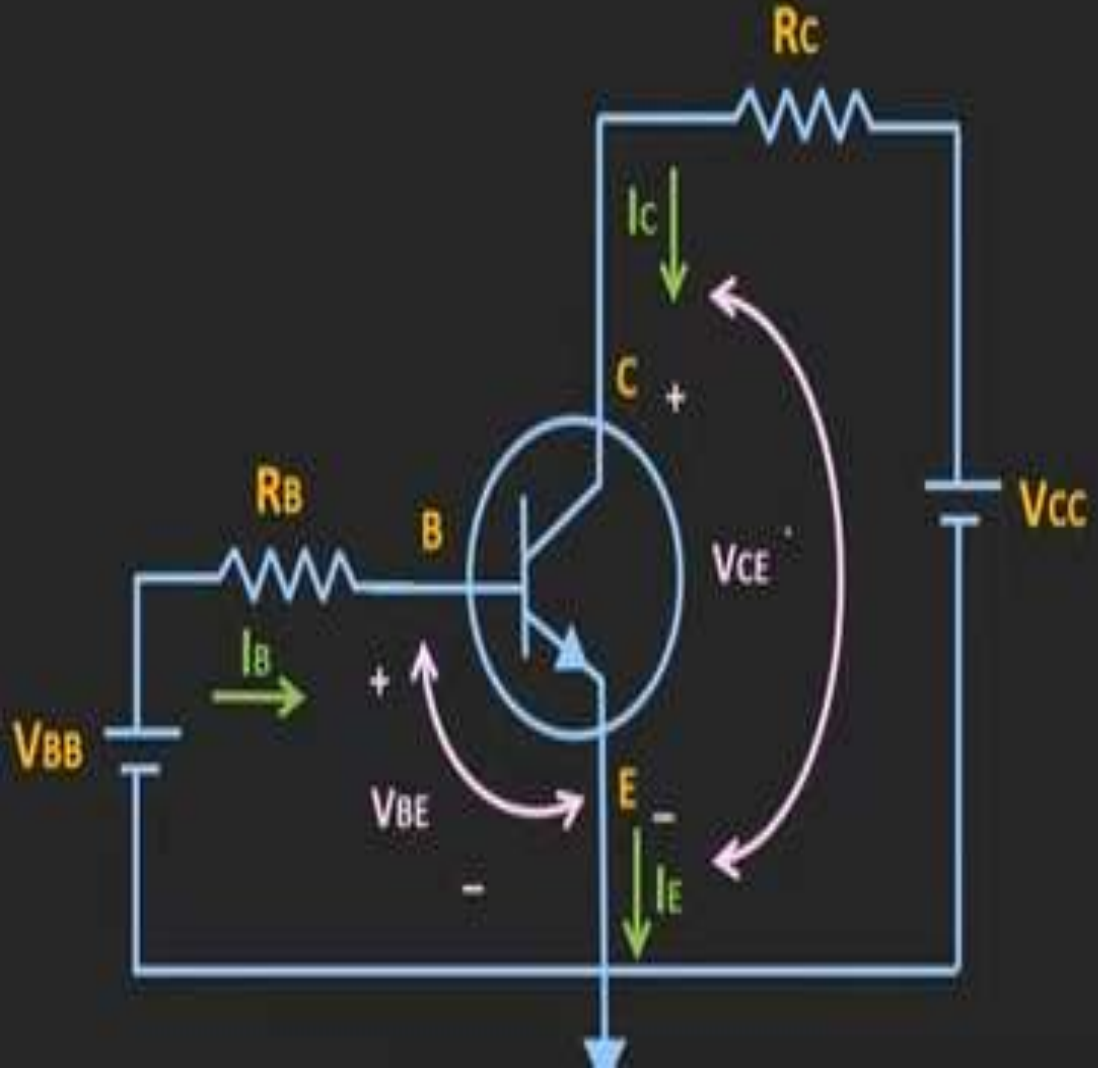
Common Emitter (CE) Configuration



$= \frac{1}{1-\alpha} I_{CBO}$

$= (\beta+1) I_{CBO}$

Common Emitter (CE) Configuration



Moderate Current Gain

Moderate Voltage Gain

High Power Gain

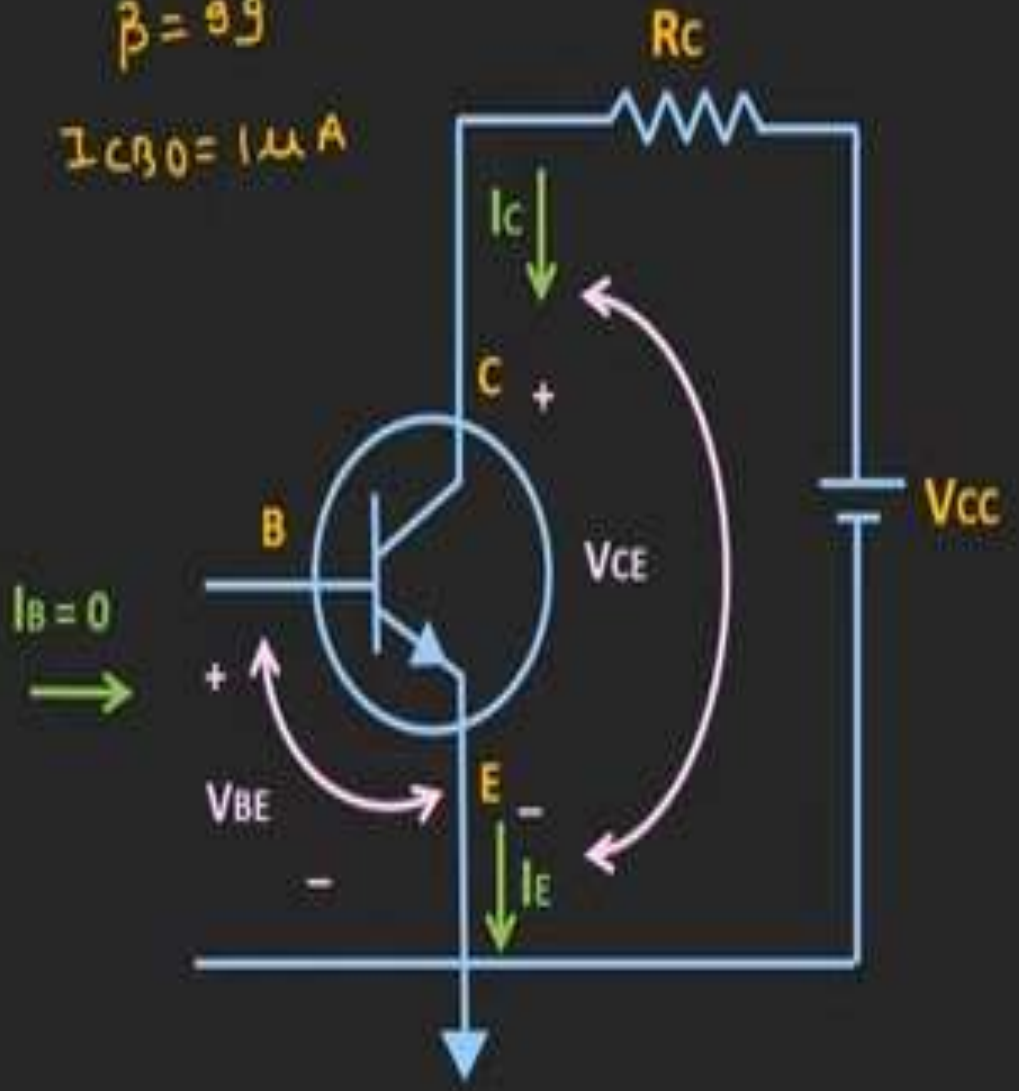
Moderate Input Impedance

Moderate Output Impedance

Common Emitter (CE) Configuration

$\beta = 99$

$I_{CBO} = 1\mu A$

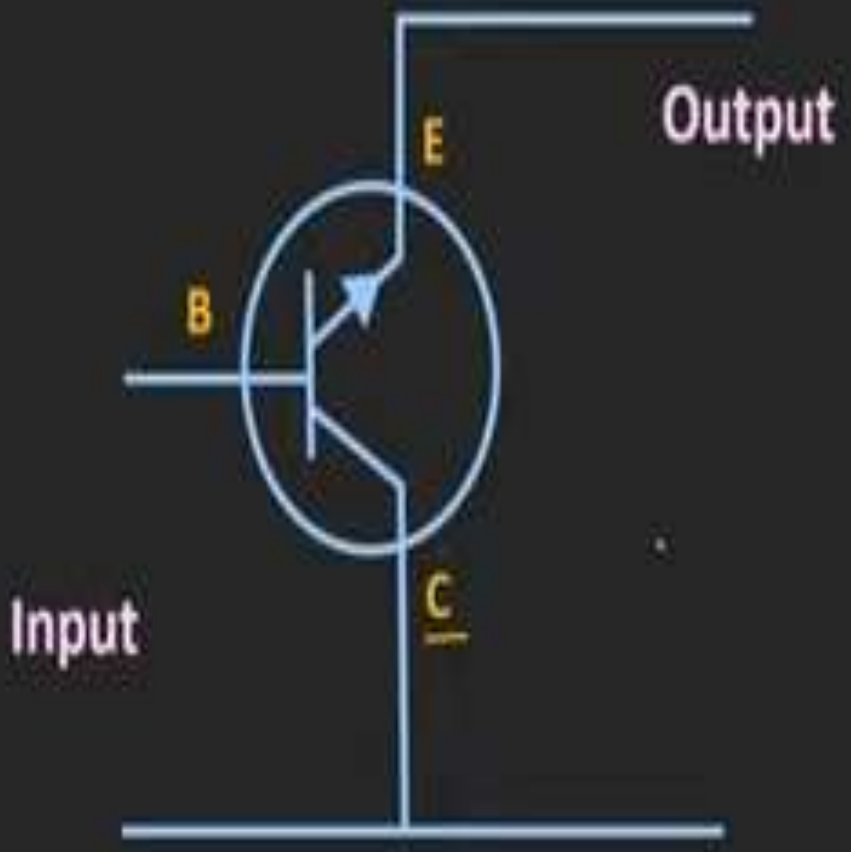


$I_{CEO} = (\beta + 1) I_{CBO}$

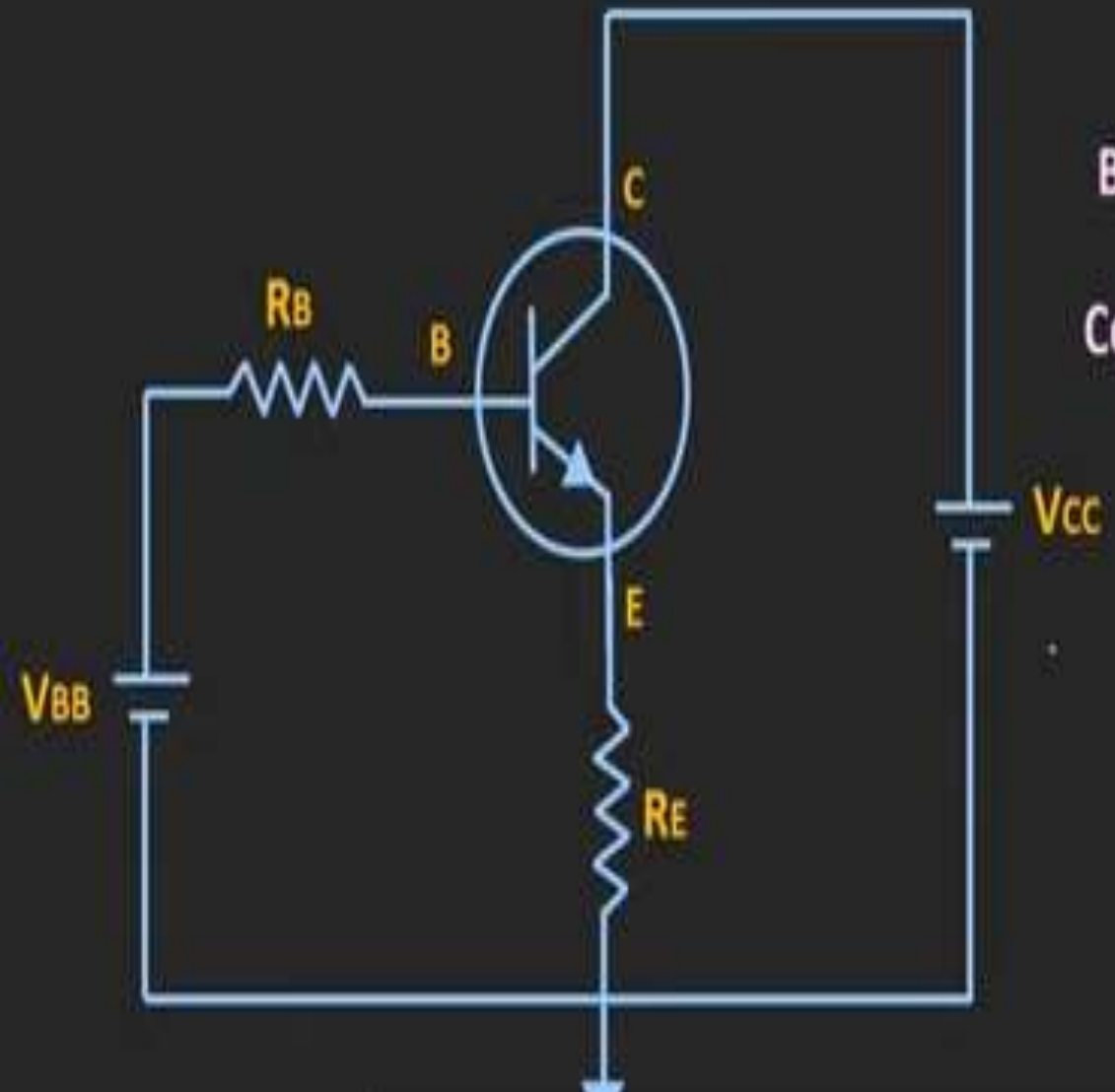
