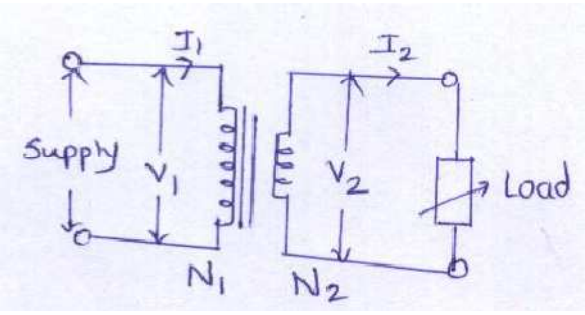
Important Instruction to examiners:

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 principle components indicated in a 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 some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 Attempt any Ten of the following **20 Marks**

a) What is step of transformer? **(2 Marks)**



or Equivalent fig.

When secondary voltage of the transformer is greater than is primary voltage than it is called step up transformer **OR**

When, $V_2 > V_1$ or $N_2 > N_1$ in case of step up transformer

b) State Ohm's law and also write it in the form of equation.

(State-1 Mark & Equation-1 Mark)

Ohms Law:-

The current flowing through a solid conductor is directly proportional to the difference of potential across the conductor. & inversely proportional to its resistance provided the temperature remains constant.

Equation:- **i.e** $I \propto V \quad \therefore \frac{V}{I} = constant \quad \therefore I = \frac{V}{R}$

$$or \quad \therefore V = I.R. \quad or \quad R = \frac{V}{I}$$

Where R is constant called as resistance, V=voltage and I = Current

c) Define: i) Passive element ii) Bilateral circuit. **(Each Definition 1 Mark)**

i) Passive Element:

If a network does not contain any energy source then it is called as passive element.

ii) Bilateral Circuit:

It is the network whose characteristics or response does not depend on the direction of current through the various elements in it.

d) Write down two applications of Servo motor.

Applications of Servo Motor: - **(Each Application 1 Mark, any two expected)**

1. Widely used in radar
2. Tracking system
3. Guidance system
4. Process controller
5. Computer system
6. Various machines tools

e) What do you mean by emf equation of the transformer? **(2 Marks)**

$E_1 = 4.44\ f\ \phi_m N_1$ **OR**

$E_1 = 4.44\ f\ B_m A N_1$

R.M.S. value in the whole table secondary winding

$E_2 = 4.44\ f\ \phi_m N_2$ **OR**

$E_2 = 4.44\ f\ B_m A\ f\ N_2$

f) Name any four parts of a D.C motor. **(Each part of motor 1/2Mark)**

Name of the parts of DC Motor: (Any four expected)

1. Yoke
2. Pole cores and pole shoes
3. Pole coils
4. Armature cores
5. Armature windings
6. Commutator
7. Brushes
8. Bearings.

g) Define resistance and conductance of a material. . **(Each Define 1 Mark)**

Resistance:-

It is defined as the opposition offered by a conductor to the flow of current. It is represented by R & its unit is ohm (Ω).

OR The formula for resistance is given by

$R = \rho \times (l/a)$ OR $R = V/I$

Where ρ= resistivity of conducting material

l= length of conducting material

a= area of cross section of conductor

Unit: - Ohm (Ω).

Conductance:

It is defined as the reciprocal of resistance, since the resistance is a measure of opposition offered by the conductor to the flow of current, conductance is taken as a measure of the ease with which current may flow through a conductor.

It is represented by the letter 'G' it's unit is mho

h) Why transformer rating is always specified in terms of the KVA? (2 Marks)

Output power of transformer is given by P= VICosØ, for different types of load i.e (resistive, capacitive, inductive) cosØ changes so, for same voltage and current output power will different, so transformer is designed to operate at particular voltage and current levels and it not designed to deliver particular output power that is why rating of transformer is in KVA.

OR

As copper loss of a transformer depends on current and iron loss on voltage, Hence total transformer loss depends on volt-ampere and not on phase angle between voltage and current ie. It is independent of load power factor. That is why rating of transformer is in KVA.

i) Define RMS value of a.c. voltage.

R.M.S Value: ---------- (2 Mark)

The r.m.s value of an alternating current is that steady current (d.c) which when flowing through a given resistance for a given time produces the same amount of heat as produced by the alternating current when flowing through the same resistance for the same time.

OR

∴ RMS Value = Form Factor × Average Value **OR**

RMS Value = 0.707× maximum value

j) What is the function of a transformer in a.c circuit? **(2 Marks)**

The function transformer is:

1. To transfer electric power from one circuit to another without change in frequency.
2. It can raise or lower the input voltage.

k) For star connected load, state numerical relationship between: i) Line current and Phase current ii) Line voltage and Phase voltage. **(Each Relationship- 1 Mark)**

i) Line current and Phase current: $\mathbf{I_L = I_{Ph}}$

ii) Line voltage and Phase voltage: $\mathbf{V_L = \sqrt{3}\, V_{Ph}}$

l) Define peak factor and form factor. **(Each Definition 1 Mark)**

Peak factor-

The maximum value of an alternating quantity is called as peak factor.

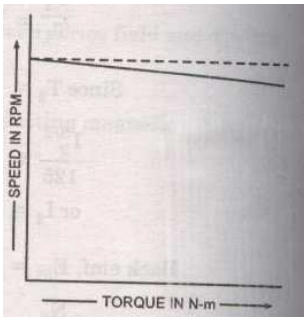
Form factor-

It is defined as the ratio of its RMS value to its Average value.

Q.2 Attempt any Four of the following **16 Marks**

a) Draw any two characteristics of a DC shunt motor and comment on the shape of the characteristics. **(Characteristics-1 Mark & Comments-1 Mark for each)**

i) Torque speed:



$$Eb = \frac{\phi ZNP}{60A}$$

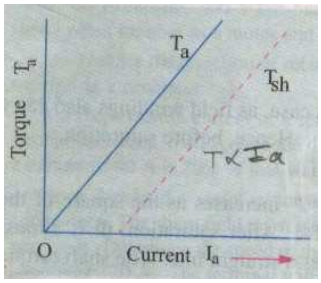
$$N \propto E_b \propto V - I_a R_a \qquad \text{(since all other constant)}$$

Comments:-

It is a dropping characteristic by small drop since:

From these $N \propto E_b \propto V - I_a R_a$ it is clear that as load increases $I_a R_a$ drop increases hence speed decreases as shown in the graph

ii) Torque Armature current:-



$$T = \frac{1}{2\pi} \times \phi Z I_a \frac{P}{A}$$

$T \propto I_a$ (Since all others are constant)

Comments:-

It is a straight line characteristic since:

In case of shunt motor ϕ is constant therefore $T \propto I_a$ (This is equation of straight line) from this equation it is clear that as armature current increases, torque increases. As shown in graph.

b) Explain the concept of short circuit and open circuit. **(Each Concept-2 Marks)**

Short Circuit:-

1. When phase and neutral wire touches then short circuit takes place. **OR**
2. When different phases (R, Y, B) touches each other then short circuit takes place

Open Circuit:-

1. An open circuit exists between two isolated terminals of a network which are not connected by an element of any kind **OR**
2. Open circuit means there is no continuity between two terminals.

c) Given Data:

V = 25 sin (200 π t) To Find :- Frequency =?, ii) w =?, iii) peak factor=? And iv) form factor=?

