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 TEN of the following :** **20 Marks**

a) **Define (i) frequency (ii) time period.**

Ans:

i) Frequency: **(1 Mark)**

It is the number of cycles completed by an alternating quantity in one second.

ii) Time Period: ----------**(1 Mark)**

The time (in sec) required by an alternating quantity to complete its one cycle is known as time period.

b **Give the difference between AC and DC supply. (any two points)**

Ans: **(Any TWO Point Expected: 1 Mark each, Total 2 Marks)**

S.No.	Point	AC Supply	DC Supply
1	Amount of energy that can be carried	Safe to transfer over longer city distances and can provide more power.	Voltage of DC cannot travel very far until it begins to lose energy.
2	Frequency	The frequency of alternating current is 50Hz or 60Hz depending upon the country.	The frequency of direct current is zero.
3	Direction	It reverses its direction while flowing in a circuit.	It flows in one direction in the circuit.
4	Current	It is the current of magnitude varying with	It is the current of constant

		time	magnitude.
5	Flow of Electrons	Electrons keep switching directions - forward and backward.	Electrons move steadily in one direction or 'forward'.
6	Obtained from	A.C Generator and mains.	Cell or Battery.
7	Passive Parameters	Impedance.	Resistance only
8	Power Factor	Lies between 0 & 1.	it is always 1.
9	Types	Sinusoidal, Trapezoidal, Triangular, Square.	Pure and pulsating.

c) State working principle of PMMC meter.

Ans: **Working principle of PMMC meter:- ----------(2 Mark)**

When a current carrying conductor is placed in a magnetic field, it experiences a force and tends to move in the direction as per Fleming's left hand rule.

d) Write any two applications of D.C. series motor.

Ans: **i) Application of 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,

e) Define transformation ratio of a transformer, write equation for it.

Ans: **Transformation Ratio (k):- ----------(1 Mark)**

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.

Equation of Transformation ratio: ----------(1 Mark)

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

f) State the types of transformers on the basis of construction.

Ans: **Types of transformers on the basis of construction: ----------(1 Mark each)**

	i) Shell Type transformer ii) Core type Transformer
g)	**Name any two safety devices used in electric wiring.**
Ans:	**i) Spirit Level:-** **(Any Two expected: 1 Mark each)** ➢ It is used to check the level. ➢ It is a common instrument to test or adjust horizontal surface. **ii) Growler:-** ➢ It is a equipment used for finding shorted turns of armature coil or stator/rotor winding. It is essentially a single winding transformer. **iii) Bearing Puller:-** ➢ Bearing puller is used for holding and removing the item. **iv) Megger:-** ➢ Megger is used to find out insulation resistance of electrical machine/equipment ➢ Megger (mega ohm meter) are available for DC voltage of 500V to 5000V. **v) Earth Tester :-** ➢ A earth tester works on the same principle as a megger. ➢ It is used to measure earth resistance. **vi) Bench Vice :-** ➢ It is used to Clamp the material in its vice for cutting or threading operations. ➢ For electrical work generally bench vice is used. ➢ The machine vice is used holding the item while they are being drilled. **vii) Dial Indicator :-** ➢ Dial type indicator are used to check the run-out (Unbalance) of rotating parts (commutators, rotor, shafts) and indicators can also used to check the alignment of shaft in electrical machines. **viii) Filler Gauge :-** ➢ It is used to check the air gap. **x) Multimeter:-** ➢ Measurement of voltage of various ranges. ➢ Measurements of current of various ranges. ➢ Measurement of DC resistance ➢ To check the Continuity **ix) Combination plier :** ➢ It is used for cutting of wires, gripping operation by hand, twisting wires and other different operations required in electrical work **(xi) Tester :** To verify the live main or supply verification

	(xii) Wire Stripper: To cut the wire & remove the insulation of the wire.
h)	**State any four types of tarrifs used in electricity billing.**
Ans:	**Types of Tariff:-** **(Any Four Types expected: 1/2 each, Total 2 Marks)** 1) Flat-demand Tariff 2) Simple-demand Tariff or Uniform Tariff 3) Flat-rate Tariff 4) Step-rate Tariff 5) Block-rate Tariff 6) Two-part Tariff 7) Maximum demand Tariff 8) Three-part Tariff 9) Power factor Tariff :- a) KVA maximum demand Tariff b) Sliding Scale Tariff or Average P.F. Tariff c) KW and KVAR Tariff 10) TOD (Time of Day) Tariff 11) ABT:-This tariff system is called availability based tariff. As its name suggest it is a tariff system which depends on the availability of power.
i)	**State two applications of universal 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
j)	**Write the meaning of slip w.r.t. a 3 ph induction motor.**
Ans:	**Meaning of slip w.r.t. a 3 ph induction motor** : **(2 Marks)** The ratio of relative speed of rotor (difference between synchronous speed and rotor speed) to the synchronous speed of rotating magnetic field. Slip = $(N_S-N) / N_S$ Where, N_S = Synchronous speed and N = speed
k)	**State types of enclosures for electric motors.**
Ans:	**Types of enclosures for Electric Motor: (Any TWO Expected: 1 Mark each, Total 2 Marks)** i) Open type enclosure:- ii) Screen Protected enclosure iii) Drip proof (moisture) enclosure: iv) Flame (Fire) proof enclosure:- v) Totally enclosed type enclosure:- vi) Pipe ventilated totally enclosed type enclosure:
l)	**Name any two electrical machines used in electro-agro system.**
Ans:	**Electrical machines used in electro agro system: (Any two each carrying 1 Mark each)** 1) Three phase induction motor for pumping of water 2) Single phase induction motors for cutting purpose 3) PMDC motor for insecticide spraying machines
Q.2	**Attempt any FOUR of the following : 16 Marks**
a)	**Define following terms used in A.C. circuits : (i) Cycle (ii) Rms value (iii) Phase difference (iv) Average value**

Ans:

(i) Cycle: **(1 Mark)**

A complete set of variation of an alternating quantity which is repeated at regular interval of time is called as a cycle.

OR

Each repetition of an alternating quantity recurring at equal intervals is known as a cycle.

(ii) RMS value : **(1 Mark)**

The RMS value of an AC is equal to the steady state or DC that is required to produce the same amount of heat as produced by AC provided that the resistance and time for which these currents flow are identical.

iii) Phase difference: **(1 Marks)**

Phase difference is the difference in phase angle between two sinusoids or phasors.

