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Total No. of Questions : 09

B.Tech (All Branches Physics Group) (2018 Batch) (Sem.–1,2)

BASIC ELECTRICAL ENGINEERING

Subject Code : BTEE-101-18

M.Code : 75339

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION - B & C. have FOUR questions each.
3. Attempt any FIVE questions from SECTION B & C carrying EIGHT marks each.
4. Select atleast TWO questions from SECTION - B & C.

SECTION-A

1. **Answer following questions in brief.**

   a) Differentiate active and passive components.

   b) Define R.M.S. value of A.C.

   c) Differentiate phase and phasor difference with example.

   d) What are various losses in transformer?

   e) Give the working principle of boost converter.

   f) Draw the static characteristics of thyristor.

   g) What do you mean by duty ratio control in power converter?

   h) Write the working principle of rotating magnetic fields.

   i) List various types of wires and cables.

   j) Significance of toque slip characteristics .

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SECTION-B

2. Discuss in brief construction and principle of single phase induction motor. Also explain the losses.

3. Explain the working and basic principle of Single Phase Transformer.

4. Write a short note on :

   a) Magnetization curve or B-H curve.

   b) Kirchoff's voltage and current law.

5. Derive the relationship between voltage and current in star and delta connections.

SECTION-C

6. Explain the necessity of earthing in an electrical installation. Also state the points to be earthed in internal / wiring system of a residential building.

7. Open-circuit and short-circuit tests were conducted on a 50 kVA, 6360/240 V, 50 Hz, single phase transformer in order to find its efficiency. The observations during these tests are :

   (a) Open-circuit test : Voltage across primary winding 6360 V. Primary current, 1.0 A. power input 2 kW.

   (b) Short-circuit test : Voltage across primary 180 V , current in secondary winding 175 A, power input 2 kW. Calculate the efficiency of the transformer when supplying full load at power factor of 0.8 lagging.

8. Critically examine the difference between single phase and three phase voltage source inverters.

9. Explain the construction and working of synchronous generators.

NOTE : Disclosure of identity by writing mobile number or making passing request on any page of Answer sheet will lead to UMC against the Student.

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SECTION - A

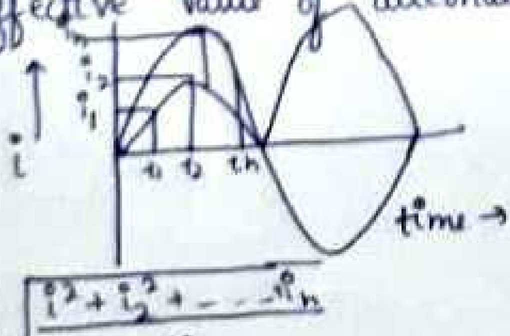
Q1(a) Differentiate active and passive elements.

→

Active Elements	Passive elements
1) Active components deliver power or energy to the circuit.	Passive elements utilizes power or energy in the circuit.
2) Devices which produce energy in the form of voltage or current.	Devices which stores energy in the form of voltage or current.
3) Active components can control the flow of current.	Passive components cannot control the flow of the current.
4) Examples → Diodes, Transistors, Integrated Circuits etc.	Examples → Capacitor, Inductor, Resistor etc.

1(b) Define RMS value of A.C.

→ The RMS value of an A.C is given by that steady current or voltage which when flows through a resistor of non resistance for a given time produces same amount of heat as produced by alternating current when flows through same resistor for a same time known as RMS value or effective value of alternating current.



$$RMS = \sqrt{\frac{i_1^2 + i_2^2 + \ldots i_n}{n}}$$

c) Differentiate phase and phasor difference with examples.

→

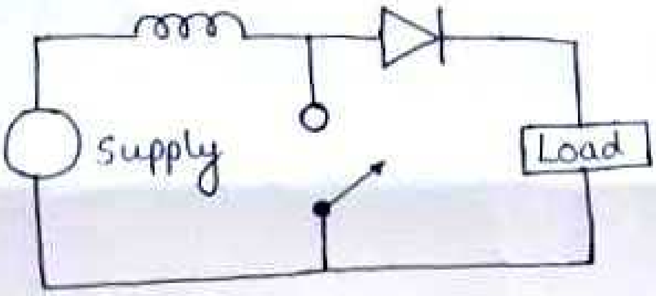
Phase	Phasor Difference
① The phase of an A.c is defined as the divisional part of a cycle through which the quantity moves forward from a selected origin.	The phasor Difference between the two electrical quantities is defined as the angular phase difference between the maximum possible value of the two alternating quantities having the same frequencies.

d) What are various losses in transformers?

