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INTERNATIONAL PUBLIC SCHOOL

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PHYSICS INVESTIGATORY PROJECT

AISSCE (2023-2024)

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STD: XII SEC: ‘’B’’
TOPIC: TRANSISTOR OF COMMON EMITTER CONFIGURATION.

CERTIFICATION

Certified to be bonafide Investigatory project done by Kathryn Simone David of XII ‘’B’’ during the academic year 2023-2024.

Reg. No.

Teacher in charge principal

Submitted for the practical examination held on ---------- at the Zion international public school,Chennai-600126.

Internal examiner external examiner

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I would also like to extend my gratitude to the principal and vice principal for providing me with all the facility that was required.

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AIM:

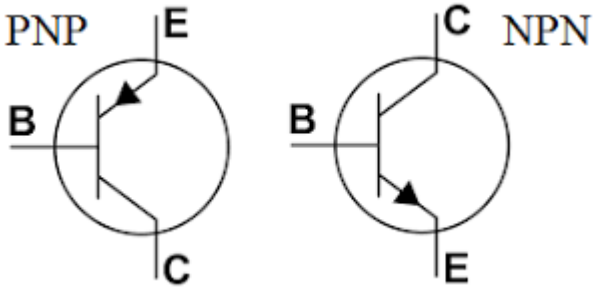
To study and observe the input and output characteristics and the current gain factor of common-emitter (C-E) transistor.

INTRODUCTION:

TRANSISTOR:

1) Transistors are semiconductor devices that serve as fundamental building blocks in modern electronics.
2) They control the flow of electrical current based on input voltage, acting as amplifiers, switches, or signal modulators.
3) Their importance lies in their ability to amplify weak signals, switch electronic circuits on and off rapidly, and perform logic operations, forming the foundation for digital technology.
4) Transistors enable the creation of highly compact and efficient electronic devices, paving the way for advancements in computing, communication, and countless other applications.
5) Transistors are a fundamental component of modern electronic circuits and come in two main types:

N-P-N and P-N-P transistor



BASIC STRUCTURE OF A TRANSISTOR**:**

A transistor typically consists of three layers of semiconductor material: the emitter, base, and collector.

1. **Emitter (E):**
    - The emitter is heavily doped with a certain type of semiconductor material (e.g., N-type for an NPN transistor).
    - Its primary function is to emit majority charge carriers (electrons in an NPN transistor) into the transistor.
2. **Base (B):**
    - The base is lightly doped and situated between the emitter and collector.
    - Its width and doping concentration are critical to the transistor's operation.
    - The base controls the flow of charge carriers between the emitter and collector, acting as a switch.
3. **Collector (C):**
    - The collector is moderately doped and larger in size compared to the emitter and base.
    - It collects the majority charge carriers (e.g., electrons in an NPN transistor) that pass through the base-emitter junction.

BASIC ROLES OF EACH REGION**:**

1. **Emitter:**
    - Emits the majority charge carriers (electrons in NPN transistors) into the base region.
    - It serves as the source of electrons or holes, depending on the type of transistor (NPN or PNP).
2. **Base:**
    - Controls the flow of majority charge carriers (electrons or holes) from the emitter to the collector.
    - Determines whether the transistor is in an "on" or "off" state (active or cutoff).
    - The small current flowing into the base (base current) controls the much larger current flowing from the emitter to the collector (collector current).
3. **Collector:**
    - Collects the majority charge carriers (electrons in NPN transistors) coming from the emitter through the base.
    - It is the primary output terminal from which the amplified or switched current is obtained.

CHARACTERISTICS OF TRANSISTOR:

Any two-port network which is analogous to transistor configuration circuits can be analyzed using three types of characteristic curves. They are:

Input Characteristics:

- The curve describes the changes in the values of input current with respect to the values of input voltage, keeping the output voltage constant.

Output Characteristics:

- The curve is obtained by plotting the output current against output voltage, keeping the input current constant.

Current Transfer Characteristics:

- This characteristic curve describes the variation of output current in accordance with the input current, keeping the output voltage constant.

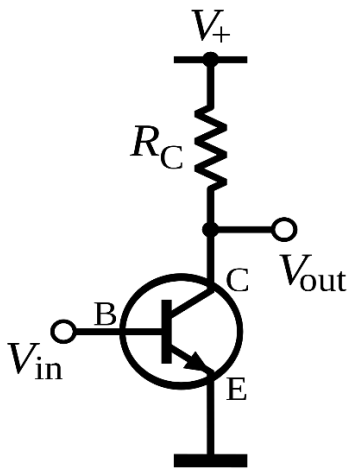
CONFIGURATION OF TRANSISTOR:

There are three primary transistor configurations: common emitter, common collector, and common base. In this explanation, I'll focus on the common emitter configuration.

