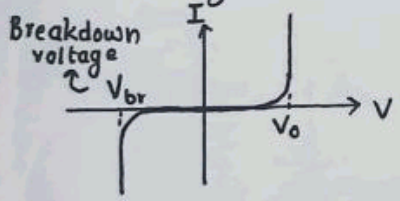
Semiconductor Electronics

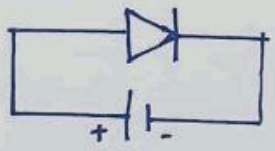
Semiconductor and Types:

	Conductors	Semiconductors	Insulators
ρ	10^{-8}-10^{-2} Ωm	10^{-6}-10^{-5} Ωm	10^{11}-10^{19} Ωm
σ	10^{2}-10^{8} Ωm^{-1}	10^{5}-10^{6} $(\Omega m)^{-1}$	10^{-19}-10^{-11}

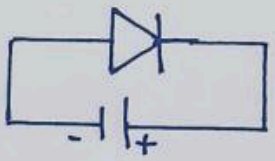
- Energy band gap :- Gap b/w top of valence band and bottom of conductor band.
  - → For conductors - $E_g \approx 0$
  - → For insulators - $E_g > 3eV$
  - → For semiconductors - $E_g < 3eV$
- * Intrinsic - pure semiconductors
- * Extrinsic - doped semiconductors

Biasing of PN Junction :





Forward Biased

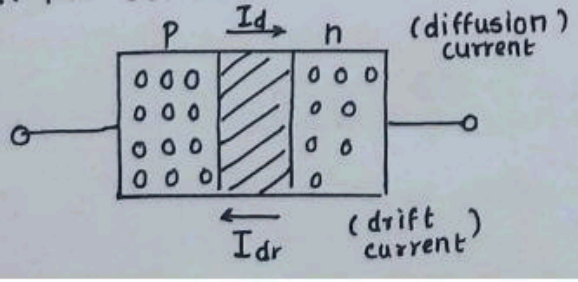


Reverse Biased

- Applications →

1) Photodiode - is a PN junction whose function is controlled by light allowed to fall on it.
2) LED - used in T.V. or electronic gadgets. V-I characteristics are similar to that of Si function diode.
3) Solar cell - generates emf when solar radiat^n falls on it.

PN Junction :



- Biasing of p-n junction
  - → when p-side is given higher potential → forward biased
  - → when n-side is given higher potential → reverse biased

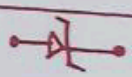
Extrinsic Semiconductor :

- n-type - pentavalent dopant
  - → donor
  - → $n_e > n_n$
- p-type - trivalent dopant
  - → acceptor
  - → $n_e < n_n$

→ For semiconductors - $n_e n_h = n_i^2$

α - NOTES

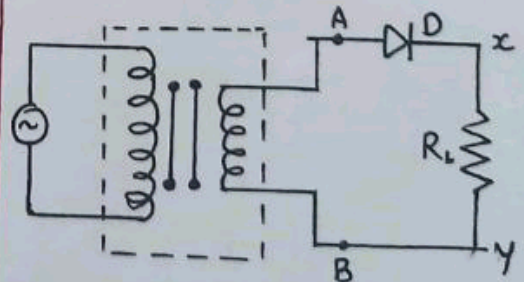
Zener Diode :

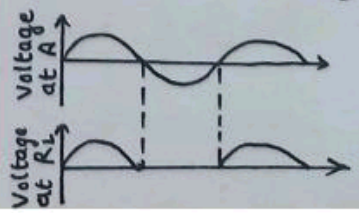


→ Operates under reverse bias in the breakdown voltage, used as voltage regulator.

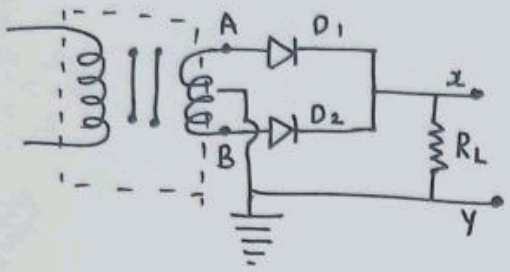
→ Depletion region is very thin.

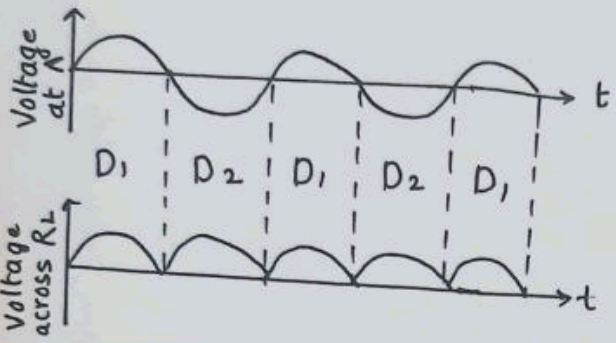
- Half-wave rectifier





- Full wave rectifier





Logic Gates

Electronic circuit which make logistic decision.

→ Basic building blocks for most digital systems.

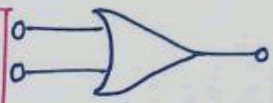
3 Basic Logic Gates →

① AND gate - Bike start (break, accelerator)

② OR gate - Air bags of car

③ NOT gate - Invert gate

① OR GATE → High output, if any of the input is high



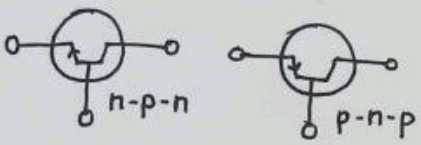
$Y = \underbrace{A + B}_{\text{Boulien expression}}$

x	y	O/P
0	0	0
0	1	1
1	0	1
1	1	1

$1 + x = 1$

$1 + y = 1$

Transistor :



$I_E = I_C + I_B$

As an Amplifier →

- Voltage gain

$A_V = \frac{\Delta V_c}{\Delta V_{in}}$

$A_R = R_L / R_i$

$A_V = -A_R \beta_{AC}$

- Power gain

$A_P = \beta_{AC} A_V$

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

- Trans-Conductance

$g_m = \frac{\Delta I_c}{\Delta V_B}$

② AND Gate → High output, if both inputs are high

$Y = A \cdot B$

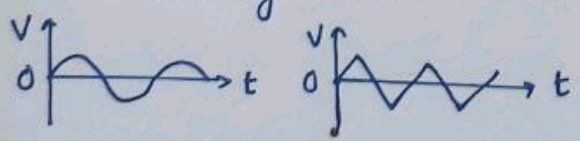
$A \cdot A = A$

$B \cdot B = B$

x	y	O/P
0	0	0
0	1	0
1	0	0
1	1	1

Analog Signals - Signals which vary continuously with time.

Circuit - Analog electronic Circuits



Digital Signals - Signals having either of the two levels, 0 or 1 are called digital signals. 0 → off, 1 → on.

Gate - Digital signal which either allows or stops the signal.

③ NOT Gate →

X	O/P
0	1
1	0

Invert Gate

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④ NOR Gate →

OR + NOT

X	Y	OR	NOR
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

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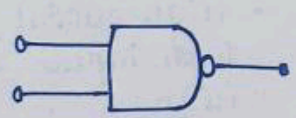
⑤ NAND Gate →

AND + NOT



x	y	AND	NAND
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0