(iv) Average value: **(1 Marks)**

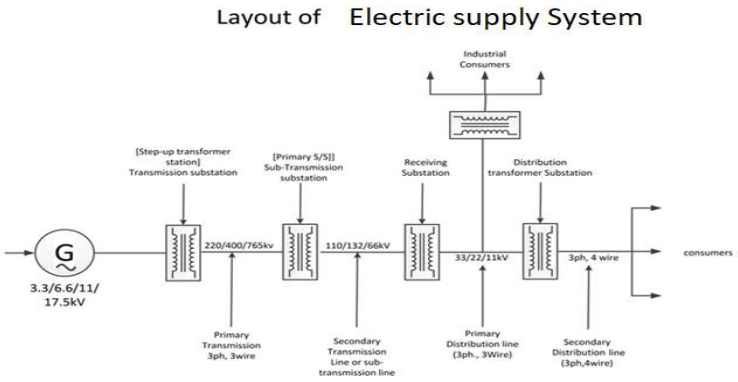
It is defined as the arithmetical average or mean of all the values of an alternating quantity over one cycle.

OR

For an alternating current , the average value is defined as that value of steady current (DC) which transfers the same charge as is transferred by the alternating current during the same time under the same conditions.

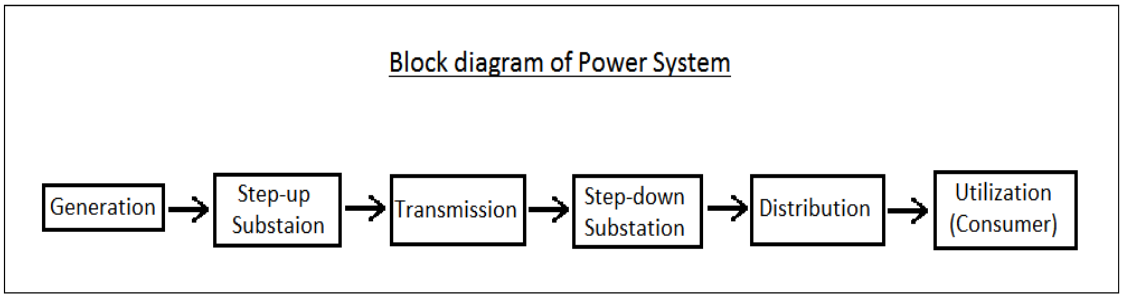
b) Draw single line diagram of electrical power system and show different stages.

Ans: **Single line diagram of electrical power system and show different stages:** **(4 Marks)**



OR Equivalent Figure

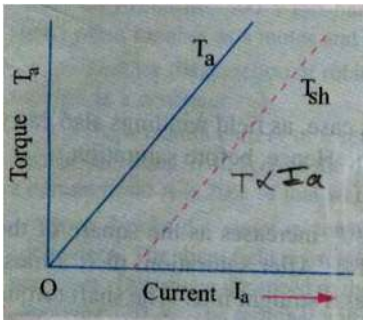
OR



c) Draw and explain torque-armature current characteristics of D.C. shunt motor.

Ans: **(Characteristics 2 Marks & Explanation 2 Marks)**

Torque-armature current characteristic of DC shunt motor:



or equivalent figure

Explanation:

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

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

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

d) Differentiate between PMMC and MI type meters (any four points).

Ans: **(Any Four Point expected: 1 Mark each, Total: 4 Marks)**

Sr. no	PMMC Instrument	MI Instrument
1	It works on the principle of DC motor	It works on the principles of magnetism.
2	Deflection torque is proportional to current	Deflection torque is proportional to square of current

3	Damping is provided by eddy current	Damping is provided by air damping
4	Controlling torque is proportional to angle of defection	Controlling torque is proportional to Sine
5	Spring controlled instruments	Gravity controlled instruments.
6	Scale is uniform	Non uniform scale.
7	Delicate, sensitive and accurate	Robust, reliable accurate.
8	Costly.	Cheap.
9	Low power consumption	high power consumption than moving coil
10	It is used only in D.C. Circuits.	It is used both in A.C. and D.C. Circuits.
11	Can be used as voltmeter, Am-meter, Galvanometer, ohmmeter	Can be used as Ammeter, Voltmeter and Watt meter

e) **An A.C. voltage of v (t) = 230 sin 314 t volts is applied to a circuit. Calculate (i) Angular frequency (ii) Frequency (iii) RMS value (iv) Average value**

Ans:

Given data :

v = 200 sin (314 t) **Maximum Value V_m :** 230 V

i) Maximum voltage V_m = 230 volt ---------- **(1/2 Mark)**

ii) Angular Frequency:

$\omega = 314$ **rad/sec** ---------- **(1/2 Marks)**

iii) Frequency $= \frac{\omega}{2\pi}$ ---------- **(1/2 Mark)**

$= \frac{314}{2\pi}$

$F = 49.97 \cong 50\ H_Z$ ---------- ---------- **(1/2 Mark)**

iv) RMS value Vrms = 0.707 x Vm---------- **(1/2 Mark)**

= 0.707 x 230

= 162.61 Volt ---------- **(1/2 Mark)**

v) Average value:

$$V_{av} = \frac{V_{rms}}{Form\ \ factor} = \frac{162.61}{1.11}$$ ---------- **(1/2 Mark)**

$$V_{av} = 146.49\ V$$ ---------- **(1/2 Mark)**

OR

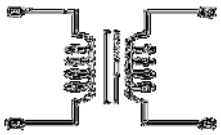
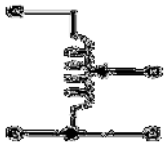
= 0.637 x Vm---------- **(1/2 Mark)**

= 0.637 x 230

V_{av} = 146.51 Volt ---------- **(1/2 Mark)**

f) Compare two winding transformer and auto transformer.

Ans: **(Any four points expected: Each point 1 Mark)**

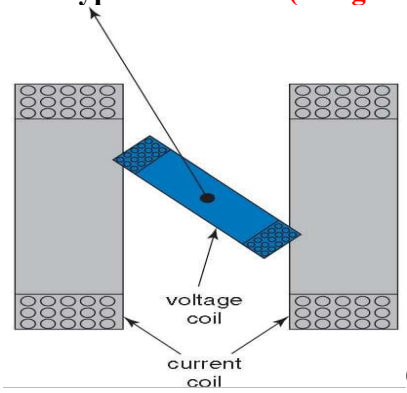
Sr no.	Points	Two winding transformer	Autotransformer
1.	**Symbol**		
2.	**Number of windings**	It has two windings	It has one winding
3.	**Copper saving**	Copper saving is less	Copper saving takes more as compared to two winding
4.	**Size**	Size is large	Size is small
5	**cost**	Cost is high	Cost is low
6	**Losses in winding**	More losses takes place	Less losses takes place
7.	**Efficiency**	Efficiency is low	Efficiency is high
8.	**Regulation**	Regulation is poor	Regulation is better

9.	**Electrical isolation**	Electrical isolation is present in between primary and secondary winding	There is no electrical isolation
10.	**Movable contact**	Movable contact is not present	Movable contact is present
11.	**Application**	Mains transformer, power supply, welding, isolation transformer	Variac, starting of ac motors, dimmerstat.