We know, $\therefore v = V_m \sin wt$ ----------(I)

$\therefore V = 25\sin(200\pi t)$ ----------(II)

Comparing equation (I) & (II) we get

Step-I:- To find the frequency:---------- **(1 Mark)**

$\therefore w = 200\pi \quad w = 2\pi f$

$\therefore \quad f = \frac{200\pi}{2\pi}$

$\therefore \quad f = 100\ Hz$

Step-II:- To find Angular Velocity:---------- **(1 Mark)**

$\therefore w = 200\pi, \quad = 628.31$

$\therefore w = 628.31 \ rad/\sec$

Step-III:- To find Peak Factor:---------- **(1 Mark)**

$$Peak \ \ factor = \frac{Maximum\ value}{RMS\ value}$$

$RMS\ \ Value = 0.707 \times \max imum\ value$

$RMS\ \ Value = 0.707 \times 25 = 17.675$

$$\therefore Peak \ \ factor\ Kp = \frac{Maximum\ value}{RMS\ value}$$

$$\therefore Peak \ \ factor\ Kp = \frac{25}{17.675}$$

$\therefore Peak \ \ factor\ Kp = 1.414$

Step-IV:- To find Form Factor:---------- **(1 Mark)**

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

$Average\ \ value = 0.637 \times \max imum\ vale$

$Average\ \ value = 0.637 \times 25 = 15.925$

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

$$Form\ \ factor = \frac{17.675}{15.925}$$

$$\therefore Peak\ \ factor\ Kp = 1.11$$

d) Write four advantages of 3-phase system over single phase system.

Advantages of 3-phase system over 1-phase system:- (Any Four points each point 1 Mark)

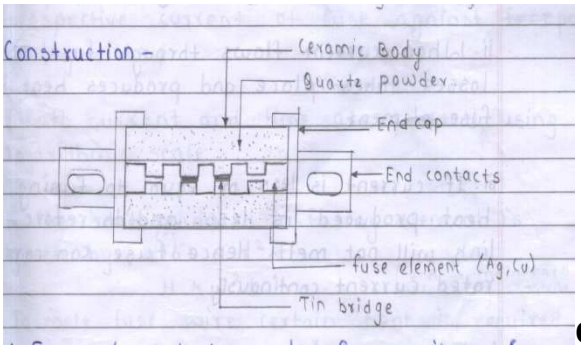
1. **More output:-** for the same size output of poly-phase machines is always higher than single phase machines.
2. **Smaller size:-**for producing same output the size of three phase machines is always smaller than that of single phase machines.
3. **More power is transmitted-** it is possible to transmit more power using a three phase system than single system.
4. **Smaller cross-sectional area of conductors-** if the same amount of power is transmitted then the cross-sectional area of the conductors used for three phase system is small as compared to that of single phase system.
5. Better power factor-power factor of three phase machines is better than that of single phase machines.
6. Three phase motors are self starting-three phase ac supply is capable of producing a rotating magnetic field when applied to stationary windings, the three phase ac motors are self starting. While single phase induction motor needs to use additional starter windings
7. Horse power rating of three phase motors is greater than that of single phase motor.
8. Power delivered by a single phase system fluctuates whereas for three phase system power delivered to the load is the same at any instant.

e) What is fuse? Also explain the working of HRC fuse in brief.

(Definition of fuse-1 Mark, Figure-1 Mark and Explanation-2 Marks)

Fuse:

It is protective device against over current, occurs due over load or short circuit



OR Equivalent Fig.

Working of HRC fuse:

i) Fuse is always connected in series with the device to be protected. Therefore the device current flows through fuse element.

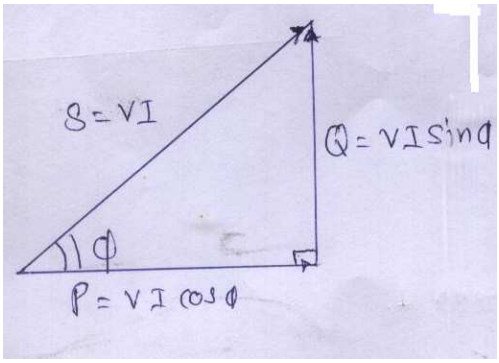
ii) When current flows through fuse, I^2R losses takes place and produces heat in fuse element.

iii) If current is less or equal to fusing current heat produced is less and therefore fuse link will not melt. Hence fuse can carry rated current continuously.

iv) If current increases then heat developed is also increased. If temperature increases above 230^0 then tin bridges melt and arc is produced. Due to heat of arc metal vapours react with the quartz powder and produces electrically insulating substance. It fills gap between fuse elements and hence current is interrupted.

f) Draw power triangle for R-C circuit. Define inductive reactance and impedance

Power triangle for R-C circuit:-



Where, P = Active power, Q = Reactive power (in case of R-C circuit leading)

S= Apparent Power

Inductive Reactance:

When alternating current of frequency 'f' flows through inductance L, a voltage drop V= (2 π fL) x I is produced in the inductance the quantity 2 π fL which has the same units as ohm, and is called reactance of the inductance. **OR**

$$X_L = 2\pi f L \quad \text{ohm}$$

Impedance:

The combined effect of resistance and reactance is called Impedance **OR**

$$Z = \sqrt{R^2 + (XL - XC)^2} \quad Ohm$$

Q.3 Attempt any Four of the following **16 Marks**

a) What is meant by trouble shooting? State any two problems and remedies in UPS.

(Meaning of trouble shooting-2 Mark and Remedies of UPS-2 Marks)

Note: In this question credit may be given by judgment on part of examiner of relevant answer based on candidate understands.

