FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGINEERING

Chapter 1 : Introduction

Basics of Electricity, Revision of insulators and conductors and their examples, Definition and units of voltage, current, resistance, inductance, capacitance, different voltage sources, Ohm's law, series & parallel combination of resistance.

Chapter 2 : DC network

DC network : Kirchhoff's Law, solving network problem to find current and voltage, wheatstone bridge and its problem.

Chapter 3 : Generator & motor

Faradays laws of electromagnetic induction, Flemings right hand and left hand rule

D.C Generator and motor : Construction, operating principle, Types, uses.

Chapter 4 : AC Fundamental

AC Fundamentals :

Basic terms - cycle, amplitude, time period, frequency, equation of alternating voltage and current, RMS, average value, instantaneous value, peak factor, form factor, simple problem.

Chapter 5 : AC Circuit

R-L-C series circuit, AC through resistance, capacitance, inductance and their combinations. expression for impedance reactance, current, power factor, simple problem

6. Transformer:

Transformer Construction; opering principle, types and uses.

Chapter 7: Semiconductor

Semiconductor: Definition of semiconductor, energy band diagram, intrinsic and extrinsic semiconductor, doping, P-type, N-type semiconductor, PN junction diode, forward and reverse biased, diode characteristics; application of PN Junction diode like half wave, Full-wave rectifier.

Chapter 8: Transistor

Transistor: Physical construction of bipolar PNP and NPN transistor; biasing circuit configuration.

(CE, CB, CC) Application of transistor as an amplifier
Elementary ideas of display - LED, LCD, seven segment display.

Chapter 9: House wiring

9.1 Introduction to house wiring

9.2 Methods of house wiring

9.3 Safty and precautions measure against electrical hazard.

Chapter 10: Microprocessor

1. Symbolic representation of logic gates, combinational logic, basic operation of flip-flops counters and registers.

2. Fundamental concept of microprocesson and its application in instrumentation, 8085 microprocesson and its operation.

INTRODUCTION

— Basics of Electricity —

ELECTRICITY is the of electrical power and charge.

Conductance

The ability of a substance to Conduct electricity is conductance

It is expressed as

$$G = \frac{1}{R}$$

> 2019
> The practical unit of capacitance is ______

SI unit : mho (Ω^{-1}) or Siemen (S)

Dimensional formula: $[M^{-1}L^{-2}T^{3}A^{2}]$.

Conductivity

The ability to allow electric charges or heat to pass through substance. is Conductivity

Its SI unit is mho per metre ($\Omega^{-1}m^{-1}$) or siemen per metre (S/m)

It is expressed as

$$\sigma = \frac{1}{\rho}$$

The dimensional formula: $[M^{-1}L^{-3}T^{3}A^{2}]$

Classification of Materials Terms of Conductivity

INSULATORS:

2021
The ___ offer max resistance to the flow of current

These are those materials whose electrical conductivity is either very very small or nil.
e.g Glass, rubber, etc

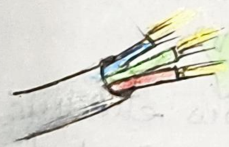
2018
Q. Define insulator and conductor. Give example each? 3marks

CONDUCTORS:

2018
Q. Differences between insulator and conductor

These are those materials whose electrical conductivity is very high e.g Silver aluminium etc
Best conductor ~~are~~ is: Silver

2021
The best conductor is



SEMICONDUCTORS:

These are those materials whose electrical conductivity lies between the Insulators and Conductors eg. germanium and silicon

Definition of some terms of electricity and their units :

Voltage :

It is describes as the pressure that pushes electricity.

Unit of voltage : Volt (V),

Dimension of voltage : $M L^2 T^{-3} I^{-1}$

Symbol : V, ΔV

Current :

It is a flow of electrical charge usually electrons on electron-deficient atoms.

Unit of Current : Ampere (A)

Dimensional formula of ~~vol~~ current : $[M^0 L^0 T^{-1} Q]$

Symbol : A

Resistance :

It is the property of a material ~~conductor~~ to resist the flow of charges through it.

S.I unit of resistance : Ohm (Volt per ampere)

Dimensional formula of resistance : $M^1 L^2 T^{-3} I^{-2}$

Symbol : Ω

Resistance of insulator is the highest than conductor and semiconductor. Conductor has almost nil resistance.

Inductance :

It is the ability of an electrical circuit or device to store energy in form of a magnetic field.

S.I unit is : Henry (H)

Dimensonal formula : $[M L^2 Q^{-2}]$

Symbol : (L)

It is in always in AC circuit.

Some Formula :

X_L ← Inductive Reactance

$$X_L = \omega L$$

ω ← angular velocity ($\omega = 2\pi f$)

X_C ← Capacitive Reactance

$$X_C = \frac{1}{\omega C}$$

$$I = \frac{V}{R}$$

$$I = \frac{V}{Z}$$

Z ← Impedance

$$Z = R + j(X_L + X_C)$$

$$= \sqrt{R^2 + (X_L + X_C)^2}$$

Ohm's Law :

It states that the current I flowing througha conductor is always directly proportional to the potential difference V across the end of the conductor, provided that the physical conditions (temprature, mechanical strain, etc) are kept constant.

2018, 21
Q states ohm's Law.
2 marks

Mathematicaly

$I \propto V$

$V \propto I$

$V = IR$ ← Resistance of a conductor.

Its value depends upon :

① Length ($R \propto L$)
② Shap ($R \propto \frac{1}{A}$)
③ nature of the material ($R \propto \frac{L}{A}$)

$R = \rho \frac{l}{A}$ ← Resistivity on specific resistance

Deduction of ohm's Law :

We know that , $V_d = \frac{eE}{m} \tau$

But, $E = \frac{V}{l}$

$\therefore$ $V_d = \frac{eV}{ml} \tau$

Also $I = Anev_d$

$I = Ane\left(\frac{eV}{ml}\tau\right) = \left(\frac{Ane^2\tau}{ml}\right)V$

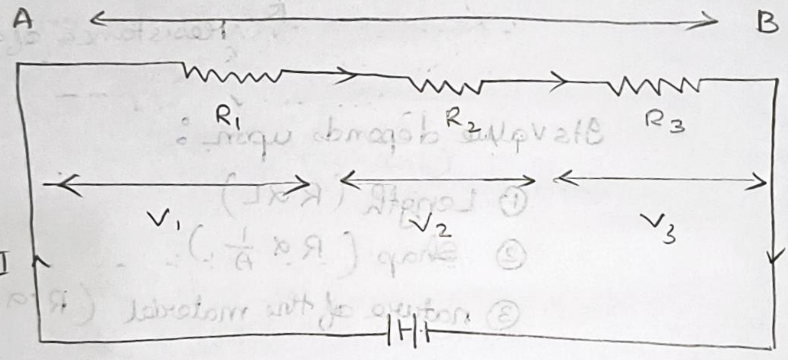
$\frac{V}{I} = \frac{ml}{Ane^2\tau} = R = \text{constant}$

$\frac{V}{I} = R \Rightarrow \boxed{V = IR}$ ← Ohm's Law

Combination of Resistors :

Resistors in Series

Resistors are said to be connected in series, if the same current is flowing through each resistor, when different potential difference is applied across the combination. In this combination, the resistors are connected end to end, i.e second end of first resistor is connected to first end of second resistor



Resistors in Series

2019
Q. state differences between series circuit and parallel circuit.

Consider three resistors having resistances R_1, R_2 and R_3, respectively are connected in series. Let V be the potential difference applied across A and B using the battery and the same current I is passing through each resistor. If V_1, V_2 and V_3 be the potential difference across R_1, R_2 and R_3 respectively

According to Ohm's Law,

$$V = V_1 + V_2 + V_3$$
$$= IR_1 + IR_2 + IR_3$$
$$= I(R_1 + R_2 + R_3)$$

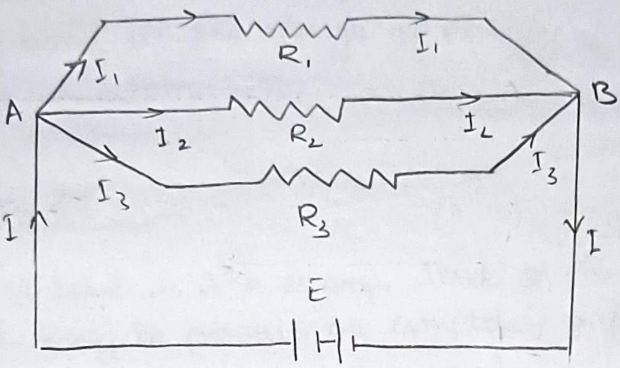
Now, $V = IR$

$\therefore R_S = \frac{V}{I} = \frac{I}{I}(R_1 + R_2 + R_3)$ (R is equivalent resistance)

$\Rightarrow \boxed{R_S = R_1 + R_2 R_3}$

Resistor in Parallel

Resistors are said to be connected in parallel, if the potential difference across each resistor is same and sum of individual current applied to each resistance is equal to the total current from the battery



Consider three resistors having resistance R_1, R_2 and R_3, respectively are connected in parallel. Let V be the potential difference applied across A and B using the battery E and I be the main current in the circuit from battery. I & I_1, I_2 and I_3 are current in the circuit from battery. If I_1, I_2 and I_3 are currents through three resistances R_1, R_2 and R_3 respectively, then the current is given by

$$I = I_1 + I_2 + I_3 \quad \text{—— (1)}$$

But potential difference

$$V = I_1 R_1 = I_2 R_2 = I_3 R_3$$

$$I_1 = \frac{V}{R_1}, \; I_2 = \frac{V}{R_2} \; I_3 = \frac{V}{R_3}$$

Substituting I_1, I_2 and I_3 in eqn (1)

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

We know, $V = IR$

$$\Rightarrow I = \frac{V}{R_P}$$

$$\Rightarrow \frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\Rightarrow \boxed{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

SEMICONDUCTOR

Semiconductore are the material whose conductivity and resistivity lies between conductore and insulatore

Energy Bands in Solids:

Energy band is the range of energy of electrons possessed in an atom

Valence Band:

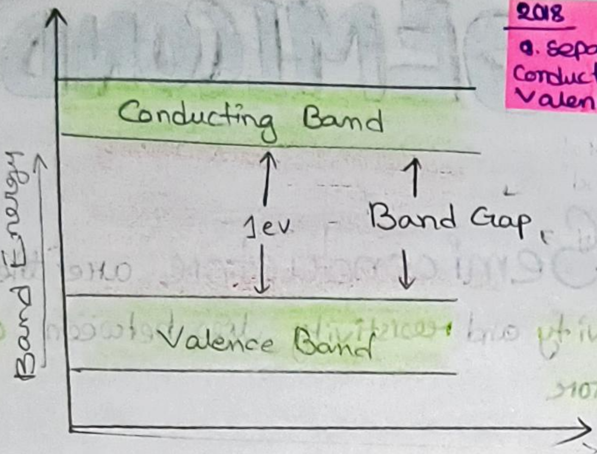
Valence band is the energy levels of the valence electrons. This band may be partially or completely filled with electrons. This band is never empty

Conduction Band:

Conduction band is the energy band above the valence band. At room temperature, this band is either empty or partially filled with electrons. Electrons can gain energy from external electric field and contribute to the electric current.

Energy Band Gap:

The minimum energy required for shifting electrons from valence band to conduction band is called energy band gap (E_g)



2018

Q. separation between Conduction band and valence band is ____

The energy gap of:
- Conductors → Overlap
- Semiconductors → very large
- Insulators → very small

Properties of Semiconductor

1. The Resistivity of a semiconductor is than that of an insulator but more than that of a conductor.

2. ~~The~~ A Semiconductor has almost filled Valance band and nearly empty Conduction band with a small energy gap ($\simeq$ 1ev) sepearating the two.

3. A semiconductor has negative temprature coefficent of resistance i.e, the resistance of a semicondon decreases ~~in~~ with increase in temperature and vice - versa.

4 A Semiconductor is formed by Covalent bonds and has Crystalline Structure.

5. ~~when~~ A semiconductors conductivity increases with addition of a suitable ~~atom~~ Impurity (eg As, Ga etc)

6. In semiconductores, bonds are formed by sharing of Valence eletrons. Such bonds are called **Covalent bonds**

For example

2018
Q. In semiconductor current conduction is due to ______

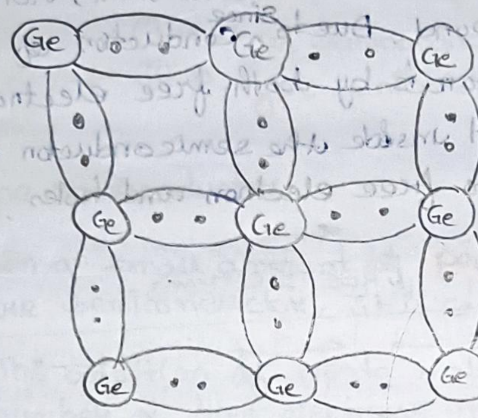
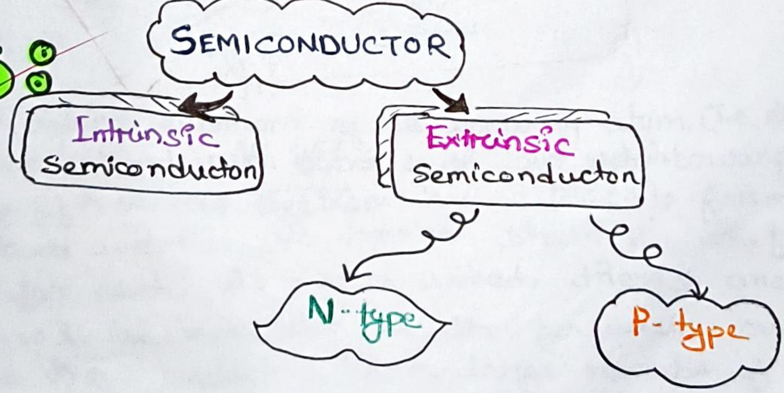


Fig: Co - valent bonds among Ge - atoms

A Ge- atom has 4 valance electrons. Because of the tendency to have 8 electrons in the outermost orbit, Ge positions itself between four other Ge atoms as shown in fig. Each neighbouring atom shares one valence electrons with the central atom and thus completing its orbit.