$I_{CEO} = 100\mu A$

BJT
Common Collector Configuration

Common Collector (CC) Configuration



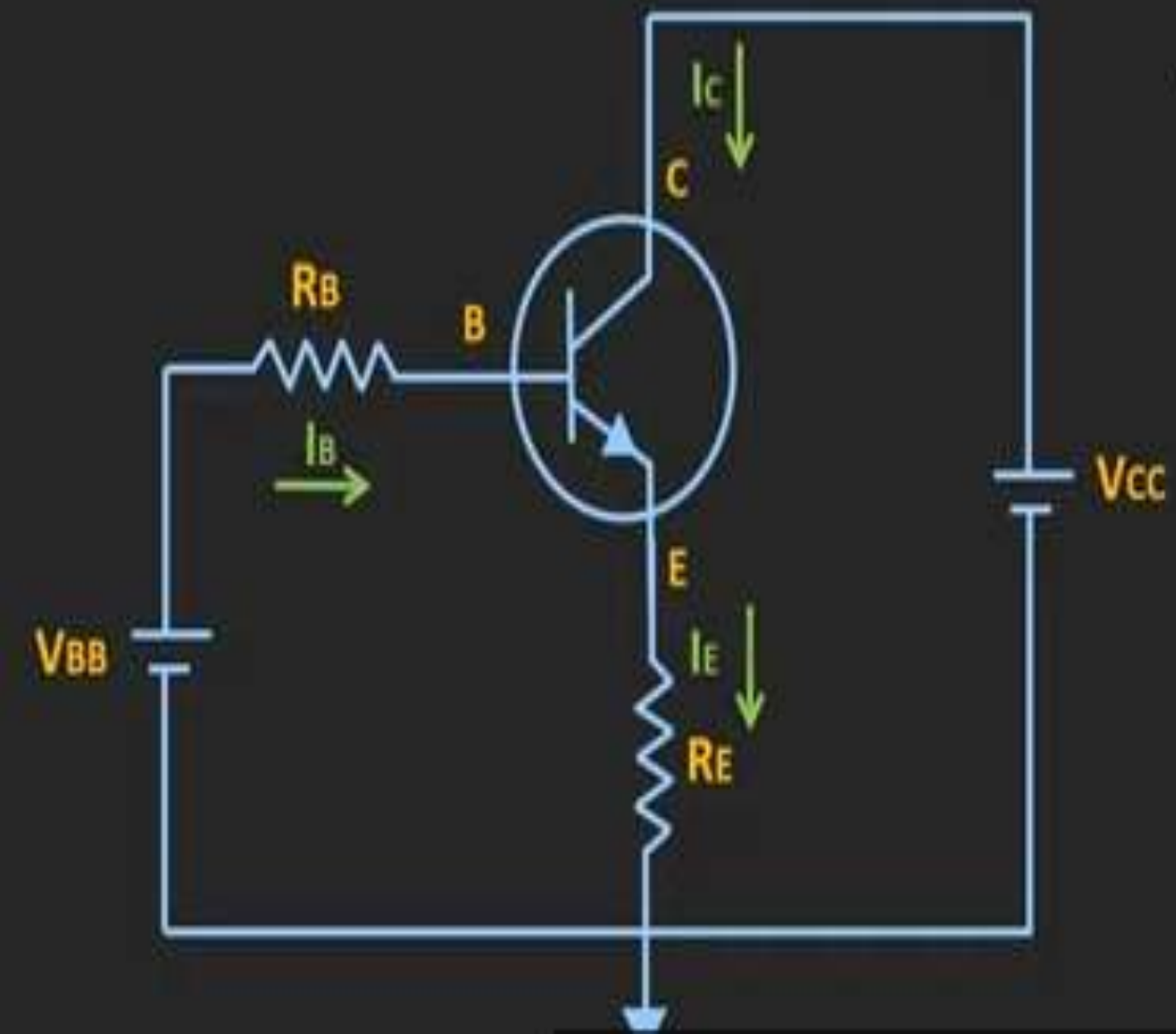
Common Collector (CC) Configuration



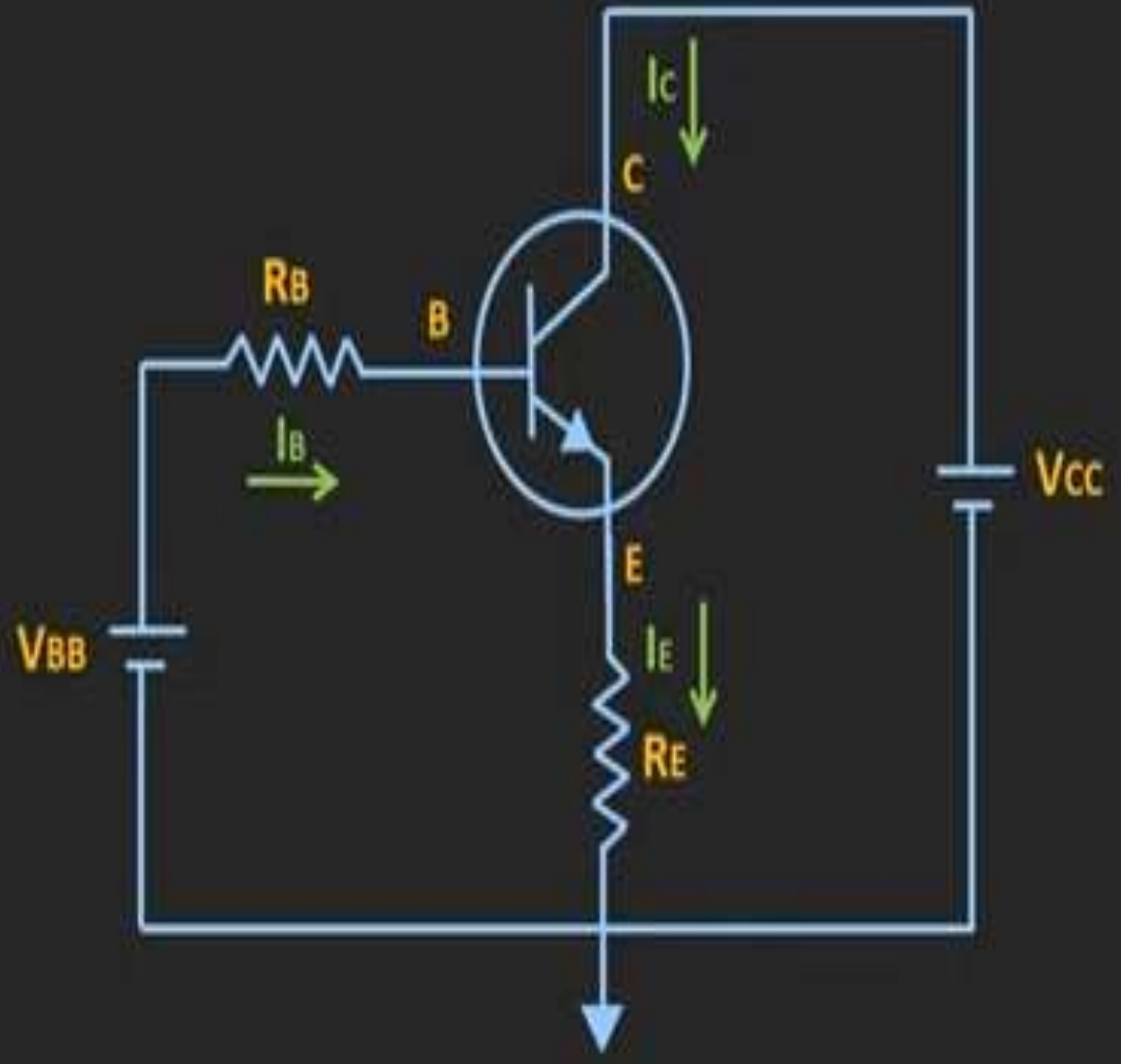
Base- Emitter Junction - Forward Bias

Collector- Base Junction - Reverse Bias

Common Collector (CC) Configuration



Common Collector (CC) Configuration



Input Characteristics

V_{CB}, I_B

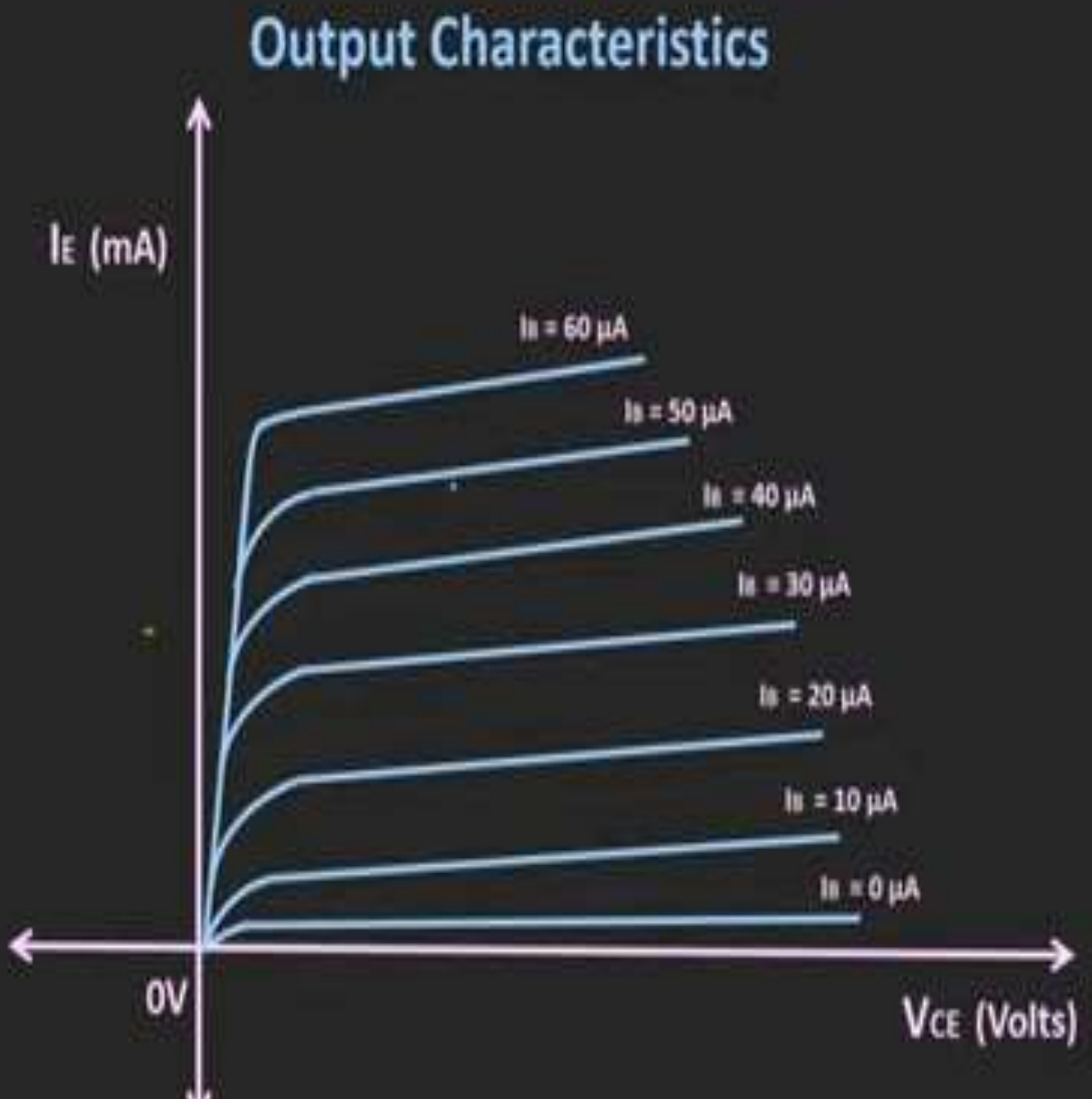
Output Characteristics

V_{CE}, I_E

