# CONCEPT MAP

## Electronic Devices

**Band Theory:**
- In metal, the conduction band and valence band partially overlap each other.
- In semiconductors, valence band is completely filled and conduction band is empty.

**Forbidden Band:** The energy gap between the valence band and conduction band.
$$E_g = h\upsilon = \frac{hc}{\lambda}$$

**Valence Band:** It may be partially or completely filled with electrons.

**Conduction Band:** It is either empty or partially filled.

**Energy Bands in Solids**

**Semiconductor:** Solids which have low conductivity and high resistivity.

**Electrical Conductivity:** The conductivity of the semiconductor is given by
$\sigma = e(n_e\mu_e + n_h\mu_h)$

**Extrinsic Semiconductor:** It is a doped semiconductor.

**Intrinsic Semiconductor:** It is free from every impurity.
eg. Ge and Si

**n-type Semiconductor:** Conduction of electricity is due to motion of electrons.

**p-type Semiconductor:** Conduction of electricity is due to motion of holes.

**p-n Junction Diode:** When donor impurities are introduced into one side and acceptors into the other side of a single crystal of an intrinsic semiconductor, a $p$-$n$ junction is formed.

**Zener Diode:** It is designed to operate under reverse bias in the breakdown region and is used as a voltage regulator.

**Transistor:** A transistor is basically a silicon or germanium crystal containing three separate regions. It can either be $n$-$p$-$n$ type or $p$-$n$-$p$-type.

**Transistor as an Amplifier:** When the transistor is used in the active region, it acts as an amplifier.

**Transistor as a Switch:** When the transistor is used in the cut off region or saturation region, it acts as a switch.

**Transistor as an Oscillator:** The frequency of the oscillation is given by
$$\upsilon = \frac{1}{2\pi\sqrt{LC}}$$

**Half Wave Rectifier:**
- Peak value of current is $I_m = \frac{V_m}{r_f + R_L}$
- rms value of current is $I_{rms} = \frac{I_m}{2}$
- dc value of current is $I_{dc} = \frac{I_m}{\pi}$
- Peak inverse voltage is $P.I.V = V_m$
- dc value of voltage is $V_{dc} = I_{dc}R_L = \frac{I_m}{\pi}R_L$

**Full Wave Rectifier:**
- Peak value of current is $I_m = \frac{V_m}{r_f + R_L}$
- rms value of current is $I_{rms} = \frac{I_m}{\sqrt{2}}$
- dc value of current is $I_{dc} = \frac{2I_m}{\pi}$
- Peak inverse voltage is $P.I.V = 2V_m$
- dc value of voltage is $V_{dc} = I_{dc}R_L = \frac{2I_m}{\pi}R_L$

**Logic Gates:** A digital circuit with one or more input signals but only one ouput signal is known as logic gate.

**OR Gate:** Output is high if any or all the inputs are high.
$Y = A + B$

**AND Gate:** Output is high only when all the inputs are high. $Y = A.B$

**NOT Gate:** It inverts the input, so it is also called inverter.
$Y = \bar{A}$

**NAND Gate:** It is an AND gate followed by NOT gate $Y = \overline{A.B}$

**XOR Gate:** The Boolean expression for XOR gate is
$Y = \bar{A}.B + A.\bar{B}$
$= A \oplus B$

**NOR Gate:** It is an OR gate followed by NOT gate.
$Y = \overline{A + B}$

**XNOR Gate:** The Boolean expression for XNOR gate is
$Y = A.B + \bar{A}.\bar{B}$
$= \overline{A \oplus B}$

**Symbol Used**

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| $h$ = Planck's constant | $L$ = inductance |
| $\upsilon$ = frequency | $C$ = capacitance |
| $c$ = velocity of light | $n_e$ = electron density |
| $\lambda$ = wavelength of radiation | $n_h$ = hole density |
| $\mu_h$ = holes mobility | |
| $\mu_e$ = electron mobility | |