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Experiments of analog electronics laboratory

Lab(6)

The output characteristic of transistor

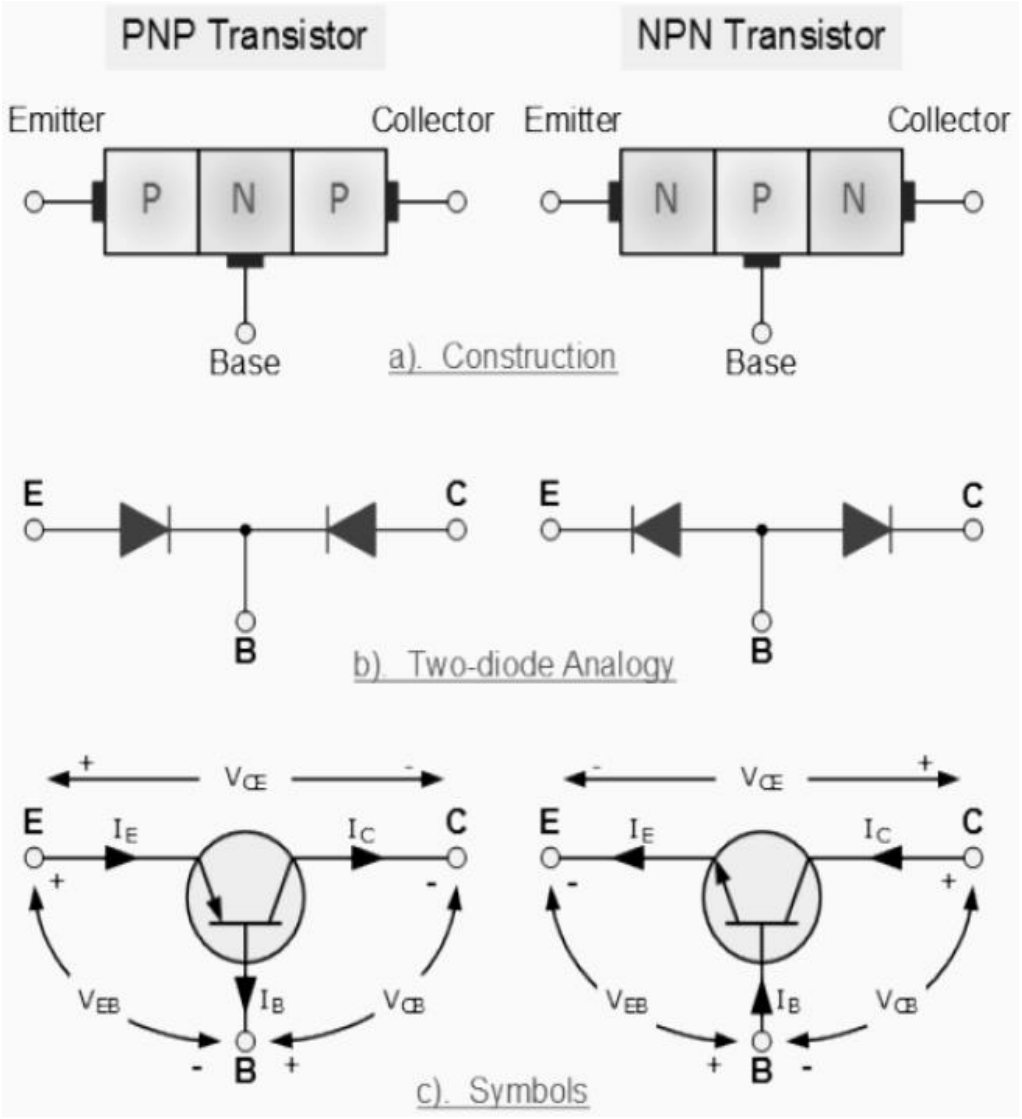
1. **Aim of the experiment :**

Determining the output characteristic curve of the transistor and measurement of the collector current I_C as a function of base voltage V_{CE} keeping the Base current I_B constant.

2. Theory:

A bipolar junction transistor (BJT) is a three-terminal device capable of amplifying a small AC signal. The three terminals are called the base, emitter, the collector. BJTs consist of a very thin base material sandwiched between two of the opposite type materials. Bipolar transistors are available in two forms, either NPN or PNP. The middle letter indicates the type of material used for the base, while the outer letters indicate the emitter and collector terminals. The emitter is heavily doped, the base is lightly doped, and the collector is intermediately doped. Fig.1 shows BJT transistor construction and symbols.

As shown in Fig.1, two P-N junctions are formed when a transistor is made, the junction between the base and emitter, and the junction between the base and collector. These two junctions form two diodes, the emitter-base diode and the collector-base diode. There are three configurations in connecting the BJT depending on which of the three terminals is used as the common terminal. These configurations are the common emitter (CE), the common base (CB), and the common collector (CC).



