Name:- Aryan Dilipbhai Langhanoja	**Roll Number:- 92200133030**
Subject Name and Code:- Basics of Electronics Engineering (01EC101)	**Date of Experiment:-** 26-12-2022

What Is Transistors:-

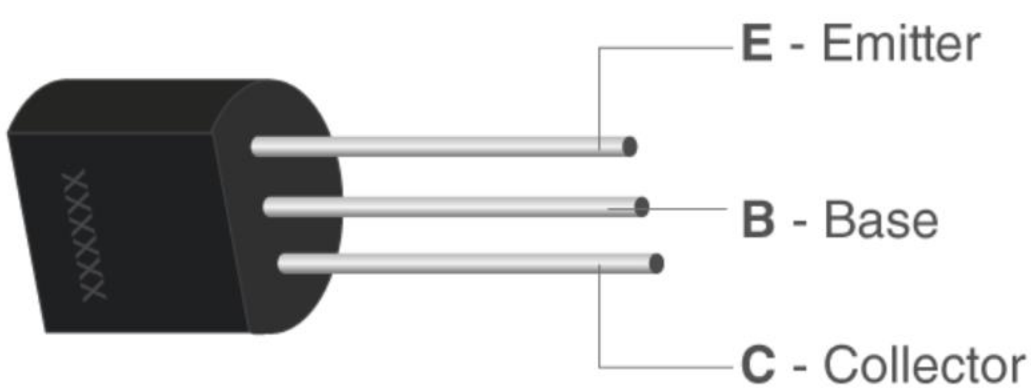
- A transistor is a type of a semiconductor device that can be used to both conduct and insulate electric current or voltage. A transistor basically acts as a switch and an amplifier. In simple words, we can say that a transistor is a miniature device that is used to control or regulate the flow of electronic signals.

- Transistors are one of the key components in most of the electronic devices that are present today. Developed in the year 1947 by three American physicists John Bardeen, Walter Brattain and William Shockley, the transistor is considered as one of the most important inventions in the history of science.

Parts Of Transistors:-

- A typical transistor is composed of three layers of semiconductor materials or more specifically terminals which helps to make a connection to an external circuit and carry the current. A voltage or current that is applied to any one pair of the terminals of a transistor controls the current through the other pair of terminals. There are three terminals for a transistor. They are:-

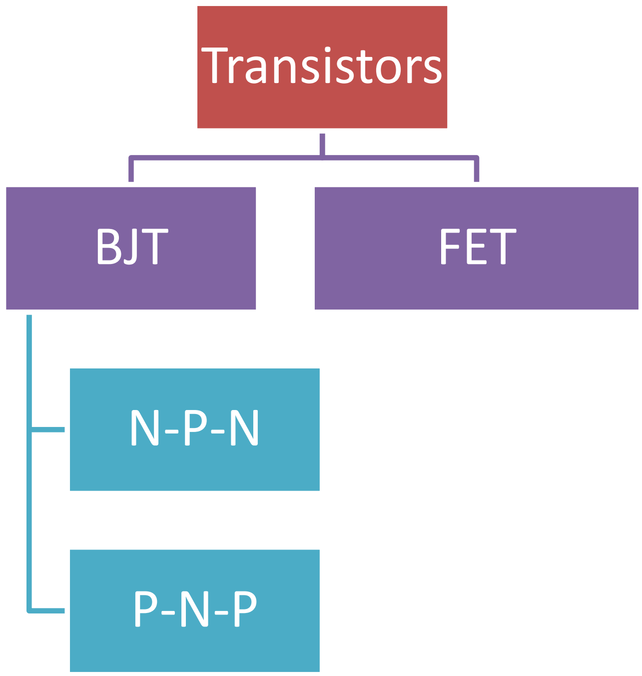
    - **Base: -** This is used to activate the transistor.
    - **Collector: -** It is the positive lead of the transistor.
    - **Emitter**: - It is the negative lead of the transistor.



