Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1.

A. Attempt any Six of the following: (12M)

a) Define electromotive force and state its unit.(Definition 1M, Unit 1M)

Ans: The value of total potential difference created between the electrodes, when the cell is not connected to an external circuit, is known as its electromotive force (E.M.F). Its unit is Volts.

b) Define branch and mesh of an electric network.(1 M each definition)

Ans. Branch: It is that part of a network which lies between two junctions (nodes).

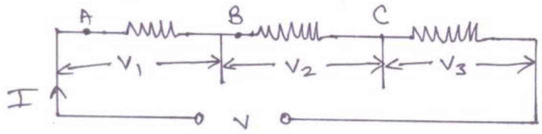
Mesh: It is a loop that contains no other loop within it.

OR

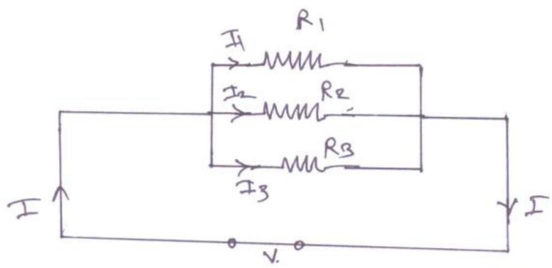
It is a set of branches forming a closed path.

c) Draw a (i) series electric circuit (ii) parallel electric circuit.(Each for 1M)

Series Circuit



Parallel Circuit



d) Define crest factor for a sine wave. State its value.(Definition 1M, value 1M)

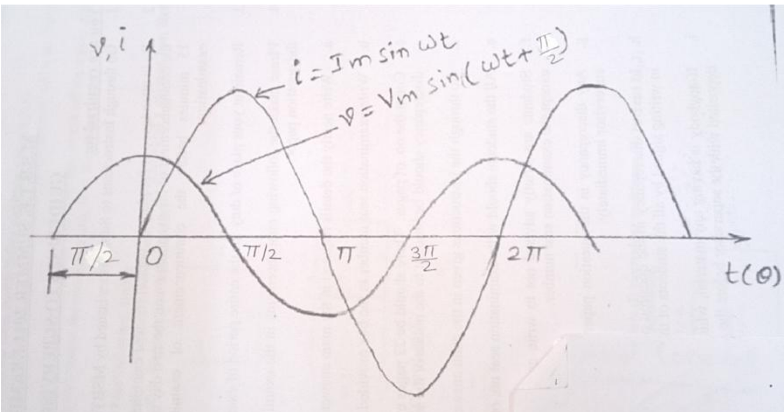
Ans. Crest factor for a sine wave is defined as the ratio of its Maximum value to its R.M.S value. It is denoted as K_a or K_p.

Its value= $\frac{Maximum\ value}{r.m.s\ value} = \frac{Im}{\frac{Im}{\sqrt{2}}}$

$\therefore Ka\ (Kp) = \sqrt{2} = 1.414$

e) Draw the waveforms of voltage and current of a pure capacitive circuit.(Correct and labeled diagram 2 M)

Ans.



f) For a delta connected balanced load, state the numerical relationship between
(i) line current (ii) phase current.(Correct relationship 2M)

For delta balance load numerical relationship between line and phase current:

$$I_L = \sqrt{3}I_{ph}\ (\ I_L = line\ current, I_{ph} = phase\ current)$$

g) What is earthing? What is its importance?(Earthing 1M, Importance 1M)

- The term earthing means connecting the noncurrent carrying metal parts used in electrical distribution system or the neutral point of star connected winding (Transformer, Alternator etc.) to the earth by a conductor of negligible resistance.
- **Importance**:- This brings the body of electrical equipment's to zero potential and thus will avoid the electric shock to the operator.

h) State the function of the term: (i) MCB (ii) Fuse.(each for 1M)

(i) **MCB:** It performs interruption function only. The detection of fault is made by relay system.

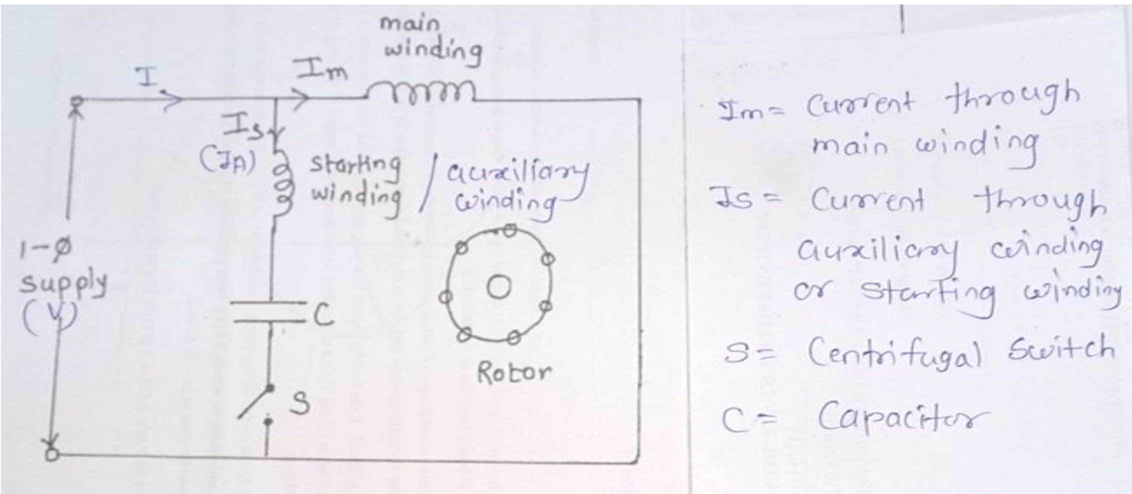
(ii) **Fuse:** It performs both detection of fault and interruption function.

B. Attempt any two of the following: (8M)

a) Compare auto transformer with two winding transformer (any four 4 M).

