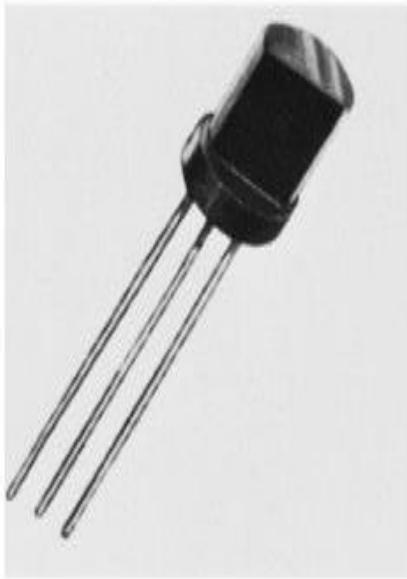
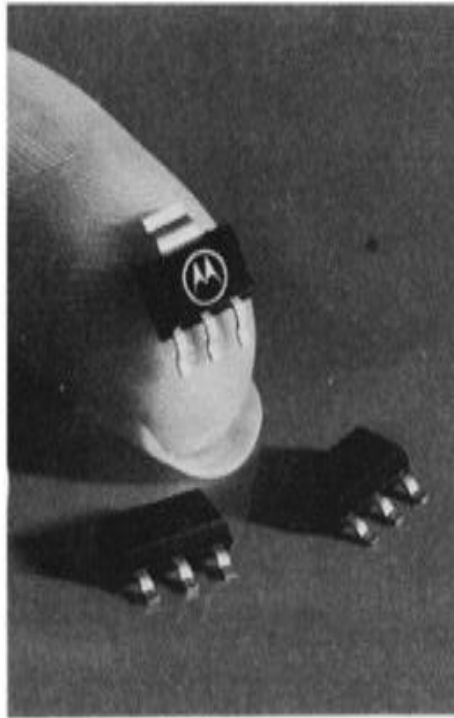


Unit-4:

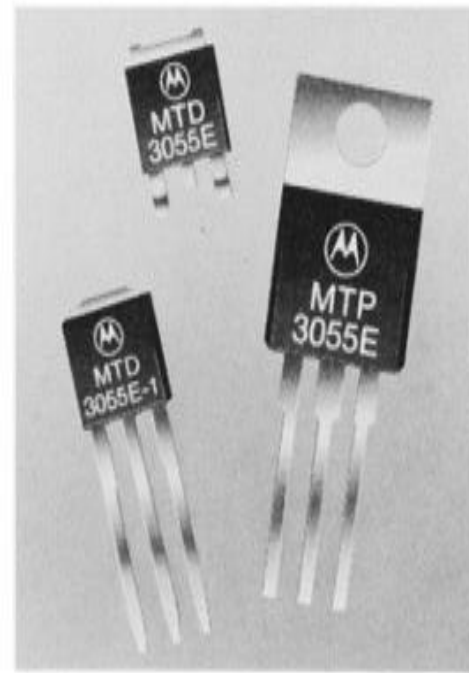
TRANSISTOR - Introduction



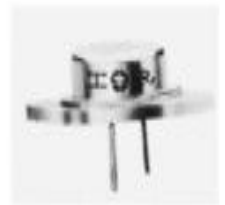
(a)



(b)



(c)



(d)

Introduction

- Beside diodes, the most popular semiconductor devices is transistors.
Eg: Bipolar Junction Transistor (BJT)
- If cells are the building blocks of life, transistors are the building blocks of the digital revolution.