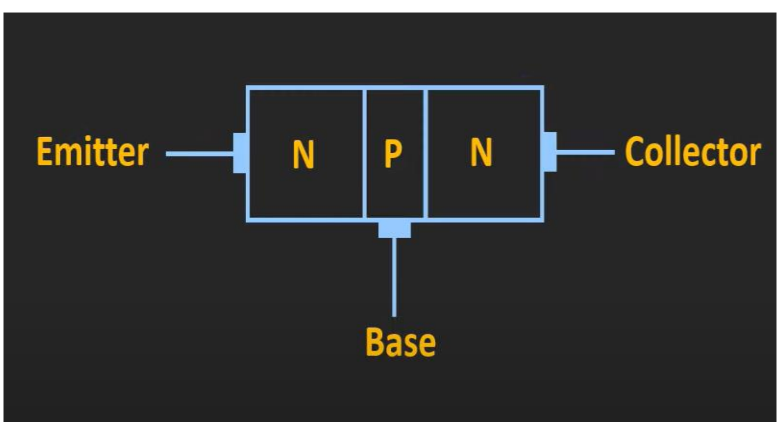
❖ **Thickness and Doping of Emitter, Base and Collector:-**

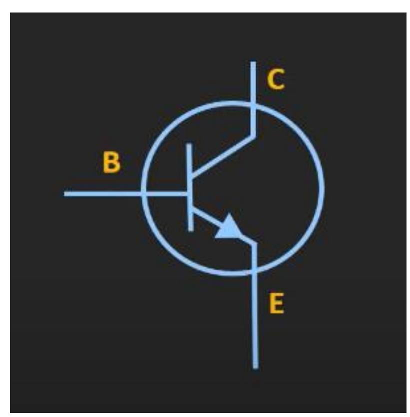
	Thickness	Doping
Emitter	Wide	Heavily Doped
Collector	More Wide than Emitter	Moderately Doped
Base	Very Thin	Lightly Doped

Types Of Transistors:-



❖ **N-P-N Transistors & Symbol In Circuit:-**



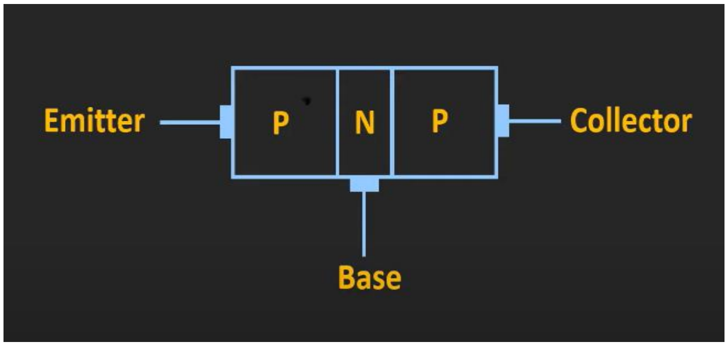


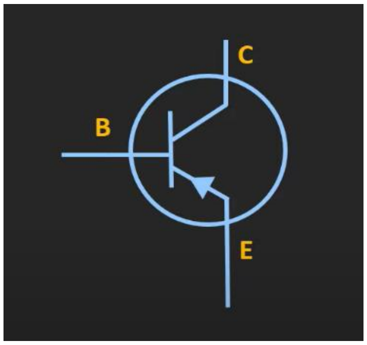
N-P-N Transistors Symbol

- In this transistor, we will find one p-type material that is present between two n-type materials. N-P-N transistor is basically used to amplify weak signals to strong signals. In NPN transistor, the electrons move from the emitter to collector region resulting in the formation of current in the transistor. This transistor is widely used in the circuit.

P-N-P Transistors Symbol In Circuit:-

- It is a type of BJT where one n-type material is introduced or placed between two p-type materials. In such a configuration, the device will control the flow of current. PNP transistor consists of 2 crystal diodes which are connected in series. The right side and left side of the diodes are known as the collector-base diode and emitter-base diode, respectively.





