Practical No.21: Test input/output characteristics of NPN transistor in CE Configuration.

I Practical Significance:

A BJT is commonly used as an amplifier. Common Emitter (CE) mode is the universal mode of operation for a BJT. All types of amplifications can be performed using CE mode with suitable biasing. Common-emitter amplifiers are also used in radio frequency circuits..

II Industry/Employer Expected Outcome(s):

Amplifier circuits are used in all electronic equipment used in industries. Employee should be able select suitable type of transistor and configuration for given application.

III Course Level Learning Outcome(s):

Use BJT and FET in various Electronic circuits.

IV Laboratory Learning Outcome(s):

Check the operation of NPN Transistor under CE Configuration.

V Relevant Affective Domain related outcome(s):

1. Handle components and equipment carefully.
2. Work in team.

VI Relevant Theoretical Background (With diagrams if required):

BJT is called as Bipolar Junction transistor. It has 3 terminals namely emitter, base and collector. It is called bipolar device because current through it is due to free elctrons and holes. A transistor can be in any of the three configurations namely common base, common emitter and common collector.

The relation between of α,β and γ of CB, CE & CC are

$\alpha = \beta / 1+\beta$

$\beta = \alpha/1-\alpha$

$\gamma = 1+\beta = 1/1-\alpha$

In CE configuration base will be the input node and collector will be output node. Emitter is common to both input and output and hence the name common emitter configuration. A transistor in CE configuration is used widely as an amplifier

Symbol:

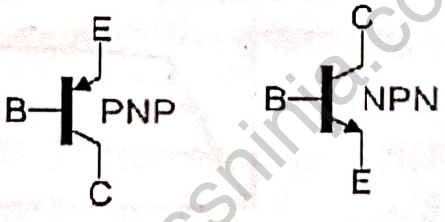


Figure 1: Symbol of BJT

X Procedure:

Part I Input characteristics:

1. Connect the electrical circuit as shown in Figure 3.
2. Select suitable range of milli-ammeter, voltmeter and power supply.
3. Switch on the power supply and adjust the voltage V_{CE}=2V by varying Vcc
4. Vary the input voltage V_{BE} in steps of 0.1V and measure the current I_B for each Step.
5. Repeat the steps 3 and 4 for V_{CE} values of 5V and 10V.
6. Tabulate the readings

Part II Output characteristics:

1. Connect ammeter and adjust base current I_B.
2. Select suitable range of milli-ammeter, voltmeter and power supply.
3. Switch on the power supply and apply a constant current I_B=20 μA.
4. Vary V_{CE} from 0 to 10V is steps of 0.5 volts. Measure corresponding collective current I_C for each step.
5. Repeat steps 9 and 10 for various values of I_B=30 μA and 40 μA
6. Tabulate the readings

Graph

Plot a graph of V_{BE} (V) (X-axis) versus I_B(μA) (Y-axis) for different V_{CE} voltages.

Plot a graph of V_{CE} (V) (X-axis) versus I_C (mA) (Y-axis) for different I_B (μA) currents.

Calculate dynamic input resistance using the formula given below

$$r_i = \left.\frac{\Delta V_{BE}}{\Delta I_B}\right|_{V_{CE}} = \frac{0.1V}{1.420} = 2.00V$$

Calculate dynamic output resistance using the formula given below.

$$r_o = \left.\frac{\Delta V_{CE}}{\Delta I_C}\right|_{I_C} = \frac{4.600}{191.3} = 0.024$$

XI Required Resources/apparatus/equipment with specifications:

S. No	Instruments/Components	Suggested broad specification	Quantity
1	DC power supply	0-30 V	2 no.
2	DC voltmeter	(0-2V), (0-20V)	1 no.
3	DC Ammeter	(0-25), (0-500MA)	1 no.
4	Transistor	BC 107	1 no.