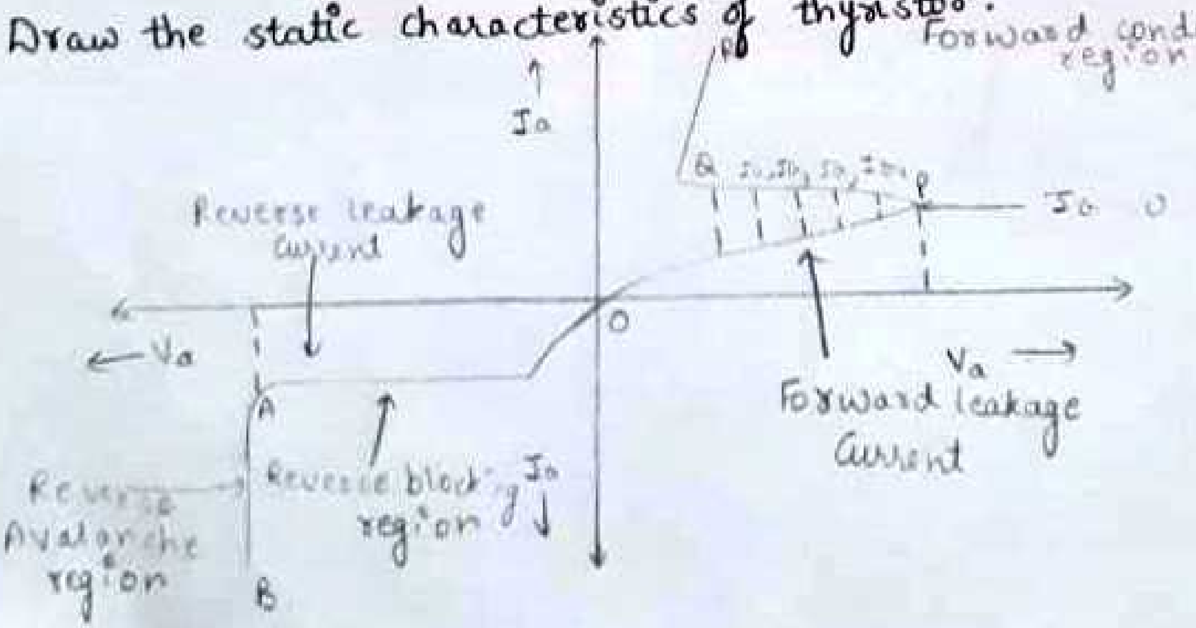
→ The are various losses in the transformers such as iron loss, copper loss, hysteresis loss, eddy current loss, stray loss, and dielectric loss. The hysteresis losses occur because of the variation of the magnetization in the core of the transformer and the copper loss occur because of the transformer winding resistance.

e) Give the working principle of boost converter.

→ A boost converter is a DC-to DC power converter that steps up voltage from its input to its output. It is a class of switched-mode power supply containing atleast one energy storage element: a capacitor, inductor or the two in combination. To reduce voltage ripple, filters made of capacitors are normally added to such a converter's output and input.



f) Draw the static characteristics of thyristor.



- Thyristor are current operating devices, a small Gate current controls a larger Anode current.
- Conducts current only when forward biased and triggering current applied to the Gate.
- Thyristors acts like a rectifying diode once it is triggered "ON".

g) What do you mean by duty ratio control in power converter?

→ A duty cycle or power cycle is the fraction of one period in which a signal or system is active. Duty cycle is commonly expressed as a percentage or a ratio. A period is the time it takes for a signal to complete an on-and off cycle.

As a formula, $D = \frac{PW}{T} \times 100\%$

Equally, a duty cycle may be expressed as: $D = \frac{PW}{T}$

Where D = duty cyle
PW = Pulse width
T = Total period of the signal.

Thus a 60% duty cycle means the signal is on 60% of the time but off 40% of the time. The "on time" for a 60% duty cycle could be a fraction of a second, a day, or even a week, depending on the length of the period.

h) Write the working principle of rotating magnetic fields.

→ A rotating magnetic field is a magnetic field that has moving polarities in which its opposite poles rotate about a central point or axis. Ideally, the rotating changes direction at a constant angular rate. This is a key principle in the operation of the alternating-current motor.

Rotating magnetic fields are often utilized for ~~electromag~~ electromechanical applications such as induction motors and electric generators. However, they are also used in purely electrical ~~appliances~~ applications such as induction regulators.

i) List various types of wires and cables.

→ Cable types

- Coaxial cable – used for radio frequency signals, for example in cable television distribution systems.
- Communication cable
- Direct-buried cable
- Flexible cable
- Heliax cable
- Non Metallic sheathed cable
- Paired cable
- Single cable
- Twinax cable

Wire is a single electrical conductor, whereas a cable is a group of wires swathed in sheathing.

Types of wires →

- Triplex Wires → are usually used in single phase service drop conducto between the power pole and weather heads.
- Main Feeder Wires → are the wires that connect the service weather head to the house they are made with stranded or solid THHN wires and the cable installed is 25% more than the load required
- Pannel Feed Wires → are generally black insulated Thin wire. These are used to power the main junction box and the circuit breaker panels.
- Non-Metallic Sheathed Wires → Is used in most homes and has 2-3 conductors each with plastic insulation are a bare ground wir.
- Single Strand Wires → Also used THHN wire, through there are other variants. Each wire is separate and multiple wires can be drawn together through a pipe easily.

j) Significance of torque slip characterstics.

