SYLLABUS

UNIT-I Ac fundamentals, Batteries and UPS

Ac fundamentals : Difference between Ac and Dc advantages of Ac over Dc - Wave form of Sinusoidal Ac cycle - Generation of Single phase Ac by elementary alternator Defnition of cycle, frequency, time period, amplitude, peak value, average value and rms value - Define peak factor and form factor - Concept of phase, Phase difference and Phase angle - Single phase and 3 phase (Definition) - Meaning of lagging and leading Sine wave - Advantages of 3 phase over Single phase.

Batteries : Classification of cells - Construction of Lead acid cell - Methods of charging - Care and maintainence of Lead acid Battery - Indications of a fully charge Battery - Maintainence free batteries.

UPS - Need for UPS - online and offline UPS - Definition - Block diagram - Explanation of each block - Merits and demerits of online and offline UPS - Need of heat Sink - Specification and Ratings - Maintainences of UPS including batteries.

Switches - Basic of Switches used - Ratings of Switches - used for System Installation - Ratings and types of wire used - necessity of MCB, ELCB.

UNIT-II Transformer and Special motors.

Single phase Transformer : Working principle and Construction of transformer - Brief description of each part - function and materials used - emf equation of Transformer (no derivation) -

Voltage and Current ratio of a transformer - Efficiency - Losses in a transformer - Auto transformer - Comparison with two winding transformer - Applications - Step up and Step down transformer (Definition only)

Special Motors : Stepper motor : Definition - Working principle - Types and applications - Servo motor Definition - Working Principle - Types and Applications - Factors to be Considered for Selecting a motor for particular application

Electrical Safety - Electric Shock - need for earthing - types of earthing, fuses - need - of type of fuses.

UNIT - III Semiconductor Devices :

Diodes : PN Junction diode - Barrier Voltage - Depletion Region - Forward biased and Reverse Biased Junction - Working Principle - Forward & Reverse characteristics of PN Junction diode - Application of Diode - Zener diode : Construction - characteristics (Forward and Reverse) - Avalanche and Zener Break down - Applications of zener diode. Light emitting Diodes - Operation, Construction and characteristics. LDR - principle of Operation and characteristics. Photo diode - Principle of operation (Concept only)

Rectifiers : Definition - Need of Rectification - Circuit diagram Operation, i/p and o/p waveforms of Half wave - Full wave - Bridge rectifiers (without filter) - Uses of filter in rectifier Circuit - Ripple factor, Efficiency and PIV (no derivation) - Comparison.

Bipolar Junction Transistor : Definition - principle of NPN and PNP transistor - Symbol - Transistor terminals - Operating

Principle (NPN transistor only) - Configuration of Transistor.

UNIT - IV Boolean algebra, Logic Gates, Combinational System

Number representation: Decimal, Binary, Octal and Hexa decimal number System - Conversion of number from one number System to another (without decimal point) - BCD Code ASCII Codes - parity bit - Use of a parity bit - Odd parity and Even parity.

Logic gates: Positive and negative logic System - Definition Truth table, Symbol and Logical equations of AND, OR, NOT, EXOR - EXNOR (only 2 inputs) gates - Universal gates - NAND - NOR Symbol and Truth table.

Boolean algebra: Basic Laws of Boolean algebra - Demorgan's Theorem and proofs - Duality theorem - Simplification of logical equation using Boolean laws - De-morgan's theorem - Two and Three Variable Karnaugh map

Arithmetic Circuits: Half adder and Full adder - Truth table, Circuit diagram - Half Subtractor and Full Subtractors - Truth table Circuit diagram

Combinational Circuits: parity generator and checker - Multiplexer - De multiplexer - Encoder - Decoder (Definition and Basic Circuits only)

UNIT - V Sequential logic System.

Flipflops: Basic principles of operation - S-R, D flipflop - Operation and truthtable - Race Condition - JK flipflop - T flipflop Toggling - Edge Triggered flipflop - level triggered flip flop - J-K Master Slave flip flop.

Counters: Need - Types of Counter - 4 bit asynchronous

Counter - Mod N Counter - Decade Counter - 4 bit Synchronous Counter Distingwish between Synthronous and Asychronous Counter - Application of Counters.

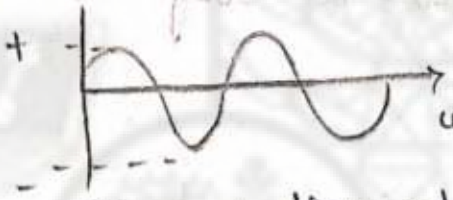
Registers : Shift registers - Block diagram representation and waveform of Serial in Serial out, Serial in parallel out, parallel in parallel out - Application of Shift registers.

UNIT-1 AC fundamentals, Batteries and UPS

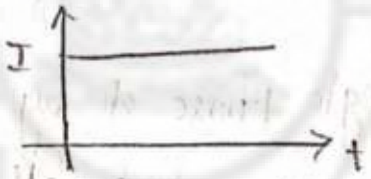
AC fundamentals:

*When direct of current through a circuit continuously changes → Alternating circuits / Alternating current (AC)

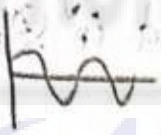
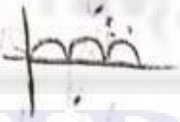
*Polarities: Positive and Negative (changes alternatively)



*Direct current: Current flow only in one direction.



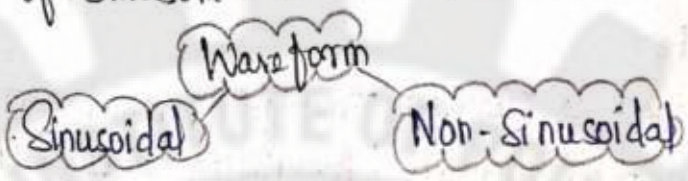
Difference between AC and DC

AC	DC
*Alternating current is that flows in alternate direction	*Direct current is that flow continuously in one direction.
*Polarities: +ve and -ve	*Polarities: Either Positive (or) negative
*Source: dc generator (or) Alternator	*Source: DC generator, Batteries
	

Advantages of dc over dc:

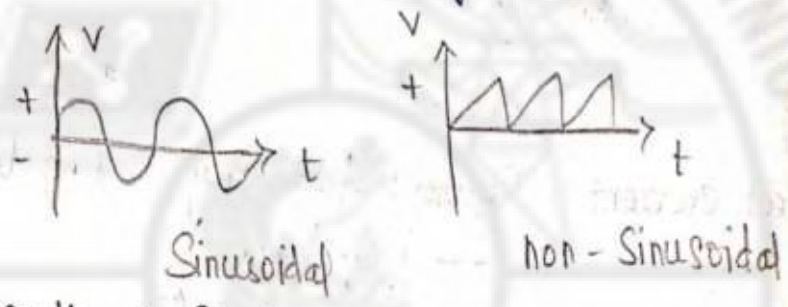
* More Voltage can be generated than DC.
* AC Voltage can be increased and decreased with help of Transformer.
* AC Transmission and distribution is more economical
* AC can be Converted to DC easily
* Maintainence and Efficiency is higher.

Waveform of Sinusoidal AC



Sinusoidal → obey Sine law

Non-Sinusoidal - does not obeys Sine law.



Sinusoidal non-Sinusoidal

Cycle generation of Single phase AC by Elementary Alternator:

* Generator → It is a machine that converts mechanical energy into Electrical energy.

* Whenever a Conductor cuts the magnetic flux, an emf is induced in it.

* According to faraday's Law of electromagnetic induction.

* Two ways:

By rotating a Coil in a Stationary magnetic field

By rotating a magnetic field in Stationary coil

* Value depends on following factors

No. of ~~turns~~ turn in the coil (N)

Strength of the field

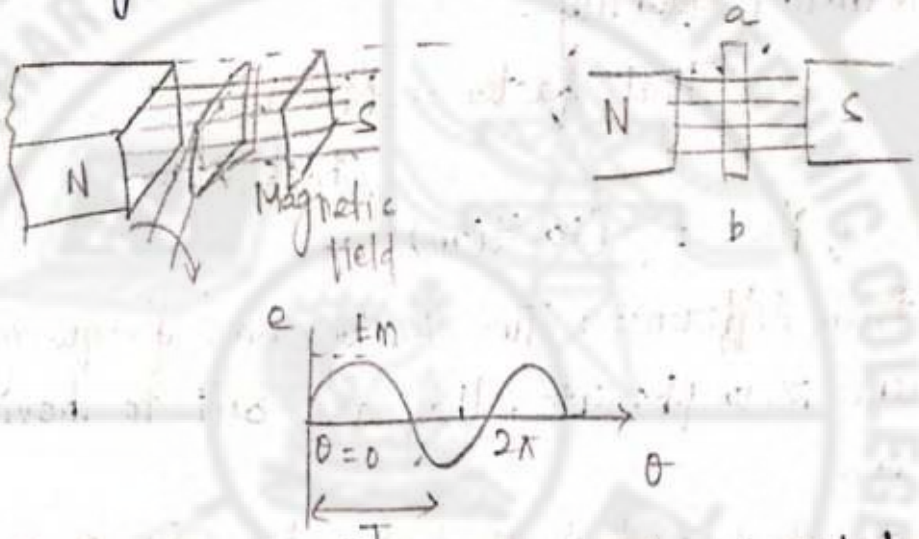
Speed of Rotation.

* Induced emf (e) $= \frac{d}{dt}(N\phi)$

$= \frac{N d\phi}{dt}$ V

where $(N\phi)$ → flux density.

* Flux is perpendicular to the Coil
* In Vertical position → EMF maximum
  Horizontal position → EMF minimum



Definition of Cycle, frequency, time period, Amplitude, peak Value, Average Value and RMS value

* Cycle: One Complete Set of +ve and -ve halves
* Frequency: Number of Cycles per Second
  → Unit: Hertz
* Time period: Time taken to Complete the Cycle

$$T = \frac{1}{f}$$ (reciprocal of frequency)

Unit: Seconds.

* Amplitute and Peak Value: The maximum positive (or) negative Value of AC is called amplitude and also peak value.
* Average Value: Average of value of AC over one Complete Cycle $I_{av} = \frac{i_1 + i_2 + \cdots i_n}{N}$
* RMS Value: Root Mean Square Value, The Value of Steady current which has caused the same heat of AC.

Definition of Peak factor and form factor:

* Form factor: Ratio of rms value to Average Value of an alternating quantity.

Form factor = $\frac{\text{RMS value}}{\text{Average value}}$.

* Peak factor: Ratio of maximum value to RMS value of alternating quantity.

Peak factor = $\frac{\text{Max. Value}}{\text{RMS Value}}$.

Concept of phase: (position)

Phase difference: Two AC of same frequency have different zero points, they are said to have phase difference.

Phase Angle: Angle of lead or lag with respect of the reference axis (or) another wave.

Single phase and 3 phase (Definition)

* Single phase: Has only one armature winding EMF induced in the Single phase generator is called the Single phase Supply.

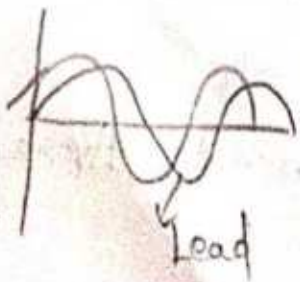
* Three phase: Has Three Seperate identical windings displaced from each other by 120°

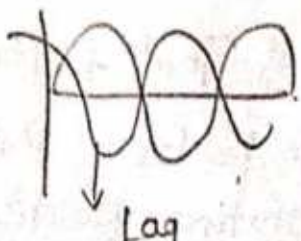
The Supply produced by 3 phase generator is called 3 phase Supply.

Meaning of lagging and leading Sine Wave

* Lead means a given wave peaks before the reference wave

* Lag means the reference wave peaks and then the wave peaks at later time





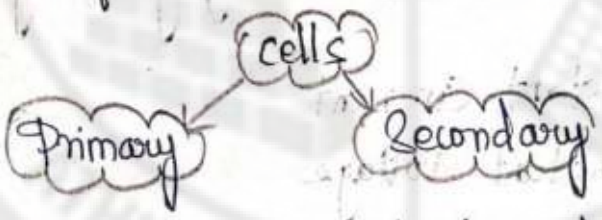
Advantages of Three phase over Single phase:

* 3ϕ power has Constant Magnitude
* 3ϕ System can be set up a Stationary magnetic field in Stationary windings.
* Three phase induction motors are Self Starting.
* Three phase System is more economical.

Batteries:

Battery is an electro-chemical device which delivers the electric energy by chemical reaction.

Classification of cells:



* Primary cell: It can be discharged once and then discarded
  Eg: Dry cell, Voltaic cell
* Secondary cell: It can be recharged and used again and again.
  Eg: Lead acid Battery, Alkaline Cell

Construction of Lead acid cell:

This Consists of the following items:

↳ Separator: It is made of thin sheet of porous insulating material and placed blw +ve and -ve plates

↳ Electrolyte: Dilute Sulphuric acid.

↳ Container: Container houses the plates and the electrolyte and it is made of Acid resisting materials

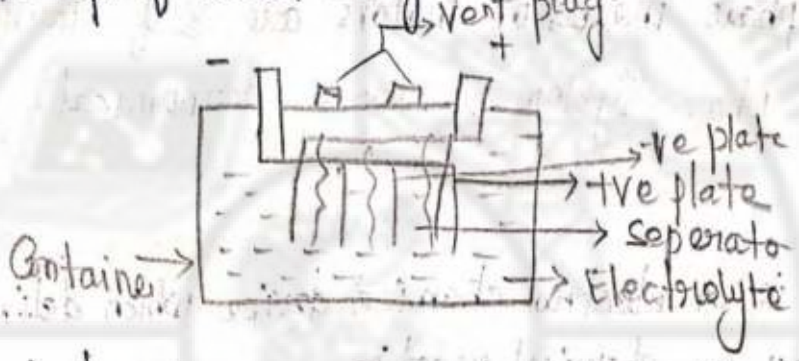
↳ Cover of cell: has a Cover made of moulded hard rubber

↳ Vent plug: They are used to fill up the electrolyte

in the cell.

↳ cell Connection : It is used to Connect two cells in Series.

↳ Battery terminals : Two → +ve and -ve and they are made up of lead alloys.



Methods of charging :

* Direct current is used for charging storage Battery.
* Two methods
  - ↳ Constant Current
  - ↳ Constant Voltage
* Constant Current method : The charging current is maintained Constant throughout the process by adjusting the rheostat and Batteries are connected in Series
* Constant Voltage method : The Batteries are Connected in parallel and the charging voltage is maintained Constant throughout the process.

Care and Maintainence of Battery :

* Temperature of the Battery should not exceed 40°
* Tighten all Connections Periodically
* keep it dry and clean to avoid discharge
* keep the Surface free of any electrolyte
* Apply petroleum jelly to terminals to Avoid corrosion
* Battery terminals shouldn't be Short circuited

Indications of fully charged Battery:

* Voltage: If there is no further rise in voltage while charging, then the cell reaches the full charge condition.

* Gassing: When the battery is fully charged, it freely gives off H_2 and O.

* Specific gravity of the electrolyte: During discharging water is formed, hence the specific gravity of the electrolyte decreases. But during charing, water is absorbed, the specific gravity is increased.

* Colour of plates: Colour of +ve plates turns dark brown and the negative plate to grey indicating that Battery is fully charged.

Maintainence free Batteries:

* It uses a specialized system, such as glass mat or gel, to absorb and immobilize the electrolyte.

* When a Maintainence free battery losses its ability to hold a charge, it must be replaced.

UPS: Unitiinterrupted Power Supply.

Need for UPS:

* The power supplies are commonly used as stand by sources for critical loads and in applications where normal ac not available.

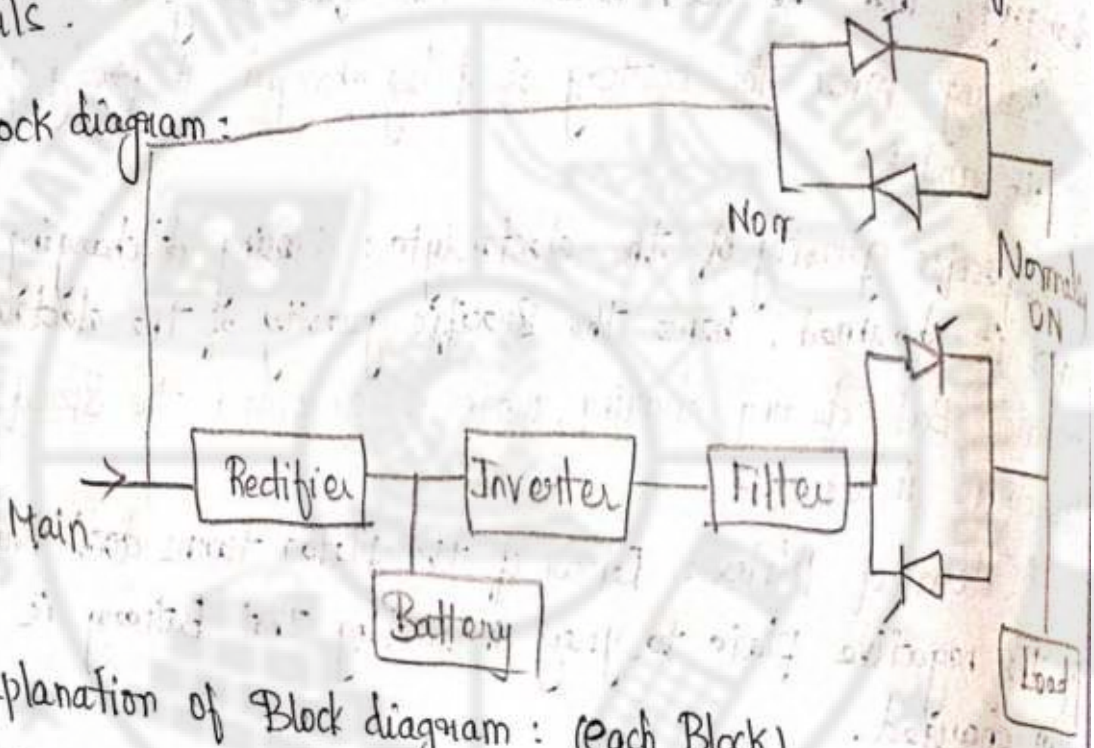
Online UPS and Offline UPS:

* Online UPS: Online UPS supplies the dc power through the rectifier and inverter circuit even when the AC mains power is available.