Types:



Intrinsic Semiconductor

A semiconductor in an extremely pure form is known as an Intrinsic Semiconductor.

In an Intrinsic semiconductor even at room temprature, hole electron pairs are created. When electric field is applied across an intrinsic semiconductor, the curren conduct takes place by free electrons and holes as shown in fig A. The free electrons are produced due to the breaking up of some covalent bond by thermal energy and at the same time, holes are created in the covalent bond. ~~Due to~~ since conduction of electric field in the semiconductor is by both free electrons and holes. So, the total current inside the semiconductor is the sum of the current due to free electron and holes.

2018, 19 T/F The semiconductor in pure form is extrinsic

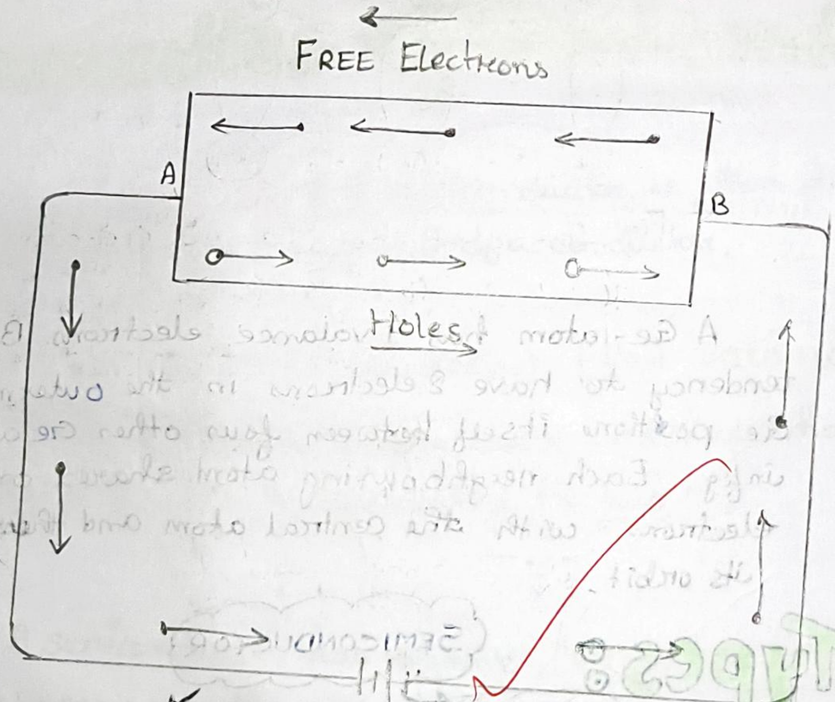


Fig: A

Extrinsic Semiconductor

The semiconductors in which metallic impurity is added to increase the conductivity are known as extrinsic semiconductor. The process of adding impurities ~~to a small amount of suitable~~ to a semiconductor is known as doping.

The purpose of adding impurity is to increase either the number of free electrons or holes in the semiconductor crystal. Depending upon the type of impurity added, extrinsic semiconductors are classified into:

(i) n-type semiconductor
(ii) P-type semiconductor

(i) n-type semiconductor

When a small amount of pentavalent impurity is added to a pure semiconductor, it is called as n type semiconductor.

The addition of penta valent impurity provides a large number of free electrons in the semiconductor crystal.

2018
Q. Differentiate between intrinsic and extrinsic semiconductor. 2

Q. ~~Describe~~ 1 mark
2021
Q. The impurities added to a semiconductor to make it n type is

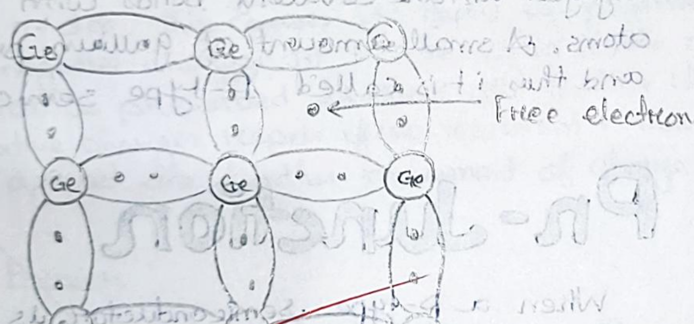
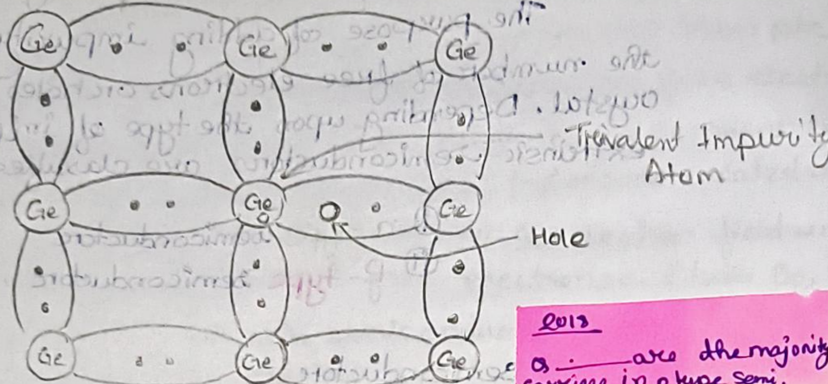


Fig: (i)

Four valence electrons of the impurity atom (i.e As) forms covalent bonds with bonds with four neighbouring Ge-atom. The fifth valence electrons has no place to form a covalent bond and thus is free as shown in the figure. Therefore for each As-atom added, there is one free electron will be available in the germanium crystal. Since the semiconductor has a large number of electron it is called n type semiconductor.

(ii) P type semiconductore

When a small amount of trivalent impurity is added to a pure semiconductor, it is called P-type semiconductor. The addition of trivalent impurity provides a large number of holes in the semiconductor, which acts as the majority carriers in this types of semi conductor.



2018
Q. ______ are the majority carriers in p type semi.

Three valence electrons of the impurity atom from co-valent bonds with three germanium atoms. In the forth co-valent bond, only germanium atom contributes one valence electron while gallium has no valence electron to contribute as all its three valence electron are already engaged in the covalent bonds with the neighbouring Ge atoms. A small amount of gallium provides million of holes and thus it is called P-type semiconducton.

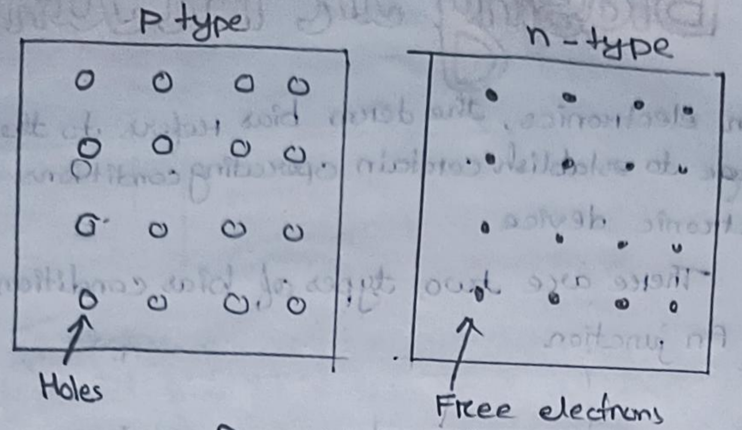
Pn-Junction

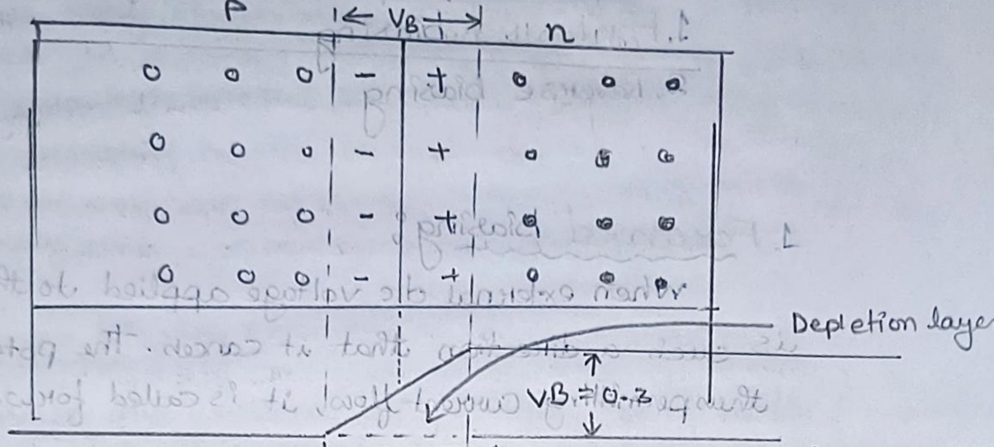
When a P-type semiconductore is suitably joined to a n-type semiconductor, the contact surface is called P-n Junction.

2018
Q Describe Pn Junction

Properties of Pn-junction:

Let us consider two types of materials, one p type and the other n-type as shown in figure.





At the Junction, there is a tendency for the free electrons from n-type to diffuse over to the p-side and holes from the p-side to the n-side. This causes to built up positive charge on n-side and negative charges on p-side. After some moment further diffusion is prevented because the positive charge repels holes and negative charges repels free electron. Thus a barrier is formed against the further movement of charge carriers.

- **Potential barrier**

  The potential difference developed across the pn junction which opposes the diffusion of charge and bring it in a equilibrium position is called potential barrier (V_B)

- **Depletion layer**

  The region in the immediate vicinity of the junction is called depletion layer.

Biasing in Pn Junction

In electronics, the term bias refers to the use of d.c voltage to establish certain operating conditions for an electronic device

There are two types of bias condition in relation to Pn junction

1. Forward biasing
2. Reverse biasing

1. Forward biasing:

When external d.c voltage applied to the pn junction is such a direction that it cancels the potential barrier, thus permitting current flow, it is called forward biasing

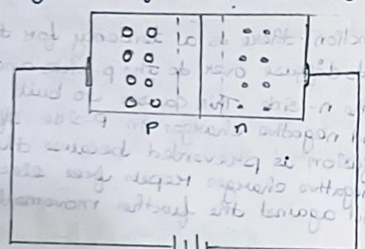
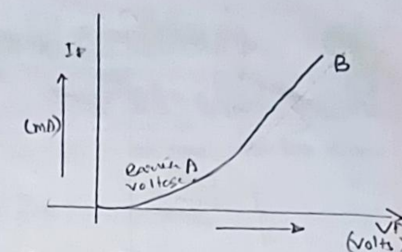


Fig: a

Q. What is Semiconductor? What are the different biasing in PN junction diode? (2021) 4 marks

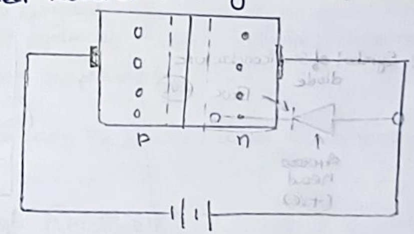
When the positive terminal of the battery is connected to p type and negative terminal to the n-type, the forward biasing is formed. The applied forward potential establishes an electric field which acts against the field due to potential barrier. As potential barrier voltage is very small, a small forward voltage is sufficient to completely eliminate the potential barrier. This allows more current to flow through the junction, which will act as a conductor in this situation. Incidentally, it may be noticed that forward bias reduces the thickness of the depletion layer



The fig. shows the voltampere curve of a pn junction under forward bias. It is seen that at first, the current increases very slowly and the curve is non linear. This is because the external voltage is used up in overcoming the potential barrier. Once the external voltage exceeds the potential barrier voltage, the Pn junction behaves like an ordinary conductor. Thus, current rises very sharply with increase in external voltage.

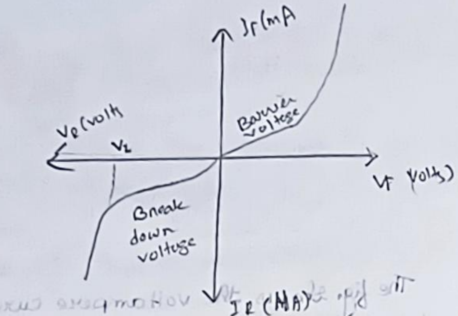
2. Reverse biasing:

When the external d.c voltage applied to the Pn Junction is in such a direction that potential barrier is increased it is called reverse biasing.