→ The torque slip Characterstics is represented by a rectangular hyperbola. For the immediate value of the slip, the graph changes from one form to the other. Thus it passes through the point of the maximum torque when $R_2 = sX_{20}$. The maximum torque developed in an induction motor is called the Pull Out Torque on the Breakdow Torque. This torque is a measure of the short time overloading capability of the motor.

The torque slip characterstic curve is divided roughly into three regions. They are →

- Low slip region
- Medium slip region
- High slip region

Ques 2) Discuss in brief construction and principle of single phase induction motor. Also explain the losses. Section-B

Ans) Single-phase a.c supply is commonly used for lighting purpose in shops, offices, house, schools etc. Hence instead of d.c motors, the motors which work on single-phase a.c supply are popularly used. These a.c motors are called single-phase induction motor.

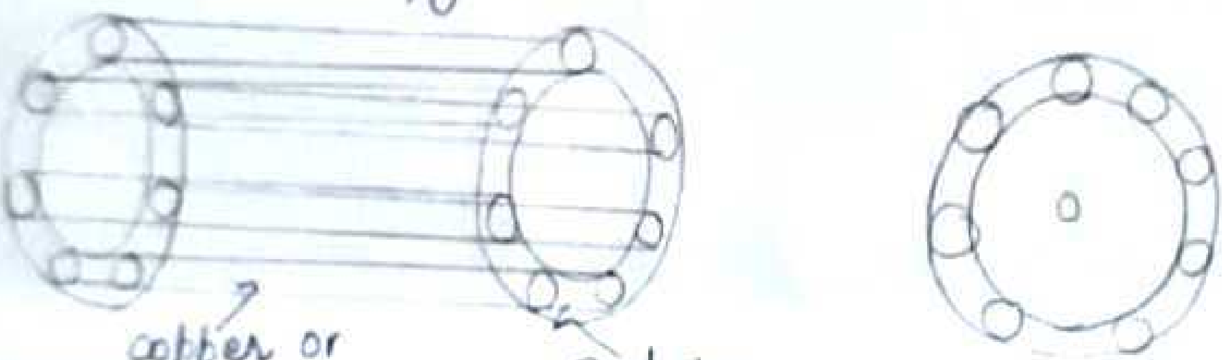
Construction of Single phase Induction Motors:
Similar to a d.c motor, single phase induction motor i.e. has two main parts, one rotating and other stationary. The stationary part in single-phase induction motor is stator. and the rotating part is Rotor.

The stator has laminated construction, made up of stampings. The stampings are lotted on its periphery to carry the winding called stator winding. This is excited by a single phase a.c supply. The laminated construction keeps iron losses to the minimum. The stampings are made up of material from silicon steel which minimise the hysteresis loss.

The stator winding is wound for a certain definite no. of poles means when excited by single-phase a.c supply stator produces the magnetic field which creates the effect of the certain definite number of pole. The number the number of poles for which stator winding is wound decides the synchronous speed of the motor. The synchronous speed is denoted as Ns and it has a fixed relation with supply frequency f and number of poles P. The relation is given by ⇒ $N_s = 120f/P$

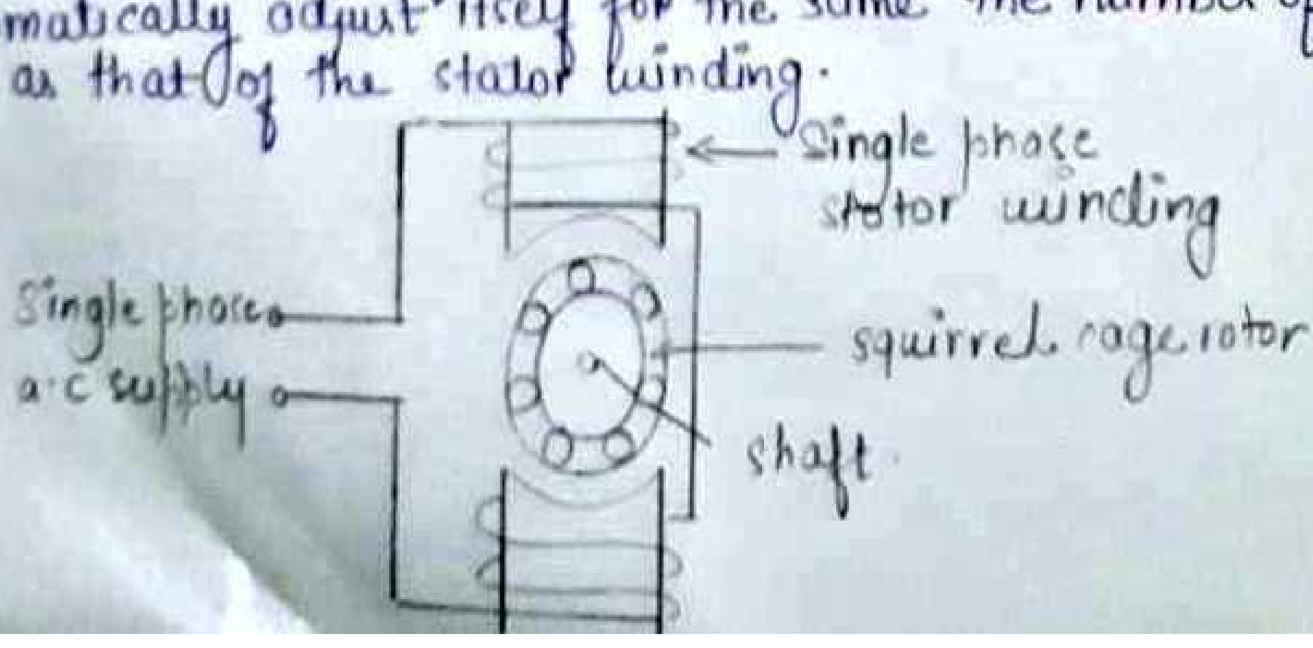
The induction motor never rotates with the synchronous speed but rotates at a speed that is slightly less than the synchronous speed. The rotor construction is of squirrel cage type. This rotor consist of uninsulated copper or aluminium bar, place in the slots.