Common Collector (CC) Configuration

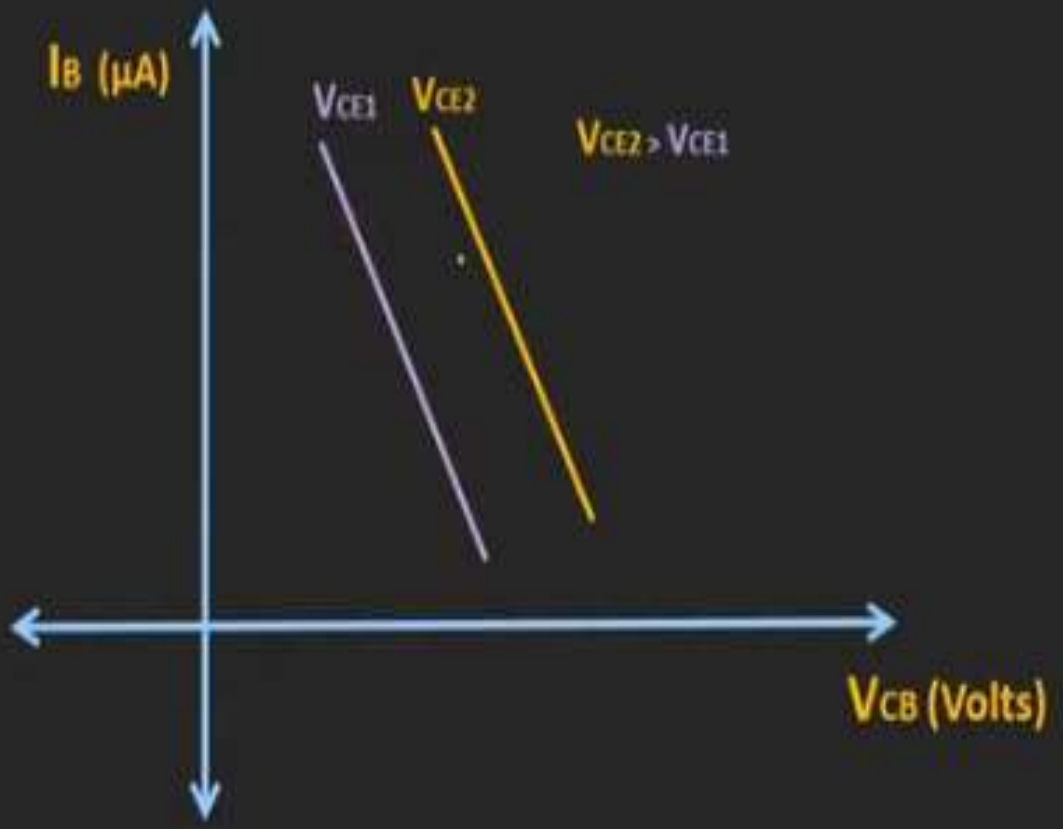
$I_E = \alpha I_C$

$I_E \simeq I_C$

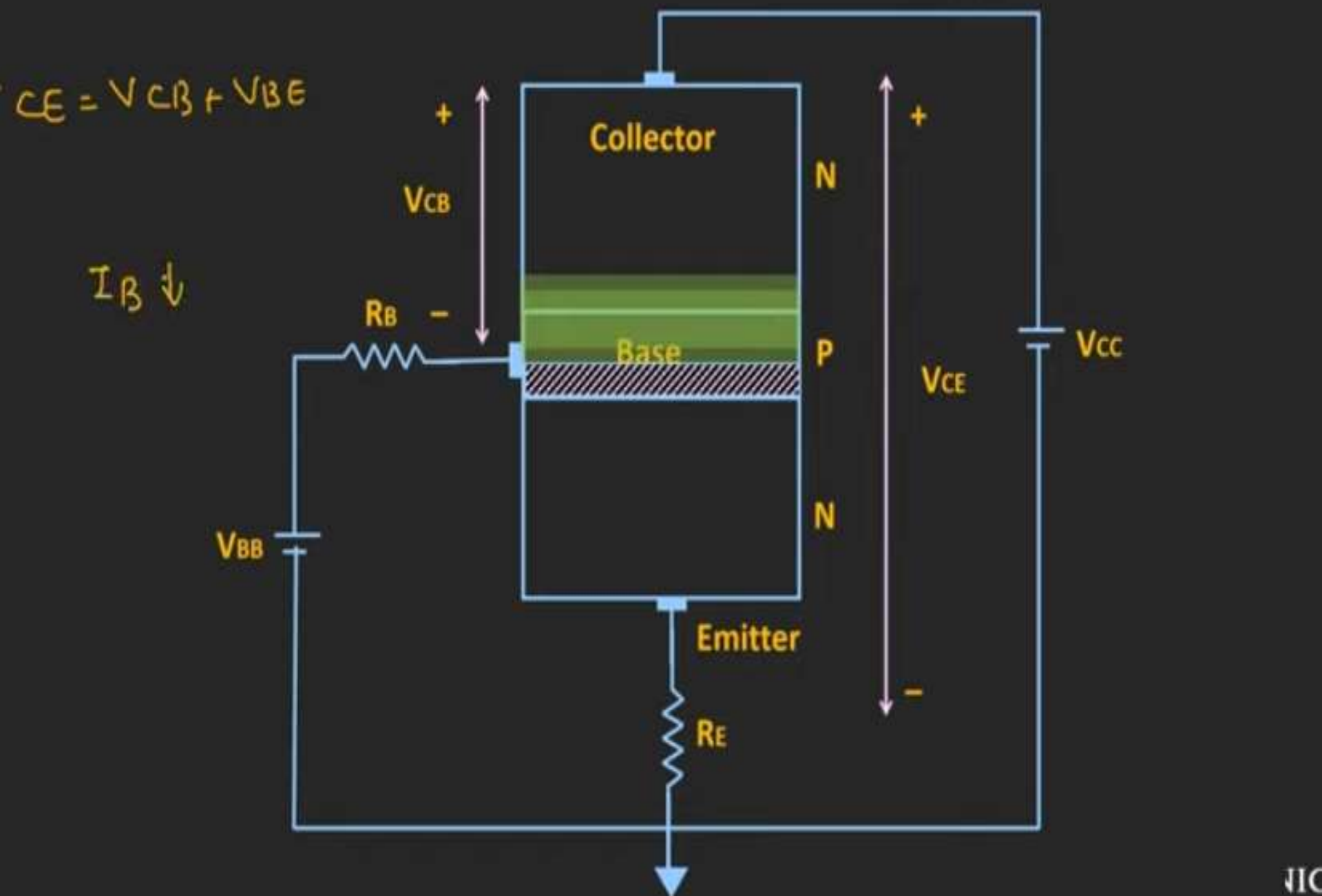


Common Collector (CC) Configuration

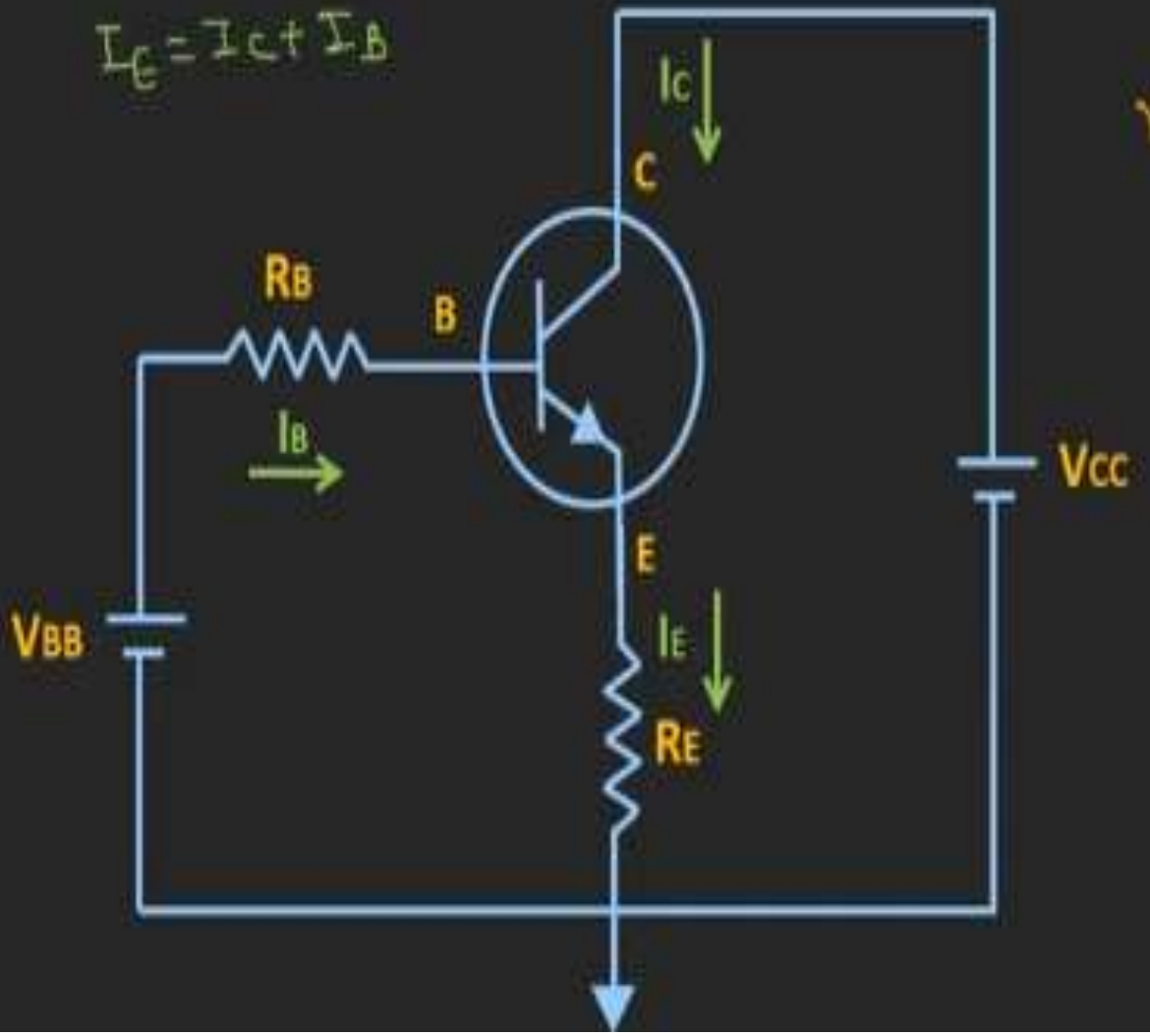
Input Characteristics



Common Collector (CC) Configuration



Common Collector (CC) Configuration



$I_E = I_C + I_B$

$\gamma = \frac{I_E}{I_B}$

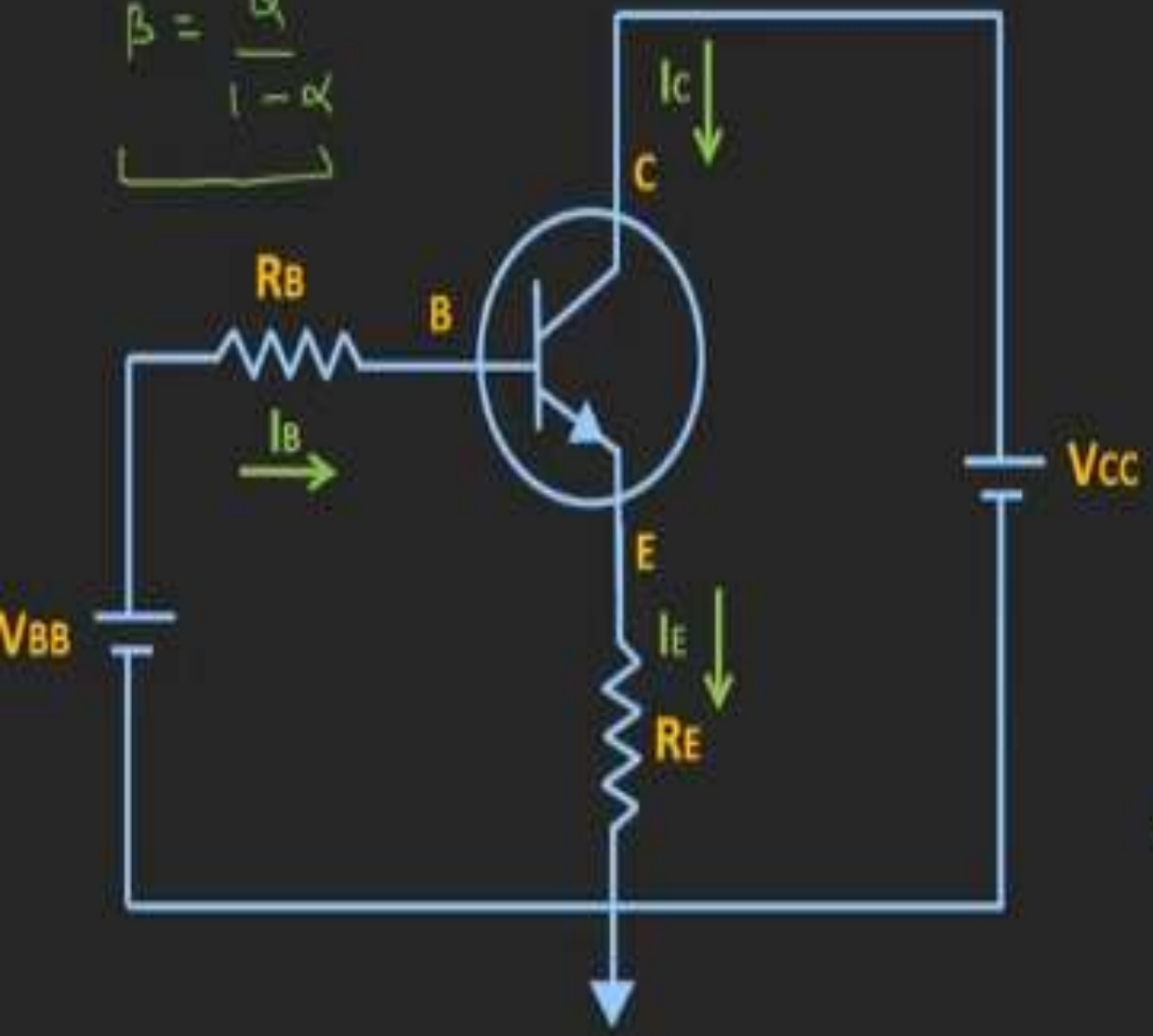
$I_C \simeq \beta I_B$

α, β, γ

$\gamma = \frac{I_C + I_B}{I_B}$

