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Summer– 2018 Examinations

Model Answer **Subject Code: 22215 (EEC)**

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 should assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given 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 should give credit for any equivalent figure/figures drawn.
5) Credits to 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 (as long as the assumptions are not incorrect).
6) In case of some questions credit may be given by judgment 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

1 Attempt any FIVE of the following: **10**

1 a) Define Faraday's first law of electromagnetic induction.

Ans:

Faraday's First Law:

Whenever a changing magnetic flux links with a conductor, an emf is induced in that conductor. 2 Marks

OR

When a conductor cuts across magnetic field, an emf is induced in that conductor.

1 b) Define :
(i) Form factor
(ii) Peak factor

Ans:

(i) Form factor:

The form factor of an alternating quantity is defined as the ratio of the RMS value to the average value.

Form factor = I_{rms}/I_{av} = 0 .707 I_m / 0.637 I_m = 1.11 (For sinusoidal quantity)

OR

Form factor = V_{rms}/V_{av} = 0 .707 V_m / 0.637 V_m = 1.11 (For sinusoidal quantity) 1 Mark for each Definition

(ii) Peak factor:

The peak factor of an alternating quantity is defined as the ratio of its maximum value to the rms value.

Peak factor = V_m / V_{rms} = 1.414 (For sinusoidal quantity)

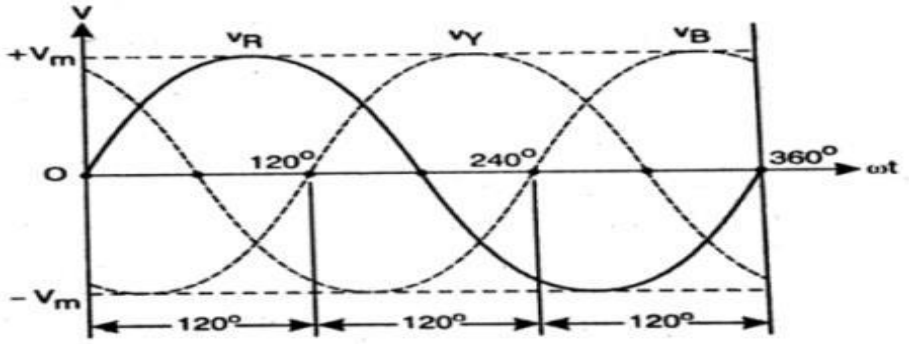
OR

Peak factor = I_m / I_{rms} = 1.414 (For sinusoidal quantity)

1 c) Draw 3- phase voltage waveform of a.c. supply with respect to time.

Ans:

Three-phase Voltage waveform representation of three phase supply:



2 Marks for labeled waveform

1 Mark for unlabeled waveform

1 d) State working principle of transformer.

Ans:

Working principle of transformer :

Transformer works on the principle of mutual electromagnetic induction. When AC voltage is applied to the primary winding it causes ac current to flow through primary winding which produces alternating flux in the core. This changing flux links with the secondary winding and according to Faraday's law of electromagnetic induction, an emf is induced in the secondary winding. The current flows in the secondary circuit if load is connected.

2 Marks

1 e) Write two applications of D.C. series motor.

Ans:

The applications of D.C. series motor:

1. Cranes 2. Hoists 3. Trolley and cars 4. Conveyors
5. For traction work i.e. electric locomotives 6. Elevator 7. Air compressor

1 Mark for each of any 2 applications = 2 Marks

1 f) List different types of stepper motor. State one application of stepper motor.

Ans:

Types of stepper motor :

(i)Variable – reluctance motor
(ii) Permanent- magnet motors
(iii) Hybrid motors.

Applications of stepper motor :

In robotics,
In CNC machines,
In computers, printers, tape readers,
In Watches,
In biomedical applications such as X-ray machines, CT scan,
In Process control systems.

Any two Types 1 Mark + Any one Application 1 Mark = 2 Marks

1 g) State function of ELCB.

Ans:

Functions of ELCB:

1. Provides protection to apparatus by detecting the unsafe magnitudes of leakage currents diverting to earth.
2. Disconnect the supply to the circuit if line to ground fault occurs.
3. Provides protection to users by detecting the unsafe magnitudes of leakage currents diverting to earth.

Any one function = 2 Marks

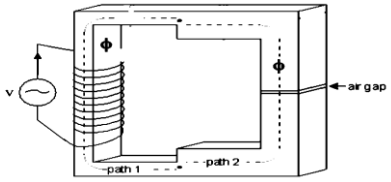
2 Attempt any <u>THREE</u> of the following: 12

2 a) Explain with neat diagram series and parallel magnetic circuits.

Ans:

Series magnetic circuit: When different magnetic materials having different lengths, cross sectional areas and permeability are connected one after another, in which same flux is established in different sections, then it is called series magnetic circuit.

1 Mark Explanation



Valid Figure 1 Mark

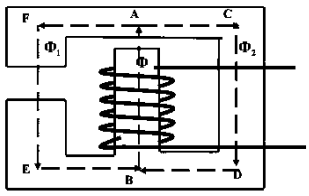
Fig. Series magnetic circuit

Parallel magnetic circuit: Magnetic circuit which has more than one path for magnetic flux, is called as parallel magnetic circuit. Reluctances are in parallel.

1 Mark Explanation

Total flux, $\Phi = \Phi_1 + \Phi_2$

Path 1: BAFE Path 2: BACD



Valid Figure 1 Mark

= 4 Marks

Fig. Parallel magnetic circuit.

2 b) Explain the concept of lagging and leading phase angle by waveform.

Ans:

i) Leading phase angle :

When two ac quantities of same frequency do not attain their respective zero or peak values simultaneously, then the quantities are said to be out-of-phase quantities. The quantity which attains the respective zero or peak value first, is called 'Leading Quantity'.

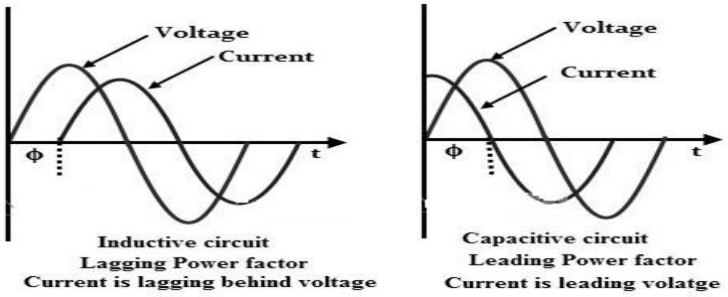
2 Marks for Explanation

In the following first diagram, the voltage attains its zero or positive peak first and after an angle of ϕ, the current attains its respective zero or positive peak value, hence voltage is said to be leading the current by an angle of ϕ. Similarly, in the second diagram, the current is said to be leading the voltage by ϕ.

ii) Lagging phase angle:

The quantity which attains the respective zero or peak value later, is called 'Lagging Quantity'.

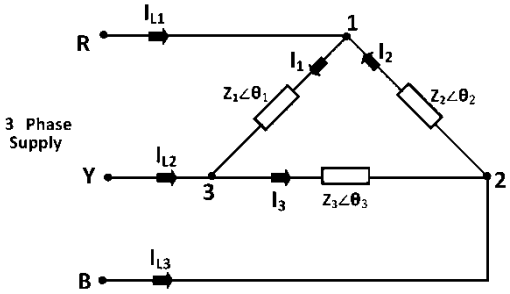
In the following first diagram, the current attains its zero or positive peak later than the voltage after an angle of ϕ, hence current is said to be lagging the voltage by an angle of ϕ. Similarly, in the second diagram, the voltage is said to be lagging the current by ϕ.



2 Marks for any one neat labeled diagram

2 c) Draw delta connected load. State relation between:
i) Line voltage and phase voltage.
ii) Line current and phase current.

Ans:



2 Marks for neat labeled diagram and

i) **Relation between Line voltage and phase voltage in delta connection:**

Line voltage = Phase voltage

$$\mathbf{V_L = V_{ph}}$$

ii) **Relation between Line current and phase current in delta connection:**

Line current = √3 phase current

$$\mathbf{I_L = \sqrt{3}\, I_{ph}}$$

2 Marks for relations (1 mark each) = 4 Marks

2 d) List the main parts of D.C. motor. Give the function of any two parts.

Ans:

Main parts of D.C. motor and their functions:

Part	Functions
Yoke	i) Provides mechanical support for poles. ii) Acts as protecting cover for machine. iii) Carries magnetic flux.
Pole Core & Pole Shoes	i) Provides support for the field winding, which is placed around it. ii) Allows the field winding to produce magnetic flux in it. iii) Pole shoes spread out the magnetic flux over the armature periphery more uniformly.

1 Mark for each of any four parts = 4 Marks

Field Winding	Produces mmf and consequently magnetic flux when carries current.
Armature	i) It houses the armature conductors. ii) It provides rotation of armature conductors in the magnetic field.
Armature Winding	Provides conductors to - induce emf in it (in generator) - produce force on it (in motor)
Commutator	i) Works as media to collect from or to send current to the armature winding. ii) Helps to maintain unidirectional current in armature winding.
Brush	i) To inject or collect current from rotating armature winding. ii) To facilitate electrical connection of rotating armature winding to external stationary circuit.
Bearings	i) To support the rotor and reduce friction for smooth rotation of rotor. ii) Maintains rotor in a fixed physical position relative to the stator.
Shaft	Used to transfer mechanical power

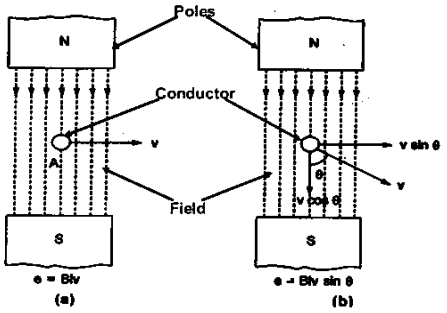
3 Attempt any <u>THREE</u> of the following: 12

3 a) Explain dynamic and static induced emf with neat diagram.

Ans:

Dynamically Induced EMF:-

- In this case, either coil moves or magnet moves, so that there is relative motion between coil & magnetic field. Thus magnetic field is cut by coil & emf is induced in it. The emf induced due to relative motion is called dynamically induced emf. 1 Mark
- The expression for induced EMF is e = B.l.v.sinϕ
- Dynamically induced EMF is observed in DC generator, Induction Motors, Back EMF in D.C. Motor, Alternators.



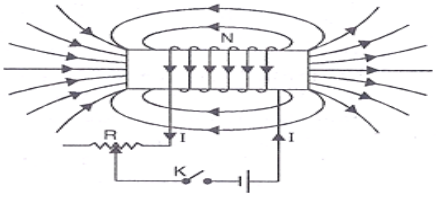
1 Mark for diagram

Statically Induced EMF:-

- In this case, neither coil moves nor magnet moves. The changing magnetic field links with stationary coil and emf is induced. The emf induced without any motion is called statically induced emf.
- Statically induced EMF is having two main types:
  - Self-induced EMF: The changing magnetic flux produced by coil when links with the coil itself, the emf induced in it is called self-induced emf.
  - Mutually induced EMF : The changing magnetic flux produced by one coil when links with the second coil, the emf is induced in second coil. This emf is called mutually-induced emf.
- The expression for induced EMF is e= -L(di/dt) or = -N(dϕ/dt).

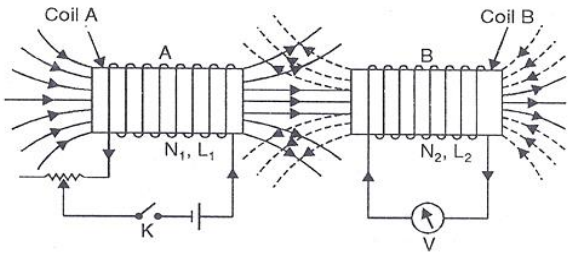
1 Mark

Self-induced EMF:



1 Mark for any one diagram

Mutually induced EMF :

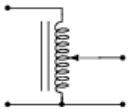
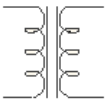


3 b) Compare auto transformer with two winding transformer. (Any four Points)

Ans:

Comparison of Autotransformer with Two winding transformer:

Sr. No.	Autotransformer	Two winding Transformer
1	Only one winding, part of the winding is common for primary and secondary.	There are two separate windings for primary and secondary.
2	Movable contact exist	No movable contact between primary and secondary

3	Electrical connection between primary and secondary.	Electrical isolation between primary and secondary windings.
4	Comparatively lower losses.	Comparatively more losses
5	Efficiency is more as compared to two winding transformer.	Efficiency is less as compared to autotransformer.
6	Copper required is less, thus copper is saved.	Copper required is more.
7	Spiral core construction	Core type or shell type core construction
8	Special applications where variable voltage is required.	Most of the general purpose transformers where fixed voltage is required.
9	Cost is less	Cost is more
10	Better voltage regulation	Poor voltage regulation
11	 Symbol of Autotransformer	 Symbol of Two winding transformer

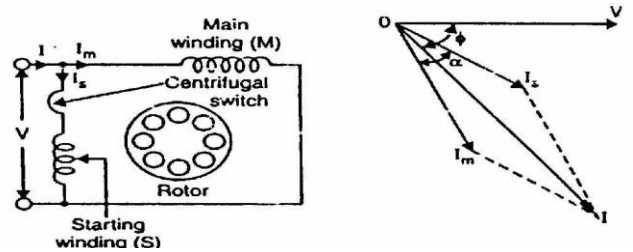
1 Mark for each of any valid four points = 4 Marks

3 c) Draw and explain split phase induction motor.