Parameter	**Auto-transformer**	**Two-winding transformer**
Number of windings	One winding common to both primary and secondary circuits	Two separate windings in primary and secondary circuits
Volume	Less	More
Cost	Less	More
Efficiency	High	Low
Copper Loss	Less	More
Application	Variac, voltage boosters starting of a. c. motor	Power supply, isolation transformer
Weight	Less	More
Size	Small	Large
Voltage regulation	Better	Poor

b) Draw a neat diagram of capacitor start induction motor. State any two applications.(Labeled diagram 2M, Any two applications 2M)



Applications: (any 2)

1. Fans & Blowers
2. Drilling machines
3. Grinders
4. Refrigerators
5. Compressors
6. Conveyers
7. Washing machines
8. Air conditioners
9. Domestic water pumps

c) Write any four safety precautions to be taken while working with any electrical system.(any four points 4M)

1. The sockets should be fixed at a height beyond the reach of the children to ensure their safety.
2. Before putting the wiring installation into service for the first time, it is essential to ensure that all the fuses and the switched are inserted in the phase (or live) wires only.
3. For proper protection, fuses must have correct ratings.
4. Always switch off the main switch before replacing a blown fuse.
5. While using any electrical device, put on rubber soled footwear and keep your hands dry.
6. While cleaning any portable appliance like table fan, switch off the supply given to the appliance and remove the connecting plug from the socket.

Q.2. Attempt any four of the following: (16M)

a) Find the current through 12Ω resistance using Kirchhoff's current law. Ref. fig no.1.(Current flow in circuit Diagram 1M, Solution 3M)

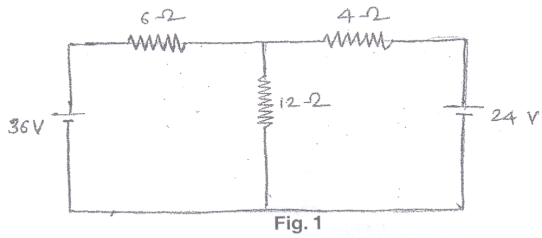
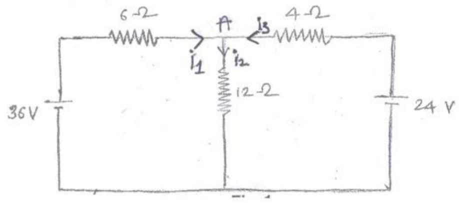


Fig. 1

Soln:



Applying KCL at Node A,

$i_1+i_3=i_2$

$\frac{36-V_A}{6}+\frac{24-V_A}{4}=\frac{V_A}{12}$ **(1M)**

$$Taking\ L.C.M$$
$$Simplifing\ above\ equation\ we\ get$$
$$144-5V_A=V_A$$
$$\therefore V_A=24\text{V}$$ **(1M)**

$$\therefore current\ through\ 12\Omega\ is\ \frac{V_A}{12}=\frac{24}{12}=2A(\downarrow)$$ **(1M)**

b) In a circuit shown fig 2 calculate (i) equivalent resistance (ii) current I,I_1,I_2 (iii)Voltage drop across each resistance

Ans.

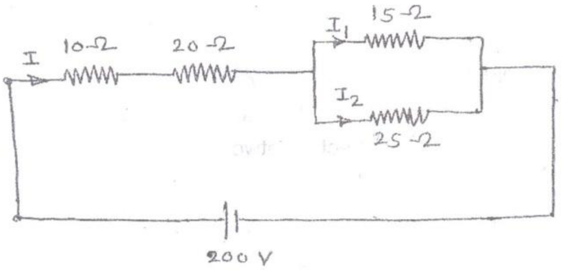
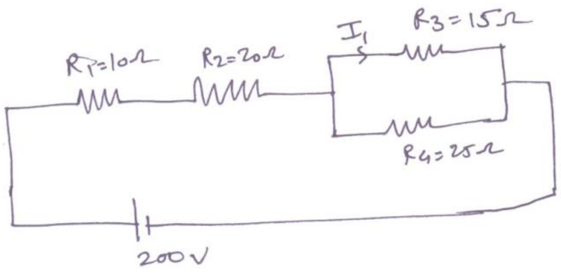


Fig. 2

Soln:



(i) equivalent resistance-------------------(1M)

$resistance R_3 \& R_4$ $are\ in\ parallel \therefore$ $R_3||R_4$

$$15||25 = \frac{15 \times 25}{15 + 25} = 9.375\Omega \quad \therefore R_p = 9.375\Omega$$

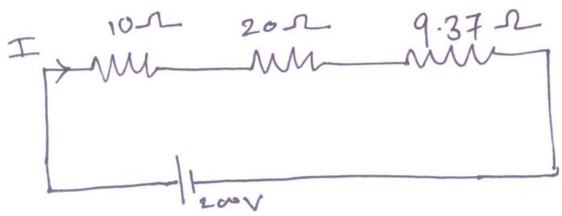
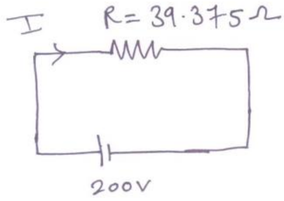


Figure 1

$resistance R_1 \& R_2$ $\& R_p$ $are\ in\ Series$

$\therefore 10 + 20 + 9.375 = 39.375\Omega$ $\therefore equivalent\ resistance \ldots\ldots\ldots\ldots.(i)$

(ii) current I,I_1,I_2---(2M)



$$I = \frac{V}{R} = \frac{200}{39.375} = 5.079A(\rightarrow)$$

Applying current division rule in Parallel resistance :

$$I_1 = I \times \frac{R_4}{R_3+R_4} = 5.079 \times \frac{25}{15+25} = 3.174A$$

$$I_2 = I \times \frac{R_3}{R_3+R_4} = 5.079 \times \frac{15}{15+25} = 1.905A \dots\dots\dots..(ii)$$

(iii)Voltage drop across each resistance.-----------------------(1M)

Referring figure 1:

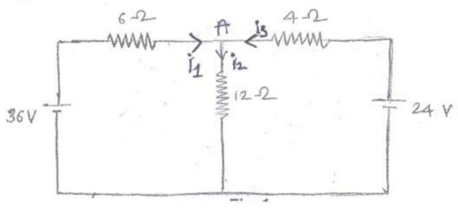
Voltage drop across 10Ω $V_{10} = 5.079 \times 10 = 50.79V$

Voltage drop across 20Ω $V_{20} = 5.079 \times 20 = 101.58V$

Voltage drop across 9.375Ω $V_{9.37} = 5.079 \times 9.375 = 47.62V$

c) State and explain KVL and KCL(Each for 2M)