$\gamma = \frac{I_C}{I_B} + 1 \simeq \beta + 1.$

Common Collector (CC) Configuration



$$\beta = \frac{\alpha}{1-\alpha}$$

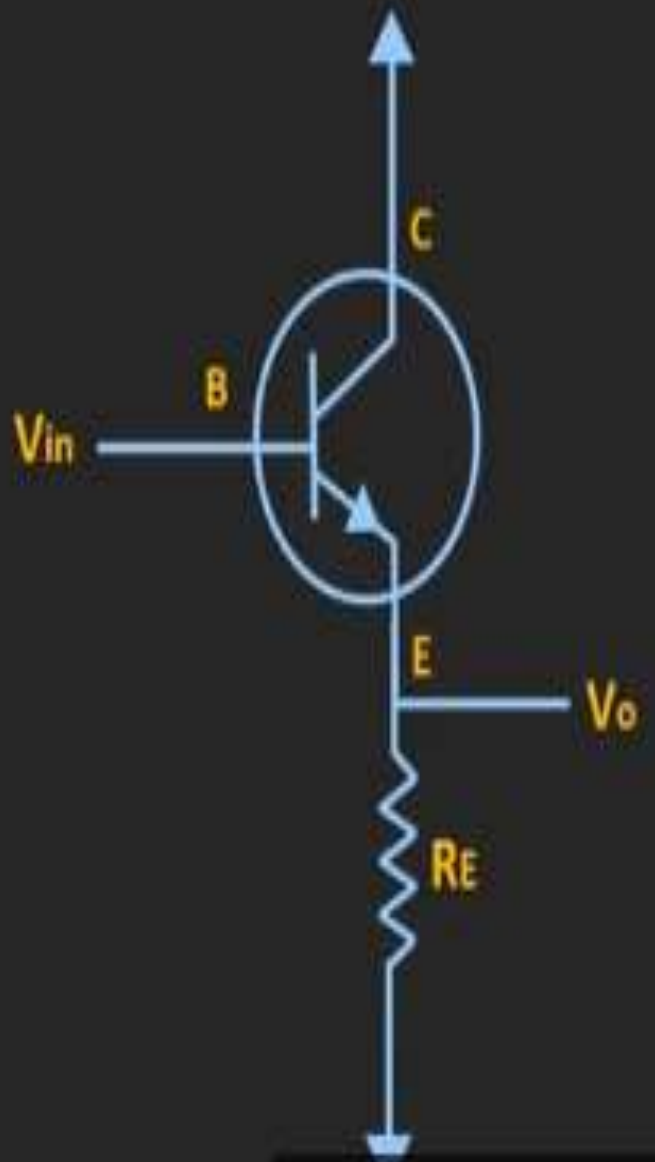
$$\therefore \gamma = \beta + 1$$

$$= \frac{\alpha}{1-\alpha} + 1 = \frac{1}{1-\alpha}$$

$$\therefore \gamma = \beta + 1 = \frac{1}{1-\alpha}$$

$$\alpha.\gamma = \frac{1-\alpha}{1-\alpha} \Rightarrow \alpha.\gamma = \beta$$

Common Collector (CC) Configuration



High Input Impedance

Low Output Impedance

$\beta + 1$

High Current Gain