Transistors Configuration

- There Are **Three** Types Of Transistors Configuration-

1) Common Emitter Transistor **(CE)**

- In Common Emitter (CE) configuration the emitter terminal is common between the input and the output terminals.

2) Common Base Transistor **(CB)**

- In Common Base (CB) configuration the base terminal of the transistor is common between input and output terminals.

3) Common Collector Transistor **(CC)**

- In Common Collector (CC) configuration the collector terminals are common between the input and output terminals.

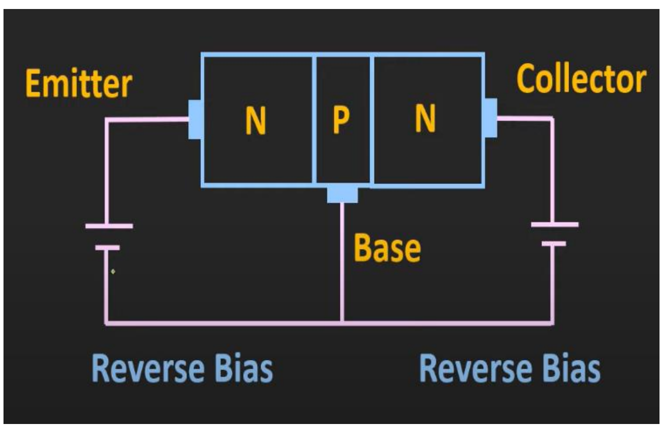
Region Of Operation:-

- There Are **Four** Different types of Operating Regions for transistors:-

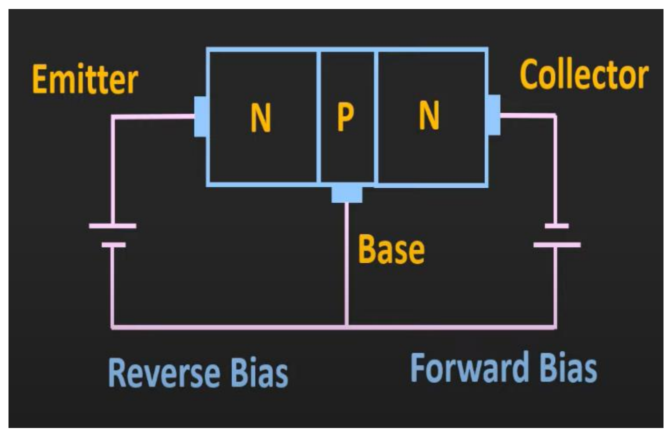
1) Active Region.
2) Cut-Off Region.
3) Saturation Region.
4) Reverse Active Region.

Let, Collector Voltage = Vc , Emitter Voltage=Ve , Base Voltage=Vb

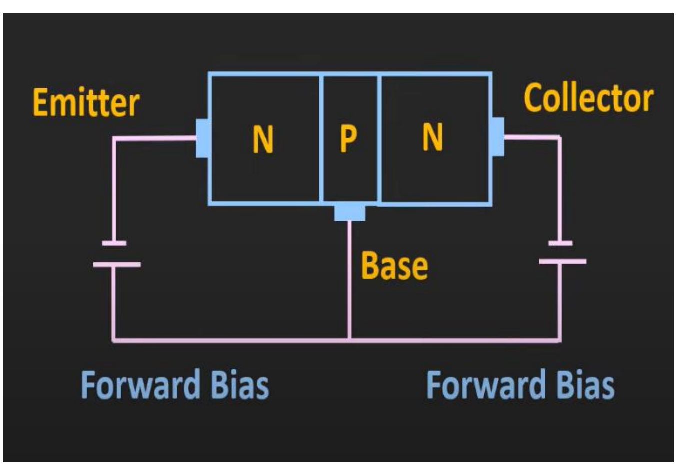
Region Of Operation	Voltage Comparison
Cut-Off Region	Ve>Vb & Vc>Vb
Reverse Active Region	Ve>Vb >Vc
Saturation region	Vb>Ve & Vb>Vc
Active Region	Vc>Vb>Ve