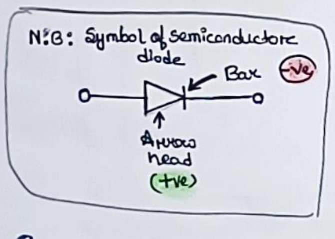


When the negative terminal of battery is connected to p-type and positive terminal to n-type, reverse biasing is formed. Reverse biasing establishes an electric field which acts in the same direction as the field due to potential barrier. The increased potential barrier prevents the flow of charge carriers across the junction. Thus a high resistance path is established for the entire circuit and hence the current does not flow. Although there is a small amount of current (only a few μA) due to the flow of minority carriers across the junction.

> 2019
> Q. Draw the VI characteristic curve of a P-N junction diode indicating different stages of its operation



The above graph shows volt-ampere characteristics of a pn junction under reverse bias. Since a very small current flow due to minority carriers as the reverse voltage is increased until its breakdown voltage (minimum voltage at which pn junction break down with sudden rise in reverse current) 'V_2'. At this point applied voltage is sufficient to breakdown covalent bonds and create a large numbers of minority carriers. This leads to a sudden rise of reverse current and a fall of the resistance of barrier region. The forward voltage at which the current through the junction starts increasing is called knee voltage.



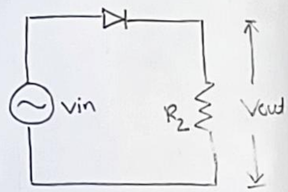


Fig A

Semiconductor diode:

They are diodes which are composed of semiconducting materials.

Characteristics of Semiconductor diode:

1. Forward biased
2. Reverse biased
3. Zero biased (voltage potential zero)

Application of Pn Junction:

or Semiconductor diode

As a Rectifier:

The property of a diode to conduct current easily when forward biased and practically no current conduction when reverse biased permits it to be used as rectifier i.e change AC to DC.

When an input of a.c voltage is passed in a circuit with diode:

- **During positive half cycle:** the diode is forward biased and conduct current. The results is that positive half cycle of the input voltage appears across the load R_2. (Fig A)
- **During negative half cycle:** the diode is reverse biased and conduct no current. The result is that output consists of positive half cycles of input voltage while the negative half cycles are supressed (Fig A)

In this way Pn junction used to change ac to dc.

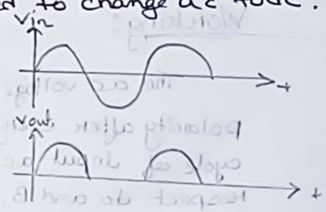


Fig: Positive and negative half cycle

Types of Rectifier:

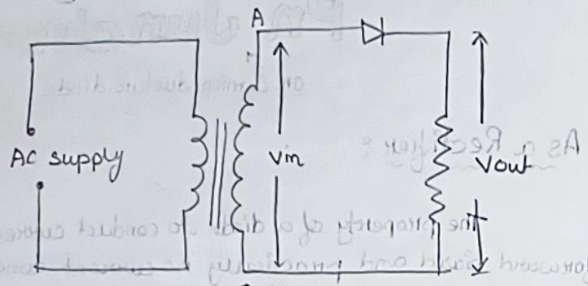
1. Half wave Rectifier
2. Full wave Rectifier

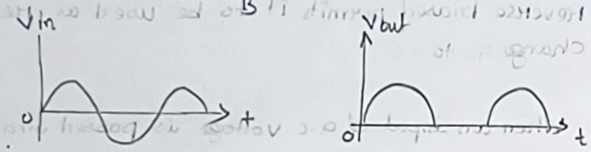
> Short note (2018, 19)
> Q Half wave Rectifier

1. Half Wave Rectifier

In half wave rectification the rectifier conduct current only during positive half cycle input AC supply.

Construction:





The It consists of a single crystal diode as shown in the fig. The AC supply to be rectified is applied in series with the diode and load resistance R_L. AC supply is given through a transformer. The transformer allows to step up or step down the voltage in AC input voltage. Secondary transformer isolates the rectifier circuit from power line and does reduces the risk of electric shock.

Working:

The ac voltage across the secondary winding AB changes polarity after every half cycle. During the positive half cycle of input ac voltage, end A becomes positive with respect to end B. This makes the diode forward biased and hence it conducts current. During the negative half cycle, end A becomes negative with respect to end B. Under this ~~condied~~ condition the diode is reversed bias and it conducts ~~current. During the negative half cycle~~ no current. Therefore the current flows through the diode during ~~negative half~~ positive half cycle of input ac voltage and it is blocked during negative half cycle. Hence the current flows through load R_L ~~also~~ always in the same direction. Hence, dc output is obtained across R_L which is ~~pl~~ pulsetting dc. filter circuit is required

2 Full Wave Rectifier

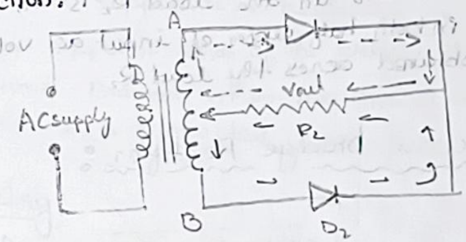
In fullwave rectification current flows through the load in the same direction for both half cycles of input ac voltage. Thus a full wave rectifier utilises both half cycles of input ac voltage to produce dc output with the help of the system of diode.

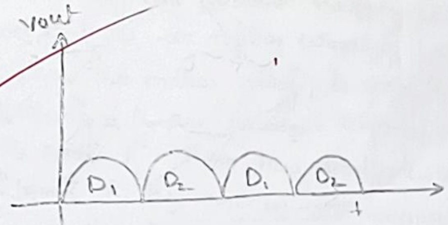
The full wave rectifier is also of two type:

ⓐ Centre tap full wave rectifier
ⓑ Full wave bridge rectifier

ⓐ Centre tap full wave Rectifier:

Construction:

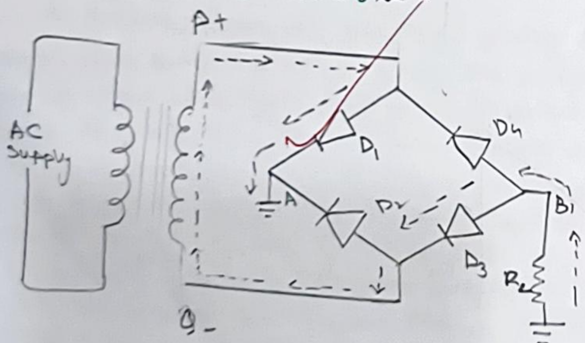


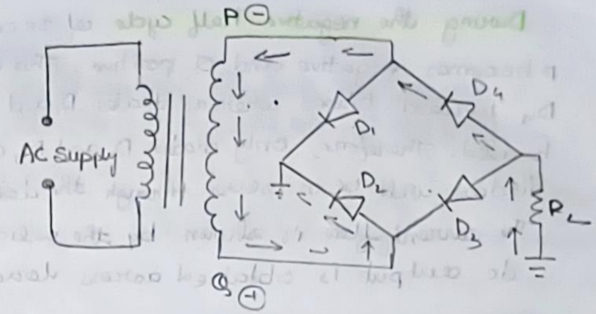


The circuit employs two diods D_1 and D_2 as shown in the figure. A centre tapped secondary winding 'AB' is used with the two diods connected so that each uses one half cycle of input ac voltage. In other words diode D_1 utilises the ac voltage appearing the upper half of secondary winding for rectification while diode D_2 uses the lower half winding.

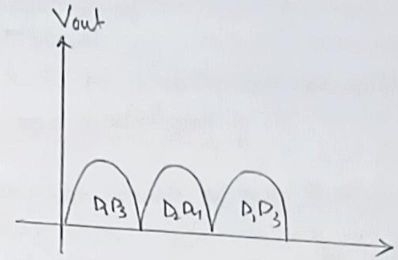
Working: During the positive half cycle of secondary voltage the end A of the secondary winding becomes positive and B negative. This makes the diode D_1 forward biased and diode D_2 reverse biased. Therefore diode D_1 conducts while diode D_2 does not. The conventional current flows through diode D_1, load resistance R_L and the dotted arrows. During the negative half cycle, end A of the secondary winding becomes negative and end B positive. Therefore diode D_2 conducts while diode D_1 does not. The conventional current flow is through diode D_2, load R_L and lower half winding as shown by solid arrows. It may be seen that current in the load R_L is in the same direction in both half cycles of input ac voltage. Therefore d.c. is obtained across the load R_L.

(b) Full wave bridge Rectifier:





2021 4.5 marks
Q. What is Rectifier? Describe full wave Bridge Rectifier.



The need for a centre tapped power transformer is eliminated in the bridge rectifier. It contains four diods D_1, D_2, D_3 and D_4 connected to form bridge as shown in figure. The ac supply to be rectified is applied to the diagonally opposite ends of the bridge through the transformer. Between other two ends of the bridge, the load resistance R_L is connected.

Working:

During the positive half cycle of secondary voltage, the end P of the secondary winding becomes positive and end Q negative. This makes diode D_1 and D_3 forward biased while diodes D_2 and D_4 are reverse biased. Therefore only diodes D_1 and D_3 conduct. These two diodes will be in series through the load R_L as shown. The conventional current flows shown dotted arrows.

During the negative half cycle of secondary voltage and p becomes negative and Q positive. This makes diodes D_2 and D_4 forward biased whereas diodes D_1 and D_3 are reverse biased. Therefore, only diodes D_2 and D_4 conduct. These two diodes will be in series through the load R_2 as shown. The current flow is shown by the solid arrows. Therefore dc output is obtained across load R_2

TRANSISTOR

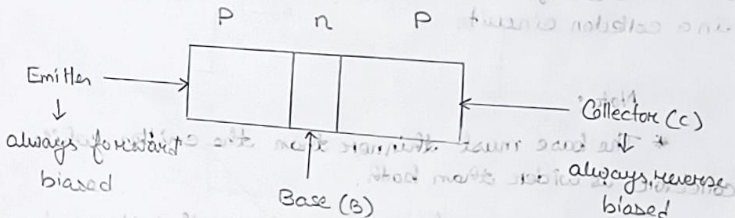
A transistor is A semiconductor device that controls (amplify or switch) electrical signals and power.

↓ Increase of magnitude of circuit

Construction :

A transistor consists of two P-n junction formed by sandwiching eith P type or n type semiconductor between the pair of opposite type. According to there are two types of transistor

1. n-P n transistor
2. P-n-P transistor



There are two P-n Junction, three terminal taken for each type of transistor. The middle section is a very thin layer.

Emitter:

The section or one side that supply's charge carrier (electron or holes) is called the emitter. The emitter is always forward bias with respect to base. So, that it can supply a large number of majority carries.

Collector:

The section on the other side that collected the charges is called the collector. The collector is always reverse bias. Its function is to remove charges from a junction with the base.

Base:

The middle section which forms by two p-n junction between the emitter and collector is called the base. The base emitter junction is always forward bias, Allowing low resistance for the emitter circuit. The base collector junction is always reverse bias and provide high resistance in a collector circuit.

Note:

* The base must thinner than the emitter while collector is wider than both.

* The emitter is havily dopped. So, that it can inject a large number of charge carries electron on holes into the base. The base is lightly dopped and very thin.

Types of Transistor:

Base on the arrangement of the semiconductor layers, the transiston are of two types -

- N-P-N transistor
- P-N-P transiston

N-P-N Transistor:

An N-PN transiston is the one in which two layers of N-type semiconductor material are separated by a thin layer of P-type semi conductor material. hence in case of N-P-N transiston, the emitter is N type and always forward bias and collector is N-type and always reverse bias while the base is of P-type. The circuit diagram of NPN transiston is shown below.

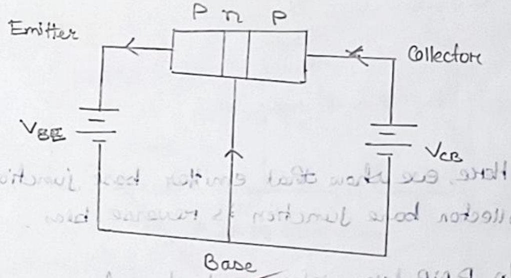


Fig: P-P-N transiston

Here, we show that emitted base junction is forward bias and collector base junction is reverse bias. The voltage across the device causes electrons from emitter to flow collector. electrons pass through P-type lightly doped base region and some of the electrons recombine with holes. therefore collector current less than the emitter current

P-N-P TRANSISTOR :

A P-N-P transistor is the one in which two layers of P-type semiconductor material are separated by a thin layer of N-type semiconductor material. hence, in case of P-N-P transistor, the emitter is P-type and always forward bias, collector is P-type and always reverse bias, and Base is N type. The circuit diagram of P-N-P transistor is shown below-

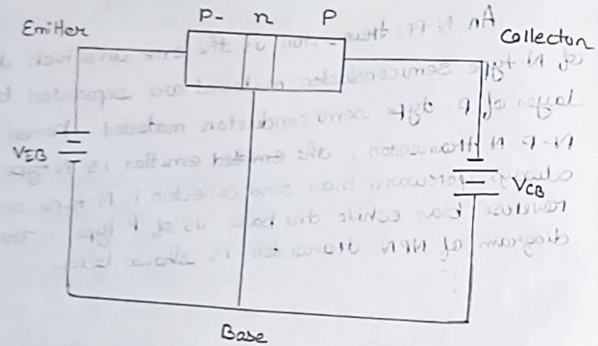


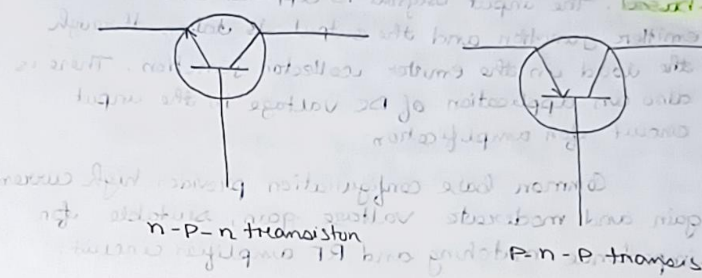
Fig: P-N-P transistor.

