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 ten:** **(2×10=20)**

1 a) Define time period and RMS value of an a.c. wave.

Ans:

1) **Time Period:**
It is the time required for an alternating quantity to complete one cycle. It is measured in second.

2) **RMS Value of Sinusoidal AC Waveform:**
The RMS value is the Root Mean Square value. It is defined as the square root of the mean value of the squares of instantaneous values of the alternating quantity over one cycle.

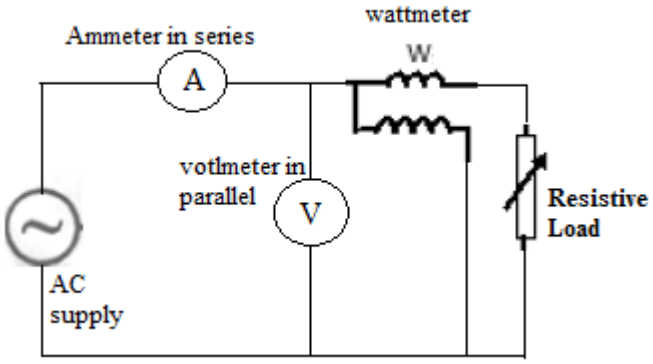
OR

For an alternating current, the RMS value is defined as that value of steady current (DC) which produces the same heat or power as is produced by the alternating current during the same time under the same conditions.

1 Mark for each bit = 2 Marks

1 b) Draw neat connection diagram to measure voltage, current, power in an a.c resistive circuit showing necessary meters.

Ans:



2 Marks for labeled diagram

1 c) State applications of D.C. series motor.

Ans:

Applications of D.C. series motor:

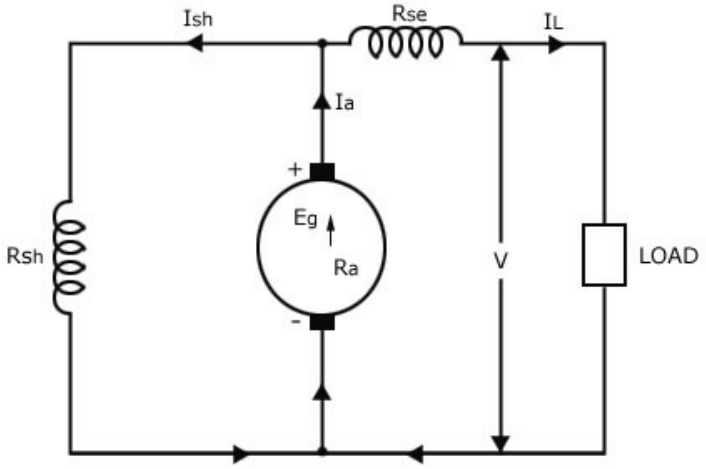
1) Cranes
2) Hoists
3) Electric traction
4) Elevators
5) Lifts
6) Air compressors
7) Hair driers
8) Vacuum cleaners
9) Sewing machines, etc.

½ Mark for each of any four = 2 Marks

1 d) Draw schematic diagram of short shunt compound generator.

Ans:

Schematic diagram of Short Shunt Compound Generator:



Short Shunt Compound Generator

2 Marks for labeled diagram

1e) State working principle of transformer.

Ans:

Working principle of transformer:

Transformer works on the principle of electromagnetic induction. When the primary winding is connected to ac supply, applied alternating voltage circulates an alternating current through it. This current flowing through the primary winding produces an alternating magnetic flux in the core. This alternating flux links with secondary winding placed on the magnetic core & induces an emf in it according to the Faraday's laws of electromagnetic induction (mutual induction). If load is connected to secondary side, the induced emf in secondary winding circulates load current and power is given to load. Thus power is transferred from ac supply on primary side to load on secondary side without any electrical connection between primary and secondary, through magnetic coupling.

2 Marks

1f) Define transformation ratio of transformer. Write equation for it.

Ans:

Transformation Ratio (k):

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.

1 Mark for definition

$$k = \frac{N_2}{N_1} = \frac{V_2}{V_1} = \frac{I_1}{I_2}$$

1 Mark for equation

1 g) Why transformer rating is in KVA?

Ans:

An important factor in the design and operation of electrical machines is the relation between the life of the insulation and operating temperature of the machine. Therefore, temperature rise resulting from the losses is a determining factor for the rating of a machine. We know that copper loss in a transformer depends on current and iron loss depends on magnetic flux, which depends on the voltage Therefore, the total loss in a transformer depends on the volt-ampere product only and not on the phase angle between voltage and current i.e., it is independent of load power factor. For this reason, the rating of a transformer is specified in terms of product of voltage and current i.e in VA or in kVA or in MVA and not in W or kW or MW. — 2 Marks

OR

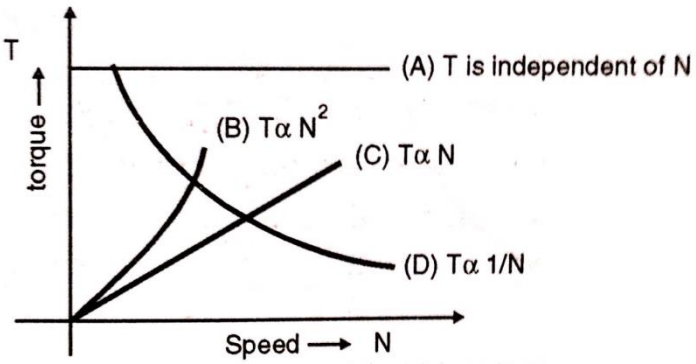
1) The output of transformer is limited by heating and by the losses.
   Two types of losses in the transformer: (1) Iron loss, (2) Copper loss
2) Iron loss depends on the transformer voltage (v)
   Copper loss is depends on transformer current (I)
3) As the losses depends on voltage (V) and Current (I) and almost unaffected by load power factor

Hence transformer output is expressed in VA or kVA or MVA and not in W or kW or MW.

1 h) State classification of electric drives on the basis of speed-torque characteristics.

Ans:

Classification of electric drives on the basis of speed-torque characteristics:



(Figure optional)

The electric drives are classified according to the speed-torque characteristics as follows:

1) Constant Torque drives: Torque is independent of speed, characteristic (A) shown in the figure.
2) Variable Torque drives:
   (i) Torque proportional to Speed ($T \alpha N$), characteristic (C)
   (ii) Torque proportional to (Speed)^2 ($T \alpha N^2$), characteristic (B)
   (iii) Torque inversely proportional to Speed ($T \alpha 1/N$), characteristic (D)

½ Mark for each = 2 Marks

1 i) State types of enclosures for electric motors.