KCL: it states that in any electrical network, the algebraic sum of the currents meeting at a node (pointor junction) is zero. ∑I=0 **(1M)**
Explanation with circuit diagram and equation **(1M)**



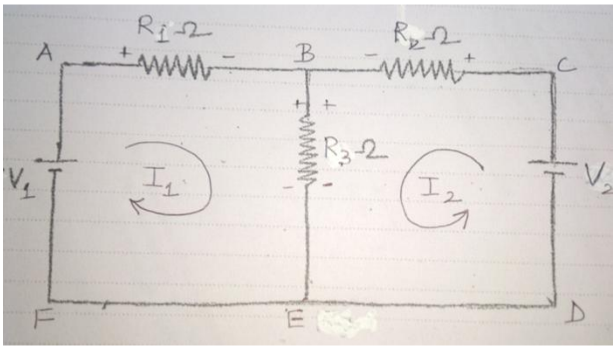
Applying KCL at Node A,

$i_1+i_3=i_2$

(Incoming current at the node is considered to be positive and outgoing current to be negative)

KVL: It states that the algebraic sum of all the branch voltages around any closed path (mesh or loop) in a network is equal to zero. **OR** It states that the algebraic sum of the product of current and resistance in each of the branch in any closed path (mesh or loop) in a network plus the algebraic sum of the e.m.f.s in that path is zero. ∑IR+∑e.m.f.=0 **(1M)**

Explanation with circuit diagram and equation **(1M)**



Applying KVL to Loop ABEFA, $V_1 - I_1R_1 - (I_1+I_2)R_3 = 0$
Applying KVL to Loop BCDEB, $V_2 - I_2R_1 - (I_1+I_2)R_3 = 0$
(Potential rise considered to be positive and potential drop to be negative)

d) Define the following terms: (i) Induced emf (ii) Dynamically induced emf (ii) Statically induced emf.

i. **Induced e.m.f:** Whenever the magnetic field linking with a conductor changes an emf is induced in the conductor which is known as induced e.m.f.

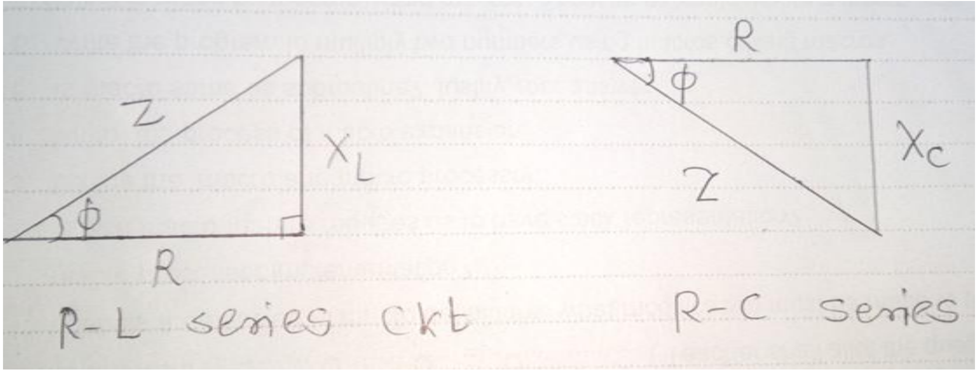
Induced e.m.f can be either(i) dynamically or(ii) statically induced. In the first case, usually the field is stationary and conductors cut across it. But in the second case, usually the conductor or the coil remains stationary and flux linked with it changes**.**
(2M)

ii. **Dynamically induced e.m.f:** The change in the flux linking with the particular coil or the circuit can be brought about by its motion relative to a magnetic field i.e. by moving the coil or the circuit in the stationary magnetic field or by moving the magnetic field with respect to the stationary coil. The emf induced in the coil or the circuit under this condition is called dynamically induced emf. **(1M)**

iii. **Statically induced emf.:** It is possible to change the number of lines of force linking with the coil and hence induce emf in it even without any physical motion relative to magnetic field. Such an emf is called as **statically induced emf.** **(1M)**

e) State the meaning of impedance and impedance triangle.
(Meaning of Impedance 2M)

Impedance is defined as the total opposition offered by all the elements in the circuit to the flow of alternating current. It is a combination of resistance and reactance. It is represented by Z. Its unit is Ohms.
Impedance triangle (2M)
Referring impedance triangle of R-L or R-C series circuit



1. Where R is resistance of the circuit.
2. X_L or X_c is reactance of the circuit.
3. Z is impedance of the circuit.
4. Ø Represents phase difference.

f) Explain the phenomenon of resonance in R-L-C series circuit.

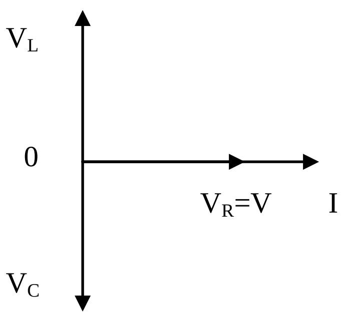
A R-L-C series circuit is said to be in electrical resonance when its net reactance is 0 i.e. Inductive reactance (X_L) = Capacitive reactance (X_C) and hence power factor of the circuit becomes unity. The frequency at which it happens is known as resonant frequency.

(2M)

The conditions under which resonance occurs in R-L-C series circuit are – **(2M)**

i) $X_L = X_c$ Hence Z = R (Minimum)
ii) Power factor is unity
iii) Voltage and current in R-L-C circuit are in phase with each other
iv) Current is Maximum
v) Power absorbed by the circuit is maximum.

