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 may should 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 principal components indicated in the 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 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 of the following. 2 X 10 = 20

1 a Define : (i) Frequency (ii) Period.

Ans-

(i)**Frequency**: Number of cycles of alternating quantity completed in (unit time) one second is its frequency. (unit: Hertz or cycles/second) 01 mark

(ii)**Time period**: The time taken by an alternating quantity to complete one cycle is called its time period (Unit of time i.e seconds, minute etc.) 01 mark

1 b State any two applications of digital multimeter.

Ans- 1 mark each point any 2 = 2 marks

Applications of digital multimeter:

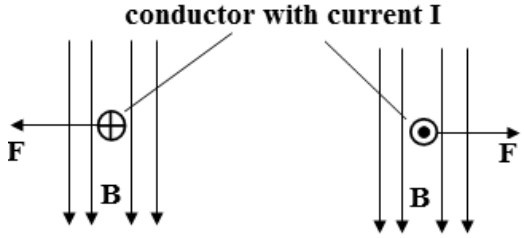
1) To measure ac & dc voltages.
2) To measure ac& dc currents.
3) To measure resistances.
4) To check continuity.
5) To test Diode.
6) To test transistor.
7) To measure capacitance.

1 c State Working Principle of D.C. Motor

Ans-

Working Principle of D.C. Motor: Current carrying conductor placed in a magnetic field experiences a force given by **F = B I** L sinΘ. 1 mark

The direction of the force is given by Fleming's Left Hand rule.



1 mark

where B = external magnetic field, I current in conductor, L = length of conductor in magnetic field, Θ = physical angle between directions of vectors **I** and **B (90^O in above case)** .

1 d State any two applications of Transformer.

Ans-

1. Step up voltage to transmission levels for efficiency of transmission.
2. Step down voltage to distribution levels as required by loads as 3 phase 400 V, 230 V single phase.
3. Step up or step down as required the voltage for special types of loads such as furnaces, ovens etc.

1 mark each any 2 = 2 marks

4. Step up or step down as required the voltage for motional machines such as 22 kV motors etc.
5. In DC power supplies derived from AC to get appropriate voltage inputs for the rectifier.
6. For isolation of electronic circuits from the harmful effects of ac voltage fluctuations.

1 e List various types of starters used for 3 phase induction motor.

Ans-
1) D.O.L. Starter.
2) Star Delta Starter.
3) Stator resistance Starter.
4) Auto Transformer Starter.
5) Rotor Resistance Starter.
6) Soft starter (solid state)

1 mark each any 2 = 2 marks

1 f List various types of Enclosures.

Ans:
1) Screen protected (SP).
2) Drift Proof (DP).
3) Totally Enclosed Non-Ventilated (TENV)
4) Totally Enclosed Fan Cooled (TEFC)
5) Explosion Proof (XP)
6) Splash proof.

½ mark each any 4 = 2 marks

1 g Define Tariff.

Ans:
The rate at which electrical energy supplied to the consumers is charged to them is called as Tariff.

02 marks

1 h State any two methods of Power factor improvement.

Ans:
1) Static Capacitor Method
2) Synchronous Condenser
3) Phase Advancer.

1 mark each any 2 = 2 marks

1 i State any two applications of Stepper Motor.

Ans-
1) Wall Clocks
2) C.D.Drives
3) Robots
4) Printers

1 mark each any 2 = 2 marks

5) Scanners
6) C.N.C. Machines, etc.

1 j Define Regulation of Transformer.

Ans-

Regulation of transformer: The voltage regulation is the percentage of voltage difference between no load voltage and voltage under loaded condition with respect to its rated voltage (also called full load voltage) or no load voltage. 01 mark

% Regulation for any load condition

$= [(V_{NL} - V_L)/V_{NL}] \times 100.$ 01 mark

OR $= [(V_{NL} - V_L)/V_{RATED}] \times 100.$

Where V_{NL} = no load voltage, V_L = voltage when loaded, V_{RATED} = rated voltage. (these voltages are of the secondary side)

1 k Define R.M.S. value in terms of a.c. circuit.