Ans:

Types of enclosures for electric motors: ½ Mark for each of any four = 2 Marks

1) Screen protected 2) Open type 3) Protected type
4) Totally enclosed 5) Drip-proof type 6) Pipe ventilated type
7) Flame proof type 8) Explosion proof 9) Splash proof

1j) State types of tariffs.

Ans:

Different types of tariffs: ½ Mark for each of any four = 2 Marks

i) Simple tariff ii) Flat rate tariff
iii) Block rate tariff iv) Two part tariff
v) Maximum demand tariff vi) Power factor tariff
vii) Three part tariff viii) Time-of-Day (TOD) tariff

1k) State function of ELCB.

Ans:

Function of ELCB:

The ELCB is used to protect the circuit from the electrical leakage. When someone gets an electric shock, then this circuit breaker cuts off the power in the time of 0.1 sec for protecting the personal safety and circuit components.

OR 2 Marks

It provides protection by detecting the leakage currents of unsafe magnitudes flowing to earth and disconnecting the supply to the circuit.

1l) State various faults that may occur in an electric motor.

Ans:

Faults that may occur in an electric motor:

A) Electrical / magnetic sections:

1) Electrical supply failure due to single phasing, under voltage, unbalanced voltages and reversal of phases.
2) Short circuit faults between turns of a stator coil due to failure of insulation.
3) Short circuit faults between stator coils due to failure of insulation.
4) Short circuit faults between stator coil/s and body of motor due to failure of insulation.
5) Open circuit in stator winding/coils or their terminal connections.
6) Loose or broken rotor bars.
7) Damaged core stampings/teeth.

½ Mark for each of any four = 2 Marks

B) Mechanical section:

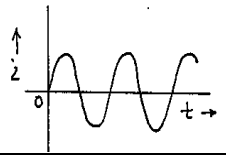
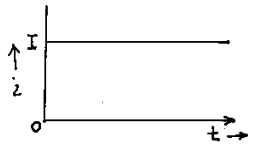
1) Unbalanced rotor.
2) Damaged bearings.
3) End play in shaft, bent shaft.
4) Cooling/ventilation system failures, damaged fan.
5) Failure/disturbances of alignment.
6) Foundation arrangement disturbed.

2 Attempt **any four:** **(4×4=16)**

2 a) Distinguish between A.C. and D.C. supply (any four points).

Ans:

Comparison between A.C. and D.C. supply:

Parameter	A.C.Supply	D.C.Supply
Waveform		
Definition	It is the current whose magnitude and direction continuously changes with respect to time.	It is the current whose magnitude and direction do not change with respect to time.
Use of transformer	Possible	Not Possible
Distribution efficiency	High	Low
Design of machines	Simple	Complicated
Frequency	Finite	Zero
Generation	Mostly by electromechanical energy conversion	Mostly by electrochemical energy conversion and also by conversion of AC to DC using converters
Applications	AC machines, Domestic and industrial load.	DC machines, electroplating, HVDC system, battery charging, etc.

1 Mark for each of any four points = 4 Marks

2 b) Define following terms used in A.C. circuit**.**

i) Cycle ii) Frequency
iii) Phase iv) Average value

Ans:

i) Cycle:

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) Frequency :-

Number of cycles completed by an alternating quantity in one second is called as frequency. Its unit is cycles/second or hertz.

iii) Phase:

It is defined as the fractional part of a period or cycle through which the quantity has advanced from its selected origin (usually last zero value while increasing towards positive maximum value)

iv) Average Value:

1 Mark for each term = 4 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.

2c) An A.C. Voltage of v(t)= 230sin314t volts is applied to a circuit. Calculate
i) Angular Frequency ii) Frequency
iii) RMS value iv) Average value

Ans:

Standard form of sinusoidal quantity: $v = V_m \sin(\omega t \pm \emptyset)$

i) Angular frequency ω = 2πf = 314 rad/sec

ii) Frequency: $f = \frac{\omega}{2\pi} = \frac{314}{2\pi} = 50\ Hz$

iii) RMS value:

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{230}{\sqrt{2}} = 162.634\ V$$

iv) Average Value:

$V_{av} = V_{rms} / \text{Form factor}$ OR $V_{av} = 0.637\ V_m$
$= 162.63 / 1.11$ $= 0.637\ (230)$
$= 146.52\ V$ $= 146.52\ V$

1 Mark for each bit = 4 Marks

2d) A series circuit consisting of resistance 40 Ω and inductance 30mH is supplied by 230V, 50Hz AC supply. Calculate impedance and current taken by the circuit.

Ans:

Data given:
Resistance R = 40 **Ω**
Inductance L = 30 mH = 30×10^{-3} H
RMS supply voltage V = 230 volt
Supply frequency f = 50 Hz
Inductive reactance $X_L = 2\pi fL = 2\pi(50)(30\times10^{-3}) = 9.425\ \Omega$ 1 Mark

i) Impedance of series circuit is given by,

$$Z = \sqrt{\left[R^2 + {X_L}^2\right]} = \sqrt{40^2 + 9.425^2} = \mathbf{41.095\ \Omega}$$ 2 Marks

ii) Current through the circuit:

$$I = \frac{V}{Z} = \frac{230}{41.095} = \mathbf{5.596A}$$ 1 Mark

2e) Calculate active and reactive power drawn from 230V, 50Hz a.c. supply when it is loaded by a series circuit consisting of resistance of 10**Ω** and a capacitor of 200 mFd.

Ans:

Data Given:
V = 230V, f = 50 Hz R = 10**Ω** C = 200×10^{-6} F

i) Capacitive Reactance $X_C = \frac{1}{2\pi fC}$

$$= \frac{1}{2\pi(5)(200 \times 10^{-6})} = \mathbf{15.916\Omega}$$ 1 Mark

$$Impedance\ Z = \sqrt{(R^2 + X_C^2)} = \sqrt{(10^2 + 15.916^2)} = 18.8\Omega.$$ 1 Mark

$$Current\ I = \frac{V}{Z} = \frac{230}{18.8} = 12.234\ A$$

$$cos\emptyset = \frac{R}{Z} = \frac{10}{18.8} = 0.532\ \ leading$$

$$sin\emptyset = \frac{X_C}{Z} = \frac{15.916}{18.8} = 0.846$$

$i)\ Active\ power\ P = VIcos\emptyset = 230 \times 12.234 \times 0.532$
$= 1496.9\ W$ 1 Mark