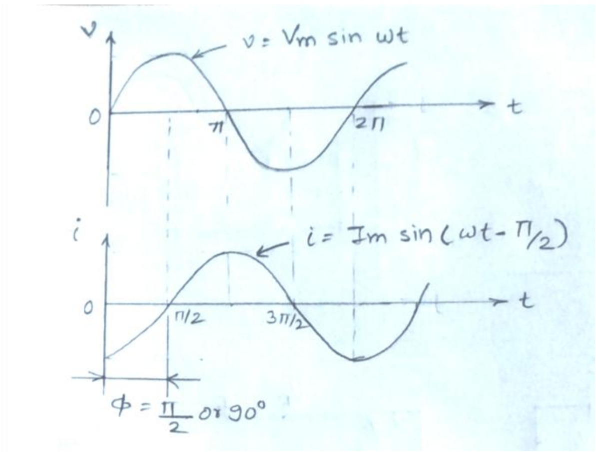
Phasor Diagram (Optional)



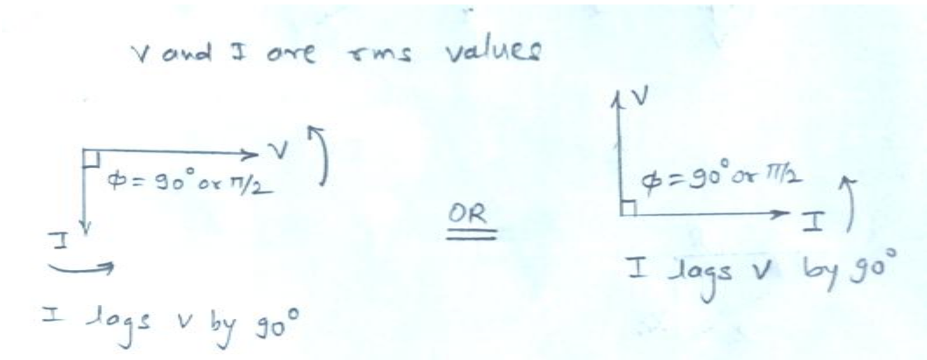
Q.3. Attempt any four of the following: (16 M)

a) Draw the waveforms and vector diagram for current and voltage when ac current flows through a pure inductance circuit. Also give equation for voltage and current.

Ans.Waveforms: (1 Mark each)



Vector Diagram:(1 Mark)



ii) Voltage equation and current equation

$v = V_m \sin wt$ ***(1/2 Mark)***

$i = I_m \sin (wt - \pi/2)$ ***(1/2 Mark)***

b) **Define**
   i. **Inductive reactance**
   ii. **Capacitive reactance**
   iii. **Impedance**
   iv. **Power factor**

(**All definitions 1 mark each**)

Inductive Reactance:-Inductive reactance is defined as the opposition to the flow of an alternating current, offered by inductance. Inductive Reactance is given as

$X_L = 2\pi fL$ Unit=Ohm(Ω)

Capacitive Reactance:-Capacitive reactance is defined as the opposition to the flow of an alternating current, offered by capacitance. Inductive Reactance is given as

$X_C = \frac{1}{2\pi fC}$ Unit=Ohm(Ω)

Impedance: Impedance is defined as the total opposition offered by all the elements in the circuit to the flow of alternating current.It is represented by Z. its unit is ohms

Power factor: The cosine of phase angle between current and voltage of the circuit is called Power factor.

p.f. = cos Φ

OR It is the factor by which apparent power is multiplied to obtain the active (true) power.

OR It is also defined as the ratio of true (or active or real) power to the apparent power.

OR It is the ratio of resistance to impedance i.e. R/Z.

c) **State Faraday's laws of electromagnetic induction and State its any two applications in electrical engineering.**
(statements : 2 marks, Applications: 1 Mark Each)

Faraday's First Law: Whenever a conductor cuts the magnetic lines of force or is cut by the magnetic lines of force or flux linking with conductor changes, an EMF is always induced in that particular conductor.

Faraday's Second Law: The magnitude of Induced EMF is directly proportional to the rate of change of flux.

$e = -N\frac{d\Phi}{dt}$ volts

Applications: Generator, Transformer

d) **A 50H_z ac voltage of Vrms=115 volt is applied across 70 ohm resistor. Write the equation for the voltage and resulting current. Draw voltage and current waveforms.**

<u>Ans.</u>

Given date: V_{rms}=115 volt, R= 70 ohm, f= 50Hz

V_{rms} = 0.707 Vm

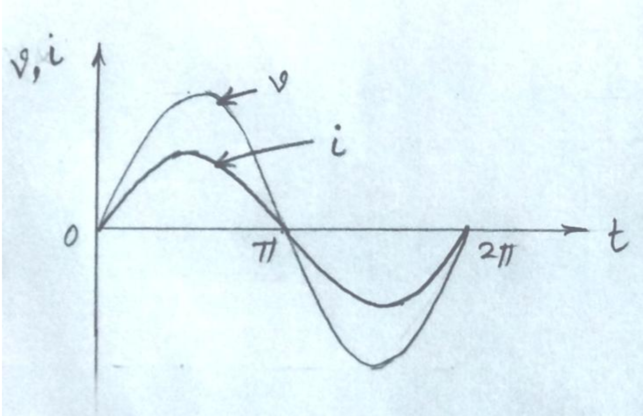
$V_m = \frac{Vrms}{0.707} = 162.66$ V

$I_m = \frac{Vm}{R} = 2.32$ A

V= 162.66 sin (314 t) **(1 Mark)**

I= 2.32 sin (314 t) **(1 Mark)**

voltage and current waveforms (1 mark each)



e) An alternating current is represented by i=28.28 sin(2π 50xt). Find frequency, rms value of current, average value of current.

Ans.

Given : i=28.28 sin (2 π 50 x t)

By comparing given expression with standard expression i=Im sin (2π f t)

Im=28.28 A **(1 Mark)**

Frequency = f = 50 Hz. **(1 Mark)**

Irms= 0.707 Im= 0.707 x 28.28= 19.99 A **(1 Mark)**

Iavg= 0.637 Im= 0.637 x 28.28= 18.01 A **(1 Mark)**

f) What is power factor? State its significance. What is the condition for unity power factor?(Definition – 1 Mark, Significance – 2 Marks, Condition – 1 Mark)

Ans.

Power factor: The cosine angle between current and voltage of the circuit is called Power factor.

p.f. = cos Φ

OR It is the factor by which apparent power is multiplied to obtain the active (true) power.

OR It is also defined as the ratio of true power to the apparent power.

OR it is the ratio of resistance to impedance i.e. R/Z.

Significance of power factor:

1. The power factor of a circuit gives the ability of a circuit to convert its apparent power into true power. Low power factor indicates that a very small percentage of total power is being actually utilized.