The bars are permanently shorted at both the ends with the help of conducting rings called end rings. The entire structure looks like cage hence it is called a squirrel cage rotor. The construction of single-phase induction motor is shown in below figure.



(a) cage like structure. (b) Symbolic representation

As the bars are permanently shorted to each other, the resistance of the entire rotor is very very small. The air gap between stator and rotor is kept uniform and as small is possible. The main feature of this rotor is that it automatically adjust itself for the same the number of poles as that of the stator winding.



* Working principle of Single phase Induction Motors:

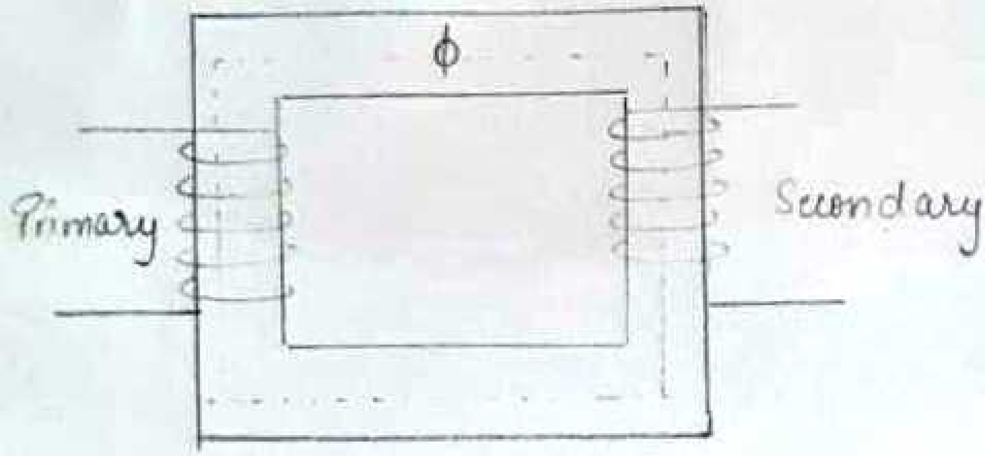
For the motoring action, there must exist two fluxes which interact with each other to produce the torque. In d.c motor field winding produces the main flux while d.c supply given to armature is reponsible to produce armature flux interact to produce the torque.

In the single-phase induction motor, single-phase a.c supply is given to the stator winding. The stator winding carries an alternating current which produces the flux which is also alternating in nature. The flux is called the main flux. This flux links with the rotor conductors and due to transformer action em.f gets induced in the rotor. The induced emf drives current through the rotor as the rotor circuit is the closed circuit.

This rotor current produces another flux called rotor flux required for the motoring action. Thus second flux is produced according to the induction principle due to induced emf hence the motor is called induction motor. As against this in d.c motor a separate supply is required to the armature to produce armature flux. This is an important difference between d.c motor and an induction motor.

Ques 3.) Explain the working and basic principle of Single phase transformer.

Ans.) The main principle of operation of a transformer is mutual inductance between two circuits which is linked by a common magnetic flux. A basic transformer consists of two coils that are electrically separate and inductive, but are magnetically linked through a path of reluctance. The working principle of the transformer can be understood from the figure below.



As shown above the electrical transformer has primary and secondary windings. The core laminations are joined in the form of strips in between the strips you can see that there are some narrow gaps right through the cross-section of the core. These staggered joints are said to be imbricated. Both the coil have high mutual inductance. A mutual electro-motive force is induced in the transformer from the alternating flux that is set up in the laminated core, due to the coil that is connected to a source of alternating voltage. Most of the alternating flux developed by this coil is linked with the other coil and thus produces the mutual induced electro-motive force can be explained with the help of Faraday's laws of electromagnetic Induction as

$$e = M^{*} dI/dt$$

If the second coil current is closed, a current flows in it and thus electrical energy is transferred magnetically from the first to the second coil.