$ii)\ Rective\ power\ Q = VIsin\emptyset = 230 \times 12.234 \times 0.846$
$= 2380.49\ VAR$ 1 Mark

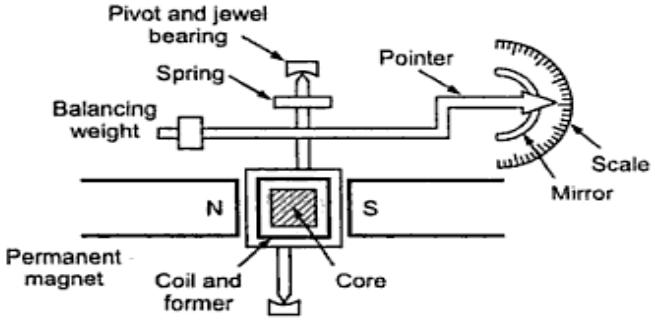
2 f) Differentiate between PMMC and MI type meters (any four points).
Ans:

	PMMC meter	MI type meter
1	Used for measurement of only DC quantities	Used for measurement of AC & DC quantities
2	Permanent magnet is used	Permanent magnet is not used.
3	Moving system consists of a coil mounted on the spindle	Moving system consists of a soft iron piece mounted on the spindle.
4	Eddy current damping is used	Air damping is used
5	Uniform or linear scale	Non-uniform or cramped scale
6	Sensitive than MI instrument	Less sensitive
7	Torque-to-weight ratio is high	Torque-to-weight ratio is less
8	Costlier	Cheaper

1 Mark for each of any four points = 4 Marks

3 Attempt **any four**: **(4×4=16)**

3 a) Explain construction and working of PMMC meters with neat sketches.
Ans:
Construction and working of PMMC meter:



2 Marks for sketch

The coil is suspended as shown to rotate in the air gap between the permanent

poles. The pointer attached to the spindle of the coil moves over the scale whenever the coil rotates. The spring attached to the spindle provides the restraining/ opposing torque and brings the system to standstill when the operating and restraining torques are equal. The pivot and jewel bearing has the minimum frictional resistance when the spindle is rotating. The balancing weight makes sure that the CG of the system coincides with the axis of spindle for positions of the spindle and thus ensures uniform wear for all positions of the spindle.

1 Mark for construction

Working-

The measuring DC current flows from one end of moving coil to another end. The current carrying coil experiences the force by the magnetic field and so deflecting torque is produced. This torque rotates the coil through certain angle and the coil rest at the position where magnetic effect becomes cancelled. The angular deflection of the moving coil is directly proportional to current flowing through it ($\Theta \alpha I$) as the current increases the deflection of moving coil also increases. The deflecting torque is given by

1 Mark for working

$\therefore T_d = NBIL$

Where, N= no. of turns of coil,

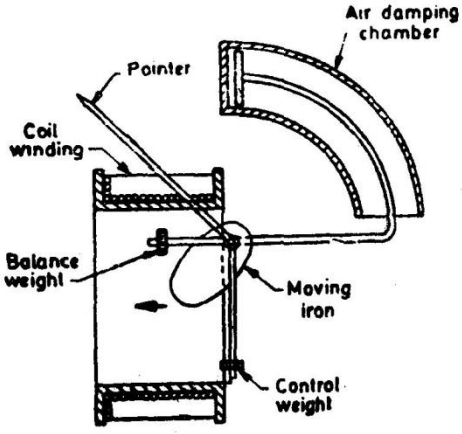
B =Flux density,

I=current through conductor, L= length of conductor.

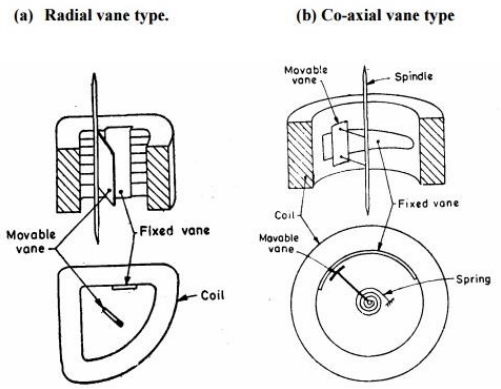
3b) Explain construction and working of MI meters with neat sketches.

Ans:

Construction and working of MI meter:



Attraction type MI Instrument



Repulsion type MI instrument

2 Marks for any one sketch

Above figures show constructional details of an attraction type and repulsion type moving iron instruments respectively.

1 Mark for construction

A) Attraction type MI instrument:

It consists of a coil, mounted vertically near the spindle carrying an oval shaped soft iron disc, called moving iron. The spindle also carries pointer, balance and control weights, air-damping vane etc.

When the current flows through the coil, a magnetic field is produced and moving iron is so magnetized that force is exerted on it by which it moves from the weaker field outside the coil to the stronger field inside

1 Mark for working

it or in other words the moving iron is attracted in. The controlling torque provided by spring but gravity control can be used for panel type of instrument which is vertically mounted. The damping is provided by air friction damping with the help of light aluminium piston (attached to the moving system) which moves in a fixed chamber closed at one end as shown in above figure. Whatever may be the direction of current, the moving iron is always attracted inside the coil, making the instrument suitable for measurement of both DC as well as AC quantities. The force of attraction is proportional to the square of current in the coil.

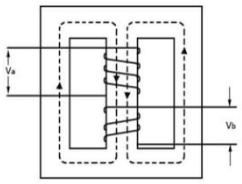
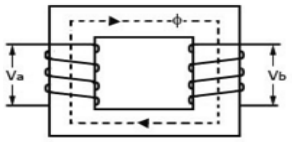
B) Repulsion type MI instrument:

It consists of a coil mounted horizontally with tongue-shaped soft iron piece, called fixed vane, fixed on its inner periphery. The spindle is mounted at the centre of coil as shown, which carries pointer, moving vane etc. When the coil carries current, both the vanes are magnetized in a similsr fashion. Due to this a force of repulsion os developed between the vanes. The shape of vanes are such that the force produces turning moment and pointer gets deflected. Whatever may be the direction of current, both the vanes are magnetized in a similar fashion and force causes deflection in a particular direction. Thus the instrument can be used for DC as well as AC measurements.

3c) Compare shell type and core type transformers on the basis of construction.