Here, we show that emitter base junction is forward bias, collector base junction is reverse bias.

In PNP transistor majority charge carriers are electrons. The emitter emits hole and is collected at the collector.

In PNP transistor, the base current which enters into the collector is amplified.

Symbol of Transistor :



Biasing Circuit Configuration :

2019 3 marks
Short note
Biasing of transistors

1. Common Base Connection

(i)

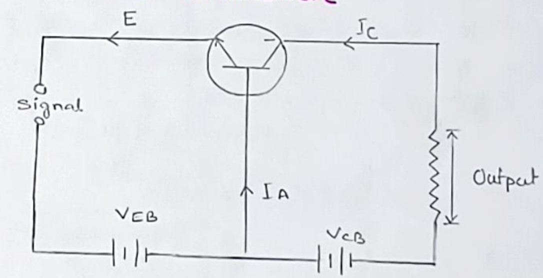
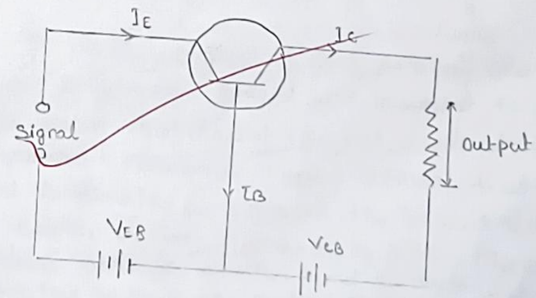


Fig: N-P-N transisture

2018 4 marks
what are the various biasing circuit configuration of npn?

(ii)



PNP transistor

In common Base Connection the input is connected In forward biased, and output is connected In reverse-biased. The input signal is applied on the base emitter junction, and the output is taken through the load in the emitter collector junction. There is also an application of DC valtage in the input circuit for amplification

Common base configuration provides high current gain and moderate valtage gain, suitable for impedance matching and RF amplifier circuit.

2 Common Emitter Connection :

①

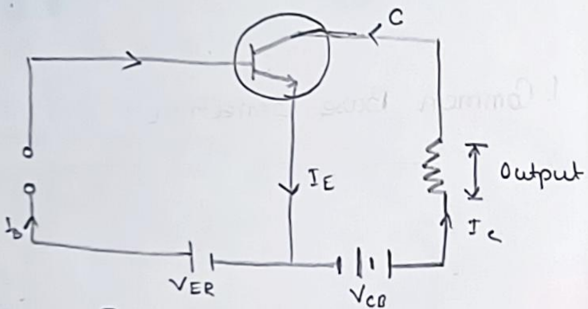


Fig: n-p-n transistor

②

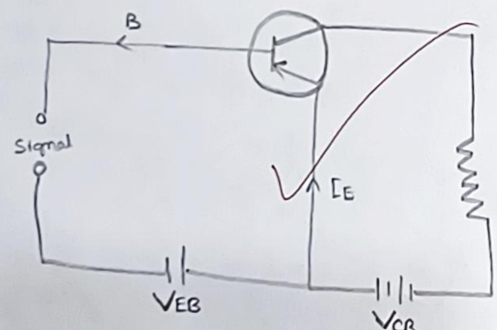


Fig: P-n-P transistor

In common Emitter connection the input is connected to forward biased and output is connected to reverse biased. The input signal is applied on the base and emitter terminal and output is taken through the load in the emitter and collector terminal. The input current IB is measured in uA because the base region is very lightly doped.

Common emitter configuration offers high valtage gain and moderate current gain, commonly used for amplifaction

3. Common Collector Configuration

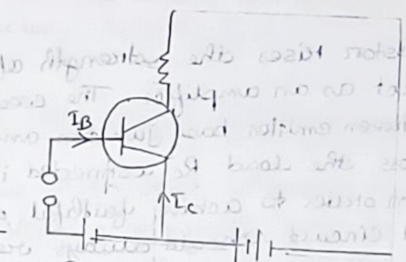


Fig: NPN transistor

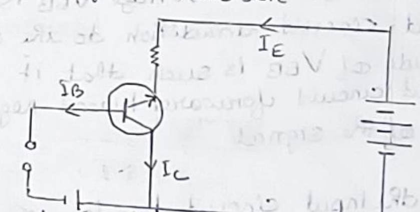
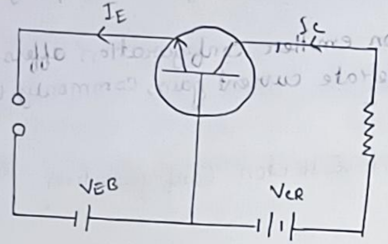


Fig: PNP transistor

In common collector configuration the input is connected to forward biased and output is connected to reverse biased. The input signal is applied on the base and collector terminals. Input current that is the base current is denoted as IB and the input voltage that is the base emitter voltage is denoted by VBE. The output current is taken through emitter and collector terminal and it is denoted as VCE the output emitter current.

Common collecton connection offers high voltage gain and unity current gain, commonly used for impedance buffering and valtage amplification.

Transistor as an Amplifier :



A transistor rises the strength of a weak signals and thus act as an amplifier. The weak signal is applied between emitter base junction and output is taken across the load R_C connected in the collector circuit. In order to achive faithful amplification the input circuit should always remain forward biased. To do so a DC Voltage V_{EB} is applied in the input circuit in addition to the signal. The magnitude of V_{EB} is such that it always kept the input circuit forward biased regarded of the plority of the signal.

As the input circuit has low resistance therefore, a small change in signal voltage causes and appreciable change in emitter current. This causes and almost chain change in collector current. The collector current flowing through a high load resistance I_C produces a large voltage across it. These a weak signal applied to the input circuit appears in amplified form in the collector circuit. In this way the transistor act as amplifier.

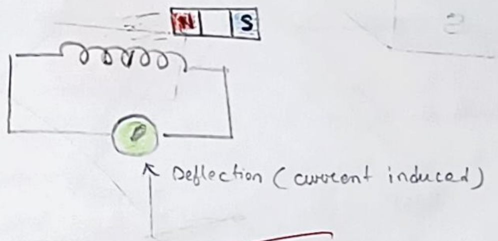
GENERATOR & MOTOR

Faradays Law of electromagnetic Induction :

Faraday's Laws of Electromagnetic Induction consists of two laws. The first law describes the induction of emf in a Conductor and the second law quantifies the emf produced in the Conductor.

Faraday's First Law of Electromagnetic Induction :

First law states that whenever a conductor is placed in a Varying magnetic field, an electromotive force is induced. If the conductor circuit is closed, a current is induced, which is called Induced current.

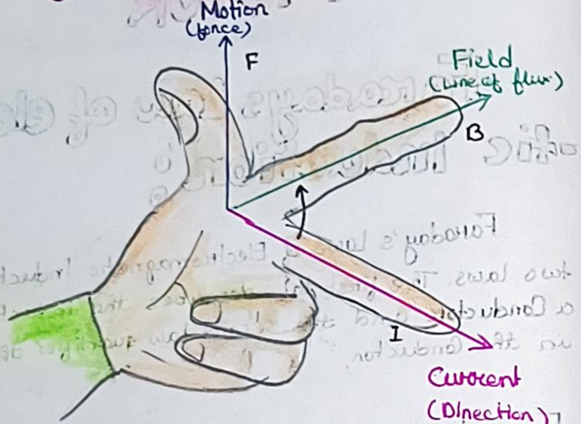


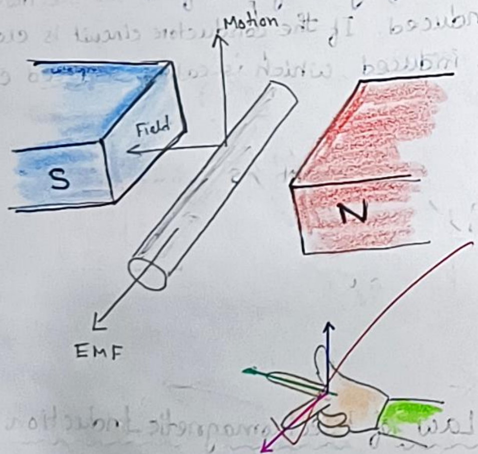
Second Law of Electromagnetic Induction :

~~The induced emf~~

- second law states that the emf induced in a coil is equal to the rate of change of flux.

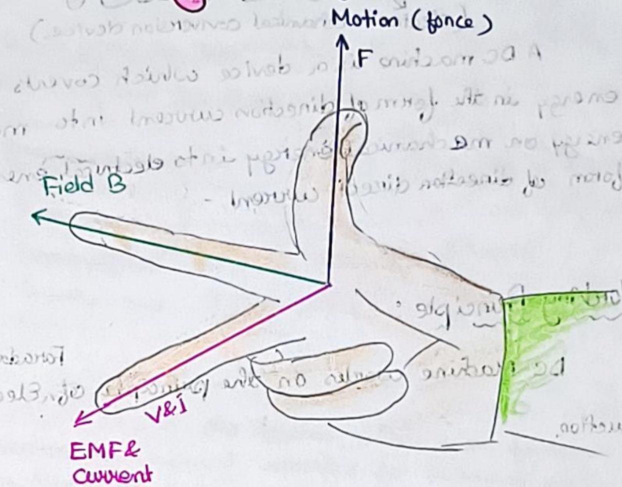
Fleming's Left hand rule :

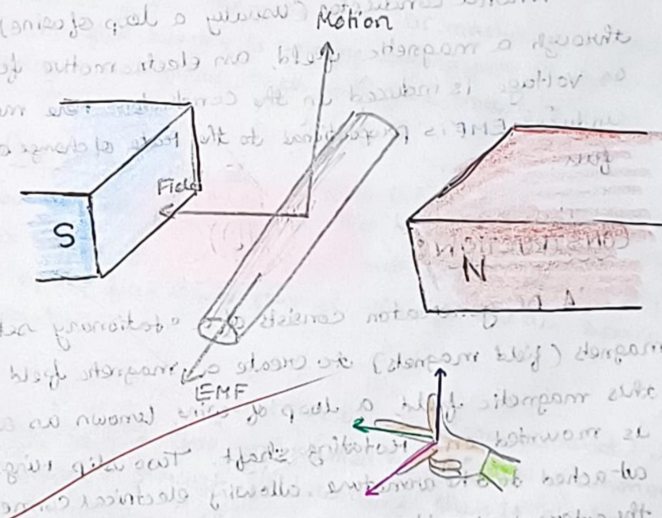




Fleming's Left - hand rule can be used to identify the forces in an electric motor.

Fleming's Right hand rule:





Fleming's right hand rule can be used to identify the direction of the induced current in an electric generator

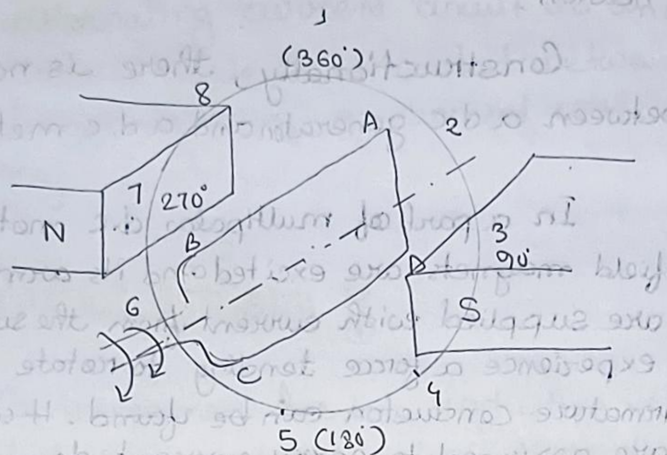
DC Machine:

(electro mechanical conversion device)

A DC machine is a device which coverts electrical energy in the form of direction current into machanical energy or mechanical energy into electrical energy in the form of ~~direction~~ direct current.