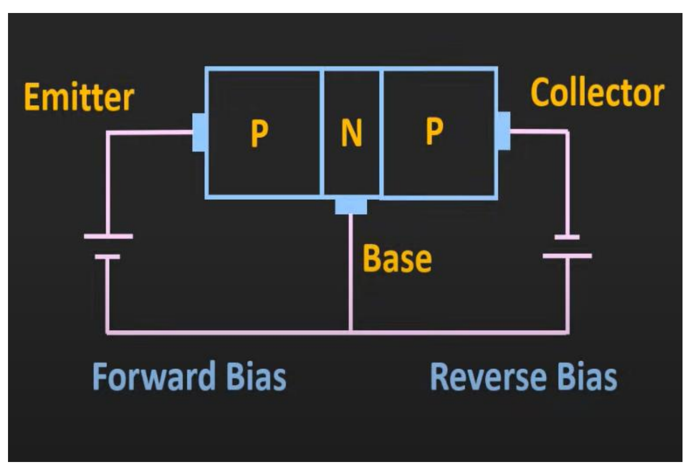
Cut-Off Region



Reverse-Active Region



Saturation region



Active Region

Application Of Transistors

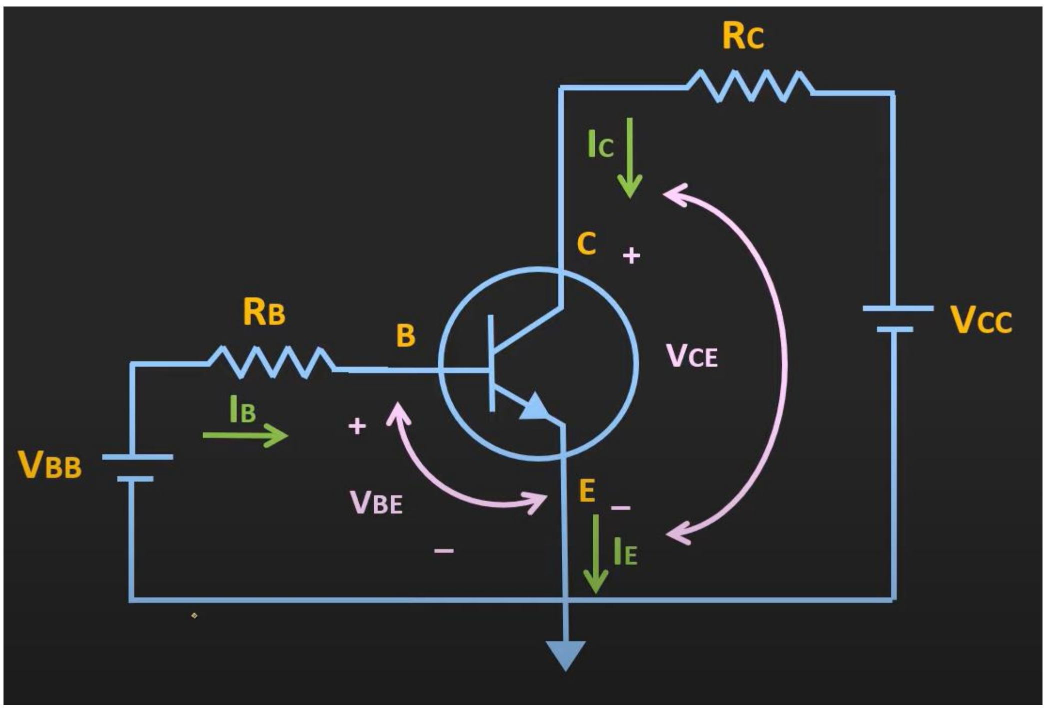
1) As A Switch
2) As An Amplifier

Biasing Method of Transistors

❖ There Are **Four** Types Of Transistor Biasing**.**

1) Fix Biased
2) Fix Biased With Emitter Resistor
3) Collector to Base Bias
4) Voltage Divider Bias
5) Emitter Bias