The alternating current supply is given to the first coil and hence it can be called as the primary winding. The Energy is drawn out from the second coil and thus can be called as the secondary winding.

Ques4) Write a short note on :

(a) Magnetization curve or B-H curve.

- Magnetization : Magnetization is the density of magnetic dipole moments that are induced in a magnetic material when it is placed near a magnet. The magnetic effects of a materia can also be induced by passing an electrical current throug the material; the magnetic effect is caused by the motion of electrons in atoms, or the spin of the electrons or the nuclei Magnetization is also as magnet polarization.

B-H curve : The B-H curve is the curve characteristic of the magnetic properties of a material or element or alloy. It tells you how the material responds to an external magnetic field, and is a critical piece of information when designing magnetic circuits.

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b) Kirchoff's voltage and current law.

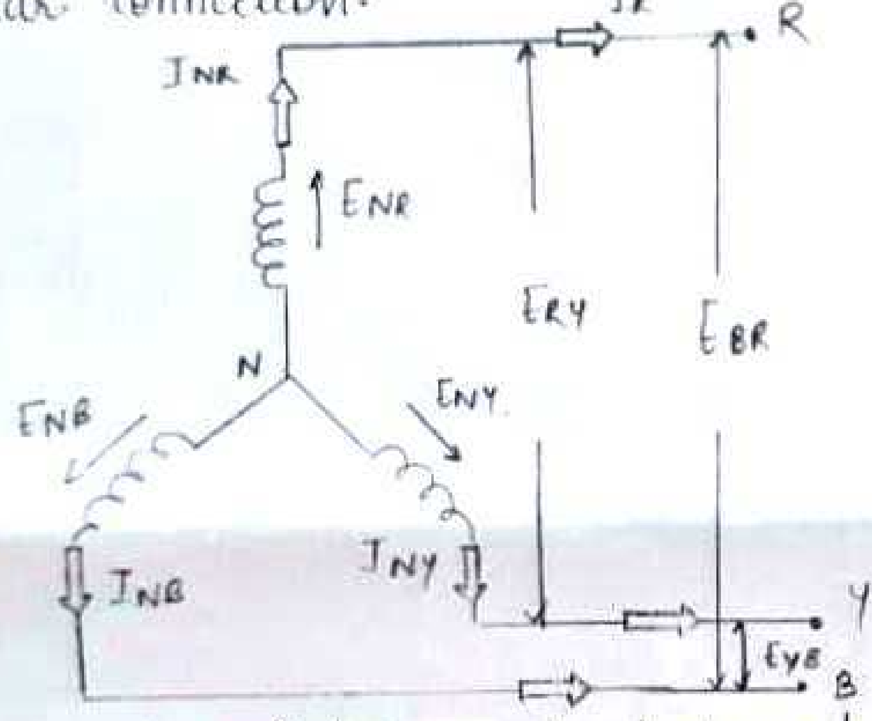
- Kirchoff's voltage law : Kirchoff's voltage law states that the algebric sum of all the voltage around any closed path is zero. Applying krichoff's voltage law to first and second in the circuit yields.

Kirchoff's current law : States that the algebric sum of all the current leaving at any point is zero. In other words the total current leaving a node is equal to the total current entering that node. Incoming signals are +ve and outgoing ~~sing~~ signal are -ve.

Ques 4.) Drive the relationship between voltage and current in star and delta connections.

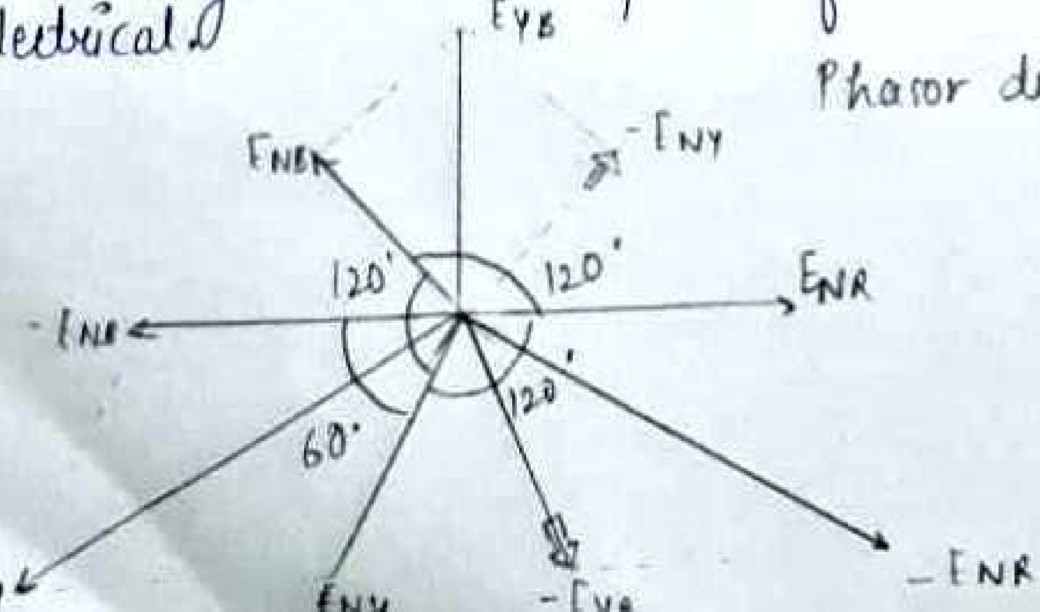
Ans.) In the star connection, the similar ends of the three winding are connected to a common point called star or neutral point. The three line conductor run from the remaining three free terminal called line conductors.