Ans:

- The stator of a split-phase induction motor is provided with an auxiliary or starting winding S in addition to the main or running winding M.
- The starting winding is located 90° electrical from the main winding and operates only during the brief period when the motor starts up. The two windings are so designed that the starting winding S has a high resistance and relatively small reactance while the main winding M has relatively low resistance and large reactance as shown in the schematic connections. Consequently, the currents flowing in the two windings have reasonable phase difference (α = 25° to 30°) as shown in the phasor diagram.
- When the two stator windings are energized from a single-phase supply, the main winding carries current I_m while the starting winding carries current I_s.

2 Marks for diagram and 2 Marks for explanation = 4 Marks



- Since main winding is highly inductive while the starting winding is highly resistive, the currents I_m and I_s have a reasonable phase angle (α = 25° to 30°) between them.
- Consequently, a revolving field approximating to that of a 2-phase machine is produced which starts the motor.
- When the motor reaches about 75% of synchronous speed, the centrifugal switch opens the circuit of the starting winding. The motor then operates as a single-phase induction motor and continues to accelerate till it reaches the normal speed. The normal speed of the motor is below the synchronous speed and depends upon the load on the motor.

3 d) Give the working of MCCB.

Ans:

Working of MCCB: (Molded Case Circuit Breaker)

- The operating mechanism consisting of lever, spring, contacts etc. is used to open or close the MCCB electrically.
- The arc extinguisher facilitates for the quenching of arc by lengthening it which is produced when MCCB gets opened and current is interrupted.
- The trip unit is the brain of the circuit breaker. It senses the overload or short-circuit condition and trip mechanism is operated to trip the MCCB.
- When overload occurs, the thermal relay mechanism permits overload for short duration, then bimetal strip actuates the tripping mechanism to open the MCCB contacts.
- When short-circuit occurs, large magnetic force produced by short-circuit current operates the lever to trip the MCCB immediately and open the contacts.

4 Marks for explanation

4 Attempt any <u>THREE</u> of the following: 12

4 a) Find ~~relactance~~ reluctance, flux, mmf required and exciting current for an iron ring with 200 turns having diameter of 15cm and 10cm^2 cross sectional area if flux density 1Wb/m^2 and permeability of 500.

Ans:

Given: 1) d =15 cm = 15 X 10^{-2} m = 0.15 2) a =10 cm^2 = 10 X 10^{-4} m^2
3) N = 200 4)B =1 Wb/m^2 5) μ_r = 500 6) $\mu_0 = 4\pi X\ 10^{-7}$

To find: 1) S = ? 2) ϕ = ? 3) mmf = ? 4) I = ?

1.Reluctance:

$$S=\frac{l}{\mu_0\ \mu_r a}$$

But l = πd =π x 15 x10^{-2} = π x 0.15 = 0.4712 m

$$S = \frac{0.4712}{4\pi x\ 10^{-7}\ x\ 500\ x\ 10\ X\ 10^{-4}} = 7.5 \times 10^5 \text{ AT/Wb}$$

2. Flux:

Flux density B= $\frac{Flux}{Area} = \frac{\phi}{a}$

Φ =B X a =1 x 10 x 10^{-4} = 1 mWb

3. MMF:

MMF= ϕ x S = 1 x 10^{-3} x 7.5 x 10^{5} = 750 AT

1 Mark for each correct answer = 4 Marks

4. Current:

MMF = N x I

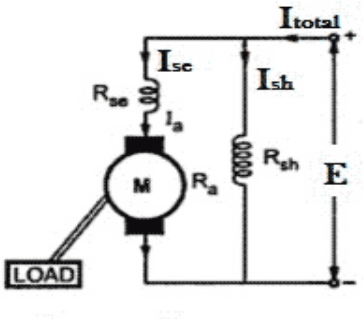
750 = 200 x I

I = 3.75 A

4 b) Draw a schematic diagram of long shunt D.C. compound motor. Give one application.

Ans:

Long shunt D.C. compound motor :



Applications:

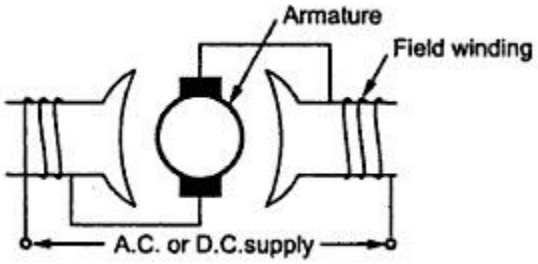
1. Rolling mills
2. Cutting and shearing tools.
3. Presses
4. Punches
5. Conveyors
6. Elevators.

Labeled diagram 3 Marks and 1 Mark for any one application= 4 Marks

4 c) Explain in brief the working of universal motor.

Ans:

Working of universal motor:



i) Working of universal motor with DC supply:

- When the universal motor is fed with a DC supply, then current flows in the field winding, it produces an electromagnetic field. The same current also flows through the armature conductors.
- According to basic motor principle, when a current carrying conductor is placed in the magnetic field, it experiences a mechanical force and torque exerted on

2 Marks

the current carrying armature conductors, therefore the rotor starts to rotate.

ii) Working of universal motor with AC supply:

- When fed with AC supply, current flows through armature and field winding. So current carrying armature conductors are in magnetic field experiences mechanical force and ultimately produces unidirectional torque, because armature winding and field winding are connected in series, they carry same current.
- Hence, as polarity of AC voltage changes and current reverses its direction, the direction of current in armature conductors and magnetic field in the air-gap reverses at the same time. 2 Marks
- The direction of magnetic field and the direction of armature current reverses in such a way that the direction of force experienced by armature conductors remains same.

4 d) With a neat sketch give the working of shaded pole induction motor.

Ans:

Working of Shaded Pole Induction Motor:

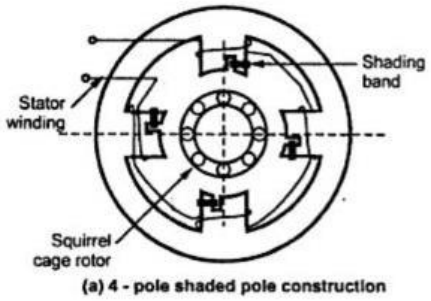
When single phase supply is applied across the stator winding, an alternating field is created. The flux distribution is non uniform due to shading bands on the poles. The shading band acts as a single turn coil and when links with alternating flux, emf is induced in it. The emf circulates current as it is simply a short circuit. The current produces the magnetic flux in the shaded part of pole to oppose the cause of its production which is the change in the alternating flux produced by the winding of motor. Now consider three different instants of time t_1, t_2, t_3 on the flux wave to examine the effect of shading band as shown in the figure.

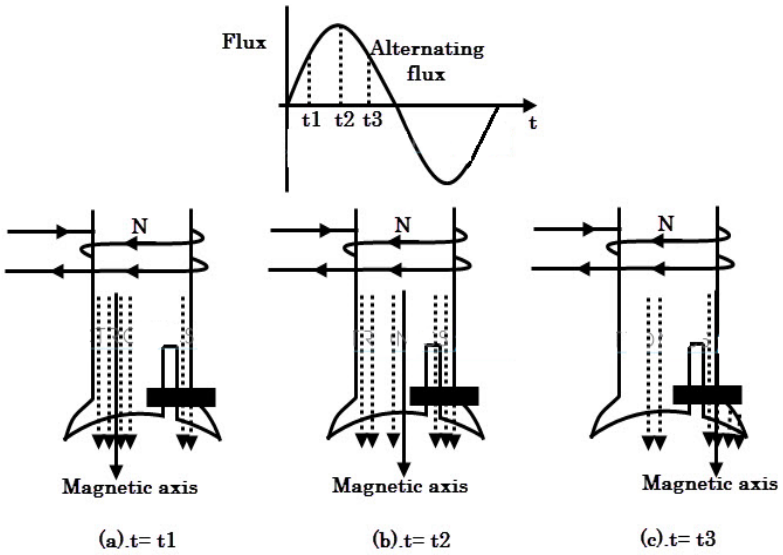
At instant t_1: The flux is positive and rising, hence the shading band current produces its own flux to oppose the rising main flux. Due to this opposition, the net flux in shaded portion of pole is lesser than that in unshaded portion. Thus the magnetic axis lies in the unshaded portion and away from shaded portion.

At instant t_2: The flux is maximum, the rate of change of flux is zero. So the shading band emf and current are zero. Thus the flux distribution among shaded and unshaded portion is equal. The magnetic axis lies in the centre of the pole.

At instant t_3: The flux is positive but decreasing, hence according to Lenz's rule, the shading band emf and current try to oppose the fall in the main flux. So the shading band current produces its own flux which aids the main flux. Since shading band produces aiding flux in shaded portion, the strength of flux in shaded portion increases and the magnetic axis lies in the shaded portion. Thus it is seen that as time passes, the magnetic axis shifts from left to right in every half cycle, from non-shaded area of pole to the shaded area of the pole. This gives to some extent a rotating field effect which is sufficient to provide starting torque to squirrel cage rotor and rotor rotates.

2 Marks for Diagram + 2 Marks for Explanation = 4 Marks





4 e) Give the function of fuse and switch.

Ans:

Functions of fuse: 2 Marks for two functions

- To break the circuit under fault condition.
- To provide overcurrent protection to the circuit.
- To provide short circuit protection to the circuit.
- To provide safety to the users.

Functions of Switch: 2 Marks

- To make the electric circuit manually.
- To break the electric circuit manually.

5 Attempt any <u>TWO</u> of the following: 12

5 a) An alternating voltage is represented by v = 50.5 sin (314t +90°). Calculate frequency, amplitude, RMS value and phase difference.

Ans:

Given Data:

v = 50.5 sin(314t +90°)

On comparing with the standard form $v = V_m \sin(\omega t + \emptyset)$

Maximum voltage = $V_m = 50.5$ volt

Angular frequency =Angular Velocity = $\omega = 314$ rad/sec

Phase angle = $\emptyset = 90°$

1) **Frequency (f):** 2 Marks

Angular frequency $\omega = 2\pi f$

$314 = 2 \times 3.14 \times f$

$\mathbf{f = 50\ Hz}$

2) **Amplitude:** 1 Mark

Amplitude = Peak or Maximum value = $V_m = \mathbf{50.5\ volt}$

3) **RMS Value:**

$V_{rms} = 0.707 \times V_m$

$V_{rms} = 0.707 \times 50.5 = \mathbf{35.70\ volt}$ 2 Marks

4) **Phase difference:** 1 Mark

$\emptyset = \mathbf{90°}$ **(leading)**

5 b) A balanced 3-Ø star connected load consist of three resistances each of four ohms connected to 400V, 3 phase 50 Hz supply, find (i) Phase voltage (ii) Phase current (iii) Line current (iv) Power consumed.

Ans:

Given Data:

Load is star connected.

Line voltage=$V_L = 400$ Volt

$$\text{Frequency} = f = 50\ \text{Hz}$$

$$\text{Resistance per phase} = R_{ph} = 4\ \Omega$$

1) Phase voltage: $V_{ph} = \frac{V_L}{\sqrt{3}} = 400/\sqrt{3}$ = **230.94 Volt** 1 Mark

2) Phase current: $I_{ph} = \frac{V_{ph}}{R_{ph}} = \frac{230.94}{4} = \mathbf{57.73\ ampere}$. 2 Marks

3) Line Current: $I_L = I_{ph} = \mathbf{57.73\ ampere}$ 1 Mark

4) Power consumed: $P = \sqrt{3} \times V_L \times I_L \times \cos\emptyset$

$= \sqrt{3} \times 400 \times 57.73 \times 1$

$= \mathbf{39996.51\ watt\ or\ 39.99\ KW}$ 2 Marks

OR

Power consumed = $P = 3 \times Vph \times Iph \times \cos\emptyset$.