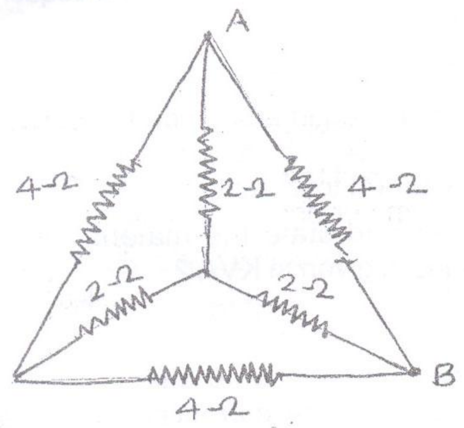
2. Greater the phase difference, lesser the power factor and lesser is the capability to utilize true power from available apparent power. If power factor is low, then a large power is required to be generated to delivered the required power to the load.

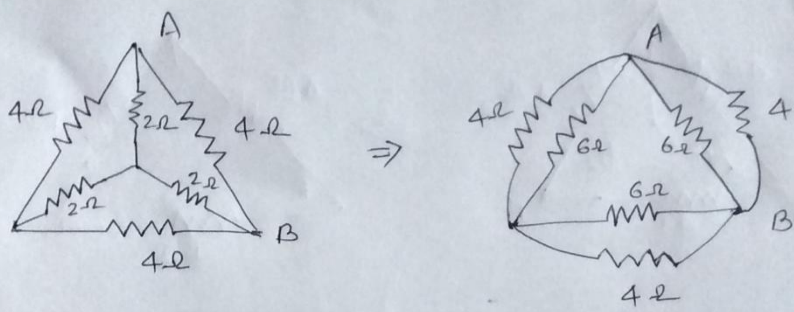
Condition for unity power factor: circuit should be purely resistive. i.e. V & I are in phase and hence the phase angle Φ = 0^0.

Power Factor $= \cos \Phi = 1$

Q.4. Attempt any four of the following: (16 M)

a) Calculate the resistance between terminal A and B using delta-star conversion as shown in Fig3.





(1 mark)

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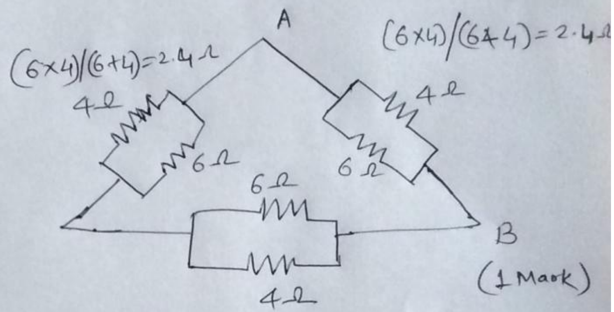
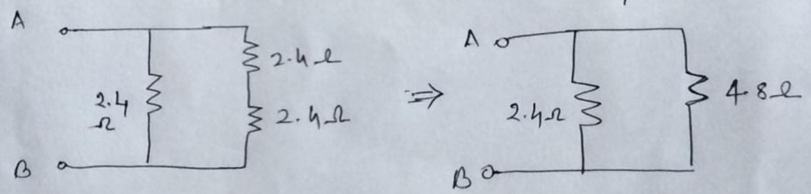


(1 Mark)

$(6 \times 4)/(6+4) = 2.4\,\Omega$



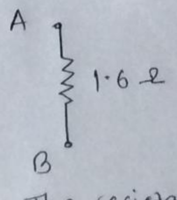
(1 Mark)

R in parallel

$= (2.4 \times 4.8)/(2.4+4.8)$

$= 11.52/7.2$

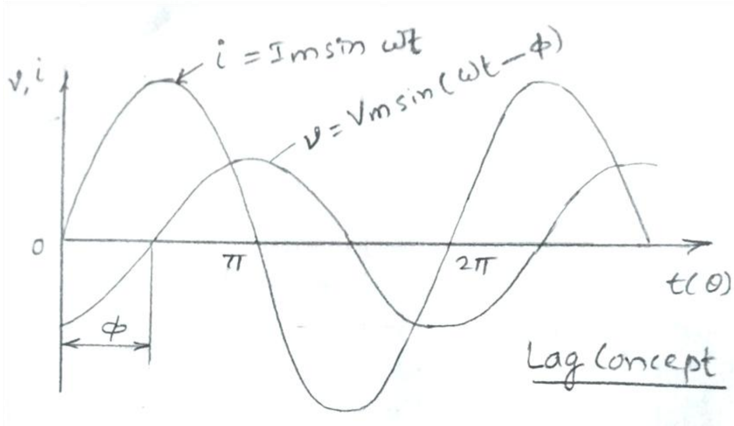
$= 1.6\,\Omega$



The resistance bet^n A and B = $R_{AB} = 1.6\,\Omega$ (1 Mark)

b) What is meant by lag and leads as regards to voltage and current vector? Explain.

Lag Concept: (2 Marks)



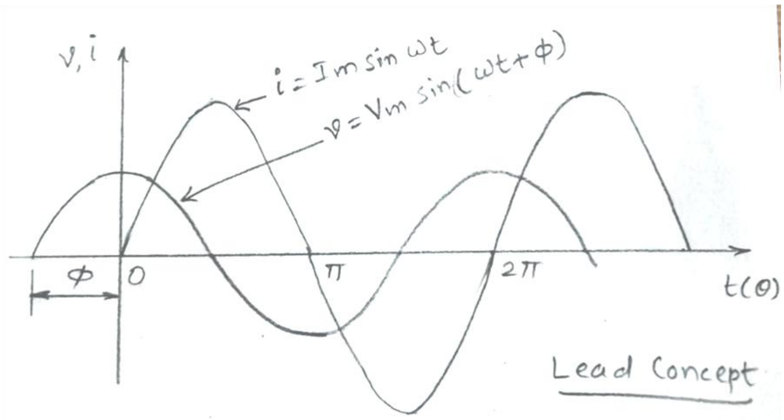
V lags I by an angle Φ.

Current equation is i = Im sin (ωt)

Voltage equation is v =Vm sin (ωt - Φ)

So the lagging alternating quantity is one which attains its zero or maximum value later as compared to the other quantity having same frequency.

Lead Concept: (2 Marks)



V leads I by an angle Φ

Current equation is i = Im sin (ωt)

Voltage equation is v =Vm sin (ωt+Φ)

So the leading alternating quantity is one which attains its zero or maximum value earlier (before)as compared to the other quantity having same frequency.

c) What are the different types of power in AC circuit? Explain.

i) Active (Real or True) Power (P):-The active power is defined as the average power Pavg taken by or consumed by the given circuit**.**

OR It is the product of V, I and cosine angle between V andI i.e. Φ.

