Experiment: 3
Current-Voltage Characteristics of BJT

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***Abstract*—This week's experiment consisted basically in two primary parts. In first part, we aim at implementing the current-voltage characteristics of a BJT in common base.And also find out the value of α . In second part, we aim at implementing the current-voltage characteristics of a BJT in common emitter. And also find out the value of β .**

Also we were required to analyze and than subsequently remove the various problems encountered in circuits in the laboratory. Going through this experiment we encountered several unexpected results which we solved and analyzed by help of our instructor Hitesh sir and TAs.

I. Introduction

A. Bipolar Junction Transistor

BJT is a semiconductor device constructed with three doped semiconductor regions(Base , Emitter , Collector) separated by two p-n junctions. And on the basis of biasing BJT classified in four regions.

Region	V_{be}	V_{bc}
Active	Forward biased	Reversed biased
Saturation ("on")	Forward biased	Forward biased
Cutoff ("off")	Reversed biased	Reversed biased
Reverse Active	Reverse biased	Forward biased

Fig. 1. Region on the basis of biasing

B. Common Base Configuration

In common base configuration we have to put base common for emitter and collector and the input is given across the base and emitter and output is taken across the collector and base. And in this configuration we calculate the value of α.
$\alpha = \frac{I_C}{I_E}$

C. Common Emitter Configuration

In common emitter configuration we have to put emitter common to the base and collector and we gives input across the base and emitter and take output across collector and emitter.And in this configuration we also calculate the value of β.
$\beta = \frac{I_C}{I_B}$

II. Apparatus Required

A. Multiple Power Supplier-1

B. Bread Board

C. BJT-1

BC547

Fig. 2. BJT

D. Resistor-3

$R_1 = R_2 = 1K\Omega$
$R_3 = 1M\Omega$ (for Common Emitter configuration)

E. Some copper wire to have connection between circuit

III. Procedure

A. For Common Base

1) We made the circuit by using a BJT and two resistor $R_B = R_C = 1K\Omega$. :

2) We gave two voltage V_{EB} and V_{CB} by using multiple power supplier :

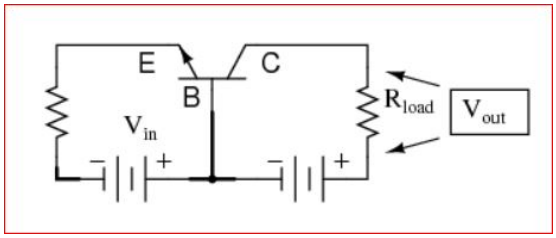

Fig. 3. Circuit for common base$V_{in} = V_{BE}$ and $V_{out} = V_{BC}$

3) We fixed $V_{CB} = 15V$ and varied V_{BE} from 0 to 5V and we noted the value of I_e for every V_{BE}:

4) We repeated the above experiment for $V_{CB} = 10V$.:

5) We plotted the graph of I_e V/s V_{BE} for both $V_{CB} = 15V$ and $V_{CB} = 10V$ and compared both of them.:

6) This is the input characteristics of common base transistor.:

7) We fixed $V_{BE} = 5V$ and varied V_{CB} from 0 to 15V and we noted the value of I_C for every V_{CB}:

8) We repeated the above experiment for $V_{BE} = 3V$.:

9) We plotted the graph of I_c V/s V_{CB} for both $V_{BE} = 5V$ and $V_{BE} = 3V$ and compared both of them.:

10) This is the output characteristics of common base transistor.:

B. For Common Emitter

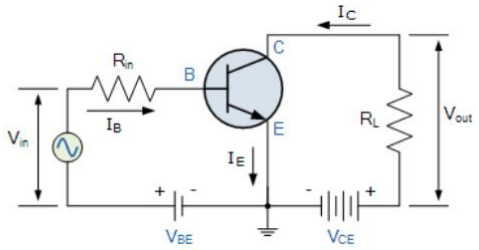

Fig. 4. Circuit for common Emitter$V_{in} = V_{BE}$ and $V_{out} = V_{BC}$

1) We made circuit by using a BJT and two resistor , values $R_B = 1M\Omega$ $R_C = 1K\Omega$:

2) We gave two voltage V_{EB} and V_{EC} from multi power supplier:

3) We fixed $V_{CE} = 15V$ and varied V_{BE} from 0 to 6V and we noted the value of I_b for every V_{BE}:

4) We repeated the above experiment for $V_{CE} = 10V$.:

5) We plotted the graph of I_b V/s V_{BE} for both $V_{CE} = 15V$ and $V_{CE} = 10V$ and compared both of them.:

6) This is the input characteristics of common Emitter transistor.:

7) We fixed $V_{BE} = 6V$ and varied V_{CE} from 0 to 15V and we noted the value of I_C for every V_{CE}:

8) We repeated the above experiment for $V_{BE} = 3V$.:

9) We plotted the graph of I_c V/s V_{CE} for both $V_{BE} = 6V$ and $V_{BE} = 3V$ and compared both of them.:

10) This is the output characteristics of common Emitter transistor.:

IV. Calculation

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

A. For α

$V_{CB} = 15V$
$V_{EB} = 5V$
$I_C = 4.40A$
$I_B = 4.41A$
So $\alpha = \frac{4.40}{4.41} = 0.997$

B. For β

$V_{CE} = 15V$
$V_{BE} = 5V$
$I_B = 3.2\mu A$
$I_B = 1.26mA$
So $\beta = \frac{1260}{3.2} = 393$

V. Experimental Results

Input Characterstics of Common Base Transistor		
	Vcb=15V	Vcb=10V
Vbe(in V)	Ie(in A)	Ie(in A)
0-0.50	0	0
0.6	63.8µA	96µA
0.7	128.2µA	160.8µA
0.8	210.7µA	215µA
1	379.4µA	0.42mA
1.5	0.9mA	0.93
2	1.41	1.8
2.5	1.9	1.9
3	2.45	2.36
3.5	2.91	2.87
4	3.38	3.4
4.5	3.88	3.94
5	4.43	4.41

Fig. 5. Input table for common base

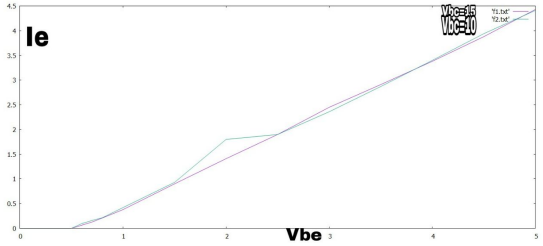

Fig. 6. Graph for input characteristics of common base

In Fig. 6. By keeping V_{CB} constant we varied V_{BE} , . We measured I_e . We can conclude from the graph that for initial value of V_{BE} , I_e is zero . After reaching the knee voltage $V_{BE} = 0.5$ V graph starat rising.

Output Characterstics of Common Base Transistor		
	Vbe=5V	Vbe=3V
Vcb(in V)	Ic(in mA)	Ic(in mA)
0	0.71	0.67
0.1	0.78	0.82
0.2	0.88	0.87
0.3	0.98	0.99
0.4	1.07	1.08
0.5	1.17	1.18
0.6	1.36	1.27
0.7	1.43	1.39
1	1.77	1.65
1.5	2.24	2.16
2	2.69	2.41
2.5	3.22	2.41
3	3.72	2.41
3.5	4.21	2.41
4	4.36	2.41
4.5	4.36	2.41
5	4.43	2.41

Fig. 7. output table for common base

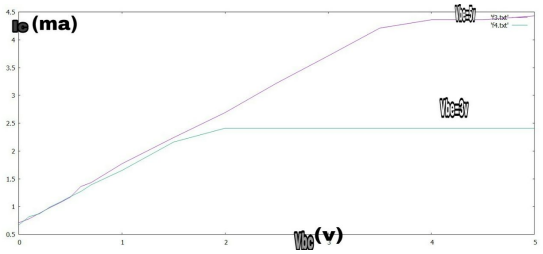

Fig. 8. Graph for output characteristics of common base

Fig. 8. shows output characteristics of a common base transistor where we kept V_{BE} constant and varies V_{CB}. We measured output as I_C . As we can see it becomes constant after a certain value of V_{CB}.