$= 3 \times 230.94 \times 57.73 \times 1$

$= \mathbf{39996.49\ watt\ or\ 39.99\ KW}$

5 c) 20kVA, 3300/ 240 V, 50 Hz single phase transformer has 80 turns on secondary winding. Calculate no of primary winding turns, full load primary and secondary currents and maximum value of flux in the core.

Ans:

Given Data:

kVA = 20 kVA

Primary voltage $= V_1 = 3300$ Volt

Secondary voltage $= V_2 = 240$ Volt

Frequency $= 50$Hz

No. of turns on secondary $= N_2 = 80$

1) **Primary winding turns (N_1):**

$\frac{N1}{N2} = \frac{V1}{V2}$

$N_1 = \frac{3300}{240} \times 80 =$ **1100 turns** — 1 Mark

2) **Full load primary current (I_1):**

$KVA = \frac{V_1 I_1}{1000}$

$I_1 = \frac{20 \times 1000}{3300}$ — 1.5 Marks

$I_1 =$ **6.06 ampere**

3) **Full load secondary current (I_2):**

$KVA = \frac{V_2 I_2}{1000}$

$I_2 = \frac{20 \times 1000}{240}$ — 1.5 Marks

$I_1 =$ **83.33 ampere**

4) **Maximum value of flux in core ($\emptyset_m$)**

$E1 = 4.44 \times f \times \emptyset m \times N1$

$3300 = 4.44 \times 50 \times \emptyset m \times 1100$ — 2 Marks

$\emptyset m =$ **0.0135 wb or 13.5 mwb**

OR

$E2 = 4.44 \times f \times \emptyset m \times N2$

$240 = 4.44 \times 50 \times \emptyset m \times 80$

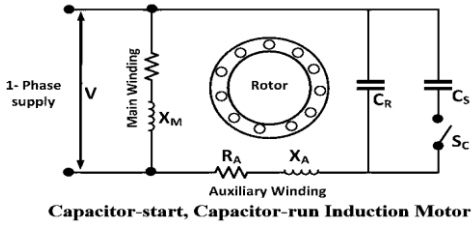
$\emptyset m =$ **0.0135 wb or 13.5 mwb**

6 Attempt any <u>TWO</u> of the following: 16

6 a) Draw schematic diagram of capacitor start capacitor run induction motor. Give any two applications of the same.

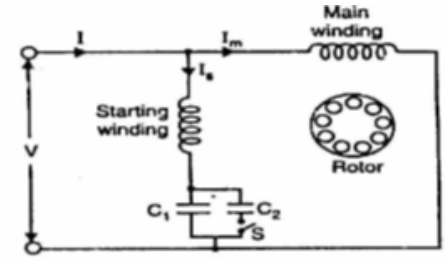
Ans:

Capacitor-start, Capacitor-run Induction Motor:



Capacitor-start, Capacitor-run Induction Motor

OR



4 Marks for labeled diagram
3Marks for partially labeled diagram
2 Marks for un-labeled diagram

Applications of Capacitor-start, Capacitor- run Induction Motor:

Fans, Blowers, Grinder, Drilling Machine, Washing Machine, Refrigerator, Air conditioner, Domestic Water Pumps, Compressor.

2 Marks for each of any 2 applications

6 b) What is earthing? Give the importance of earthing.

Ans:

Earthing:

Earthing means connecting metallic body of the electrical equipment to earth to avoid the hazards due to leakage current. If the leakage current keeps circulating in the body of the equipment, it might result in electrical shock to person who touches the metallic body.

Definition of earthing = 2 Marks

Importance of Earthing:

i) To provide protection and safety to the operator.
ii) To provide protection and safety to the equipment.
iii) To facilitate the balanced supply conditions.
iv) To provide safe path to discharge lightning and short circuit currents.
v) To isolate the faulty section.
vi) To protect installation from sudden high voltages, switching surges with lightning arrestor and surge suppressor.

Any four importances = 4 Marks

6 c) Write two applications of each of the following:(i) Fuse (ii) MCB (iii) MCCB.

Ans:

i) **Applications of fuse:**

- Used in domestic installations to provide short circuit protection.
- Used in commercial / Industrial installations to provide overload and short

circuit protection.

- Used in educational institutes for practical.
- Used for protection of various appliances.
- Used for protection of various electronic circuits.

2 Marks

ii) Applications of MCB:

- Used in lightning circuits.
- Used in distribution feeders.
- Used in switching motors.
- Used in capacitors.
- Used in power circuits.
- Used in control transformers.

2 Marks

iii) Applications of MCCB:

Used in

- Distribution feeders,
- Distribution transformers,
- Diesel generating sets
- L.T capacitors
- Rectifiers panels,
- U.P.S, Electronic equipment,
- Motors,
- Furnaces

2 Marks

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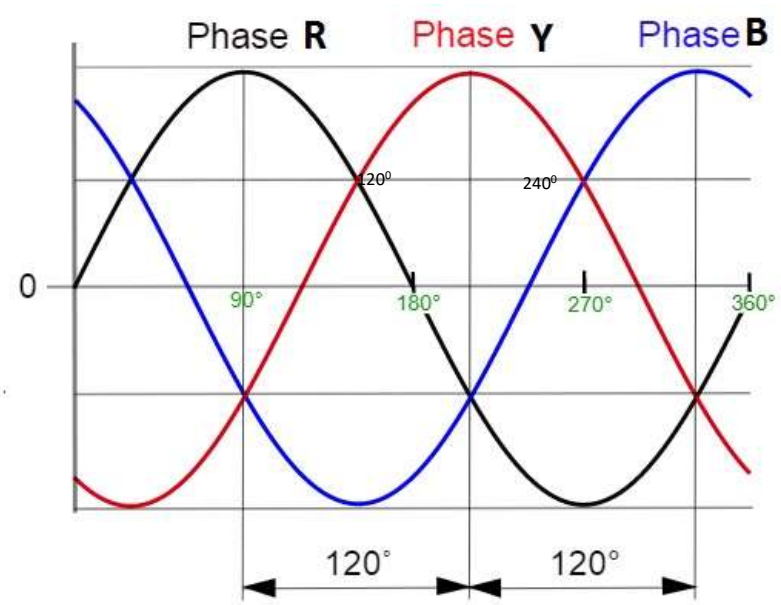
Important suggestions to examiners:

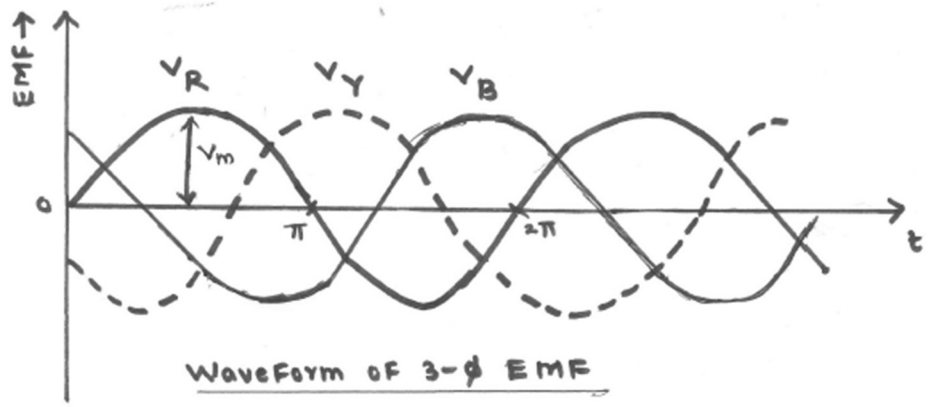
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 FIVE of the following :**	**10 Marks**
a)	**Define Reluctance. What is its units?**	
Ans	**Reluctance (s) :-** **(1 Marks)** Reluctance is the property of the substance which opposes the creation of flux in it. **OR** It is defined as the opposition to the creation of flux in the material. **Unit of Reluctance (s) :-** **(1 Marks)** Its unit is : AT/Wb	
b)	**Write any two advantages of AC over DC.**	
Ans	**Advantages of AC over DC :** **(Any Two advantages expected : 1 Mark each)** 1) We can easily step up or step down the voltage easily with the help of transformer 3) Generation is easy. 4) Design of AC machine is easy.	

c)	**Draw the waveform representation of a three phase AC supply with neat labels.**
Ans	**waveform representation of a three phase AC supply with neat labels :** **(2 Marks)**



OR equivalent Figure

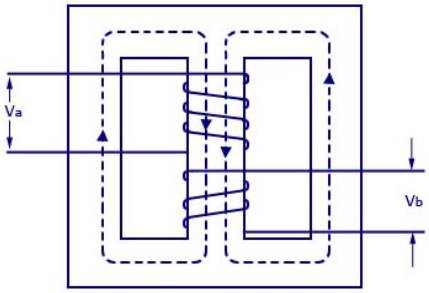


d)	**Define the transformation ratio of a transformer.**
Ans	**Transformation Ratio (k):- ----------** **(2 Marks)**

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.

OR

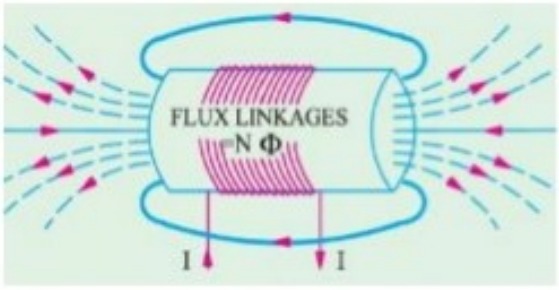
$$Transformation\ \ ratio\ (k) = \frac{N_2}{N_1}\ or = \frac{E_2}{E_1}\ or = \frac{V_2}{V_1}\ or = \frac{I_1}{I_2}$$

e)	**Draw neat constructional sketch of shell type transformer.**
Ans	**Constructional sketch of shell type transformer :** **(2 Marks)**  **OR Equivalent**
f)	**State the types of single phase induction motors.**
Ans	**Types of single phase induction motors:** **(Any Two Types expected: 1 Mark each)** 1. Split phase induction motor**.** 2. Capacitor start **inductor** motor**.** 3. Capacitor start **capacitor** run **induction motor.** 4. Permanent split capacitor motor. 5. Shaded pole induction motor**.**
g)	**List the types of Fuses.**
Ans	**Types of Fuses:** **(Any Two Types expected: 1 Mark each)** 1. Rewirable Fuses 2. HRC Fuse 3. Cartridge type Fuses 4. D-type Cartridge Fuse 5. Link Type Fuse 6. Blade and Bolted type Fuses 7. Striker type Fuse 8. Switch type Fuse 9. HV (High Voltage) Fuses 10. Cartridge Type HRC Fuse 11. Liquid Type HRC Fuse 12. Expulsion Type HV Fuse

Q.2	**Attempt any THREE of the following :**	**12 Marks**
a)	**Explain self induced emf and mutually induced emf with neat sketch.**	

Ans:

i) Self induced emf : **(Figure : 1 Mark & Explanation : 1 Mark)**



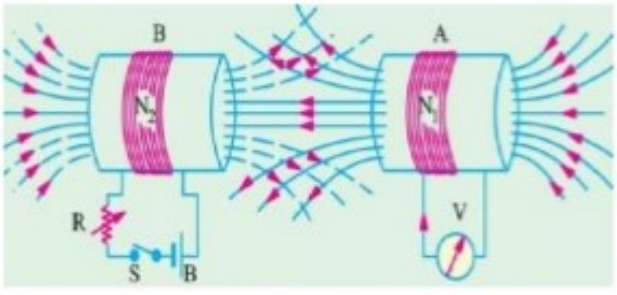
Self induced EMF

OR equivalent figure

Self-induced emf is the e.m.f induced in the coil due to the change of flux produced by linking it with its own turns. This phenomenon of self-induced emf

$$e \alpha \frac{dI}{dt} or \quad e = L \frac{dI}{dt}$$

ii) Mutually induced emf : **(Figure : 1 Mark & Explanation : 1 Mark)**



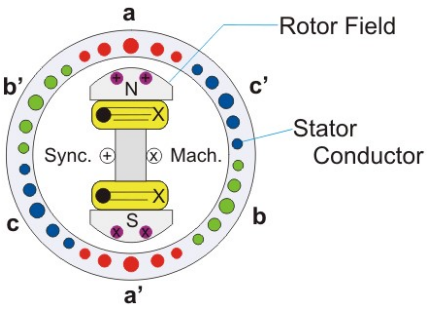
Mutually induced EMF

OR equivalent figure

The emf induced in a coil due to the change of flux produced by another neighboring coil linking to it, is called **Mutually Induced emf.**

$$e_m \alpha \frac{dI_1}{dt} or \quad e = M \frac{dI_1}{dt}$$

b)	**Explain the generation of single phase AC supply by an elementary alternator with neat sketch.**
Ans:	**Diagram:** **(2 Marks)**

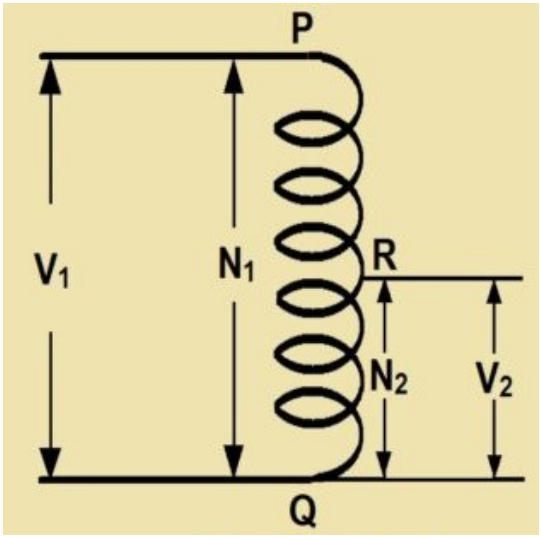


Explanation *:* **(2 Marks)**

Principle of alternator depends upon Faraday's law of electromagnetic induction. When the field winding gets excited field current flows through the field winding which produces magnetic flux in the air gap. As the prime mover rotates, the field winding also rotates and hence the magnetic flux also rotates.

