Palestine Technical University - Kadoorie
جامعة فلسطين التقنية - خضوري

Electrical Engineering Department

Electronics Lab

Exp (6):

Bipolar Junction Transistor (BJT) (1)

Presentation By:
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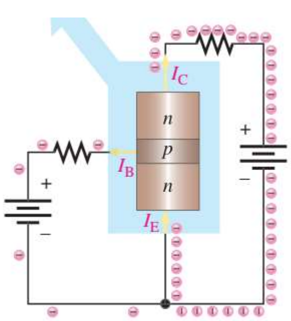
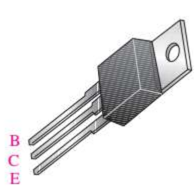
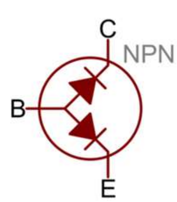
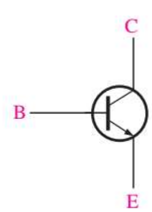
BJTs

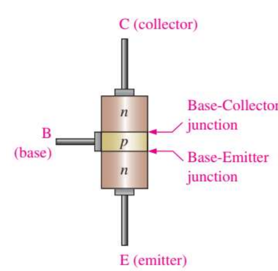
- The BJT is constructed with three doped semiconductor regions separated by two pn junctions.
- The three regions are called emitter, base, and collector.
- The base region is lightly doped and very thin compared to the heavily doped emitter and the moderately doped collector regions.









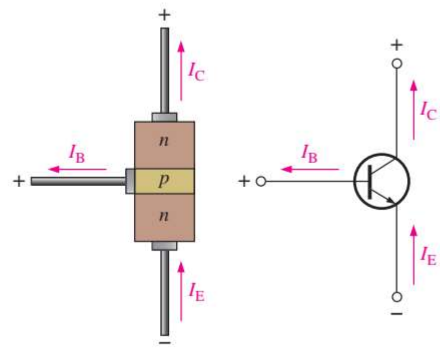


2

Transistor Currents

- The diagram show that the emitter current (IE) is the sum of the collector current (IC) and the base current (IB), expressed as follows:

$$I_E = I_C + I_B$$



3

Transistor Parameters/Relations

- When a transistor is connected to dc bias voltages, VBB forward-biases the base-emitter junction, and VCC reverse-biases the base-collector junction.

DC Beta (β_{DC}) and DC Alpha (α_{DC})

The dc current **gain** of a transistor is the ratio of the dc collector current (I_C) to the dc base current (I_B) and is designated dc **beta** (β_{DC}).

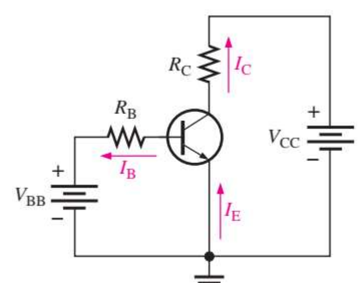
$$\beta_{DC} = \frac{I_C}{I_B}$$

Typical values of β_{DC} range from less than 20 to 200 or higher.

The ratio of the dc collector current (I_C) to the dc emitter current (I_E) is the dc **alpha** (α_{DC}). The alpha is a less-used parameter than beta in transistor circuits.

$$\alpha_{DC} = \frac{I_C}{I_E}$$

Typically, values of α_{DC} range from 0.95 to 0.99 or greater, but α_{DC} is always less than 1. The reason is that I_C is always slightly less than I_E by the amount of I_B.