Input Characterstics of Common Emitter Transistor		
	Vce=15V	Vce=5V
Vbe(in V)	Ib(in μA)	Ic(in μA)
0-0.5	0	0
0.6	0	0
0.7	0.2	0.1
0.9	0.3	0.2
1	0.4	0.4
1.5	0.9	0.9
2	1.4	0.3
2.5	1.8	1.8
3	2.3	2.3
3.5	2.7	2.7
4	3.3	3.3
4.5	3.6	3.6
5	4.2	4.2
5.5	4.7	4.7
6	5.1	5.1

Fig. 9. input table for common emitter

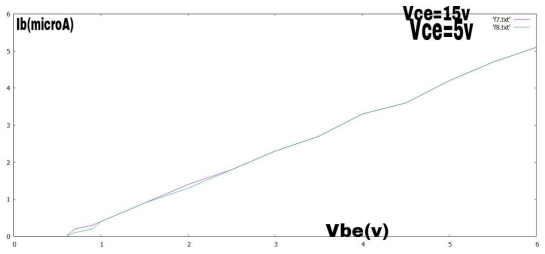

Fig. 10. Graph for input characteristics of common emitter

In Fig. 10. We varied V_{BE} by keeping V_{CE} constant . Out output was I_B. This is the input characteristics of common emitter transistor . From graph we can conclude that I_B os very small and is zero for initial values of V_{BE}.

Output Characterstics of Common Emitter Transistor		
	Vbe=6V	Vbe=3V
Vce(in V)	Ic(in A)	Ic(in A)
0	0.8μA	0.1μA
0.1	84.6μA	81.2μA
0.2	136.2μA	167μA
0.3	224.2μA	221μA
0.4	335.2μA	303μA
0.5	404μA	408μA
0.6	465μA	461μA
0.7	596μA	575μA
1	0.9mA	0.78
1.5	1.38	0.79
2	1.76	0.8
2.5	1.8	0.8
3	1.81	0.81
3.5	1.83	0.81
4	1.84	0.82
5	1.86	0.82
7	1.89	0.83
9	1.92	0.84
10	1.94	0.85
12	1.98	0.85
15	2.02	0.86

Fig. 11. output table for common emitter

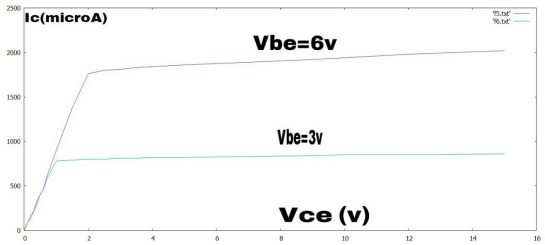

Fig. 12. Graph for output characteristics of common emitter

In Fig. 12. We plotted $V_{CE}V/sI_C$ by keeping V_{BE} constant and varying V_{CE} . This is the output characteristics of common emitter tranistor.

VI. PRECAUTION

A. Don't let touch your hand while measuring the resistor, it will give wrong result or measurement.

B. Don't give the V_{BC} and V_{EB} more than given in datasheet it can damage the BJT

VII. CONCLUSION

It is concluded that the value of β is in between 200 to 450 and the value of α is always less than 1. And it is also concluded that the value of β is high so we can use BJT as a amplifier.

VIII. SOURCE OF ERROR

In the lab session in common emitter we put both resistance $1K\Omega$ so we got value of $\beta = 3.5$ which was not expected so we consulted to TAs and they told us to put the R_B $1M\Omega$ and after doing that we got desired results.

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