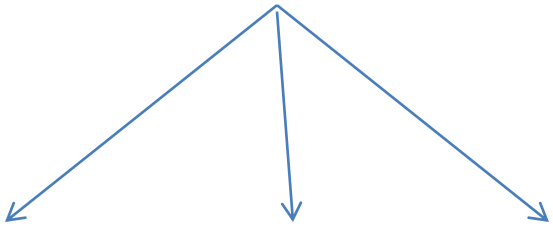
# EEE1024: Fundamentals of Electrical and Electronics Engineering

Dr. Sanchit Khatavkar

# *Semiconductor Devices*

**Diode**

Applications



***Rectifiers*** ***Voltage regulation (Zener)*** ***Solar Cells***

**Transistors –& *BJT*** & CMOS

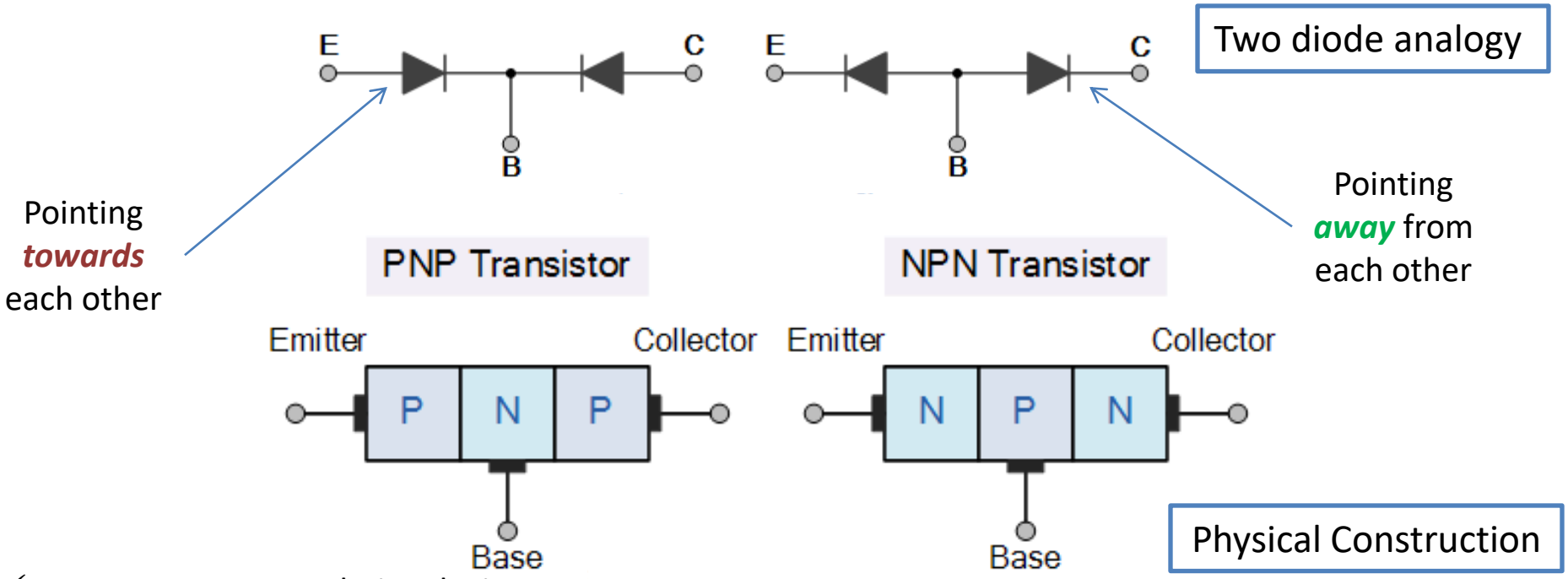
Applications

Infinite !

Billions or crores of circuit elements inside the chip or IC on the motherboard !

# *Bipolar Junction Transistor*

BJT: If two individual diodes are joined together back-to-back, it gives two PN-junctions connected together in series that share a common **P** or **N** terminal.




✓ BJTs are current regulating devices

✓ The amount of current flowing from the Emitter to the Collector terminals is controlled depending upon the amount of biasing voltage applied to their base terminal, thus acting like a current-controlled switch.