Trouble Shooting Means:

Problems/ symptom their causes and remedies.

Trouble shooting:

1. Connection may loose.
2. Switch terminals may loose.
3. Three plug points may not be property earthed.
4. Defective switch or plug.
5. Loose fixing of switch board.
6. Battery may be discharge.
7. Level of distilled water is low in battery.
8. Electronic Fault in UPS

OR (Any two expected)

S.No.	Problems	Cause:	Remedy:
1	No power output and green "AC LINE" lamp on.	Blown 2A fuse or system malfunction	Inspect 2A fuse at the front of UPS. Replace if Busted (same rating.) Chirping sound, yellow "CHARGING" lamp & red "LOW BATT" lamp flickering.
		Battery disconnected from UPS or loose battery cable or blown 25A/30A fuse	Check the connection of the battery to the UPS. Re connect cables if it has been disconnected. Clean battery post if it's dirty. Check all 25A/30A fuse for signs of meltdown
2	Backup time shorter than normal or early beeping for "LOW BATT" alarm.	Blown fuse.	Check all fuse at the front panel for meltdown and replace it with the some rating. If symptom persists, take unit to dealer for servicing.
3	"UPS MODE" & "AC LINE" lamp always on, fan running, UPS beeping & "LOW BATT" lamp blinking.	Blown fuse.	Check all fuse at the front panel for meltdown and replace it with the same rating. If symptom persist, take unit to dealer for servicing.

b) Given Data:

$V_1 = 6600$ V $V_2 = 600$ V f = 50 Hz N_1 =? N_2=?

A= 200 cm^2 = 200 x10^{-4} m^2

i) Number of turns in the primary side:-

$$e_1 \text{ or } V_1 = 4.44 \times f \times B_m \times A \times N_1$$ ---------- **(1 Mark)**

$$6600 = 4.44 \times 50 \times 1.35 \times 200 \times 10^{-4} \times N_1$$

$$N_1 = \frac{6600}{4.44 \times 50 \times 1.35 \times 200 \times 10^{-4}}$$

$N_1 = 1101.10\ turns \cong 1101\ turn$ ---------- **(1 Mark)**

ii) Number of turns in the Secondary side :-

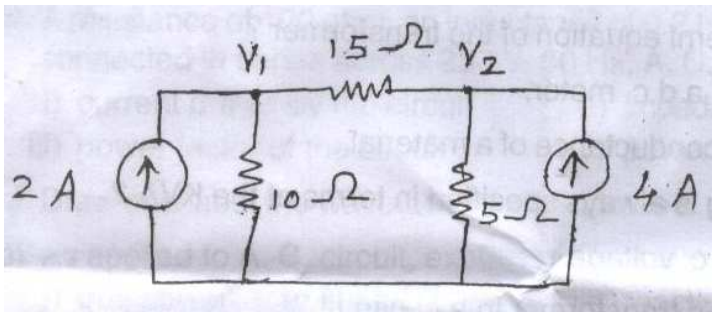
$V_2 = 4.44 \times f \times B_m \times A \times N_2$ ---------- **(1 Mark)**

$600 = 4.44 \times 50 \times 1.35 \times 200 \times 10^{-4} \times N_2$

$$N_2 = \frac{600}{4.44 \times 50 \times 1.35 \times 200 \times 10^{-4}}$$

$N_2 = 100.10\ turns \cong 100\ turns$ ---------- **(1 Mark)**

c) Using nodal analysis find the node voltages V_1 and V_2 for the circuit shown in fig.No.1



Applying KCL at node V_1 we get

$$2 = \frac{V_1}{10} + \frac{V_1 - V_2}{15}$$ ---------- **(1/2 Mark)**

$$2 = \frac{15V_1 + 10V_1 - 10V_2}{150}$$

$300 = 25V_1 - 10V_2$

$5V_1 - 2V_2 = 60$ ---------- (I) ---------- **(1 Mark)**

Applying KCL at node V_2 we get

$$\frac{V_1 - V_2}{15} + \frac{4}{1} = \frac{V_2}{5}$$ ---------- **(1/2 Mark)**

$$\frac{V_1 - V_2}{15} + 4 = \frac{V_2}{5}$$

$V_1 - V_2 + 60 = 3V_2$

$V_1 - 4V_2 = -60$ ---------- (II) ---------- **(1 Mark)**

Solving equation (I) and (II) we get

$-10V_1 + 4V_2 = -120$ (Multiply both side by 2 and – ve sign)

$V_1 - 4V_2 = -60$

$-9\,V_1 = -180$

$$V_1 = \frac{180}{9}$$

V1= 20V

Substituting the value of in equation No. II

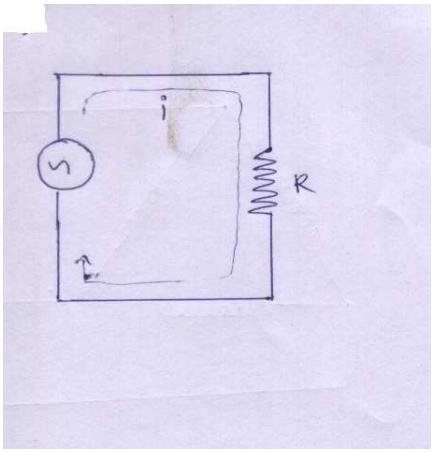
$$V_1 - 4V_2 = -60$$

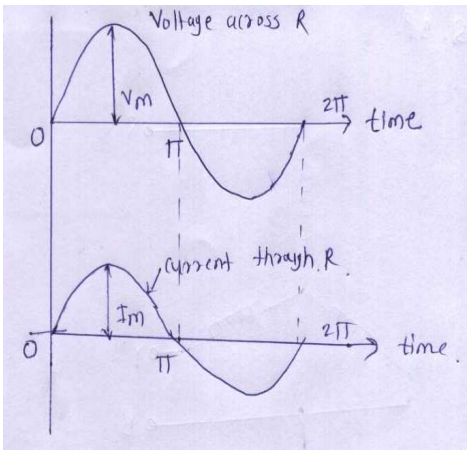
$$V_2 = \frac{V_1 + 60}{4}$$

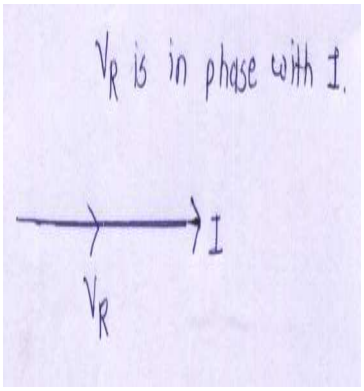
$$V_2 = \frac{20 + 60}{4}$$

V_2 = 20 Volt---------- **(1 Mark)**

d) Draw waveform and phasor diagram of simple pure resistive circuit. When a.c. is applied it?







