6. Logical Operations, Transistors

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LOGICAL OPERATIONS

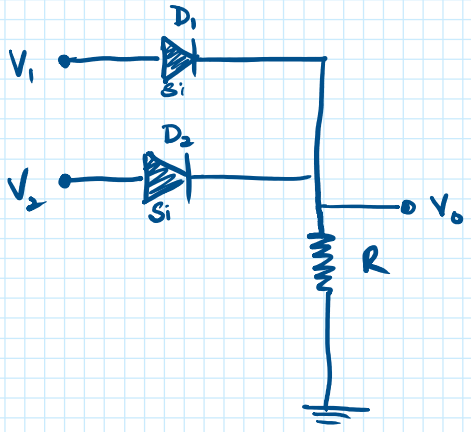
- OR GATE

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

Binary levels from voltage

1 → 4-5 V (say)

0 → 0-1 V

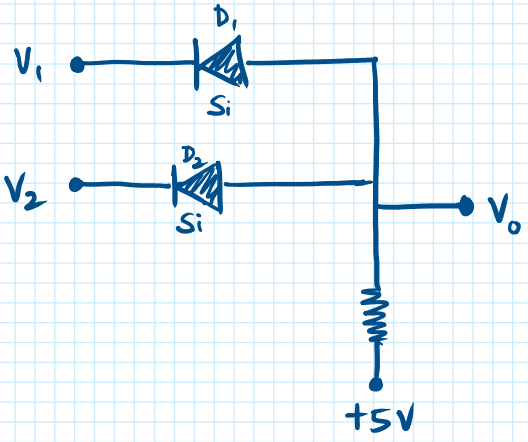


V_1	V_2	V_o
0V [0]	0V [0]	0V [0]
0V [0]	5V [1]	4.3V [1]
5V [1]	0V [0]	4.3V [1]
5V [1]	5V [1]	4.3V [2]

▨ equivalent logic levels

- AND GATE

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1



V_1	V_2	V_o
0V [0]	0V [0]	0.7V [0]
0V [0]	5V [1]	0.7V [0]
5V [1]	0V [0]	0.7V [0]
5V [1]	5V [1]	5V [1]

EDA tools :
to check analysis of circuits
LTspice

TRANSISTORS

"transfer + resistance"

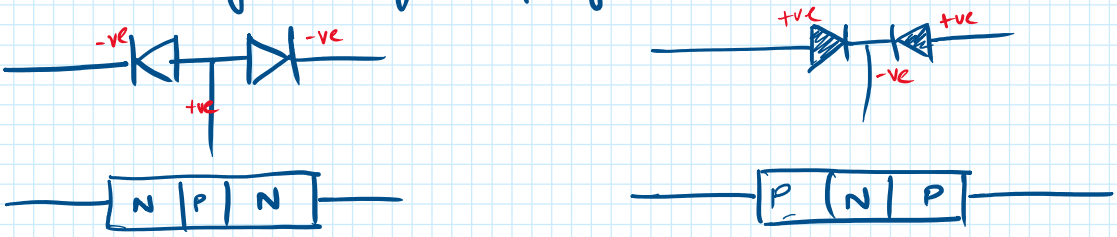
Transfer of current from a low resistance region to a high resistance region

Transfer of resistance

Transfer of current from a low resistance region to a high resistance region

① Bipolar Junction Transistor (BJT)

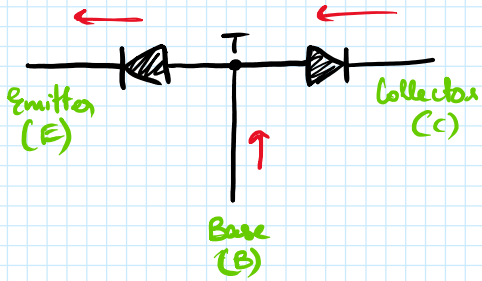
- Three terminal devices
- Constructed by connecting two p-n junctions back to back

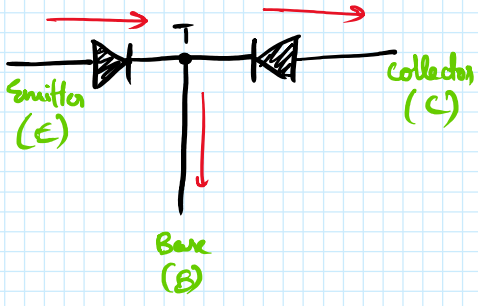


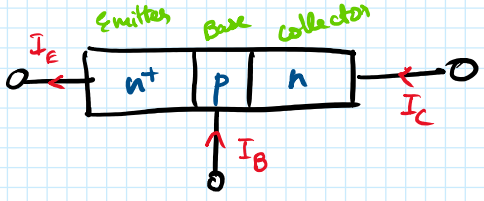
- p-type / n-type sandwiched between two of its opposite types
- Bipolar — why → both majority and minority carrier actively participate in its operation

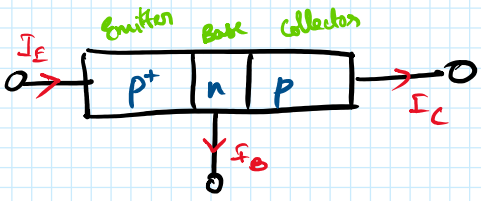
Terminals

Three terminals : Emitter, base, collector



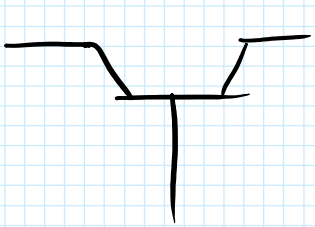


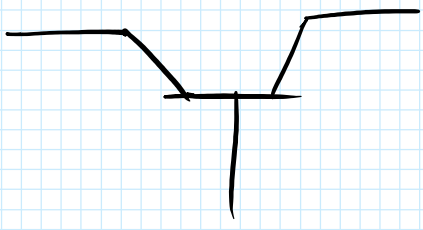




NOTE

p^+, n^+ → more doped





Emitter (E)

- supplies charge carriers
- heavily doped
- moderate in size

Base (B)

- middle portion; forms two p-n junctions b/w E, C
- lightly doped
- smallest in width

Collector (C)

- collects charge carriers
- moderately doped
- widest of all regions; maximum heat dissipated

- moderate in size
- highly doped
- smallest in width
- controls no. of charge carriers emitted
- widest of all regions; maximum heat dissipated here

TRANSISTOR BIASING

- Transistor has two p-n junctions:
  1. Emitter - base (EB)
  2. Collector - base (CB)
- Each of these can be biased independently

Thus we have the following regions of operation:

	EB junction	CB junction	Application
Active region (common)	Forward	Reverse	works as amplifier
Saturation region	Forward	Forward	ON - switch (digital)
Cut-off region	Reverse	Reverse	OFF - switch (digital)
Inverse active region (rare)	Reverse	Forward	Attenuator

ACTIVE REGION

- Emitter current = $I_E = I_C + I_B$
- Collector current = $I_C = I_{C(majority)} + I_{C(minority)}$

NUMERICALS

① In a common base connection, $I_E = 1\ mA$, $I_C = 0.95\ mA$. $I_B = ?$

Sol:

$$I_E = I_C + I_B$$

$$I_B = I_E - I_C$$

$$= 1 - 0.95$$

$$I_B = 0.05\ mA$$

Input characteristics