* Relation Between Phase voltage and line voltage in star connection.



As the system is balanced, balanced system means that in all three phases, R, Y and B, the equal amount of curr[illegible] flows through them. Therefore, the three voltages E_{NR}, E_{NY} and E_{NB} are equal in magnitude but displaced from one another by 120° electrical.

Phasor diagram.



The arrowheads on the emfs and current indicate direction and not their actual direction at any instant. Now,

$E_{NR} = E_{NY} = E_{NB} = E_{Ph}$ (in magnitude).

There are two phase voltage between any two lines.

Tracing the loop NRYN

$\overline{E_{NR}} + \overline{E_{RY}} - \overline{E_{NY}} = 0$

$\overline{E_{RY}} = \overline{E_{NY}} - \overline{E_{NR}}$ (vector difference).

To find the vector sum of E_{NY} and $-E_{NR}$ we have to reverse the vector E_{NR} and add it with E_{NY} as shown in phasor diagram, therefore

$$E_{RY} = \sqrt{E^2_{NY} + E^2_{NR} + 2E_{NY}E_{NR}\cos 60^\circ}$$

$$E_L = \sqrt{E^2_{Ph} + E^2_{Ph} + 2E_{Ph}.E_{Ph} \times 0.5} \quad \text{or} \quad E_L = \sqrt{3E^2_{Ph}} = \sqrt{3}\,E_{Ph}$$

Similarly, $E_{YB} = E_{NB} - E_{NY}$ or $E_L = \sqrt{3}_{Ph}$

Hence, line voltage $= \sqrt{3} \times$ phasor voltage.

* Relation between Phase current and line current in star connection.

The same current flows through phase winding as well as in the line conductor as it is connected in series with the phase

$I_R = I_{NR}$, $I_Y = I_{NY}$ and $I_B = I_{NB}$

where the phase current will be.

$I_{NR} = I_{NY} = I_{NB} = I_{Ph}$

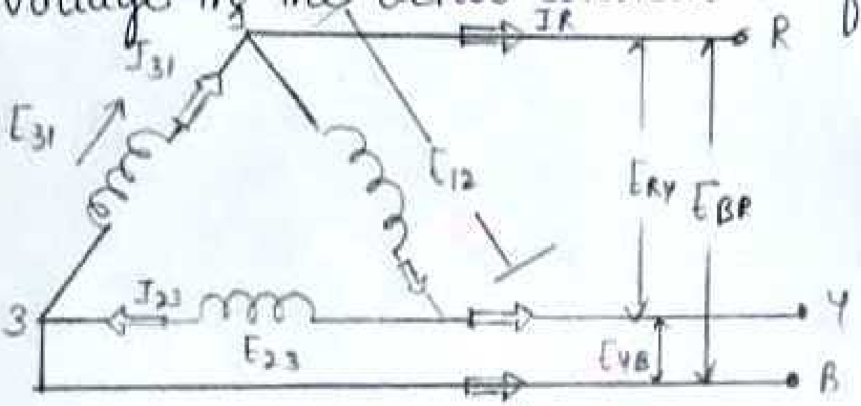
The line current will be

$I_R = I_Y = I_B = I_L$

Hence in a 3 phase system star Connections, the line current is equal to phase current.

* Relation between phase voltage and line voltage in delta connection.

To understand the relationship between the phase voltage and line voltage in the delta consider the figure A.



It is clear from the fig that the voltage across terminals 1 and 2 is the same as across the terminal R and Y. Therefore,