This rotating magnetic field is cut by the stationary armature conductors (Stator). So according to Faraday's law of electromagnetic induction , an EMF is induced in the armature conductors.

c)	**Draw neat constructional sketch of auto transformer. State its advantages and applications.**
Ans:	**Constructional sketch of auto transformer:** **(2 Mark)**



OR Equivalent Figure

Advantages of autotransformer:-

(Any Two accepted from following or equivalent: 1/2 Mark each :Total 1 Mark)

1. Saving of copper takes place/Copper required is less.
2. Autotransformer is smaller in size.
3. Cost is less as compare to conventional transformer.
4. Copper losses are less.
5. Superior voltages regulation than two winding transformer.
6. High efficient than two winding transformer.
7. Resistance and leakage reactance is less compared to two winding transformer.

Application of autotransformer-

(Any Two accepted from following or equivalent : 1/2 Mark each: Total 1 Mark)

1. It is used as a starter for induction motor.
2. It is used in electrical testing laboratory.
3. It is used to control the voltage level.
4. It is used in locomotives for control equipment.

d) State four advantages of poly-phase circuit over single phase circuit.

Ans: **Advantages of 3-phase supply over 1-phase supply: (Any four points are accepted from following or equivalent 1 Mark each point : Total 4 Marks)**

1. **Constant power output:** The power delivered by a three phase supply is constant and that of single phase supply is oscillating.
2. **Higher power:** For the same copper size output of 3 phase supply is always higher than single phase supply.
3. **Smaller conductor cross section:** For given power, cross section area of copper is smaller as compared to single phase.
4. **Magnetic field:** Three phase supply has rotating magnetic field and single phase supply has pulsating magnetic field.
5. **Power Handling Capacity:** Power handling capacity of three phase supply is three times more than single phase supply

Q.3 **Attempt any THREE of the following :** **12 Marks**

a) Compare magnetic circuit and electric circuit on any four points.

Ans: **Compare Magnetic and Electric circuit:**

(Any four points are accepted from following or equivalent 1 Mark each point, total 4 Marks)

S.No	Magnetic circuit	Electric circuit
1	The magnetic circuit in which magnetic flux flow	Path traced by the current is known as electric current.
2	MMF is the driving force in the magnetic circuit. The unit is ampere turns.	EMF is the driving force in the electric circuit. The unit is Volts.
3	There is flux φ in the magnetic circuit which is measured in the weber.	There is a current I in the electric circuit which is measured in amperes.
4	The number of magnetic lines of force decides the flux.	The flow of electrons decides the current in conductor.
5	Reluctance (S) is opposed by magnetic path to the flux. The Unit is ampere turn/weber.	Resistance (R) oppose the flow of the current. The unit is Ohm
6	$S = l/(\mu_0\mu_r a)$.	$R = \rho . l/a$.
7	The Flux = MMF/ Reluctance	The current I = EMF/ Resistance
8	The flux density	The current density
9	Kirchhoff mmf law and flux law is applicable to the magnetic flux.	Kirchhoff current law and voltage law is applicable to the electric circuit.

b) A 2000/200V, single phase, 50Hz transformer has the maximum flux of 30 mwb. Find out the no. of turns on primary and secondary windings if the cross sectional area of the core is 1.1 cm².

Ans: $V_1 = 2000\,V \quad V_2 = 200\,V \quad N_1 = ? \quad N_2 = ? \quad \phi_m = 30mwb = 30\times10^{-3}\,wb$

$A = 1\,cm^2 = 1\times10^{-4}\,m^2$

i) Number of primary winding turns N_1:

$V_1 = 4.44\,\phi_m\,f\,N_1$ ---------- **(1 Mark)**

$$N_1 = \frac{V_1}{4.44 \times f \times \phi_m}$$

$$N_1 = \frac{2200}{4.44 \times 50 \times 30 \times 10^{-3}}$$

$N_1 = 300.30\ turns \cong 300\ turns$ ---------- **(1 Mark)**

ii) Number of Secondary winding turns N_2:

$V_2 = 4.44\,\phi_m\, f\, N_2$ ---------- **(1 Mark)**

$$N_2 = \frac{V_2}{4.44 \times f \times \phi_m}$$

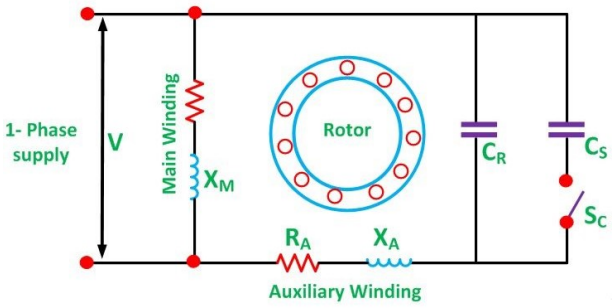
$$N_2 = \frac{200}{4.44 \times 50 \times 30 \times 10^{-3}}$$

$N_2 = 30.30\ turns \cong 30\ turns$ ---------- **(1 Mark)**

c) Draw schematic representation of capacitor start capacitor run induction motor. Also state its applications.

Ans: **Schematic representation of capacitor start capacitor run induction motor:**

(Diagram-2 Marks & Application-2 Marks)



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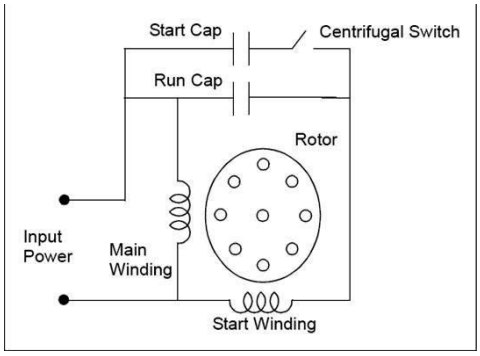


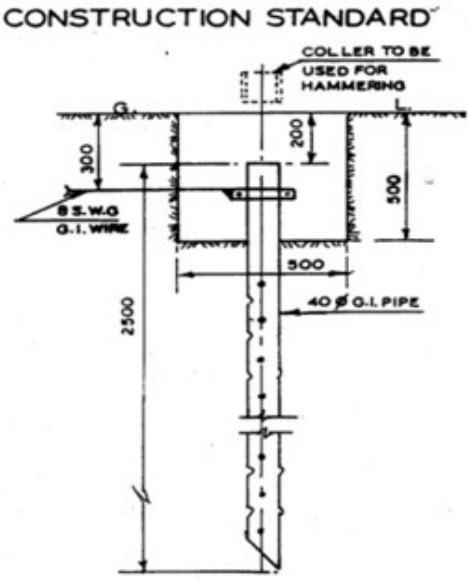
or Equivalent fig

Applications of capacitor start capacitor run induction motor:

(Any two applications are accepted from following or equivalent 1 Mark each point)

1) Fans, Blowers,
2) Grinder
3)Washing machine,
4) Refrigerator, Air conditioner
5) Drilling machine
6) Domestic water pumps, Compressors.

d)	**Explain pipe earthing with a neat labelled diagram.**
Ans:	**Diagram for Pipe Type earthing :** **(2 Marks)**



or equivalent figure

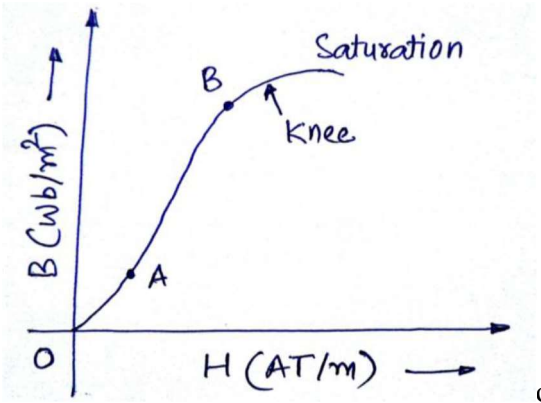
Explanation: (Following or equivalent explanation is to be accepted) (2 Marks)

- Excavation on earth for a normal earth Pit of size 2.7 M X 0.6 M X 3.0 M.Or 4.5 M
- For Pipe type earthing normal practice is to use; GI pipe [C-class] of 75 mm diameter of length Having 6 numbers of holes for the connection of earth wires
- Normal Practice is to use GI earthing pipe of length as per requirement.
- Cover Top of GI pipe with a T joint to avoid jamming of pipe with dust & mud.
- These types of earth pit are generally filled with alternate layer of charcoal & salt up to 4 feet from the bottom of the pit.
- The electrical installation which to be earthed, is connected to the top of the earth pipe by means of copper or aluminium earth continuity conductor of sufficient cross-section.
- Normal practice is to use GI earthing wire of 10/8/6 SWG as per requirement

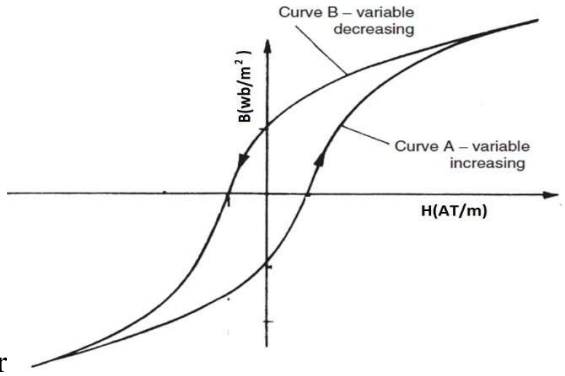
Q.4	**Attempt any THREE of the following :** **12 Marks**
a)	**Explain B-H curve and draw with all parameters.**
Ans:	**B-H curve:** **(Diagram ; 2 Marks & Explanation: 2 Marks)**

The B-H curve is the graphical representation of relation between flux density (B) and applied field strength (H), with H plotted on the x-axis and B plotted on the y-axis.

Typical B-H curve is as shown in figure below:



or



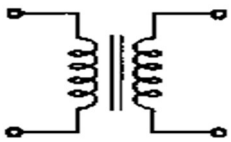
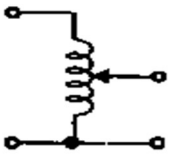
OR Equivalent Figure

The B-H curve can be described by dividing it into 3 regions.

- **Region OA:** For zero current, H = 0 and B is also zero. The flux density B then increases gradually as the value of H is increased. However B changes slowly in this region.
- **Region AB:** In this region, for small change in H, there is large change in B. The B-H curve is almost linear in this region.
- **Region beyond B:** After point B, the change in B is small even for a large change in H. Finally, the B-H curve will tend to be parallel to X axis. This region is called as saturation region.

b) Compare two winding transformer and auto transformer. (Any four points)

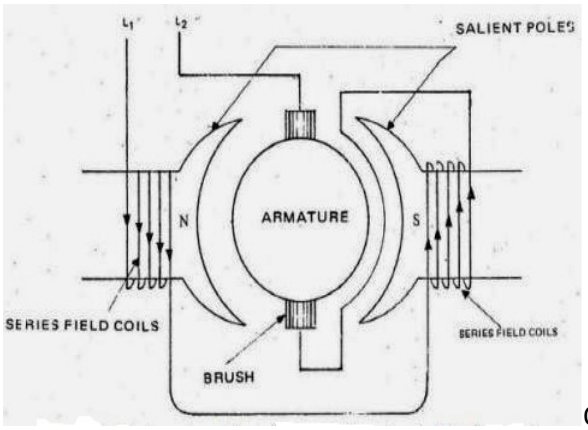
Ans: **(Any four points are accepted from following or equivalent 1 Mark each point, total 4 Marks)**

S.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 high	Efficiency is low
8.	**Electrical isolation**	Electrical isolation is present in between primary and secondary winding	There is no electrical isolation
9.	**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.

c) Explain principle of operation of universal motor with neat diagram.