Ans-

The effective or RMS value of an alternating current is equal to the steady state or DC that is required to produce the same amount of heat as produced by the ac current provided that the resistance and time for which the currents exist are identical respectively . 01 mark

$= I_M/\sqrt{2}$ (for sinusoidal varying quantity where I_M = max. value of AC. 01 mark

OR

It is the square root of the mean of squares of the alternating current taken over a cycle or half cycle.

$I_{RMS} = \sqrt{[(I_1^2 + I_2^2 + \ldots + I_{(n-1)}^2 + I_n^2)/n]}$ (where $I_n = n^{th}$ value of alternating current I). 01 mark

$= I_M/\sqrt{2}$ (for sinusoidal varying quantity where I_M = max. value of AC. 01 mark

1 l Classify single phase Induction Motor.

Ans:

½ mark each = 2 marks

1) Split phase IM (Resistance start)
2) Capacitor Start Induction Run
3) Capacitor Start Capacitor Run
4) Shaded Pole Induction Motor

2 Attempt any FOUR of the following. 16

2 a State relation between Phase and line current and phase and line voltage of the following system;

i) Star connected balanced system.

ii) Delta connected balanced system.

Ans:

i) Star connected balanced system-

Line Voltage = √3 x Phase Voltage

$V_L = \sqrt{3}\ V_{Ph}$ 1 mark

Line Current = Phase Current

$I_L = I_{Ph}$ 1 mark

ii) Delta connected balanced system.

Line Voltage = Phase Voltage

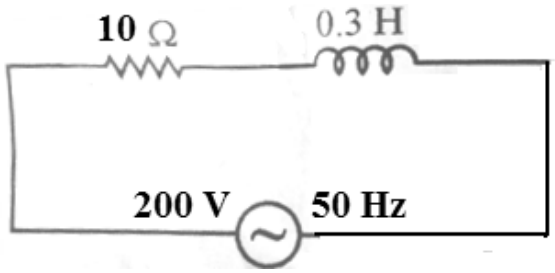
$V_L = V_{Ph}$ 1 mark

Line Current = √3 X Phase Current

$I_L = \sqrt{3} * I_{Ph}$ 1 mark

2 b Find i) Impedance ii) Phase angle iii) current iv) Total Power for the circuit shown below,

Ans-



i) Impedance $Z=\sqrt{R^2 + X_L^2}$

$X_L = 2\pi fL = 2 \times 3.14 \times 50 \times 0.3 = 94.2477\ \Omega$

$R = 10\ \Omega$

$Z=\sqrt{10^2 + 94.2477^2}$

$Z = 94.77\ \Omega$…….. 01 mark

ii)Phase angle Ø:

$$cos\emptyset = \frac{R}{Z} = \frac{10}{94.77} = 0.105$$ 01 mark

$$\emptyset = cos^{-1}(0.105) = 83.97^0\ldots$$ 01 mark

iii) current

$$I = \frac{V}{Z} = \frac{200}{94.77} = 2.11\ A$$

iv) Total Power

$$P = V\ I\ cos\ \emptyset = 200 * 2.11 * 0.105$$
$$P = 44.31\ watts$$ 01 mark

2 c A 3 Phase 6 poles Induction motor works on a 25 Hz Supply. Calculate the synchronous speed and rotor speed if it runs at a slip of 5 percent.