Ans:

Comparision of Shell type and Core type transformer:

Sr. No.	Shell type	Core type
1		
2	It has two windows	It has one window
3	It has two magnetic circuits.	It has one magnetic circuit.
4	Core surrounds the winding.	Winding surrounds the core.
5	Average length of core is less.	Average length of core is more.
6	Area of cross section is more so less turns are required.	Area of cross section is less so more turns are required.
7	Better cooling for core	Better cooling for winding
8	Mechnical strength is high	Mechnical strength is less
9	Repair and maintenance is difficult	Repair and maintenance is easy
10	Application: High current, low voltage	Application: Low current, high voltage

1 Mark for each of any four points = 4 Marks

3d) Compare auto transformer with two winding transformer on the basis of construction, copper savings, cost, voltage levels.

Ans:

Comparison between Auto transformer and Two-winding transformer:

Points	Auto transformer	Two winding transformer
Construction	A part of winding is common between Primary & secondary.	Primary & secondary windings are separate
Copper saving	Amount of copper required is less.	Amount of copper required is more.
Cost	Cost is less	Cost is more
Voltage levels	Designed for lower voltage ratings	Designed for higher voltage ratings

1 Mark for each point = 4 Marks

3e) Derive E.M.F. equation of transformer.

Ans:

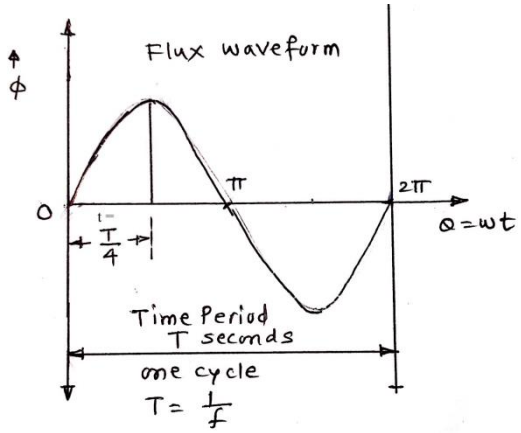
Emf equation of transformer:

Let N_1 be the no. of turns of the primary winding.

N_2 be the no. of turns of the secondary winding.

$\emptyset_m$ be the maximum value of the flux in wb.

f be the frequency of supply in Hz.



1 mark for diagram

First Method:

Maximum value of flux is reached in time $t = \frac{1}{4f}$

Average rate of change of flux

$= \frac{\emptyset_m}{t} = \frac{\emptyset_m}{(1/4f)} = 4\emptyset_m f$ wb/sec. 1 mark

According to Faraday's law of electromagnetic induction,

Average emf/turn induced =Average Rate of change of flux$= 4\emptyset_m f$

Form factor $= \frac{RMS\ Value}{Average\ Value} = 1.11$ for sinusoidal quantity.

$\therefore$ RMS value of emf/turn $= 1.11 \times Average\ value = 4.44\emptyset_m f$ volt 1 mark

$\therefore$ RMS value of emf in primary winding = RMS value of emf/turn $\times N_1$

$E_1 = 4.44\ \emptyset_m f N_1$ volt

Similarly,

RMS value of emf in secondary winding $E_2 = 4.44\ \emptyset_m f N_2$ volt 1 mark

OR

Second Method:

The alternating magnetic flux in the core is given by,

$$\emptyset = \emptyset_m sin(\omega t)$$

According to Faraday's law of electromagnetic induction, 1 mark

Instantaneous value of emf/turn $= e = -\frac{d\emptyset}{dt}$

$$= -\frac{d}{dt}[\emptyset_m sin(\omega t)]$$
$$= -\omega\emptyset_m cos(\omega t)$$
$$= \omega\emptyset_m sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{volt}$$

1 mark

Maximum value of emf/turn $= \omega\emptyset_m = 2\pi f\emptyset_m$

RMS value of emf/turn $= 0.707 \times 2\pi f\emptyset_m = 4.44\,\emptyset_m f$ volt

$\therefore$ RMS value of emf in primary winding = RMS value of emf/turn $\times N_1$

1 mark

$E_1 = 4.44\,\emptyset_m f N_1$ volt

Similarly,

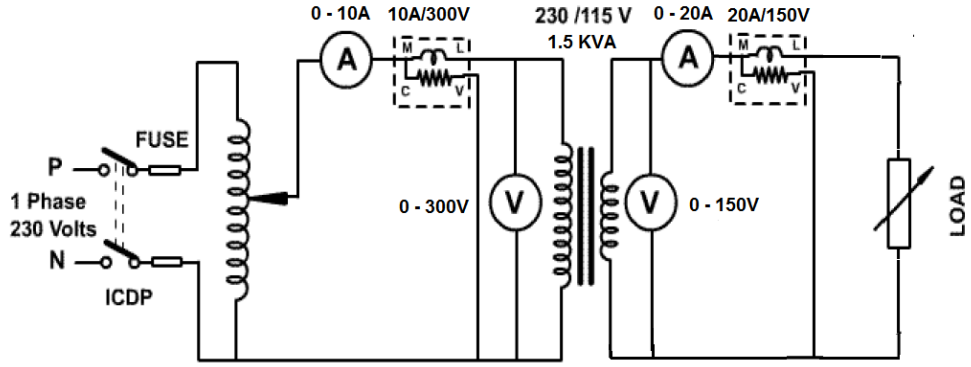
RMS value of emf in secondary winding $E_2 = 4.44\,\emptyset_m f N_2$ volt

1 mark

3 f) Draw experimental setup to conduct load test on a single phase transformer for finding efficiency and regulation. Assume 1.5 KVA, 230 V/115V, 50 Hz transformer. State the ratings of meters used for measurement.

Ans:

Experimental setup to conduct load test:



2 Marks for circuit diagram

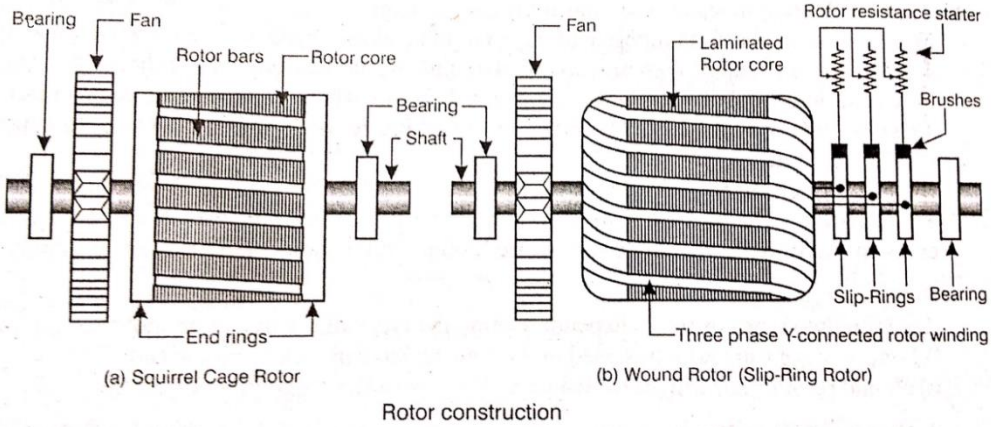
2 Marks for proper ratings of meters

4 Attempt **any four:** **(4×4=16)**

4 a) Explain with neat sketches construction of rotor of three phase induction motor.