❖ Fix-Bias Configuration



➢ In This Figure, Shown that Voltage Given at Base-Emitter Junction is VBB and Voltage Given at Emitter-Base Junction is VEE. We are using active Region of operation.
➢ When we applied Voltage at Emitter, Emitter emits lot of free electron, because it is heavily doped. That Electron Enters in Base. Where some holes are present. And electron combines with them.
➢ Now electron has two choices, go to VBB or to go VCC. Because VCC>>VBB. Some electrons are attracted by VBB and rest all electron is attracted by the VCC. And it is shown

that the current is I_C due to that. And the current I_B is the current produces by the electron attracted by the VBB.

Now, applying KCL, we can say that $I_E = I_B + I_C$ ……… (1)

- As already mentioned that very few electron attracted by VBB

$\therefore I_C \approx I_E$

$\therefore I_C = \alpha I_E$ ……… (2).

- Now, From eq (1).

$\therefore I_E = I_B + \alpha I_E$

$\therefore I_B = I_E - \alpha I_E$

$\therefore I_B = I_E - \alpha I_E$

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

From eq (1) $I_E = I_C / \alpha$.

$\therefore I_B = (1- \alpha) I_C / \alpha$.

$\therefore I_B = (1- \alpha/ \alpha) I_C$.

$\therefore I_C = (\alpha/1- \alpha)I_B$.

$\therefore I_C = (\alpha/1- \alpha)I_B$

$\boldsymbol{\therefore I_C = \beta I_B}$

Where β is called the current gain.

- Now, if we took Emitter-Base Loop and apply KVL in it,

$\therefore V_{BB} - I_B R_B – V_{BE} = 0.$

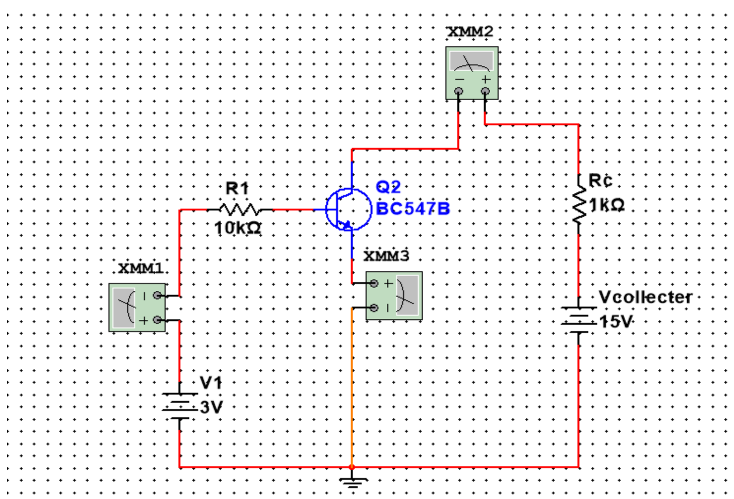
$$\therefore I_B = \frac{V_{BB} - V_{BE}}{R_B}$$