Fig(1): Types of BJT Transistors

Output characteristics of a transistor: are curves showing the variation of the output current I_C as a function of output voltage V_{CE}, when the input current I_B is kept constant.

there are Four operating regions, breakdown, cut-off, saturation, and active.

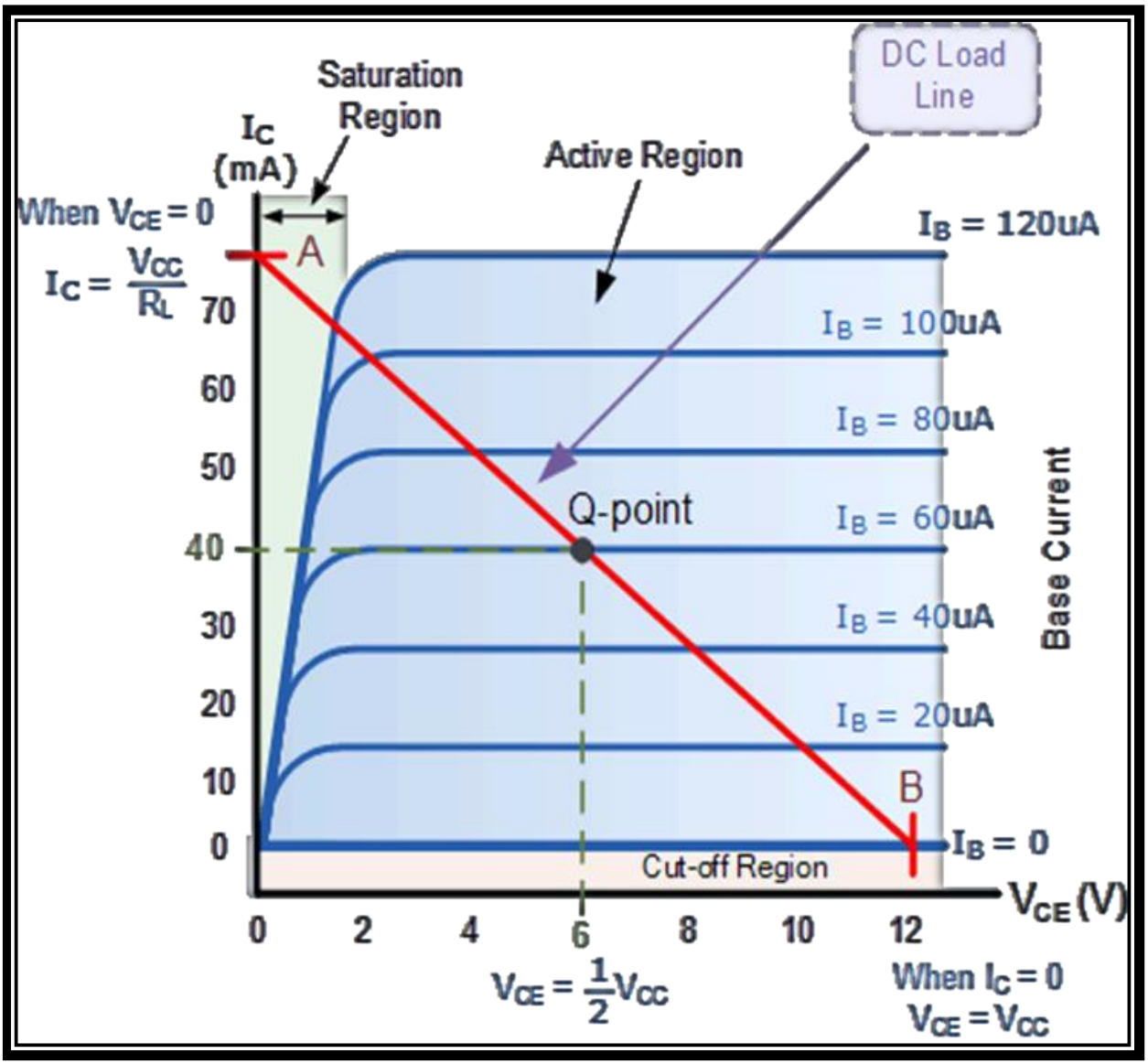
A. <u>The saturation region</u> is characterized by a low value of V_{CE} (0.1 to 0.2 V). In the saturation region on the output curve of the transistor where the collector current increases rapidly with the slight increase in output voltage. To operate

the transistor in the saturation region, the base resistance should be smaller than the maximum allowed value. Also, for the operation in the saturation region, both of emitter junction and collector junction should be in forward bias. In the saturation region, the transistor acts like the ON stage of a switch.

B. **The cut-off region** In this region the base current is almost zero. Therefore, the collector current also becomes zero even at higher output voltage. To operate a transistor in the cut off region, both of emitter junction and collector junction should be in the reverse bias condition. In the cut-off region, a transistor acts like the OFF stage of a switch.