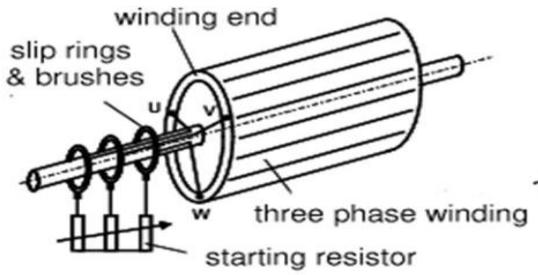
Ans:

Rotor constructions of three-phase induction motor:

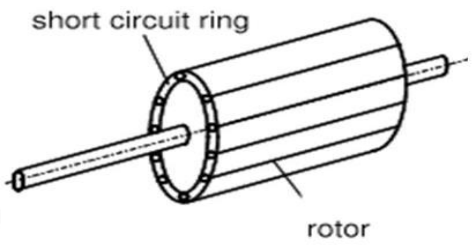


1 Mark for sketch of each type

OR



slip ring rotor



squirrel cage rotor

There are two types of rotors:
i) Squirrel cage rotor
ii) Wound rotor or slip-ring rotor

i) Squirrel Cage Rotor: This rotor is formed by a laminated cylindrical core having semi-closed slots provided around its outer periphery. This rotor is mounted on the shaft and placed in the central space of the stator. Thick copper or aluminium bars are driven through the slots and short-circuited at the two ends by the two thick end rings as shown in the figure (a). These bars are the rotor conductors. They are brazed or welded to the end-rings to produce the short-circuited rotor winding. The appearance of the rotor bars and the end rings is like a squirrel cage and hence the rotor is called by that name. The rotor slots are not exactly parallel to the shaft but skewed slightly to avoid magnetic noise and direct magnetic locking between rotor and stator teeth. — 1 Mark

ii) Slip-Ring Rotor (Wound Rotor): This rotor is formed by a cylindrical laminated core having slots on its outer periphery to carry a three-phase uniformly distributed winding, wound for the same number of poles as that of the stator winding. The rotor winding is inherently connected in star and the terminals are connected to the three copper slip-rings mounted on the shaft. External resistance can be inserted in each phase of the rotor winding through brushes and slip-rings. In this rotor also the slots are not exactly parallel to the shaft but slightly skewed. — 1 Mark

4 b) A three phase induction motor is rotating at 2960 rpm.Calculate
i) Ns
ii) Slip Speed
iii) Slip
iv) Rotor current frequency

Ans:

i) Synchronous speed Ns:

Ns = $\frac{120f}{P}$ Here frequency f and no. of poles P are not given. So the synchronous speed close to the actual speed is obtained with f = 50 Hz and P = 2

Ns = $\frac{120\times 50}{2}$ = **3000 rpm**

1 Mark for each bit = 4 Marks

ii) Slip speed:

= Ns – N = 3000 – 2960 = **40 rpm**

iii) Slip(s):

$$= \frac{Ns-N}{N} = \frac{3000-2960}{3000} = \mathbf{0.01333} \ \ \boldsymbol{or} \ \ \mathbf{1.3333}\%$$

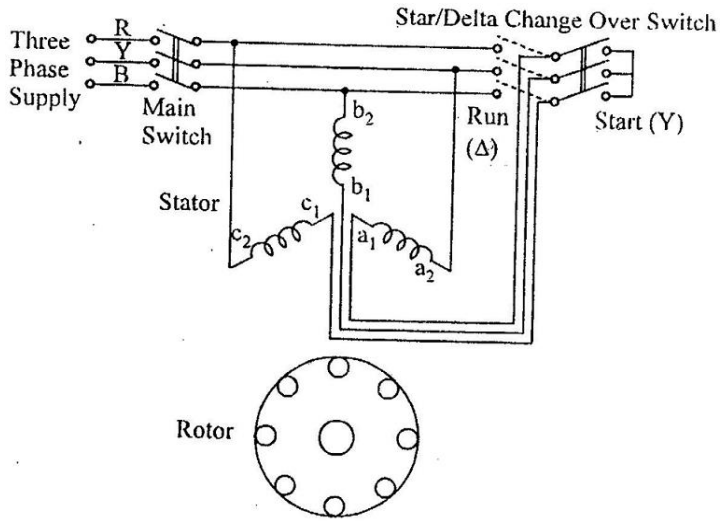
iv) Rotor current frequency (fr):

f_r = s.f = 0.01333 × 50 = **0.67 Hz**

4 c) With neat diagram explain working of star-delta starter for 3 phase induction motor.

Ans:

Star-delta starter for 3 phase induction motor:



2 marks for circuit diagram (equivalent circuit please be considered)

It essentially consists of a two way change-over switch as shown in fig. At the instant of starting, the switch is placed on "Start (Y)" position, stator winding terminals: a_1, b_1, c_1 get connected together by the switch, so the winding is connected in star. Therfore, reduced voltage is applied across each phase. The applied voltage is only 58 % of line value of supply voltage. The motor starts with reduced voltage and picks up the speed. When sufficient spped is attained, the change-over switch is placed to "Run (Δ)" position, causing motor winding connected in delta. The motor then continue to run with full voltage applied across stator winding in delta connection..

2 Marks for explanation

4 d) Write factors for selection of motor for electric drives.

Ans:

Factors for selection of motor for electric drives:

1) Type of drive:- individual or group
2) Electrical supply:-whether it is AC or DC,1phase or 3 Phase
3) Nature of the load: The load on the motor may be constant or variable, and according to the nature of load the motor is selected.
4) Speed requirement: The application may require constant speed or variable speed operation.
5) Environmental condition: The environmental condition means the condition of surroundings in plant. For chemical or explosive conditions, the totally enclosed type motor is selected
6) Efficiency: In some application precise output required, in that case high efficient motors are used.