XII Actual procedure followed:

Part - I Input Characteristics
1. Connect the electrical circuit
2. Select suitable range of milli-ammeter, voltmeter and power supply.
3. Switch on the power supply and adjust the voltage V_{CE} = 2 V by varying V_{CC}.
4. Vary the input voltage V_{BE} in steps of 0.1V & measure the current I_B for each step.
5. Repeat the steps 3 and 4 for V_{CE} values of 5V & 10 V.
6. Tabulate the readings.

XIII Observations and Calculations:

Table 1: Input characteristics

S.No.	V_{CE} = 2.000V		V_{CE} = 1.400		V_{CE} =.....V	
	V_{BE} (V)	I_B(μA)	V_{BE} (V)	I_B(μA)	V_{BE} (V)	I_B(μA)
1	0.0200	NaN	0.2200	4.255		
2	0.1200	2.398	0.4200	5.160		
3	0.0200	2.082	0.6400	6.506		
4	0.5200	4.228	0.9600	9.398		
5	0.9200	7.468	1.240	13.27		
6	1.420	15.23	1.580	20.63		

Table 2: Output characteristics

15.35 15.35

S.No.	I_B=..15μA		I_B=..... μA		I_B=..... μA	
	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)
1	0.1000	3.290	0.1000	3.290	0.9000	43.08
2	0.9000	44.97	1.000	47.81	1.900	57.51
3	2.200	61.25	1.700	58.82	2.800	59.70
4	3.000	104.5	2.500	61.94	4.500	60.13
5	3.800	104.9	4.100	62.74	6.100	6.14
6	4.600	191.3	7.100	62.78	8.500	60.14

Calculations:

$r_i = \frac{\Delta V_{BE}}{\Delta I_B}$ $\frac{1.420}{15.35} = 0.0925$

$r_o = \frac{\Delta V_{CE}}{\Delta I_C}$ $\frac{2V}{} = 0.0104$

$\beta = \frac{I_C}{I_B}$ $\frac{1913}{15.35}$ $\frac{191.3}{} = 12.46$

XIV Results:

1. Input resistance = 0.0925 Ω
2. Output resistance = 0.0104 Ω
3. Current amplification factor β = 12.46

XV Interpretation of Results:

by analyzing both input & output characteristics, we can understand how a transistor operates as common emitter & output impedance, depending on applied base current and collector -emitter voltage.

XVI Conclusions & Recommendations:

The curve plotted between base current Ib and the base-emitter voltage Vbe is called input characteristic curve. Hence, we have learn to plot the graph between I/P & O/P characteristics of NPN transistor in CE configuration.

XVII Practical Related Questions:

1. Write the steps to identify emitter, base and collector terminals of given transistor.
2. State the range of ammeter and voltmeter selected
3. The BJT has I_B-10 μA, I_{CO}=1 μA what is collector current I_C? (Take value of β obtained from the graph)?

[Space for Answers]

1: by looking at the transistor's pinout & using a multimeter
for NPN transistor: 1: emitter: the pin closest to tab on the transistor's rim is the emitter. base: the pin opposite the emitter is collector. & the pin in the middle is the base. Collector: The schematic symbon for NPN transistors has an arrow on the emitter that points outward.

2. Common ranges for ammeters include:
0-50 mA, 0-100 mA, and 0-500 mA.
Common ranges for voltmeters include
0-20 V, 0-10 V, 0-100 V, and 0-1000 V.

3 for a transistor, the base current, the emitter current, and the collector current are related as:
$I_E = I_B + I_C$ where $I_C = \beta I_B$