✓ A small current flowing into the base terminal controls a much larger collector current - working of transistor action.

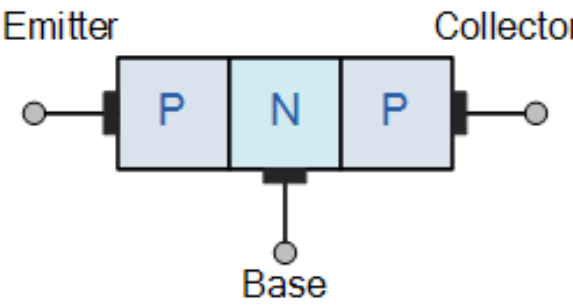
# *Bipolar Junction Transistor*

Uses of TRANSISTORS

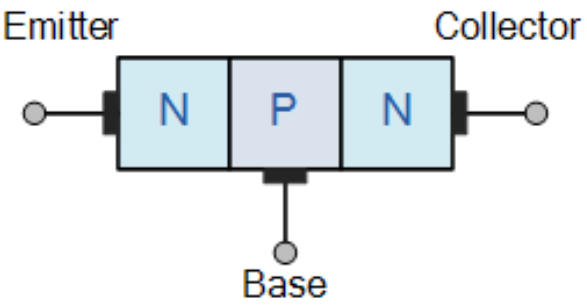
*SWITCHING* *AMPLIFICATION*

Physical Construction

PNP Transistor



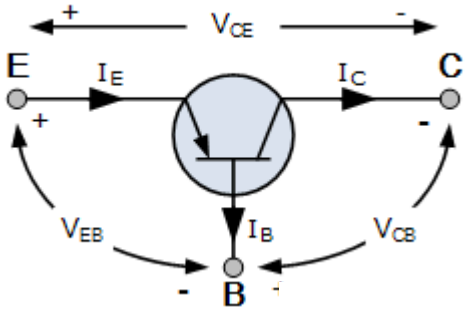

NPN Transistor



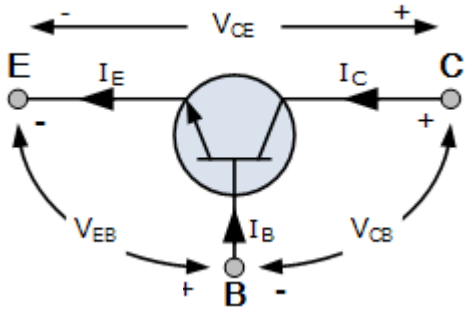

Circuit Symbols

Arrow →

- Direction of conventional current from Base to Emitter
- Always from P to N




***Inward arrow*** - **PNP**




***Outward arrow*** - **NPN**

# *BJT Configurations*

BJT – Three terminal device

– 3 possible ways it can be connected in an electronic circuit where each terminal is made common between the input and output by grounding it.