Q.3 **Attempt any FOUR of the following :** **16 Marks**

a) **Explain with neat diagram working of dynamometer type wattmeter.**

Ans: **Dynamometer type wattmeter:** **(Diagram : 2 Mark & Explanation: 2 Marks, Total 4 Marks)**



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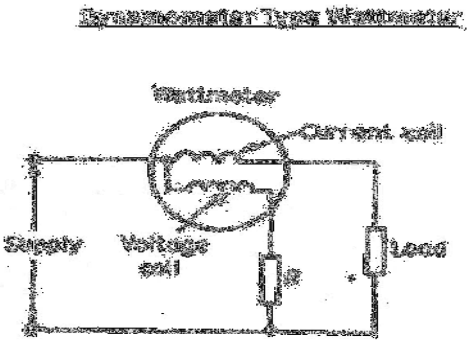


Working Principle of Wattmeter:

It consists of two stationary coils, called current coils and one moving coil, called voltage or potential coil. The moving coil is mounted on the spindle, in the gap between two stationary coils, as shown. The current coils are connected such that they carry the current proportional to (or equal to) the load current and the voltage coil is connected in such a way that it carries the current proportional to the load voltage.

The interaction between two magnetic fields causes the production of force on moving system, which is proportional to the product of voltage and current i.e. power. The meter can be calibrated directly to indicate the power in watts.

Or

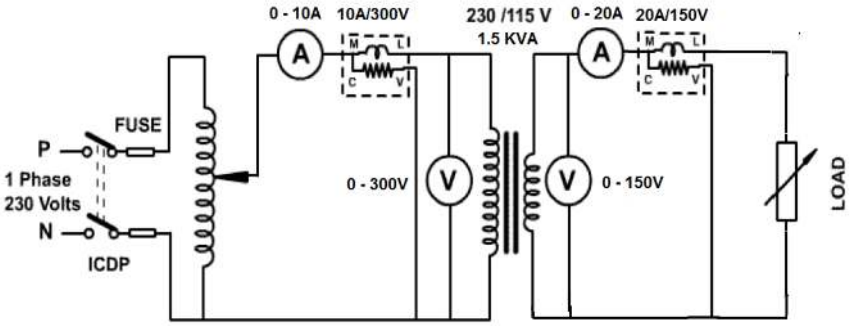
- The dynamometer wattmeter works on the motor principle
- When a current carrying conductor is placed in a magnetic field, it experiences a force and

tends to move in the direction as per Fleming's left hand rule.

b) Explain direct loading test on single phase transformer with neat circuit diagram.

Ans: **Direct loading test on single phase transformer with neat circuit diagram:**

(Diagram : 2 Mark & Explanation : 2 Mark, Total 4 Marks)



OR equivalent figure

Direct loading test on transformer is carried out to calculate the losses, efficiency and voltage regulation of the transformer. The circuit diagram is as shown in figure above. Single phase supply is given to the primary of the transformer and load is connected to the secondary side.

1) **No load Operation:**

The rated voltage is supplied to primary winding and load is switched off. The secondary current & power is then zero. This is no load operation. The readings of voltmeter, ammeter and wattmeters are taken. The input power read by primary side wattmeter then represents the constant loss of the transformer. The secondary voltage under no-load will be the secondary emf E_{20}.

2) **On-load operation:**

Few more sets of readings are taken for different loading conditions on secondary side keeping rated supply voltage.

Efficiency and regulation can be calculated by using following formulae:

Efficiency = output power/Input power

$= W_2/W_1$

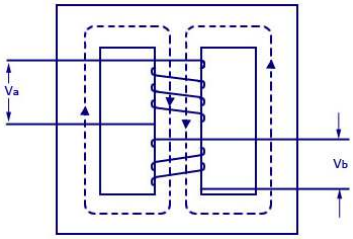
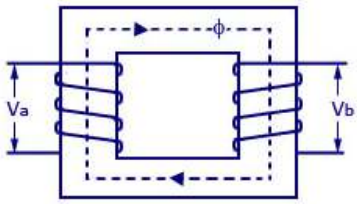
Regulation = $(V_{NL}-V_{FL})/V_{NL}) \times 100$ **OR**

$= (V_{NL}-V_{FL})/V_{FL}) \times 100$

c) Compare shell type and core type transformer on the basis of construction.

Ans: **(Any Four points expected each:1 Marks)**

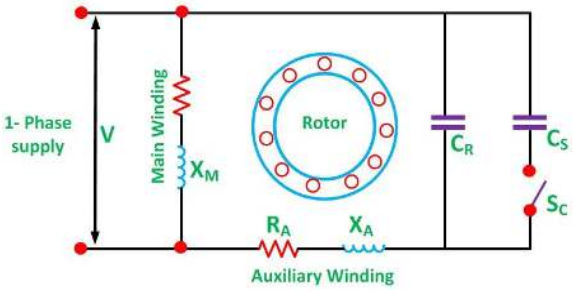
S.No	Shell Type Transformer	Core Type Transformer

	1.		
	2.	The core surround the windings	The Winding surround the core
	3.	Magnetic Flux is distributed into 2 paths	Magnetic Flux has only one continuous path
	4.	Suitable for less voltage & high output	Suitable for high voltage & less output
	5.	Difficult for repairs	Easy for repairs
	6.	More in Weight	Less in Weight
	7.	It has two windows opening	It has one window opening

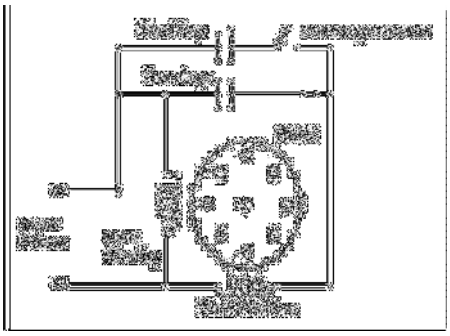
d) Draw schematic diagram of single phase capacitor start-run induction motor.