1. **Common Emitter Configuration:**

The common emitter (CE) configuration is one of the most widely used transistor configurations due to its high voltage and current gain. It's typically used for signal amplification.

- **Symbol:** The symbol for a common emitter transistor consists of an arrow pointing outward from the emitter, indicating the direction of conventional current flow.



- **Circuit arrangement:** In this configuration, the emitter is common to both the input and output circuits.

  The transistor is connected with the emitter at a lower potential, the base as the input, and the collector as the output.

- **Operation:** When a small input current (I_b) flows into the base-emitter junction, it controls the much larger output current (I_c) flowing between the collector and emitter.

This relationship is described by the transistor's current gain, β (beta).

- **Current Gain (β):** β (beta) is the ratio of the collector current (I_c) to the base current (I_b).

  It typically ranges from tens to hundreds, indicating the amplification capability of the transistor.

- **Voltage Gain:** The common emitter configuration also provides voltage gain, which is the ratio of the output voltage (V_{in}) to the input voltage (V_{out}).

- **Characteristics:**
  - High current gain (β).
  - Inverts the input signal (180° phase shift between input and output).
  - Provides both current and voltage amplification.

- **Applications:**
  - Signal amplification in audio amplifiers, RF (radio frequency) amplifiers, and other electronic circuits.
  - Used as a switch in digital circuits.
- **Advantages:**
  - High voltage and current gain.

    - Good amplification capabilities.
- **Disadvantages:**
    - Nonlinear behavior.
    - High sensitivity to temperature changes.

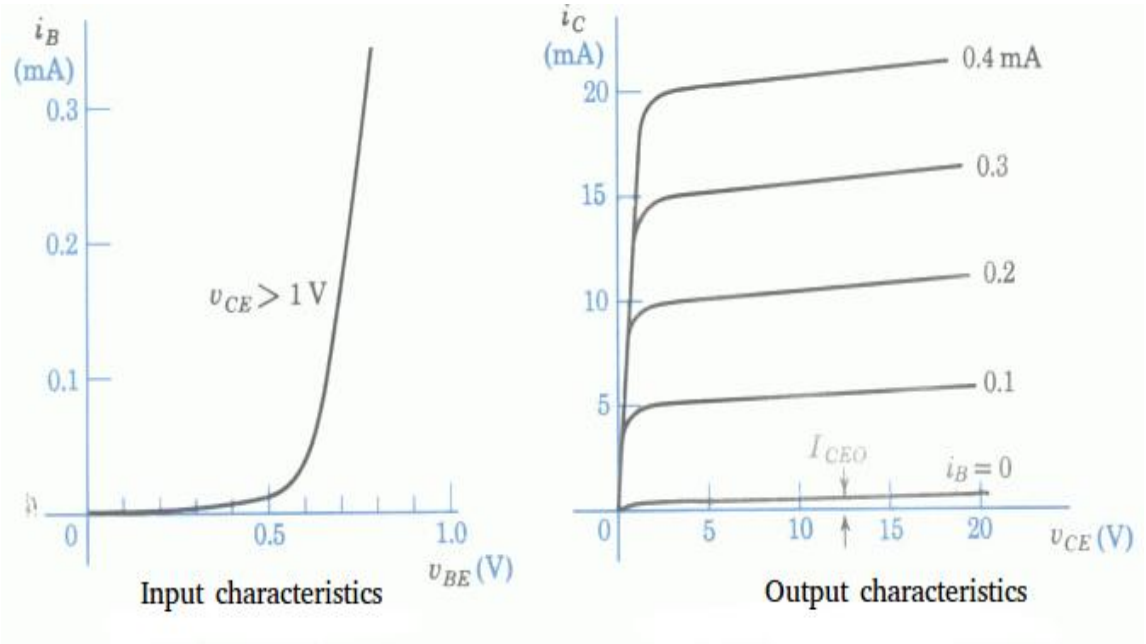
INPUT CHARECTERISTICS:

- The connection between the input current, or base current (IB), and the input voltage, or base-emitter voltage (VBE)., is described by the input characteristics of the common emitter configuration.
- The input voltage (VBE) is taken along the x-axis (horizontal line), and the input current or base current (IB), is taken along the y-axis (vertical line).The input voltage VBE is raised from zero volts to various voltage levels while the output voltage VCE is maintained at zero volts.
- The matching input current (IB) for each voltage level of the input voltage (VBE) is kept track of.
- R_{in} = VBE/IB (at a constant VCE)

OUTPUT CHARECTERISTICS

- The connection between output current (IC) and output voltage (VCE) is described by the output characteristics of the common emitter configuration.