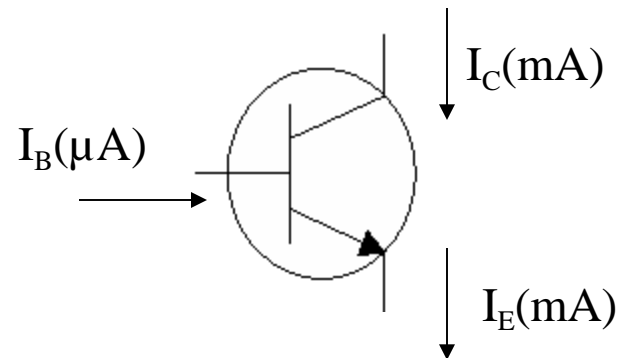
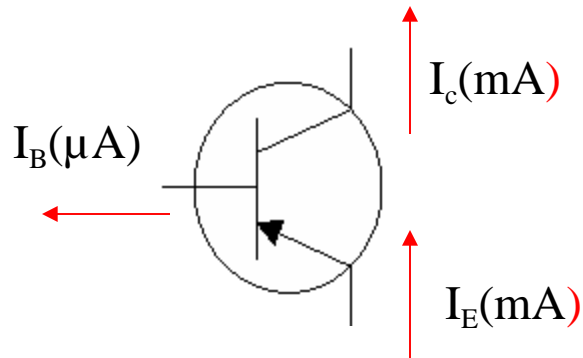
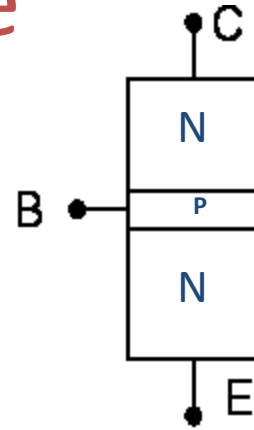
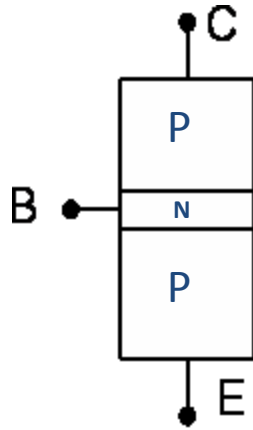
Without transistors, technological wonders you use every day -- [cell phones](#), [computers](#) -- would be vastly different, if they existed at all.

- Transistors are more complex and can be used in many ways Most important feature: can **amplify signals** and **switch**
- Amplification can make weak signal strong (make sounds louder and signal levels greater), in general, provide function called Gain

Transistor Structure

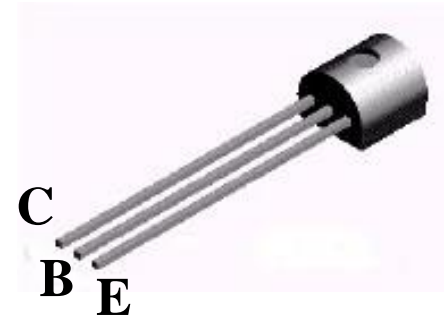
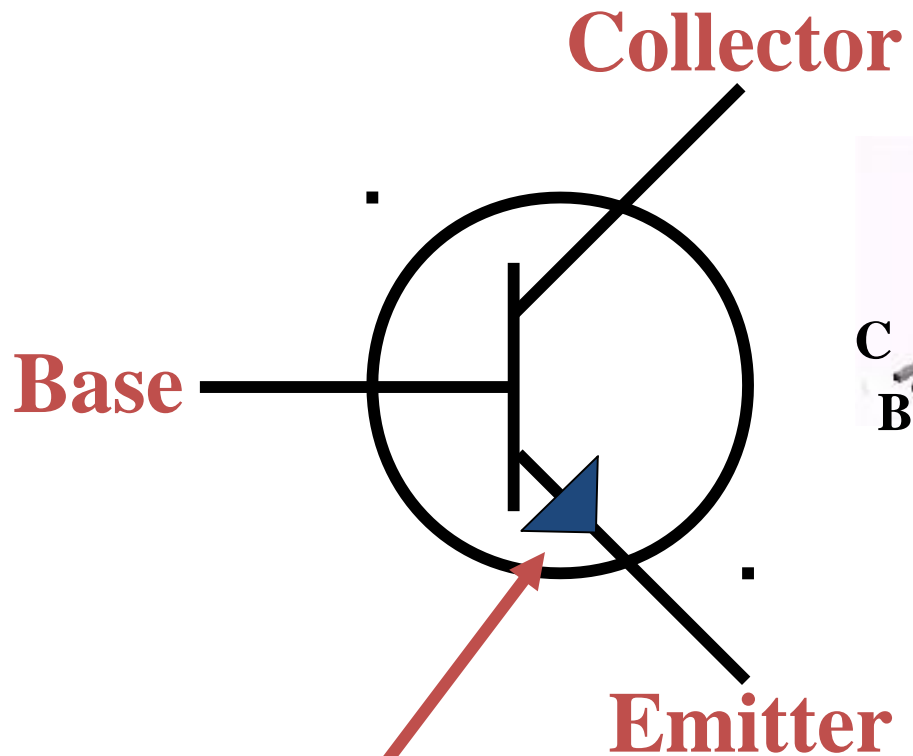
- BJT is bipolar because both holes (+) and electrons (-) will take part in the current flow through the device
 - N-type regions contains free electrons (negative carriers)
 - P-type regions contains free holes (positive carriers)
- **Types of BJT**
 - NPN transistor
 - PNP transistor
- The **transistor regions** are:
 - Emitter (E) – send the carriers into the base region and then on to the collector
 - Base (B) – acts as control region. It can allow none, some or many carriers to flow
 - Collector (C) – collects the carriers