And Now, if we took Collector-Base Loop and apply KVL in it,

$\therefore V_{CC} - I_C R_C – V_{CE} = 0.$

$\boldsymbol{\therefore V_{CE} = V_{CC} - I_C R_C}$

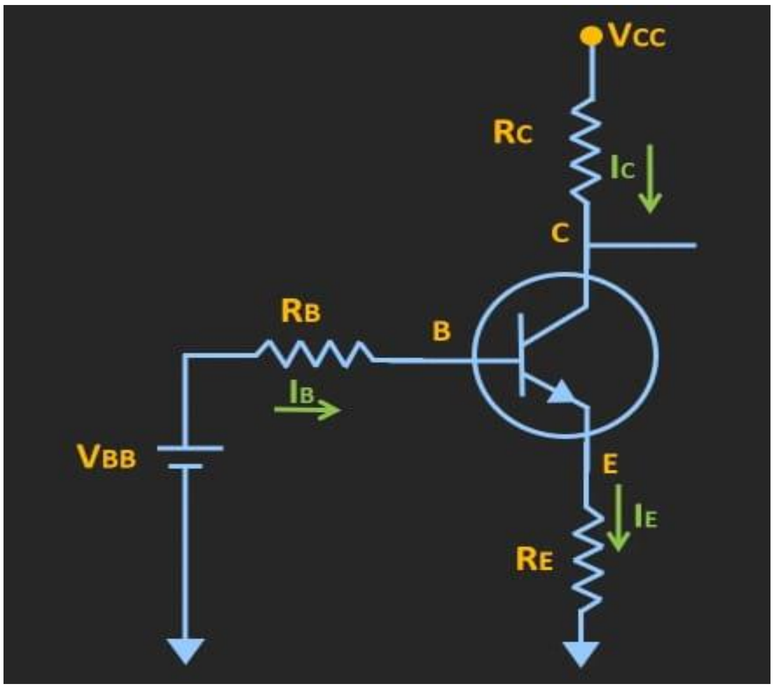
- **Multisim Circuit**:-



- Observation Table:-

VCC	RC	IC	VCE
12 V	1 K Ω	11.902 mA	0.098 V
12 V	1.01 KΩ	11.784 mA	0.09816 V
12 V	1.02 KΩ	11.669 mA	0.09762 V
12 V	1.03 KΩ	11.556 mA	0.09732 V
12 V	1.04 KΩ	11.446 mA	0.09616 V

❖ Fix Bias With Emitter Resistor



- In this condition, the Emitter Resistor R_E will act as a feedback resistor. In any situation, temperature changes, then β changes. Let suppose the temperature increases, then β increases, and for the fix current I_B, Collector Current I_C will increases. Then the voltage drop across emitter Resistor will also increase. and base voltage V_{BE} will also increase. And because of V_{BE} increased V_B is also increased and I_B will decrease. And Q-point will be stable.

- Now, if we took Emitter-Base Loop and apply KVL in it,

$\therefore V_{BB} - I_B R_B - V_{BE} - I_E R_E = 0.$
$\therefore V_{BB} - I_B R_B - V_{BE} - I_E R_E = 0.$
$\therefore V_{BB} - I_B R_B - V_{BE} - (I_B + I_C) R_E = 0.$
$\therefore V_{BB} - I_B R_B - V_{BE} - (I_B + \beta I_B) R_E = 0.$
$\therefore V_{BB} - I_B R_B - V_{BE} - (1 + \beta) I_B R_E = 0.$

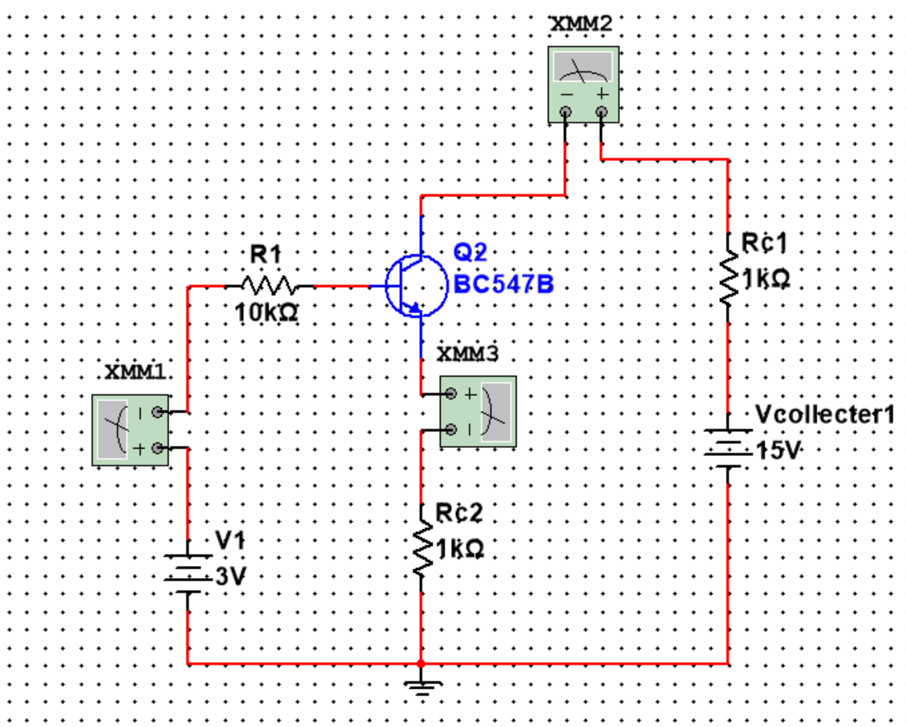
$$\therefore I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta+1)R_E}$$