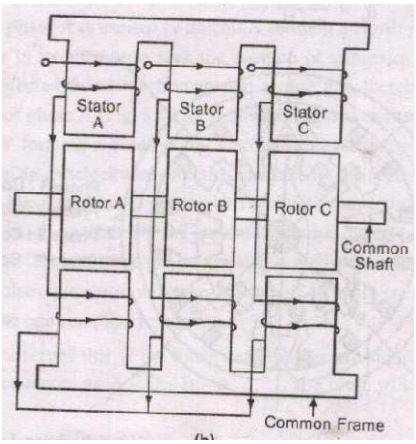
e) Draw a neat labeled diagram of stepper motor and state its working principle.

(Any one method of Stopper motor: Diagram-2 Marks & Working-2 Marks)

Stepper Motor: -

1. A stepper motor is basically an electromagnetic transducer or an incremental actuator which converts digital pulse into inputs into output shaft motion.
2. The essential property of stepper motor is its ability to translate switched excitation into precisely defined increment of output shaft motion.

1) Variable Reluctance Motors:-



or equivalent dia.

Working:-

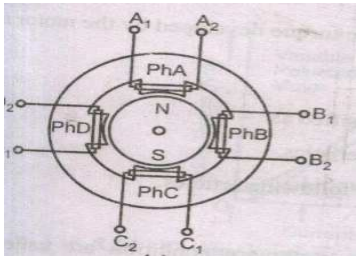
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

Then phase 'B' is excited disconnecting supply of phase 'A' then rotor will move 30 anticlockwise directions. The Same process is repeated for phase 'C'

In this way chain of signals can be passed to get one revolution and direction can be also changed.

OR

2) Permanent Magnet Motor:-



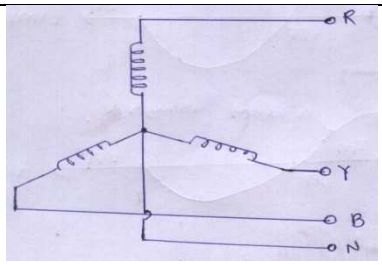
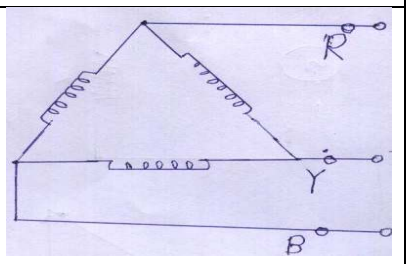
or equivalent dia.

Working :-

If the phase is excited in ABCD, due to electromagnetic torque is developed by interaction between the magnetic field set up by exciting winding and permanent magnet.

Rotor will be driven in clockwise direction.

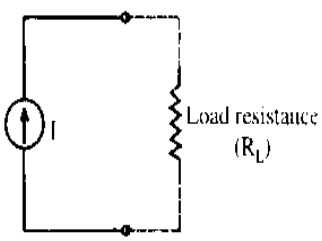
f) Compare between Star connection and delta connection. (Any four point) (1 Marks Each)

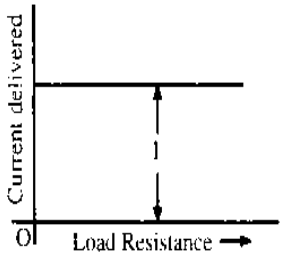
Sr no	Parameter	Star connection	Delta connection
1.	Way of connection		
2.	Voltage relationship	$V_L = \sqrt{3}\, V_{Ph}$	$V_L = V_{Ph}$
3.	Current relationship	$I_L = I_{Ph}$	$I_L = \sqrt{3}\, I_{Ph}$
4.	Neutral wire	Neutral point formed	No neutral point formed

Q.4 Attempt any Four of the following **16 Marks**

a) Represent the following by their symbols: i) Ideal and practical current source ii) Ideal and practical voltage source

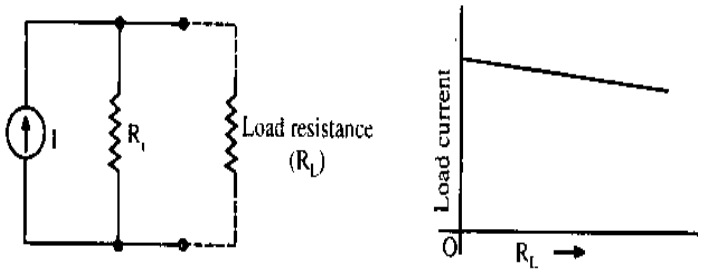
i) Ideal current source: - ---------- (1 Mark)





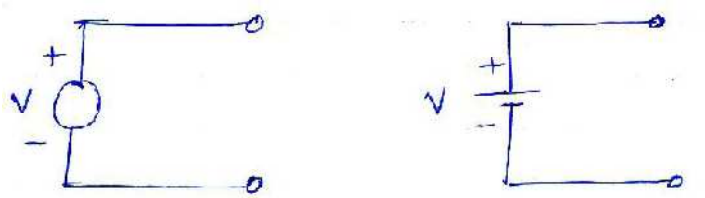
or Equivalent fig.

i) Practical current source: ---------- (1 Mark)



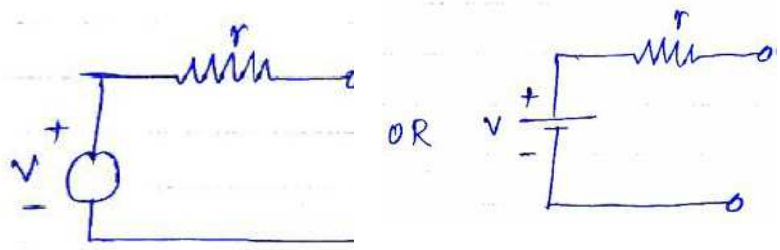
or Equivalent fig.

i) Ideal voltage source- ---------- (1 Mark)



or Equivalent fig.

ii) Practical voltage source- ---------- (1 Mark)