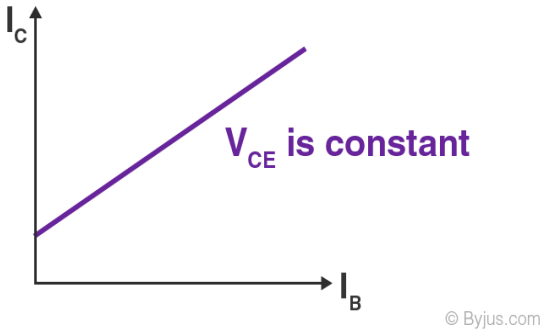
- Draw two lines first—one vertical and one horizontal. The y-axis is represented by the vertical line, and the x-axis by the horizontal line. The output voltage (VCE) is taken along the x-axis, while the output current (IC), also known as the collector current, is taken along the y-axis (vertical line).
- R_{out} = VCE/IC (at a constant IB)



CURRENT TRANSFER CHARECTERISTICS

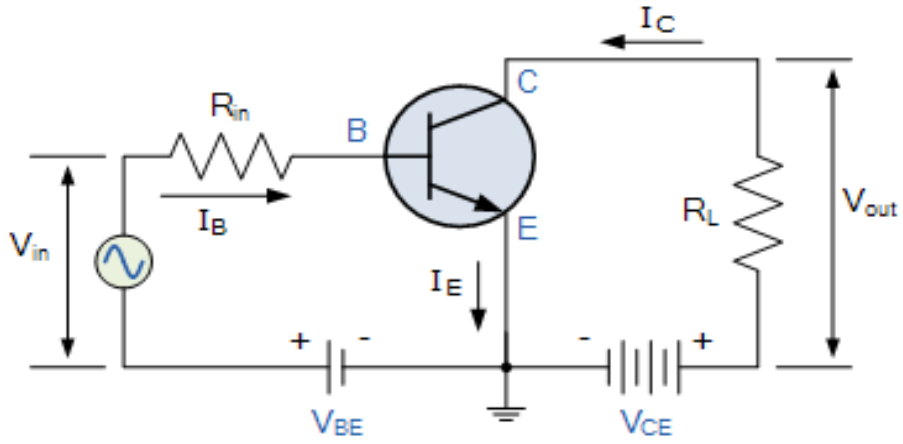
The variation of collector current(I_C) with the base current(I_B), keeping Collector-Emitter voltage(V_{CE})constant.

- The resulting current gain has a value greater than 1.



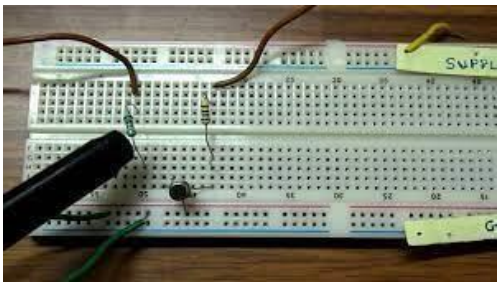
THEORY

CIRCUIT DIAGRAM:



APPARATUS REQUIRED:

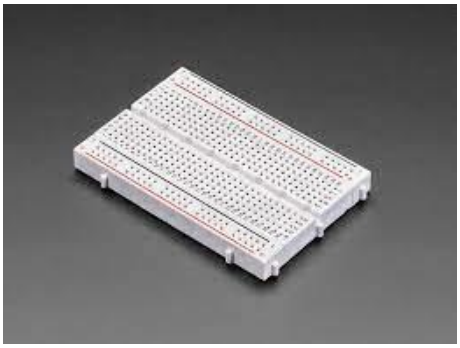
1.C-B transistor circuit board.



2. Resistors.

3. D.C ammeters (0-20 mA)

4. bread board.



5. 2 D.C voltmeters (0-2V& 0-20V)

6.DC power supply.

Connecting wires, battery etc… is also required.

