**III)**

**Q.3.1**

Circuit Diagram:

**A diagram of a circuit

AI-generated content may be incorrect.**

VBE vs IB:

A graph with a line

AI-generated content may be incorrect.

IB

VBE

X Axis: IB (ranging from 0 to 100µA in steps of 10µA)

Y Axis: VBE

Obtained Emitter Base Junction Voltage = 667.39572mV

VBE vs IB and VCC:

A graph with blue lines

AI-generated content may be incorrect.

VBE

**IB**

X Axis: IB (ranging from 0 to 100µA in steps of 10µA)

Y Axis: VBE

VCC ranging from 0 to 12V in steps of 2V

The different plot lines converging together after IB shows that VBE does not depend on VCC while in Forward Active mode. The single separate plot line is for VCC = 0 , as it represents Saturation mode.

**Q.3.2**

Circuit Diagram:

A diagram of a diagram

AI-generated content may be incorrect.

IC vs VBE and Temperature:

A graph of a diagram

AI-generated content may be incorrect.

IC

VBE

X Axis: VBE ranging from 0 to 700mV in steps of 10mV

Y Axis: IC

Calculated for temperatures 20ºC, 30ºC, 40ºC and 50ºC

This calculation shows that collector current increases with temperature during Forward Active Mode of operation

**Q.3.3**

Circuit Diagram:

A diagram of a circuit

AI-generated content may be incorrect.

Ic vs VCE and IB:

A screen shot of a graph

AI-generated content may be incorrect.

IC

VCE

X Axis: VCE (ranging from 0 to 12V in steps of 0.01V)

Y Axis: IC

IB ranging from 0 to 100µA in steps of 10µA

The boundary between the Saturation region and Forward Active region is roughly at VCE = 303.79747mV, as shown by the cursor in the plot.

Ic vs IB at VCE = 100mV (Saturation):

A graph with a red line

AI-generated content may be incorrect.

IB

IC

IC at IB = 50µA: 5.34046 mA

IC at IB = 60µA: 6.21322 mA

Ic vs IB at VCE = 600mV (Forward Active):

A graph with a line

AI-generated content may be incorrect.

IB

IC

IC at IB = 50µA: 12.9573 mA

IC at IB = 60µA: 15.2992 mA

Clearly, β during Forward Active is much higher than during Saturation. This is because the collector current decreases a lot in Saturation mode, due to the Collector Base Junction being in forward bias conducting in the opposite direction.

Ic vs IB at VCE = 1V:

A graph with a red line

AI-generated content may be incorrect.

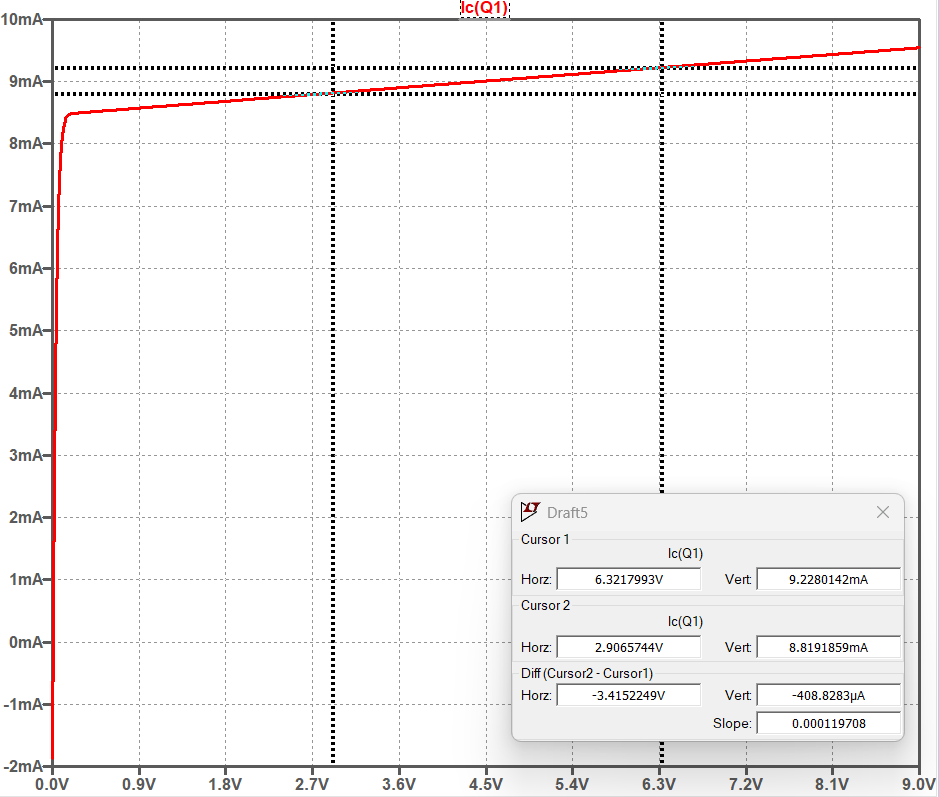
IB

IC

|  |  |  |
| --- | --- | --- |
| IB (uA) | IC(mA) | β |
| 10 | 2.80528 | 280.528 |
| 20 | 5.5026 | 275.13 |
| 30 | 8.10143 | 270.0477 |
| 40 | 10.6117 | 265.2925 |
| 50 | 13.0418 | 260.836 |
| 60 | 15.3989 | 256.6483 |
| 70 | 17.6893 | 252.7043 |
| 80 | 19.9181 | 248.9763 |
| 90 | 22.0902 | 245.4467 |
| 100 | 24.2097 | 242.097 |

We see a gradual decrease in the value of β, with increasing IC. This shows the presence of Early effect, since an increase in IB will cause the base width to decrease, (due to increase in VB), which leads to an increase in IC, with respect to the expected value, i.e., Early effect.

To find Early voltage, we need the plot of IC vs VCE at constant VBE,



VCE

IC

Slope of the Graph = 0.000119708 A/V,

Take VCE as the average of the 2 points measured, i.e., 4.6141867 V.

IC at the edge of Forward Active Mode = 8.442923mA

We know that,

Therefore, the Early voltage is estimated to be 65.91512 V.