PNP and NPN transistor structure



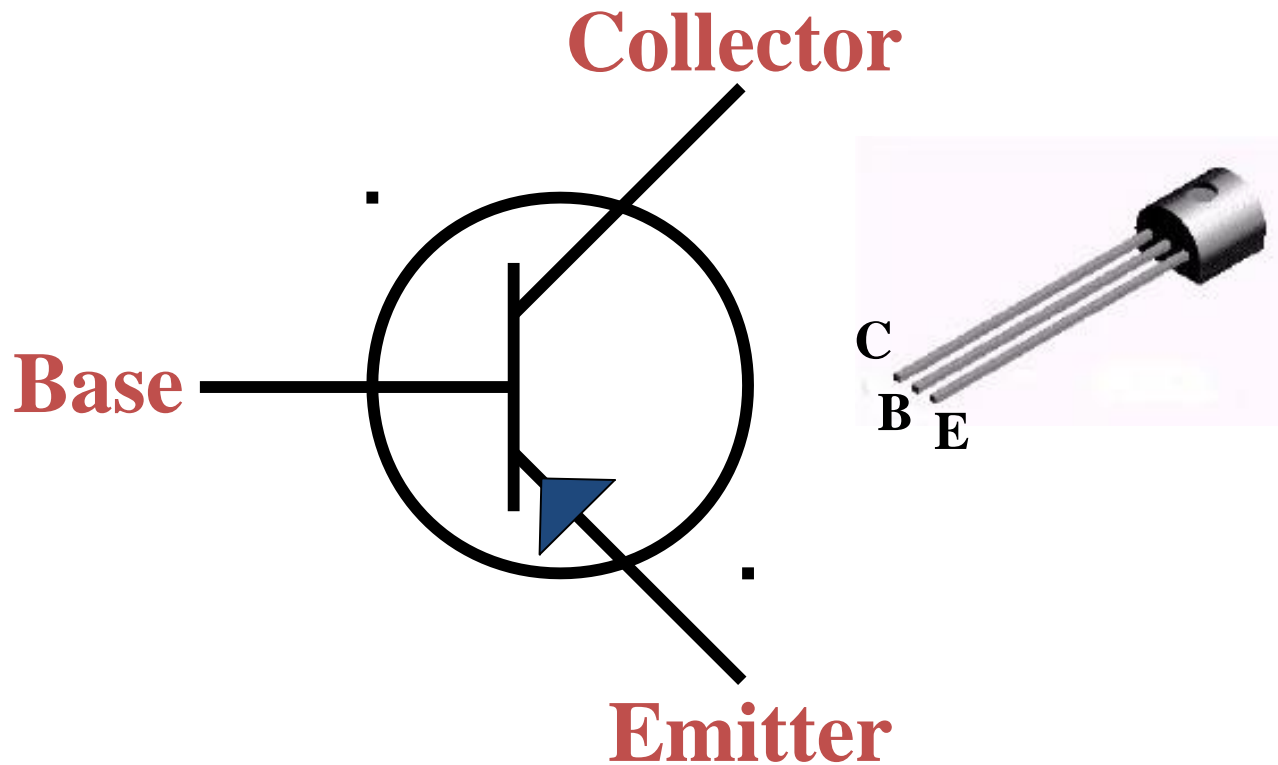
Arrow shows the current flows

NPN Schematic Symbol



Memory aid: **NPN**
means **Not Pointing iN**.