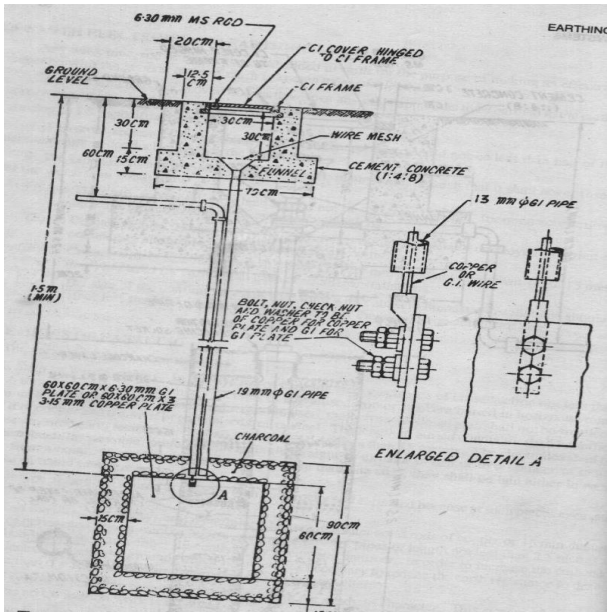
or Equivalent fig.

b) State the importance of earthing. Draw neat labeled diagram of plate earthing.

Importance of Earthing:- ----------(2 Marks)

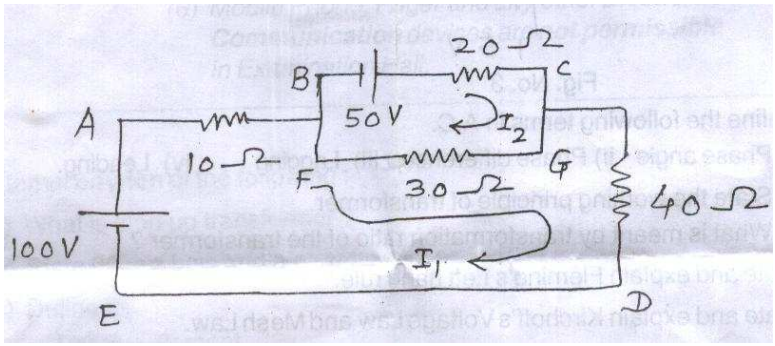
1. Earthing is protects human from shocks from leakage current.
2. It avoids electrical accidents due to leakage current.

Neat labeled Diagram of Plate Earthing: ---------- **(2 Marks)**



or Equivalent fig.

C) Given Data: Using Maxwell's loop current method



Applying KVL for Loop –I: (AFGDEA)

$100 - 10\ I_1 - 30\ (I_1 - I_2) - 40\ I_1 = 0$ ---------- **(1/2 Mark)**

$-80\ I_1 + 30\ I_2 + 100 = 0$

$80\ I_1 - 30\ I_2 = 100$

$8\ I_1 - 3\ I_2 = 10$---------- (I) ---------- **(1 Mark)**

Applying KVL for Loop –II: (BCGFB)

$50 - 20\ I_2 - 30(I_2 - I_1) = 0$---------- **(1/2 Mark)**

$30\ I_1 - 50\ I_2 = -50$

$3\ I_1 - 5\ I_2 = -5$ (Divided by 10 to above equation) ---- (II) ---------- **(1 Mark)**

Solving equation (I) and (II) we get

$8\ I_1 - 3\ I_2 = 10$ --- (I) $3\ I_1 - 5\ I_2 = -5$--- (II)

$40\ I_1 - 15\ I_2 = 50$ (Multiplying equation (I) by 5)

$-9\ I_1 + 15\ I_2 = +15$ (Multiply both side by 3 and – ve sign)

$31\ I_1 = 65$

$31\ I_1 = 65$

$I_1 = \frac{65}{31}$

$I_1 = 2.09$ Amp---------- **(1/2 Mark)**

Substituting the value of I1 in equation I

$8\ I_1 - 3\ I_2 = 10$

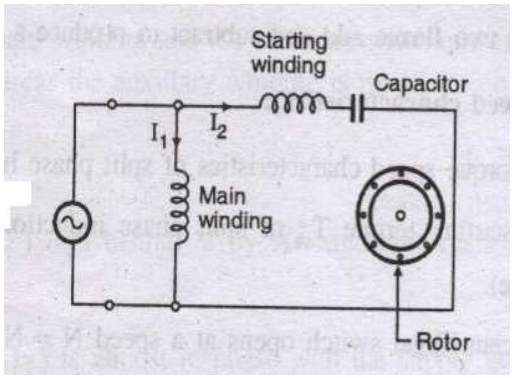
$I_2 = \frac{8(I_1) - 10}{3}$

$I_2 = \frac{(8 \times 2.09) - 10}{3}$

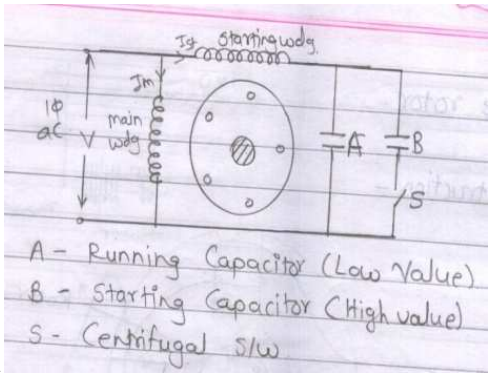
$I_2 = 2.24\ Amp$ ---------- **(1/2 Mark)**

d) Draw and explain working principle of capacitor start capacitor run single phase induction motor. **(Diagram-2 Marks & Working-2 Marks)**

Capacitor-start capacitor run 1-Ph Induction Motor:-



OR

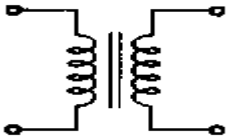
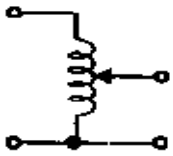


or Equivalent fig

Working Principle:

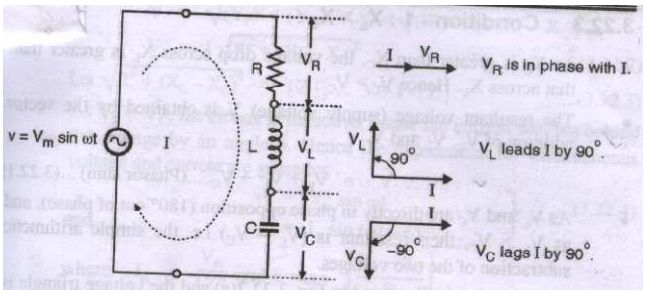
In these motors one capacitor is connected in series with the auxiliary winding. There is no centrifugal switch. Thus this winding along with the capacitor remains energized for both starting and running conditions. Capacitor used serves the purpose of obtaining necessary phase displacement at the time of starting and also improves the power factor of the motor.