Working Principle of generator :

The coil rotating in clock - wise direction successive positions in the field, the flux linked with it changes. Hence, an emf is induced in it which is proportional to the rate of change of flux linkages. (Faraday's Law of electromagnetic Induction)



In the first half revolution of the coil, no (or minimum) e.m.f is induced in when in position 1. maximum when in position 3 and no emf when in position 5. The direction of this induced emf can be found by applying's Right hand rule which gives its direction from A to B and C to D. Hence, the direction of current flow is ABMLCD. The current through the load resistance R flows from M to L during the first half revolution of coil.

In the next half revolution i.e from 180° to 360°, the variations in the magnitude of e.m.f and similar to those in the first half revolution. Its value is maximum when coil is in position 7 and minimum when in positions 1. But it will be found that the direction of the induced current ~~not only~~ is from D to C and B to A. Hence path of current flow is along DCLMBA which is just the reverse of previous direction of flow.

Working Principle of Motore :-

An Electric motor is a machine which converts electric energy into mechanical enegy. Its action is based on the principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Flemings Left hand Rule and whose magnitude is given by F = BIL newton.

Constructionally, there is no basic difference between a d.c generator and a d.c moton.

In a part of multipolar d.c moton. When its field magnets are excited and its armature conductors are supplied with current from the supply mains, they experience a force tending to rotate the armature. Armature conducton ~~can be found~~. ~~It will~~ under N-pole are assumed to carry current downwards (crosses) and those under S-poles, to carry current upwards (dots). By applying Fleming's Left hand Rule, the direction of the force on each ~~other~~ conducton. It will be seen that each conducton can be found. It will be seen that each conducton experiences a force F which tends to rotate the armature in anticlockwise direction. These forces collectively produce a driving torque which sets the armature rotating.

It should be noted that the function of a commutaton in the moton is the same as in a generaton. By reversing current in each conductor as it passes from one pole to another. it helps to develop continous and unidirectional torque.

fuel.

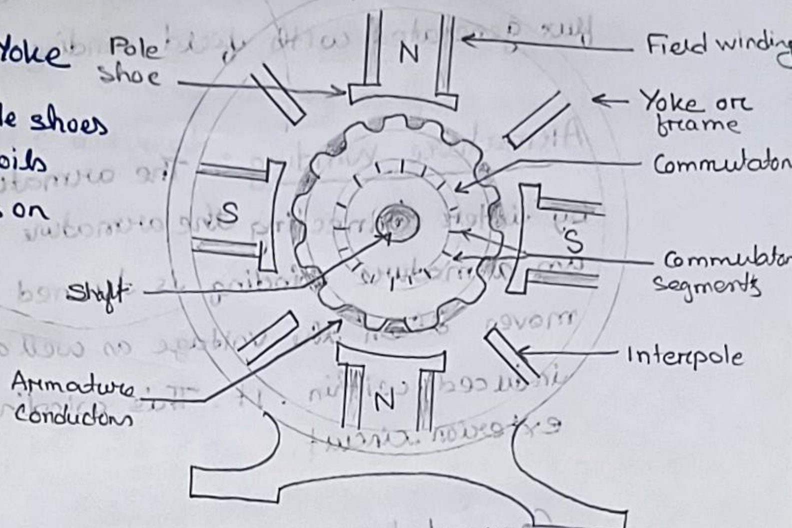
2018 7 marks
Describe the consti of a DC generator

CONSTRUCTION:

A DC generator consists of a stationary set of magnets (field magnets) to create a magnetic field. Inside this magnetic field, a loop of wire, known as armature, is mounted on a rotating shaft. Two slip rings are attached to the armature, allowing electrical connections to the external circuit.

Constructionally, there is no basic difference between DC generator and Motor. It consists of following essential parts -

1. Magnetic frame or Yoke
2. Pole cores and Pole shoes
3. Pole coils or Field coils
4. Armature windings or Conductors.
5. Armature Core
6. Commutator
7. Brushes and Bearing.



Yoke: Yoke is the frame whose main function is to offer machanical support intended for poles and protects the entire machine from moisture, dust etc.

Pole & Pole Core: The pole of the DC machine is an electromagnet and the field winding is winding among pole whenever field winding is energized. Then poles give magnetic field.

Pole shoe: Pole shoe in the DC machine is an extensive part as well as to enlarge the region of the pole, because of this region, flux can be spread out within the air gap as well as extra flux can be passed through the air space towards armature.

Field Windings: In this windings are wounded in the region of pole core and named as field coil. whenever current is supplied through field winding than it ~~electromagnet~~ electromagnetics the poles which generate required flux.

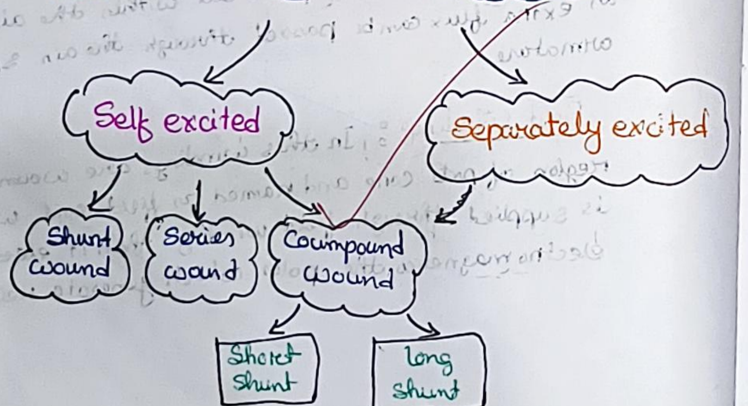
Armature Core: Armature core include a huge number of slots with its edge. The armature conductor is located in this slots. It provides the Low- reductance path toward the flux generated with field winding.

Armature Winding: The armature winding can be formed by inter connecting the armature conductor. whenever an armature winding is turned with the help of prime mover then the voltage as well as magnetic flux ; gets induced within . it. This winding is ~~called~~ allined to exterior circuit.

Commutator: The main function of the commutator in the DC machine is to collect the current from the armature conductor as well as supplies the current to the load using bruses and also provide unidirectional torque for DC- motor.

Brushes: Brushes in DC machine transfer current from commutator to the exterior load.

Types of DC Machine :



Separately excited :

Separately excited generator (DC machine) are those whose field magnets are energized by ~~in~~ from an independent external source of d.c current.

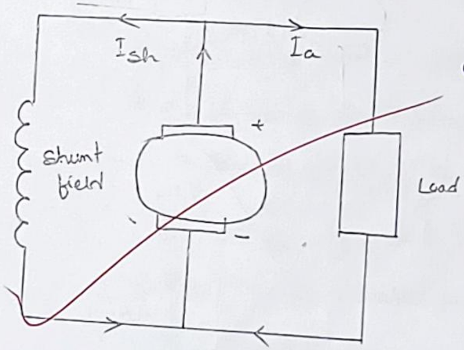
Self excited

~~Whose~~

Self excited generator (DC machine) are those whose field magnets are energized by the generator themselves due to residual magnetism, there is always present some flux in the poles. when the armature is rotated, some emf and hence some induced current is produced which is partly on fully passed through the field coils thereby strengthening the residual pole flux.

Types of Self excited generator :

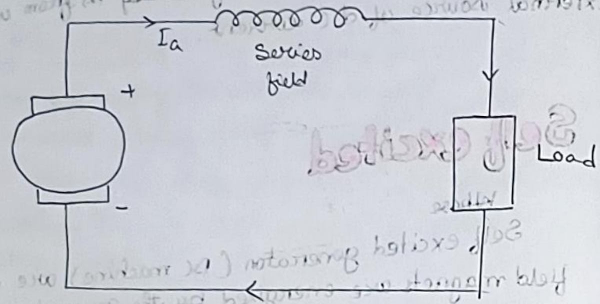
① Shunt Wound (Parallel)



The field windings are connected across in parallel with armature conductors and have voltage of the generator applied across them.

② Series Wound

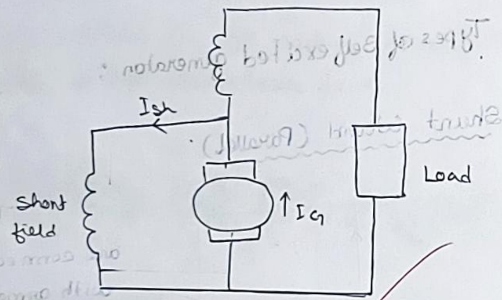
The field windings are joined in series with the armature conductors. As they carry full load, they consist of relatively few turns of thick wire on strips.



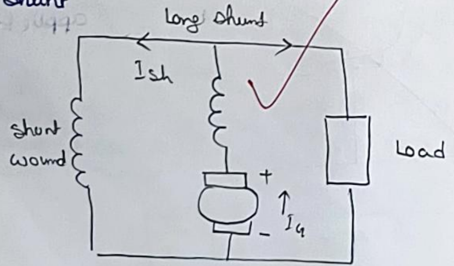
③ Compound Wound

In a combination of a few series and a few shunt windings and can be either short shunt on long shunt.

ⓐ Short Shunt

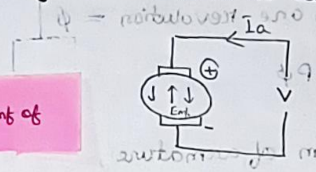


ⓑ Long Shunt



Back or Counter EMF :

When the motor armature rotate the conductor also rotate and hence cut the flux in accordance of emf is induced in them whose direction is given flaming right hand rule and is because of opposite to the applied voltage it is known as counter emf on Back emf



2018
Define back emf of DC Motor

$$I = \frac{V}{R_a}$$ ← voltage across armature

$$\Rightarrow I = \frac{V - E_b}{R_a}$$ (for Back emf)

(I: current, E_b: Back emf, R_a: armature circuit resistance)

Generated emf or emf equation of an generator :

2019 6 marks
Deduce emf equation of DC generator

Let,

ϕ = Flux per pole in weber

Z = Total no. armature conductors

= No. of slots × No. of Conductor

P = no. of poles

A = no. of parallel path

N = Armature rotation in revolution per minutes

E = E.m.f induced in any parallel path in armature

Generated emf Eg = Emf generated in any one of the parallel path

$$\text{Average Emf generated / Conductor} = \frac{d\phi}{dt} \text{ Volt}$$

Now,

Flux cut / conductor in one revolution $= \phi$

$$d\phi = P\phi$$

N is the rpm of armature,

∴ Revolution of armature in one second $N/60$

∴ time for one revolution $= 60/N$ second

∴ $dt = 60/N$ second

$$\text{EMF generated / conductor} = \frac{d\phi}{dt} = \frac{\phi PN}{60} \text{ Volt}$$

For, simple wave wound than the no. of parallel path = 2.

∴ No. of conductor is series in one path $= Z/2$

$$\therefore \text{E.MF generated/path} = \frac{\phi PN}{60} \times \frac{Z}{2}$$

$$= \boxed{\frac{\phi ZPN}{120}} \text{ Volt}$$

∴ Simplex lap – wound

No. of parallel path = P

∴ No. of conductor in series in one path $= \frac{Z}{P}$

$$\therefore \text{EMF generated/ path} = \frac{\phi PN}{60} \times \frac{Z}{P}$$

$$= \frac{\phi ZN}{60} \text{ Volt}$$

In general ;

$$\text{Generated emf } E_g = \boxed{\frac{\phi ZN}{60} \times \left(\frac{P}{A}\right) \text{ Volt}}$$

Uses of DC Machine :

2019 : Write three industrial use of DC Machine.

1. Battery Charging :

They are commonly use to charge batteries in automobiles, electric vehicles, and back up power system.

2. Power Generation :

In some remote or off grid areas, DC generators can provide electrical power when AC power sources are unavailable.

3. Welding :

Dc generators are used in welding equipment to provide a stable current for welding process.

4. Labonatony and Testing :

Dc generaton are used in Labnatonies and lasting facilities fon experiments and calibration purpose.

5. Traction

They can be found in electric locomotives and trams fon propulsion.

TRANSFORMER

What is transforemere ?

A transforemere is a static piece of apparatus by means of which an electrical power is transferred from one alternating current circuit to another electrical circuit. there is no electrical contact between them. The desire change in voltage or currend without any change in frequency.

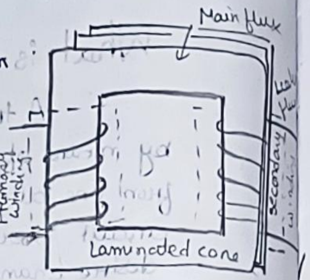
Construction :

2018 5 marks
Write Construction of a single phase transformer

The tranforemere has two inductive coils, these are electrical separated but linked through a common magnetic current circuit. These two coils have a high mutual induction. One of the two coils ~~have~~ a is connected of alternating voltage. this coil in which electrical energy is fed with the help of source called primary winding (P). The other winding is connected to a load the electrical energy is transforemed to this winding drawn out to the load this winding is called secondary winding (s). The primary and secondary coil wound on a ferromagnetic metal core. The function of the core is to transfer the changing magnetic flux from the primary coil to the secondary coil. The primary has N1 no of turns and the secondary has N2 no of turns the of turns plays major important role in the function of transformer.

Working Principle of transformer

The basic principle behind the transformer is the phenomenon of mitual Induction between two windings link by common magnetic flux. Bascially transformer consists of two Inductive coils. Primary winding and secondary winding the winding the coil electrically separated and magnetically linked to each other.