* The ONLINE UPS is connected to main load at all the time

* Offline UPS : The Offline ups need not find its usage often. It is required only when the main supply fails.

Block diagram :



Explanation of Block diagram : (Each Block)

* Rectifier → Converts AC Supply to DC Supply
* Inverter → Converts DC Supply to AC Supply
* Battery → The Standby battery is normally either nickel Cadmium (or) Lead acid type
* filter → Used to filter out necessary power.
* Static Switches : This Configuration requires breaking the Circuit momentarily and transfer by a Solid Switch.

Merits and Demerits of Online and offline UPS

* If Supply fails load is switched to the o/p of Inverter in Off-line whereas the load is always connected to o/p
* The offline requires breaking the Circuit momentary whereas Online do not require it.
* Load i/p is unregulated and Unconditional power in offline.

Need of Heat Sink:

* A Heat Sink is a passive heat exchanger that transfer the heat generated by a electronic device to a fluid medium.

* This allows the regulation of the device's temp of optional level.

Specifications and Ratings:

↳ Input Connection → Dual Input, hardwired

↳ Nominal ouptput connection → 220 | 230 | VAC Single phase

↳ O/p Voltage regulation → ± 2 %. Static, ± 5 %. dynamic

↳ Overload Capacity → 150 %. for 5 sec | 125 %. for 1 min

↳ O/p frequency → 50 Hz ± Hz

Maintainance of UPS:

* Make Suthe the UPS keeps in Contact with it electrical ground at all times

* Don't overload it.

Switches:

Basics of Switches:

* An electric Switch is responsible for allowing (or) inhibiting the transfer of electricity in an circuit.

* Common form: Basic Manual Switch.

* When Switch is open → electrical Contacts do not touch and electricity don't flow.

* When Switch is closed → electrical Contacts touch and electricity flows.

Ratings of Switches used for a System Installation:

* Two ratings

* Current Rating: The indicated current rating in amphere on switch name plate shows the maximum capacity the switch can carry.

* Voltage Rating: Maximum voltage a switch can be used and installed in the circuit.

Ratings and Types of Wires Used:

* Ampacity is the maximum current that a conductor can carry under the conditions.

* The number and type of electrical devices connected to a circuit determine the ampacity requirement.

* Types of wires: ↳ Triplex
↳ Main feeder
↳ Panel feed
↳ Non-metallic sheathed
↳ Single stand.

Necessity of MCB, ELCB:

* MCB → Miniature Circuit Breaker is an electrical switch which is operating (Self) and is needed as a protection to human and electrical appliances from shocks caused by overload (or) short circuits.

* Once the current exceeds the rated limit, the MCB detects the excess flow and at once breaks the circuit.

* ELCB → Earth leakage Circuit Breaker is used to detect the earth leakage and prevent injury to human beings from electrical shocks and prevents fires.

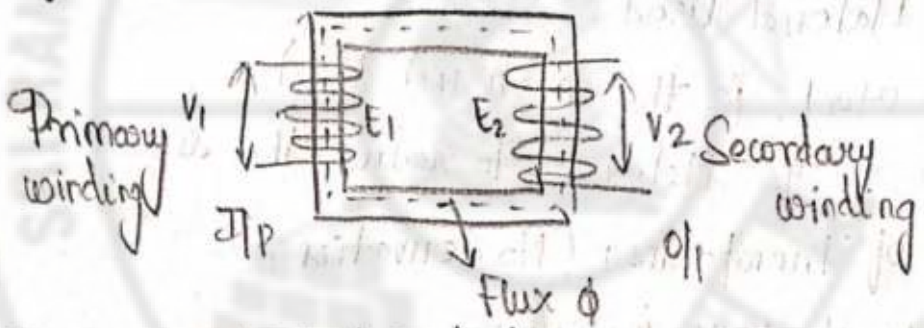
UNIT - II TRANSFORMERS AND SPECIAL MOTORS

Single phase Transformer:

Transformer: Device used to Stepping up or Stepping down of Voltage.

Function: Transform alternating current energy from one voltage into another voltage with same frequency.

Working Principle and Construction of Transformer:



*Principle: Mutual Induction.

*Parts: Three Parts → Primary winding
Secondary winding
Core.

*Working: AC Supply is given to the primary winding, an alternate flux is set up in the Core

* The flux cuts both primary and Secondary winding

* Emf is induced in the primary winding

* according to faraday's mutual Induction, emf is induced in the Secondary winding.

* Load is Connected in Secondary winding, thus electrical energy can be Obtained

* Construction: Core is made of thin laminated Silicon Steel.

* Classification according to Construction,
Core type Transformer
Shell type Transformer.

* Losses: Copper, eddy current

Breif description of each part :

Primary winding : AC supply given to winding known as primary winding.

Secondary winding : The winding from which electric supply is taken.

Core : Two windings are wound over an iron core made up of thin laminated Silicon steel.

Function and Material Used :

Silicon steel, is the material used.

Function of the Material : To reduce the loss.

Emf equation of Transformer (No derivation)

$N_1 \rightarrow$ no. of turns in primary

$N_2 \rightarrow$ no. of turns in Secondary

$\phi_m \rightarrow$ max. flux in Core

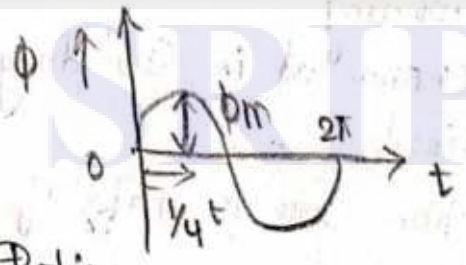
$f \rightarrow$ frequency.

$\therefore$ RMS value of emf induced in primary winding

$$E_1 = 4.44 f \phi_m N_1$$

RMS value of emf induced in Secondary winding,

$$E_2 = 4.44 f \phi_m N_2$$



Voltage and Current Ratio :

Voltage Ratio : $\frac{E_2}{E_1} = \frac{4.44 f \phi_m N_2}{4.44 f \phi_m N_1}$

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

$K \rightarrow$ Voltage Transformation Ratio.

Current Ratio : $V_1 I_1 = V_2 I_2$

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = k$$

Efficiency :

$$\% \text{ Efficiency} = \frac{\text{O/p power}}{\text{I/p power}} \times 100$$

$$= \frac{\text{O/p power}}{\text{O/p power + core loss + copper loss}} \times 100$$

$$\eta = \frac{\text{input power - loss}}{\text{input power}} \times 100$$

Losses in a Transformer :

* Two types : Core losses (or) Iron losses
  Copper losses.

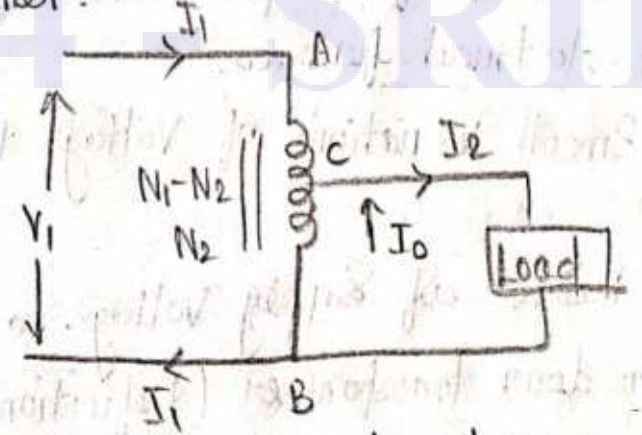
* Core loss : These consists of hysterisis and eddy current loss and occur in core due to alternating flux.

Core loss = Hysterisis loss + Eddy current loss
= Constant loss

* Copper loss : They occur in both primary and secondary winding due to its resistance.

Total Copper losses = $P_c = I_1^2 R_1 + I_2^2 R_2$

Auto Transformer :



* Auto transformer is a transformer which has one winding only.

* One part of winding is common to both primary and Secondary.

* Theory and operation are similar to two winding transformer

* Due to alternating flux and emf E_1 is induced in Coil (AB) and Emf E_2 will be induced in coil BC or apply the Voltage.

Comparison with two winding Transformer.

Auto Transformer	Two winding Transformer
* It has only winding common to both primary and Secondary	* It has two seperate windings
* Primary and Secondary windings are not electrically isolated	* In this, they are electrically isolated.
* Uses less Copper and it is Cheaper.	* Uses more Copper and Cost is high.
* Higher efficiency and has Smaller Size	* Lower efficiency and large in Size.

Applications:

* Used as Starters for 3 phase Induction motors
* Used in electrical furnace
* Gives Smooth variations of Voltage to test circuits in laboratories
* As a booster of Supply Voltage to a Small extent Step up and Step down transformer (Definition only)

Step Up Transformer: If the no. of turns in the

Secondary winding (N_2) is more than the primary winding turns, the emf induced will be higher.

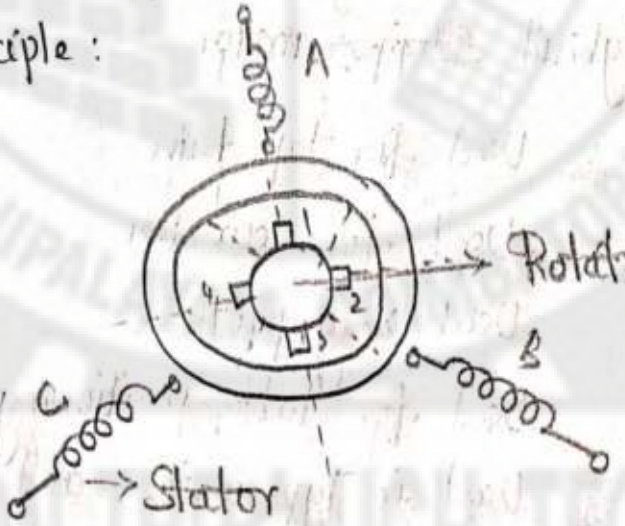
Step down transformer: If the number of turns in the Secondary winding (N_2) is less than that of primary winding turns (N_1), the emf induced will be lower.

Special Motors:

Stepper motor: Defnition:

Stepper motor does not run continuously but rotates in jerks (or) Step in either direction when electric pulse is given to it.

Working principle:



* If we give one pulse, the motor will move through a Particular angle, If we give 2 pulse, it will move through next angle and so on.

* Parts: Stator and Rotor

* Angular Shift: $\alpha = \frac{360^\circ}{\text{no. of Stator phase} \times \text{no. of Rotor poles}}$

Eg: Stator = 3 phase rotor = 6 poles

$$\alpha = \frac{360^\circ}{3 \times 6} = 20^\circ$$

* Motor has Salient poles and Stator has Three Coils Seperated by 120° apart

* When phase A is excited, the rotor teeth 1 and 3 line up with the axis A.
* If B is excited, Motor will move 30° clockwise (2 line up.
* If C is excited, motor will move another 30°
* Hence Step by Step movement takes place.
* One Complete revolution = 12 pulses.

Types and applications:

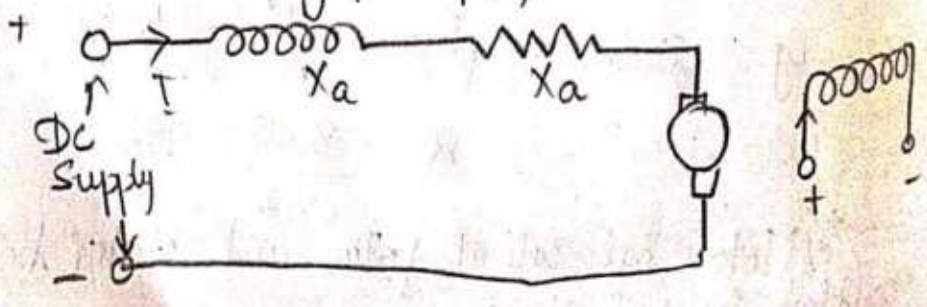
* Types: Variable reluctance Stepper motor
  Permanent magnet Stepper motor
  Hybrid Stepper motor
* Applications: Used for tape drive
  Used for recorder
  Used X-y plotters
  Used for table positioning of tools
  Used in Type writers and teleprinters

Servo motors: (Definition)

Servo motors are the motors which has precise Cont of linear position, Velocity and acceleration.

Types: DC Servo motor
  AC Servo motor

Dc Servo motor (Working principle)



* A DC Servo motor is same as that of the DC Seperately excited Shunt motor.

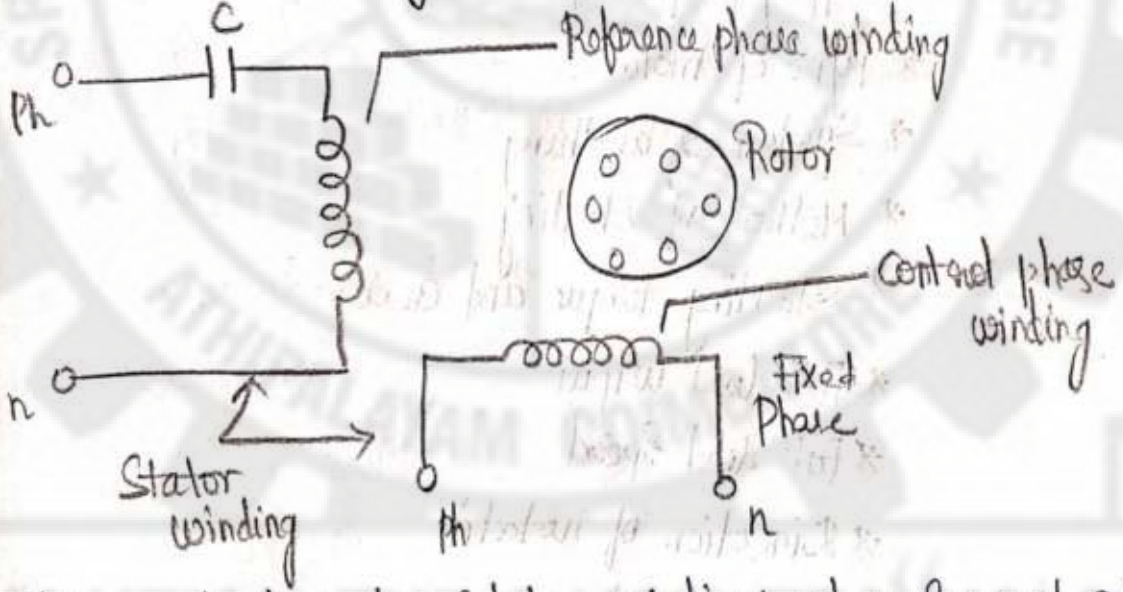
* It has two seperate windings

* One is field winding place on the Stator and the other winding is armature winding.

* Speed of rotation is proportional to armature Voltage Reversal of armature Current will reverse the direction of rotation.

* Speed and direction of rotation are easily controlled

AC Servo motor (Working principle)



* This motor has two Stator windings at a Space of 90° to each other.

* They are reference phase and Control phase windings.

* The Rotor is usually Squirrel Cage type.

* The Speed of AC Servo motor can be varied within limit by varing the Voltage applied to Control phase winding.

* If the Control voltage is In phase with reference Voltage, motor runs in clockwise direction

* If the Control Voltage is Out of phase, then motor runs in anticlockwise direction.

* Low cost and Simple in Construction

Applications:

* Automatic Control System
* Measuring and monitoring equipments
* Computers

Factors to be Considered for Selecting a Motor for a Particular Application:

* Number of phases
* Rated Voltages
* Supply frequency
* Type of motor
* System of earthing
* Method of starting
* Starting torque and current
* Full load output
* Full load Speed
* Direction of rotation
* Type of enclosure
* Site and operating Condition
* Class of insulation
* Nature of driven load
* Maximum temperature

Electrical Safety:

Electric Shock:

* Human as Conductor, when live wire touches the body, current completes its path through body and earth.
* Hence muscular fns of the body are paralyzed due to current action on nervous system.

Prevention and Precaution against Shock.

- Always be careful
- Use good quality wire
- While replacing fuse, put off the Main Switch
- Replace the Broken (or) damaged Switches and plugs
- Check proper working of Safety devices
- Keep proper Condition of electrical hand tools.
- Always keep proper earth connection.

Need for Earthing:

* To Save human life from danger
* To protect large buildings from lightning
* To protect all machines
* To maintain line Voltage Constant

Types of Earthing:

* Pipe earthing
* Plate earthing
* Strip earthing
* Rod earthing

Fuse: A short piece of metal inserted in Series with the Circuit, which melts when excessive current flows.

Types of fuse and Need of fuse:

Need: The function of fuse is to carry the normal current without over heating but when the current exceeds its normal value, it rapidly heats up to melting point and disconnected the circuits protected by it.