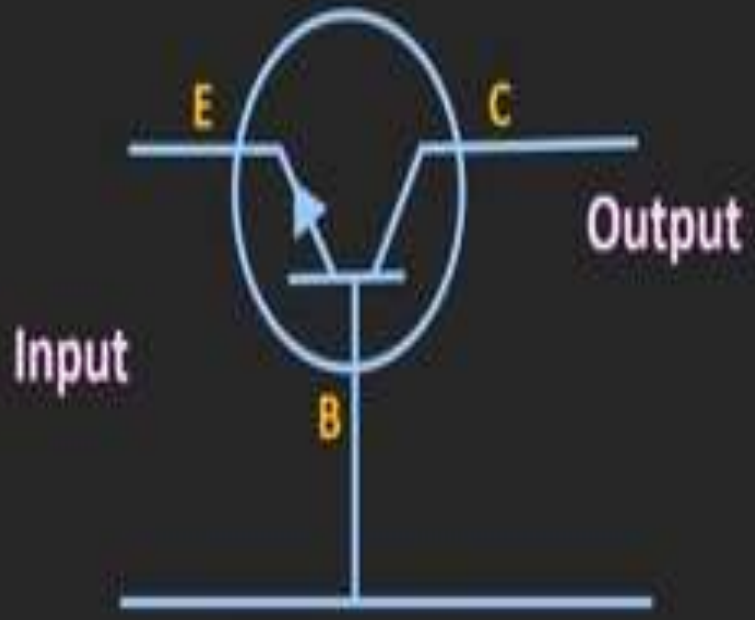
$\simeq 1$

Low Voltage Gain

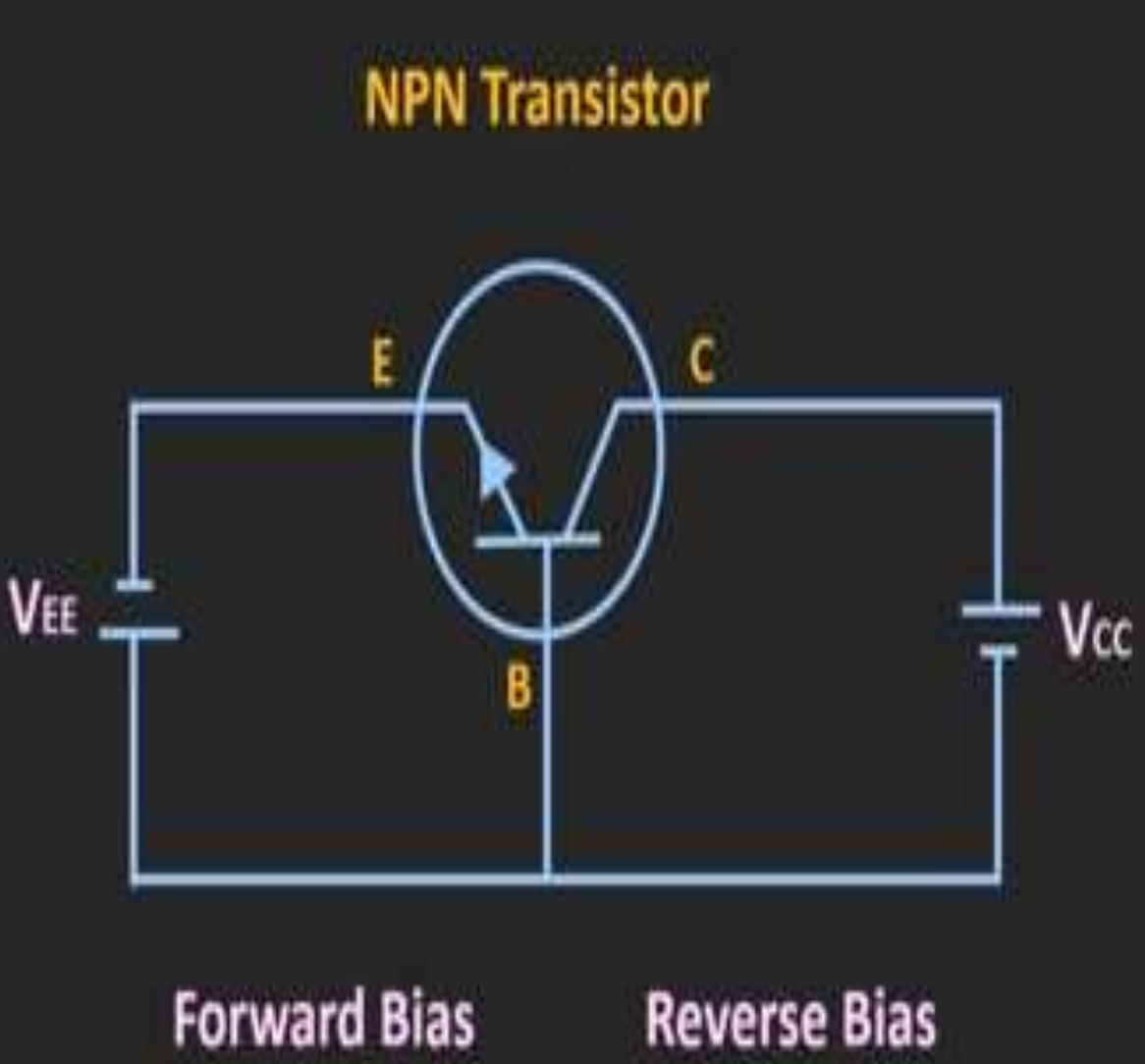
Low Power Gain

BJT
Common Base Configuration

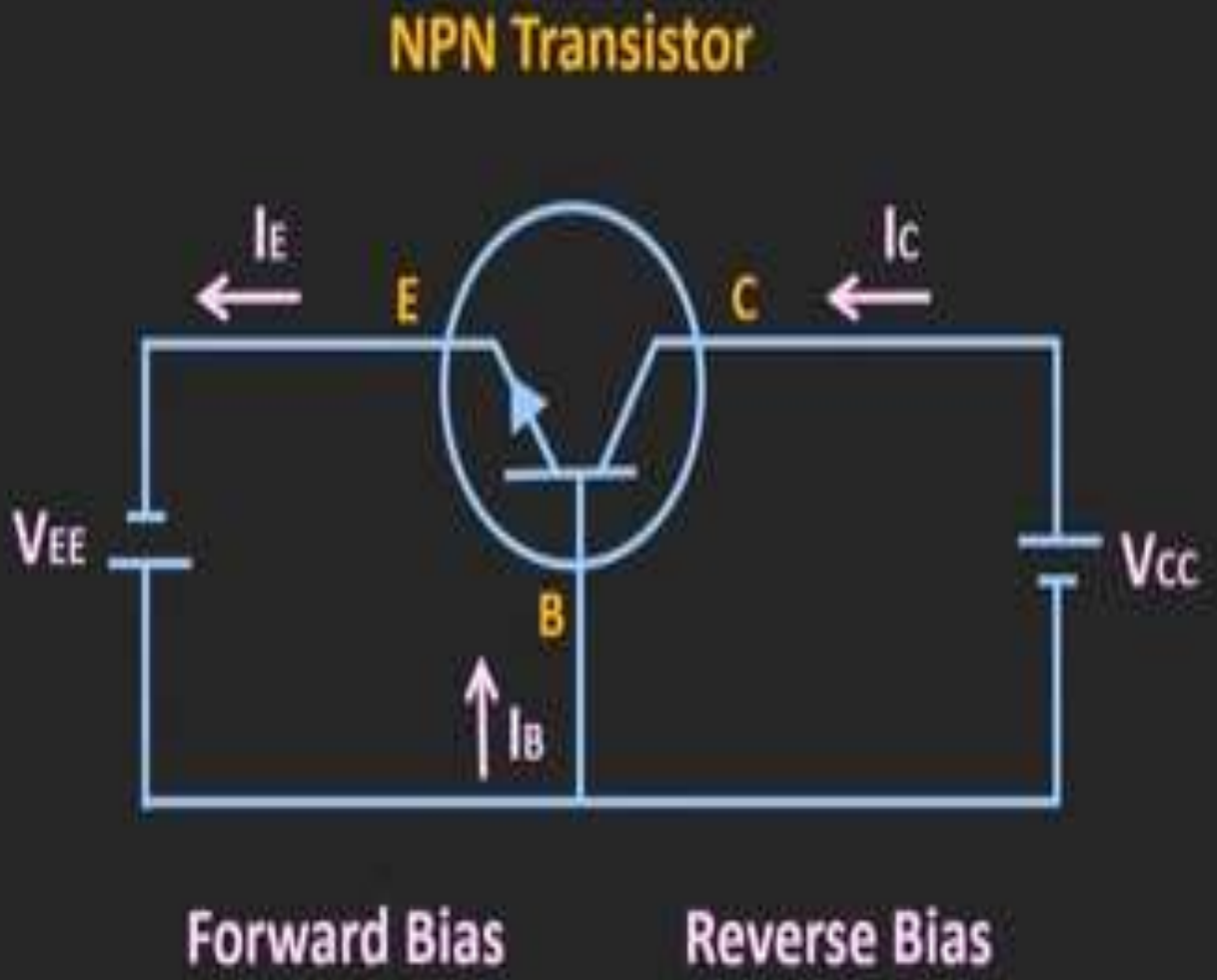
Common Base (CB) Configuration



Common Base (CB) Configuration

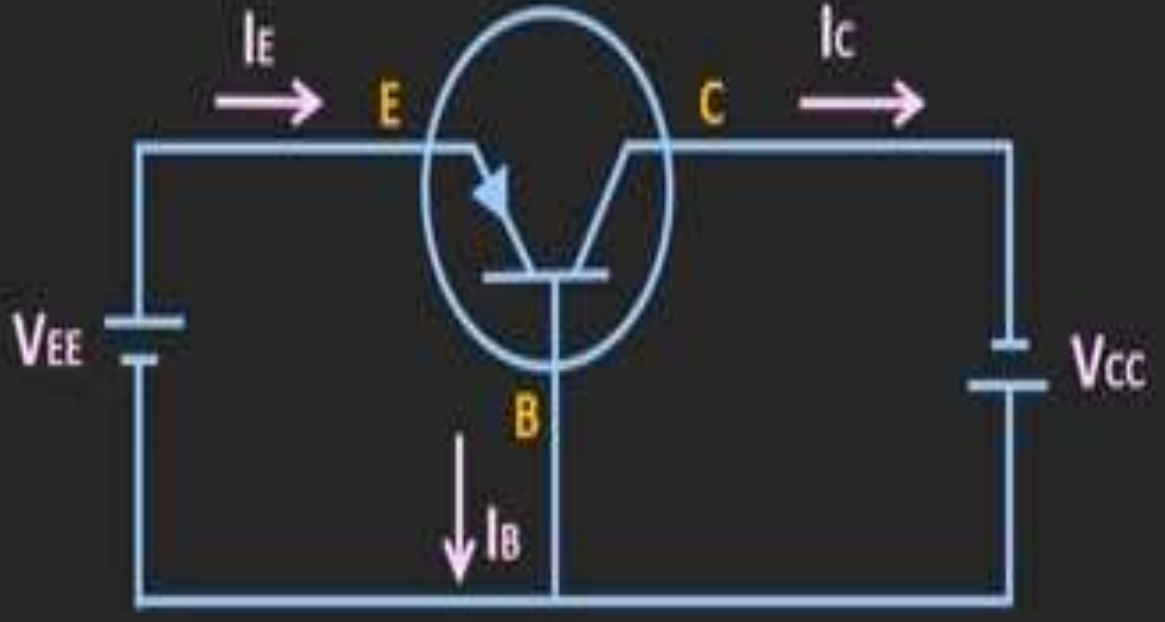


Common Base (CB) Configuration



Common Base (CB) Configuration

PNP Transistor

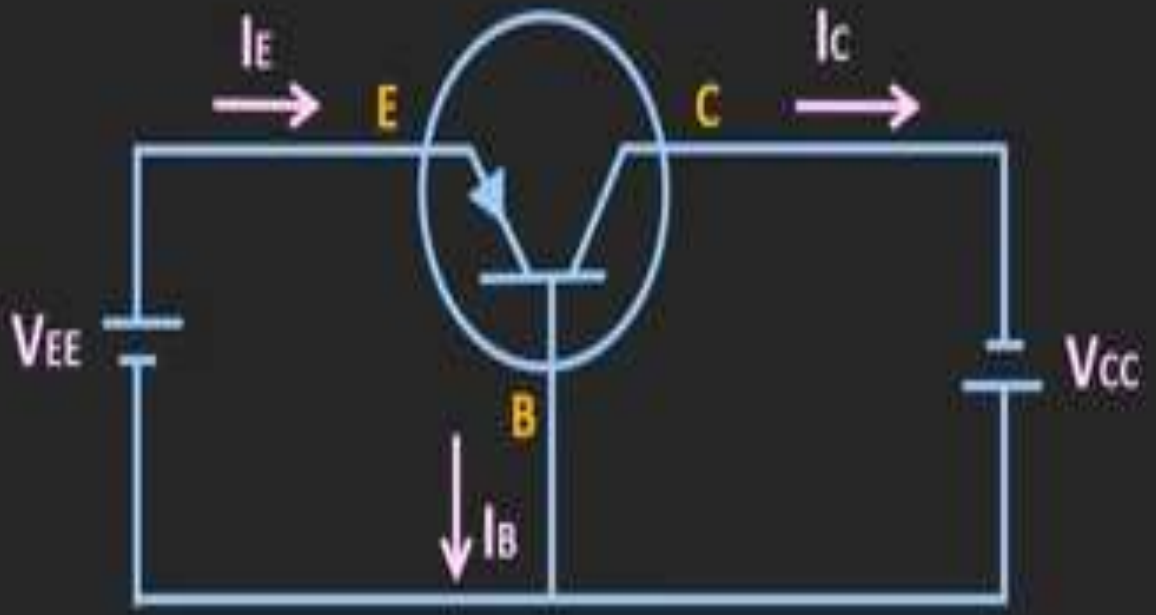


Forward Bias Reverse Bias

Common Base (CB) Configuration

PNP Transistor