Ans:
Given data,
P=6, f=50Hz and slip=5%.

i) Synchronous speed,

$$Ns = \frac{120f}{p} = \frac{120\ x\ 25}{6}$$ 01 mark for formula

= 500 RPM 01 mark

ii) %Slip(s)= $\frac{Ns-N}{Ns}$ x 100

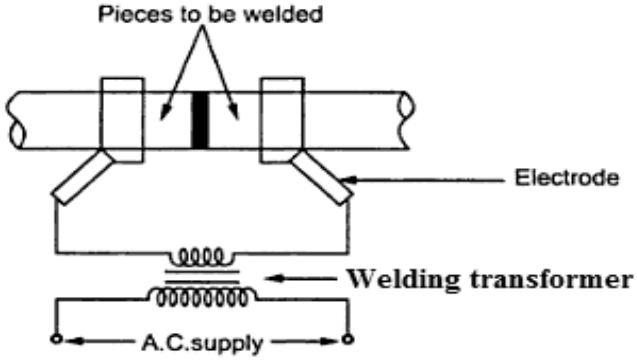
$$N = Ns\ (1 - S)$$ 01 mark for any one formula

$$N = 500\ (1 - 0.05)$$

Rotor speed N = 475 r.p.m. 01 mark

2 d Describe Butt welding and Seam Welding in brief along with relevant labeled diagram.
Ans-

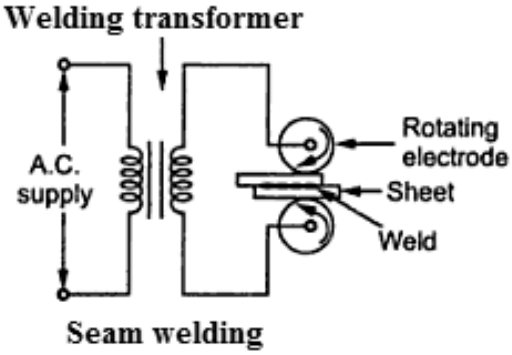
Butt Welding:
In this method the two metal parts are held in clamps and pressed together end to end and a heavy current is then passed through the joint. Rods, pipes and wires are welded by this method. 1 mark



Butt welding 1 mark

Seam Welding: Rotating wheels are used to rotate the electrodes. The sheets travel between these rollers. Heavy current is passed across the joint. The weld is obtained 1 mark

which is the series of overlapping spot weld.



1 mark

2 e Distinguish between PMMC and Moving iron instrument.

Ans:

Sr No	PMMC Instruments	MI Instruments
1	It is suitable only for for D.C. Supply	It is suitable for a.c. as well d.c. supply.
2	Scale is uniform.	Scale is non linear
3	It is much sensitive than M.I. instruments	Less Sensitive as compared to PMMC instruments.
4	Torque to weight ratio is high compared to M.I. type	Torque to weight ratio is less as compared to P.M.M.C. instruments type.
5	It is costlier than M.I. type	It is cheaper than PMMC type.
6	Damping is perfect as eddy current damping is used.	Air friction damping is used

1 mark each any 4 points = 4 marks

2 f Name four types of tariff and describe any one.

Ans-

i) Simple tariff
ii) Flat rate tariff
iii) Block rate tariff
iv) Two-part tariff
v) Three-part tariff
vi) Maximum demand tariff
vii) Power factor tariff

02 marks

I) **Simple Tariff:** In this type of tariff, rate per unit is fixed. The rates will not vary with type of consumers so it is very simple tariff to understand for consumers.

II) **Flat rate Tariff:** In this type of tariff different type of consumers are charged at different rates i.e. the flat rate for light and fan load is slightly higher than that for power load.

III) **Block rate tariff**: In block rate tariff the first block of energy is charged at

02 marks for any one description

higher rates and succeeding blocks of energy are charged at progressively reduced rates.

IV) **Two Part Tariff**: The total charge to be made to the consumer is split in to two components mainly Fixed charge and running charge.
Total Energy charge= a x kW + b x kWH, where a= charge per kW of maximum demand and b = Charge per kWH of energy consumed.

V) **Three Part Tariff:** The total charge to be made to the consumer is split in to three components mainly Fixed charge plus maximum demand charge and running charge.
Total Energy charge= a + b x kW + c x kWH, where a= Fixed charge, b= charge per kW of maximum demand and c = Charge per kWH of energy consumed.