Protects the appliances, Circuit.

Types of fuses:

* In general fuses may be classified into
  - Low voltage fuses
  - High Voltage fuses

* Low Voltage fuses is classified into
  - Semi enclosed rewirable fuse
  - HRC cartridge type fuse

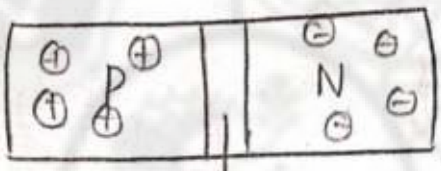
* High Voltage fuses are classified into
  - Cartridge fuses
  - Liquid type fuses
  - Metal clad fuses

UNIT - III. SEMICONDUCTOR DEVICES

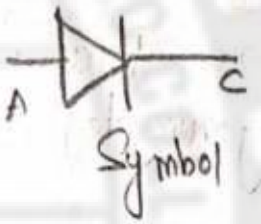
Diodes: PN Junction diode

PN Junctions is formed by suitably joining a p-type and N-type Semiconductor

Diode → Allows flow of current in only one direction



Depletion region



Symbol

Barrier Voltage: The barrier potential is defined as the potential difference build up across the PN-Junction which restricts further movement of charge carries across the Junction.

Barrier potential for Silicon PN Jn is 0.7V and for Germainum PN Jn is 0.3V

Depletion region:

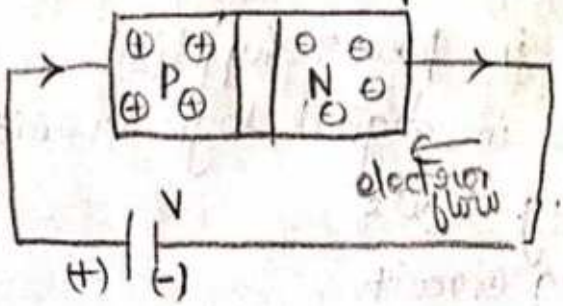
* A p-type Semiconductor has more holes and N-type Semiconductor has more electron.

* At PN Junction, the electrons and holes recombine with each other, to form a region called Depletion region.

Forward and Reverse Biased Junction:

* The two types of Biasing are: ↳ Forward Bias
↳ Reversed Bias

* Forward Bias: → Holes flow (Working principle)

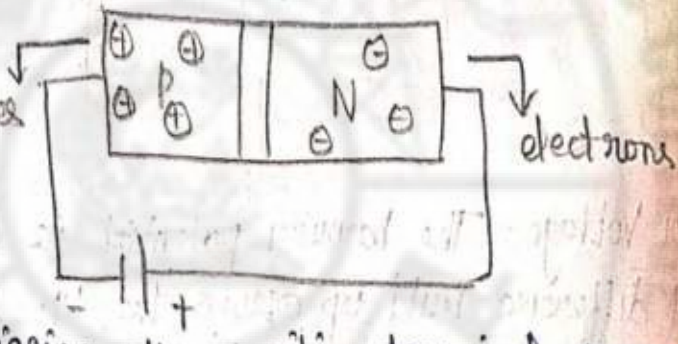


* In forward bias, positive terminal is connected to P-type and negative terminal of the battery connected to N-type.

* Under this, the applied potential repels the carriers and reduces the width of the depletion region and barrier potential.

* In forward Bias → Conduction takes place.

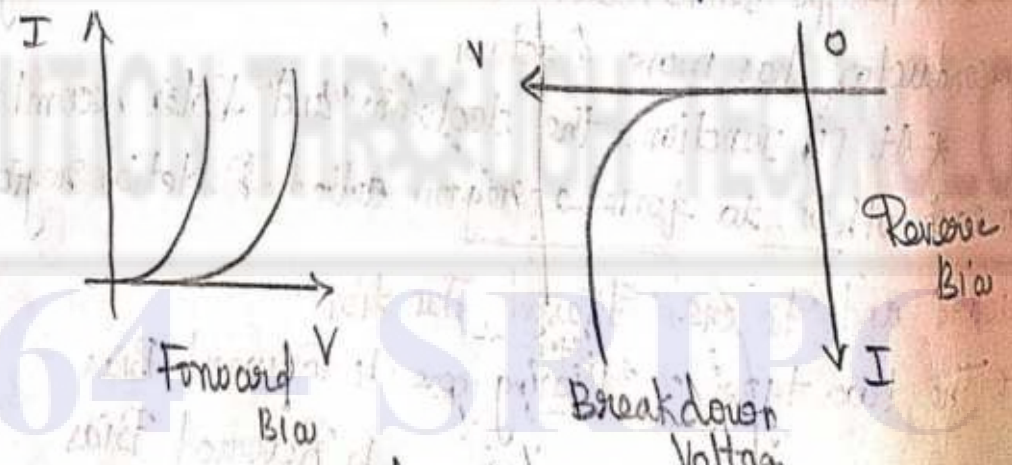
Reverse Bias :
(Working principle)



* In reverse biasing, the positive terminal of the battery is connected to the ~~ner~~ N-type and negative terminal of the battery is connected to P-type.

* Under this, the carriers move towards the Battery and width of the depletion region increases.

* In reverse bias → No current flows.



Characteristics of PN-Junction Diode.

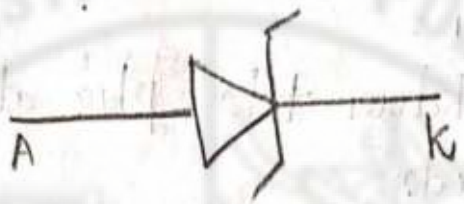
Application of diode :

* Rectifier in power supplies
* Switches in digital logic circuit
* Clamping n/ws
* Clipping circuits.

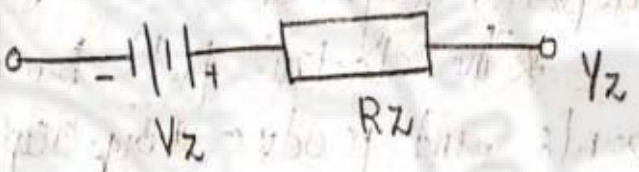
Zener Diode:

* Zener diode is specially designed PN-junction diode. It is a heavily doped PN-Junction diode.

* Symbol:



* Equivalent circuit:



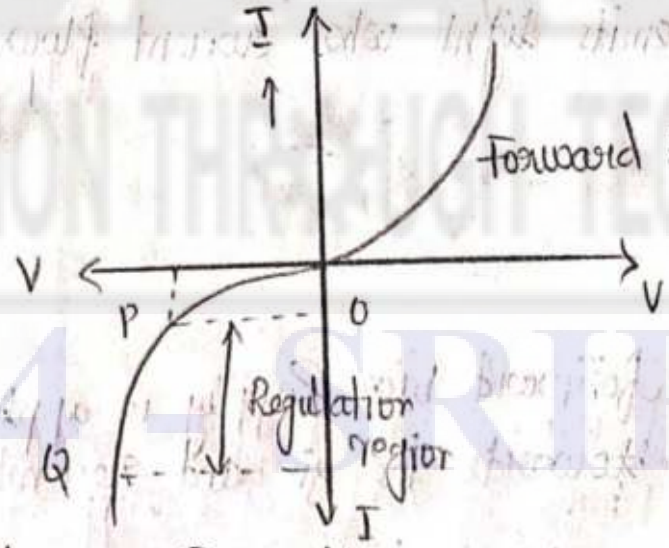
Construction:

* The zener diode operation and construction is same as the ordinary PN-Jn diode in forward Bias

* In Reverse Bias, Breakdown may occur, the Breakdown Voltage depends upon amount of doping.

* Heavily doped diodes breakdown at low voltage levels, lower doped diodes, breakdown at high voltage levels.

Characteristics (Forward and Reverse)



Avalanche and Zener Breakdown:

Avalanche Breakdown: The breakdown occurs at lightly doped zener diodes, the width of depletion layer is large.

* Due to collision Co-valent bonds are broken and electron hole pairs are generated. These new carriers again acquire sufficient energy and collide with other.

* This process is cummulative in nature and results in generation of avalanche charge carries in a short time.

Zener Breakdown:

* Zener Breakdown takes place at heavily doped, thin depletion layer diodes.

* The electric field breaks a large no. of Co-valent bonds and produce large currents. This process is called Zener breakdown.

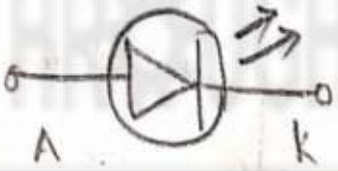
Applications of Zener diode:

* Can be used as Voltage regulator
* Used in clipping circuits
* Used as a limiter in waveshapping circuits

Light Emitting Diode (LED):

* LED is a Specially made forward biased PN Junction diodes, which emits light when current flows through it.

* Symbol:



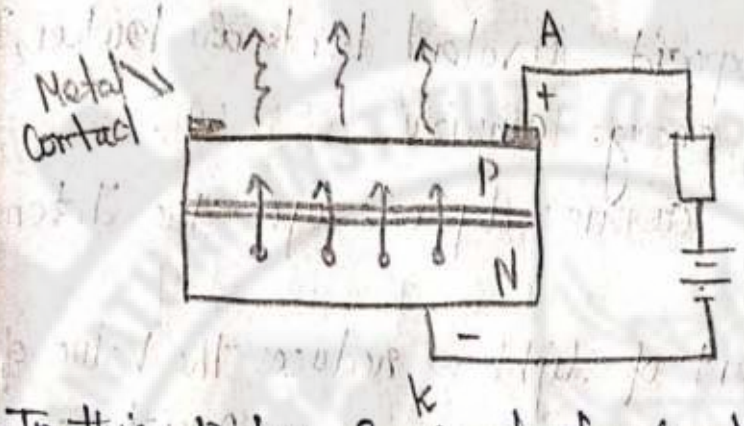
Operation:

* When a forward bias supply is applied, the electrons and holes move towards the jn and recombination takes place.

* After recombination, the electron movement takes place from Valence band to Conduction band.

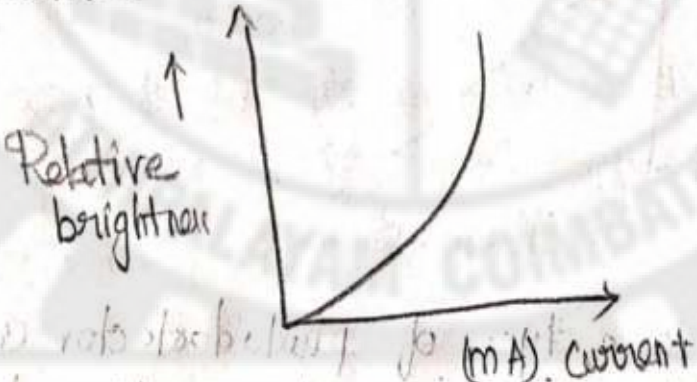
* The energy difference b/w the Bands is radiated in the form of light.

Construction :



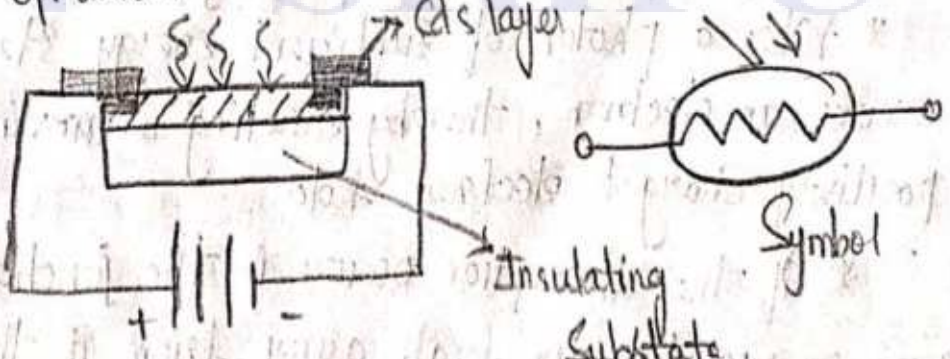
* In this, P-type Semiconductor is deposited on N-type Substrate layer.
* Anode are made at outer edge of P-layer
* Cathode Connection is also formed by coating a metal film at bottom of N-Substrate.

Characteristics :



LDR : Light Dependent Resistor :
* LDR is a Semiconductor device whose resistance value changes when exposed with light energy.
* Also called photo resistor.

Principle of Operation :



* Principle : Photo Conductuctive effect.
* The Conductivity of certain material varied when they

are exposed to light.

* When light is exposed, covalent bonds are broken, This effect produces more charge carriers.

* The amount of carriers depends upon the Intensity of light.

* Large amount of light → reduces the Value of resistance

* Lower amount of light → Increases the Value of resistance

Characteristics:

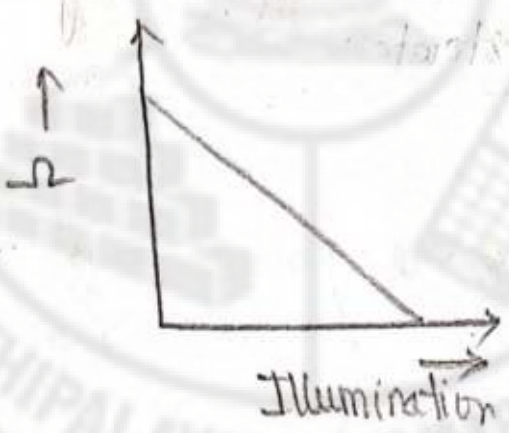
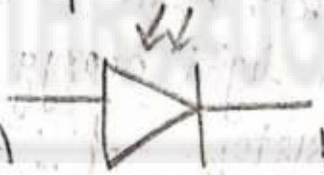


Photo Diode:

*Photo diode is a type of photodetector capable of converting light into either current or voltage depending upon the mode of operation.

* Symbol:



Principle of operation (Concept only)

* When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a moving electron and a positively charged electron hole.

* If the absorption occurs in the junction depletion region, or one diffusion length away from it these carriers are swept from the jn by the built in field of depletion region

* Thus holes move towards the anode and electrons towards the cathode and a photo current is produced.

Rectifiers:

Definition: Rectifier is an electronic device which converts an Ac Signal into Dc Signal.

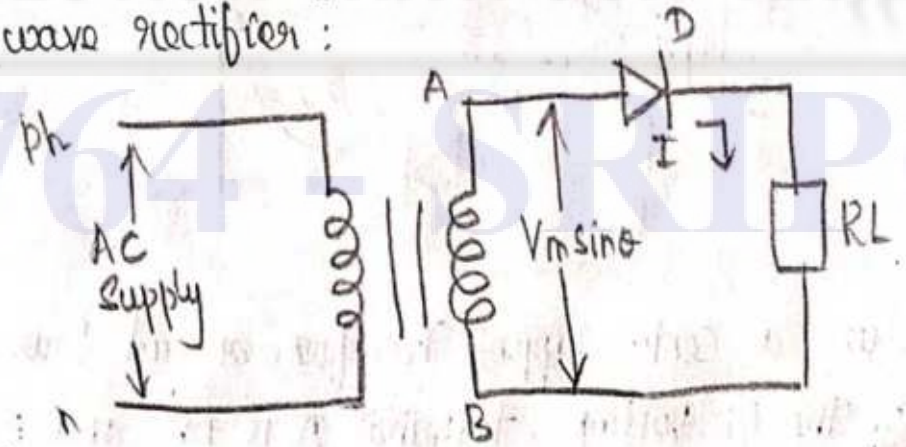
* There are three types: L→ Half wave rectifier
  L→ Full wave rectifier
  L→ Bridge rectifier

Need for rectification:

* Most of the electrical power is generated as AC power But for the operation of the most electronic devices Dc power is required
* Hence it is necessary to convert ac power into Dc power. This process is called Rectification.
* Ac flow is both direction, but dc flow only in one direction.

Circuit diagram, Operation, i/p and o/p waveform of Half wave, Full wave and Bridge rectifier:

Half wave rectifier:



Operation:

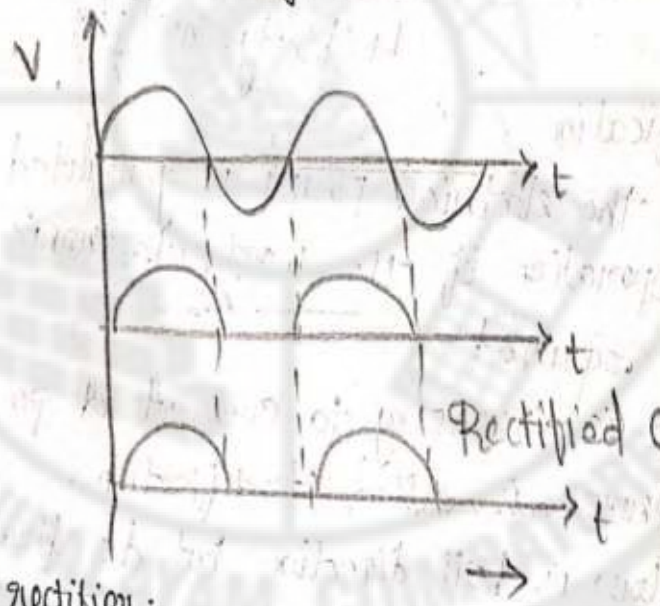
* During positive half cycle of I/p is positive with r to terminal B.
* Diode Conducts in forward Bias, So the current

flows from A to B, hence I/p voltage is fully dropped across R_L.