When primary is windindg is connected to a source of alternating current alternating magnetic flux is produce around the winding the core provides magnetic flux to gets linked with the secondary winding which is called the main flux and the main flux which is does not linked with secondary winding is called Leakage flux. As the flux produced is alternating emf gets induced and the frequency of the mutually induced emf is same as that of applied emf. If the secondary winding is close circuit then mutually induced current flow through it and hence electrical energy is transfered from one circuit to another.

$$\frac{N_2}{N_1} = \text{Turn reatio}(k)$$

$k>1$, step up in transformer

$k<1$, step down transformer

NOTE:

Basically transformere are consists of two inductive winding and laminated steel core. The coil are insulated from each other as well as stell core. It also consists of containers for winding and core assembly called as tank transformer. Suitably bushing to take out the oil consumed to provide oil in the transformer tank for cooling.

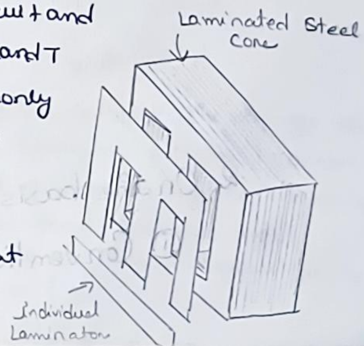
In all types of transformer core is constructed by assembling laminated steels sheet of steel minimum air gape between to achieve continous magnetic flux. The steel use is high silicon contain and heat treated. to provide high perniability low viscousis lose. Laminated sheet of steel is use to reduce eddy current loss. The sheet are cut in the shape of E, I and L

Types of transformere

① On the basis of Construction:

1. Core type:

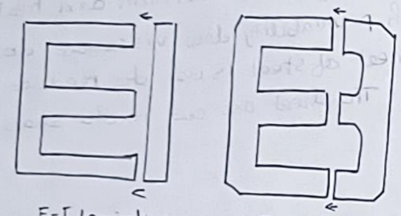
In this type magnetic circuit and cylindrical coils are used. Normally L and T shaped laminations are used. Commonly primary winding would on one limb while secondary on the other but Performance will be reduce. To get high performance it is necessary that other the two winding should be very close to each other.



2. Shell type :

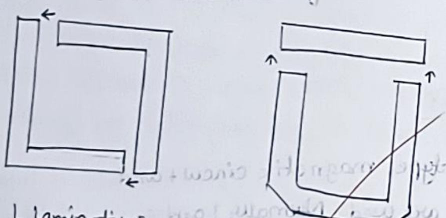
In this type two magnetic circuit are used. The winding is wound on central limbs. For the cell type each high voltage winding lie between two voltage portion sandwiching the high voltage winding. Sub division of windings reduces the Leakage flux. Greata the number of sub division lesser the reactance. This type of Construction is used for high voltage.

Shell-type :



E-I Laminations E-E Laminations

Core-type :



L Laminations

UI Laminations

2. On the basis of number of windings

(i) Conventional transformers: two windings.

(ii) Autotransformer : One winding

(iii) Others :, more, than two windings

3. On the basis of number of phases

(i) Single-phase transformer

(ii) Three phase transformer.

4. On the basis of Voltage level

(i) Step up transformer: Primary winding is a Low Voltage (LV) winding

(ii) Step-down transformer: Primary winding is a high voltage (HV) winding}.

Uses of transformer :

1. Battery charging :

Transformers are used to control the voltage that enters the battery during the charging process in order to prevent any damages that can occur to the internal battery components. This is important because an unregulated voltage can result in high surges during charging of batteries.

II. Steel Manufacturing :

Steel manufacturing plants rely on the functioning of high voltage transformers to provide a range of voltages for the manufacturing process. High currents are required during melting and welding of steel. and lower current are current are required during the cooling process. In order to provide this range of voltages transformers are necessary for regulating currents within the system.

III. Electrochemicals :

Metals such as copper, zinc, and aluminium are normally used for the purposes of electroplating. During the process, transformers provide regulated electrical current that is use to drive the chemical reaction from the begining stages untill completion.

AC FUNDAMENTAL

Alternating current ~~and~~ or voltage is one which regularly changes its direction as its value. It is a type of current or voltage which flows first in one direction then in the opposite direction. In one cycle it changes the value to zero to the maximum. Maximum to zero in the opposite direction and again zero to maxm and maxm to zero.

A Polarity of DC voltage and direction of DC current are always the same i.e it is unidirectional value.

Cycle :

One complete set +ve and -ve values of alternating quantity such as voltage and current is called cycle. A cycle is a complete alternation.

Amplititude :

The maximum value +ve or -ve of an alternating quantity such as voltage or current is known as Amplititude

Time Period :

The ~~time~~ taken by an ~~taken~~ alternating quantity such as voltage and current to complete one cycle is called cycle. ~~T is the~~ Time period is inversly proportional to frequency.

$$T = \frac{1}{f}$$

2018 3 marks
Define: Time Period, frequency and RMS value

Frequency :

Frequency is the number of cycle pass through per second.

$$f = \frac{1}{T}$$

Equation of Alternating Voltage and current :

The mathematical formule for AC voltage is

$$V(t) = V_0 \sin(2\pi f t)$$

V_0 is called "Peak" or "maximum votage"
f is frequency

For current,

$$I(t) = V(t)/R = \frac{V_0}{R} \sin(2\pi f t)$$
$$= I_0 \sin(2\pi f t)$$

Here, we have found the maximum current,

$$I_0 = \frac{V_0}{R}$$

We have multiple options to express the magnitude and different values related to a Ac quantity :

① RMS Value (Root mean Square Value)

The RMS value or also called effective value of an AC is the value of direct current when flowing through a circuit on a resistor for a specific time period and produced, the same amount of heat which produced by the AC when flowing through the same circuit or resistor for specific time.

For a sinasodial wave

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$I_{rms} = 0.707\ I_{max}$$

$$V_{rms} = 0.707\ V_{max}$$

② Average Value :

If we convert the AC sine wave in to directo sine wave to rectifiers then the converted value current sine wave to direct current wave. The average value of an AC is expressed by that direct current which transfers accross any circuit the same amount of charge as is transfered by the AC during the same time and average value of current.

$$I_{av} = 0.637\ I_{max}$$
$$E_{av} = 0.637\ E_{max}$$

3. Instantaneous Value :

The value attained the alternating quantity at any instant is known as instaneous value denoted by I or V.

4. Peak or Max Value :

It is the max value of AC from zero position whometer +ve or -ve half cycle in a sinsodal wave expressed or imax or Emax.

5. Peak Factor :

Peak Factor is ratio between maximum value to rms value.

$$\text{Peak Factor} = \frac{\text{Max}^m \text{ Value}}{\text{rms Value}}$$

For a sinosodal alternating votage peak factor equal to

$$\text{Peak factor} = \frac{E_{max}}{0.707 E_{max}}$$

$$= 1.414$$

6. Form Factor :

The ratio between rms value and average value of an alternating quantity is called form factor.

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

$$= \frac{0.707 E_{max}}{0.637 E_{max}}$$

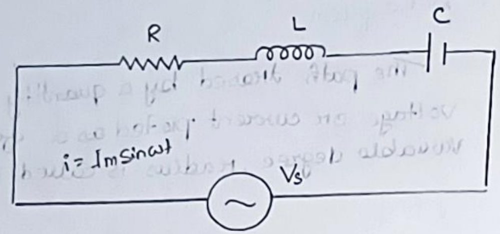
$$= 1.11$$

7. Wave form :

The path treased by a quantity such as voltage or current ploted as a function of variable degree, readius is called wave form

AC-CIRCUIT

R.L.C Series Circuit:



Resistor, Inductor and Capacitor are connected in series with the voltage supply the circuit so form is called Series RLC Circuit. Since all this components are connected in series the current in each elements remains the same

$$I_R = I_C = I_L = I_{(T)}$$

where $I_{(T)}$ = max sin wt

V_R = Voltage across Resistor

V_L = Voltage across inductor

V_C = Voltage across capacitor

X_L = It is the inductive reactance

X_C = It is the capacitive reactance

2018 3 marks short note: RLC Circuit

The total voltage in the RLC circuit is not ~~eqa~~ equal to the algebric sum of voltages across the RLC but it is a vector sum in case of the resistor the voltage is place with current for inductor the current ~~lags~~ lead then ~~current~~ voltage by 90°.

AC through Resistance:

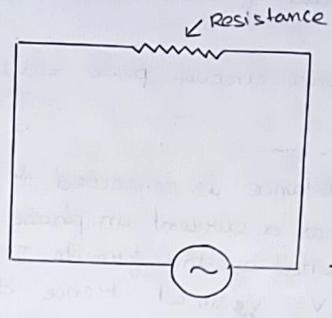


Fig: Circuit diagram

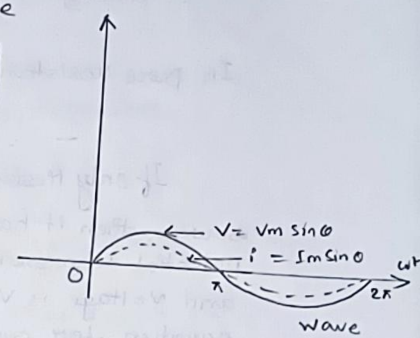


Fig: Phasor diagram

$$i = \frac{V_m}{R} \sin\theta$$
$$= I_m \sin\theta \quad \text{--- (i)}$$

$$i = \frac{V_m}{R} \sin\omega t$$
$$= I_m \sin\omega t \quad \text{--- (ii)}$$

$$I_m = \frac{V_{max}}{R}$$

$$\Rightarrow \frac{I_{max}}{\sqrt{2}} = \frac{V_{max}/2}{R}$$

$$\Rightarrow I_{rms} = \frac{V_{rms}}{R}$$

$$\Rightarrow I = \frac{V}{R}$$

Power $P = Vi$

$$\Rightarrow V_{max} \sin\theta \, I_{max} \sin\theta$$

$$\Rightarrow V_{max} I_{max} \sin^2\theta$$

$$\Rightarrow V_m I_m \frac{1}{2} (1 - \cos 2\theta)$$

$$\Rightarrow \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} - \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} \cos 2\theta$$

$$\Rightarrow V.I = \frac{VI \cos 2\theta}{0}$$

$\therefore$ Average value of $VI \cos 2\theta = 0$

In pure resistance circuit power $= VI$ watt $= I^2R$

If only resistance is connected to an AC source, then it has a current in phase with the potential represented by the formula $I = I_m \sin \omega t$ and voltage is $V = V_m \sin \omega t$. Hence the equation for current becomes $I = V_m/R$

AC through Capacitance :

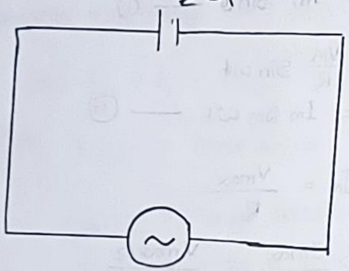


Fig: Capacitance circuit

If only a capacitor is connected to an AC source, then the current leads the potential by 90°, which is represented by the formula $I = I_m \sin(\omega t + \pi/2)$ and voltage is $V = V_m \sin(\omega t \pm \frac{\pi}{2})$, hence the equation for current becomes. $I = V_m/X_c$. where X_c is the capacitive reactance calculated $X_c = 1/2\pi f C$ and its unit is ohm

$v = V_{max} \sin \omega t$ - Supply voltage

C = Capacitance across the supply voltage when capacitor is connected across ac voltage it will aquire change.

q = Change on capacitor

C = Capacitance of the capacitor

V = Applied voltage

$$i = \frac{dq}{dt}$$

$$i = \frac{dcv}{dt} = \frac{cd(V_{max} \sin \omega t)}{dt}$$

$$= CV_{max} \cos \omega t \times \omega$$

$$\text{or, } i = \omega C V_{max} \sin(\omega t + \frac{\pi}{2})$$

$$= \frac{V_{max}}{1/\omega C} \sin(\omega t + \frac{\pi}{2})$$

Replacing $\frac{V_m}{1/\omega C}$ by I_{max}, we have,

$$i = I_{max} \sin(\omega t + \frac{\pi}{2}) \quad \text{(11)}$$

where, $\frac{1}{\omega C}$ is called capacitance reactance and represented by X_c

$$\therefore X_c = \frac{1}{\omega c} = \frac{1}{2\pi f C}$$

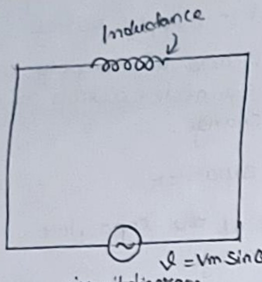
$$I_{max} = \frac{V_{max}}{X_c}$$

$$\frac{I_{max}}{\sqrt{2}} = \frac{V_{max}/\sqrt{2}}{X_c}$$

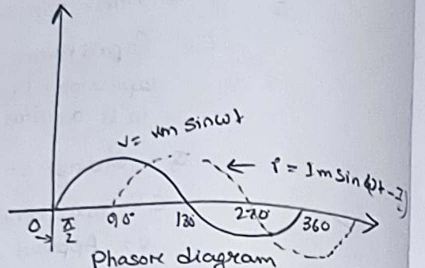
$$I = \frac{V}{X_c}$$

From the above current expression, we absorbed the current is lead the voltage $\frac{\pi}{2}$.