$I_E = I_\beta + I_C$



Forward Bias Reverse Bias

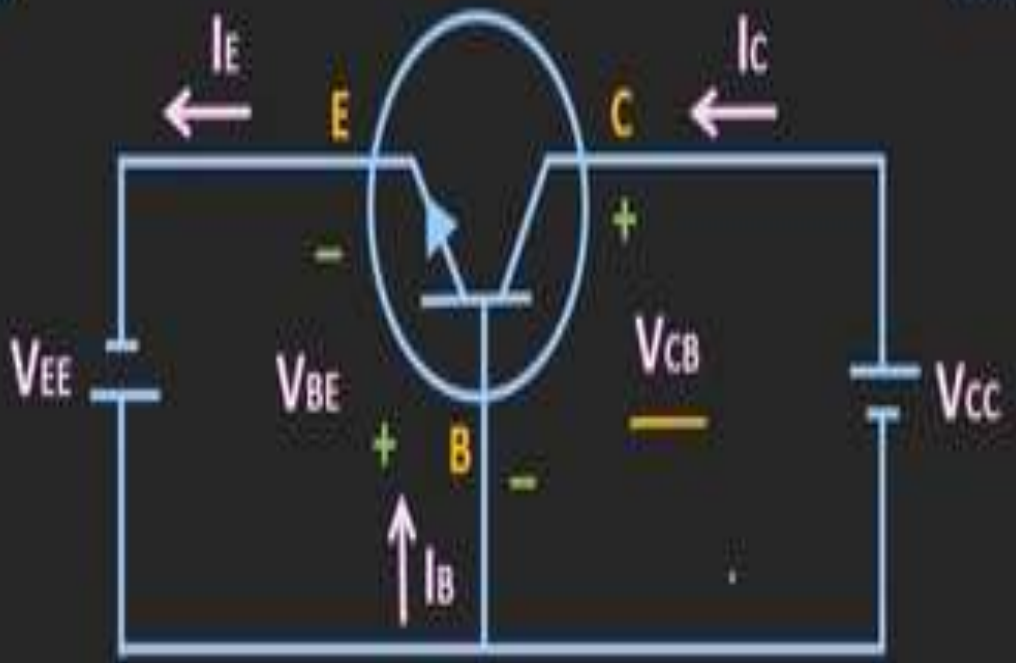
Common Base (CB) Configuration

NPN Transistor

Input Characteristics

I_E, V_{BE}

Output Characteristics

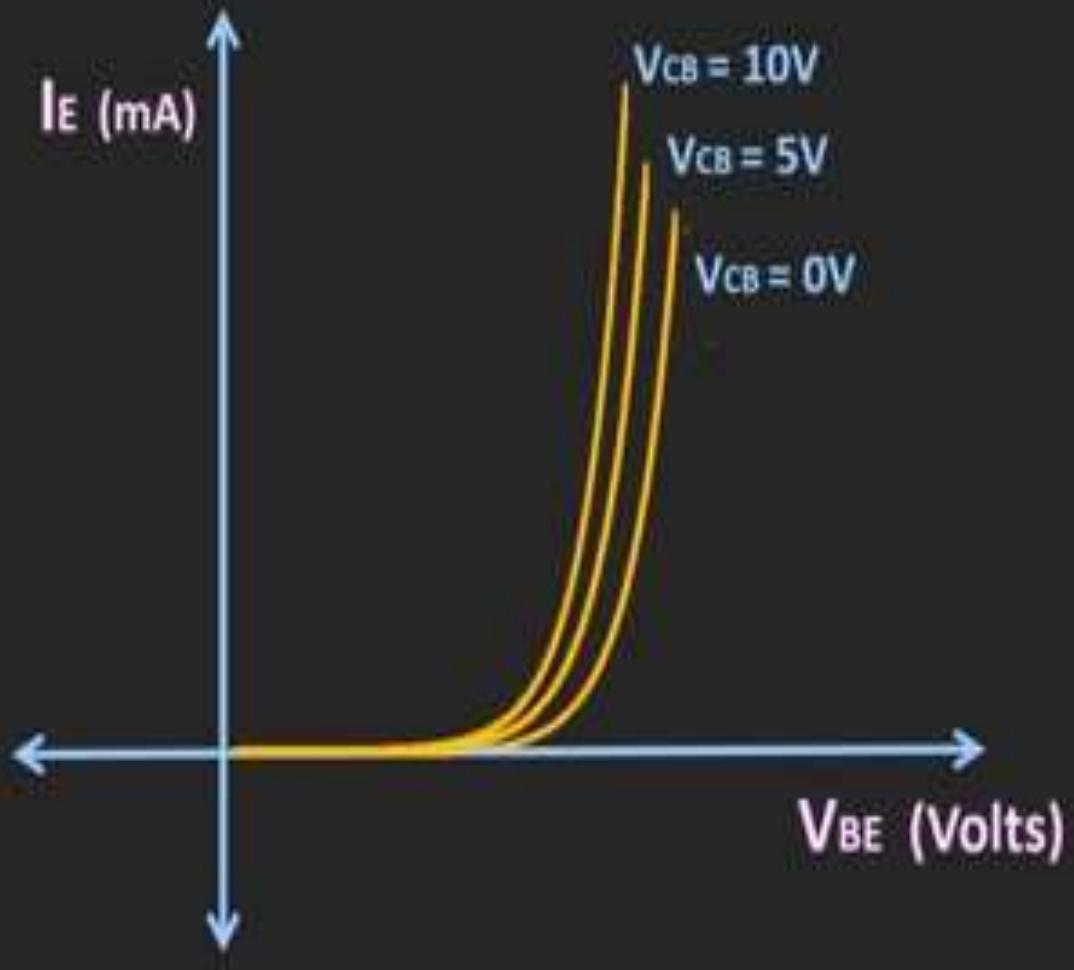


Forward Bias

Reverse Bias

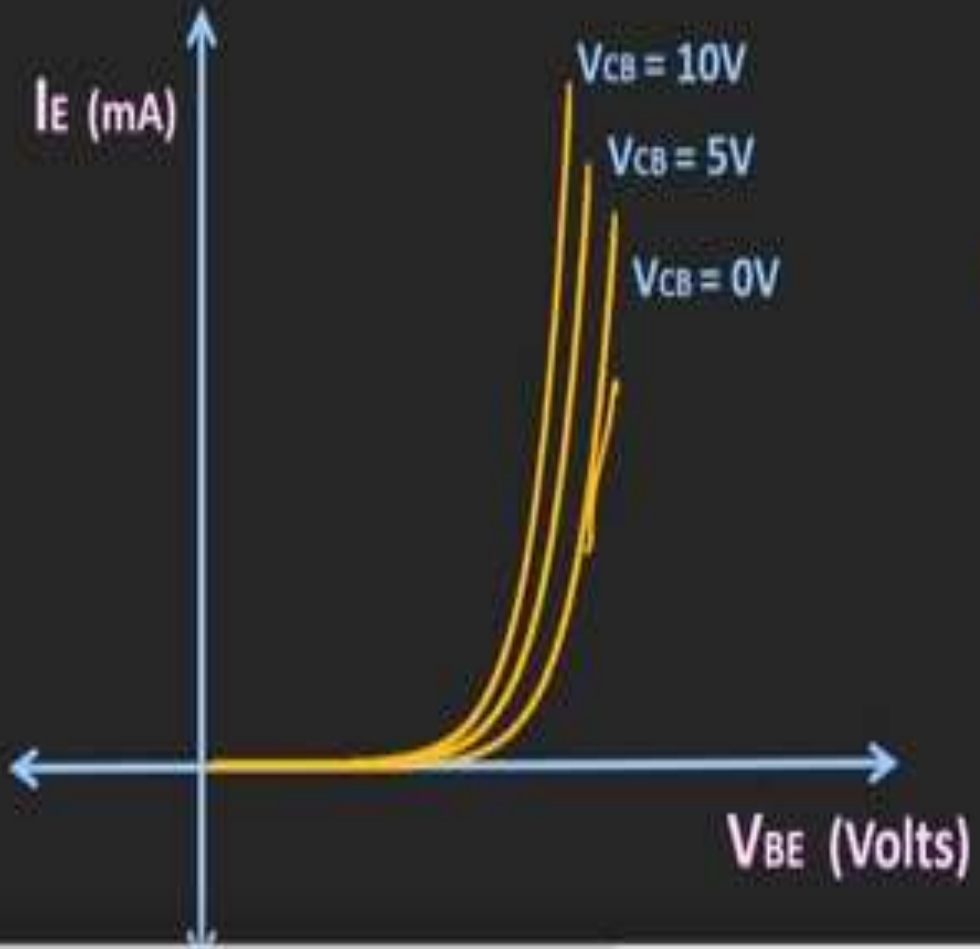
Common Base (CB) Configuration

Input Characteristics



Common Base (CB) Configuration

Input Characteristics



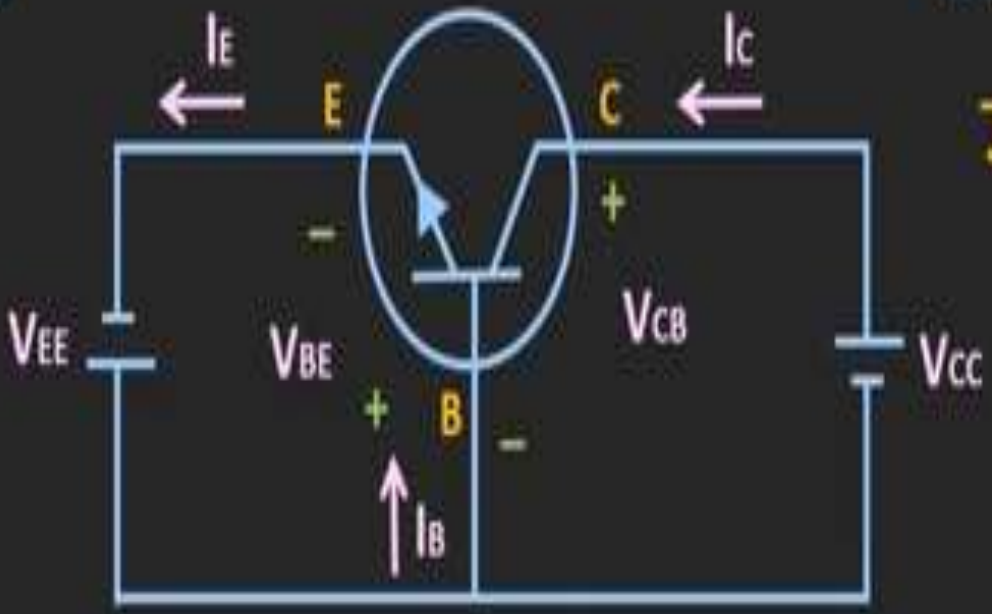
$$R_{in} = \frac{\Delta V_{BE}}{\Delta I_E}$$