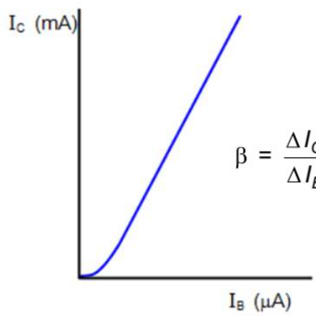


(a) *npn*

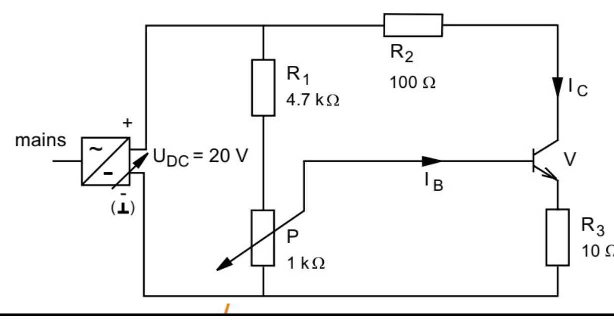
4

Transistor Parameters/Relations

- **the variation of collector current (IC) with base current (IB)**
- The Figure shows how the collector current varies when there is a change in the base current. You can see that a change in base current (ΔI_B) of a few microamps will produce a collector current change (ΔI_C) of a few milliamps. This shows the amplifying action of the transistor and also that this amplification is current-controlled rather than voltage-controlled. The ratio of the change in collector current to the change in base current is called the current gain of the transistor, and is written as β_{DC}.

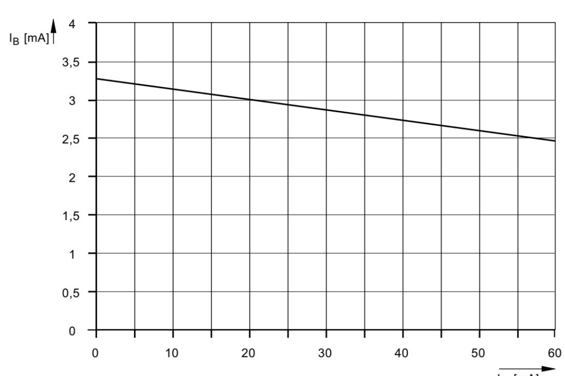


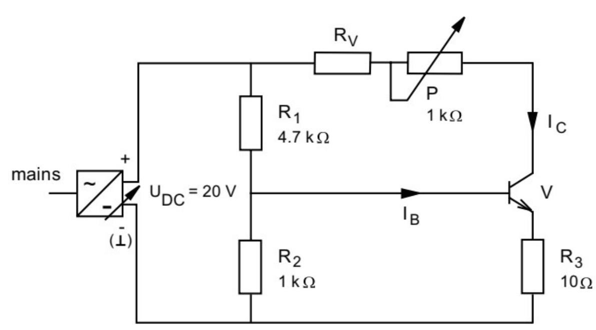
$$\beta = \frac{\Delta I_C}{\Delta I_B}$$



Transistor Parameters/Relations

- **the variation of base current (IB) with collector current (IC)**
- The Collector current Ic is related to your base current Ib using the relation Ic=(βDC)(Ib) where βDC is typical for your transistor. Hence, Collector voltage will be given by the eaquation Vc=V-IcR=V-(βDC)IbR. Hence the graph between collector Ib and Vc will be a straight line with a negative slope

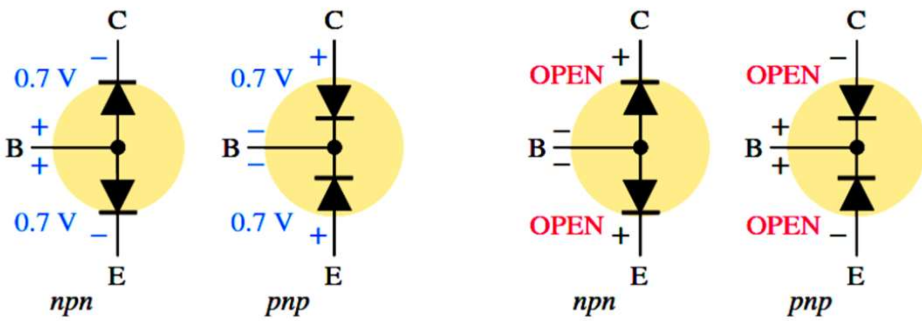




Practical Part:

Part 1: Testing the Transistor functionality.

Test the transistor using DMM.