And Now, if we took Collector-Base Loop and apply KVL in it,

$\therefore V_{CC} - I_C R_C - V_{CE} - I_E R_E = 0.$

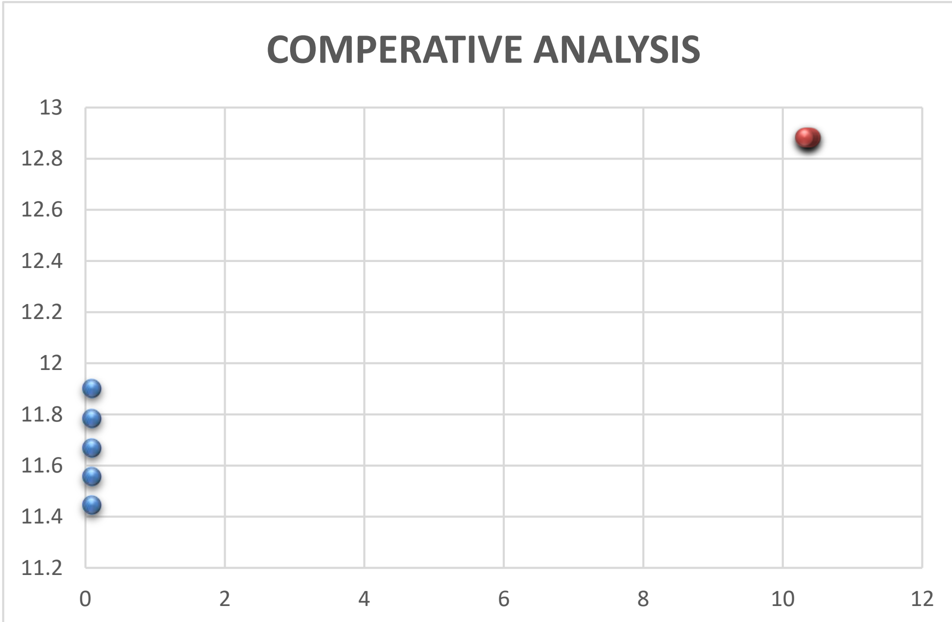
$$\therefore V_{CE} = V_{CC} - I_C(R_C + R_E)$$

❖ Multisim Circuit:-



➢ Observation Table:-

VCC	RC	IC	RE	VCE
12 V	1 KΩ	2.287 mA	1 KΩ	9.713 V
12 V	1.01 KΩ	2.287 mA	1 KΩ	9.69013 V
12 V	1.02 KΩ	2.287 mA	1 KΩ	9.66726 V
12 V	1.03 KΩ	2.287 mA	1 KΩ	9.64439 V
12 V	1.04 KΩ	2.287 mA	1 KΩ	9.62152 V



$I_C \rightarrow V_{CE}$ GRAPH Q-POINT STABILITY

- Fix Base With Emitter Resistor
- Fix-Base