$E_{12} = E_{RY}$ Similarly, $E_{23} = E_{YB}$ and $E_{31} = E_{BR}$

where, the phase voltage are

$E_{12} = E_{23} = E_{31} = E_{Ph}$

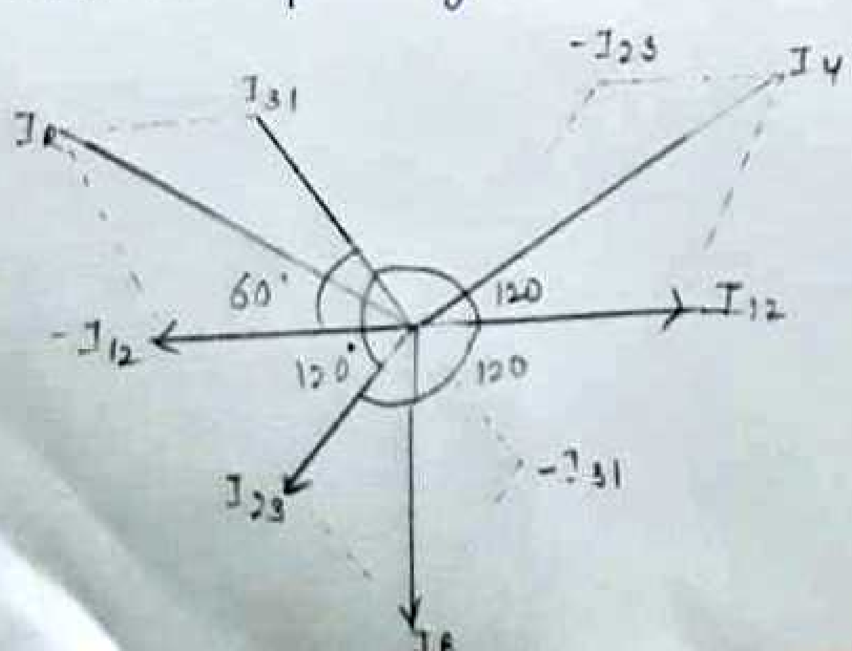
The line voltage are $\Rightarrow E_{RY} = E_{YB} = E_{BR} = E_L$

Hence, in Delta connection line voltage is equal to phase voltage.

* Relation Between phase current and line current in delta connection.

As in the balanced system the three phase current I_{12}, I_{23} and I_{31} are equal in magnitude but are displaced from one another by 120° degree electrical.

Phasor diagram.



Hence,

$$I_{12} = I_{23} = I_{31} = I_{ph}$$

If we look at fig A, it is seen that the current is divided at every junction 1, 2 and 3.

Applying Krichoff's law at junction 1.

The Incoming currents are equal to outgoing currents.

$$\overline{I}_{31} - \overline{I}_R + \overline{I}_{12}$$

And their vector difference will be given as.

$$I_R = \overline{I}_{31} - \overline{I}_{12}$$

Vector I_{12} is reverseve and is added in the vector I_{31} to get the vector sum of I_{31} and $-I_{12}$ as shown above in the phasor diagram. Therefore,

$$I_R = \sqrt{I_{31}^2 + I_{12}^2 + 2 I_{31} I_{12} \cos 60^\circ}$$

$$I_L = \sqrt{I_{Ph}^2 + I^2_{Ph} + 2 I_{Ph} I_{Ph} \times 0.5}$$

As we know $I_R = I_L$, therefore,

$$I_L = \sqrt{3 I^2_{Ph}} = \sqrt{3} I_{Ph}$$

Similarly,

$$\overline{I}_Y = \overline{I}_{12} - \overline{I}_{23} \text{ or } I_L = \sqrt{3} I_{ph}$$

$$\overline{I}_B = \overline{I}_{23} - \overline{I}_{31} \text{ or } I_L = \sqrt{3} I_{ph}.$$

Hence, in delta connection line current is root three time of phase current.

Line current = $\sqrt{3}$ × phase current.

Section - C

Ques 6 Explain the necessity of earthing in an electrical installation. Also state the point to be earthed in internal wiring system of a residential building.

Ans Earthing is important component of electrical Systems :

1) It keeps people safe by preventing shock.

2) Dissipation of static charge: In perfectly earthed system its potential remains approximately equal to zero. So it can remove most of the static charge build-up in the conductors

3) Voltage stabilization: In a network which has multiple feeder or sources there must be a common point act universal point. The earthing act like as a balance point.

4) For proper functioning of equipment's : Because in order to operate all these devices use reference of leakage current through the earth line which helps in protection device.

Purpose of wiring system of a residential building:

1) The electrical system is related to the potential of the general earth mass and cannot reach a diff potential. The potential of earth is zero volts and is known as the neutral of electricity supply. This helps in keeping the balance.

2) An electrical circuit has to be connected with a lot of attention to the kind of reactions each transformer may have in response to any action on the part of any other transformer.

Qu7 Open-ckt and Short ckt tests were conducted on a 50kVA, 630/240V, 50Hz single phase transformer in order to find its efficiency. The observations during these tests are:

a) open-circuit test: Voltage across primary winding 630V Primary current, 1A power input 2kW

b) Short-circuit test: Voltage across primary 180V, current in secondary winding 175A, power input 2kW. Calculate the efficency of transformer when supplying full load at power factor 0.8 lagging.