VI) **Maximum Demand Tariff**: It is similar to that of two part tariff but maximum demand (in kVA) is charged to customer + energy charges.

VII) **Power Factor Tariff**: In this type consumers are charged depending on value of power factor i.e. for lower p.f. higher rates and for higher p.f. rates will be lower.

3 Attempt any FOUR of the following. 16

3 a Draw a single line diagram of electrical power supply & show different stages in it.
Ans-

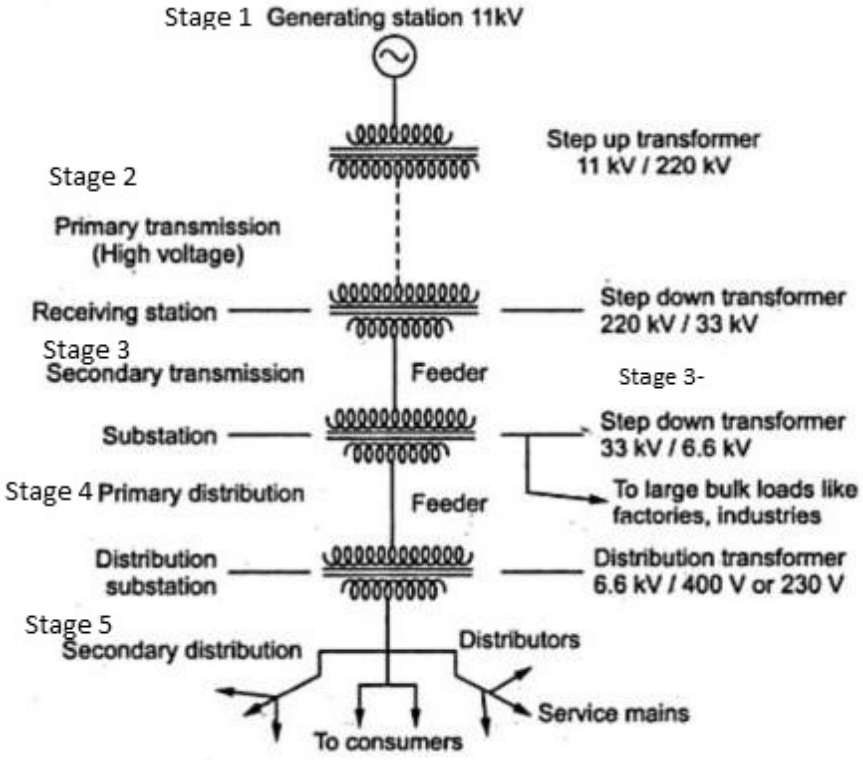


Fig. Single line diagram of electrical power supply

Fully labeled 04 marks, partially labeled 2 to 3 marks, unlabeled 1 mark.

3 b An Alternating current is given by i = 141.4 sin 314 t.
Calculate the maximum value, frequency, time period and instantaneous value when t is 3ms.

Ans-
Given- i = 141.4 sin 314 t
We have $i = I_m \sin \omega t$

Therefore,
$\omega = 314$ rad/sec.
Maximum value $I_m = 141.4$ A…… 01 marks

Angular frequency $\omega = 2\pi f = 314$

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

$f = 50$ Hz…… . 01 marks

Time period:

$$T = 1/f = 1/50 = 0.02\ sec\ldots$$ 01 marks

Instantaneous value when t = 3ms.