OR It is the power developed in the resistance of the circuit. It is given by

P =V.I.Cos Φ **Unit :-** Watt **OR** Kwatt**($1\frac{1}{2}$ Marks)**

Where
Φ = Phase angle between V and I

ii) Reactive Power (Q):-The reactive power is defined as the product of V, I and sine of angle between V and I i.e. Φ.
OR It is the power developed in the reactance of the circuit. The reactive power is also called as imaginary power. It is given by

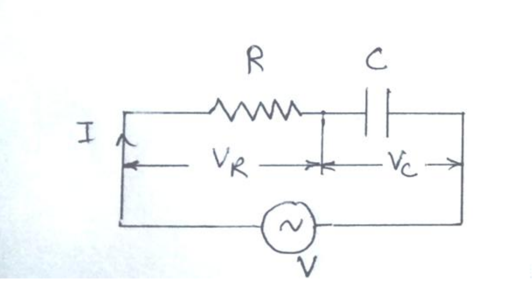
Q= V.I. sin Φ **Unit :-** VAR **OR** KVAR**($1\frac{1}{2}$ Marks)**

iii) Apparent Power (S) :-Apparent power is defined as the product of rms values of voltage (v) and current (I). It is given by
S=V.I **Unit :-** VA **OR** KVA**(1 Mark)**

d) For R-C circuit:

1. **Draw the circuit diagram**
2. **Write the voltage and current equation**
3. **Draw the vector diagram**
4. **Draw the impedance triangle.**

i) Draw circuit diagram(1 Mark)

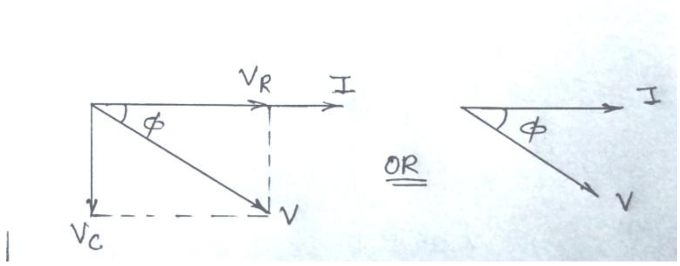


ii) Voltage equation and current equation (1 Mark)

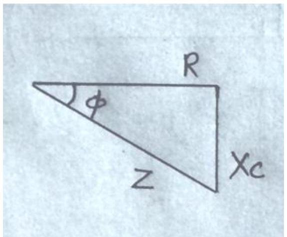
$v = V_m \sin wt$

$i = I_m \sin (wt+\Phi)$

iii) vector diagram (1 Mark)



iv) impedance triangle (1 Mark)



e) Explain voltage ratio, current ratio and transformation ratio of a transformer with a neat sketch.

<u>Ans.</u>

Voltage Ratio:- It is the ratio of primary voltage to secondary voltage. **(1 Mark)**

$Voltage\ ratio = \frac{V1}{V2}$

Where, V_1 is voltage in primary winding
V_2 is voltage in secondary winding

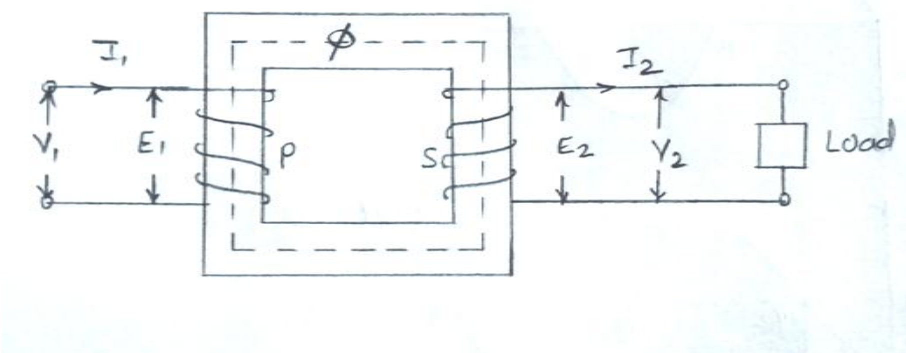
Current Ratio:- It is the ratio of primary current to secondary current**.** **(1 Marks)**

$Current\ \ ratio = \frac{I1}{I2}$

Where, I_1 is current in primary winding
I_2 is currrent in secondary winding

Transformation Ratio (k):- It is the ratio of secondary voltage to primary voltage of the transformer.**(1 Mark)**

Transformation ratio$=K= \frac{V2}{V1}= \frac{E2}{E1} = \frac{N2}{N1} =\frac{I1}{I2}$



(1 Mark)

f) State the principle of operation of an universal motor. Give any two applications.

Principle of operation: **(2 marks)**

These motors can run both on a.c. as well as d.c. Universal motor works on the principle that when a current carrying conductor is kept in magnetic field, it experiences a mechanical force and the direction of force is given by Fleming's left hand rule.

(In this motor, supply is given to filed winding as well as armature winding. Field winding is connected I series with armature winding. As current flows through field winding, magnetic field is produced. Since current is flowing through armature winding also, so armature winding becomes current carrying conductor kept in magnetic field. Hence armature winding experiences force and makes armature to rotate.) ---- **Optional**

Applications of Universal motor : **(2 marks)**

For domestic appliances like VacuumCleaners, food mixers, Coffee Grinders, Hair dryers, Sewing machines, electric shavers, etc.

Other applications include blowers, mechanical computing machines, portable tools like Drilling Machines and other small power drives.

Q.5. Attempt any four of the following: (16 M)

a) A 50 Hz voltage of 230 volt rms value is applied across a capacitor of 26.5μF. Calculate

i. The capacitive reactance

ii. Write the time equation for voltage and the resulting current. Let the zero axis of the voltage be at t=0.

(5(a)i-1Mark, 5(a)ii-3Marks)

Ans.

Given f = 50Hz, V_{rms} = 230V, C = 26.5 μF.

X_C = ? Equations for V = ? & I = ?