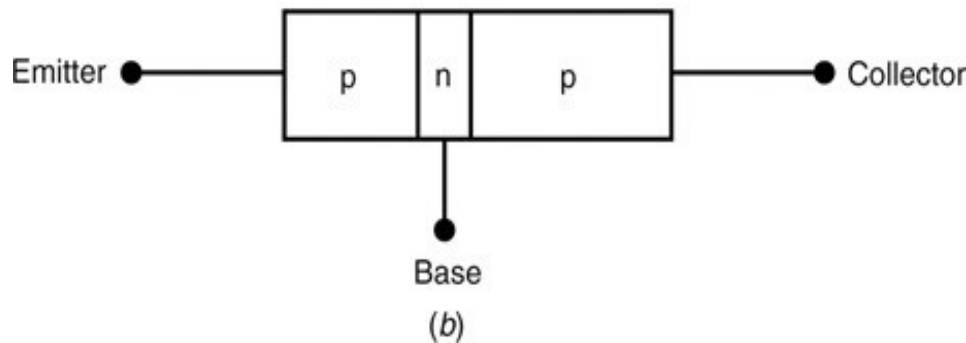
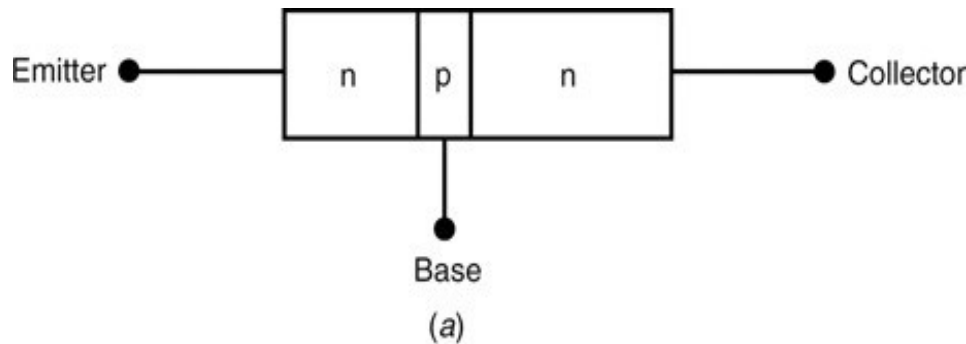
PNP Schematic Symbol



Memory aid: **NPN**
means **P**ointing **iN** **P**roperly.

Transistor Construction

- A transistor has three doped regions.
- For both types, the base is a narrow region sandwiched between the larger collector and emitter regions.



▪The emitter region is heavily doped and its job is to emit carriers into the base.

▪The base region is very thin and lightly doped.

▪Most of the current carriers injected into the base pass on to the collector.

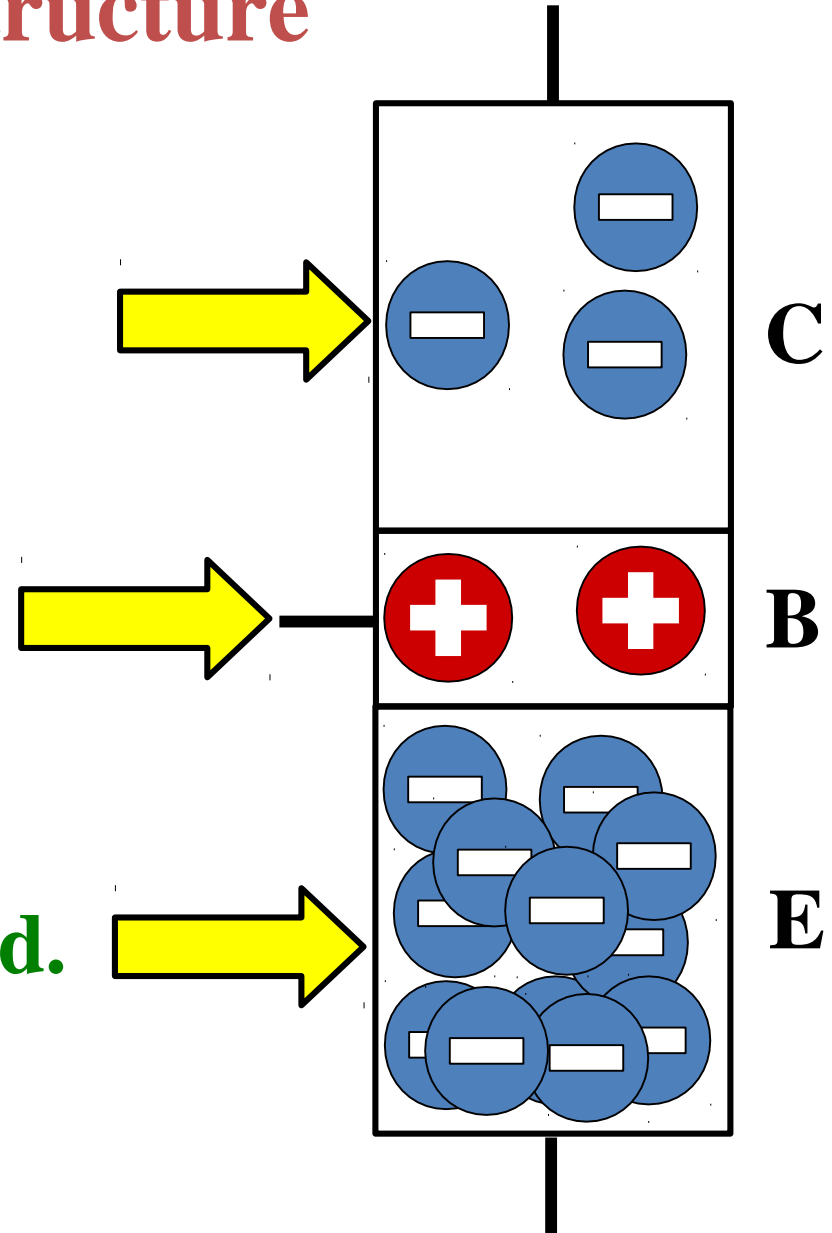
▪The collector region is moderately doped and is the largest of all three regions.