Ans O.C: $W_i = 2000W$; $I_{2(FL)} = \frac{kVA \times 1000}{V_2} = \frac{50 \times 1000}{240} = 208.33A$

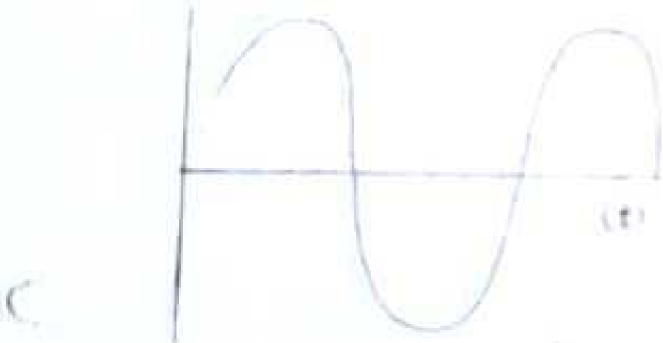
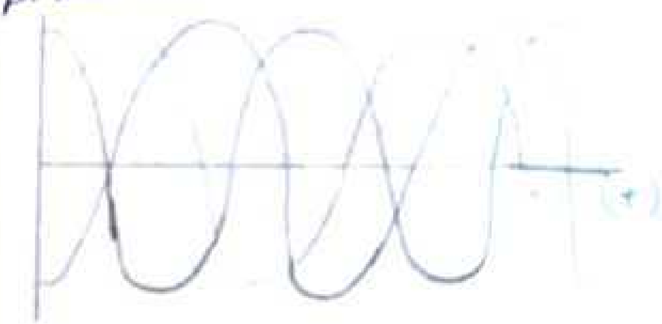
S.C test $I_{2S} = 175A$, $W_c = 2000W$

$\therefore$ Cu loss at full load $P_c = W_c \left(\frac{I_{2(FL)}}{I_{SC}}\right)^2 = 2000 \left(\frac{208.33}{175}\right)^2 = 2833W$

$$\text{Efficency} = \frac{kVA \times 1000 \times \cos\phi_2}{kVA \times 1000 \times \cos\phi_2 + P_i + P_c} \times 100$$

$$= \frac{50 \times 10^3 \times 0.8 \times 100\%}{50 \times 10^3 \times 0.8 + 2000 + 2833} = 95.33\%$$

Ques 8 Critically examine difference b/w single and three phase voltage source inverters.

Single Phase Inverter	Three Phase Inverter
•) A single phase inverter can connect to and export power through a single phase.	•) In three phase inverters can connect and send power across the network using 3 diff current all out of phase with each other.
	
Require two wires for completing the ckt.	•) Requires four wires for completing the ckt.
Power loss maximum	•) Power loss minimum
•) Efficiency is less	•) Efficiency is high.
•) Economical is less.	•) Economical is more.
•) For home appliances	•) In large industries and for running heavy loads.

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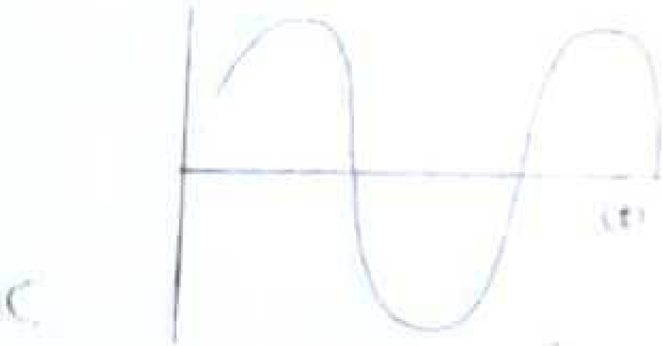	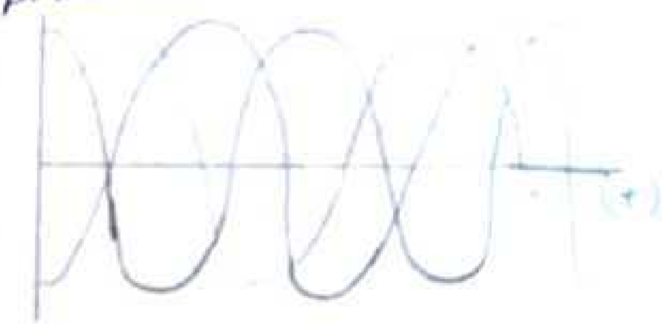
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•) For home appliances	•) In large industries and for running heavy loads.

Ques 9 Explain the construction and working of synchronous generator.

Ans: The Synchronous generator or alternator is an electrica machine that converts the mechanical power from move into an AC electrical power at a particular voltage and frequency. The synchronous motor always runs at a constant speed called synchronous speed.

Working Principle of Synchronous Generator: The synchronous generator works on the principle of faraday laws of electromagnetic induction. The electromagnetic induction states that emf induced state in armature coil if it is rotating in the uniform magnetic field. The EMF will also be generated if the field rotates and conductor becomes stationary. Thus, the relative motion b/w the conductor and the field induces EMF in the conductor. The wave shape of the induces voltage always a sinusoidal curve.

Construction of Synchronous Generator: The rotor and stator are the rotating and the stationary part of the synchronous generator. They are the power generating components of the synchronous generator. The rotor has the field pole and the stator consists the armature conductor. The relative motion b/w rotor and stator induces the voltage between the conductor.