Ans: **Figure of Universal motor:** **(Figure : 2 Marks & Explanation : 2 Marks)**



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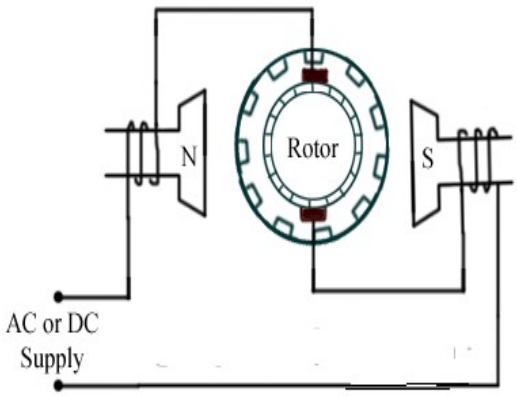


OR Equivalent figure

Working of universal motor: **(Following or equivalent working is to be accepted)**

- A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due to this mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule.

  When fed with AC supply, it still produces unidirectional torque. Because, armature

	winding and field winding are connected in series, they are in same phase. Hence, as polarity of AC changes periodically, the direction of current in armature and field winding reverses at the same time. Thus, direction of magnetic field and the direction of armature current reverses in such a way that the direction of force experienced by armature conductors remains same. Thus, regardless of AC or DC supply, universal motor works on the same principle that DC series motor works.
d)	**Write any two applications of following motors - (i) Universal motor (ii) Stepper motor**
Ans:	**(Any two applications are accepted from following or equivalent 1 Mark each point)** **i) Application of Universal Motor :** 1) Mixer 2) Food processor 3) Heavy duty machine tools 4) Grinder 5) Vacuum cleaners 6) Refrigerators 7) Driving sewing machines 8) Electric Shavers 9) Hair dryers 10) Small Fans 11) Cloth washing machine 12) portable tools like blowers, drilling machine, polishers etc **ii) Applications of stepper motor-** **(Any two applications are accepted from following or equivalent 1 Mark each point)** 1.Suitable for use with computer controlled system 2. Widely used in numerical control of machine tools. 3. Tape drives 4. Floppy disc drives 5. Computer printers 6. X-Y plotters

7. Robotics
8. Textile industries
9. Integrated circuit fabrication
10. Electric watches
11. In space craft's launched for scientific explorations of planets.
12 Automotive
13. Food processing
14. Packaging

e) State the function of the fuse and material used for fuse.

Ans: **Functions of fuse:** **(2 Marks)**

1. To break the circuit under fault condition.
2. To provide overcurrent protection to the circuit.
3. To provide short circuit protection to the circuit.
4. To provide safety to the users.

Name the material used for fuse wire: **(2 Marks)**

S.No	Material used for fuse wire
1	Tin
2	Lead
3	Zinc
4	Silver
5	Copper
6	Aluminum

Q.5 Attempt any TWO of the following : **12 Marks**

(a) An alternating current given by equation i = 142.14 sin 628 t. find - (i) Maximum value (ii) Time period (iii) RMS value (iv) Average value (v) Form factor (vi) Peak factor

Ans: $i = 142.14 \sin 628\,t$

Comparing with standard equation : $i = I_M \sin \omega t$

(i) Maximum value : $I_M = 142.14\ Amp$ ---------- **(1/2 Mark)**

Frequency $= \frac{\omega}{2\pi}$

$= \frac{628}{2\pi}$

$F = 99.94 \cong 100\ H_Z$ ---------- **(1/2 Mark)**

(ii) Time Period (T) :

$T = \frac{1}{F} = \frac{1}{100}$ ---------- **(1/2 Mark)**

$T = 0.01$ sec - ---------- **(1/2 Mark)**

(iii) RMS value I_{rms} = $0.707 \times I_m$ ---------- **(1/2 Mark)**

$= 0.707 \times 142.14$

$= 100.49$ Amp ---------- **(1/2 Mark)**

vi) Average Vale I_{avg} $= 0.637 \times I_m$- ---------- **(1/2 Mark)**

$= 0.637 \times 142.14$

$= 90.54$ Amp ---------- **(1/2 Mark)**

v) Form Factor $= \frac{RMS\ Value}{Average\ Value}$ - ---------- **(1/2 Mark)**

$= \frac{100.49}{90.54}$

$= 1.11$ ---------- **(1/2 Mark)**

vi) Peak Factor $= \frac{Maximum\ Value}{RMS\ Value}$ - ---------- **(1/2 Mark)**

$= \frac{142.14}{100.49}$

$= 1.41$ ---------- **(1/2 Mark)**

b) **Three impedance, each of 10 Ω resistance and 5 Ω inductive reactance in series, are connected in star across a 3 phase, 400 V, 50 Hz AC supply. Determine (i) Phase current (ii) Line current (iii) Phase voltage (iv) Line voltage (v) Power factor (vi) Total line power**

Ans: Given Data:

$Z_{ph} = 10 + j\,5\,\Omega$ $\quad V_L = 400\,V$

$R_{ph} = 10\,5\,\Omega$ $\quad X_{LPh} = 5\Omega$ $\quad F = 50Hz$

(i) Phase voltage (V_{ph}):

$$V_{ph} = \frac{V_L}{\sqrt{3}}$$ ---------- **(1/2 Mark)**

$$V_{ph} = \frac{400}{\sqrt{3}}$$

$V_{ph} = 230.94\ volts$ ---------- **(1/2 Mark)**

(ii) Phase Current (I_{ph}) :

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$ ---------- **(1/2 Mark)**

$$I_{ph} = \frac{230.94}{10 + j\,5}$$

$$I_{ph} = \frac{230.94}{11.18 \angle 26.56}$$

$I_{ph} = 20.65 \angle -26.56\ Amps$ ---------- **(1/2 Mark)**

(iii) Line Current (I_L) :

In Star connection $I_L = I_{ph}$

$I_L = 20.65$ Amps ---------- **(1 Mark)**

iv) Line Voltage (V_L) : 400 Volt ---------- **(1 Mark)**

v) Power Factor (P.F) :

$$Cos\phi = \frac{R}{Z}$$ ---------- **(1/2 Mark)**

$$Cos\phi = \frac{10}{11.18}$$

$Cos\phi = 0.8944\ lag$ OR $P.F = Cos\phi 26.56 = 0.8944\ lag$ --- **(1/2 Mark)**

vi) Total Line Power (P_T) :

$$P_{total} = \sqrt{3}\ V_L\ I_L\ Cos\phi$$ ---------- **(1/2 Mark)**

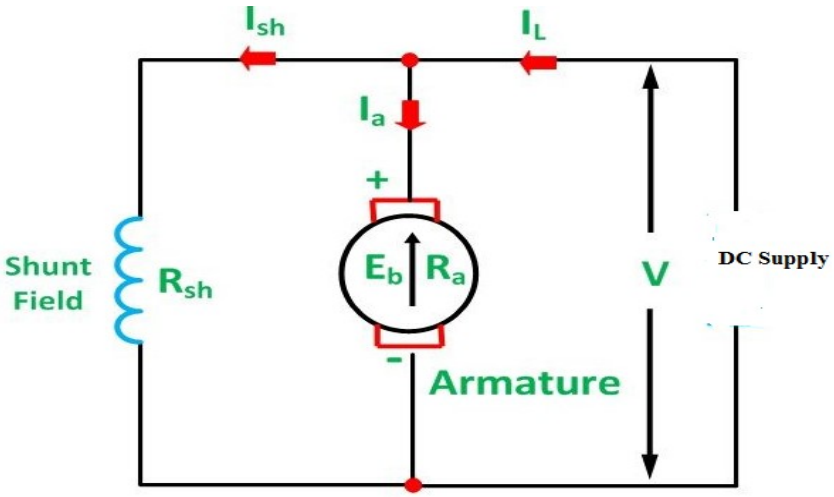
$$P_{total} = \sqrt{3} \times 400 \times 20.65 \times 0.89$$

$$P_{total} = 12732.99\ watt$$ ---------- **(1/2 Mark)**

c) Draw schematic representation of - (i) DC shunt motor (ii) DC series motor (iii) DC compound motor

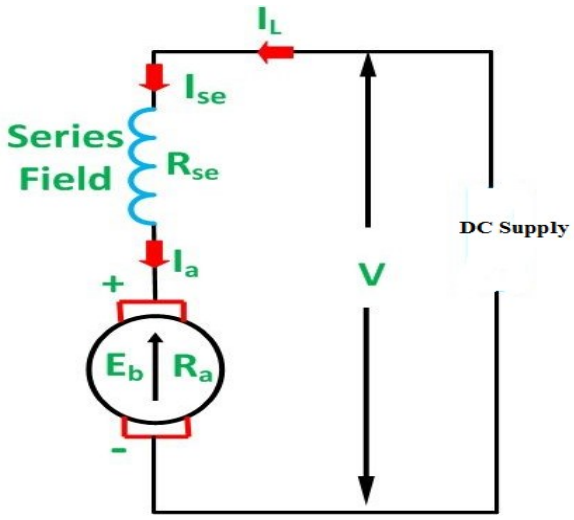
Ans:

i) Schematic representation of DC shunt motor : **(2 Marks)**



OR Equivalent Figure

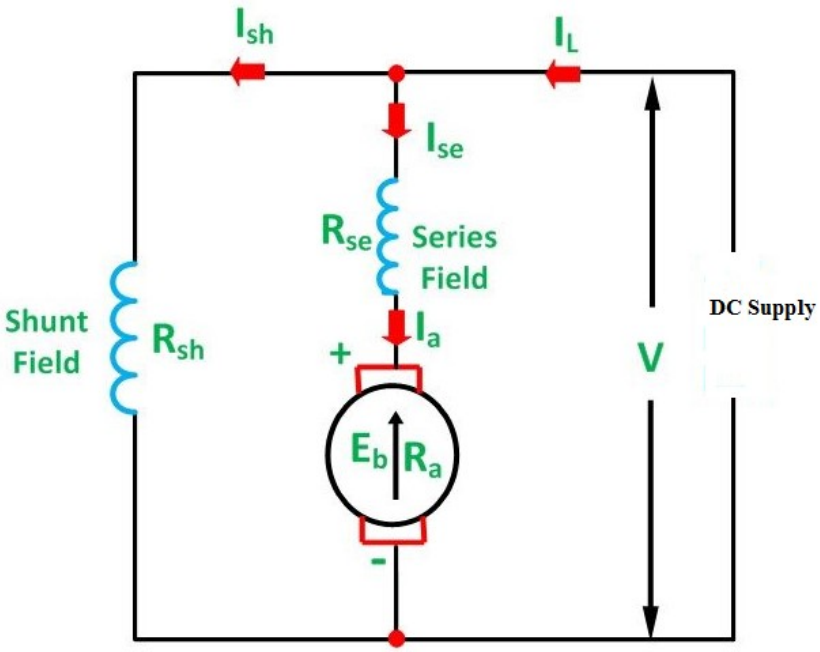
ii) Schematic representation of DC series motor : **(2 Marks)**



OR Equivalent Figure

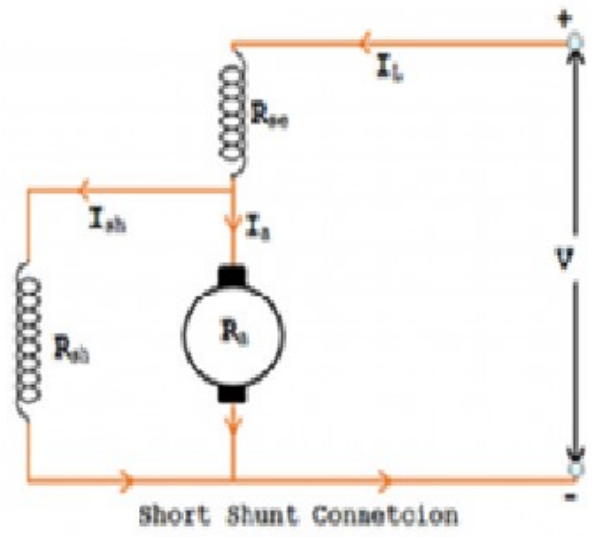
iii) Schematic representation of DC compound motor : **(2 Marks)**

1) Long shunt dc compound motor-



OR Equivalent Figure

2) Short shunt dc compound motor-



OR Equivalent Figure

Q.6	**Attempt any TWO of the following :** **12 Marks**
a)	**Explain the working principle of stepper motor and explain any one type with neat sketch.**

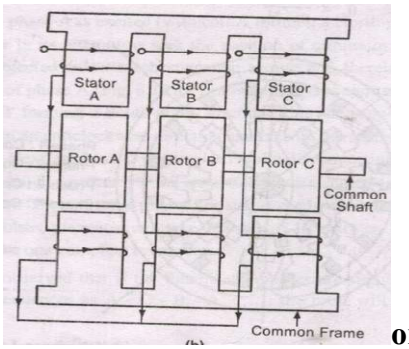
Ans:

Types of Stepper Motor :-

1) Variable Reluctance Motor
2) Permanent Magnet Motor

(Any One Type of Stepper Motor Expected: Figure : 3 Mark & Explanation : 3 Mark)

1) Variable Reluctance Motors:-



or equivalent dia.