NPN Transistor Structure

The collector is Moderately doped.

The base is thin and is lightly doped.

The emitter is heavily doped.



Transistor configuration

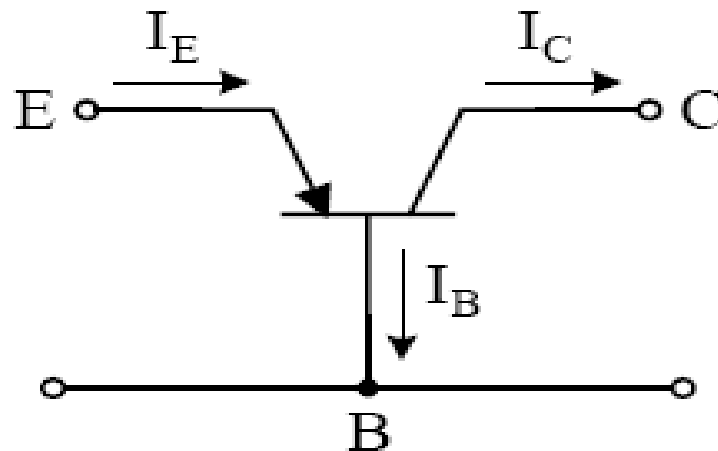
Transistor configuration –is a connection of transistor to get variety operation.

3 types of configuration:

- *Common Base*
- *Common Emitter*
- *Common Collector*

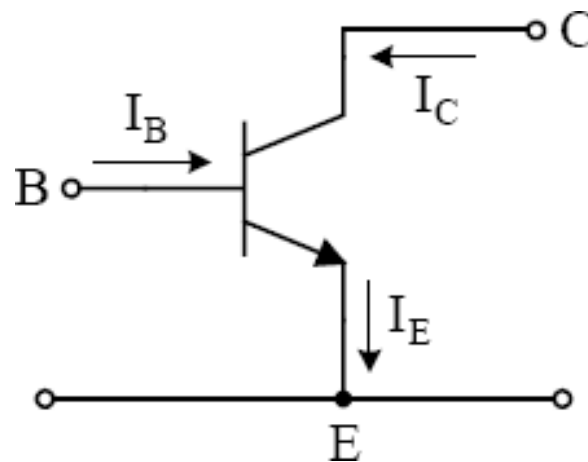
Common-Base Configuration

- Base terminal is a common point for input and output.
- Input – EB
- Output – CB
- Not applicable as an amplifier because the relation between input current gain (I_E) and output current gain (I_C) is approximately 1



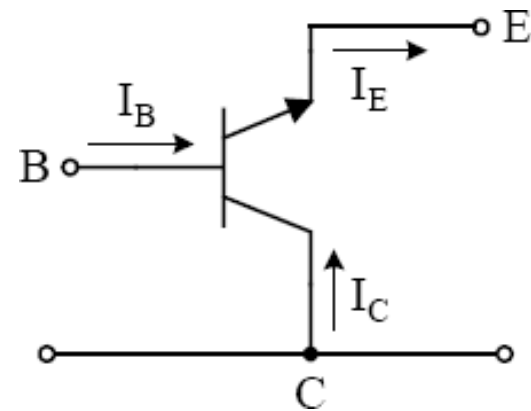
Common-Emitter Configuration

- Emitter terminal is common for input and output circuit
- Input – BE
- Output – CE
- Mostly applied in practical amplifier circuits, since it provides good voltage, current and power gain



Common-Collector Configuration

- The input signal is applied to the **base** terminal and the output is taken from the **emitter** terminal.
- Collector terminal is common to the input and output of the circuit
- Input – BC
- Output – EC