Common Base (CB) Configuration

NPN Transistor

Input Characteristics

Output Characteristics



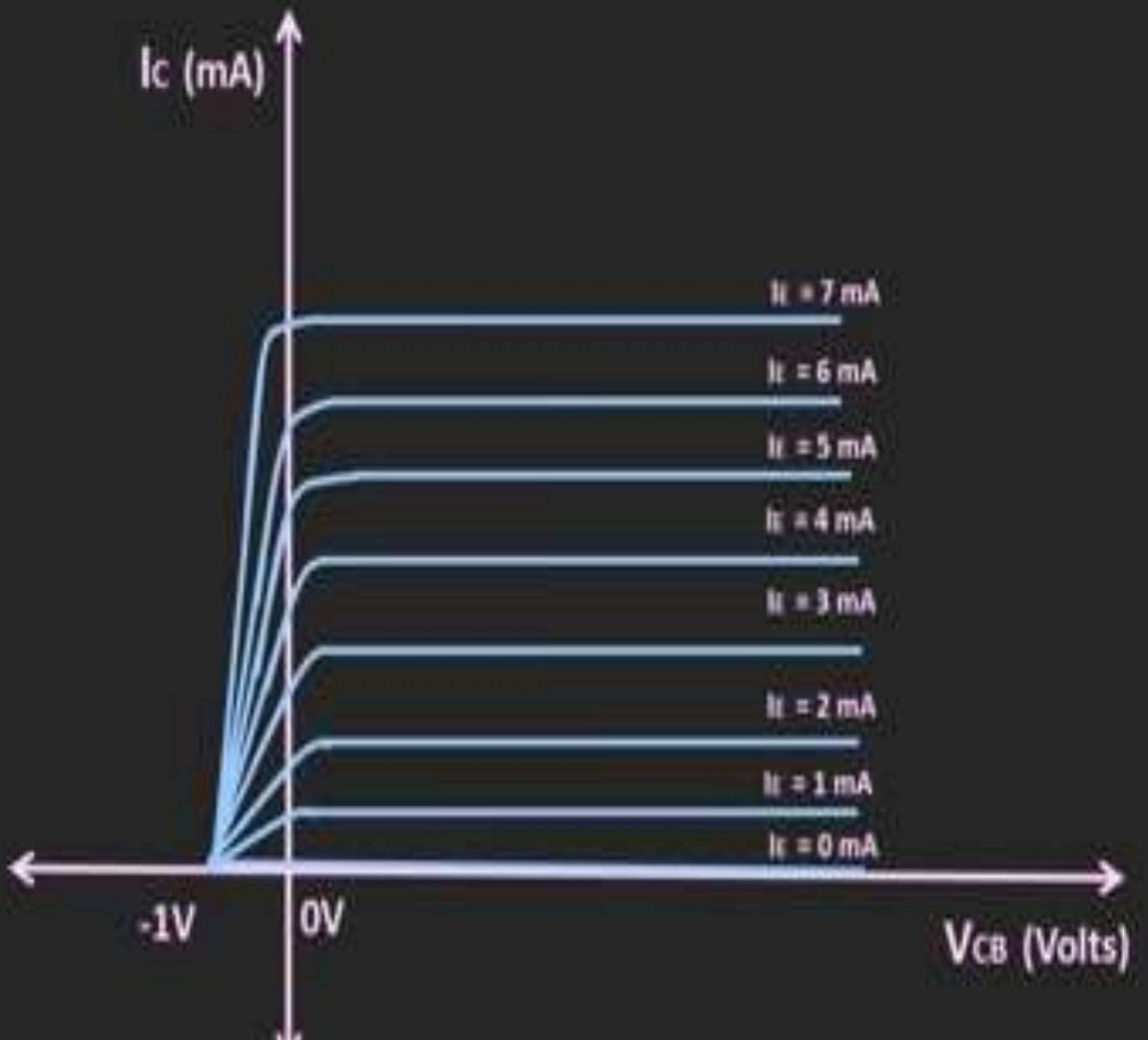
I_C, V_{CB}

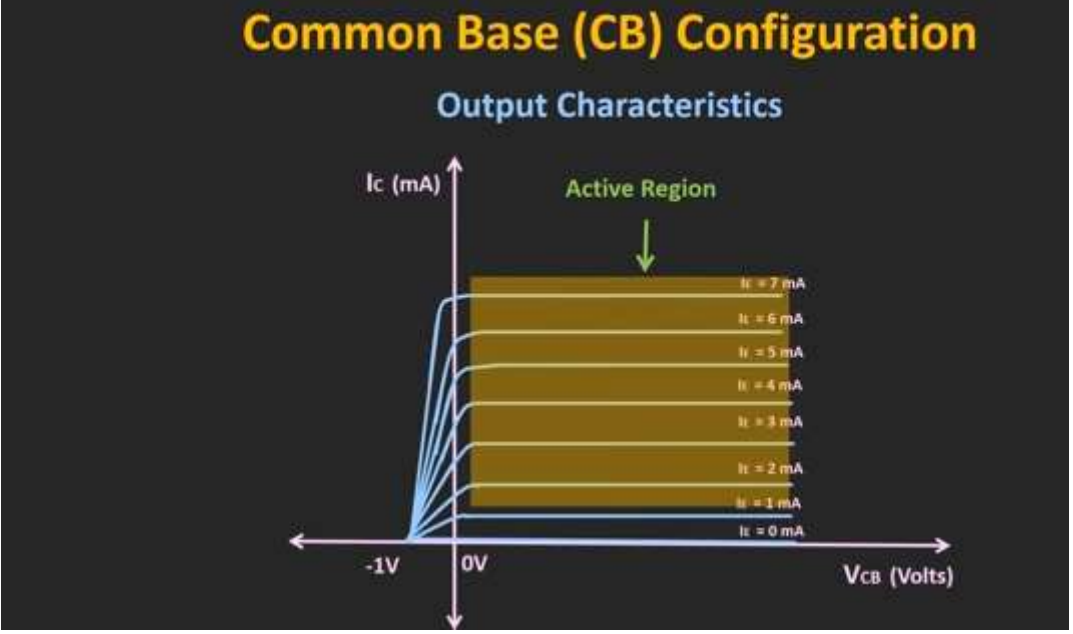
Forward Bias

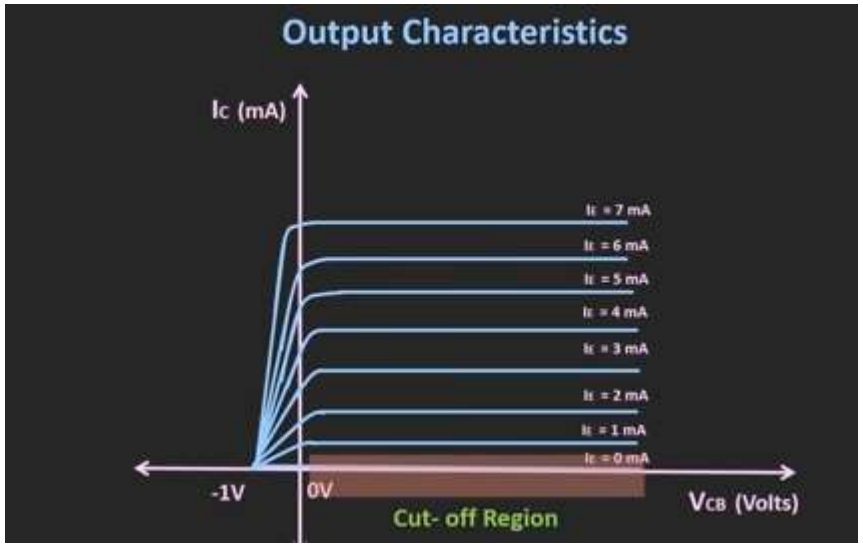
Reverse Bias

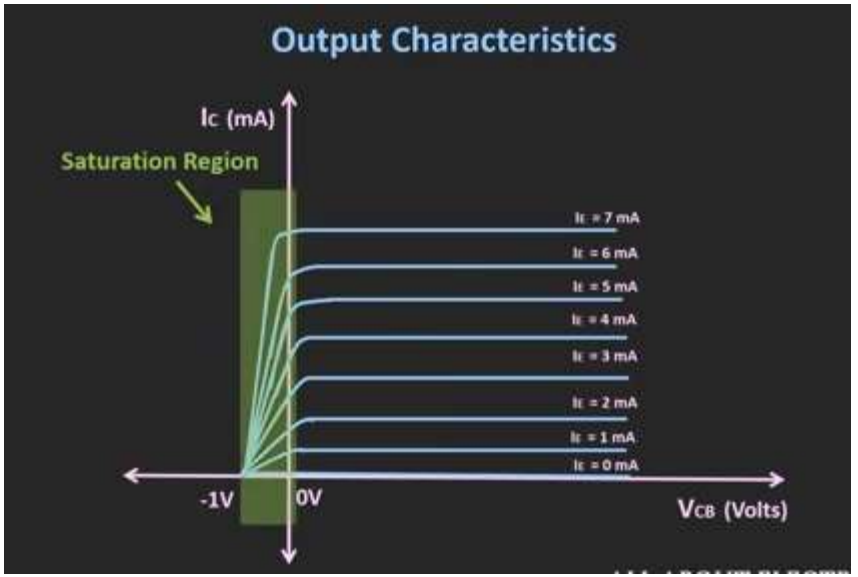
Common Base (CB) Configuration

Output Characteristics



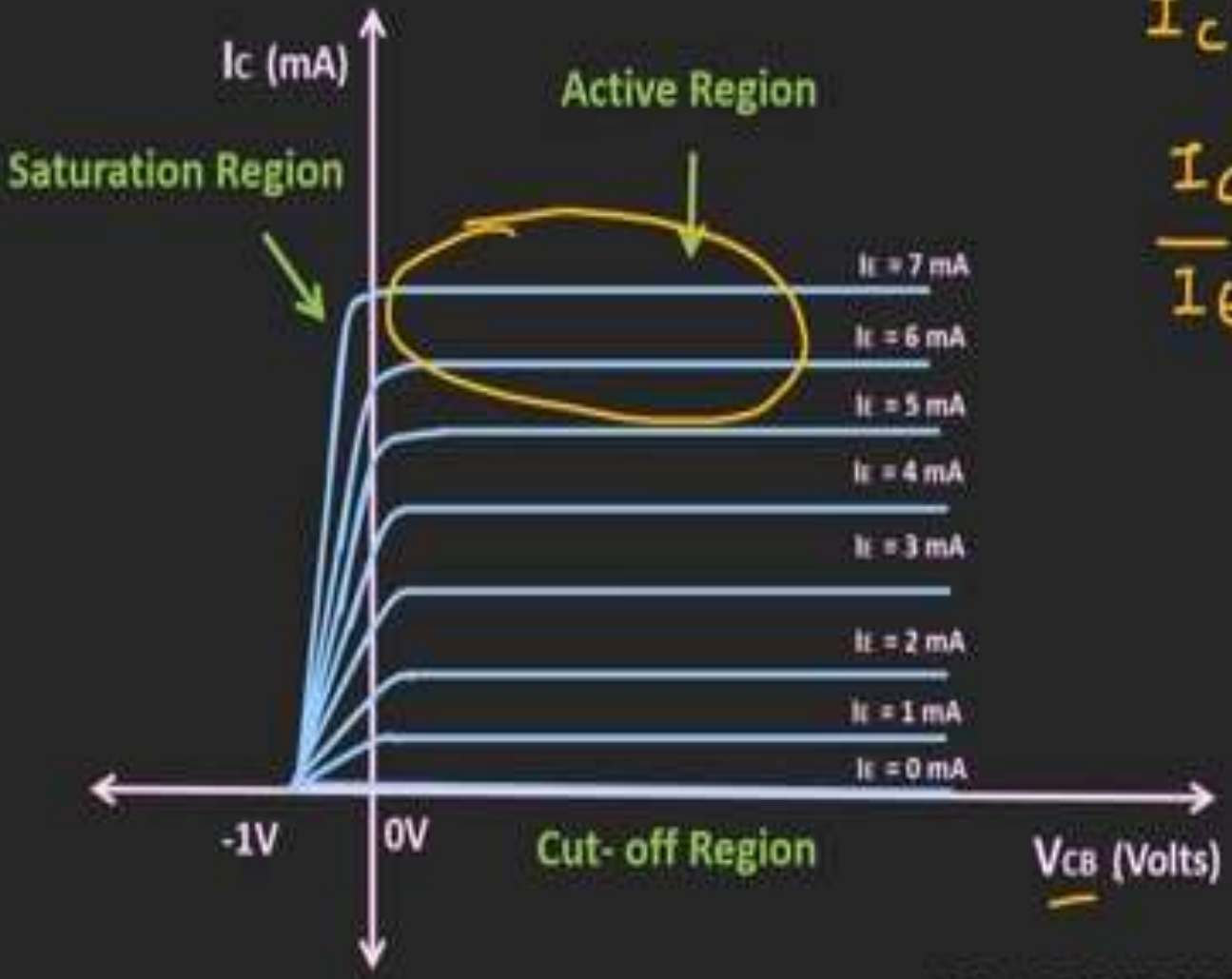

Common Base (CB) Configuration
Output Characteristics
Ic (mA)
Active Region
Ie = 7 mA
Ie = 6 mA
Ie = 5 mA
Ie = 4 mA
Ie = 3 mA
Ie = 2 mA
Ie = 1 mA
Ie = 0 mA
-1V
0V
VCB (Volts)


Output Characteristics
Ic (mA)
Ie = 7 mA
Ie = 6 mA
Ie = 5 mA
Ie = 4 mA
Ie = 3 mA
Ie = 2 mA
Ie = 1 mA
Ie = 0 mA
-1V
0V
Cut- off Region
VCB (Volts)


Output Characteristics
Ic (mA)
Saturation Region
Ie = 7 mA
Ie = 6 mA
Ie = 5 mA
Ie = 4 mA
Ie = 3 mA
Ie = 2 mA
Ie = 1 mA
Ie = 0 mA
-1V
0V
VCB (Volts)