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

(Diagram-2 Marks & Operation-2 Marks, Total :4 Marks)



OR



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.
e)	**Write factors for selection of motor for electric drives.**
Ans:	**(Any FOUR factor are expected: 1 Mark each factor, Total : 4 Marks)** **Following Factors governing / or are considered while selecting electric drive (Motor) for particular application:** ➢ **Factors to be considered for selection of Electrical Drives:** **1) Nature of Supply:-** Whether supply available is AC, pure DC or rectified DC **2) Nature of Drive :-**Whether motor is used to drive individual machines or group of M/c **3) Nature of Load: -** Whether load required light or heavy starting torque or load having high inertia require high starting torque for long duration. **4) Electric Characteristics of drive: -** Starting, Running, Speed control and braking characteristics of electric drive should be studied and it should be match with load. **5) Size and rating of motor: -** Whether motor is continuously running, intermittently running or used for variable load cycle. **6) Mechanical Consideration: -** Types of enclosure, Types of bearings, Transmission of power, Noise level, load equalization **7) Cost: -** Capital, Running and maintenance cost should be less.
f)	**State any four advantages of LED over CFL.**
Ans:	**Advantages of LED over CFL: (Any FOUR Point expected: 1 Mark each, Total :4 Marks)** **1) Efficiency**: LED bulbs use close to a third of the amount of power CFL bulbs would use to produce the same amount of light. This makes them the ideal choice in portable applications for the purpose of extended battery life. **2) Durability**: LED bulbs last ten times longer than CFL bulbs. Additionally, the lifetime of a CFL bulb tends to drop drastically when it is used in a frequently cycled application. LED bulbs also exhibit a far better performance in a vibratory application. **3) Cost**: The complex manufacturing process of semiconductors makes LED bulbs expensive on the market. LED manufacturers rationalize this fact by the bulbs longer life time and energy efficiency. **4) Environment**: The traces of mercury in CFL bulbs will be spilled when the glass is broken.

The smallest amounts of mercury vapor are toxic to the human body and cause nervous system problems. Mercury is not used in LED bulbs.

5) Versatility: CFL bulbs are limited to general lighting applications while LED bulbs could range in size, color and shape. LED bulbs could be used from decorative to heavy duty industrial applications.

6) Maintenance: Smooth light and low maintenance compared to CFL

Q.4 **Attempt any FOUR of the following :** **16 Marks**

a) **A balanced delta connected load supplied with 440 V, 50 Hz, three phase a.c. supply has R = 10 ohm and L = 0.6 mH in its each arm. Calculate : (i) phase current (ii) line current (iii) impedance per phase (iv) active power**

Ans:

Given Data:

$R_{ph} = 10\ \Omega \qquad V_L = 440\ V \qquad L = 0.6\ x10^{-3}\ H \qquad F = 50Hz$

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

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

$X_L = 2\ \pi \times 50 \times 0.6 \times 10^{-3}$

$X_L = 0.1885\ \Omega$ ---------- **(1/2 Mark)**

i) Impedance per phase :

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

$Z_{ph} = 10 + j\ 0.1885\ \Omega$

$Z_{ph} = 10 \angle 1.08^0\ \Omega$

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

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

$V_L = V_{ph}$

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

iv) Phase Current (I_{ph}) :

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

$I_{ph} = \frac{440}{10.0018}$

$I_{ph} = 43.992\ Amps$ ---------- **(1/2 Mark)**

v) Line Current (I_L) :

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

$$I_L = \sqrt{3} \times 43.992$$

$I_L = 76.1964.54$ Amps ---------- **(1/2 Mark)**

vi) Power Factor (P.F) :

$$Cos\phi = \frac{R}{Z}$$

$$Cos\phi = \frac{10}{10.0018}$$

$Cos\phi = 0.9998\ lag \approx 1$ ----------**(1/2 Mark)**

vii) Active Power (P_A) :

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

$$P_A = \sqrt{3} \times 440 \times 43.992 \times 1$$

$P_A = 58069.44\ watt$ ---------- **(1/2 Mark)**

b) **A 6 pole, 3 phase induction motor operates from a supply whose frequency is 50 Hz. Calculate : (i) synchronous speed of motor (ii) the speed of the rotor when slip is 0.04.**

Ans: Given data:

F = 50 Hz, P = 6 pole S = 0.04

i) Synchronous speed: ----------**(2 Marks)**

$$N_S = \frac{120f}{P}$$

$$N_S = \frac{120 \times 50}{6}$$

$$\boldsymbol{N_S = 1000\ rpm}$$

ii) Actual speed: ----------**(2 Marks)**

$$N = N_S\ (1 - S)$$

$N = 1000\,(1 - 0.04)$

$N = 960 \;\; rpm$

c) Derive the emf equation of transformer.

Ans:

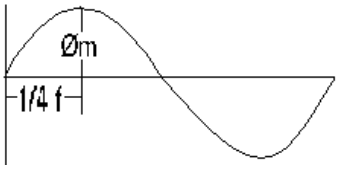
➢ **EMF equation of single phase Transformer:-** **(04 Marks)**

Let, N_1= Number of turns in the primary

N_2= Number of turns in the Secondary

Øm= Maximum flux in core (wb)= BmxA

F= Frequency



As shown in figure, flux increases from its zero value to maximum value Øm in one quarter of the cycle (i.e. ¼ f) sec

➢ Average rate of change of flux

➢ $\dfrac{\phi m}{1/4f} = 4 \; f\phi m$ (wb/sec)

Rate of Change of flux per turn means induced emf, If flux various sinusoidally then r.m.s value of induced emf is obtained by multiplying the average value with form factor.

From factor = $\dfrac{R.M.S\ Value}{average\ \ value} = 1.11$

R.M.S.value of emf /turn = 1.11 x 4 f Øm= 4.44 f Øm

R.M.S value in the whole primary winding

= (induced emf / turn) x No. of primary turns

$E_1 = 4.44\ f\ \phi_m N_1$

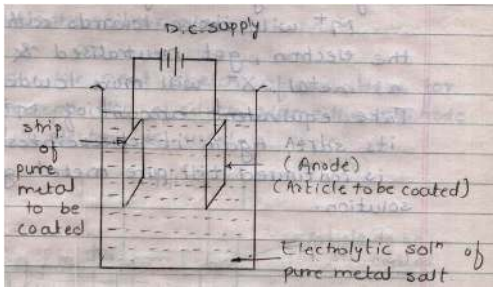
E_1 = 4.44 f B_mAN_1

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

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

d) Explain process of electroplating.

Ans: **Process of Electroplating:-** **(2 Marks diagram & 2 Marks explanation)**



or equivalent fig

A DC current passed through a solution of chemical compound then the solution can be dissociated into its constituent's parts & deposition of metal takes place on the cathode. Metal is the constituent part of the solution.

The solution used for electrolysis due to which electroplating is to be carried out is known as electrolyte or salt solution. In such a solution each molecule of the substance dissolved is negatively charged.

Electroplating is carried out with a desire to coat particular metal on the surface of other metal. At first, the orticle be coated is properly cleaned. Then it is made cathode. The metal of which coating is desired is taken in pure form as a strip & it is connected to anode. In an electrolytic bath, Solution of the salt of the pure metal to be coated is taken By closing the key.

M^+ will move towards cathode, accept the electron, get neutralized & depositioned as metal .X^- will move towards anode. Take equipment amount of M^+ & from its salt. Again it dissociates & process is continued till pure metal goes into solution.

e) Compare resistance welding with arc welding.