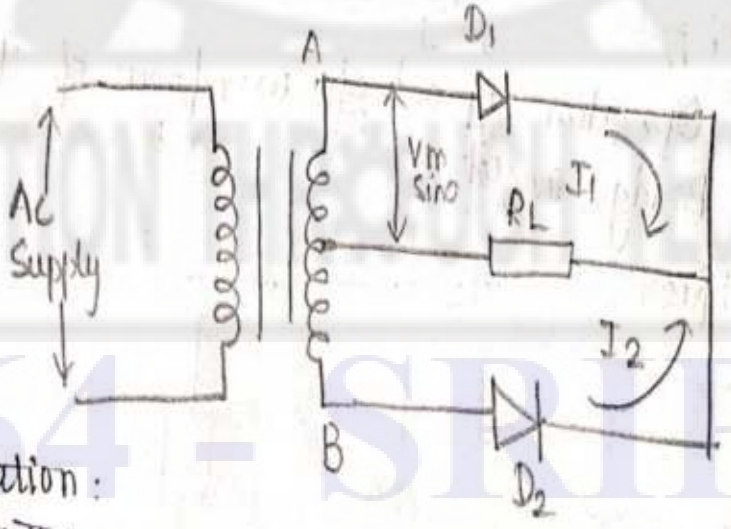
* During negative half cycle of I/p, is positive with terminal A.

* In this, o/p contains only the positive half cycle, a called halfwave rectifier

* Peak Inverse Voltage = Vm



Full wave rectifier:



Operation:

* This uses a center tapped Transformer and During +ve half cycle of the i/p voltage, terminal A is +ve and B is -ve

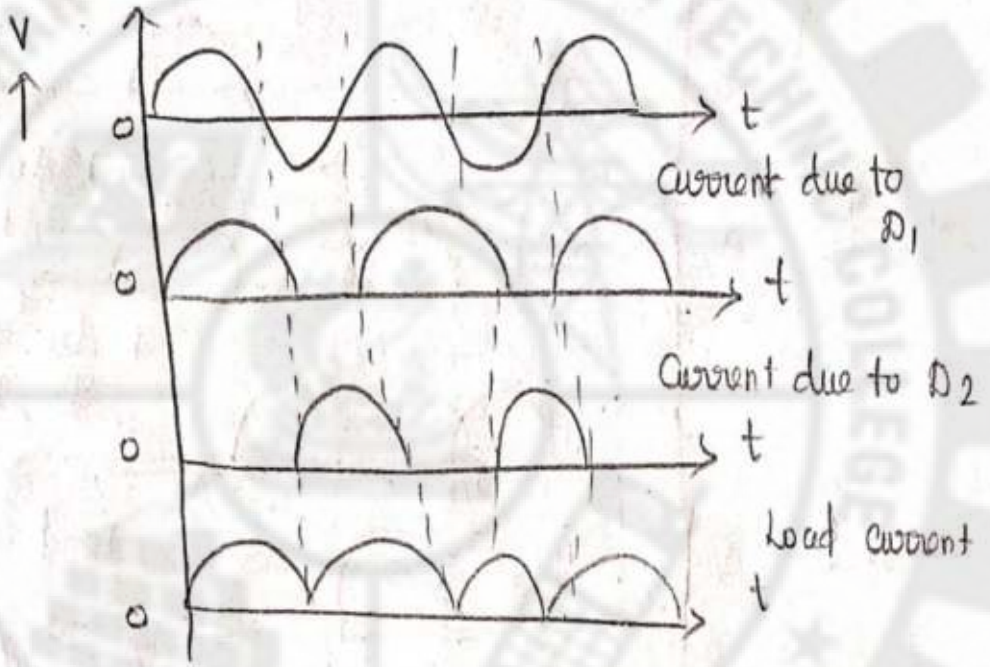
* Now D1 conducts in forward Bias and D2 is reverse bias.

* So current I_1 flows from A to load.

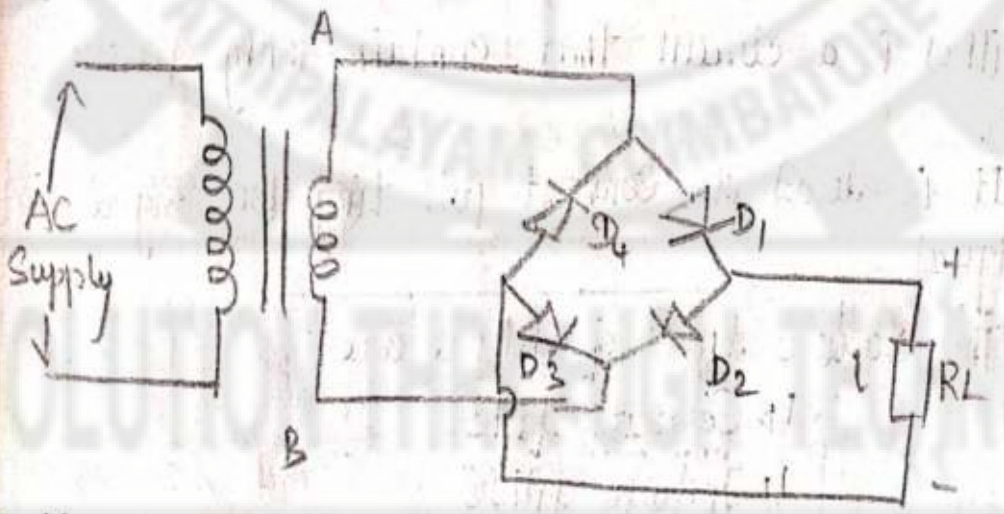
* During -ve half, Terminal B is +ve and A is

and the D_2 conducts in forward bias and diode D_1 conducts in reverse bias.

* Current flows from terminal B to load through D_2



Bridge Rectifier:



Operation:

* During positive half cycle, terminal A is positive with respect to B, the current flows through D_1 and R_L and D_3.

$D_1, D_3 \rightarrow$ Conducting

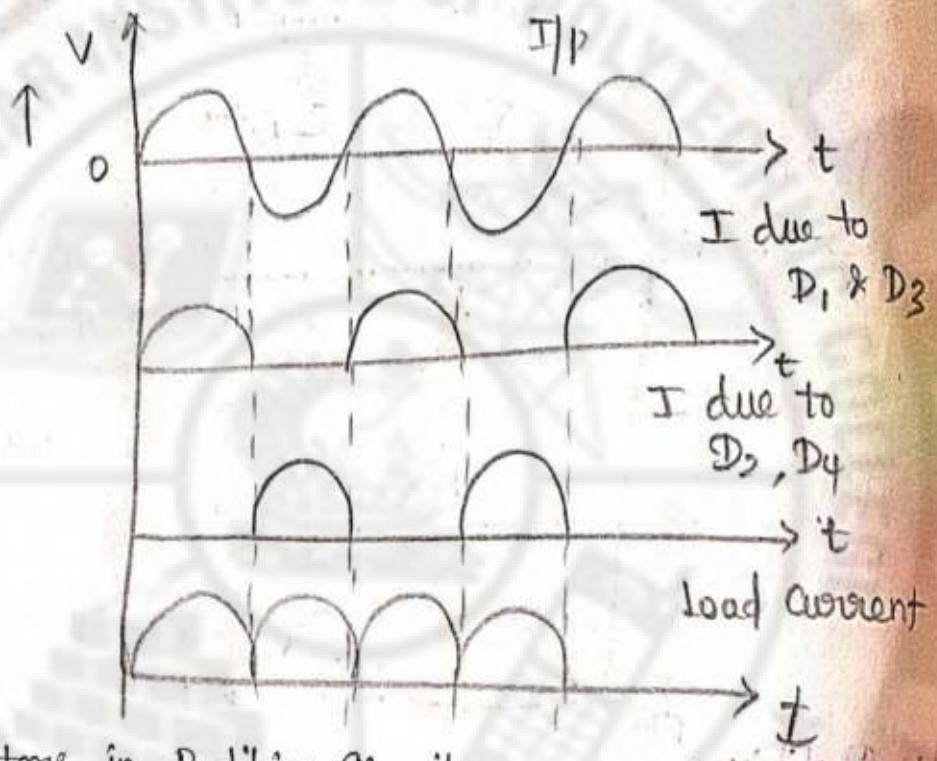
$D_2, D_4 \rightarrow$ non Conducting.

* During negative half cycle of the terminal B with respect to A, Current flows through D_2, R_L and D_4

$D_2, D_4 \rightarrow$ Conducting

$D_3, D_3 \rightarrow$ non Conducting.

* During Both half cycles, the current flows through RL. and PIV = Vm.



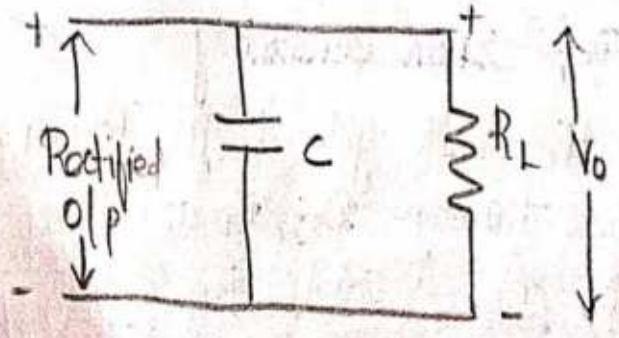
Uses of filters in Rectifier Circuits:

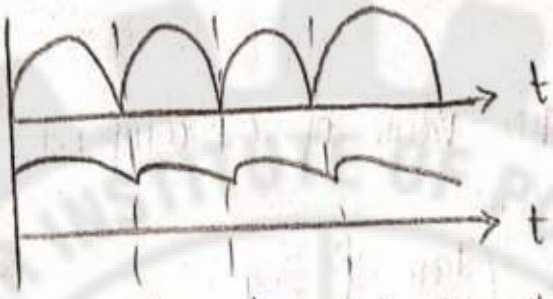
* Filter is a circuit that contains only passive components.

* It is used to convert pulsating DC signal into a steady signal.

* The various types of filters are
  - Capacitor filter
  - Inductor filter
  - LC filter
  - π filter
  - RC filter

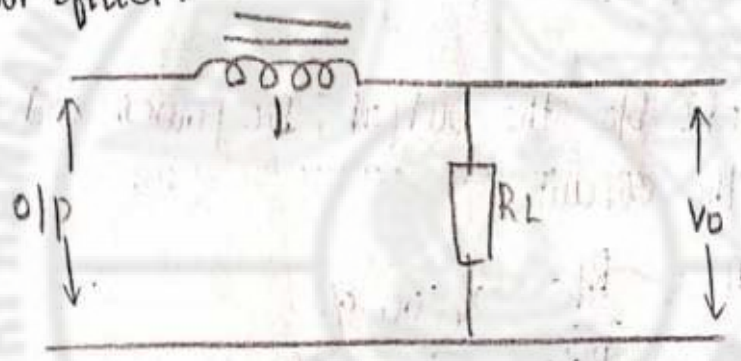
Capacitor filter

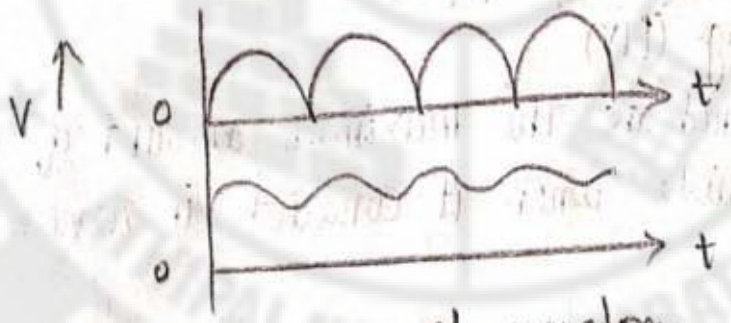




waveform of Capacitor filter

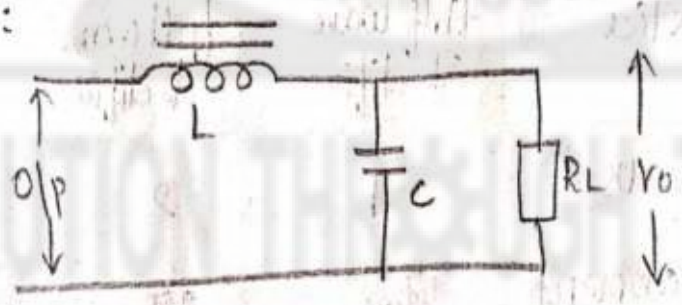
Inductor filter :

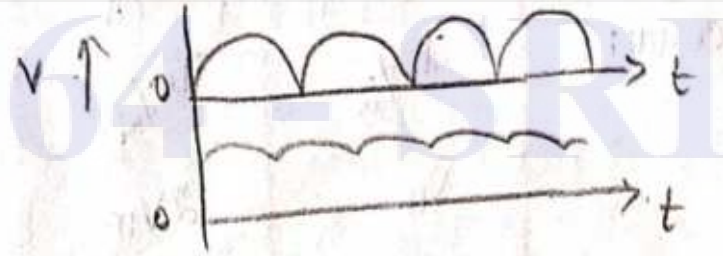




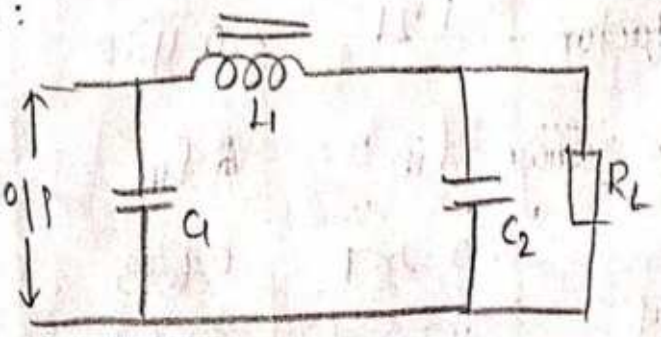
o/p waveform

LC filter :





Pi filter :



Ripple factor:

* Ratio between RMS value of AC component and Dc component in Ripple o/p

$$\gamma = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

Efficiency:

* Defined as ratio b/w the output, Dc power and I/p Ac Power supplied to the circuit

$$\eta = \frac{P_{dc}}{P_{ac}} \times 100\ \%$$

Peak Inverse Voltage (PIV)

* It is defined as the maximum amount of voltage drop across the diode when it conducts in reverse biasing

Comparison:

S.No	Characteristics	Half wave Rectifier	Full wave Rectifier	Bridge Rectifier
1	Diodes used	1	2	4
2	Dc o/p current	I_m/π	$2I_m/\pi$	$2I_m/\pi$
3	RMS current	$I_m/2$	$I_m/\sqrt{2}$	$I_m/2$
4	PIV	V_m	$2V_m$	V_m
5	Ripple factor	1.21	0.482	0.482
6	Ripple frequency	f_{in}	$2f_{in}$	$2f_{in}$
7	TUF	0.287	0.693	0.812
8	Efficiency	40.8%	81.6%	81.6%

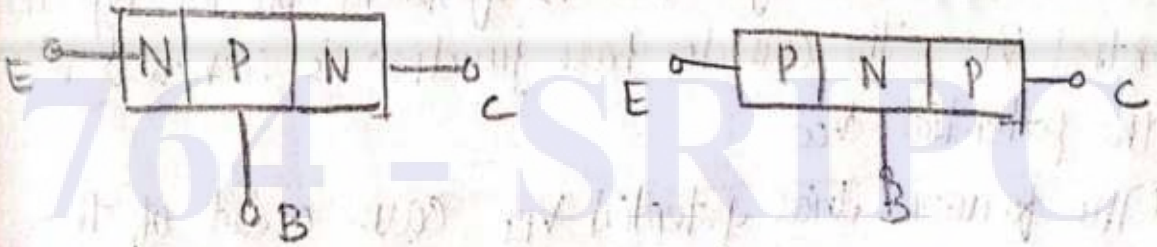
Bipolar Junction Transistor:

Definition:

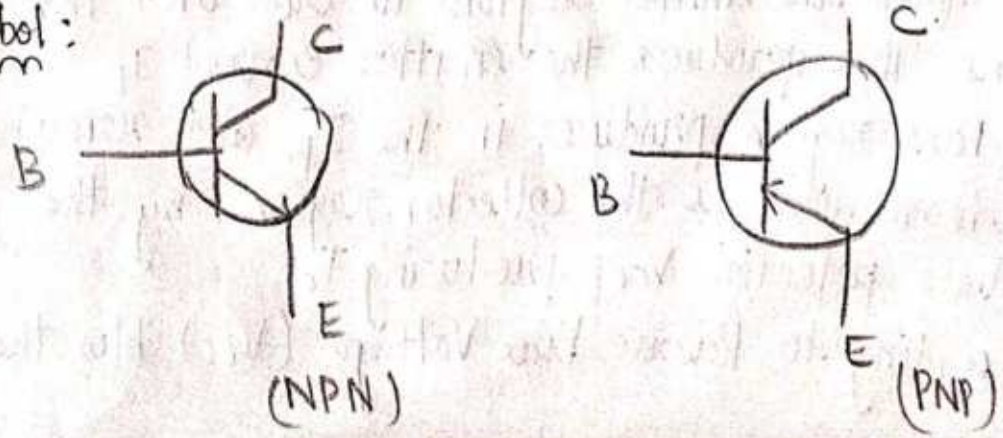
* Transistor is a three terminal Semiconductor device containing three layers and two junctions.
* It has two types: NPN and PNP
* It has three Configuration: Common Base
  Common Collector
  Common Emitter

Principle of NPN and PNP transistor:

* In NPN, a thin layer of P-type is sandwidched b/w two N type layers.
* In PNP transistor, a thin layer of N-type is Sandwidched b/w two P-type layers.
* Usually the Emitter base jn is forward bias and Collector base junction is reverse biased.
* Emitter → heavily doped
* Base → lightly doped
* Collector → moderately doped.