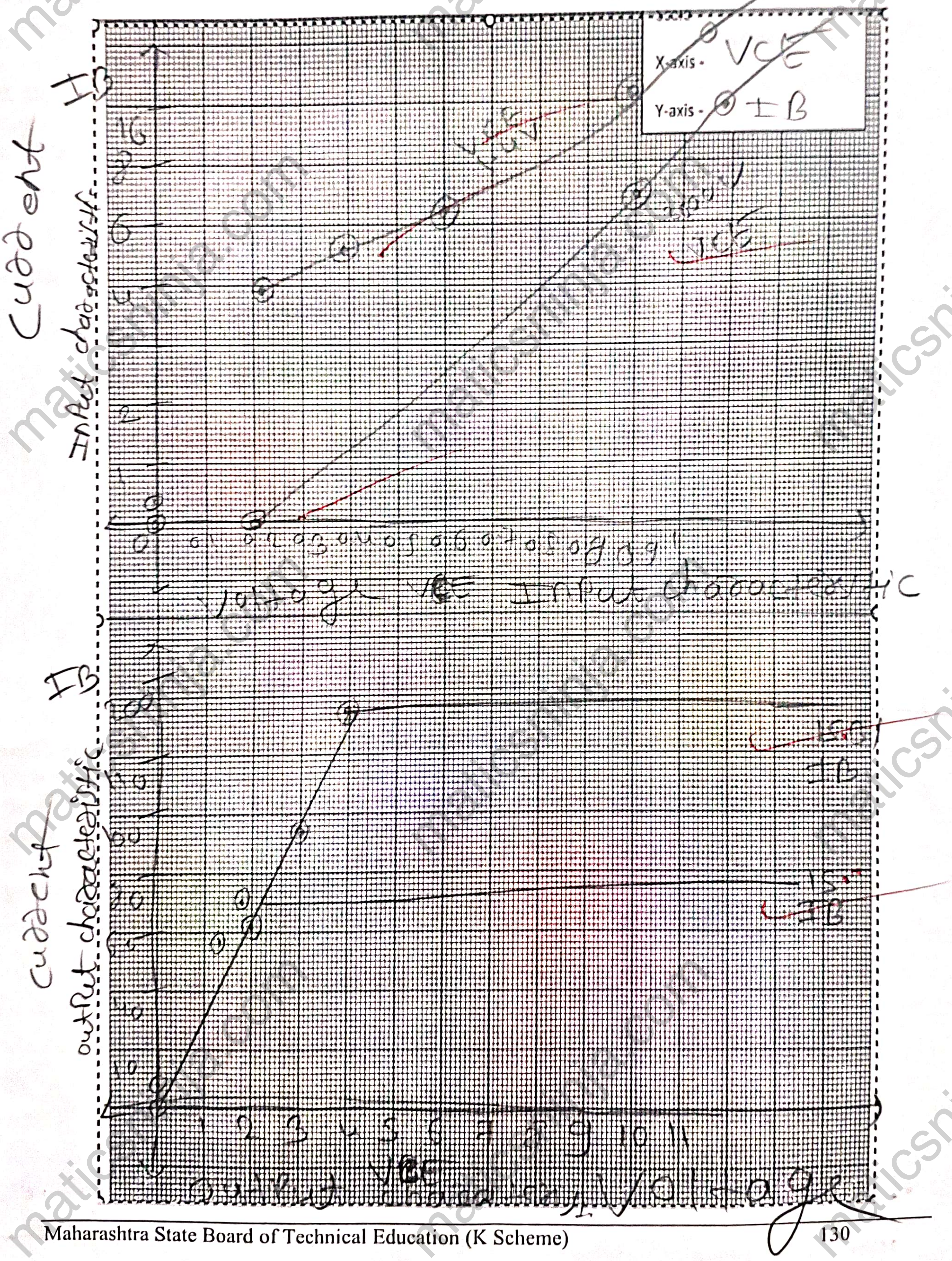
$r_1 = 0.0925$

$r_0 = 0.0104$

$\beta = 12.46$

XVIII References/ suggestions for further reading ; includes websites:

S. No.	Title of Book / Website	Author	Publication
1	Applied Electronics	R.S.Sedha	S. Chand and Co., New Delhi 2008,ISBN 978-8121927833
2	Principles of Electronics	V.K.Mehta.	S. Chand and Co., Ram Nagar ,New Delhi-110055,11th Edition,2014.ISBN 978812192405
3	Web References		a. https://www.electrical4u.com/transistor-characteristics/ b. http://nptel.ac.in/courses/117107095/10


X-axis - VCE
Y-axis - IB
Current IB
Input characteristic
Voltage VCE Input characteristic
Output characteristic
Output VCE
Voltage