Ans: **(Any Four point expected: 1 mark each, Total 4 Mark)**

S.No.	Parameters	Resistance Welding	Arc Welding
1	Type of welding	Plastic / Pressure / Non-	Fusion / Non pressure welding

		fusion welding	
2	Principle of heat developed	Heat is developed due to I^2R losses where R is the contact resistance	Heat developed due to arc produced in between electrode and job
3	External filler material required	Not required during welding	Required during welding
4	External pressure required	Required	Not required
5	Type of supply used	Both AC, DC supply is used. But generally Ac Supply is used.	Metal arc welding – Both AC, DC supply is used. But generally Ac Supply is used. and for Carbon arc welding –only DC supply are used
6	Voltage &current required	Low voltage (2 to 20V AC) and high current (40 to 400A, in some cases 5 to 20KA) supply is required	Metal Arc welding Voltage- 70 to 100V AC and Carbon arc welding voltage- 50 to 60V DC, Current- 50-600-800A
7	Energy consumption	Low (3 to 4 KWH/Kg of deposited material)	High (5 to 10 KWH/Kg of deposited material.)
8	Temperature obtained	Temperature obtained is not very high (up to 1350^0C)	Temperature obtained is very high (up to 3500^0C to 6000^0C)
9	Power factor	Low	Poor
10	Type of electrode	Non-consumable electrodes are used.	Coated electrodes are used for metal arc welding and bare electrodes are used for carbon arc welding. (Electrodes may be consumable or non-consumable)
11	Application	It is suitable for mass production	It is suitable for heavy job, maintenance and repair work

f) Explain any two types of enclosures used for electric motors.

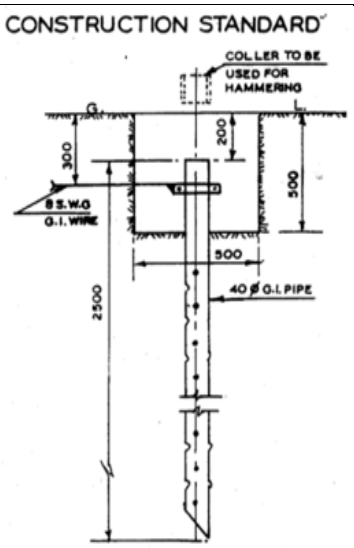
Ans: **(Any Two type of use expected: 2 Mark each, Total 4 Marks)**

Types of enclosures used for electric motors: (Any Two Types expected)

i) Open type enclosure:

This type of motor is completely open from both ends, the bearing being placed on

	pedestals or brackets. In spite of low cooling cost, this type is rarely used. **ii) Screen protected enclosure:** If the ventilating opening in the protective cover of a motor is covered with wire mesh screens, it is called as screen protected type motor. **iii) Drip proof (moisture) enclosure:** The ventilating opening are protected by overhanging cowls so as to prevent the entry of drops of water directly falling on the machine. **iv) Flame (Fire) proof enclosure:** These are design for explosive atmosphere e.g. coal mines, chemical plants, etc. the cooling arrangement is provided in case of these motors is such that if there is explosion in the machine, the flame transmission from inside to outside is strictly prevented. **v) Totally enclosed type enclosure:** Provided with full protection against ingress of dirt or foreign matter and are used in situations where the atmosphere is very dusty e.g. stone crushing plants, coal handling plants. **vi) Pipe ventilated totally enclosed type enclosure:** The large size totally enclosed motors are normally provided with the arrangement for forced air cooling. This arrangement employs a duct or pipe through which clean air is supplied.
Q.5	**Attempt any FOUR of the following : 16 Marks**
a)	**State necessity of earthing. Explain any one type of earthing.**
Ans:	**necessity of earthing :** **(Any Two points expected - 1 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. **(Any One Type of Earthing Explanation expected)** **Diagram for Pipe Type earthing : (2 Marks)**

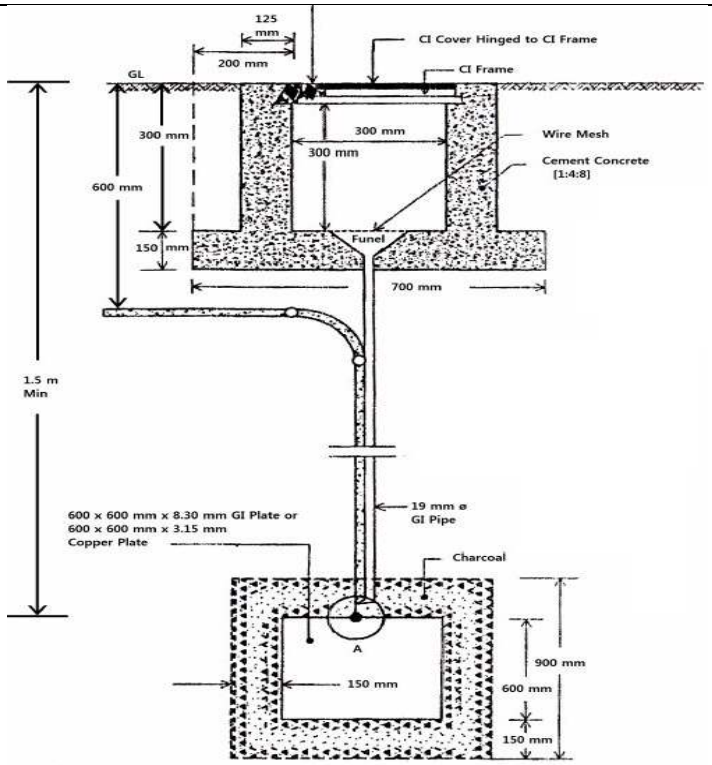


or equivalent figure

Explanation: (Following or equivalent explanation is to be accepted) (1 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

(2) Plate type Earthing:



Explanation:

- Excavation on earth for a normal earth Pit size is 1.5M X 1.5M X 3.0 M.
- **Specifications:** Generally for plate type earthing normal Practice is to use GI earthing plate of size mentioned below as per requirement.

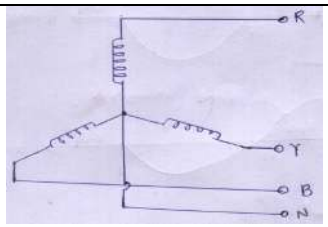
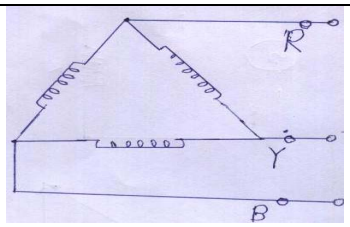
- GI strip of size 40×6 mm or 50 mmx6 mm bolted with the plate is brought up to the ground level or Cu Strip of size 25×3 mm or 40×3 mm or 50×3 mm is used if Copper plate is used.
- These types of earth pit are generally filled with alternate layer of charcoal & salt up to 4 feet from the bottom of the pit.(**Amount of Salt and Charcoal more than 8Kg)**
- Make a mixture of Coal Powder Salt & Sand all in equal part. Because of following reasons-
- Coal is made of carbon which is good conductor minimizing the earth resistant.
- Salt use as electrolyte to form conductivity between GI Plate, Coal and Earth with humidity.
- Use of Coal Powder also beneficial as it is anti corrosive, rust proves for GI Plate for long

life.