Current Relationships

- Relations between I_C and I_E :

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

- Value of α usually 0.9998 to 0.9999, $\alpha \approx 1$
- Relations between I_C and I_B :

$$I_C = \beta I_B$$

- Value of β usually in range of 50 to 400
- The equation, $I_E = I_C + I_B$ can also be written in β

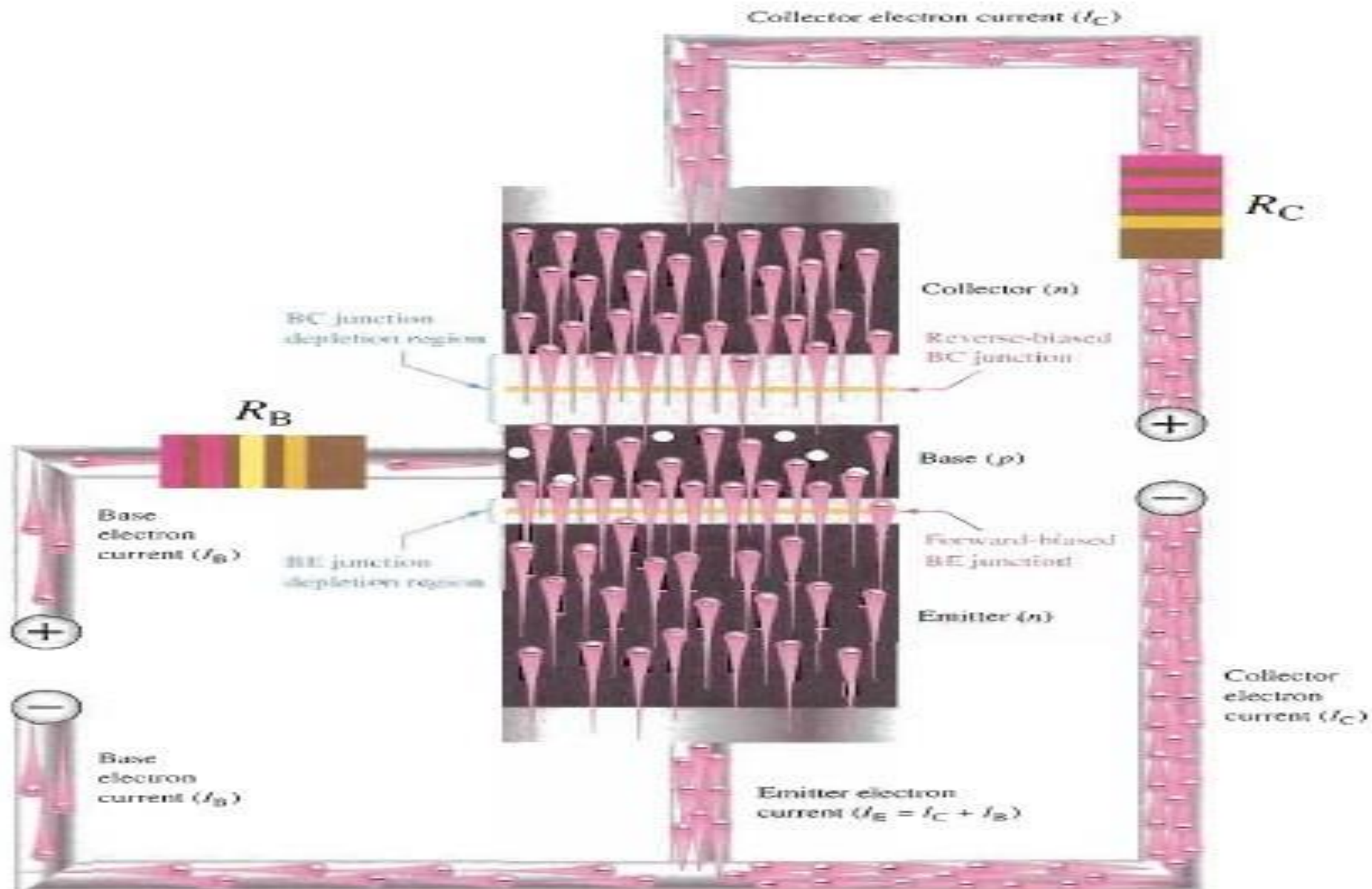
$$I_C = \beta I_B$$

$$I_E = \beta I_B + I_B \Rightarrow I_E = (\beta + 1) I_B$$

- The current gain factor, α and β is:

$$\alpha = \frac{\beta}{\beta + 1} \quad @ \quad \beta = \frac{\alpha}{\alpha - 1}$$