PROCEDURE:

Input characteristic

1. Make the circuit connection as shown in the circuit diagram.
2. Set the voltage VCE = 0 V and vary IB with the help of VBB and measure VBE.
3. Set the voltage VCE = 3 V and vary IB with the help of VBB and measure VBE.
4. Set the voltage VCE= 6 V and vary IB with the help of VBB and measure VBE.
5. Plot graph of IB v/s VBE.
6. Evaluate dynamic input resistance which is the ratio of change in VBE to the resulting change in base current at constant collector emitter voltage. It is given by $\Delta VBE / \Delta IB$
7. The reciprocal of the slope of the linear part of the characteristic gives the dynamic input resistance of the transistor.

Output characteristics:

1) Keep IB constant say 20 μA, vary VCE and note down the collector current IC.

2) Now keep IB = 30 μA, vary VCE and note down the collector current IC. Repeat the same with IB = 40μA

3) Plot graph of IB v/s VCE.

4) The change in collector emitter voltage causes small change in the collector current for the constant base current, which defines the dynamic output resistance and is given as $\Delta VCE / \Delta IC$ at constant IB or the output conductance is given $\Delta IC/\Delta VCE$ with the IB at a constant current.

5) Find output conductance from the slope of the linear portion of the characteristic curves and also find small-signal current gain which is calculated by $\beta = \Delta IC/\Delta IB$ with the VCE at a constant voltage

OBSERVATION

TABULAR COLUMN:

(a) INPUT CHARACTERISTICS

S.NO	V_{CE} = 0V		V_{CE} = 3V		V_{CE} = 6V	
	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B(μA)
1.	0.1	0	0.1	0	0.1	0
2.	0.2	0	0.2	0	0.2	0
3.	0.3	0	0.3	0	0.3	0
4.	0.4	0	0.4	0	0.4	0
5.	0.5	0	0.5	0	0.5	0
6.	0.6	0.3	0.6	0.1	0.6	0.08
7.	0.7	5.10	0.7	7.2	0.7	7.5

(B) OUTPUT CHARACTERISTICS

S.NO	I_B = 20mA		I_B = 30mA		I_B = 40mA	
	V_{CE} (V)	I_C (μA)	V_{CE} (V)	I_C (μA)	V_{CE} (V)	I_C (μA)
1.	0.1	0.2	0.1	0.6	0.1	0.7
2.	0.2	0.5	0.2	1.3	0.2	2.1
3.	0.3	0.5	0.3	1.4	0.3	2.8
4.	0.4	0.5	0.4	1.4	0.4	2.8
5.	0.5	0.5	0.5	1.4	0.5	2.8
6.	0.6	0.5	0.6	1.4	0.6	2.8
7.	0.7	2	0.7	1.4	0.7	2.8

CURRENT TRANSFER CHARACTERISTICS:

S.NO	COLLECTIVE VOLTAGE V_C = 5V	
	I_C (mA)	I_B (mA)
1.	0.6	1
2.	2	2.1
3.	2.5	3
4.	3.9	5
5.	5	6

CALCULATIONS:

$\beta_{AC} = \frac{\Delta I_C}{\Delta I_B}$, V_C = constant

Current transfer characteristics:

$\beta = \frac{0.6}{1} = 0.6$

$\beta = \frac{2}{2.1} = 0.9$

$\beta = \frac{2.5}{3} = 0.8$

$\beta = \frac{3.9}{5} = 0.7$

$\beta = \frac{5}{6} = 0.8$

The current transfer characteristics is less than 1 from the calculations made above.

RESULT

- Input and output characteristics of the transistor common emitter configuration was observed.
- In input characteristics, the V_{CE} is constant where the readings were noted at 0V,3V,6V in which until V_{EB} is 0.5V the I_B value will be zero after which there is slight increase in the value of emitter current and at 0.7V there is a drastic increase in the value of Base current.
- Whereas, in output characteristics the value of collector current I_B is constant at all readings of voltage. The emitter current I_C varies where the readings were noted at 20mA ,

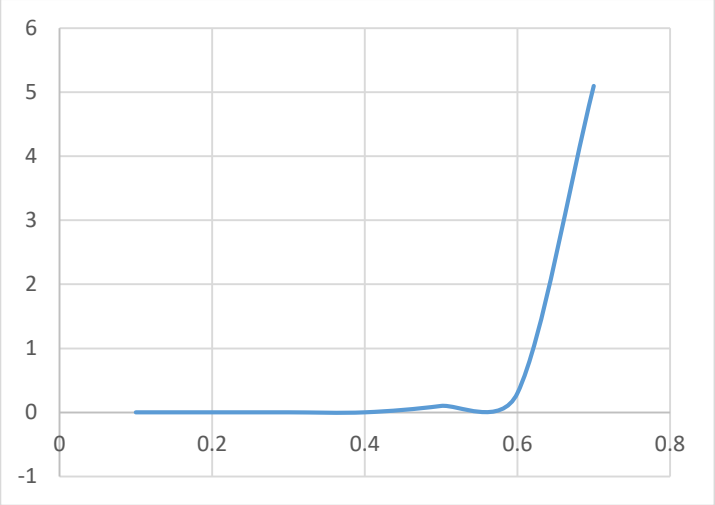
30mA, 40mA in which for all the values of V_{CE} , the I_B is constant.