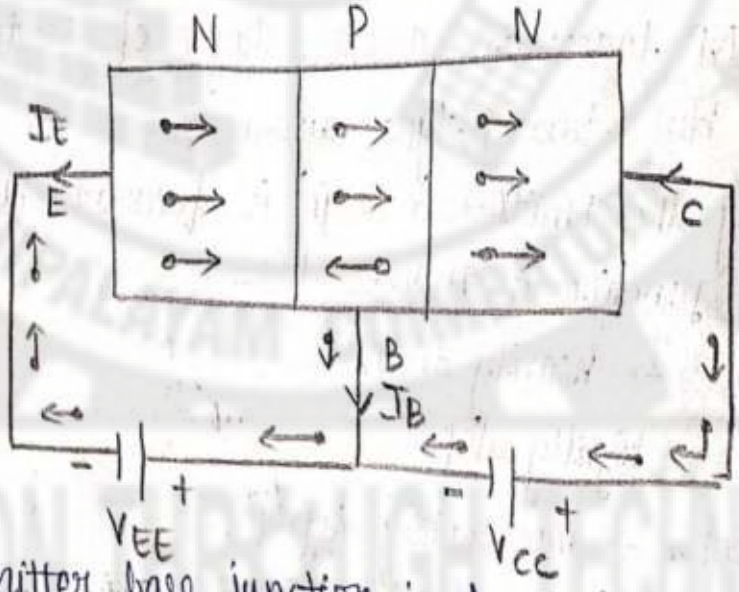
Symbol:



Transistor Terminals :

* There are Three terminals
  - Collector
  - Base
  - Emitter
* Collector → Collects majority carriers from emitter
* Base → Passes the charge carriers from emitter to the collector
* Emitter → emits large no. of carriers.

Operating principle (NPN transistor)



* The emitter base junction is forward biased by the Potential VEE. The collector base junction is reversed biased by the potential Vcc.
* The forward bias potential VEE, cause a lot of the electrons from the emitter region to cross over the base regions. This produces the emitter current I_E
* The base region produces in the I_B and remaining electron, move towards the collector region, by the Collector base potential Vcc producing I_C

According to Reverse Bias Voltage (Vcc) b/w the

collector and base, a small reverse current flows through the region.

*There are three region : ↳ Active region
↳ Cutt off region
↳ Saturation region.

Configuration of Transistor :

* There are three configuration and they are :
  - ↳ Common Emitter
  - ↳ Common Base
  - ↳ Common Collector

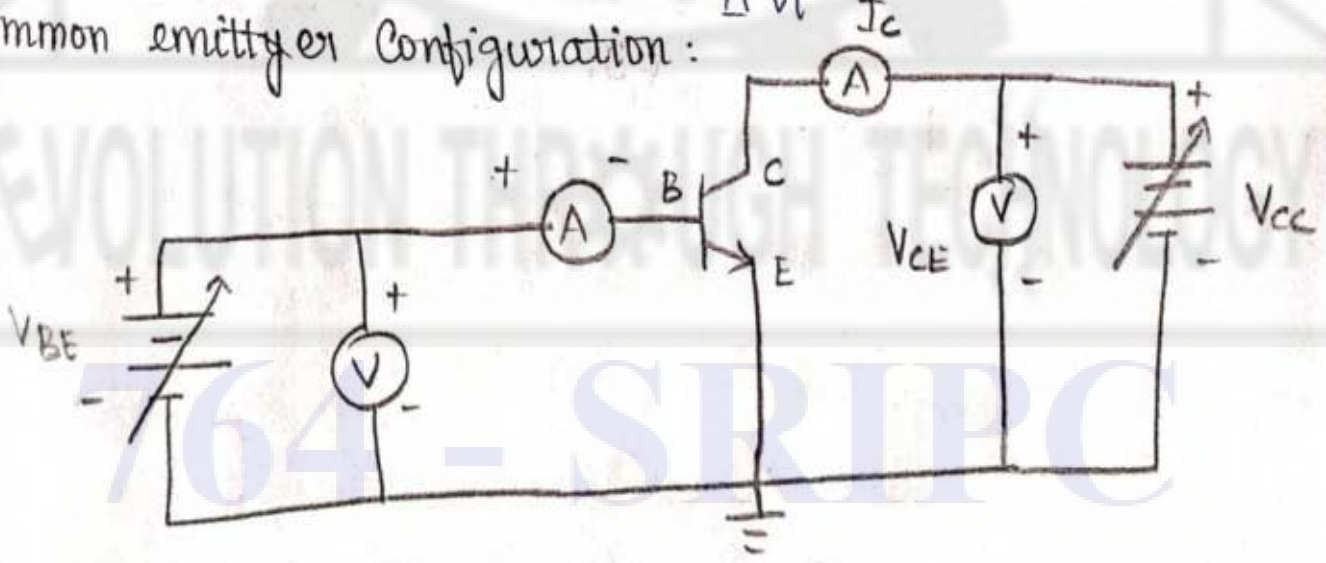
* To determine the input characteristics, the i/p V vs i/p I will be taken with a constant variation of o/p voltage

From the characteristics

Input Impedance = $\frac{\Delta V_i}{\Delta I_i}$ at Constant V_o

Output Impedance = $\frac{\Delta V_o}{\Delta V_i}$ at Constant I_i

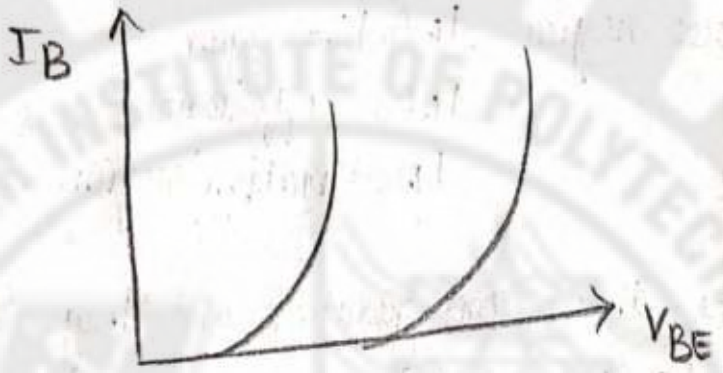
Common emitter Configuration :



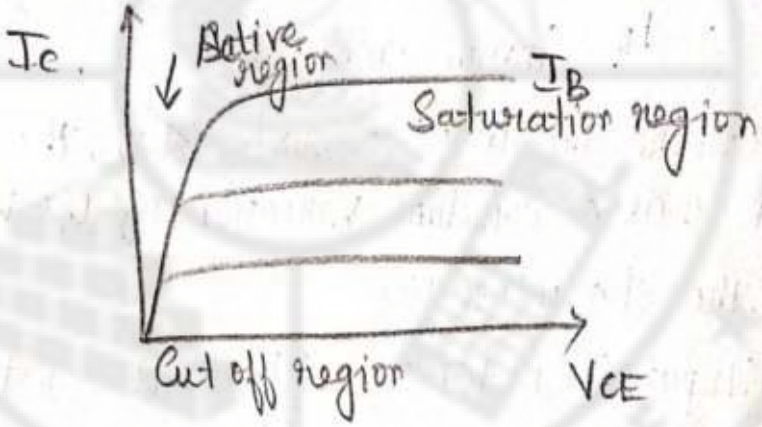
Input Impedance ⇒ $Z_i = \frac{\Delta V_{BE}}{\Delta I_B}$

Output Impedance ⇒ $Z_o = \frac{\Delta V_{CE}}{\Delta I_{CE}}$

Input Characteristics.



Output characteristics.



UNIT-IV Boolean algebra, Logic gates and Combinational System

Number Representation :

* The number system are of four types and they are
  - Decimal Number System
  - Binary Number System
  - Octal Number System
  - Hexadecimal Number System

Decimal Number System :

* The decimal number has 10 numbers
* Numbers are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
* Base → 10

Example : $(25)_{10}$

Binary Number System :

* The Binary number has 2 digits
* Digits : 0 and 1
* These digits are called Bits
* Used in Digital Computers and System
* Base → 2

Example : $(011)_2$

Octal Number System :

* The octal number has 8 number
* The eight digits are 0, 1, 2, 3, 4, 5, 6, 7
* Base → 8

Example : $(432)_8$

Hexadecimal Number System :

* The hexa decimal number system has Base 16
* The digits are : 0 - 9, and A, B, C, D, E, F

* This is commonly used in Microprocessor applications

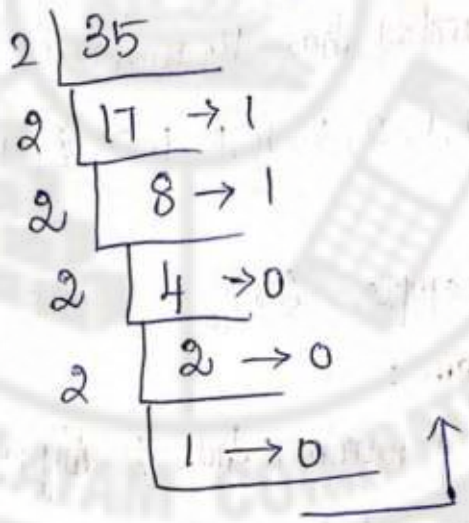
Example : $(DT)_{16}$

Conversion of Number from One to another System

Decimal to other Number System :

① Decimal to Binary :

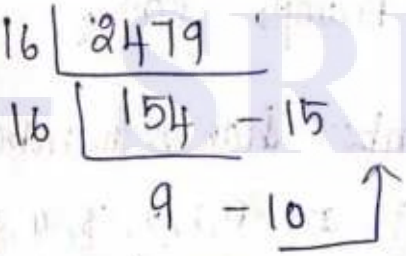
Convert 35 to Binary



$(35)_{10} = (100011)_2$

② Decimal to Hexa decimal :

Convert $(2479)_{10}$ to Hexadecimal



$(2479)_{10} = (9AF)_{16}$

③ Decimal to octal :

Convert 265_{10} to Octal

8 | 265
8 | 33 - 1
4 - 1

$(265)_{10} = (411)_8$

Binary to other number system:

① Binary to Decimal

Convert $(111011)_2$ to decimal

1 1 1 0 1 1

$1 \times 2^0 = 1$
$1 \times 2^1 = 2$
$0 \times 2^2 = 0$
$1 \times 2^3 = 8$
$1 \times 2^4 = 16$
$1 \times 2^5 = 32$

$(59)_{10}$

$(111011)_2 = (59)_{10}$

② Binary to Hexadecimal:

Convert $(111111100000)_2$ to Hexadecimal

1111 1110 0000
F E 0

$(111111100000)_2 = (FE0)_{16}$

③ Binary to octal:

Convert $(10101111)_2$ to octal

010 101 111
2 5 7

$(10101111)_2 = (257)_8$

Octal to other number systems:

① Octal to Binary:

$(3574)_8$ to Binary

3	5	7	4
011	101	111	100

$(3574)_8 = (011101111100)_2$

② Octal to Decimal:

$(216)_8$ to decimal

2 1 6

$6 \times 8^0 = 6$

$1 \times 8^1 = 8$

$2 \times 8^2 = 128$

142

$(216)_8 = (142)_{10}$

③ Octal to Hexadecimal:

$(327)_8$ to Hexadecimal

3	2	7
011	010	111
0000	1101	0111

$(327)_8 = (D7)_{16}$

Hexadecimal to other number systems:

① Hexadecimal to Binary:

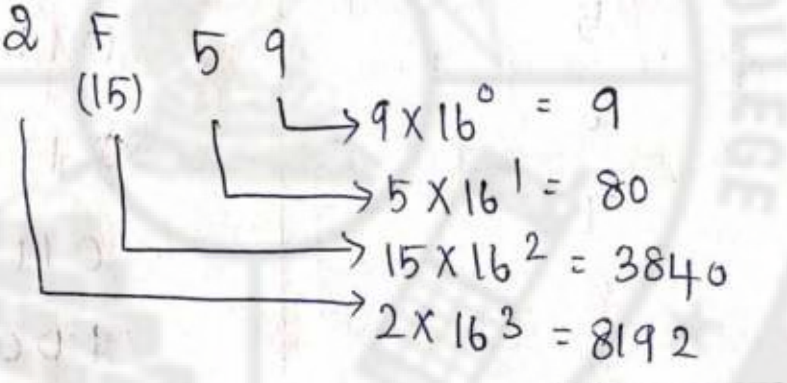
Convert $9AF_{16}$ to Binary

9 A F
↓ ↓ ↓
1001 1010 1111

$(9AF)_{16} = (100110101111)_2$

) Hexadecimal to Decimal

$(2F59)_{16}$ to Decimal



$(2F59)_{16} = (12121)_{10}$

) Hexadecimal to octal:

$(A246)_{16}$ to octal

A 2 4 6
1010 0010 0100 0110

001 010 001 001 000 110
1 2 1 1 0 6

$(A246)_{16} = (121106)_8$

D Code:

* BCD code Stands for Binary Coded Decimal.
* It uses Binary number System to specify the imal number 0 to 9.
* It is also called 8421 Code.

Decimal digit	BCD code
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1

ASCII Codes :

* ASCII → American Standard Code for Information Interchange

* It is a 7 bit Code

* Used to Represent numbers, letters, characters and other special computer control functions.

* They include

Alphabets (Upper case / Lower case) = 52

Decimal digits (0-9) = 10

Symbols = 33

Control characters = 33

128

Parity Bit:

* The digit as information is always in Binary form
* If it is transmitted from one digital System to another System, error may occur.
* To find these errors parity bit (0 or 1) is usually transmitted along with original data.
* Two types : ↳ Odd parity
  ↳ Even parity.

Uses of parity Bit:

* A parity Bit is used to detect errors during the transmission of Binary information
* The message including the parity bit is transmitted and then checked at the receiving end for errors
* The circuit that generates parity bit is called the Parity generator.

Odd parity Bit:

* In this, extra Bit of left Side is added to make whole number as odd number.

Eg: 1101100 is added with 1

Now 11101100 becomes odd number

Even parity Bit:

* In the even parity, extra Bit is added to make whole number as even number

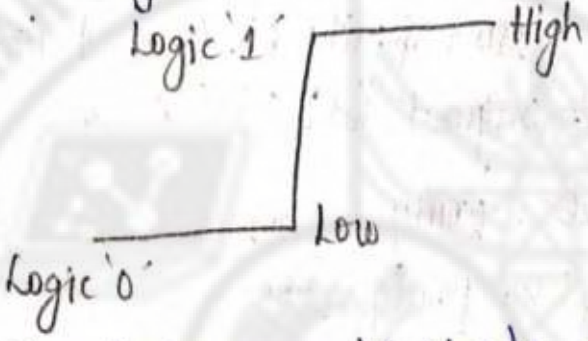
Eg: 1010100 → 11010100 (Becomes even)

* Totally 8 bit is present in the above example, this is called even parity number.

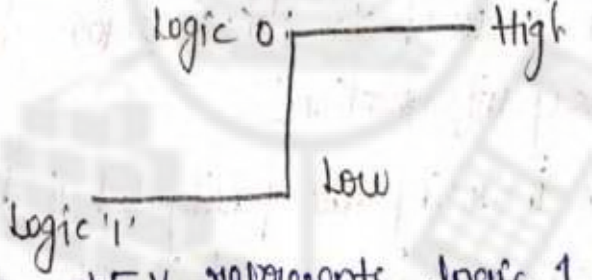
Logic gates:

Positive and Negative Logic System:

* Positive logic means '1' stands for High and 0 is Low.



* Negative logic means '1' stands for Low and 0 is High.



* In this, +5V represents logic 1 and 0V represents logic '0' in positive logic System.

Defnition, Truthtable, Symbol and logical equations of AND, OR, NOT, EXOR - EXNOR gates:

AND:

* This gate has two or more i/p Signals and only o/p Signal.

* Operation: Multiplication.

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

OR:

* It has two or more i/p signals and only one o/p signals

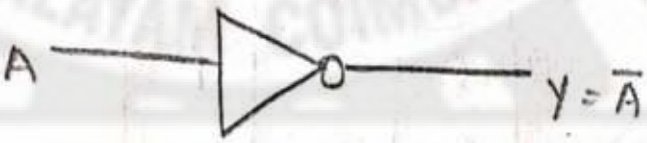
* Operation: Addition.

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

NOT:

* This has only one i/p and one o/p.

* Operation: Complement



A	$\overline{A}$
0	1
1	0

EX-OR:

* Exclusive OR has two or more i/ps and produces one o/p.