Working:-

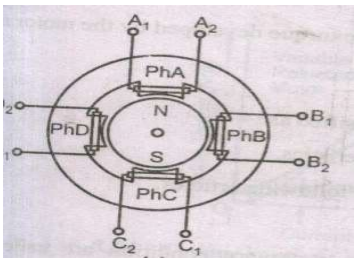
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

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.

b) Explain the need of earthing in electrical systems. State the types of earthing and any two advantages of earthing.

Ans:

Necessity of Earthing: (Any Two point are expected) (2 Mark)

1. To provide an alternative path for the leakage current to flow towards earth.
2. To save human life from danger of electrical shock due to leakage current.
3. To protect high rise buildings structure against lightening stroke.
4. To provide safe path to dissipate lightning and short circuit currents.
5. To provide stable platform for operation of sensitive electronic equipment's.

Types of Earthing: (Any Two types Expected : 1 Mark each)

1. Pipe type earthing
2. Plate earthing
3. Rod earthing or Driven Rod earthing
4. Strip earthing or Wire earthing

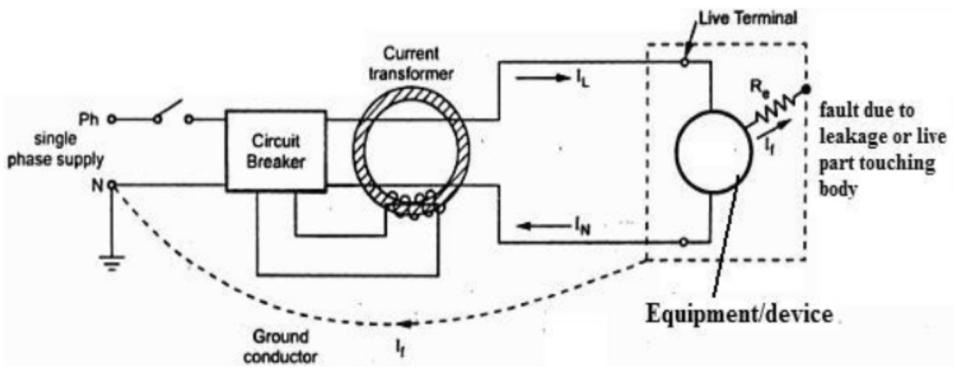
Advantages of Earthing : (Any Two advantages from the following or equivalent are expected) (2 Marks)

1. It provides an alternative path for the leakage current to flow towards earth.
2. It saves human life from danger of electrical shock due to leakage current.
3. It protects high rise buildings structure against lightening stroke.
4. It provide safe path to dissipate lightning and short circuit currents.
5. It provide stable platform for operation of sensitive electronic equipment's.

c) Explain with neat diagram, operation of ELCB and two applications.

Ans:

Diagram of ELCB (Earth Leakage Circuit Breaker) : (2 Marks)



OR Equivalent Figure

Operation of ELCB (Earth Leakage Circuit Breaker) : **(2 Marks)**

- It works on principle of relaying when the current in the earth path exceeds a set value.
- Under normal conditions (I_L–I_N) = I_f is very low or nearly zero. The CT surrounding the phase and neutral senses the differential current under earth fault and actuates the CB to operate (open). The difference current I_f through fault path resistance R_e is the leakage to earth. If this value exceeds a preset value, then the ELCB opens.

OR

The ELCB detects fault currents from live to the Earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other earthed body.

Applications of ELCB (Earth Leakage Circuit Breaker) : **(2 Marks)**

- In low voltage domestic, commercial and industrial applications to protect from electric shock due to leakage current.

---------- **END**----------

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Important suggestions 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 FIVE of the following :** **10 Marks**
a)	**State Faraday's law of Electromagnetic Induction**
Ans	**First Law: - ----------(1 Mark)** Whenever change in the magnetic flux linked with a coil or conductor, an EMF is induced in it. **OR** Whenever a conductor cuts magnetic flux, an EMF is induced in conductor. **Second Law: ---------- (1 Mark)** The Magnitude of induced EMF is directly proportional to (equal to) the rate of change of flux linkages. $e = \frac{-N}{dt} d\varphi$
b)	**Define following terms with respect to A.C. quantity. (i) Time period (ii) Frequency**
Ans	**i) Time Period: ----------(1 Mark)** The time (in sec) required by an alternating quantity to complete its one cycle is known as time period. **ii) Frequency: (1 Mark)** It is the number of cycles completed by an alternating quantity in one second.
c)	**State the relationship between line current and phase current for star and delta connection.**
Ans	**(i) Star connected: (1 Mark)**

a) The relation between line current and phase current in star connected load.

$$I_L = I_{ph}$$

b)The relation between line voltage and phase voltage in star connected Load

$$V_L = \sqrt{3}\, V_{Ph}$$

(ii) Delta connected load: **(1 Mark)**

a) The relation between line current and phase current in delta connected circuit.

$$I_L = \sqrt{3}\ \ I_{ph}\ \ OR\ \ I_{ph} = I_L / \sqrt{3} \qquad where\ I_L\ is\ line\ Current\ and\ I_{ph}\ is\ phase\ Currnts$$

b) The relation between line voltage and phase voltage in delta connected circuit

$$V_{ph} = V_L \quad where\ V_L = line\ voltage\ \&\ Vph = Phase\ volatge$$

d) State the working principle of transformer.

Ans **Working Principle: - ---------- (2 Marks)**

- The primary winding is connected to single phase AC supply. an ac current starts flowing through primary winding.
- The AC primary current produces an alternating flux in the magnetic core.
- This Changes flux gets linked with the secondary winding through the magnetic core
- The varying flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction.

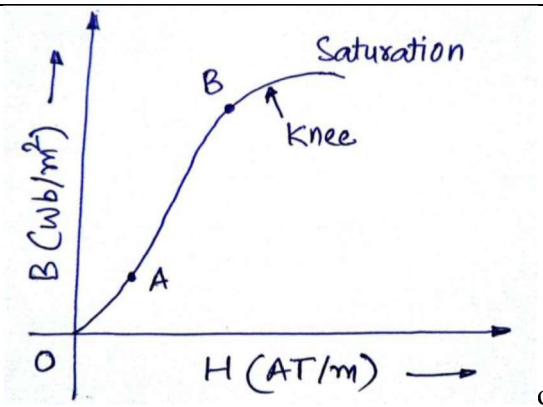
OR

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.

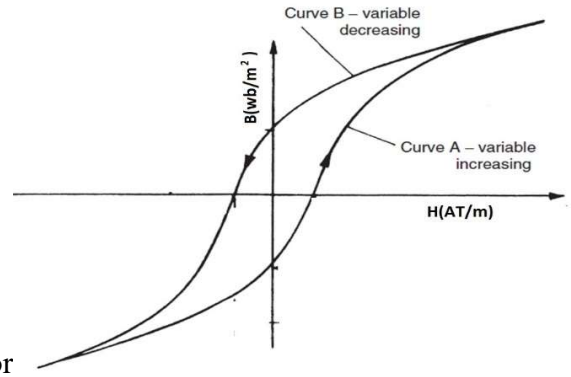
This current flowing through the primary winding produces an alternating magenetic flux (Ø).This flux links with secondary winding through the magenetic core & induces an emf in it according to the faraday's laws of electromagnetic induction.

e)	**Write any four main parts of d.c. motor.**
Ans	**Parts of DC Motor:----------(Any four parts expected: 1/2 Marks each, Total 2 Marks)** 1) Yoke: 2) Pole Cores & Pole shoe: 3) Armature core: 4) Armature winding: 5) Commentator: 6) Brush: 7) Cooling Fan: 8) End covers 9) Field winding
f)	**Write any two applications of each motor. (i) Universal motor (ii) Stepper motor**
Ans	**(Any two applications are accepted from following or equivalent 1 Mark each point)** **i) Application of Universal Motor :** 1) Mixer 2) Food processor 3) Heavy duty machine tools 4) Grinder 5) Vacuum cleaners 6) Refrigerators 7) Driving sewing machines 8) Electric Shavers 9) Hair dryers 10) Small Fans 11) Cloth washing machine 12) portable tools like blowers, drilling machine, polishers etc **ii) Applications of stepper motor-** **(Any two applications are accepted from following or equivalent 1 Mark each point)** 1.Suitable for use with computer controlled system 2. Widely used in numerical control of machine tools. 3. Tape drives

	4. Floppy disc drives 5. Computer printers 6. X-Y plotters 7. Robotics 8. Textile industries 9. Integrated circuit fabrication 10. Electric watches 11. In space craft's launched for scientific explorations of planets. 12 Automotive 13. Food processing 14. Packaging
g)	**State any two methods of reducing earth resistance.**
Ans	**(Any Two methods expected: 1 Marks for each, Total 2 Marks)** **Methods of reducing earth resistance:** Earth resistance can be minimized using any of the following measures 1. By increasing length of the earth electrode 2. By increasing no of earthing rods 3. By treatment of the soil. Soil treatment involve treating the soil with a salt, such as copper sulfate, magnesium sulfate, or sodium chloride. Combined with moisture, the salts leach into the soil to reduce earth resistivity.
Q.2	**Attempt any THREE of the following : 12 Marks**
a)	**Draw and explain B-H curve of magnetic material.**
Ans:	**B-H curve: (Diagram ; 2 Marks & Explanation: 2 Marks)** The B-H curve is the graphical representation of relation between flux density (B) and applied field strength (H), with H plotted on the x-axis and B plotted on the y-axis. Typical B-H curve is as shown in figure below:



or



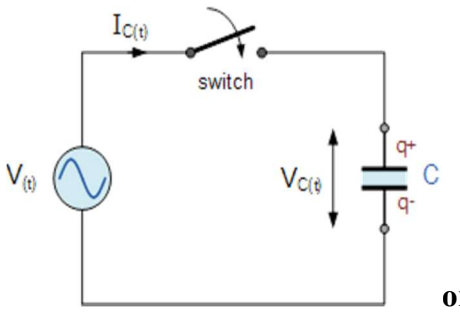
OR Equivalent Figure

The B-H curve can be described by dividing it into 3 regions.

- **Region OA:** For zero current, H = 0 and B is also zero. The flux density B then increases gradually as the value of H is increased. However B changes slowly in this region.
- **Region AB:** In this region, for small change in H, there is large change in B. The B-H curve is almost linear in this region.
- **Region beyond B:** After point B, the change in B is small even for a large change in H. Finally, the B-H curve will tend to be parallel to X axis. This region is called as saturation region.

b) Draw purely capacitive circuit. Show vector diagram and waveform and write formula for capacitive reactance.