– 3 for PNP, 3 for NPN

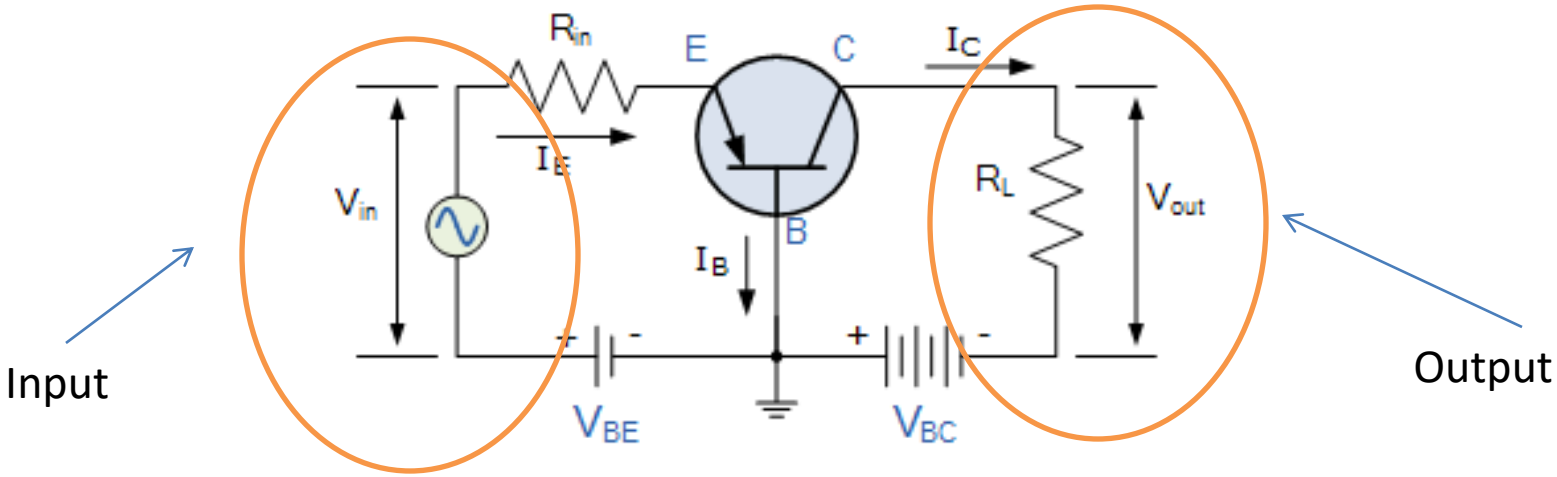
A Typical
Bipolar Transistor

Common Base (CB) configuration

Common Emitter (CE) configuration

Common Collector(CC) configuration

# PNP: Common Base Configuration




- CB configuration: Base terminal grounded or common between input and output

Current gain = Output current / Input current

Output current < Input current

$I_E$ → HIGH! $I_C < I_E$

Current gain = $A_i = 1$ LOW

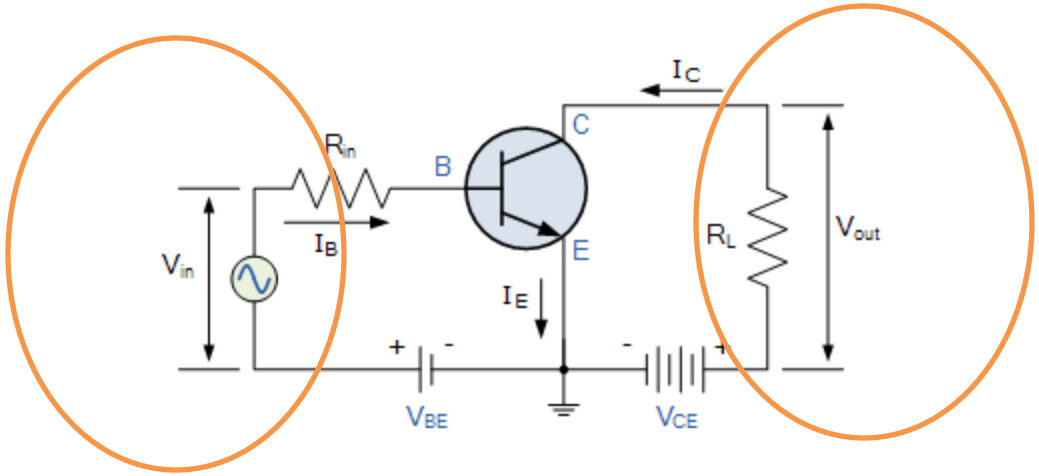
$R_L > R_{in}$

Voltage gain = $A_V = \frac{Vout}{Vin} = \frac{I_C \times R_L}{I_E \times R_{IN}}$

= HIGH

Use: Single stage amplifier circuits (microphone pre-amplifier or radio frequency ( Rf ) amplifiers )