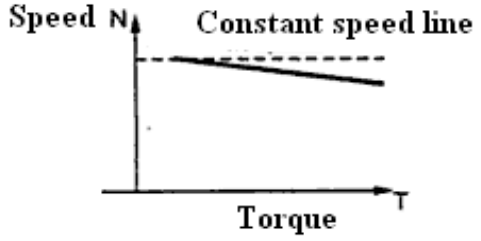
$$i_{3ms} = 141.4 \sin (2\pi f t)$$

$$i_{3ms} = 141.4 \sin (2\pi\ x\ 50\ x\ 3\ x\ 10^{-3})$$

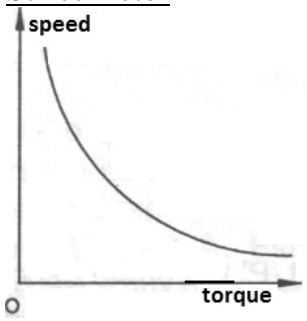
$$i_{3ms} = 114.39\ \text{A}$$ 01 marks

3 c Draw the speed-torque characteristics of DC shunt and series motor.

Ans: Shunt motor



Series motor

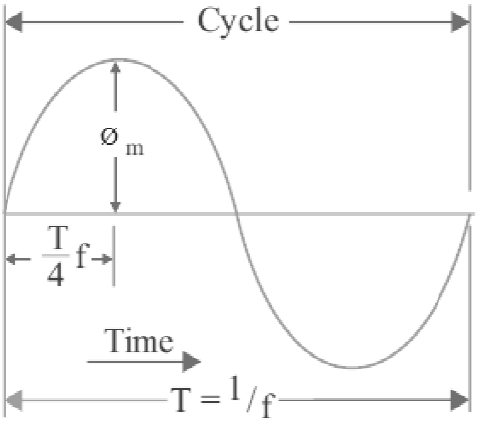


Neat diagram 02 marks each = 4 marks

3 d Deduce the emf equation of transformer.

Ans-
EMF equation of transformer

Variation of the flux in the core



01 mark

01 mark

Let,
N_1 = No. of primary turns
N_2 = No. of secondary turns
$Ø_m$ = Maximum flux in core in webers
= B_m x A.
f = Frequency of A.C. supply in Hz

01 mark

As shown in above fig flux increases from its zero value to maximum value to $Ø_m$ in one quarter of cycle i.e in 1/4f second.

Therefore Average rate of change of flux $= Ø\text{m}/(1/4\text{f})$

$$= 4\text{f}\,Ø\text{m Wb/s} \quad or \text{ volt}$$

Now, rate of change of flux per turn is induced emf in volts.
Therefore Average e.m.f/turn $= 4\text{f}\,Ø\text{m}$ volt

If flux Ø varies sinusoidally, then r.rm.s. value of induced e.m.f is obtained by multiplying the average value with the form factor.

$$\text{Form factor} = \frac{\text{r. m. s value}}{\text{average value}} = 1.11$$

Therefore value of e.m.f/turn = 1.11 x $4\text{f}\,Ø\text{m} = 4.44\text{f}\,Ø\text{m}$ volt
Now, r.m.s. value of the induced e.m.f. in the whole of primary winding
= (induced e.m.f./turn) x (No. of primary tuns)

01 mark

$E_1 = 4.44\ \text{f}\ N_1 B_m A$ ……(i)

Similarly r.m.s. value of the induced e.m.f. in the whole of secondary winding

$E_2 = 4.44\ \text{f}\ N_2 B_m A$ ……(ii)

Equation (i) & (ii) are emf equation of transformer.

3 e Draw a neat sketch of D.O.L and explain its working.