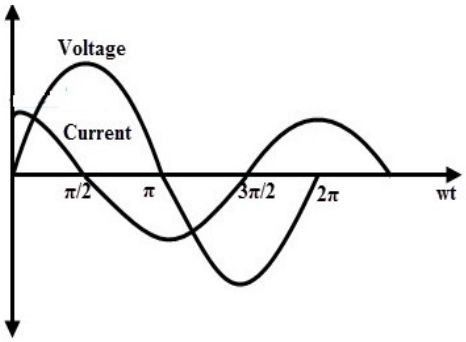
Ans: **Schematic diagram of purely capacitive circuit:** **(1 Mark)**



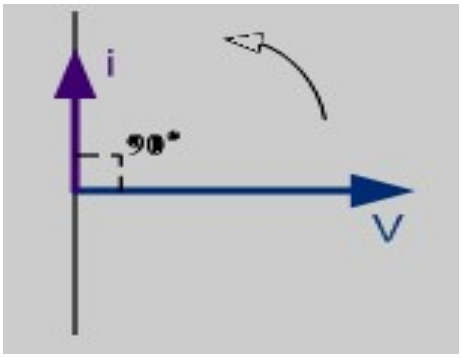
or equivalent Diagram

Pure capacitive circuit: **(Waveform: 1 Mark & Vector Diagram 1 Mark)**

Waveform:



Vector Diagram :



Formula for capacitive reactance: **(1 Mark)**

$$X_C = \frac{1}{2\pi \times f\ C}$$

Where:

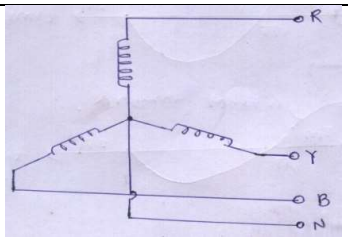
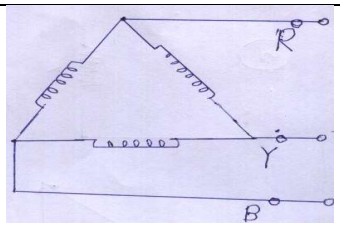
X_C = Capacitive reactance in ohm

f = Frequency in Hz

C = Capacitance in farad

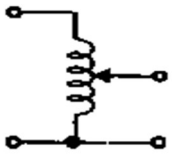
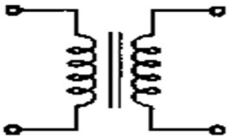
c) Compare star and delta connection on basis : (i) Connection diagram (ii) Neutral (iii) Line and phase current (iv) Line and phase voltage.

Ans: **(Each Point : 1 Mark)**

Sr no	Parameter	Star connection	Delta connection
1.	connection diagram		
2.	Neutral	Neutral point formed	No neutral point formed
3.	Line & Phase current	$I_L = I_{Ph}$	$I_L = \sqrt{3}\ I_{Ph}$
4.	Line & phase voltage	$V_L = \sqrt{3}\ V_{Ph}$	$V_L = V_{Ph}$

d) Compare auto transformer with two winding transformer on following basis: (i) Symbol (ii) Copper saving (iii) Isolation (iv) Application

Ans: **(1 Mark each point, total 4 Marks)**

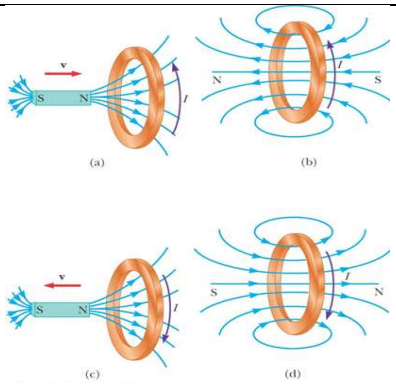
S.No.	Points	Autotransformer	Two winding transformer
1.	**Symbol**		
2.	**Copper saving**	Copper saving takes more as compared to two winding	Copper saving is less
3.	**Isolation**	There is no electrical isolation	Electrical isolation is present in between primary and secondary winding
4.	**Application**	Variac, starting of ac motors, dimmerstat.	Mains transformer, power supply, welding, isolation transformer

Q.3 Attempt any THREE of the following : 12 Marks

a) Explain with neat diagram Lenz's law. State its any two applications.

Ans: **(1 Marks for explanation and 2 marks for figure, 1 for application)**

Lenz's law of electromagnetic induction states that the direction of the current induced in a conductor by a changing magnetic field (as per Faraday's law of electromagnetic induction) is such that the magnetic field created by the induced current *opposes* the initial changing magnetic field which produced it. The direction of this current flow is given by Fleming's right hand rule.



As the magnet moves to the right toward the loop, the external magnetic flux through the loop increases with time. As the result, the induced current set up in the loop which produces magnetic field, as illustrated in figure (b).Knowing that like magnetic poles repel each other, we conclude that the left face of the current loop acts like a north pole and that the right face acts like a south pole.

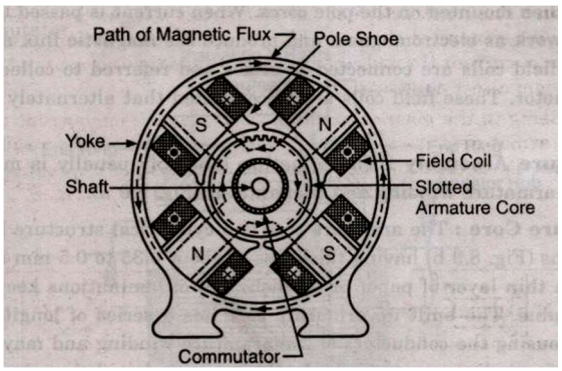
If the magnet moves to the left, as in figure (c), its flux through the area enclosed by the loop decreases in time. Now the induced current in the loop produces the magnetic field as shown in figure (d).In this case, the left of the loop is a south pole and the right face is a north pole.

Lenz law applications are plenty. Some of them are listed below-

1. Eddy current balances
2. Metal detectors
3. Eddy current dynamometers
4. Braking systems on train
5. AC generators
6. Card readers
7. Microphones

b) Explain the working principle of d.c. motor with neat sketch.

Ans: **(Figure-2, & Working principle : 2 Mark, Total 4 Mark)**



OR Equivalent Fig

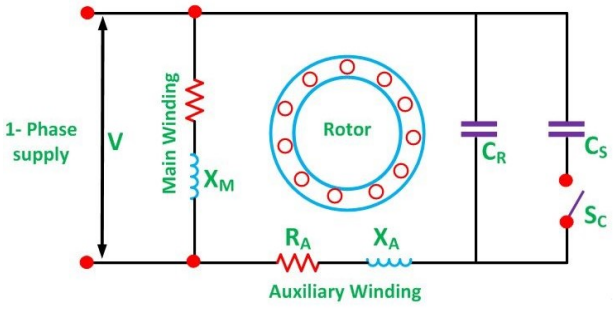
Working Principle of D.C Motor :- **(2 Marks)**

It works on Faradays law of electromagnetic induction -If a current carrying conductor is placed in a magnetic field, mechanical force is experienced on the conductor, the direction of which is given by Fleming's left-hand rule (also called motor rule) and hence the conductor moves in the direction of force.

c) Explain the principle of operation of capacitor start capacitor run motor.

Ans: **Schematic representation of capacitor start capacitor run induction motor:**

(Diagram-2 Marks & Operation-2 Marks)



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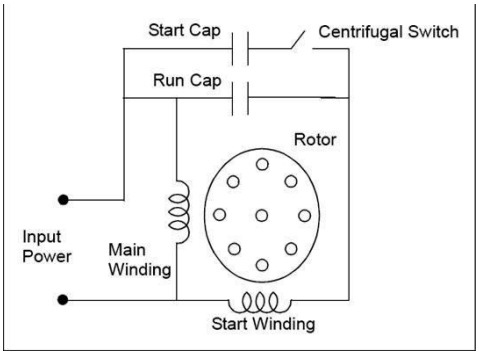


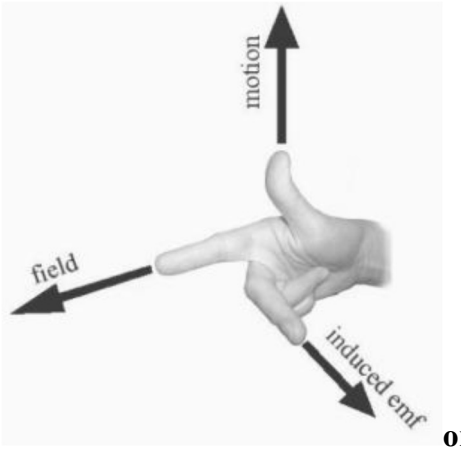
operation of capacitor start capacitor run motor:

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 serves the purpose of obtaining necessary phase displacement at the time of starting and also improves the power factor of the motor.**

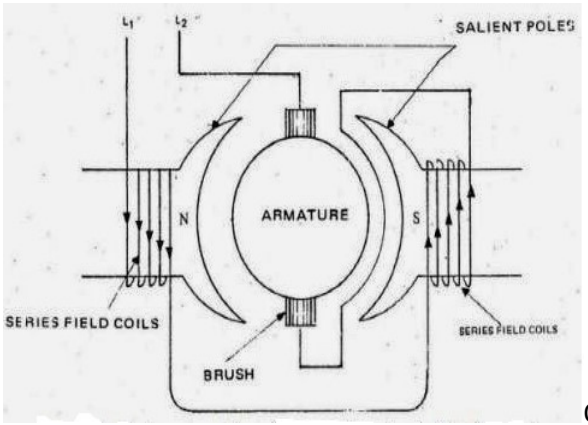
d) Explain the importance of earthing.

Ans: Importance of Earthing: **(Any Four point are expected: 1 Mark each, Total 4 Marks)**

1. To provide an alternative path for the leakage current to flow towards earth.
2. To save human life from danger of electrical shock due to leakage current.
3. To protect high rise buildings structure against lightening stroke.
4. To provide safe path to dissipate lightning and short circuit currents.
5. To provide stable platform for operation of sensitive electronic equipment's.

Q.4	**Attempt any THREE of the following :** **12 Marks**
a)	**Explain how Fleming's right hand rule helps to deciding direction of induced EMF.**
Ans:	**Fleming's Right Hand Rule: (Figure: 2 Marks & Explanation: 2 Marks, Total 4 Marks)**  **or equivalent figure** Stretch out the first three fingers of your right hand such that they are mutually perpendicular to each other, align first finger in direction of magnetic field, thumb in direction of motion of conductor with respect to magnetic field, then the middle finger will give the direction of induced emf in conductor.
b)	**Write any two applications of each of the following: (i) DC Shunt motor (ii) DC series motor.**
Ans:	**i) Applications of DC shunt motor: (Any Two applications expected: 1 Mark each)** 1. Line shafts 2. Lathes 3. Vacuum cleaners 4. Pressure blowers 5. Reciprocating pumps 6. Wood working machines **ii) DC Series Motor : (Any Two applications expected: 1 Mark each)** 1. Electric traction 2. Cranes, 3. Passenger elevators, 4. Continuous conveyors, 5. Grinders, 6. Polishers,

c)	**Explain principle of operation of universal motor with neat diagram.**
Ans:	**Figure of Universal motor:** **(Figure : 2 Marks & Explanation : 2 Marks)**



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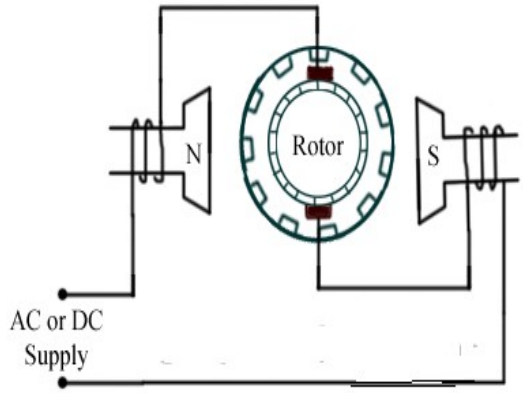


OR Equivalent figure

Working of universal motor: **(Following or equivalent working is to be accepted)**

- A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due t
- o this mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule.

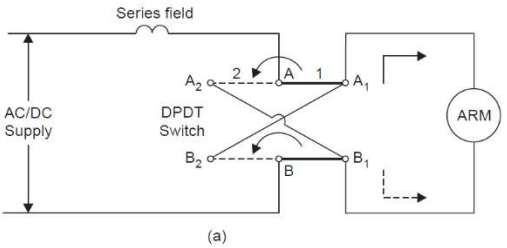
  When fed with AC supply, it still produces unidirectional torque. Because, armature winding and field winding are connected in series, they are in same phase. Hence, as polarity of AC changes periodically, the direction of current in armature and field winding reverses at the same time. Thus, direction of magnetic field and the direction of armature current reverses in such a way that the direction of force experienced by armature conductors remains same. Thus, regardless of AC or DC supply, universal motor works on the same principle that DC series motor works.

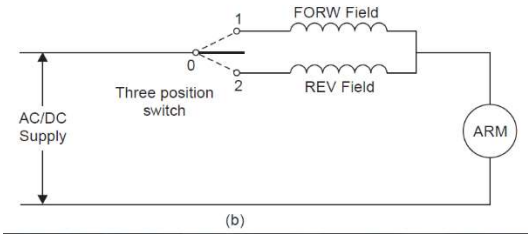
d)	**Explain how direction of rotation of universal motor is reversed.**
Ans:	**(2 Marks for explanation and 2 marks for figure)**

The direction of rotation of a universal motor can be changed by either: (i) Reversing the field connection with respect to those of armature; or (ii) By using two field windings wound

on the core in opposite directions so that the one connected in series with armature gives clockwise rotation, while the other in series with the armature gives counterclockwise rotation.