# NPN: Common Emitter Configuration




- CE configuration: Emitter terminal grounded or common between input and output

Two current gains for CE configuration

$$\text{Alpha},(\alpha) = \frac{I_C}{I_E} \quad \text{and} \quad \text{Beta},(\beta) = \frac{I_C}{I_B}$$

$$\therefore I_C = \alpha . I_E = \beta . I_B$$

$I_E > I_C$

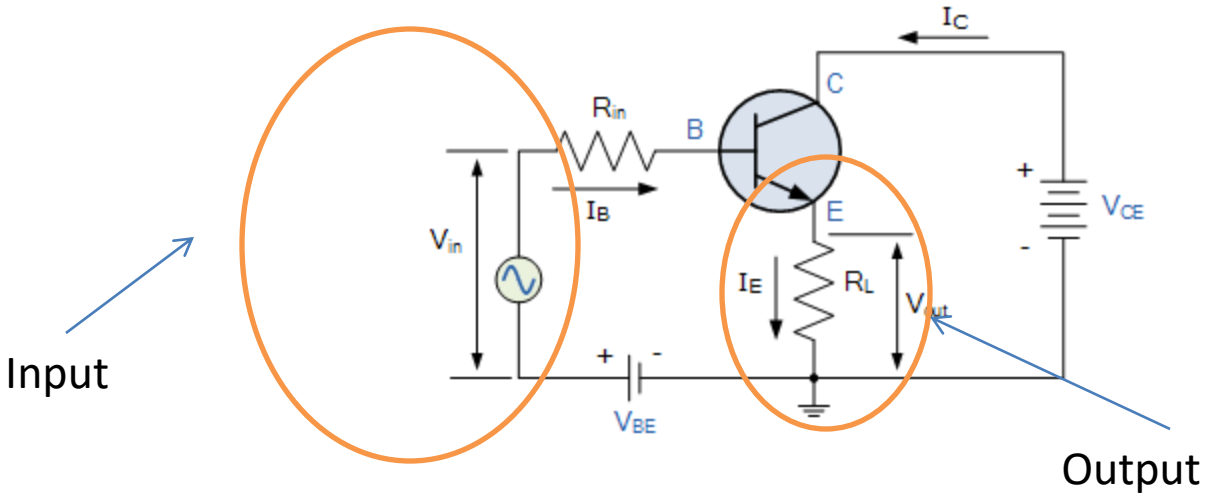
β – HIGH (20 to 200)

$\alpha < 1$

Current gain β – HIGH

Current gain α – Low  Voltage gain - LOW

# NPN: Common Collector Configuration




$$I_E = I_C + I_B$$

- CC configuration: Collector terminal grounded or common between input and output

Current gain = $A_i = \frac{I_E}{I_B} = \frac{I_C + I_B}{I_B}$

$$A_i = \frac{I_C}{I_B} + 1$$

$$A_i = \beta + 1$$

Current gain – HIGH

Voltage gain - LOW

$$A_V = 1$$

# *NPN and PNP - Differences*

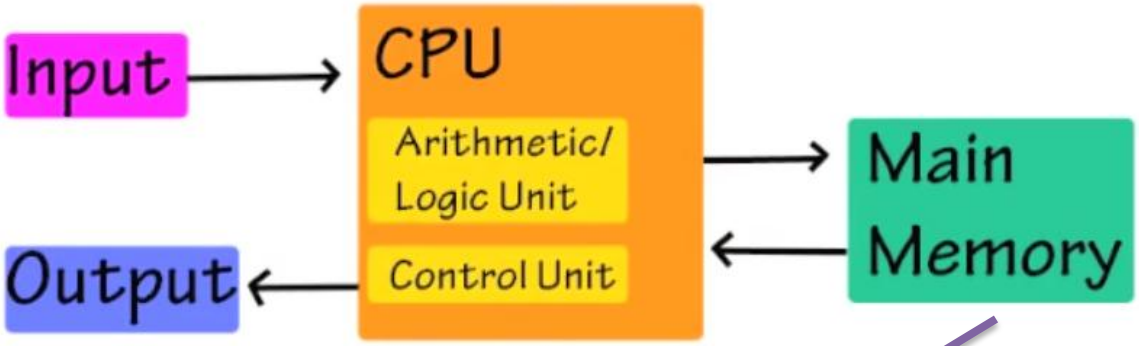
- For amplification, no difference between NPN and PNP

- They differ only structurally, i.e. where the input and outputs are in both NPN and PNP.