* o/p $\Rightarrow \overline{A}B + A\overline{B} = A \oplus B$

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

EX-NOR:

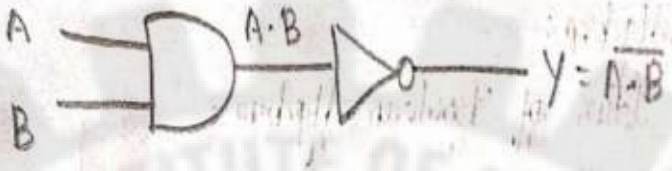
* Exclusive NOR has two or more i/ps and Produces only one o/p.
* It is complement of EX-OR.
* o/p = $\overline{A \oplus B}$

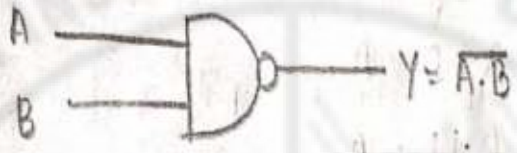
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Universal gates:

NAND:

* NAND gate is the Complement gate of AND gate
* NOT gate followed by an AND gate forms a NAND gate.
* NAND gates contains two or more i/ps and only o/p signal.
* output is $\overline{A \cdot B}$

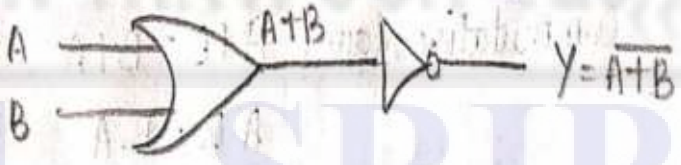


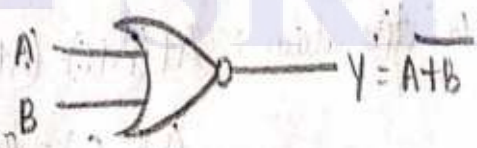


A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

NOR -

* NOR gate is the Complement of OR gate
* It is followed by OR gates and NOT gates.
* It is the Combination of OR and NOT gates
* It Contains two (or) more i/p Signals and only one o/p Signal.
* Output = $\overline{A+B}$





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

Boolean Algebra:

Basic laws of Boolean Algebra:

Postulates:

$$A + 0 = A$$

$$A + 1 = A$$

$$A + \bar{A} = 1$$

$$A \cdot 0 = 0$$

$$A \cdot 1 = A$$

$$A \cdot \bar{A} = 0$$

Theorems:

$$A + A = A$$

$$A \cdot A = A$$

$$A(\bar{A} + B) = AB$$

$$A + AB = A$$

$$A + \bar{A}B = A + B$$

Laws:

Commutative law: $A + B = B + A$

$$A \cdot B = B \cdot A$$

Associative law: $A + (B + C) = (A + B) + C$

$$A \cdot (B \cdot C) = (A \cdot B) \cdot C$$

Distributive law: $A \cdot (B + C) = A \cdot B + A \cdot C$

$$(A + B) \cdot (C + D) = A \cdot C + B \cdot C + A \cdot D + B \cdot D$$

Demorgan's Theorem and Proofs.

↳ First law:

*The Complement of Sum of the variables is equal to the product of their complements.

$$\overline{A+B} = \overline{A} \cdot \overline{B}$$

A	B	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0	0	1	1	1	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	0

Thus, $\overline{A+B} = \overline{A} \cdot \overline{B}$

↳ Second law:

*The Complement of product of the variables is equal to the Sum of their components.

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

A	B	$\overline{A \cdot B}$	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
0	0	1	1	1	1
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	0	0	0

Thus, $\overline{A \cdot B} = \overline{A} + \overline{B}$

Duality Theorum:

Duality theorum is one of the elegant theorums proved in advanced mathematics.

It says that starting with boolean relation, we can drive another boolean relation by.

Some Boolean relation along with dual relation are given below.

Boolean relation	Duality relation
$A+0=A$	$A\cdot 1=A$
$A+1=1$	$A\cdot 0=0$
$A+A=A$	$A\cdot A=A$
$A+\bar{A}=1$	$A\cdot\bar{A}=0$

Simplification of logical equations using Boolean laws:

Eg: $Y = AB\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}BC\bar{D} + ABC\bar{D}$

$= B\bar{C}\bar{D}(A+\bar{A}) + BC\bar{D}(A+\bar{A})$

$= B\bar{C}\bar{D} + BC\bar{D}$

$= B\bar{D}(C+\bar{C})$

$Y = B\bar{D}$

Eg: $Y = AB + A(B+C) + B(B+C)$

$= AB + AB + AC + BB + BC$

$= AB + AC + B(1+C)$

$= AB + AC + B$

$= (A+1)B + AC$

$Y = B + AC$

Eg: $Y = (A+B+C)(A+B)$

$= AA + AB + AB + BB + CA + BC$

$= A + AB + B + AC + BC$

$= A(1+B) + B(1+C) + AC$

$= A + B + AC$

$= A(1+C) + B$

$Y = A + B$

Eg: $Y = (\bar{A}+B)(A+B)$

$= \bar{A}A + \bar{A}B + AB + BB$

$= \bar{A}B + AB + B$

$= B(\bar{A}+A) + B$

$= B + B$

$Y = B$

Eg: $Y = A\bar{B}D + A\bar{B}\bar{D}$

$= A\bar{B}(D+\bar{D})$

$Y = A\bar{B}$

Thus, the logical equations has been simplified using boolean laws.

Two and three variable Karnaugh map:

Karnaugh Map:

* Founder: M. Karnaugh.

* Reason: To represent the logical expression in a pictorial manner.

* It is commonly called as K-Map

* It is the pictorial form of truth table.

* It is a systematic method for simplifying the boolean expression.

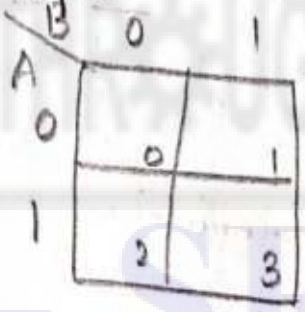
Construction of K-Map:

* n variable K map has 2^n Squares.

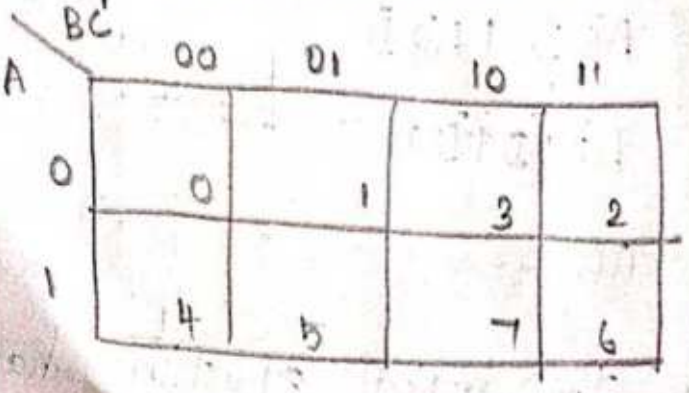
* Each i/p is allocated a Square

* 1, 0, x are used to represent the i/ps

2 Variable K-Map:

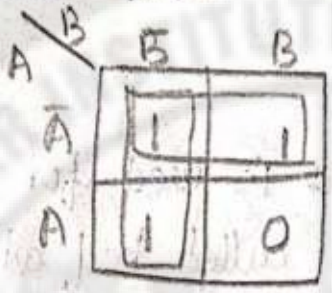


3 Variable K-Map:



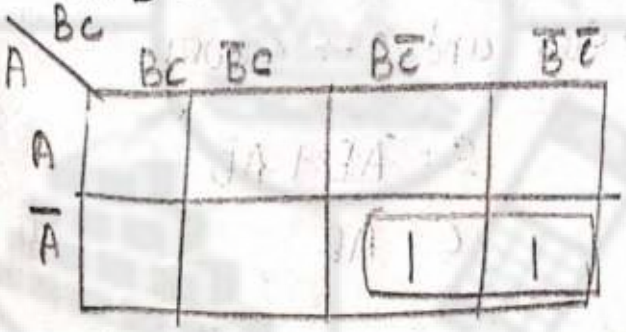
Examples:

① $Y = \bar{A}\bar{B} + \bar{A}B + AB$



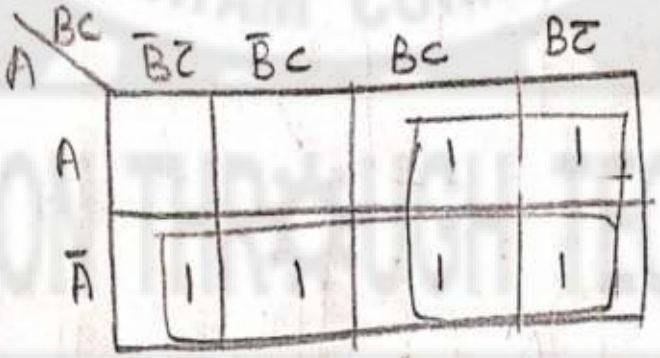
$Y = \bar{A} + \bar{B}$

② $Y = \bar{A}B\bar{C} + \bar{A}\bar{B}C$



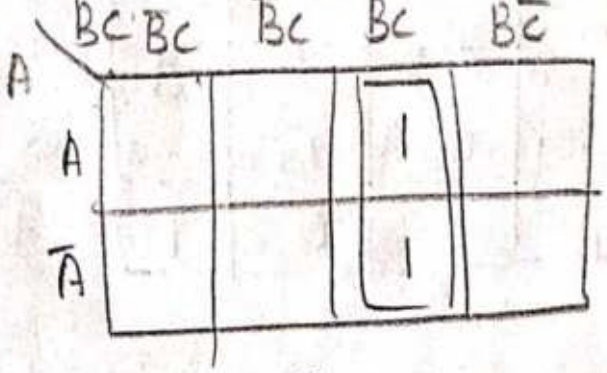
$Y = \bar{A}\bar{B}$

③ $Y = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}BC + \bar{A}BC + ABC + AB\bar{C}$



$Y = \bar{A} + B$

④ $Y = \bar{A}BC + ABC$



$Y = BC$

Arithmetic Circuits:

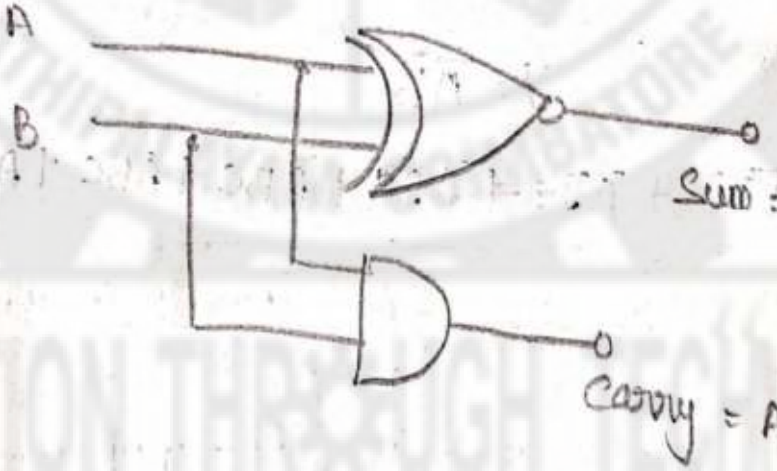
Half adder and full adder - Truth Table; Circuit diagram

Half adder:

* A logic circuit which is used for adding two single bit Binary number is called half adder.
* Two i/ps and Two o/ps are obtained.
* A, B → Two i/ps and S, C → Two o/ps
* S → Sum and C → carry.

$$S = \bar{A}B + A\bar{B}$$

$$C = AB$$



A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Full adder:

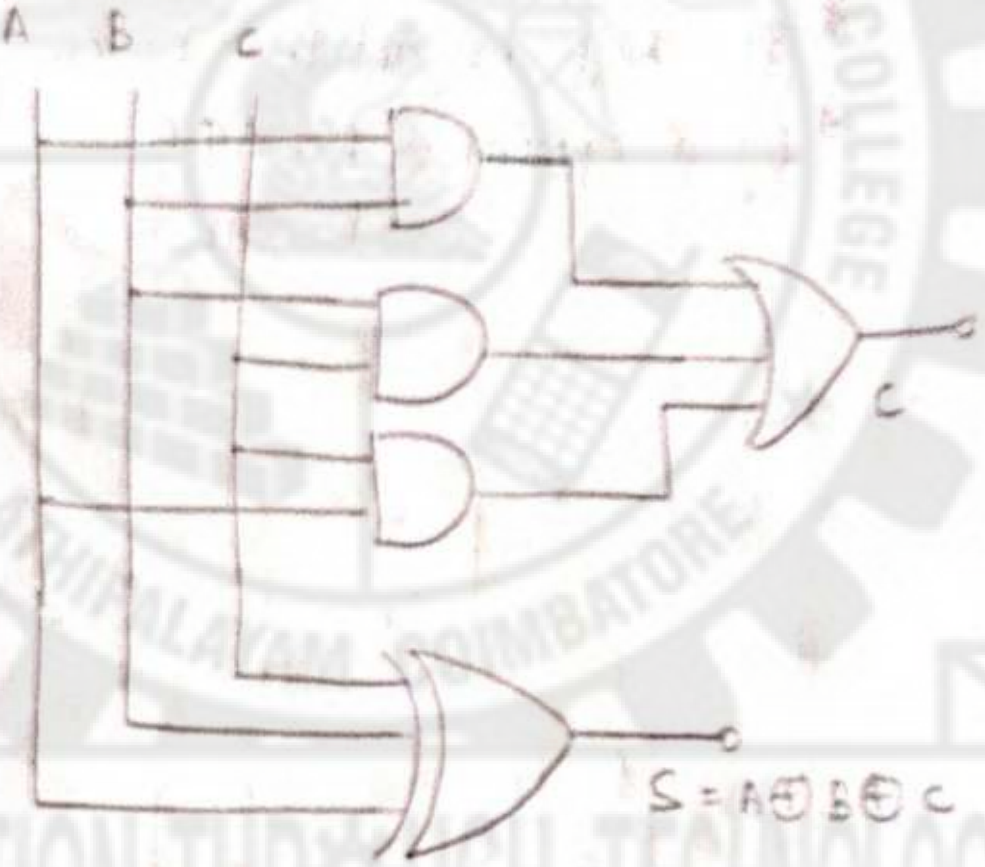
* A logic circuit that can be used for the

adding of three single bit binary numbers is called full adder.

* A, B, C are three i/ps and S and C are the o/ps

$$S = A \oplus B + C$$

$$C = AB + BC + CA$$



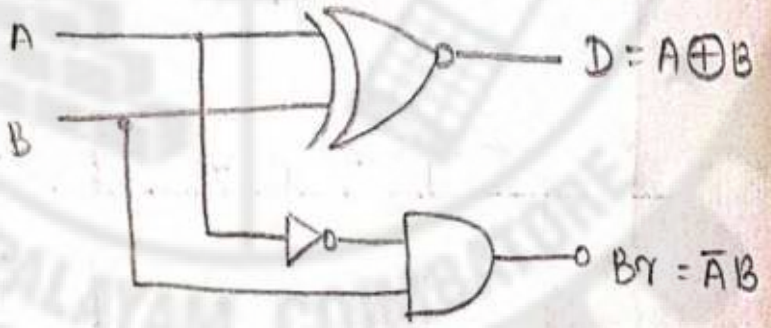
A	B	C_{in}	S	C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Half Subtractor and Full Subtractor - Truth Table, Circuit diagram:

Half Subtractor:

* A logic circuit which is used for subtract one single binary number from another is called Half Subtractor.
* Two i/ps → A, B and Two o/ps → D, Br
* D → Difference and Br → Borrow.
* Logical equation → $D = A \oplus B$

$Br = \bar{A}B$



A	B	D	Br
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Full Subtractor:

* It is a three single bit binary Subtractor used for performing multibit Subtraction.

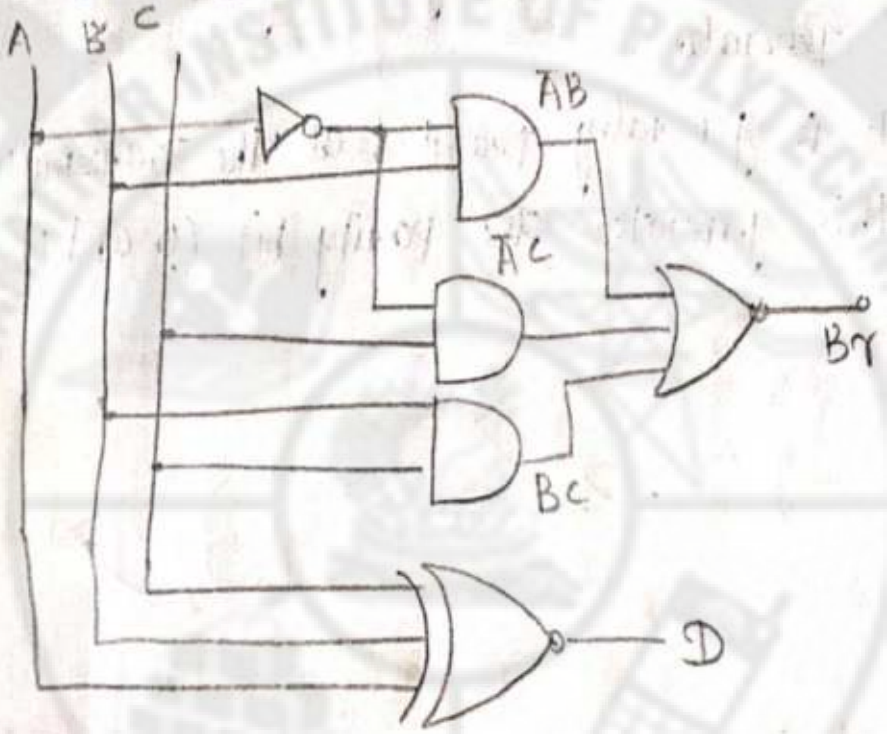
Three I/ps → A, BC and two o/ps → D and Br

Logical equation → $D = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + A$

$Br = \bar{A}BC + \bar{A}B\bar{C} + \bar{A}\bar{B}C + AB$

$D = A \oplus B \oplus C$

$B_r = \bar{A}B + \bar{A}C + BC$



A	B	C	D	Br
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Combinational Circuits:

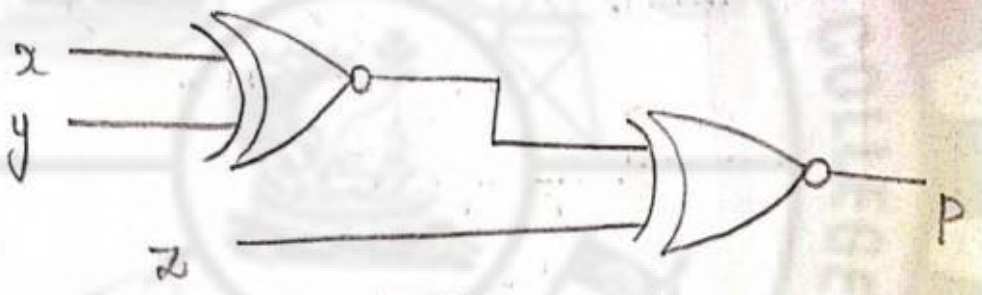
* In this circuits, the o/p depends upon present I/p
* There is no memory in the circuit.
* There is no feedback.