Common Base (CB) Configuration

Output Characteristics



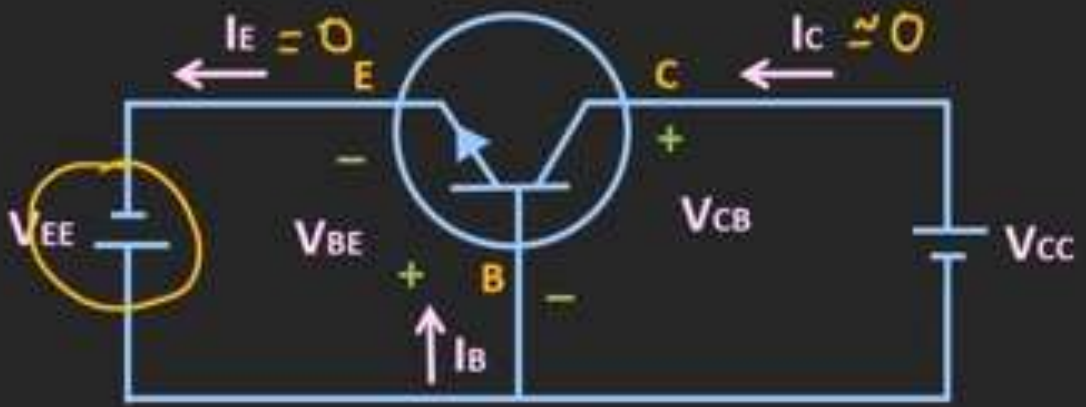
$$I_C = \alpha I_E$$

$$\frac{I_C}{I_E} = \alpha$$

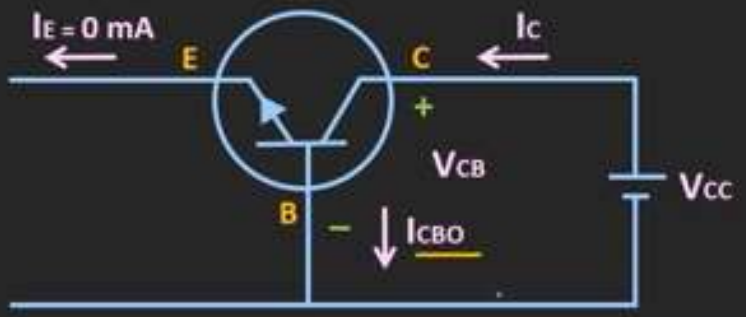
Common Base (CB) Configuration

NPN Transistor

$I_{CT} = I_C + I_{CO}$

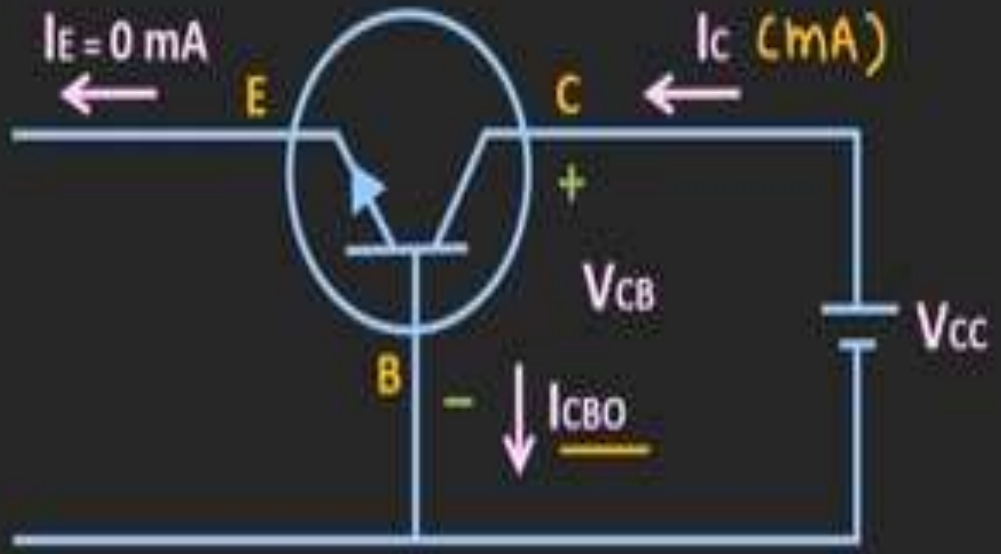


NPN Transistor



Common Base (CB) Configuration

NPN Transistor



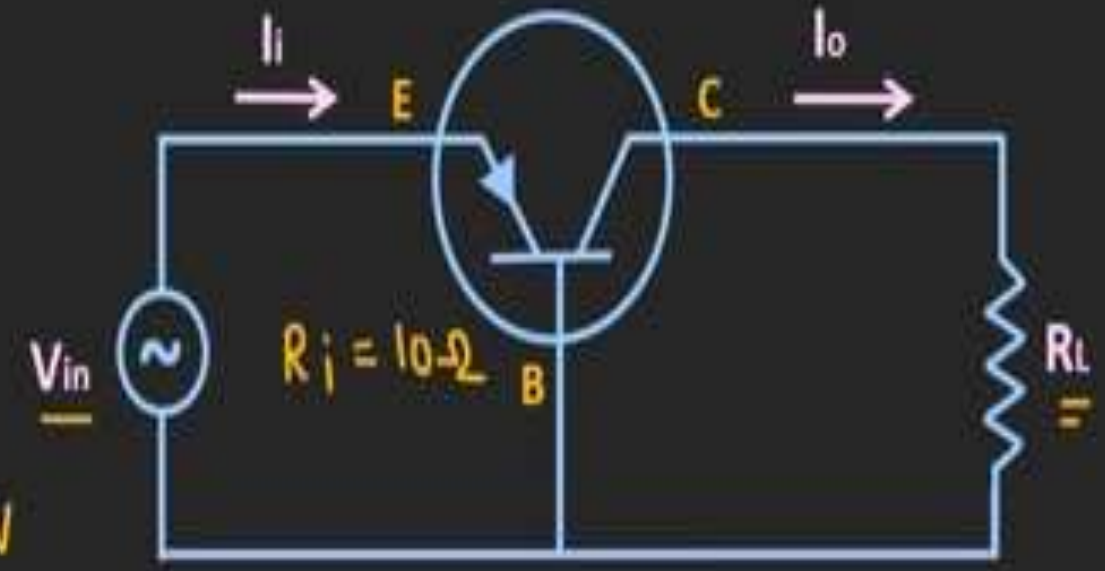
I_{CBO} $T\uparrow$

$I_{CT} = I_C + I_{CBO}$

$I_C = \alpha I_E + I_{CBO}$

Common Base (CB) Configuration

Voltage Amplification



$\alpha = 1$

$I_o = I_i$

$I_C = \alpha I_E$

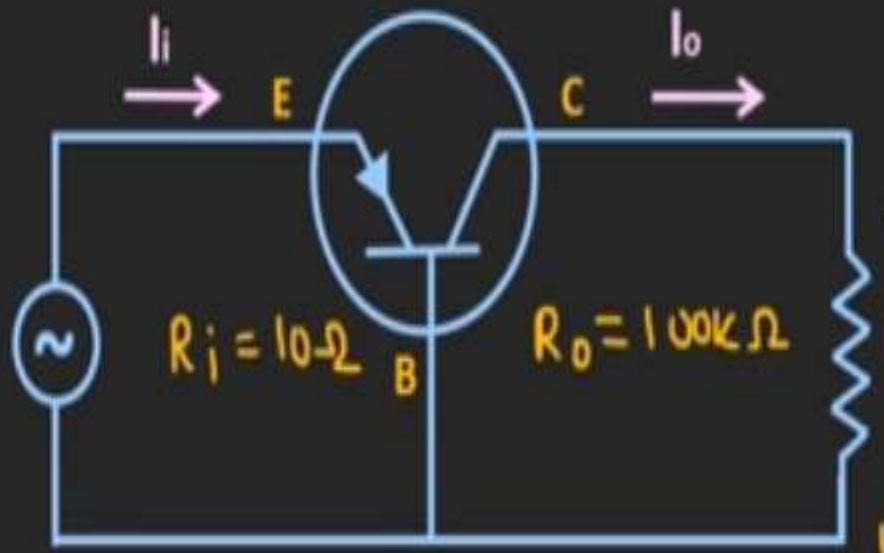
$\Rightarrow I_C = I_E$

$$I_i = \frac{5mV}{10\Omega} = 0.5mA$$

Common Base (CB) Configuration

$\frac{I_C}{I_E} < 1$

Voltage Amplification



$\alpha = 1$

$I_o = I_i$

$I_C = \alpha I_E$

$\Rightarrow I_C = I_E$

100

5mV

1kΩ

$I_i = \frac{5mV}{10\Omega} = 0.5mA$

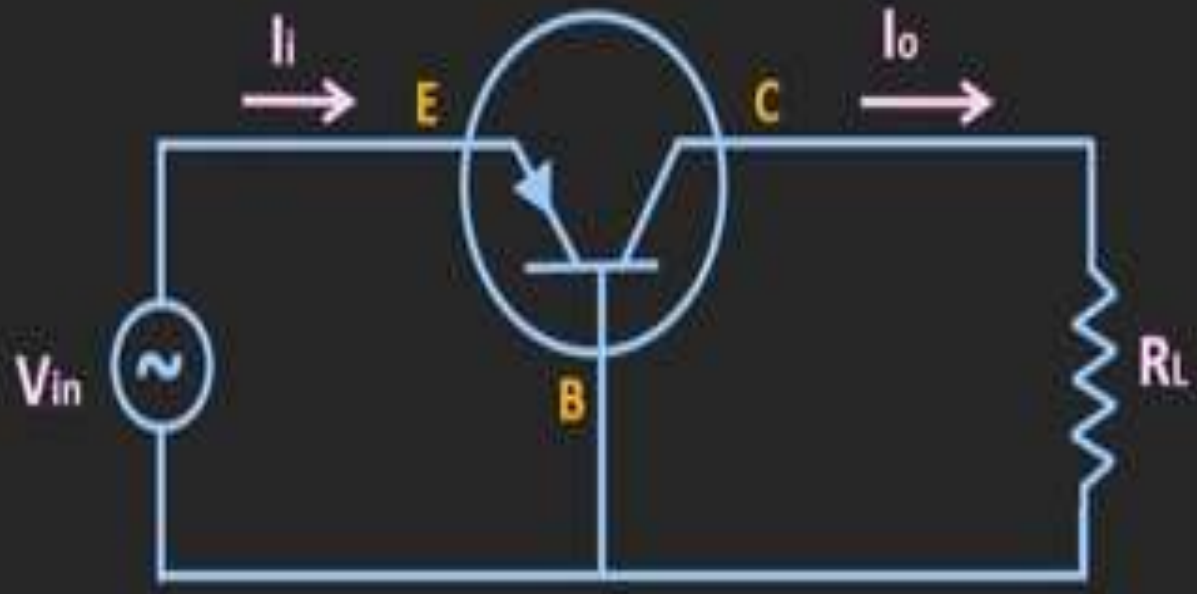
$V_o = I_o R_L$

$= 0.5mA \times 1k\Omega$

$= 0.5V = 500mV$

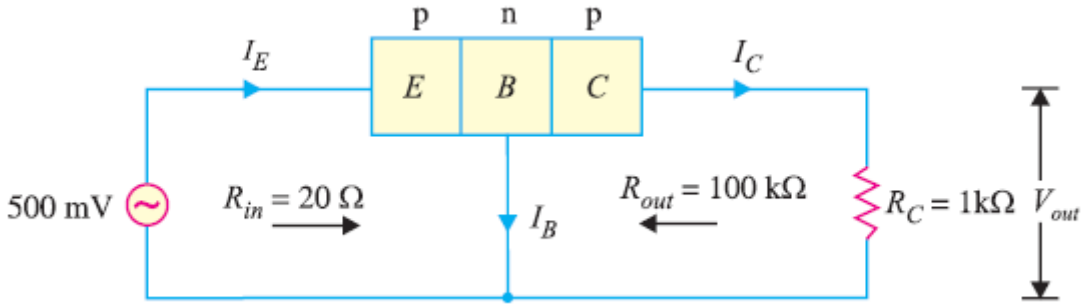
Common Base (CB) Configuration

Voltage Amplification



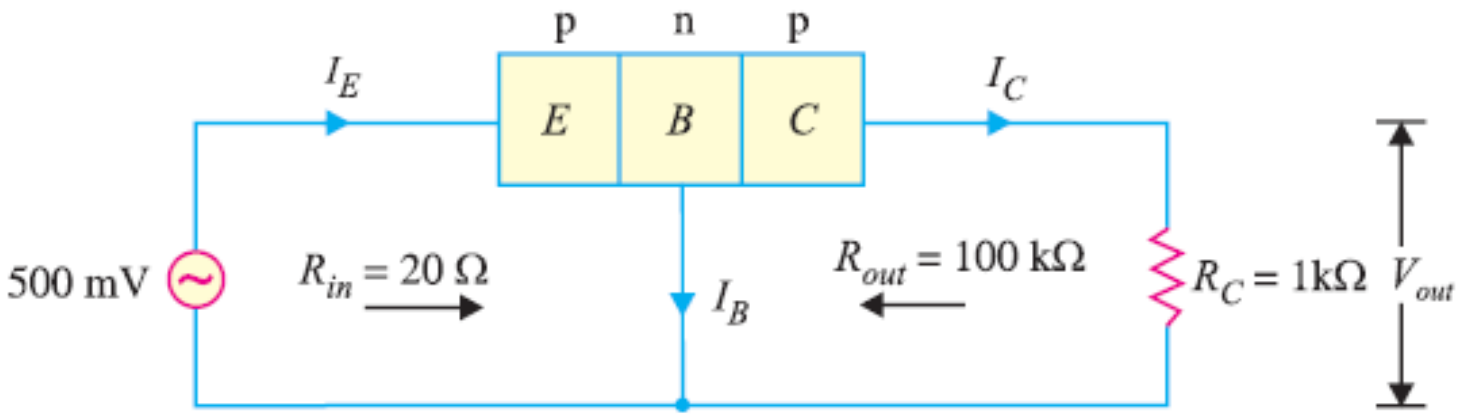
Transfer + Resistor = Transistor

A common base transistor amplifier has an input resistance of 20 Ω and output resistance of 100 kΩ. The collector load is 1 kΩ. If a signal of 500 mV is applied between emitter and base, find the voltage amplification



https://electronicspost.com/solved-problems-on-transistor/

A common base transistor amplifier has an input resistance of 20 Ω and output resistance of 100 kΩ. The collector load is 1 kΩ. If a signal of 500 mV is applied between emitter and base, find the voltage amplification



Input current, $I_E = \dfrac{\text{Signal}}{R_{in}} = \dfrac{500\ mV}{20\ \Omega} = 25\ mA$. Since α_{ac} is nearly 1, output current, $I_C = I_E = 25\ mA$.

$$\text{Output voltage, } V_{out} = I_C R_C = 25\ mA \times 1\ k\Omega = 25\ V$$

$$\therefore \quad \text{Voltage amplification, } A_v = \frac{V_{out}}{\text{signal}} = \frac{25\ V}{500\ mV} = 50$$

In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current.

In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current.

Here, $\alpha = 0.9, \quad I_E = 1\ \text{mA}$

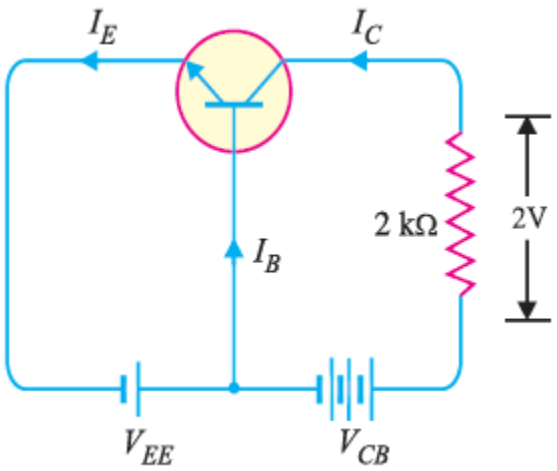
Now $\alpha = \dfrac{I_C}{I_E}$

or $I_C = \alpha I_E = 0.9 \times 1 = 0.9\ \text{mA}$

Also $I_E = I_B + I_C$

$\therefore$ Base current, $I_B = I_E - I_C = 1 - 0.9 = \mathbf{0.1\ mA}$

In a common base connection, α = 0.95. The voltage drop across 2 kΩ resistance
which is connected in the collector is 2V. Find the base current.



$\therefore \quad I_C = 2\text{ V}/2\text{ k}\Omega = 1\text{ mA}$

Now $\quad \alpha = I_C/I_E$

$$\therefore \quad I_E = \frac{I_C}{\alpha} = \frac{1}{0.95} = 1.05\text{ mA}$$

Using the relation, $I_E = I_B + I_C$

$$\therefore \quad I_B = I_E - I_C = 1.05 - 1$$
$$= \mathbf{0.05\text{ mA}}$$