- The purpose of coal and salt is to keep wet the soil permanently.
- The salt percolates and coal absorbs water keeping the soil wet.
- Prepare a Concrete chamber of size 450mm×700mm as shown in fig. and close the chamber by removable C.I. plate. Make arrangement with the help of G.I. pipe of size 19mm and funnel for pouring the water in earth pit when required.

b) Write down any four points of differentiation of star and delta connection.

Ans: **(Each Point : 1 Mark, Total : 4 marks)**

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

c) State two application of each : (i) shaded pole motor (ii) capacitor start capacitor run motor

Ans:

i) Applications of Shaded pole motor: **(Any Two expected-2 Mark)**

(i) Small fans

(ii) Toys

(iii) Hair driers

(iv) Desk fans etc.

ii) Applications of Capacitor start Capacitor run motor: **(Any Two expected-2 Mark)**

i) Compressors of air conditioner
ii) Big water cooler

d) Explain any one PF improvement method.

Ans:

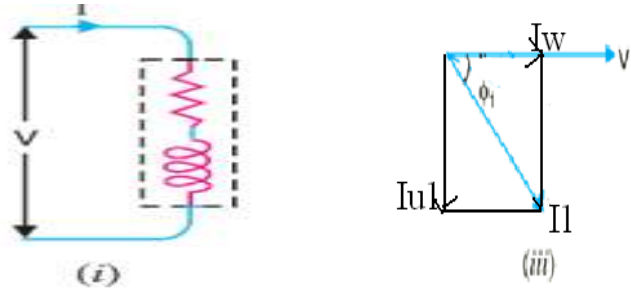
Explanation P.F improvement: **(Any ONE Types explanation Expected: 4 Mark)**

Types of power factor improvement

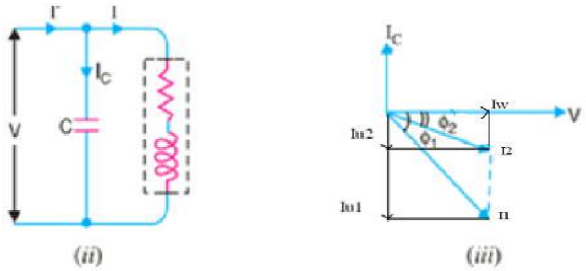
1) By use of static capacitor (Condenser)
2) By use of over excited synchronous motor (Synchronous condenser)
3) By use of over excited Schrage motor
4) By use of phase advancer.

1) static capacitor method of power factor improvement.

Before connecting capacitor phasor diagram



After connecting capacitor phasor diagram



$\text{Cos}\phi_1$ = Initial Power factor

$\text{Cos}\phi_2$ = Improved Power factor

Calculation from current vector diagram:

$I_C = I\mu_1 - I\mu_2$

$\therefore I_C = [Iw \tan\phi_1] - [Iw \tan\phi 2]$

Now, $I_C = \frac{V}{X_C} \therefore X_C = \frac{V}{I_C} \therefore X_C = \frac{1}{2 \times \pi \times f \times c}$

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

Magnitude of new current:

$$I_2 = \sqrt{(I_w)^2 + (I\mu_2)^2}$$

Calculation from power triangle: Where ,

P = Active power KW

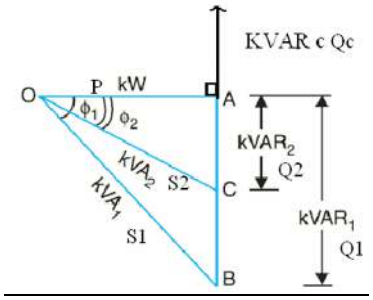
Q_1, Q_2 = Lagging reactive power before & after improving power factor

Q_C = Leading Reactive power drawn by Capacitor

S_1, S_2 = KVA Maximum demand before and after improving power factor

$\text{Cos}\phi_1$ = Initial Power factor

$\text{Cos}\phi_2$ = Improved Power factor



$Q_C = Q_1 - Q_2$

$Q_C = [P \tan\phi_1] - [P \tan\phi_2]$ KVAr rating of capacitor

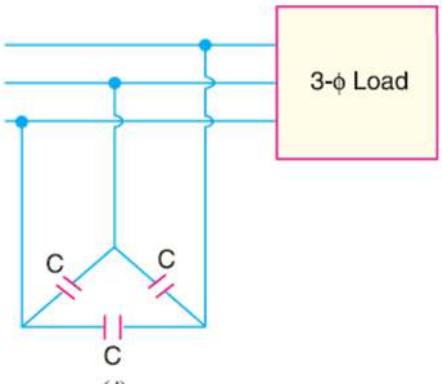
Observation:

- From above vector diagram & power triangle calculations, if capacitor is connected across load than following observations are observed.

S.No.	Parameter	Effect
1	Power factor	Improves

2	Magnetizing current ($I\mu$)	Reduces
3	Total current	Reduces
4	Lagging reactive power (KVAr)	Reduces
5	Apparent power (KVA)	Reduces

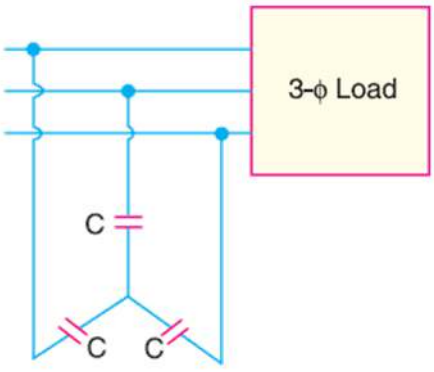
➢ **Connection diagram to connect capacitor to improve power factor (Delta connection)**



$$(Cph) = \frac{KVAR}{3\,\omega V^2} \text{ Farad}$$

$$\omega = 2\pi f$$

➢ **3-ph Star connected Capacitor Bank:**



$$(\text{Cph})_{\lambda} = \frac{\text{KVAR}}{\omega\, \text{V}^2} \text{ Farad}$$