X_C is given by,

$X_C = \frac{1}{2\Pi f C}$

$= \frac{1}{2\ X \Pi X\ 50\ X\ 26.5\ X 10^{-6}}\ \Omega$

$= \frac{1.2\ X\ 10^{-4}}{10^{-6}}$

$\mathbf{X_C = 120\ \Omega.}$ **(1 M)**

$V_{rms} = \frac{V_m}{\sqrt{2}}$ => $V_m = V_{rms} \text{ x } \sqrt{2}$

$= 230 \text{ x } \sqrt{2} =$ **325.27** V. **(1/2 M)**

Therefore, Voltage equation is,

$V = V_m \text{ Sin } \omega t$

$= V_m \text{ Sin } 2\ \Pi\ f\ t$

$\mathbf{V = 325.27\ Sin\ 314.16\ t.}$ **(1 M)**

$I_{rms} = \frac{V}{X_C} = \frac{230}{120} = 1.92A.$

$I_m = I_{rms} \text{ x } \sqrt{2} = 1.92 \text{ x } \sqrt{2} =$ **2.72** A. **(1/2 M)**

Current Equation is,

$I = I_m \text{ Sin } (\omega t + \frac{\pi}{2})$

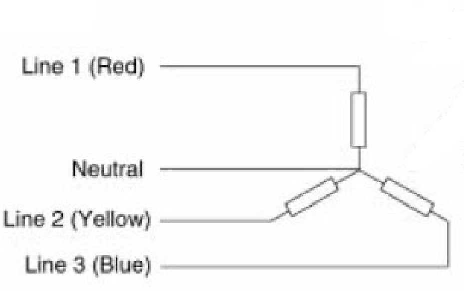
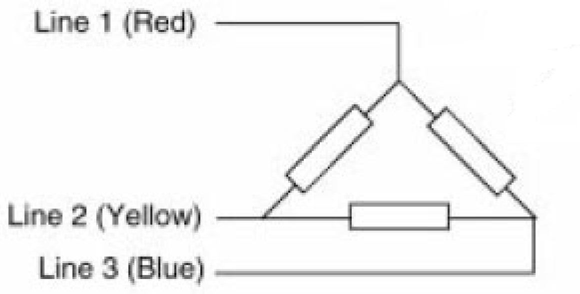
$\mathbf{I = 2.72\ Sin\ (314.16t + \frac{\pi}{2})}$ **(1 M)**

b) Compare star and delta connection(4 points)

Any 4 points – 1M each.

Ans.

Star Connection	Delta Connection
This is obtained by connecting one end of three resistors together, also called as Y connection	This is obtained by connecting three resistors to form a closed loop as symbol Δ also called as mesh loop.
Phase voltage V_{PH} is less than Line voltage V_L given by $V_{PH} = \frac{V_L}{\sqrt{3}}$	Phase voltage V_{PH} is equal to Line voltage V_L.
Phase current I_{PH} is equal to Line current I_L.	Phase current I_{PH} is less than Line current I_L given by $I_{PH} = \frac{I_L}{\sqrt{3}}$
Star connection can be shown as	Delta connection can be shown as

	
Neutral point N exists.	No neutral point.
Active power P= $\sqrt{3}$**$V_L I_L$ cosØ or** **P = 3$V_{ph}I_{ph}$cosØ**	Active power P= $\sqrt{3}$**$V_L I_L$ cosØ or** **P = 3$V_{ph}I_{ph}$cosØ**

c) Define phase sequence of 3 phase voltage. What is the normal phase sequence? What are the 3 colors used to denote the phase sequence?
(Definition 2M, phase sequence 1M, Colors 1M)

Phase sequence: This is defined as the order or sequence in which the three phases reach their maximum positive values. The three phases voltages are denoted by V_R, V_Y and V_B.
(The direction of rotation of the three phase machines depends on phase sequence. If phase sequence is changed then direction of rotation also changes.) (optional)

The normal phase sequence is R – Y – B.
The colours used to denote the phase sequence are Red, Yellow and Blue.

d) State the advantages of three phase system over single phase system.
(Any four advantages – 1M each)

Advantages of 3–φ over 1–φ :

1. The output of 3–φ system is high than single phase system.
2. For same capacity, the 3–φ systems are smaller, cheaper and lighter than 1–φ
3. 3–φ motors are self starting, hence separate starter is not required.
4. Transmission efficiency is high compared to 1–φ voltage.
5. In three phase power delivered to the load is same at any instant, whereas in 1–φ power fluctuates and falls to zero 3 times during each cycle.
6. Three phase can be used in large power and industrial applications, whereas 1–φ systems cannot be used.
7. The power factor is better in 3–φ system.

e) If a 3 phase 400V, 50Hz, supply is connected to balanced, 3 phase star connected load of impedance(3+j6) ohm per phase. Calculate (1) phase current (2)phase voltage (3) power factor (4) total active power.
(Each calculation 1M)

Given:
V_L=400V
F=50Hz
R=3Ω
X=6Ω

I_{ph}=?
V_{ph}=?
$cos\emptyset\ (p.f) =?$
$Active\ power =?$

Ans.

$$V_{Ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230.94V$$
$$z = \sqrt{R^2 + X^2} = \sqrt{3^2 + 6^2} = \sqrt{9 + 36} = \sqrt{45} = 6.708\Omega$$
$$I_{ph} = \frac{V_{Ph}}{z} = \frac{230.94}{6.708} = 34.43A$$
$$I_L = I_{ph}$$
$$\cos\emptyset = \frac{R}{|Z|} = \frac{3}{6.708} = 0.447(lagging)$$
$$\text{Active power} = \sqrt{3}\mathrm{V_L I_L}\cos\emptyset = \sqrt{3} \times 400 \times 34.42 \times 0.45 = 10.66\mathrm{Kw}$$

f) List any 4 major parts of transformer and state the material used for construction. Why the transformer rating is given in KVA?
[Name of parts – 1M (Any four) , material used - 1M)
Note: either the parts or diagram can be considered.