- The change of collector current (I_C) with base current (I_B) while maintaining constant collector-emitter voltage (V_{CE}).
- The resulting current gain is more than one.

GRAPHS

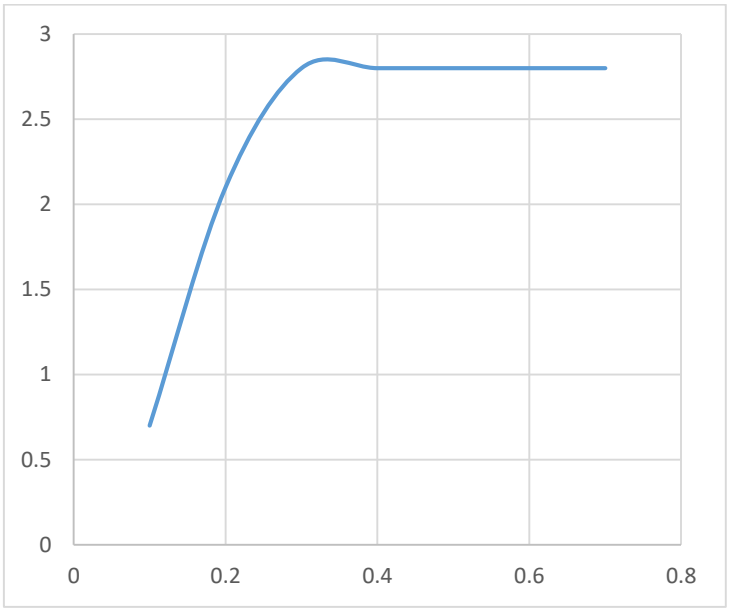
INPUT CHARACTERISTICS:

x-axis is voltage, y-axis is current

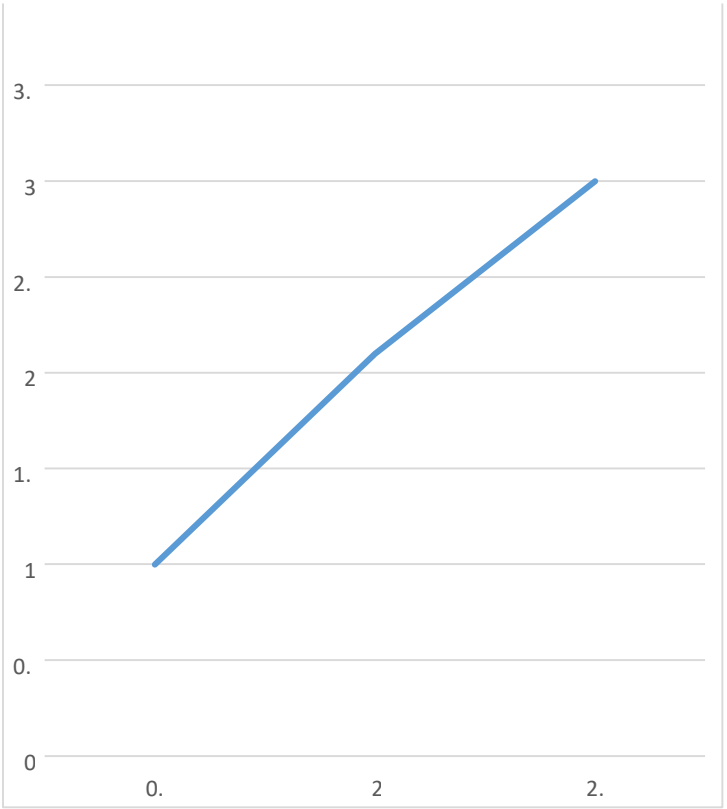


OUTPUT CHARACTERISTICS:

x-axis is voltage, y-axis is current



CURRENT TRANSFER CHARACTERISTICS:



CONCLUTION:

- Hence the input, output and current transfer characteristics of common emitter transistor was calculated and studied.

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