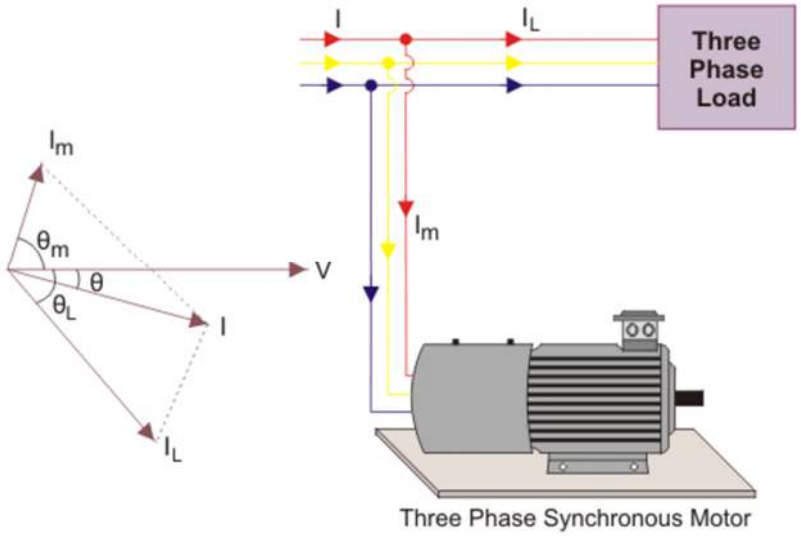
$$\omega = 2\pi f$$

Precautions to handle the capacitor bank**:**

1. Capacitors get easily damaged if the voltage exceeds than its rated value.
2. When capacitor is switched OFF then precaution is taken before making it ON. In between OFF and ON time, time should be kept to discharge the capacitor, otherwise capacitor may fail.
3. Switching current of capacitor is many times that of rated current; therefore cable size should be double of the normal current carrying capacity, so its cost increases.
4. When there is no load or system is lightly loaded at that time capacitor bank must be made OFF otherwise voltage across transformer increases

2) **By use of over excited synchronous motor (Synchronous condenser)**

Like capacitor bank, we can use an overexcited synchronous motor to improve the poor power factor of a power system. The main advantage of using synchronous motor is that the improvement of power factor is smooth. When a synchronous motor runs with over-excitation, it draws leading current from the source. We use this property of a synchronous motor for the purpose.



3) By use of over excited Schrage motor

To improve power factor an angular displacement of ρ is introduced between tertiary winding axis and secondary winding axis. Now flux φ cuts the tertiary winding axis some time later

	after it has covered an angular displacement of ρ degrees. Therefore emf phasor – Ej in this case lags the emf phasor – Ej in case b by an angle ρ. 4) **By use of phase advancer.** Phase advancers are used to improve the power factor of induction motors. The phase advancer is mounted on the same shaft as the main motor and is connected in the rotor circuit of the motor. It provides exciting ampere turns to the rotor circuit at slip frequency. By providing more ampere turns than required, the induction motor can be made to operate on leading power factor like an over-excited synchronous motor.
e)	**State advantages of electric heating over the other types of heating methods.**
Ans:	**(Any Four Types expected: 1 Mark each, Total 4 Marks)** **Advantages of Electric heating over the other types of heating methods:** 1. It can be put into service immediately. 2. No standby losses. 3. High efficiency. 4. More economical than other conventional types of heating system. 5. Easy to operate and control. 6. No air pollution. 7. System is clean, as there is no waste produced. 8. No fuel transportation cost. 9. No space is required for storage of fuel and waste. 10. Noiseless operation. 11. Uniform heating is possible, heating at particular point is also possible (spot welding) 12. Dielectric material can be heated. 13. Electrical heating equipments are generally automatic, so it requires low attention and supervision. 14. Protection against overheating can be provided by suitable switch gear.
f)	**State working principle and specification of stepper motor.**
Ans:	**Working Principle of stepper Motor-** A stepper motor rotates through a fixed angular step in response to each input current

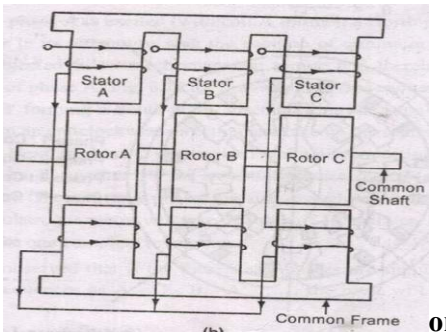
pulse received by its controller.

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

1) Variable Reluctance Motor
2) Permanent Magnet Motor

1) Variable Reluctance Motors:-

(Any One method explanation expected: Diagram : 1 Marks and Working: 1 Mark, 2 Marks)



or equivalent dia.

Working:-

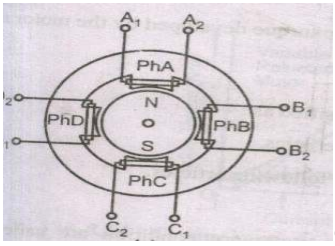
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

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.

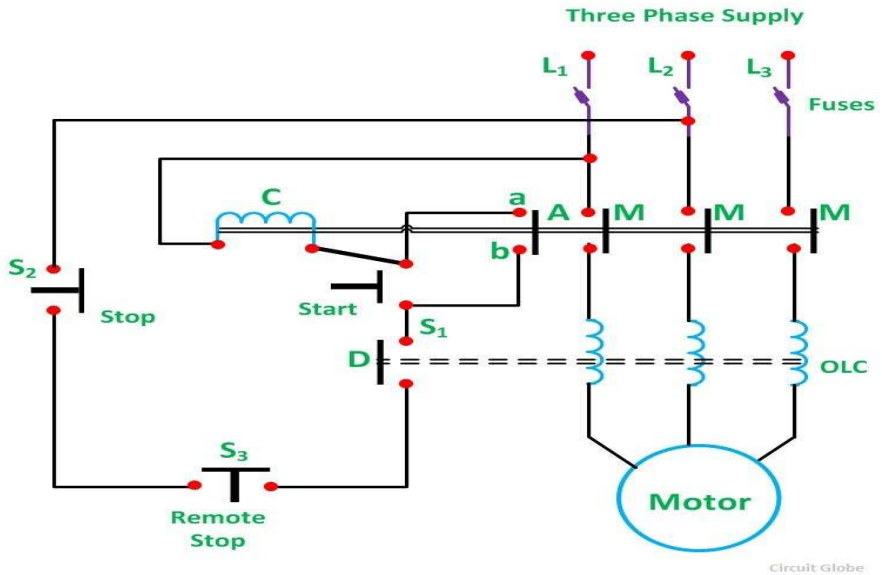
Specification of Stepper Motor: OR other equivalent specification **(1 Mark)**

Step angle	1.8°
Phase	2
Voltage	12 V DC
Current/winding	0.94 A
Resistance/winding	12.8 Ω
Inductance/winding	95 mH
Rotor inertia	$3.5x10^{-5}$ kg/m^2
Weight	1.4 kg

Q.6 **Attempt any FOUR of the following :** **4x4 = 16 Marks**

a) **Draw a circuit diagram of D.O.L. starter for three phase induction motor.**

Ans: **Circuit diagram of D.O.L. starter for three phase induction motor:** **(4 Marks)**



or equivalent figure

b) **Explain any one type of fire extinguisher.**

Ans: **Explanation =** ---------- **(4 Marks)**

Stand 6 to 8 feet away from the fire and follow the four-step PASS procedure. If the fire does not begin to go out immediately, leave the area at once. Always be sure the fire department inspects the fire site.