(a) Both junctions should typically read 0.7 V when forward-biased.

(b) Both junctions should ideally read OPEN when reverse-biased.

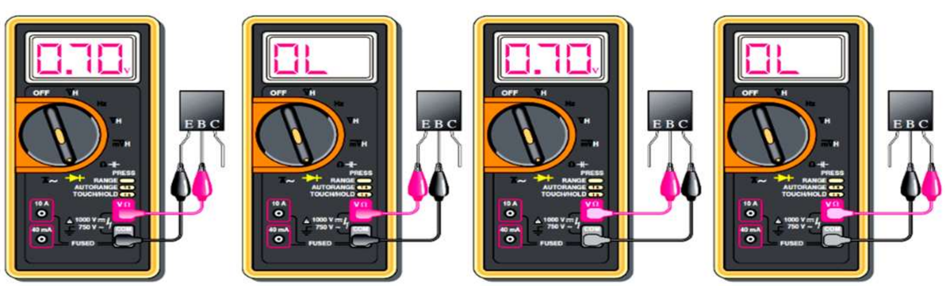
Practical Part:

Part 1: Testing the Transistor functionality.

Test the transistor using DMM.

The DMM Diode Test Position

Many digital multimeters (DMMs) have a diode test position that provides a convenient way to test a transistor. A typical DMM, as shown in Below Figure, has a small diode symbol to mark the position of the function switch. When set to diode test, the meter provides an internal voltage sufficient to forward-bias and reverse-bias a transistor junction.

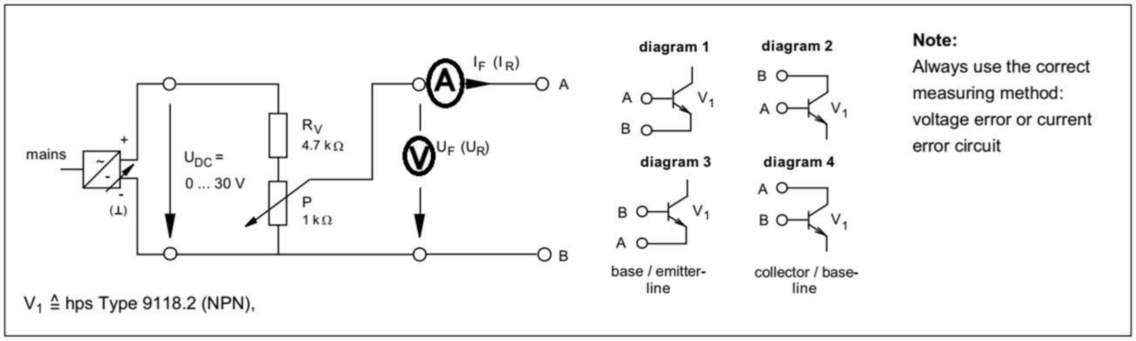


(a) Forward-bias test of the BE junction (b) Reverse-bias test of the BE junction (c) Forward-bias test of the BC junction (d) Reverse-bias test of the BC junction

Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

Examine the effect of the p-n junctions of an n-p-n transistor on the current flowing through it, in relation to the applied voltage and its polarity

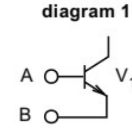


Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

1. Set up the circuit as shown in Fig. 4.1.2.1 (diagram 1). Using potentiometer P in conjunction with the multimeter, set the voltages UF consecutively according to Table 4.1.2.1. Measure each corresponding current IF and enter the values in Table 4.1.2.1. On the diagram (Fig. 4.1.2.2), plot a graph showing the dependence of the current IF on the voltage UF.

diagram 1



U_F [V]	0	0.1	0.2	0.3	0.4	0.5	0.6	0.65	0.7	0.75*	0.76*
I_F [mA]											

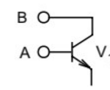
Tab. 4.1.2.1 Diagram 1 (base/emitter line)

Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

2. Set up the circuit as shown in Fig. 4.1.2.1 (diagram 2). Set the voltages UF consecutively according to Table 4.1.2.3. Measure each corresponding current IF and enter the values in Table 4.1.2.3. On the diagram (Fig. 4.1.2.3), plot a graph showing the dependence of the current IF on the voltage UF.

diagram 2



U_F [V]	0	0.1	0.2	0.3	0.4	0.5	0.6	0.65	0.7	0.75	0,8*
I_F [mA]											

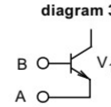
Tab. 4.1.2.3 *Diagram 2 (collector/base line)*

Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

3. For the next set of measurements, remove potentiometer P from the circuit (Fig. 4.1.2.1) and set the voltage directly on the power supply unit. Resistor RV should remain connected for safety reasons.
4. Set up the circuit as shown in Fig. 4.1.2.1 (diagram 3). Set the voltages UR consecutively according to Table 4.1.2.2. Measure each corresponding current IF and enter the values in Table 4.1.2.2. On the diagram (Fig. 4.1.2.2), plot a graph showing the dependence of the current IR on the voltage UR.

diagram 3



base / emitter-line

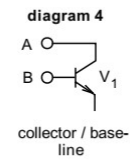
U_R [V]	0	2	4	6	8	8.1	8.2	8.3
I_R [mA]								

Tab. 4.1.2.2 *Diagram 3 (base/emitter line)*

Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

4. Set up the circuit as shown in Fig. 4.1.2.1 (diagram 4). Set the voltages UR consecutively according to Table 4.1.2.4. Measure each corresponding current IR (multimeter with 0.1 - A measuring range required) and enter the values in Table 4.1.2.4. On the diagram (Fig. 4.1.2.3), plot a graph showing the dependence of the current IR on the voltage UR.



U_R [V]	0	5	10	15	20	25	30
I_R [nA]							

Tab. 4.1.2.4 *Diagram 4 (collector/base line)*

Practical Part:

Part 2: Testing the Layers and the Rectifying Behavior of Bipolar Transistors.

	Polarity	N-P-N Type
Base/Emitter Line (conducting or blocked)	base + / emitter - (polarity 1)	
	base - / emitter + (polarity 3)	
Collector/Base Line (conducting or blocked)	collector - / base + (polarity 2)	
	collector + / base - (polarity 4)	

Practical Part:

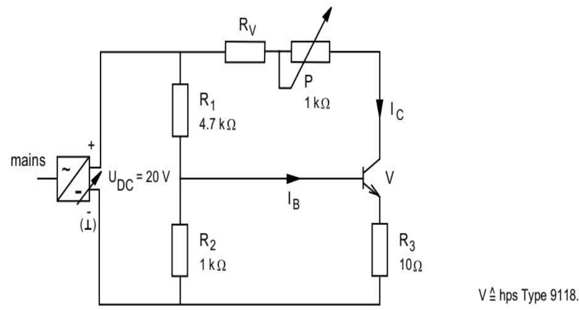
Part 3: Current Distribution in the Transistor and Control Effect of the Base Current.

Examine the influence of the collector current on the base current statically. Carry out the experiment with an n-p-n transistor.

1. Apply a DC voltage of UDC = 20 V to the circuit shown in Fig. 4.2.2.1. Measure the base current IB with interrupted collector line (potentiometer removed) and enter its value in Table 4.2.2.1.
2. Replace the potentiometer and set the collector current values listed in Table 4.2.2.1 Enter the corresponding base current values in Table 4.2.2.1

R_V [Ω]	∞	1000	680	470	470	330	220
I_C [mA]	0	20	25	30	40	50	60
I_B [mA]							

Tab. 4.2.2.1



Practical Part:

Part 3: Current Distribution in the Transistor and Control Effect of the Base Current.

Examine the influence of the base current on the collector current statically. Carry out the experiment with an n-p-n transistor.

1. Set up the circuit as shown in Fig. 4.2.2.3. Using the potentiometer, vary the base current according to the values given in Table 4.2.2.2. Measure the corresponding collector currents IC and enter the values in Table 4.2.2.2.

I_B [mA]	0	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
I_C [mA]