Parity Generator :

*The circuit used for generating parity bit is called Parity Generator.

*It is generally provided at the transmitter side.

*This generates the parity bit (0 and 1)



Parity generator

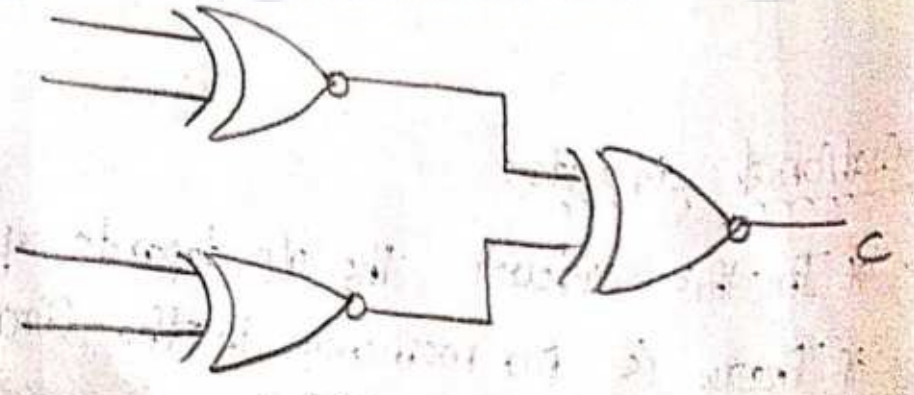
Parity checker:

* The parity checker is provided at the receiving end.

* It is used for testing the received information along with the received parity bit.

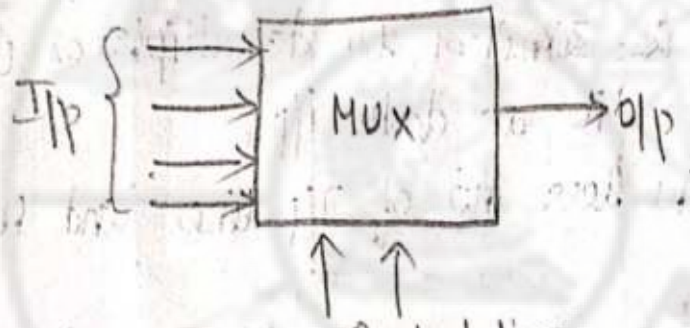
* EX-OR gate is ideal for checking the parity of given binary number.

* If the information contains even no, the EX-OR produces o/p as '0' and viceversa.



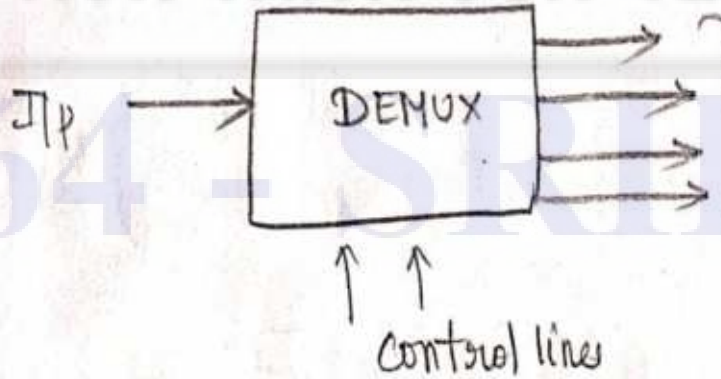
Multiplexer:

* It is also called as Data Selector (many to one)
* It is a digital circuit which contains many I/ps and only one O/p.
* Here 2^n i/ps is converted into one output.



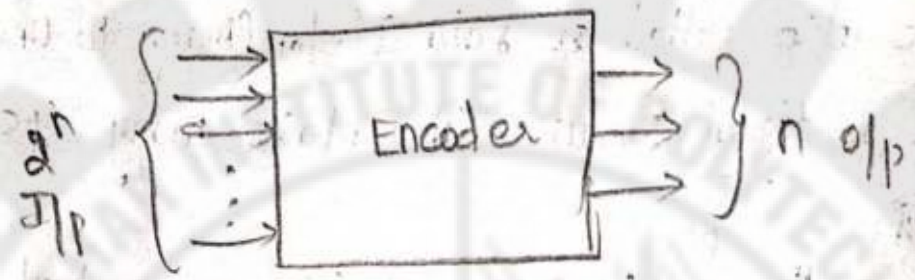
Demultiplexer:

* It is also called a Data distributor (one to many)
* It is a digital combinational circuit with one i/p
* The data is distributed to any one of the selected o/p lines.
* Here one i/p is converted into many (n) o/ps.



Encoder:

* An encoder converts an active i/p signal into a coded o/p signal.
* In encoders, the no. of o/p lines is less than the no. of i/p lines.

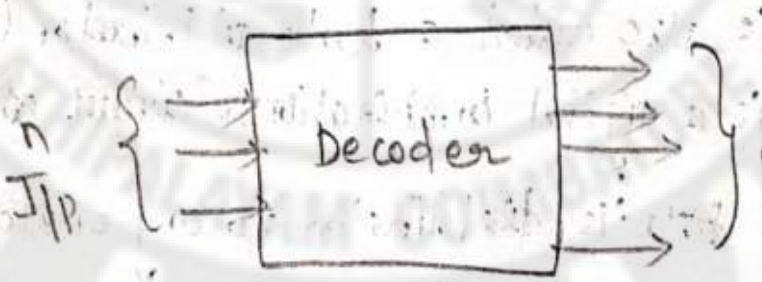


Decoder:

A decoder is similar to demultiplexer with one exception that there is an data i/p.

It contains less no. of I/p lines and more no of o/p lines.

Here n i/ps is converted into 2^n o/p.



UNIT-V Sequential Logic System

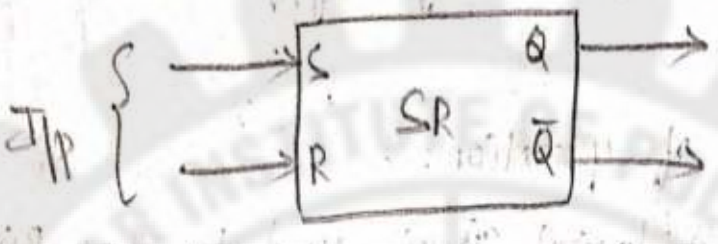
Flip flops:

Basic principle of operation:

* It is a logical circuit used to store Binary Bit (0 or 1)
* Also called Bi-stable Storage element
* It is used in Constructing memory registers, Counters, Shift registers etc.,
* Types: ↳ SR flip flop
  ↳ JK flip flop
  ↳ D flip flop
  ↳ T flip flop
* The output States of flipflop are of four types and it is denoted by Q and $\bar{Q}$
* Outputs are always Complementary
* States of output: ↳ Set
  ↳ Reset
  ↳ No change
  ↳ Toggle

SR flipflop:

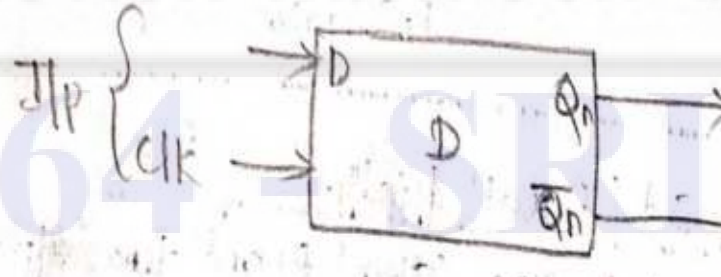
* It is a Set / Reset flipflop
* It contains two i/ps (S and R) and two o/ps (Q and $\bar{Q}$)
* Construction is done Using NAND gate and NOR gate
* Working: No change Condition $S=R=0, Q_n=0$
  Reset Condition, $S=0, R=1, Q_n=0$
  Set Condition $S=1, R=0, Q_n=1$
  Forbidden Condition $S=R=1, Q_n=X$



S	R	Q	$\bar{Q}$
0	0	Q_{n-1}	$\bar{Q}_{n-1}$
1	0	1	0
0	1	0	1
1	1	Forbidden.	

D flipflop:

* This is the modified version of SR flipflop
* This is called as Delay Flipflop (or) Data flipflop
* It contains only two i/ps (D and CLK) and two o/ps
* Operation: Reset → D=0, $Q_n = 0$
  Re Set → D=1, $Q_n = 1$



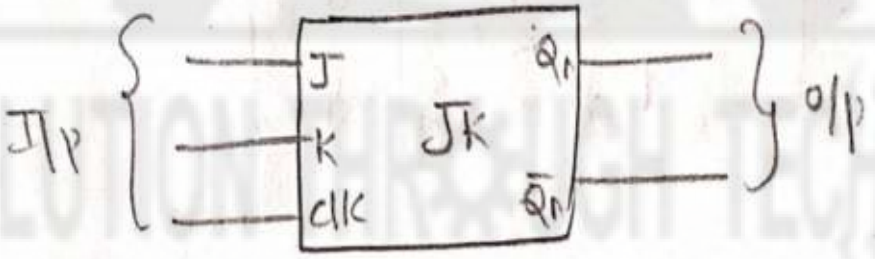
D	Q_n	$\bar{Q}_n$
1	1	0
0	0	1

Race Condition:

* In high-level triggered JK flipflop, when $J=K=Clk=1$ the o/p will toggle continuously, because the new o/p are feedback to the input gates immediately.
* By this action, we get continuous oscillation at its o/p during the full positive half cycle of i/p signal.
* This oscillation is called Race Condition.

JK flipflop:

* It is a Refined SR flipflop
* It has three inputs (J, K, Clk) and two outputs.
* Working: Reset $J=0, K=1, Q_n=0$
  Set $J=1, K=0, Q_n=1$
  Toggle $J=1, K=1, Q_n=1$



J	K	Q_n	$\bar{Q}_n$
0	0	Q_{n-1}	$\bar{Q}_{n-1}$
1	0	1	0
0	1	0	1
1	1	$\bar{Q}_{n-1}$	Q_{n-1}

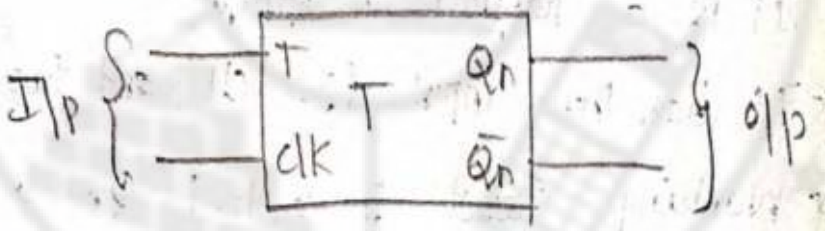
T- flipflop:

* T flipflop contains two i/ps (T and clk) and two o/ps (Qn and $\bar{Q}_n$)

* This is also called as Toggle flipflop or divide by 2 Counter.

* Working: No change T=0, $Q_n = Q_{n-1}$

Toggle T=1, $Q_n = \bar{Q}_{n-1}$

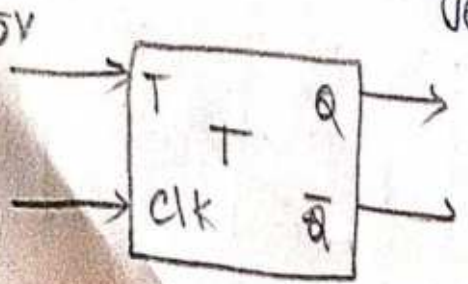


T	Q_n	$\bar{Q}_n$
0	Q_{n-1}	$\bar{Q}_{n-1}$
1	$\bar{Q}_{n-1}$	Q_{n-1}

Toggling:

* In T or JK flipflop, if the i/p is directly connected to the logic high level (+5V), The flipflop is toggled at the negative edge of each clock i/p.

* This process is called Toggling.



(T flipflop in Toggle mode)

Triggered flip flops:

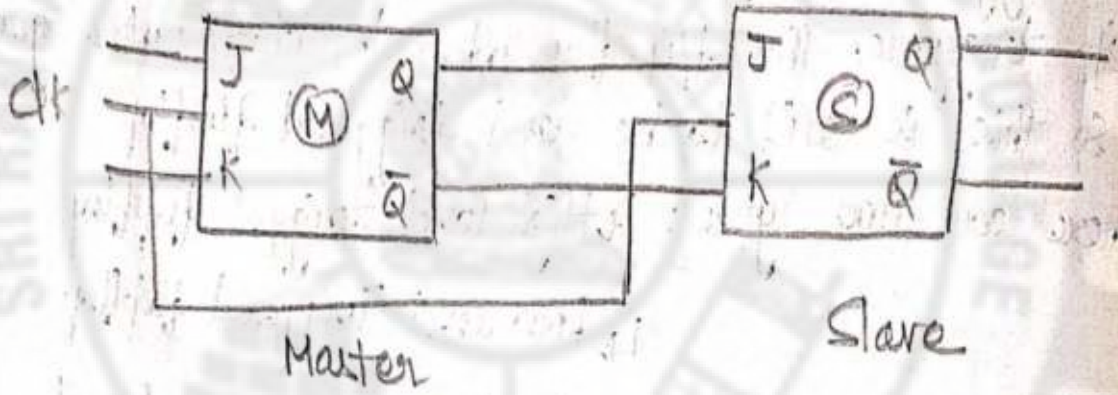
* Level Trigged Flipflop: In a clocked SR flipflop, the clock i/p triggers the flip-flop when the clock pulse goes high, so this is said to be level triggered flipflop.
  * There are two types: ↳ High level trigged flipflop
    ↳ Low level Triggered flipflop.

* Edge triggered Flipflop: The basic flipflops are level triggered because the o/ps respond to the i/p as long as the clock signal is present.
  * The flipflop which produces the original output at the falling edge of the clock pulse is called the edge triggered flip flop.
  * There are two types: positive edge triggered flipflop
    Negative edge Triggered flipflop.

JK Master Slave flipflop:

* This contains 3 i/ps and Two o/ps (Q and $\bar{Q}$)
* It is the Combination of two JK flipflops.
* One is the master and other is the Slave.
* The o/p of the master is the i/p to the Slave.

* Working: * No change
* Set
* Reset
* Toggle



J	K	Q_n	$\bar{Q}_n$
0	0	Q_{n-1}	$\bar{Q}_{n-1}$
1	0	1	0
0	1	0	1
1	1	$\bar{Q}_{n-1}$	Q_{n-1}

Counters:

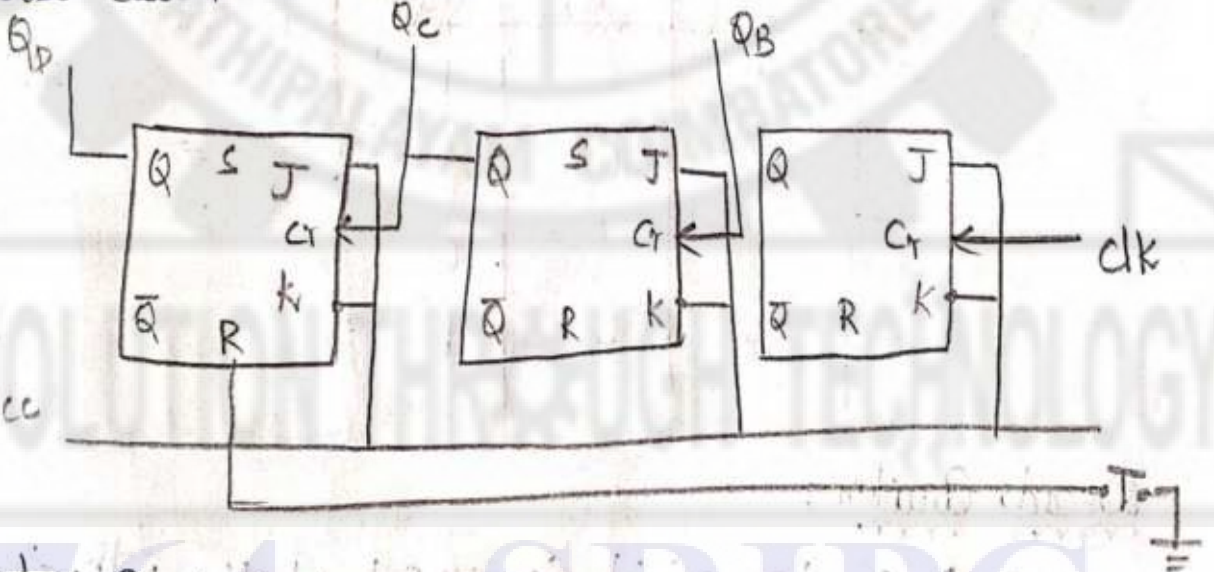
* Need for Counters:
  - Counter is one of the most powerful sub systems in a digital system.
  - A Counter is generally driven by a clock signal.
  - The counter can be used to count the number of clock pulse applied to any system.
  - The counter can also be used to measure time, period (or) frequency.