e) Compare two winding transformer and auto transformer (Any four point) (Each point 1 Mark)

Sr no.	Points	Two winding transformer	Autotransformer
1.	**Symbol**		
2.	**Number of windings**	It has two windings	It has one winding
3.	**Copper saving**	Copper saving is less	Copper saving takes more as compared to two winding
4.	**Size**	Size is large	Size is small
5	**cost**	Cost is high	Cost is low
6	**Losses in winding**	More losses takes place	Less losses takes place
7.	**Efficiency**	Efficiency is low	Efficiency is high
8.	**Regulation**	Regulation is poor	Regulation is better
9.	**Electrical isolation**	Electrical isolation is present in between primary and secondary winding	There is no electrical isolation
10.	**Movable contact**	Movable contact is not present	Movable contact is present
11.	**Application**	Mains transformer, power supply, welding, isolation transformer	Variac, starting of ac motors, dimmerstat.

f) Draw the phasor diagram for R-L-C series circuit for the following conditions. i) $X_L<X_C$ ii) $X_L>X_C$

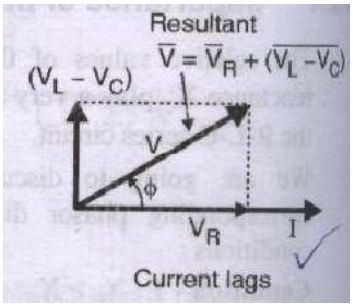
R-L-C Series circuit with vector diagram :----------(2 Marks)



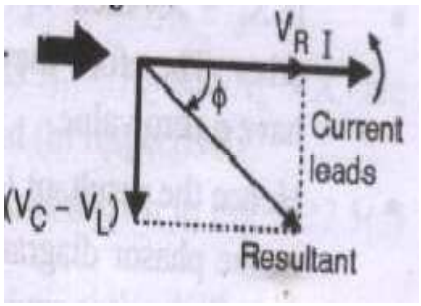
or Equivalent fig.

(Note: - Any one vector diagram is expected for the following (1 Marks Each Vector)

Vector Diagram: i) $X_L > X_C$ (lagging) ii) $X_C > X_L$ (leading)



OR



Q.5 Attempt any Four of the following 16 Marks

a) Given data:

$R_1= R_2=R_3=$ 19.5 ohm, $L_1= L_2=L_3=$ 0.35H, V= 440V, f= 50Hz 3-Ph i) Phase current=?, ii) Phase voltage=?, iii) Line current =? iv) Total power consumed

Solution:

Line Voltage (V_L) = 440V

i) Phase Voltage (V_{ph}):----------(1 Marks)

$\therefore$ Line voltage $V_L = \sqrt{3}$ Phase Voltage V_{ph}

$440 = \sqrt{3}\, V_{ph}$

$$V_{ph} = \frac{440}{\sqrt{3}}$$

$$V_{ph} = 254.03 \text{ Volt}$$

$$Inductance\ X_L = 2\pi f L = 2\times\pi\times 50\times 0.35$$

$$X_L = 109.95\ \Omega$$

$$\text{Impedance per phase } Z_{ph} = \sqrt{R^2 + X_L^2}$$

$$\text{Impedance per phase } Z_{ph} = \sqrt{19.5^2 + 109.95^2}$$

$$\text{Impedance per phase } Z_{ph} = 111.67\ \Omega$$

ii) Phase Current (I_{ph}) :----------(1 Marks)

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$

$$I_{ph} = \frac{254.03}{111.67}$$

$$I_{ph} = 2.274\ Amp$$

iii) Line Current (I_{ph}) :- ----------(1 Marks)

∴ In Star connection: - Line current I_L= Phase Current I_{ph}

Line current I_L= 2.274 Amp

iv) Power consumed (P) per phase:- ---------- (1 Marks)

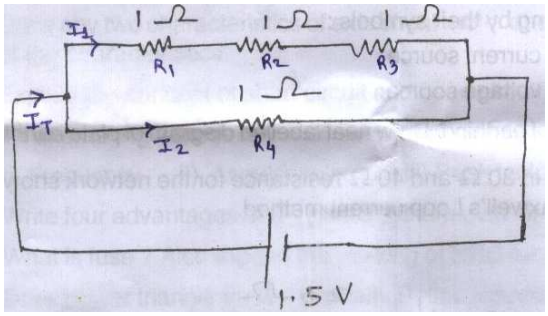
∴ $P = I^2R$

∴ $P = (2.274)^2 \text{x } 19.5$

∴ $P = 100.9$ watt

Total power consumed P = 3x Power/ph =100.9 x 3 **= 302.7 Watt**

b) Given data : For the given circuit shown in fig. determine: i) Current through each resistance ii) Power consumed by the circuit.



$$\text{Re}q = \frac{(R_1+R_2+R_3)\times R_4}{R_1+R_2+R_3+R_4} \qquad \text{Re}q = \frac{(1+1+1)\times 1}{(1+1+1)+1}$$

$$\text{Re}q = \frac{3\times 1}{3+1} = 0.75\,\Omega$$

Step-1: To find I_T = $I_T = \dfrac{V}{\text{Re}q} = \dfrac{1.5}{0.75}$

$I_T = 2\ Amp$ ---------- **(1 Mark)**

Step-2: To find I_1 = $I_1 = \dfrac{R_2}{R_1+R_2}\times I_T, \quad = \dfrac{1}{1+3}\times 2$

$I_1 = 0.5\ Amp$ ---------- **(1 Mark)**

Step-3: To find I_2 = $I_2 = I_T - I_1, \quad = 2 - 0.5$

$I_2 = 1.5\ Amp$ ---------- **(1 Mark)**

Step-4: Power consumed =

$\therefore$ $P = I_T^2\,\text{Req}$

$\therefore$ $P = (2)^2 \text{x } 0.75$

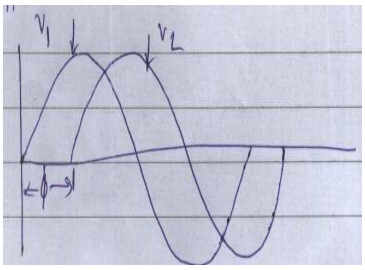
$\therefore$ P = 3 watt---------- **(1 Mark)**

c) Define the following terms in A.C i) Phase angle ii) Phase difference iii) Lagging iv) Leading **(Each Definition -1 Mark)**

i) Phase Angle:

It is the angle between any two quantities current and voltage or between two same voltages and same current.

i) Phase Difference: Suppose the two voltages V_1 & V_2



$V_1 = V_m \sin wt$ and $V_2 = V_m \sin (wt-Ø)$ **OR**

When two alternating quantities of same frequency attend their respective zero, positive maximum, negative maximum values at different instant, this angular displacement between the waveforms of two emf is known as phase difference. **OR**

Phase difference is defined as difference between the starting point of the two alternating quantity. 'Ø' is the phase difference in above example

iii) Lagging:

Alternating quantity one which attains its zero or maximum value latter than reference quantity.

iv) Leading:

Alternating quantity one which attains its zero or maximum value earlier as compared with reference quantity.

d) i) State the working principle of transformer ii) what is meant by transformation ratio of the transformer?

i) Working Principle: - ---------- (2 Marks)

- The primary winding is connected to single phase AC supply. an ac current starts flowing through it.
- The AC primary current produces an alternating flux in the core.

- This Changes flux gets linked with the secondary winding through the core
- The varying flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction. **OR**

A Transformer works on the principle of Faradays law of electromagnetic induction. When their primary winding is connected to a.c supply, applied alternating voltage circulates an alternating current through it.

- This current flowing through the primary winding produces an alternating magenetic flux ( ).This flux links with secondary winding through the magenetic core & induces an emf in it according to the faraday's laws of electromagnetic induction.

ii) Transformation Ratio (k):- ---------- **(2 Marks)**

It is the ratio of secondary number of turns to primary number of turns. OR It is the ratio of secondary voltage to primary voltage. OR It is the ratio of primary current to secondary current.

$$Transformation\ \ ratio\,(k) = \frac{N_2}{N_1}\ or = \frac{E_2}{E_1}\ or = \frac{V_2}{V_1}\ or = \frac{I_1}{I_2}$$

e) State and explain Fleming's Left hand rule.

Fleming's Left Hand Rule:- **(4 Mark)**

It states if the first three fingers of the left hand are held mutually at right angle to each other & if the index(First or Four) figure indicates of the original field, and if the middle finger indicates the direction of current flowing through the conductor, the thumb indicates the direction of force exerted on the conductor.

f) State and explain Kirchoff's voltage law and Mesh Law. (Statement 2 Marks & explanation 2 marks)

Kirchhoff's Voltage Law OR Mesh Law:-

It states that, algebraic sum of voltages & voltage drop in loop or mesh is equal to zero.

Σ voltage =0

OR

It states that in any closed loop the algebraic sum of potential rise is equal to algebraic sum of potential drop.

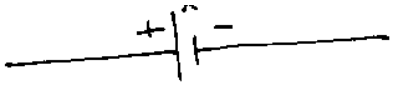
Σ Rise in voltage = Σ Fall in voltage

Sign convention for KVL

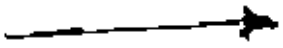
1. All loop taken in clockwise direction

2. While moving in a loop. If we cross the battery then the magnitude of voltage is the value of battery & polarity is,

a. Negative (potential drop), if positive plate is crossed first & then negative plate

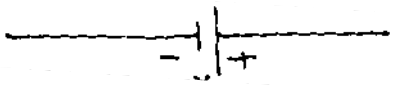


Voltage is negative i.e. -ve

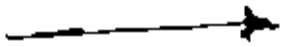


Direction of movement in loop

Positive (potential rises), if negative plate is crossed first & then positive plate



Voltage is positive i.e.+ve

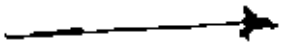


$\rightarrow$ Direction of movement in loop

3. While moving in loop , if we cross a resistor the magnitude of voltage is product of current & resistance of resistor i.e. I*R . the polarity is

a. Negative if the direction of current in that resistor is same as direction of movement in loop.

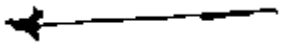
Voltage is negative i.e.-IR



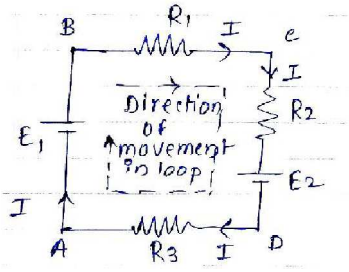
Direction of movement in loop

b. Positive if the direction of current in that resistor is opposite to direction of movement in loop.

Voltage is positive i.e.+ IR



Direction of movement in loop



Apply KVL to loop ABCDA

$\therefore + E_1 - IR_1 - IR_2 - E_2 - IR_3 = 0$

$E_1 = IR_1 + IR_2 + E_2 + IR_3$

We can conclude that

Σ Rise in voltage = Σ Fall in voltage

Q.6 Attempt any Four of the following **16 Marks**

a) State the function of any four major parts of DC Motor.(Any four expected 1 Mark to each part)

1. **Yoke:** To support the machine and to help to complete magnetic path.
2. **Pole cores and pole shoes:** To support the field coils and to distribute magnetic field uniformly
3. **Pole (field) coils:** To excite the pole to produce flux, when supply is given to pole (field) coils
4. **Armature cores:** It houses the armature winding.
5. **Armature windings:** To produce flux when supply is given to armature winding Or To carry supply current to produce torque.
6. **Commutator:**

The commentator plays a very important part in the operation of the D.C motor. It reverses the current in each conductor of the armature as it passes from one pole to another and thus helps to develop a continuous and unidirectional torque.

7. **Brushes:** To pass the current to armature winding

8. **Bearings:** To support the rotating part against stationary part. And to maintain air gap between stator and rotor .

b) Given Data:

R= 100 ohm, L= 0.2H, **C=**150 μf , V= 230V and f= 50H **To find**

i) I=?, ii) Z=? iii) P.f=? and iv) P=?