AC through Inductance :



circuit diagram



Phasor diagram

If only a ~~capaci~~ inductor is connected to an AC source, then the current lags the potential by 90°, which is represented by the formula $I = I_m \sin(\omega t - \pi/2)$ and $V = V_m \sin(\omega t - \pi/2)$. Hence the equation for voltage is $V = V_m \sin(\omega t - \pi/2)$. The current becomes $I = V_0/X_L$ where X_L is the inductive reactance calculated by $X_L = 2\pi f L$ and its unit is ohm (Ω).

$V = V_m \sin \omega t$ — Supply voltage

L = inductance connected across the supply

Voltage induce across the inductance can be given by Faraday's law of electromagnetic induction.

$$e = L \frac{di}{dt} \text{ volts}$$

The emf induced is equal and opposite to the voltage applied.

$$V = L \frac{di}{dt} \text{ Volts}$$

$$\therefore V_{max} \sin \omega t = L \frac{di}{dt}$$

$$\frac{di}{dt} = \frac{V_m}{L} \sin \omega t$$

$$\text{or } di = \frac{V_m}{L} \sin \omega t \, dt$$

Integrating both side we have -

$$\int di = \frac{V_{max}}{L} \int \sin \omega t \, dt$$

$$i = \frac{V_m}{L} \left[-\frac{\cos \omega t}{\omega} \right]$$

$$i = \frac{V_m}{\omega L} \sin(\omega t - \frac{\pi}{2}) \quad \text{— (11)}$$

$\omega L = X_L$ = Inductive reactance which opposes current flowing through the inductor phase or diagram.

Placing I_{max} in place of $\frac{V_{max}}{\omega L}$, we get.

$$i = I_{max} \sin(\omega t - \frac{\pi}{2})$$

Inductive reactance, $X_L = \omega L = 2\pi f L$ = ohm

$$I_{max} = \frac{V_{max}}{\omega L} = \frac{V_{max}}{X_L}$$

$$\frac{I_{max}}{\sqrt{2}} = \frac{\frac{V_{max}}{\sqrt{2}}}{X_L}$$

$$I = \frac{V}{X_L}$$

Power in pure Inductive circuit

$$P = v \times i \text{ watt}$$

$$= V_m \sin \omega t \cdot I_m \sin(\omega t + \frac{\pi}{2})$$

$$= V_m I_m \sin \omega t \cos \omega t$$

$$= \frac{V_m I_m}{2} \sin 2\omega t$$

$$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \sin 2\omega t$$

$$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \sin 2\omega t$$

$$P = VI \sin 2\omega t = 0$$

Power consumed by pure inductive circuit is 0.

Impedance (RLC circuit) :

The impedance for a series R.L.C circuit is defined as the opposition to the flow of current due to circuit resistor R inductive reactance X_L and capacitive reactance X_C. If the inductive reactant is greater to the capacity reactance, i.e $X_L > X_C$ the the RLC has lagging phase and if capacity reactance is greater then the inductive reactance i.e $X_L < X_C$ and if both inductor and capacitive reactance are same i.e $X_L = X_C$ then the circuit will behave as a purely resistive circuit.

$$V_S^2 = V_R^2 + (V_L - V_C)^2 \quad (\text{if } V_L > V_C)$$

$$V_S^2 = V_R^2 + (V_C - V_L)^2 \quad (\text{if } V_C > V_L)$$

where,

$$V_R = IR, \quad V_L = IX_C, \quad V_C \; I \times X_C$$

$$V_S^2 = V_R^2 + (V_L - V_C)^2$$

when, $V_R = IR$

$V_L = IX_L$

$V_C = IX_C$

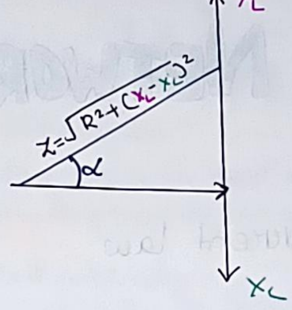
Now, $V_S^2 = IR + (IX_L - IX_C)$

$= I \; [R + (X_L - X_C)]^2$

$\therefore V_S = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

Impedance



Note:

Power Factor :

Cosine of angle between voltage and current phase is Power factor. $(\cos\phi)$

$$\phi = \tan^{-1}\left(\frac{V_L - V_C}{V_R}\right)$$

2019
Define power factor

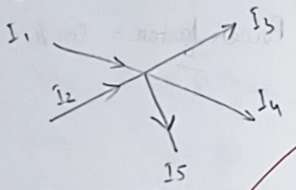
Power factor = $\cos\phi$

DC NETWORK

Kirechoff's Current law (KCL)

Kirechoff's current law or 1st Law states that the algebric sum of current meeting at points or node is zero. In other words this law can also be stated as a sum of current flowing towards points is equal to sum of current going away from that point

Mathematically



$$I_1 + I_2 - I_3 - I_4 - I_5 = 0$$

$$\rightarrow \boxed{I_1 + I_2 = I_3 + I_4 + I_5}$$

Kirechoff's Voltage law: (KVL)

2018 2 marks
State KVL and explain

Kirchoff's Voltage law or 2nd Law states that "the algebric sum of the potential drop of various branches and the emf in any closed circuit is equal to zero.

Mathematically

$$V - IR_1 - IR_2 - IR_3 = 0$$

$$\text{or, } \boxed{V = IR_1 + IR_2 + IR_3}$$

A Rish in voltage then +ve sign and fall in voltage then -ve sign. As we go from the positive terminal to negative there is a rish in potential and hence it should have to be a positive sign. If on the other hand [illegible] positive to negative terminal there is a fell in [illegible]tial. hence this voltage should be prepared by +ve [illegible]

2019,21 3 marks
Short note: Seven Segment Display

In Case of registore:

If we go through a register as the same direction there is a fall in current because current flow from higher to lower. hence this fill should goes to negative. If we go in the direction opposite to that of current there is rish in voltage i.e +ve.

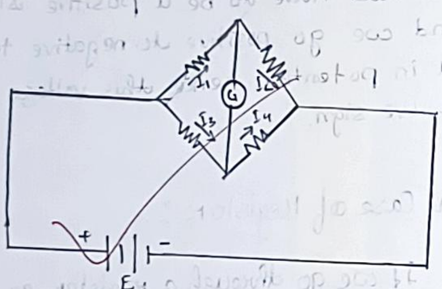
Wheatsone Bridge:

The wheatstone Bridge circuit comprises two known resistors, one unknown resistor and one variable resistor connected in the form of a bridge. This bridge is very reliable as it gives accurate measurements.

Construction of Wheatstone Bridge:

A Wheatstone bridge circuit consists of four arms, of which two arms consist of known Resistances while the other two arms consists of a unknown resistance and a variable resistance. The circuit also consists of a galvanometer and an electromotive force source. The emf source is attached between points c and d. The current that flows through the galvanometer depends on its potential difference.

CIRCUT DIAGRAM:



Principle of Wheatstone Bridge:

The Wheatstone bridge works on the principle of null deflection. i.e. the ratio of their resistances is equal, and no current flows through the circuit. Under normal conditions, the bridge is in an unbalanced condition where current flows through the galvanometer. The bridge is said to be balanced when no current flows through the galvanometer. This condition can be achieved by adjusting the known resistance and variable resistance.

Formula:

$$R = \frac{PS}{Q}$$

where,

R = The unknown resistance

S = the standard arm of the bridge

P and Q = ratio of the arm of the bridge.

MICROPROCESSOR

Digital System :

Any system or device which works on digits is digital system

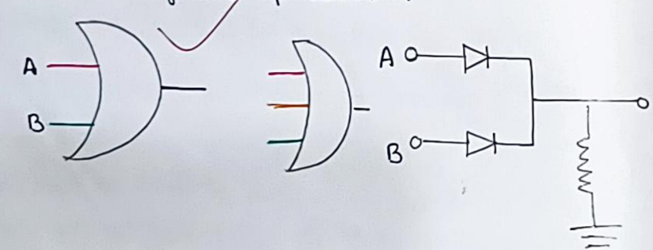
① Digital divice work on two states

- ① State on
- ⑪ State off

③ A digital computer performs completed operation by inter connecting large number of switch called logic gate. The different inter connection are designed to implement the laws of logic. If the digital gate are the basic elements which forms on the building blocks for a complex digital system.

① OR Gate :

Diagram: Symbolic representation

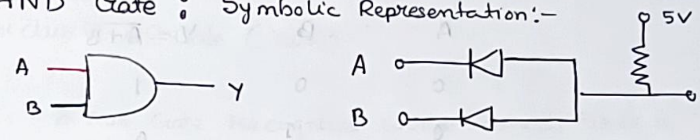


Truth table:

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

$Y = A + B = A \text{ OR } B$

② AND Gate : Symbolic Representation:-



Truth Table:

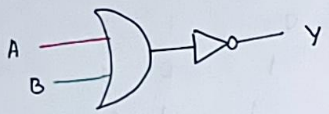
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

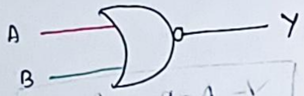
$Y = A . B$

NOR Gate :

DIAGRAM:

Symbolic Represtation





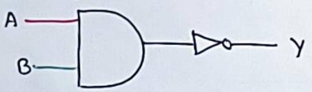
Truth Table:

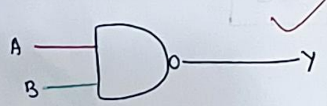
A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

$Y = \overline{A+B}$

NAND Gate:

Symbolic Representation:





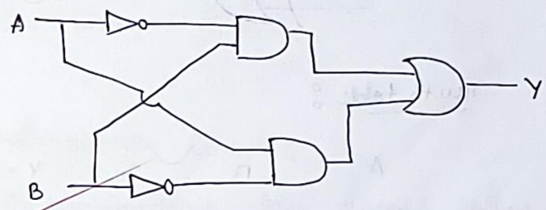
Truth Table :

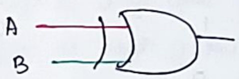
A	B	$Y = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

$Y = \overline{A.B}$

Exclusive OR Gate (XOR)

A XOR Gate recognises words which have a odd number of One.

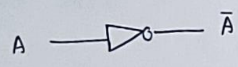




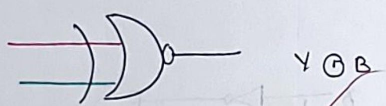
Truth Table:

A	B	$Y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

NOT Gate :-



XNOR Gate :-

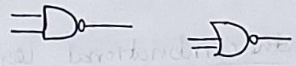


Truth table :

A	B	$Y = A \odot B$
0	0	1
0	1	0
1	0	0
1	1	1

Universal Gate :

NAND and NOR Gate (Universal Gate)



It is because By this two gate entire logic system can be implemented.

Boolean Algebric :

① Commutative Law

$A + B = B + A$

$A \cdot B = B A$

② Associative Law

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

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

Combinational logic Circuit :

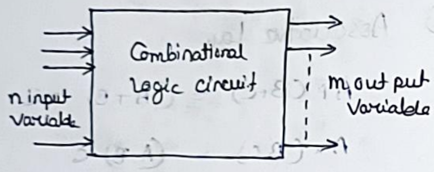
The combinational logic circuit that contains different type of logic gate or simply a circuit which different types of logic gates are combined is known as CLC. The output of a combination logic circuit from the present combination of inputs regardless of the previous input. The input veriable logic gate and output veriable are the basic components of the Combinational logic circuit. There are different types of CLC such as adder, substractor, decoder and coder multiplexer and di multiplexer.

Characteristics of the combinational logic circuits:

① At any instant of time the output of the Combination depends only on the present input terminals

② The combinational circuit does not have any previous memory. The present state of the circuit is not attracted by the previous state of the input.

③ The n number of input and m number of output are possible in combinational logic circuits.



Block diagram.

Flip Flop:
↑ memory device.

A flip flop in an digital electronics is a circuit with two stable states that can be used to store binary data. The stored data can be change by applying vary input. Flip flop and lexes are fundamental building blocks of digital electronic system used in computer communication and many other type of system Both are used as data storage device.

Four types of flip flop are-

① SR flip flop
② JK flip flop
③ D flip flop
④ T flip flop

Resisteres:

Collection of flip flop is called registers. Registers are group of flip flop. each flip flop is capable of storing one bit of information and n bit register is a group m flip flop. The basic function of a register is to hold information in a digital system and make it available to the logic elements it.

Registers contsists of finite no. of flip flop and since each flip flop capable of storing either 0-1 there is a finite 0-1 combination that can be store data bit wise. The tipical word length 4, 8/16, 32 or 64 Bit. The Several flip flop are combine to form a register to store on hold data. Registers ~~to~~ are synchronised circuit the all flip are control by common flip flop line. As registers are often used to collect data they are also called accumulators.