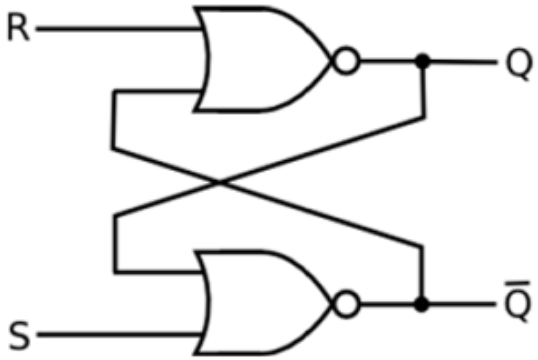
- Even though the difference is only in physical structure, the way connections are made differ, but that does not affect the amplification in CB, CE or CC configurations.

- The difference is only in the biasing and the polarity of the power supply.

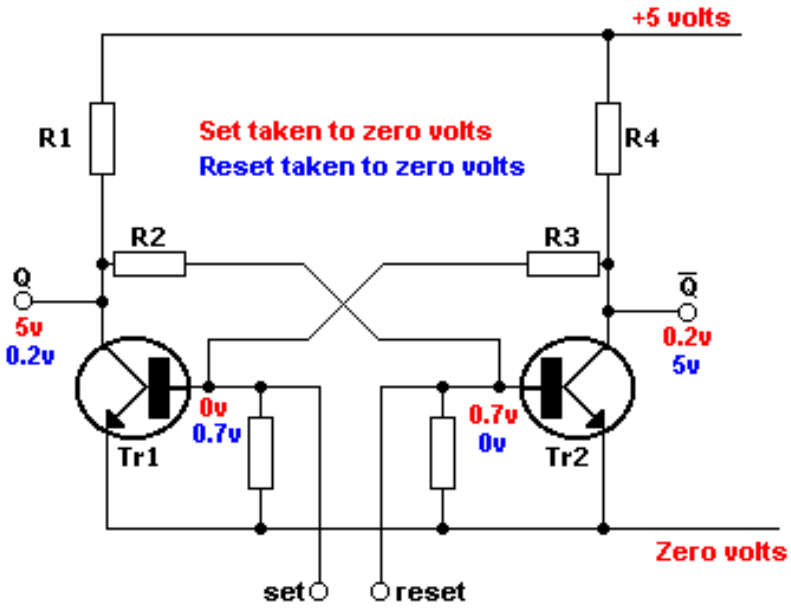
# *Transistor level implementation of S-R flipflop*

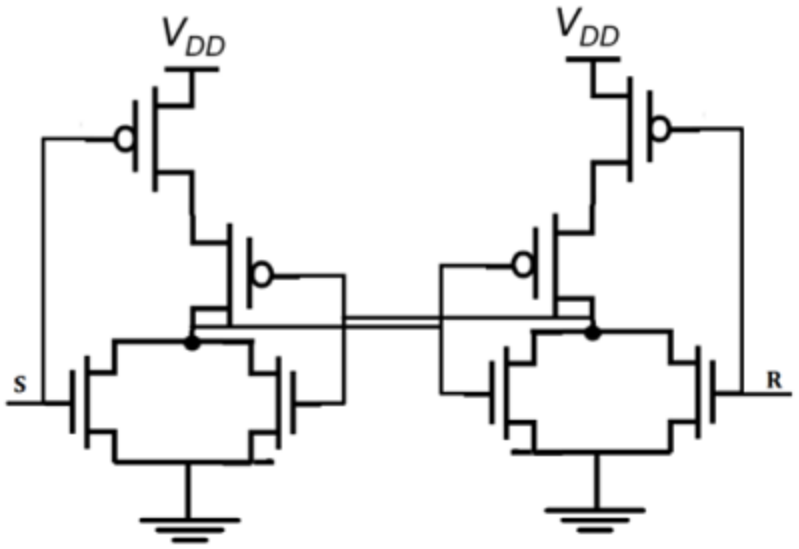



*Flip-flops*




*Transistors*






End of SEMICONDUCTOR DEVICES

Quiz – 12th Oct

# Acknowledgements


1. https://www.electronics-tutorials.ws/transistor/tran_1.html
2. https://www.hobbyprojects.com/flip_flop/a_transistor_RS_flip_Flop.html