Im *pedance per phase* $Z_{ph} = \sqrt{R^2 + (X_L - X_C)^2}$

$$X_L = 2\pi f L, \quad X_L = 2\times\pi\times 50\times 0.2$$
$$X_L = 62.831\,\Omega$$

$$X_C = \frac{1}{2\pi f C}, = \frac{1}{2\times\pi\times 50\times 150\times 10^{-6}}$$
$$X_C = 21.22\,\Omega$$

Im *pedance* $Z = \sqrt{100^2 + (62.831 - 21.22)^2}$

Im *pedance* $Z = \sqrt{100^2 + 41.611^2}$

Im *pedance* $Z = 108.31\ \Omega$ ---------- **(1 Mark)**

Step-2: To Find Current=

$$I = \frac{V}{Z}, = \frac{230}{108.31}$$

$I = 2.123\ Amp$ ---------- **(1 Mark)**

Step-3: To Power Factor =

$$Cos\,\phi = \frac{R}{Z}, = \frac{100}{108.31}$$

$Cos\phi = 0.923$ ---------- **(1 Mark)**

Step-4: Power consumed =

$\therefore \quad P = I^2 x\ R$

$\therefore \quad P = (2.123)^2 \times 100$

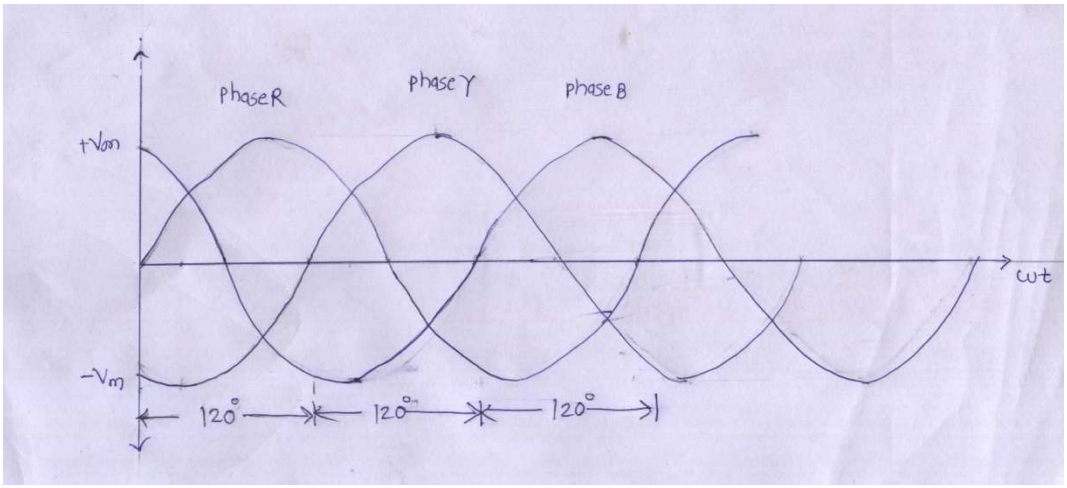
$\therefore \quad P = 450.71$watt **OR**---------- **(1 Mark)**

$\therefore P = VI\ Cos\phi$

$\therefore P = 230 \times 2.123 \times 0.923$

$\therefore P = 450.82\ watt$

c) Draw and label the waveform of a 3-Phase e.m.f **(4 Mark)**



or Equivalent fig.

d) As applied to A.C circuit, explain the terms: i) True power ii) Apparent power iii) reactive power iv) Power factor **(For Each term 1 Mark)**

i) True Power (P):-

The true power or active power is defined as the actual power consumed by the given circuit. **OR**

It is given by

$P = V.I.Cos\phi\ watt$ **Unit: -** Watt **OR** Kwatt

Where, ϕ = Phase angle between V and I

ii) 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 **Units: -** VA **OR** KVA

iii) 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 taken from the source by inductive or capacitive element which is not actually consumed.

The reactive power is also called as imaginary power.

It is given by **OR**

Q= V.I. sin ϕ

Units: - VAR **OR** KVAR

iv) Power factor (CosØ) :-

i) It is ratio of true power (active power) 'P' to the apparent power 'S'

$$P.F = \frac{Active\ \ Power(P)}{Apparant\ Power(s)}$$ **OR**

ii) It is defined as cosine angle between voltage and current. **OR**

iii) It is the ratio of resistance 'R' to the impedance 'Z.

$$Cos\phi = \frac{\text{Re}sistance(R)}{\text{Im}pedance(Z)}$$ **OR**

iv) Power factor is defined as how much current is utilized out of total current

e) Define the following terms with reference to a poly phase system: i) Phase sequence ii) Balanced load iii) Unbalanced load iv) Balanced supply system

(Each Definition 1 Mark)

i) Phase Sequence:

The phase sequence is defined as the sequence in which the three phases reaches their positive maximum values. There are two types of phase sequences.

Positive Phase sequence and Negative Phase sequence.

Normally the phase sequence is positive R-Y-B **OR**

Phase sequence is the sequence is which the currents or voltage in the 3-phase attain their peak position with particular reference of time e.g R,Y,B or R,B,Y

ii) Balanced Load:

The three phase load is said to be balance when it as same type of load having same magnitude in all three phases. **OR**

All the line currents are same i.e ($I_R = I_Y = I_B$) **OR**

If all phase impedances of the three phase load are exactly identical in respect of magnitude and their nature is is said to be balanced load.

iii) Unbalanced load

The three phase load is said to be unbalance when it does not have same type of load having same magnitude in all three phases. OR

All the line currents are not equal to each other i.e ($I_R \neq I_Y \neq I_B$)

OR

1. Voltage drop in each line R, Y, B is different.
2. So voltage at terminal point between two lines V_{RY} not equal to V_{YB} not equal to V_{BY}.
3. Due to unbalance voltage, equipment or machines performance gets affected.
4. If unbalance is beyond limit machines or equipment gets heated.

iv) Balanced supply system:

1. The e.m.f voltages for three phases are equal in magnitude and phase displaced by 120^0 from each other.

2. The current in different phases are equal and have same phase angle.
3. The impedance in any one phase is identical to that in either of the other two phases.
4. Equal power and equal reactive power flow in each phase

f) State the functions of following part of the transformer: i) Laminated steel core ii) Transformer oil iii) Conservator iv) Transformer tank (Function of Each part 1 Mark)

i) Laminated steel core:

1. The laminated core is used to provide the path of low reluctance (opposition) for the flux.
2. The core is laminated to reduce iron losses (eddy currents losses).

ii) Transformer oil:

1. Function of transformer oil for cooling and insulation purpose.

iii) Conservator:

1. To maintain oil level in transformer tank.
2. During the alternate load cycles, the oil of transformers expands and contracts.
3. The conservator is connected to transformer tank by means of pipe.
4. The conservator volume is used for expansion of oil during higher loads

iv) Transformer tank:

1. To cover the enterer transformer assembly (parts)
2. Area of transformer tanks helps for cooling of oil.

----------END----------