- **P**ull the safety pin from the handle.
- **A**im the extinguisher nozzle at the base of the fire.
- **S**queeze the handle or lever slowly to discharge the agent.
- **S**weep side to side over the fire until expanded

OR anyone expected

(i) Carbon Dioxide Extinguishing Systems: **(4 Marks)**

This type is the most suitable & widely recommended one for electrical fires. Carbon dioxide (CO2) extinguishers are normally Class C extinguishers. Before using, Switch off the supply immediately so that the source for the fire to get sustained is isolated using proper insulated hand gear/foot gear. To use the extinguisher, pull the pin near the handle, point the horn at the base of the fire, and hold down the handle. As the flames shrink, continue spraying until the fire is fully extinguished.

(ii) Dry chemical extinguisher

The Dry Powder (or Dry Chemical) charged fire extinguisher is a multipurpose fire extinguisher and can be used on wide variety of fires. They are used on electrical fires but leave a residue that may be harmful to sensitive electronics. They work by chemical reaction with the fire causing the particles to expand chemically inhibiting combustion and expelling the oxygen thereby smothering the flames.

c) Calculate active and reactive power drawn from 230 V, 50 Hz, ac supply when it is loaded by a series circuit consisting of resistance of 10 ohm and a capacitor of 200 mFd.

Ans: Given Data:

V= 230V, f= 50 Hz and R = 10 ohm $C = 200 \times 10^{-6}$ F

i) Capacitive Reactance X_c =

$$X_C = \frac{1}{2\pi f C}$$ ---------- **(1/2 Marks)**

$$X_C = \frac{1}{2\pi \times 50 \times 200 \times 10^{-3}}$$

$X_C = 0.01592\,\Omega$ ---------- **(1/2 Marks)**

ii) Impedance Z =

$Z = \sqrt{(R)^2 + (X_C)^2}$ --- ---------- **(1/2 Marks)**

$Z = \sqrt{(10)^2 + (0.01592)^2}$

$Z = 10\,\Omega$ ---------- **(1/2 Marks)**

iii) Current I =

$$I = \frac{V}{Z} = \frac{230}{10}$$

$I = 23\ \ A$ ---------- **(1/2 Marks)**

$Cos\phi = \frac{R}{Z} = \frac{10}{10}$, $Cos\phi = 1\ leading$ $\sin\phi = 0$

iv) Active Power P =

$P_A = V\ I\ Cos\phi$

$P_A = 230 \times 23 \times 1$

$P_A = 5290\ \ watt$ ---------- **(1/2 Mark)**

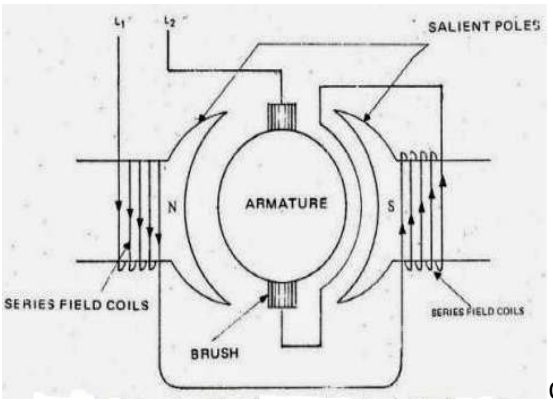
v) Reactive Power Q =

$Q = V\ I \sin\phi$ ---------- **(1/2 Marks)**

$Q = 230 \times 23 \times 0$

$Q = 0\ \ watt$ ---------- **(1/2 Mark)**

d)	**Explain operation of universal motor on A.C. and D.C. supply.**
Ans:	**Figure of Universal motor:** **(Figure : 2 Marks & Explanation : 2 Marks)**



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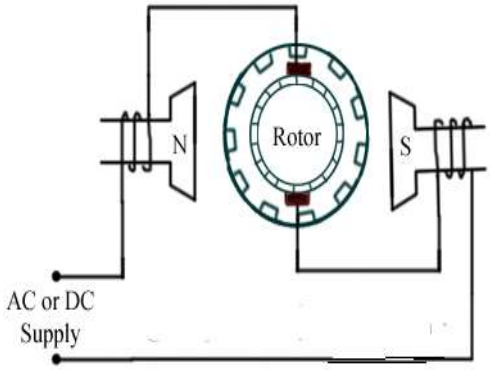


OR Equivalent figure

Operation of universal motor on A.C. and D.C. supply:

(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.**

e)	**State working principle of alternator. State the meaning self and separate excitation.**
Ans:	**Working principle of alternator:** **(2 Marks)**

When a conductor is moved in magnetic field or a magnetic field moved with respect to conductor, according to Faraday's law of electromagnetic induction, the conductor cuts the magnetic field and an electromotive force is induced in the conductor.

Self-excitation: **(1 Marks)**

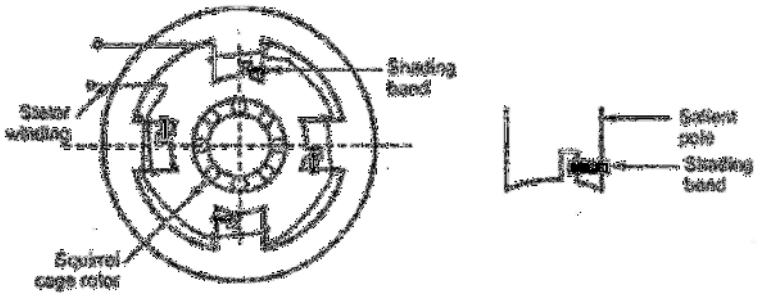
When the A.C. current from alternator itself is rectified and used for its excitation, then the excitation is said to be self-excitation.

Separate excitation: **(1 Marks)**

When D.C. excitation required for field winding of alternator is provided by using a separate source like battery or shaft-mounted exciter, then the excitation is said to be separate excitation.

f) Explain construction and working of shaded pole induction motor.

Ans: **Diagram of Shaded Pole Motor:** **(2 Marks)**



or equivalent figure

Explanation: **(2 Marks)**

It has squirrel cage rotor and salient pole stator. The stator poles are shaded partially by short circuited conductor band to create the phase difference between the fluxes emerging from shaded and un-shaded portion. These phase differing fluxes produce the required torque on the rotor for motion.

When a single phase supply is fed to the main winding, an alternating flux is produced in the pole. A portion of this flux links with the shading band and induces a voltage in it. As shading band is short-circuited, a large current flows in it. The current in the shading band causes the flux in the shaded portion of the pole to lag the flux in the unshaded portion of the pole. Thus the flux in the shaded portion reaches its maximum value after the flux in the unshaded portion reaches its maximum. The phase difference in fluxes causes equivalent rotating magnetic field in the air-gap and torque is exerted on the squirrel cage rotor.

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