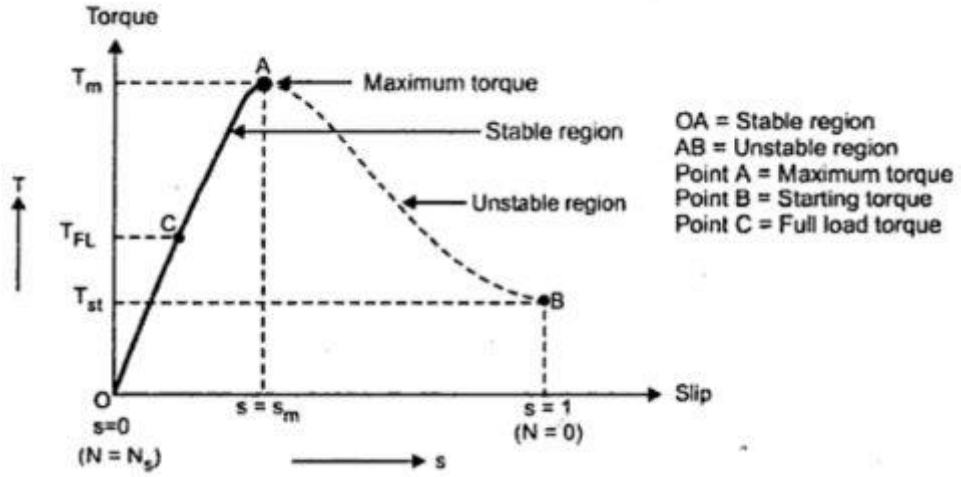
1 Mark for each of any four factors = 4 Marks

7) Price: Cost is one of the factor which is considered in motor selection.
8) Motor Duty Cycle: Applications require continuous or intermittent operation and hence duty cycle of motor is also taken in to account in selection.

4 e) Draw and explain torque-slip characteristics of three-phase induction motor. Also show effect of rotor resistance.

Ans:

Torque-slip characteristic of three-phase induction motor:



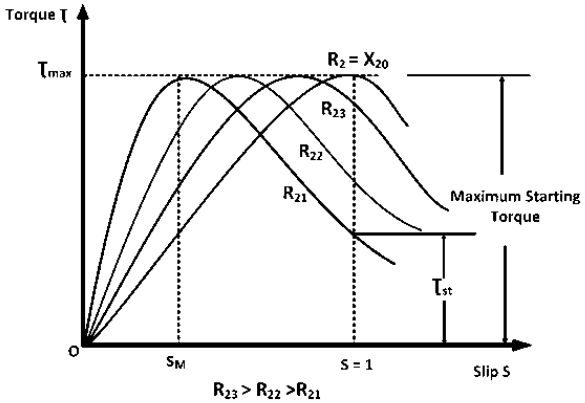
1 Mark

The starting torque is T_{st} at slip s = 1. If T_{st} is greater than load torque, then only motor accelerates and picks up the speed. When its torque becomes equal to the load torque, it runs at a constant speed in the stable region. T_m is the maximum torque that can be produced by the motor. The full load operating point is always at the values of slip less than that at maximum torque. When the load is increased, the operating point C get shifted towards A, with increase in slip & decrease in speed. If load torque is increased beyond the maximum torque T_m, the motor simply comes to rest.

2 Marks

Effect of rotor resistance:

- When rotor resistance is increased, maximum torque condition occurs at higher values of slip and characteristics shifts towards right hand side.
- The maximum torque condition can be obtained at any required slip by changing rotor resistance.

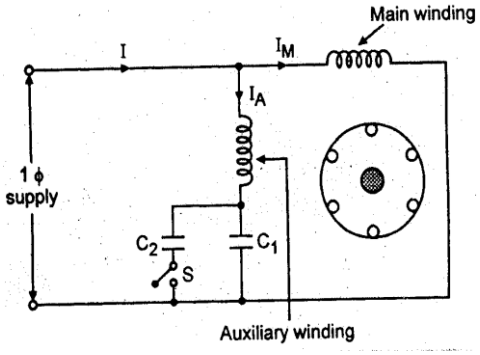


1 Mark

4f) Draw schematic diagram of single phase capacitor start –run induction motor.

Ans:

Capacitor start – Capacitor run induction motor:



4 Marks for labeled diagram

2 Marks for unlabeled diagram

5 Attempt **any four:** **(4×4=16)**

5a) A balanced delta connected load supplied with 440v, 50Hz, three phase a.c. supply has R=10Ω and L= 0.6mH in its each arm. Calculate line and phase currents, active power.

Ans:

Data Given:

Line voltage V_L = 440V, Frequency f = 50Hz

Resistance per phase R = 10Ω

Inductance per phase L = 0.6 mH = 0.6×10^{-3} H

i) Phase Current (I_{ph}):

Inductive reactance per phase $X_L = 2\pi fL$

$= 2 \times \pi \times 50 \times 0.6 \times 10^{-3} =$ **0.1885Ω**

Impedance per phase Z = R+jX_L= 10+j0.1885= **10.0018∠1.08°Ω** — 1 Mark for Z

In Delta connected load, $V_L = V_{ph}$= 440V

Hence, $I_{ph} = \frac{V_{ph}}{Z} = \frac{440}{10.0018}$ = **43.992 A** — 1 Mark for I_{ph}

ii) Line Current (I_L):

Now, line current in delta connection $I_L = \sqrt{3} I_{ph} = \sqrt{3} \times 43.992$ = **76.1964A** — 1 Mark for I_L

ϕ = 0°; cosϕ = cos(1.08°) = 0.9998 ≅ 1

iii) Active Power (P_{3ph}):

Active Power = 3 V_{ph} I_{ph} $cos\phi$ = 3×440×43.992 ×1= **58069.44W** — 1 Mark for P_{3ph}

OR Active Power = $\sqrt{3} V_L I_L cos\emptyset$ = **58069.44W**

5b) State and explain factors to be considered while selecting an electric motor for different drives.