Counter :

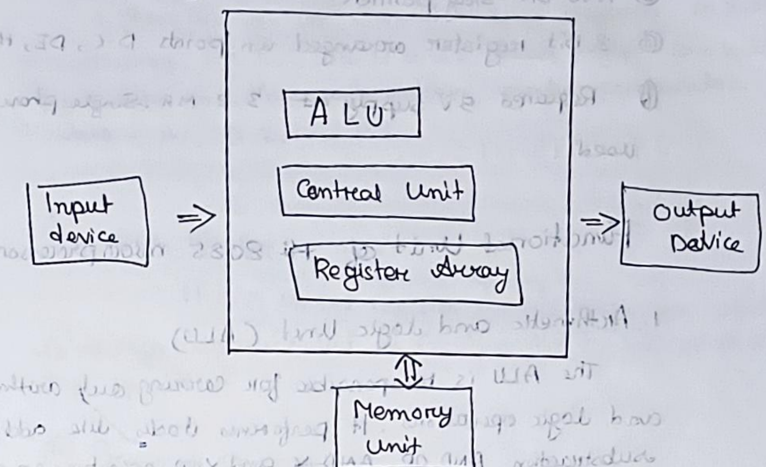
A counter is a seqencial circuit that count i.e it proceed to a predefined sequence of state where the state of the circuit is determined by the states of all its flip flop. As every state of the circuit can be a given number. If flip flop ABC are all zero the counter state is zero. If A is one and B is zero and C is one the counter state is 101 i.e 5 and so on.

MICROPROCESSOR :

It is programmable, multi purpose, long driven, register base electronic device, that required binary operation from a storage device called memory; except binary data as input and process data according to those instruction and provide results as output.

The microprocessor contains million of tiny components transistor, resistor, and diods that work together.

Block diagram of a Microcomputer :



A microprocessor is consists of ALU, Control Unit and register array where ALU perform arthematic and logical operation on the data recieved. On an input device or unit control unit. Control the instruction and flow of data and register array consists of registers identified by letter like B, C, D, E, H, L and accumulator.

In small memory all these three units are fabricated on a single chip. For example 8085 microcomputer.

2018,1 3 marks
Short-Note
@ 8085 microprocessor

8085 Microprocessor :

8085 MP is an 8 bit micro processor design by intel. In 1977 it has the following configuration

ⓐ 8-bit data bus
ⓑ 16 bit Address bus which can address up to 64 KB.

Ⓒ 16 bit programs counter.

Ⓓ A 16 bit stag pointer

Ⓔ 8 bit register arranged in points D-C, DE, HM

Ⓕ Required 5V supply at 3.2 MH..Single phase plot. used.

Functional Unit of ~~th~~ 8085 microprocessor:

1. Arthmetic and logic Unit (ALU)

The ALU is responsible for carring out arithmetic and logic operations. It performs tasks like addition substraction, AND, OR, ~~AND~~ X and XOR operation on data. After the operation the results are stored in the accumulator. The flag (5 flip flop) set on rest accordingly to the results of the operation. The 5 flag are

(i) S
(ii) Z
(iii) AC
(iv) P
(v) CY

2019 3 marks Architecture of 8085 microprocessor

2. Registers:

The 8085 has several registers for Arithmatic and logic operation.

(i) Accumulator:

It is 8 bit register used to performed Arithmatic logical Input output and load/store operation. It connect ALU and data bus.

(ii) General Purpose Registers (B, C, D, E, H, L):

There are six ~~GP~~ General Purpose Registers in 8085 microprocessor. i.e B, C, D, E, H and L. Each register can hold 8 bit data and their part. partialy. parting combination like - B-C, D-E, and H-L

(iii) Stack Pointer:

It is a 16 bit register work's like stack which is always incremented or decremented by two push or pull operation.

(iv) Program counter:

It is also 16 bit register use to store memory adress location of the next instruction to be exicuted.

3. ~~Control Unit~~:

(v) Temporary register:

It is an 8 bit register which holds the temporary data of arthmatic and logical data

(vi) Flags register:

It is an 8 bit register having file 1 bit flip flop which holds either 0 or 1 depending upon the wall stone in the accemalute.

(vii) Instruction Register

It is 8 bit register that store instruction fetched when an instruction is fetched.

3. Control Unit :

(i) Timing control unit :

It provide time and control signal to the micro processor to perform operation.

(ii) Control Signals.

READY, RD, WR, ALE

Status Signals :

S0, S1, IO/M'

DMA Signals :

HOLD, HLDA

SESET Signals :

RESET IN, RESETOUT

(iii) Interup Control

When a micro process exicuting a main program whenever interup occur the microprocessor shift the control from the main program to incoming request. After the request is completed the control goes to the main program. The interup Control signals are -

INTR, RST7.5, RST6.5, RST5.5, TRAP.

(iv) Serial input / output control :

It controls the serial data communication by using the two instruction.

SID (Serial Input data)

SOD (Serial output data)

(4) Adress bus and data bus.

Data bus causes data to be stored. It is bi-directional whereas adress bus is unidirectional.

House Wiring

2021 short note; House wiring

House wiring refers to the electrical system within a residential building connecting various appliances, lights, and outlets to the main power supply. Typically house wiring includes different circuits for lighting and power outlets, each protected by circuit breakers or fuses. The wiring is done using insulated copper or aluminum conductors, enclosed in protective conduits or sheathing to prevent electrical hazards.

Methods of House Wiring:

2018 4 marks What are various method of house wiring?

1) Tee system or Joint box system:

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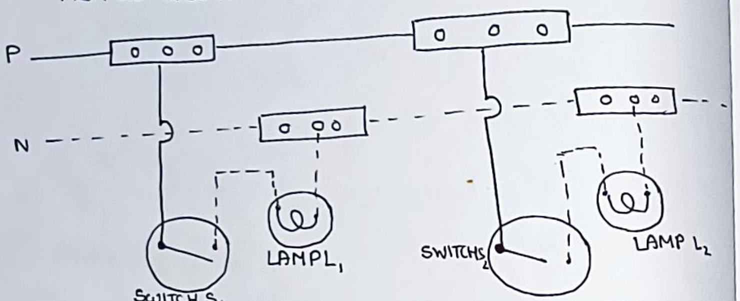

To operate any of devices under the Tee system or joint box system, we take it jointly from the middle of the wire and give it to the tool or device that we cut into the wire inside the cut box. Therefore less wire is used in this system.

This system does not require a large amount of wire, so the cost of this system is relatively low. But the money saved is used in box, so the equation of this matter of money the same. This is suitable for temprary installation.

Advantages:

1. Easy installation.
2. Flexible for adding/removing devices
3. Simplifies troubleshooting.

Disadvantages:

1. Potential for voltage drop.
2. Complexity with high loads.
3. Limited scalability.
4. Application:- specific suitability.

2) Loop-in system:

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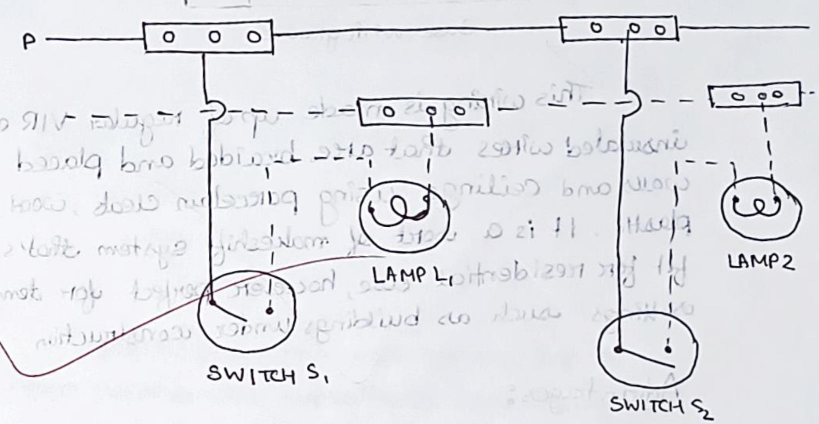


Fig: Loop in System Wiring

Advantages:

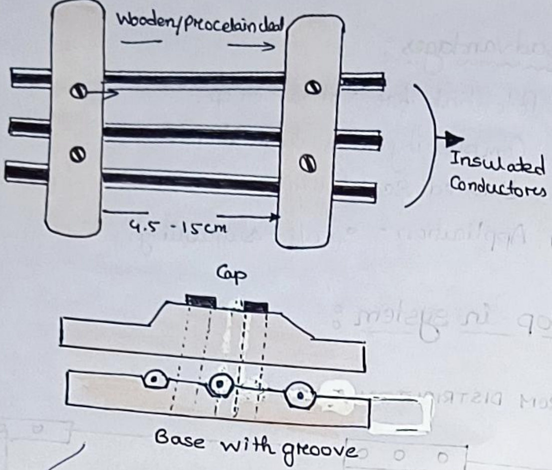
1. Efficiency in code repetition
2. Simplifies and condenses repetitive tasks.
3. Enhances scalability for large datasets.
4. Provides flexibility in handling variable input sizes.

Disadvantages:

1. Risk of infinite Loops.
2. Potential performance overhead.
3. Consumption of additional resources.

This system is set up in such a way that the lighting and other appliances are connected in parallel, allowing each device to be controlled separately. Thus, it makes it easier to find a flaw such as a damaged wire in such a system.

3) Cleat Wiring



This wiring is made up of regular VIR on PVC insulated wires that are braided and placed on the walls and ceilings using porcelain cleats, wood, or plastic. It is a sort of makeshift system that's not fit for residential use, however perfect for temporary settings such as buildings under construction.

Advantages:

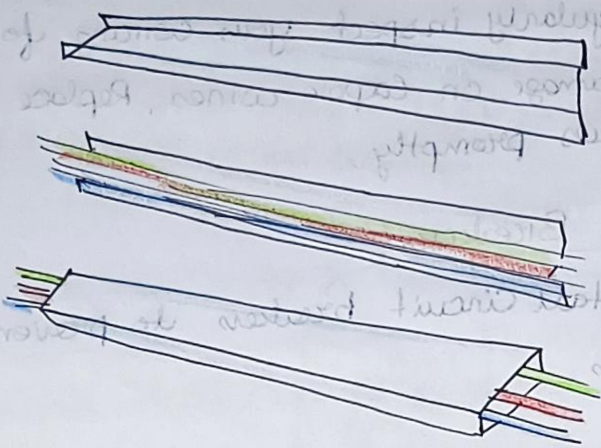
1. Simple Installation.
2. Cost effective.
3. Easy maintence.

Disadvantages:

1) Limited capacity for high loads.
2) Aesthetically unappealing due to exposed wiring.
3) Safety concerns with accidental contact.

4) Casing and Capping Wiring :

The VIR Cables are encased in hardwood casings, in this wiring. It has become obsolete in recent years. When the phase and neutral wires are put in slots individually, repair is simple



Advantages :

1. Neat and concealed wiring.
2. Suitable for moderate capacity installations.
3. Enhanced aesthetics with concealed wires

Disadvantages:

1. Limited capacity for high load.
2. Installation complexity compared to cleat wiring
3. Maintenance can be more challenging.

Safety precautions for house wiring:

1. Qualified Electrician:
Always a hire a qualified electrician for any house wiring work. DIY electrical work can be dangerous and may not comply with safety standards.

2. Inspection:
Regularly inspect your wiring for signs of wear, damage, or expose wires. Replace or reepair any issues promptly.

3. Circuit Breakers:
Install circuit breakers to prevent electrical overloads.

4. GFCI Outlets:
Install ground Fault Circuit Interuptes (GFCI) outlets in areas prone to moisture, like kitchens and bathrooms, to prevent electric shocks.

5. Emeregency Preeparedness:
know the location of emergency shut off, have a plan for electrical emergencies, and educate family members on basic electrical safety.

2018 3 marks
Short Note
Safety precaution HW

Note:

Light Emitting Diode:

An LED is just like a normal Pn junction diode, but with light emitting ~~diode~~, properties

Like ordinary diode, the LED works when it is forward biased. When it is forward biased, the potential barrier gets reduced and the electron and holes combine at the depletion layer, light or photons are emitted or radiated in all direction.

2021
Short Note: LED & LCD

Fig: LED

Light Crystal Display:

LCD is a type of flat panel display which uses liquid crystals in its primary form of operation. LCDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smart phones, televisions, computers etc.

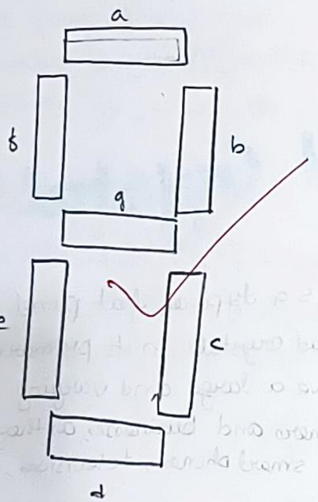
LCD Works on the principle when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light ~~of~~ which is passing through the molecule of the polarized glass and also causes a change in the angle of the top polarizing filter.

As a result, a little ligh allowed to pass the polarized glass through a particular area of the LCD. It goes layers by layers and we get the required ~~picture~~ information, we want to display.

Seven Segment Display:

~~The number~~

Seven segment displays are the out put display device that provides a way to display information in the form of images or text or decimal numbers. It consists of seven segments of LEDs which are assembled like number 8.



It is widely used in digital clocks, basic calculators, electronic devices that display numerical information.