Ans:
D.O.L. Starter

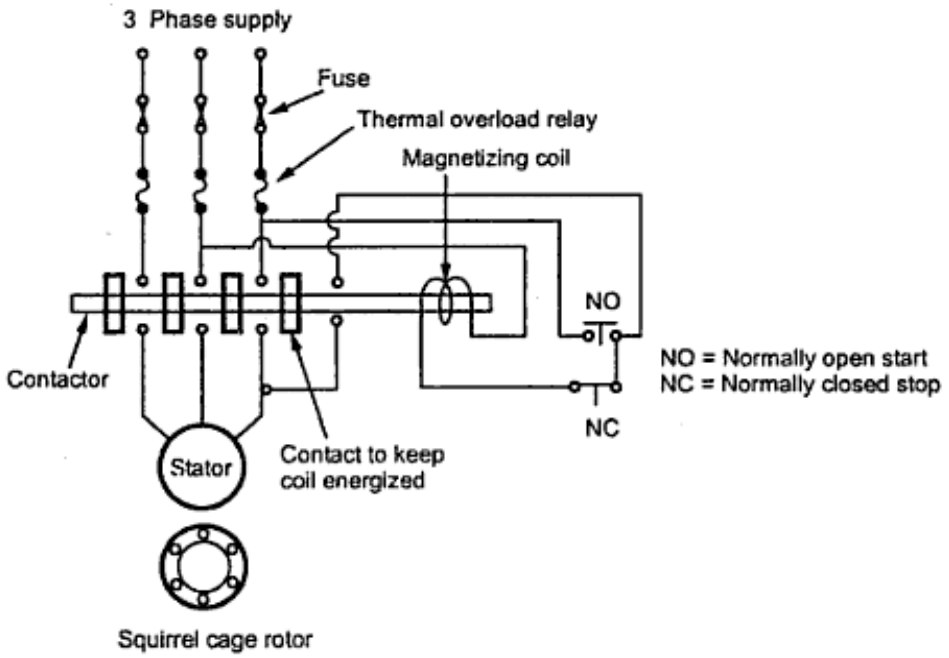


Diagram (or equivalent figure) 02 marks

To start, the contactor is closed, applying full line voltage to the motor windings. The motor will draw a very high inrush current for a very short time. The motor will develop Locked Rotor Torque and begin to accelerate towards full speed.As the motor accelerates, the current will begin to drop, but will not drop significantly until the motor is at a high speed, typically about 85% of synchronous speed. This is operation of the DOL starter. It has the thermal overload relays that sense overload in terms of the currents drawn in the motor current lines. On overload conditions the excess current drawn overheats the thermal relays that open the circuit breaker (contactor) supply lines and protect the motor from overloads.

02 mark for explanation

3 f Explain in brief fire extinguishing methods adopted in electrical safety.

Ans-

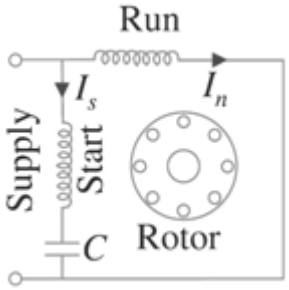
i) Switch off the supply immediately so that the source for the fire to get sustained is isolated using proper insulated hand gear/foot wear etc..
ii) Use CO_2 gas fire extinguisher as instructed. Direct the CO_2 gas over the fire such that the air/oxygen is blocked and the fire is extinguished.
iii) Use sand on the fire to extinguish especially on burning cables etc.
iv) Always isolate the electrical supply before using a water fire extinguisher if other methods are not possible. Isolating the supply converts the fire from a very dangerous electric fire to a normal burning fire.

01 mark each = 4 marks

4 Attempt any FOUR of the following. 16

4 a With the help of circuit connection diagram explain capacitor start run motor.

Circuit diagram-



02 marks

Explanation-
In this motor the starting winding (or auxiliary winding) and capacitor are connected in the circuit at all the times. It has one running winding and one starting winding in series with a capacitor as shown in above figure. There is no need to use a centrifugal switch. The starting winding and running winding are identical in nature. Same capacitor is used for starting as well as running of the motor. Generally low value capacitors are employed (capacitors of 2 to 20μF range) , thus small starting torque is developed which is about 50 to 100% of rated torque. The advantage of leaving the capacitor permanently in the circuit are- (i) improvement of overload capacity, (ii) a higher power factor of motor, (iii) higher efficiency, (iv) quieter running of the motor.