The second method, i.e., the two-field method is used in applications such as motor operated rheostats and servo systems. This method has somewhat simpler connections than the first method.





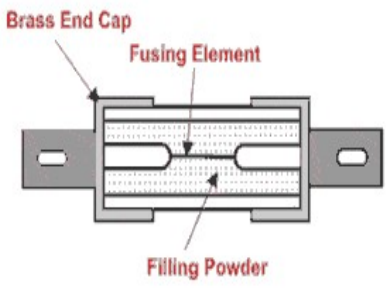
or equivalent Figure

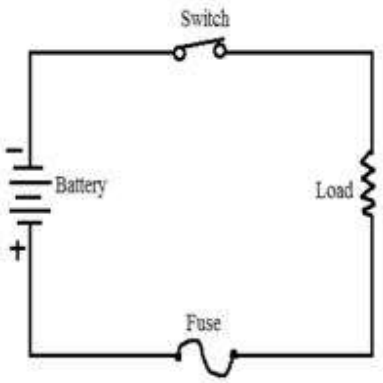
e) Explain the working of fuse with neat diagram.

Ans: **Working of fuse** **(2 Marks for explanation and 2 marks for figure)**

Fuse is an overcurrent/short circuit protection. The working principle of the fuse is based upon "heating effect of the electric current". It is fabricated in a form of strip or thread of metallic wire. The connection of the Fuse in an electrical circuit is always in series with device that is to be protected. Due to the heavy flow of current in the electrical circuit, the fuse gets melted soften and it opens the circuit. The extreme flow of current may direct to the collapse of the wire and disconnection of the circuit that is protected

Diagram of Fuse:





Q.5	Attempt any TWO of the following : 12 Marks
(a)	**A sinusoidal voltage with equation, V = 200 sin (314 t + n/3) volt is applied to a load. Calculate (i) Maximum voltage (ii) RMS voltage (iii) Frequency (iv) Time period (v) Phase angle (vi) Angular frequency.**
Ans:	**Given data :** **v = 200 sin (314 t +** $\frac{\pi}{3}$ **)** **Maximum Value V_m :** 200 V **i) Maximum voltage V_m** = 200 volt ---------- **(1 Mark)** **ii) RMS value Vrms =** 0.707 x Vm---------- **(1/2 Mark)** = 0.707 x 200 = 141.4 Volt ---------- **(1/2 Mark)** **iii) Frequency** = $\frac{\omega}{2\pi}$ ---------- **(1/2 Mark)** $= \frac{314}{2\pi}$ $F = 49.97 \cong 50\ H_Z$ ---------- **(1/2 Mark)** **iv) Time Period (T) :** $T = \frac{1}{F} = \frac{1}{49.97}$ ---------- **(1/2 Mark)** $T = 0.02$ sec - ---------- **(1/2 Mark)** **v)Phase angle** ϕ = $\frac{\pi}{3} = 60^0$ ---------- **(1/2 Mark)** $\phi = 60^0$ ---------- **(1/2 Mark)** **vi) Angular Frequency:** $\omega = 314$ rad/sec ----------**(1 Marks)**
b)	**Three similar coils each of resistance 20 ohm and on inductance 0.1 H are connected in delta to a 3-Ph, 440V, 50 Hz supply system. Calculate the phase current, line current, phase voltage, line voltage, active power and reactive power.**
Ans:	**Given Data:**

$R_{ph} = 20\,\Omega \qquad V_L = 440\,V \quad L = 0.1\,H \qquad F = 50Hz$

$$Z_{ph} = R_{ph} + X_{Lph}$$

$$X_L = 2\,\pi\,F\,L$$

$$X_L = 2\,\pi \times 50 \times 0.1$$

$$X_L = 31.41\ \Omega$$ ---------- **(1/2 Mark)**

$$Z_{ph} = R_{ph} + X_{Lph}$$

$$Z_{ph} = 20 + j\,31.41\,\Omega$$

$$Z_{ph} = 37.23 \angle 57.51\ \Omega$$

i) Line Voltage $= V_L = 440\,V$ ---------- **(1/2 Mark)**

ii) In Delta connection Line voltage = Phase voltage (V_{ph}):

$$V_L = V_{ph}$$

$$V_{ph} = 440\ volts$$ ---------- **(1/2 Mark)**

iii) Phase Current (I_{ph}) :

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$ ---------- **(1/2 Mark)**

$$I_{ph} = \frac{440}{20 + j\,31.41}$$

$$I_{ph} = \frac{440}{37.23}$$

$$I_{ph} = 11.81\ Amps$$ ---------- **(1/2 Mark)**

iv) Line Current (I_L) :

$$I_L = \sqrt{3} \times I_{ph}$$

$$I_L = \sqrt{3} \times 11.81$$

$I_L = 20.54$ Amps ---------- **(1 Mark)**

Power Factor (P.F) :

$$Cos\phi = \frac{R}{Z}$$ ---------- **(1/2 Mark)**

$$Cos\phi = \frac{20}{37.23}$$

$Cos\phi = 0.5372\ lag$ OR $P.F = Cos\phi\ 57.51 = 0.5372\ lag$ **--- (1/2 Mark)**

v) Active Power (P_A) :

$$P_A = \sqrt{3}\ V_L\ I_L\ Cos\phi$$

$$P_A = \sqrt{3} \times 440 \times 20.45 \times 0.5372$$

$P_A = 8371.51\ watt$ ---------- **(1/2 Mark)**

vi) Reactive Power ($P_{reactive}$) :

$P_{reactive} = \sqrt{3}\ V_L\ I_L\ Sin\phi$ ---------- **(1/2 Mark)**

$P_{reacttive} = \sqrt{3} \times 440 \times 20.45 \times \sin 57.51$

$P_{reactive} = 13145.71\ VAR$ ---------- **(1/2 Mark)**

c) **A 1-ph 1.5 KVA. 230/110 V transformer used in a laboratory. Calculate primary winding current.**
(i) Secondary winding current (ii) Turns ratio. (iii) Current ratio

Ans:

i) Primary current (I_1):

$$I_1 = \frac{KVA}{V_1}$$ ---------- **(1/2 Mark)**

$$I_1 = \frac{1.5 \times 10^3}{230}$$

$I_1 = 6.5217\ \ Amp$

---------- **(1/2 Marks)**

ii) Secondary current (I_2):

$$I_2 = \frac{KVA}{V_2}$$ ---------- **(1/2 Mark)**

$$I_2 = \frac{1.5\times10^3}{110}$$

$$I_2 = 13.6364 \quad Amp$$

---------- **(1/2 Marks)**

iii) Turns ratio:

$$K = \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{230}{100} = 2.0909 \quad \textbf{or}$$

$$= \frac{N_1}{N_2} = \frac{I_2}{I_1} = \frac{13.6364}{6.5217} = 2.0909$$ ----------**(02 Mark)**

iv) Current ratio:

$$K = \frac{I1}{I2} = \frac{6.5217}{13.6364} = 0.4782$$

$$K = 0.4782$$ ----------**(02 Mark)**

Q.6	**Attempt any TWO of the following :**	**12 Marks**
a)	**Explain the principle of working of stepper motor with a neat diagram.**	

Ans:

Working Principle of stepper Motor- **(1 Mark)**

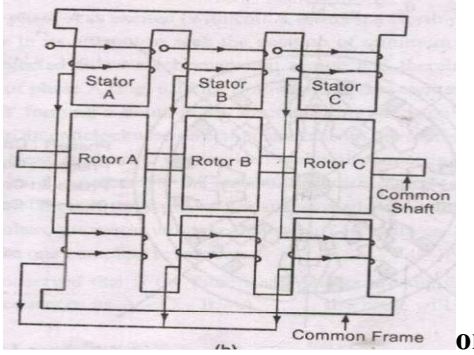
A stepper motor rotates through a fixed angular step in response to each input current pulse received by its controller.

Types of Stepper Motor :- **(1 Mark)**

1) Variable Reluctance Motor
2) Permanent Magnet Motor

1) Variable Reluctance Motors:-

(Any One method explanation expected: Diagram : 2 Marks and Working: 2 Mark)



or equivalent dia.

Working:-

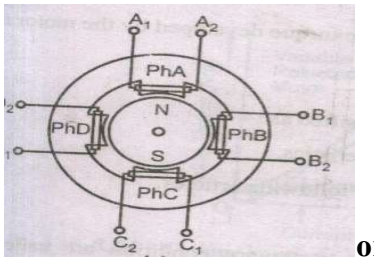
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

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.

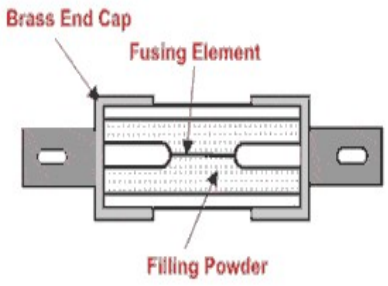
Rotor will be driven in clockwise direction.

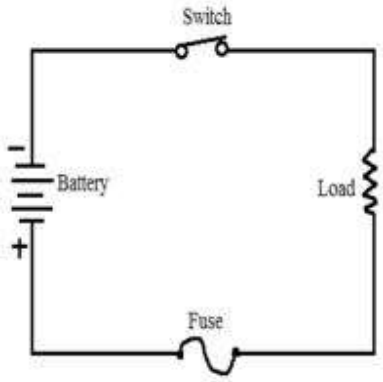
b) Explain the operation of each of the following : (i) Fuse (ii) ELCB

Ans: **i) Working of fuse :** **(2 Marks for explanation and 1 Marks for figure)**

Fuse is an overcurrent/short circuit protection. The working principle of the fuse is based upon "heating effect of the electric current". It is fabricated in a form of strip or thread of metallic wire. The connection of the Fuse in an electrical circuit is always in series with device that is to be protected. Due to the heavy flow of current in the electrical circuit, the fuse gets melted soften and it opens the circuit. The extreme flow of current may direct to the collapse of the wire and disconnection of the circuit that is protected

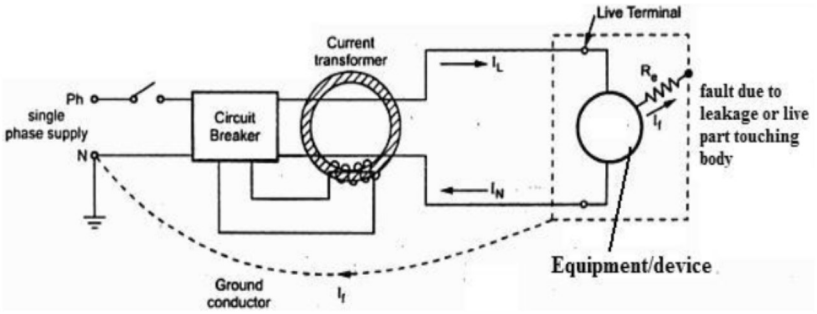
Diagram of Fuse:





or equivalent figure

ii) Diagram of ELCB (Earth Leakage Circuit Breaker) : **(1 Marks)**



OR

Equivalent Figure

Operation of ELCB (Earth Leakage Circuit Breaker) : **(2 Marks)**

- It works on principle of relaying when the current in the earth path exceeds a set value.
- Under normal conditions (I_L–I_N) = I_f is very low or nearly zero. The CT surrounding the phase and neutral senses the differential current under earth fault and actuates the CB to operate (open). The difference current I_f through fault path resistance R_e is the leakage to earth. If this value exceeds a preset value, then the ELCB opens.

OR

The ELCB detects fault currents from live to the Earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other earthed body.

c)	**Write any two applications of each of the following : (i) ELCB (ii) MCCB (iii) MCB (iv) Fuse**
Ans:	

i) Applications of ELCB : **(2 Marks)**

1. It is used for safety of the operator
2. It is used to detect presence of leakage current in a device

ii) Applications of MCCB : **(2 Marks)**

1. It is used as a protective device in low voltage distribution
2. It is used to protect secondary side of power distribution transformer
3. It is used for short circuit protection of motors

iii) Applications of MCB : **(1 Marks)**

1. It is used as an alternative to fuse in domestic and commercial applications
2. It is used in industrial control panels as overload protection and disconnection of supply
3. It is used in industrial heating systems.

iv) Applications of Fuse: **(1 Marks)**

1. Protection against overload and short circuit.
2. Electrical Appliances, like ACs (Air Conditioners), TV, Washing Machines, Music Systems, and
3. Many more.
4. Electrical Cabling in Home
5. Motor starters
6. Cameras, Scanners, Printers, and Photocopiers
7. Automobiles, electronic devices and Gaming's

---------- **END**----------