Transistor operation



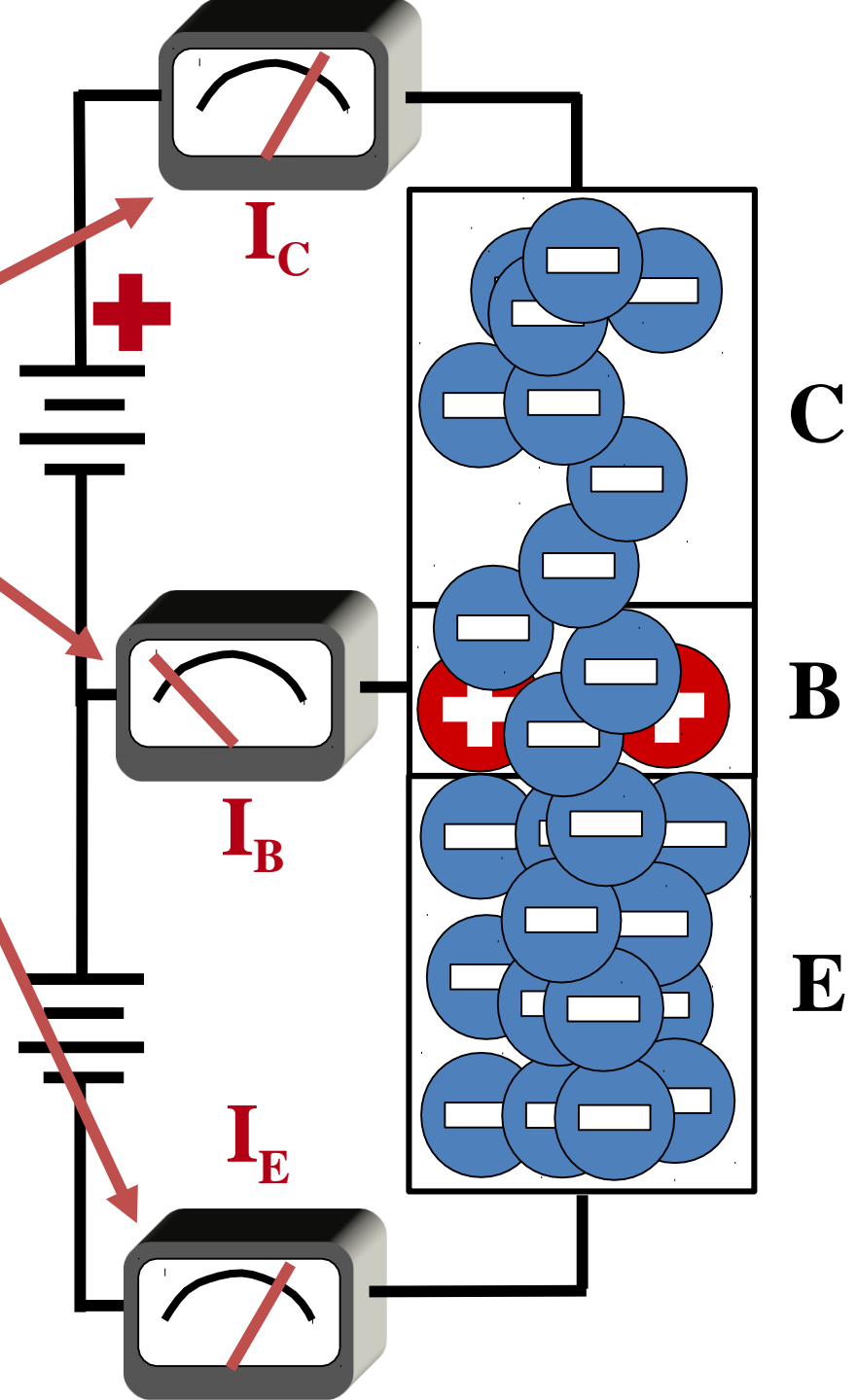
NPN Transistor Bias

Current flows everywhere.

When both junctions are biased....