Ans:-

Factors for selection of motor for electric drives:

1) Type of drive:- individual or group
2) Electrical supply:-whether it is AC or DC,1phase or 3 Phase
3) Nature of the load: The load on the motor may be constant or variable, and according to the nature of load the motor is selected.
4) Speed requirement: The application may require constant speed or variable speed operation.
5) Environmental condition: The environmental condition means the

1 Mark for each of any 4 factors = 4 Marks

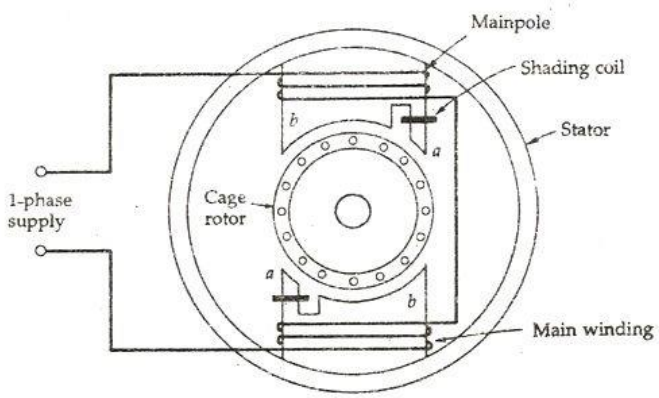
condition of surroundings in plant. For chemical or explosive conditions, the totally enclosed type motor is selected

6) Efficiency: In some application precise output required, in that case high efficient motors are used.
7) Price: Cost is one of the factors which are considered in motor selection.
8) Motor Duty Cycle: Applications require continuous or intermittent operation and hence duty cycle of motor is also taken in to account in selection.

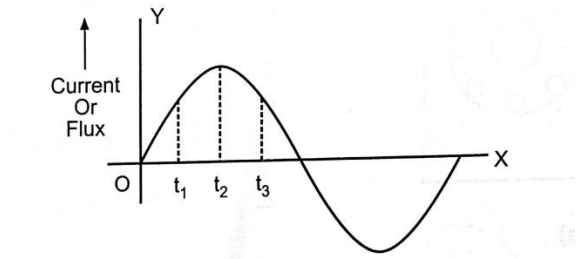
5c) Explain construction and working of shaded pole induction motor.

Ans:

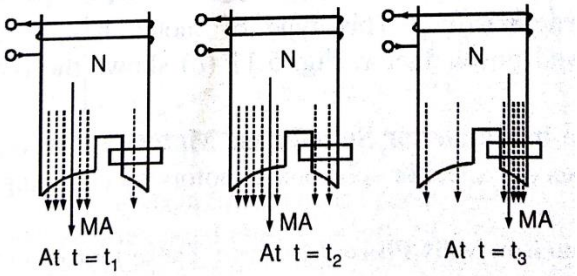
Shaded pole induction motor:



1 Mark for construction diagram



(a)



1 Mark for flux progress diagram

OR Equivalent diagram

Construction:-

The most usual form of a motor of this type has a rotor of squirrel cage type and the stator with salient poles. In addition to its own exciting coil, each pole carries a copper shading coil, on one of its unequally divided parts.

Working:-

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

2 Marks for construction & working

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 of 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.

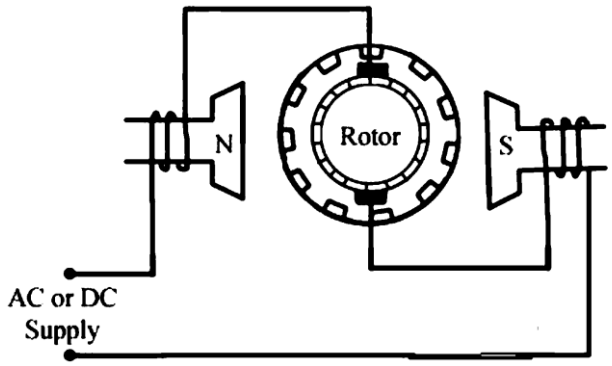
Thus it is seen that as time passes, the magnetic neutral axis shifts from left to right in every half cycle, from non-shaded area of pole to the shaded area of the pole. This gives to some extent a rotating field effect which is sufficient to provide starting torque to squirrel cage rotor and rotor rotates.

5 d) Explain the operation of universal motor on A.C. and D.C. supply.

Ans:-

Universal Motor:

The motor which operates on both AC and DC supply, is called as Universal Motor.



2 Marks for diagram

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 through the armature conductors. According to basic motor principle, when a current carrying conductor is placed in the

1 Mark for operation with DC

magnetic field, it experiences a mechanical force. Thus mechanical force is exerted on the current carrying armature conductors and torque is produced on rotor. Therefore the rotor starts to rotate.

When fed with AC supply, it still 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. 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. Thus unidirectional torque is produced and motor continues to run in the same direction. 1 Mark for operation with AC

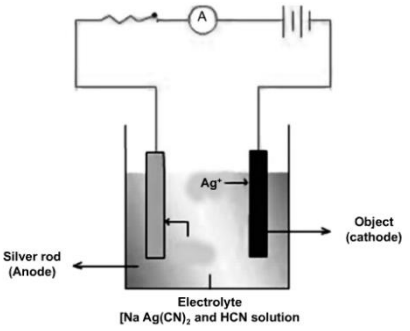
Thus, regardless of AC or DC supply, universal motor works on the same principle as that of DC series motor.

Since motor works on both the type of supply: AC or DC, it is referred as Universal motor.

5e) Explain the process of electroplating.

Ans:-

Process of electroplating:



2 marks for diagram

Electroplating is a process of depositing a layer of one material for protective or decorative purpose on the other material. The electroplating tank is made up of wood, RCC, fibre or stainless steel to avoid corrosion. The electroplating tank is filled with electrolyte solution. The anode is connected to positive terminal while cathode is connected to the negative terminal of DC supply. The article to be plated forms the cathode and the metal rod whose coating is to be given, acts as the anode. As soon as the DC supply is switched on, the process of electrolysis takes place and article gets coated with the anode material. 2 marks for explanation

5f) State working principle of alternator. State the meaning self and separate excitation. State any one application of stepper and servomotor.

Ans:-

Working principle of alternator:

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. 1 Mark

Self-excitation:

When the A.C. current from alternator itself is rectified and used for its excitation, then the excitation is said to be self-excitation. 1 Mark

Separate excitation:

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. 1 Mark

Applications of Stepper Motor:

1) Wall clocks 2) CD drive 3) Robotics 4) Printer 5) Scanners 6) CNC machine. ½ Mark

Applications of Servo-motor:

1) CNC machine 2) Precision control 3) Process controller 4) Robotics 5) Sewing machine 6) Aeronautical Application 7) Conveying ½ Mark

6 Attempt **any four:** **(4×4=16)**

6a) Explain dielectric heating.