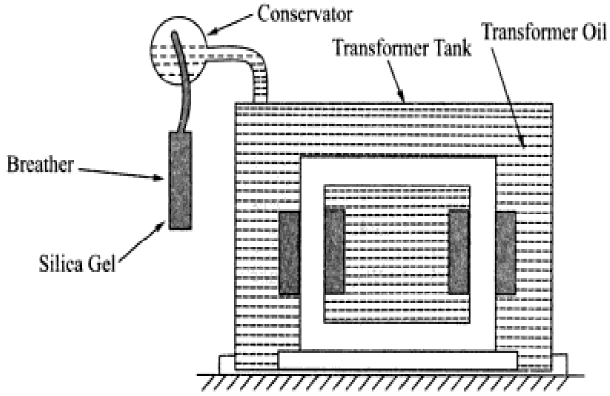
Parts of transformer:

1. Primary and Secondary winding (Copper)
2. Core (Silicon Steel)
3. Transformer Tank (Mild steel or Cast Iron)
4. Conservator (Mild steel or Cast Iron)
5. Breather with Silica gel
6. Bushings
7. Buchholz relay

Other parts include,

- A suitable container for assembled core and windings
- A suitable medium for insulating the core and its windings from container

Material used for construction is **silicon steel** for its high permeability and low magnetic reluctance.



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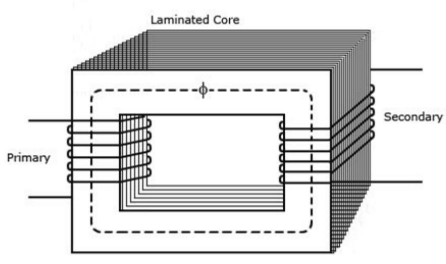

Reason for transformer rating in KVA: **(2M)**

- At the time of manufacturing of a transformer, the nature of load is not known. The output **power factor** is a function of **load.**
- Also copper loss depends on current and iron loss depends on voltage. Hence total losses depend on current and voltage only and not on power factor.
- Hence the rating of a transformer is expressed in terms of voltage and current in VA or KVA and not in W or KW.

Q.6. Attempt any four of the following: (16M)

a) Coils consist of 0.08 H inductance with resistance 40 ohm connected to 230 volt, 50 Hz supply. Find impedance, reactance, current and power factor of coil.
(Each Calculation 1M)

Given:
L=0.08H
R=40Ω
V_{rms}=230V
F=50Hz

Z=?
X_L=?
I_{rms}=?
$\cos\emptyset=?$

$$z=\sqrt{R^2+{X_L}^2}=\sqrt{40^2+(25.13)^2}=47.24\Omega$$

$$X_L=2\pi fL=2\times\pi\times50\times0.08=25.13\Omega$$

$$I_{rms}=\frac{V_{rms}}{z}=\frac{230}{47.24}=4.87A$$

$$\cos\emptyset=\frac{R}{|z|}=\frac{40}{47.24}=0.847(Lagging)$$

b) Find the impedance per phase for 3 phase supply carries the current 12.5 A with power factor 0.8 lagging.

Given: (1M)
$V_L=V_{ph}$=500V

f=50Hz

I_L=12.5A

$\cos\emptyset=0.8$ lagging
Z=?

Calculation: (3M)

$$I_{ph}=\frac{12.5}{\sqrt{3}}=7.22A$$

$$Z=\frac{V_{ph}}{I_{ph}}=\frac{500V}{7.22A}=69.25\Omega$$

c) A coil of resistance of 10Ω and inductance of 0.1 Henry is connected in series with a capacitance of 150μF across 230V, 50Hz, ac supply. Calculate impedance, current, power factor and power consumed by circuit.
(each calculation 1M)

Given:
R=10Ω
L=0.1H
C=150μF
F=50Hz
V_{rms}=230V
Z=?
I=?
$\cos\emptyset = ?$
P=?

$$X_L = 2\times\pi\times 50\times 0.1 = 31.42\Omega$$

$$X_c = \frac{1}{2\times\pi\times 50\times 150\times 10^{-6}} = \frac{2.122\times 10^{-5}}{10^{-6}} = 21.22\Omega$$

$$X_L \sim X_c = 31.41 - 21.22 = 10.19\Omega$$

$$z = \sqrt{R^2 + X^2} = \sqrt{10^2 + 10.19^2} = 14.28\Omega$$

$$I = \frac{V}{Z} = \frac{230}{14.28} = 16.11A$$

$\cos\emptyset = \frac{R}{|Z|} = \frac{10}{14.28} = 0.7$ (lagging)

$$P = VI\cos\emptyset = 230\times 16.1\times 0.7 = 2.59kw$$

d) Compare resistance split phase I.M. with capacitor start motor.(Any four points – 1M each.)

Resistance split phase I.M.	**Capacitor start I.M.**
To create the phase difference between current in the two windings, high resistance is connected in series with starting (auxiliary) winding.	To create the phase difference between current in the two windings, capacitor is connected in series with starting (auxiliary) winding.
Split phase induction motors have moderate starting torque.	Capacitor start I.M. have high starting torque
So these motors are used in fans, blowers, centrifugal pumps, washing machine, grinder etc.	These motors have high starting torque hence they are used in conveyors, grinder, air conditioners, refrigerators, compressors etc.
These motors are available in the size ranging from 1 / 20 to 1 / 2 KW.	They are available up to 6 KW.
Power factor is low.	Power factor is better.

e) Define voltage regulation of transformer. Two transformers A and B have a voltage regulation of 5% and 10% respectively. Which transformer is better and why? (**Definition -1 M; formula 1M**)

Voltage Regulation of a transformer :

- The voltage regulation of a transformer is defined as the change in secondary terminal voltage (V_2) from no load to full load with primary source voltage (V_1) and temperature of the transformer maintained constant.

- Voltage regulation = $\frac{V_{2NL}-V_{2FL}}{V_{2FL}}$ X 100

- $= \frac{E_2 - V_2}{V_2}$ X 100

Two transformers A and B have voltage regulation of 5% and 10% respectively. The transformer B with 5% regulation is better. Lesser the regulation, less is the change in the output voltage from no load to full-load. Hence 5% regulation means less change and better transformer.**(2M)**

f) Define fuse. What is need of fuse? Write rating of fuses used in labs and mention the classification of fuses. (definition 1M, need 1M, rating 1M, Classification (Any 2) - 1M)

Definition : Fuse is a thin strip of wire of low melting point and is provided in all electrical circuit as a protective device which protects and prevents damage of the electrical equipments.
Need : Fuse is used in the appliances against the flow of excessive current in a circuit as the fuse wire melts beyond its current carrying capacity. Fuse is always provided on the phase or line wire.

Voltage rating and current ratings are used in labs to decide the fuse rating according to appliances.

Classification of fuses:

1. Rewireable or Kit-Kat type(semi enclosed type)
2. HRC (high rupturing capacity) fuse
3. Totally enclosed type
4. Cartridge type