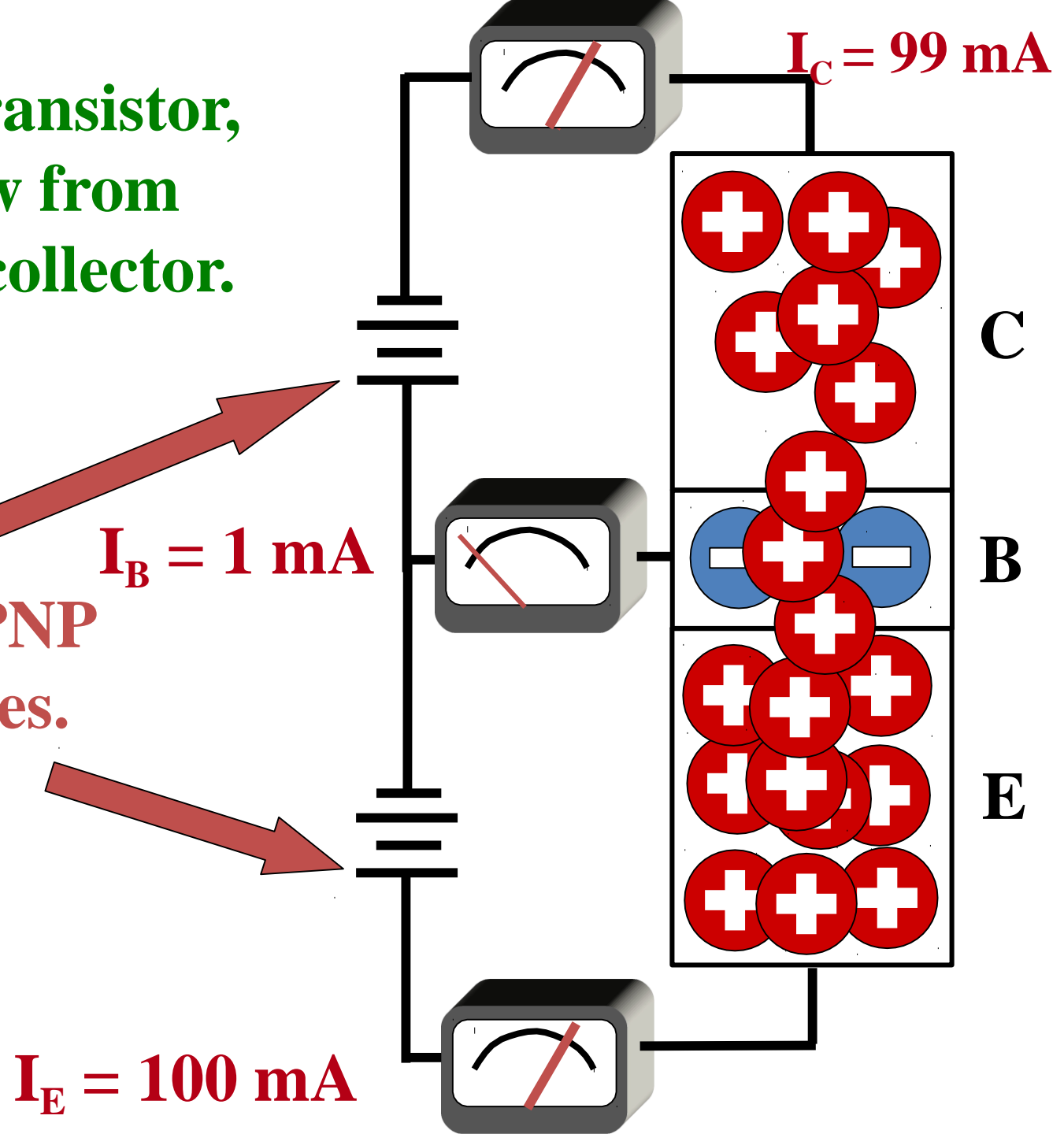


Note that I_B is smaller than I_E or I_C .



In a PNP transistor,
holes flow from
emitter to collector.

Notice the PNP
bias voltages.



MCQ

A transistor has

1. one pn junction
2. two pn junctions
3. three pn junctions
4. four pn junctions

MCQ

The number of depletion layers in a transistor is

- (a) Four
- (b) Three
- (c) One
- (d) two

MCQ

The element that has the biggest size in a transistor is

- (a) Collector
- (b) Base
- (c) Emitter
- (d) collector-base-junction

MCQ

In a npn transistor, are the minority carriers

- (a) free electrons
- (b) Holes
- (c) donor ions
- (d) acceptor ions

MCQ

The emitter of a transistor is doped

- (a) Lightly
- (b) Heavily
- (c) Moderately
- (d) none of the above

MCQ

In a transistor

(a) $I_C = I_E + I_B$

(b) $I_B = I_C + I_E$

(c) $I_E = I_C - I_B$

(d) $I_E = I_C + I_B$