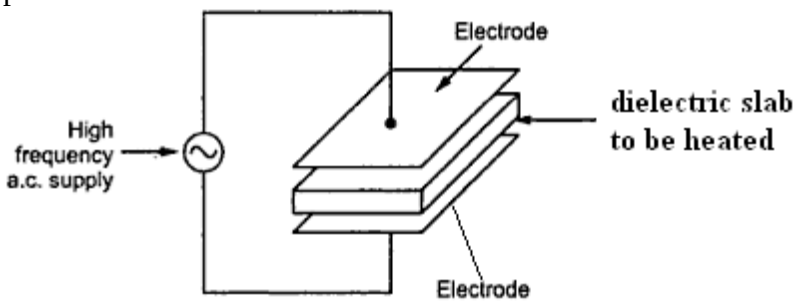
Ans:-

Dielectric heating:

When non-metallic material with extremely poor conductivity is subjected to high frequency electric field of ac supply, heat losses take place due to the leakage current and heat is produced. The frequency is normally between 12 kHz to 30 kHz.

OR

Dielectric heating (also known as Capacitance heating) is the method of heating non-conductive materials. The material to be heated is placed between two electrodes, to which a high-frequency energy source is connected. The oscillating field passes through the material and as the field direction changes, the polarization of individual molecules reverses rapidly, causing friction and hence heat. The higher the frequency, the greater the movement and large is the heat production. 2 Marks for explanation



2 Marks for diagram

6b) Compare resistance welding with arc welding.

Ans:

Sr. No.	Resistance welding	Arc welding
1.	It is plastic welding	It is fusion welding
2.	Arc is produced by heat due to resistance to flow of current by work & by application of pressure	Arc is produced by heating with an electric arc, mostly without application of pressure and filler material
3	Filler metal is not used	Filler metal may be used
4	High welding speed can achieved	Low welding speed
5	Supply is A.C only	Supply can be A.C or D.C
6	Voltage require is low	Striking voltage is high
7	Both similar and dissimilar metals can be welded easily.	Welding of similar and dissimilar metal is quite difficult.
8	Less skilled operator can do the	More skilled operator can do the

1 Mark for each of any four points = 4 Marks

	job.	job.

6c) Explain any two types of enclosures used for electric motors.

Ans:

Types of enclosures used for electric motors:

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.

2 Marks for each of any two types = 4 Marks

6d) State any four advantage of LED over CFL.

Ans:

Advantages of LED over CFL:

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

1 Mark for each of any four advantages = 4 Marks

6e) State necessity of earthing. Explain any one type of earthing.

Ans:

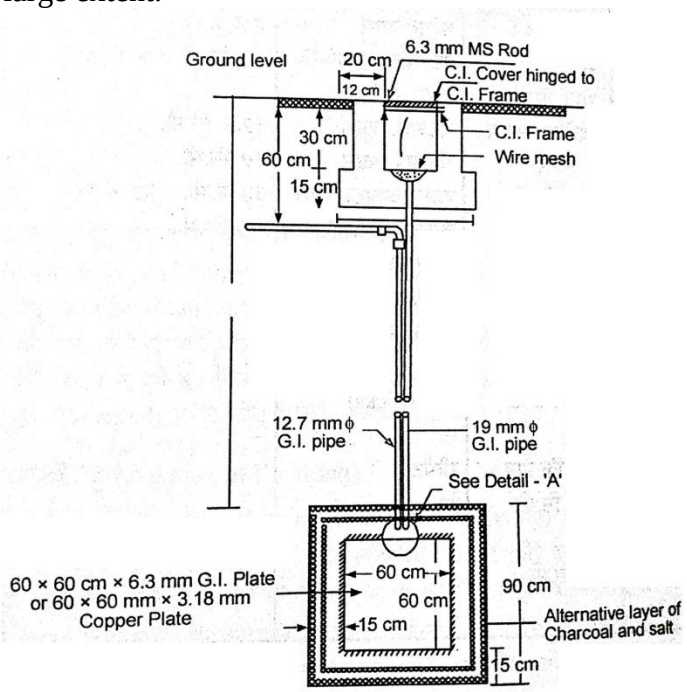
Necessity of earthing:

1. Earthing is grounding the body of the electrical equipment 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 shocks
2. Earthing is necessary for better voltage regulation and protection from surges and lightning strikes.
3. To provide safe path to dissipate lightning and short circuit currents.
4. To provide stable platform for operation of sensitive electronic equipment.

2 Marks

Plate Earthing : -

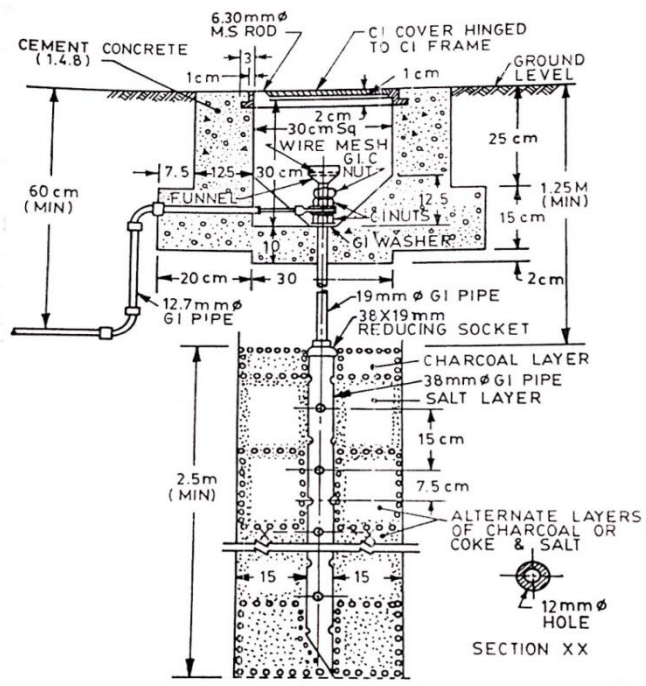
The plate is kept in vertical position and is embedded in an alternate layer of coal and salt, each with a minimum thickness of about 15 cm. The layer of coal and salt help to reduce the earth resistance. A galvanized iron pipe fitted with funnel at the top is provided to pour salty water in the pit of earth plate from time to time in the summer season when the moisture content in the soil reduces to a large extent.



1 Mark for diagram and 1 Mark for explanation of one type of earthing

Pipe earthing:-

In this method galvanized iron pipe is embedded vertically in ground to work as earth electrode. The depth at which pipe should be buried in ground depends on soil condition. Earth wire fastened to the top section of the pipe with nut bolts. In this method, the earth wire connection with galvanized iron pipe being above the ground level, it can be easily checked for carrying out continuity tests as and when desired.



A typical illustration of pipe earthing.

6f) Explain any one type of fire extinguisher.

Ans:

(i) Carbon Dioxide Extinguishing Systems

This type is the most suitable & widely recommended one for electrical fires. Carbon dioxide (CO_2) 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.

4 Marks for explanation of any one type

(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.