C. Active Region of Transistor is The region on output curve of a transistor where the output current is almost constant and independent on output voltage is the Active region of Transistor. If the base resistance is greater than the maximum allowed value then the transistor operates in the Active region. One can use **Transistor as an Amplifier** only if it operates in the active region. Also for the operation in an active region, the emitter junction should be in forward bias and the collector junction should be in reverse bias.

D. Breakdown (Inverted) region of transistor This is the inverse of the active region. A transistor will operate in an inverted region if its emitter junction is in reverse bias and the collector junction is in forward bias. In this region, breakdown occurs and collector current increases rapidly. There is no major practical use of transistors in inverted regions. Therefore, transistor operation in this region is rarely used. This region is not shown in the output diagram.



Fig(2):output characteristic of transistor

3. Equipment and Components:

a. Transistor BC550

b. potentiometer 200Ω, 1KΩ

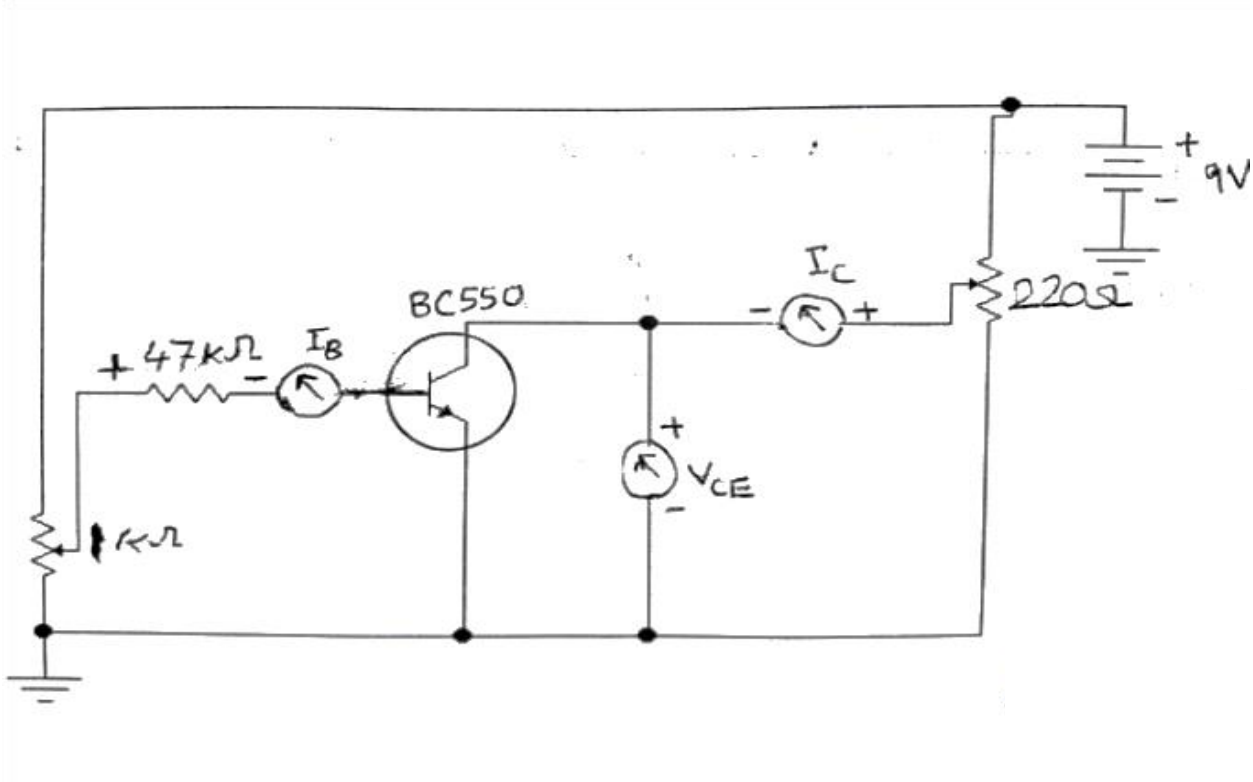
c. resistor 47 KΩ

d. oscilloscope

e. power supply unite

4. practical part:

a. Assemble the circuit as follows:



b. Adjust the voltage V_{CE} to 9 Volt.

c. measure the collector current I_C as a function of the collector-emitter voltage V_{CE}. I_B (parameter)is kept constant. I_B is checked after each change of V_{CE} and must, if necessary, be corrected with potentiometer P_1.

I_B/µA	V_{CE}/Volt	0.25	0.5	1	2	3	4	5	6
10	I_C/mA								
20	I_C/mA								
30	I_C/mA								
40	I_C/mA								

d. Draw the relationship between I_C vs V_{CE}.