Types of Counters:

* Synchronous Counter
* Asynchronous Counter.

4-bit Asynchronous Counter:

* This is also called as Ripple Counter because it is an asynchronous sequential circuit
* It is simple and straight forward in operation
* It requires a minimum number of hardware.
* In this, each flipflop is triggered by the o/p of previous flipflop
* The flipflops operate in Serial Counter and it also called as Serial Counter.

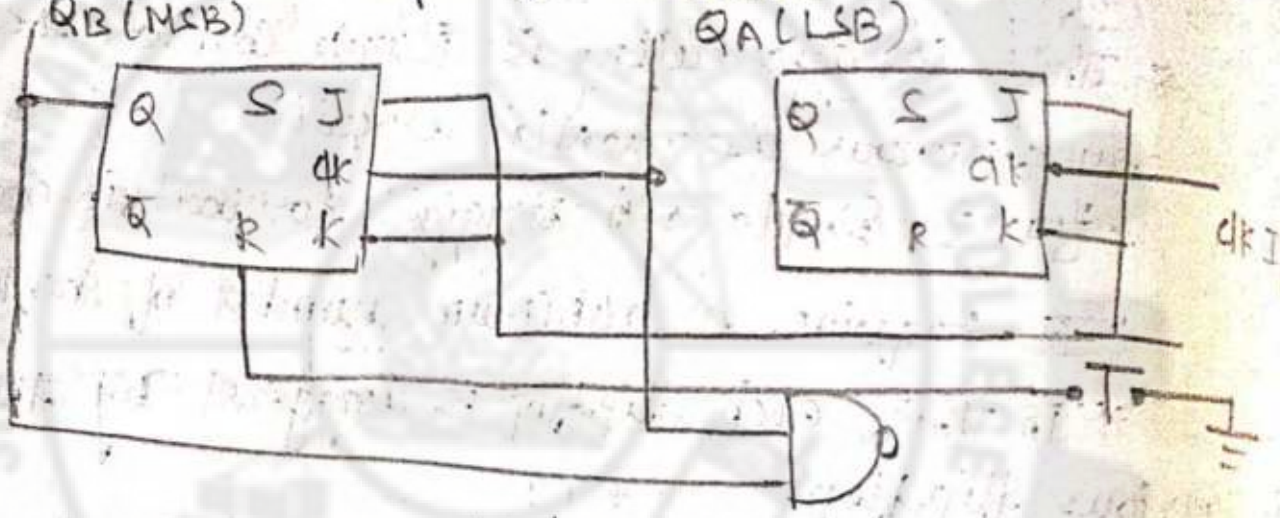


Mod N Counter:

* A Counter which is reset at the n^{th} clock pulse is called as mode n Counter
* It is also called as divide by n^{th} Counter
* Logic gates that are connected externally, make to reset the Counter at n^{th} clock pulse.
* An extra NAND gate is generally used for making divide by n Counters.

*The number of flipflops needed for this Counter depends upon the 'n' value

*A three bit Counter, counts upto 7 Similarly an n bit Counter counts upto $2^n - 1$ value.



Mod 3 Counter

CLK	Q_B	Q_A
1	0	1
2	0	0
3	1	0
4	0	1

Decade Counter :

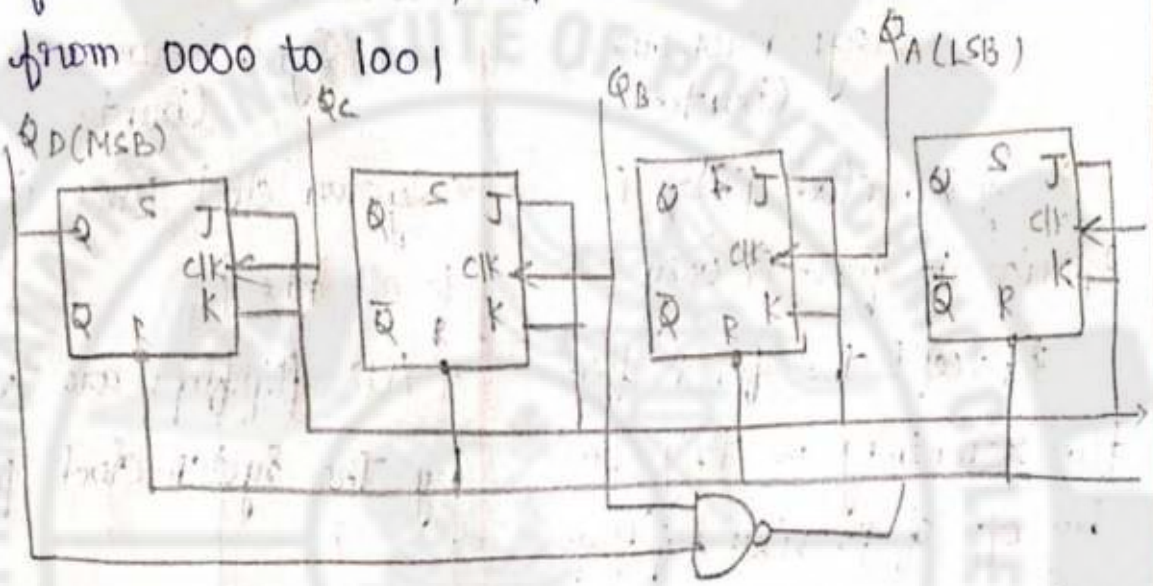
* A Counter which is reset at the 10th clock pulse is called decade Counter

* It is also called as divide by 10th Counter or BCD Counter

* This Counter is similar to a 4 bit binary Ripple Counter.

* It contains four JKMS flipflop. They are operated as T flipflops.

* A four bit ordinary binary counter counts the value from 0000 to 1111, but this counts the value only from 0000 to 1001



Decade Counter.

4 bit Synchronous Counter:

* Synchronous counter is a parallel counter. In this counter, the clock pulse is applied to all flipflops simultaneously.

* Hence all the flipflops are operated in time.

* This setting time is simply equal to the delay time of single flipflop

* The speed of operation is equal to speed of single flipflop, hence speed is high and also constant.

* It is an up counter and counts in upward direction.

* The J and K i/ps of all flipflops are connected to +Vcc such that all flipflops will toggle at the negative edge of every clock pulse.

* The triggering is done by system clock.

Difference between Synchronous and Asynchronous Counter

Asynchronous Counter	Synchronous Counter
* System clock pulse is applied to first FF only	* System clock pulse is applied to all FFs
* Except the first flip flop remaining are triggered by o/p of previous flip flop.	* All flip flops are triggered by the system clock pulse.
* The flip flop are triggered one by one	* All flip flop are triggered simultaneously.
* Propagation delay is high.	* Propagation delay is low
* Propagation delay is not uniform.	* Propagation delay is Uniform.

Applications :

* It is used for frequency divider
* Used for frequency Counter
* Used to measure the time period
* Used in digital clock.
* Used in object counter
* Used in time

Registers:

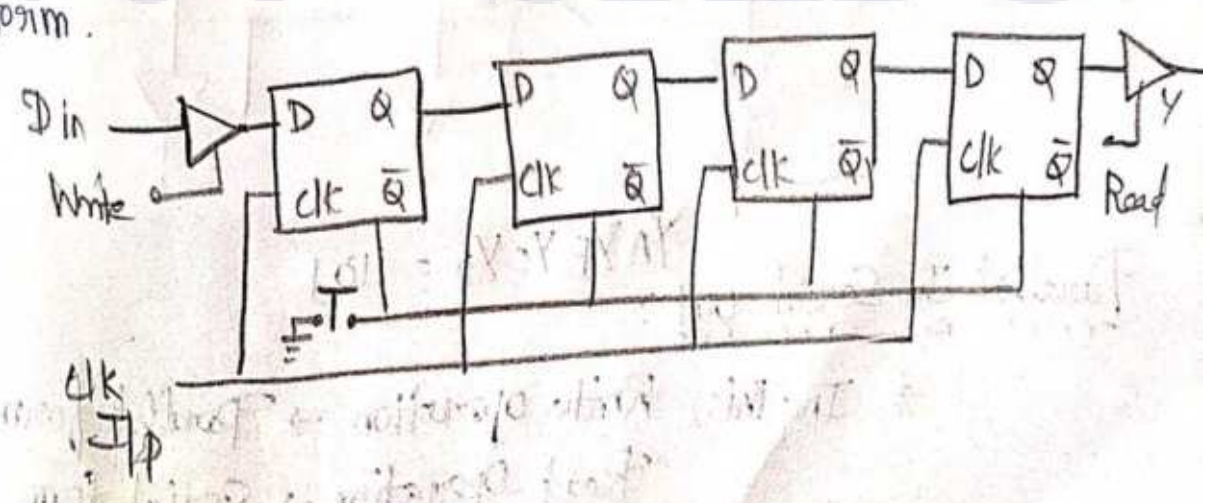
* Group of flipflops to store Binary data
* It is a temporary storage
* One flipflop can store one bit binary data and therefore N flipflop can store N bit binary data
* D flipflop are used to Construct Register.
* Operation : Read, Write

Shift Register:

* It is used for shifting the data from one flipflop to another
* There are two ways to shift data into a register and also two ways to shift the data out of the register.
* There are four types:
  - Serial in Serial out
  - Serial in Parallel out
  - Parallel in Serial out
  - Parallel in Parallel out

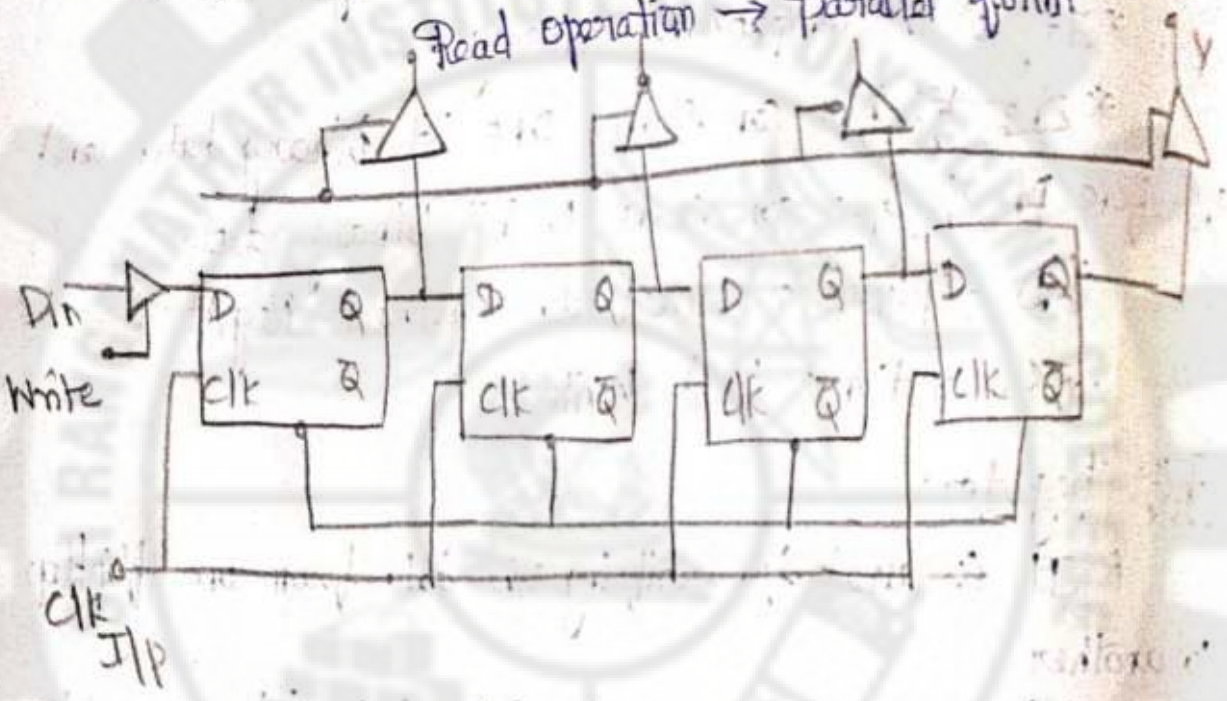
Serial in Serial Out:

* The Read and Write operations are in Serial form.



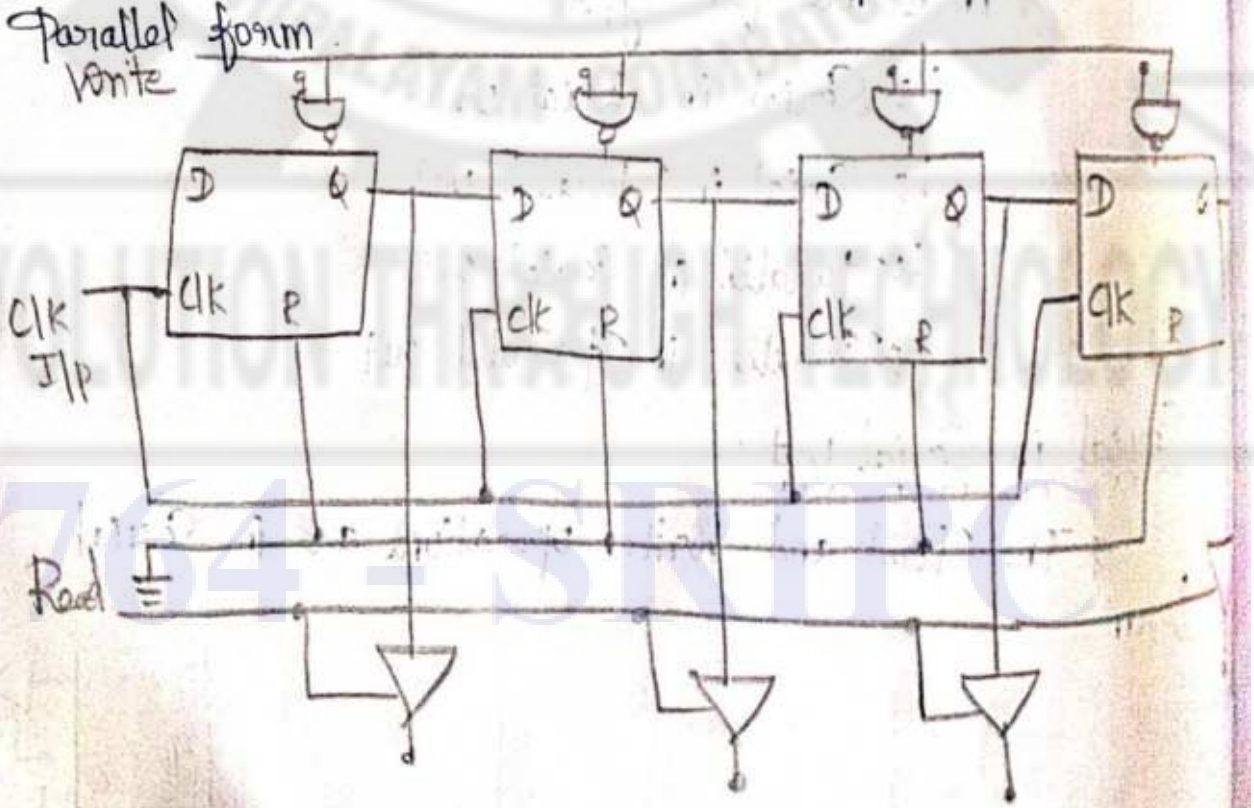
Serial in Parallel out:

* In this, Write operation → Serial form
  Read operation → Parallel form



Parallel in Parallel Out:

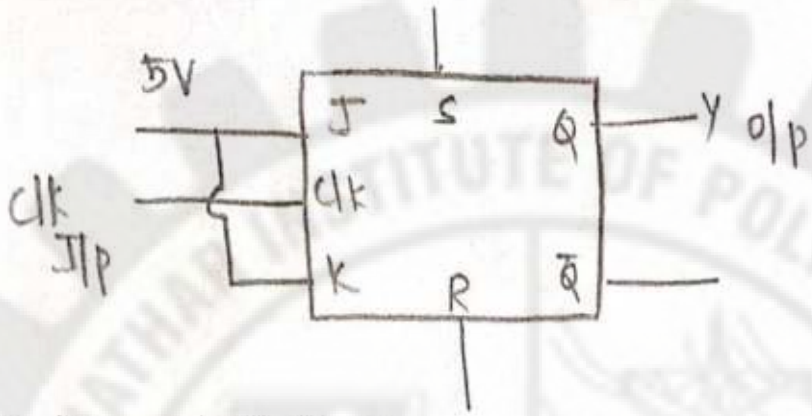
* In this, Both Read and Write operations are in Parallel form



$Y_A Y_B Y_C Y_D = 1101$

Parallel In Serial Out:

* In this, Write operation → Parallel form
  Read Operation → Serial form



Applications of Shift register:

* Used for doing arithmetic and logical operation in microprocessor
* Used to Store Binary data
* Used as data format changer
* Used for temperory data Storage and bit manipulation
* Used to introduce time delay
* Used to Convert Serial data into parallel data
* Used in Sequence generator.