02 marks

4 b Explain the factor to be considered for selection of motor for different drives.

i) Nature of speed torque characteristics required by the load.
ii) Speed regulation allowed (variation of speed permitted for loaded conditions)
iii) Speed range required (the values/range of speeds at which the load is to be operated).
iv) Duty cycle: the nature of the loading with respect to time.
v) Efficiency: for given application higher efficiency motors are always preferred.
vi) Starting, braking and reversing performance needed to be carried out.
vii) Type of supply available, (for eg if three phase supply is not available and if not very strictly needed we may go in for a single phase motor if available at the voltage we have in the premises)
viii) Capital and running cost, maintenance required and life.
ix) Space and weight restrictions if any. Odd or tricky located motors may need to satisfy certain criteria for weight/size.
x) Environment and location: different types of atmospheres are needed to be faced by the motors. Eg. Dusty conditions, humid conditions, etc. hence motors with properly suitable enclosures must be selected.
xi) Reliability. More the reliability as seen in the test reports and past products (motors) we may safely opt for it.

01 mark each point student can write any 4 points = 4 marks.

4 c Describe the speed control of three phase induction motor using VFD drive with the help of diagram.
Ans:
Diagram-

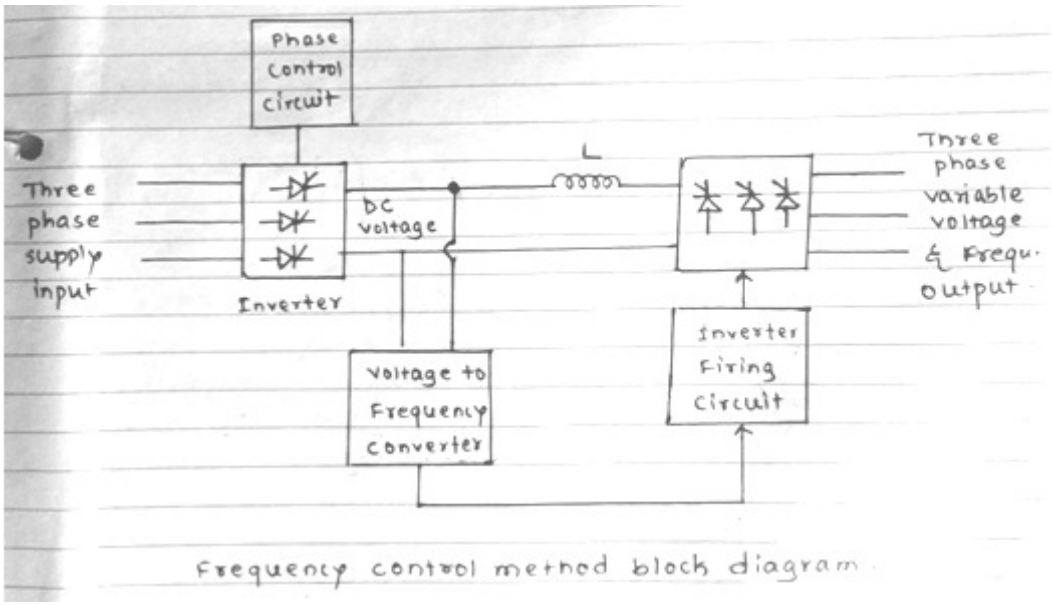


Diagram or equivalent figure =

02 marks

Explanation-

The synchronous speed of the induction motor is given by, Ns=120f/P. The synchronous speed of an induction motor can be changed by changing the supply frequency (f). Variable frequency can be obtained from solid state equipments or (i.e. VFD drives).

A basic block diagram of speed control of induction motor using variable frequency source is shown in above fig. Three phase supply at input is first converted into controlled DC. This DC voltage is applied to inverter circuit whose frequency is controlled by pulses from voltage to frequency controller unit. A smoothing reactor, L is connected in the circuit to filter the controlled DC.

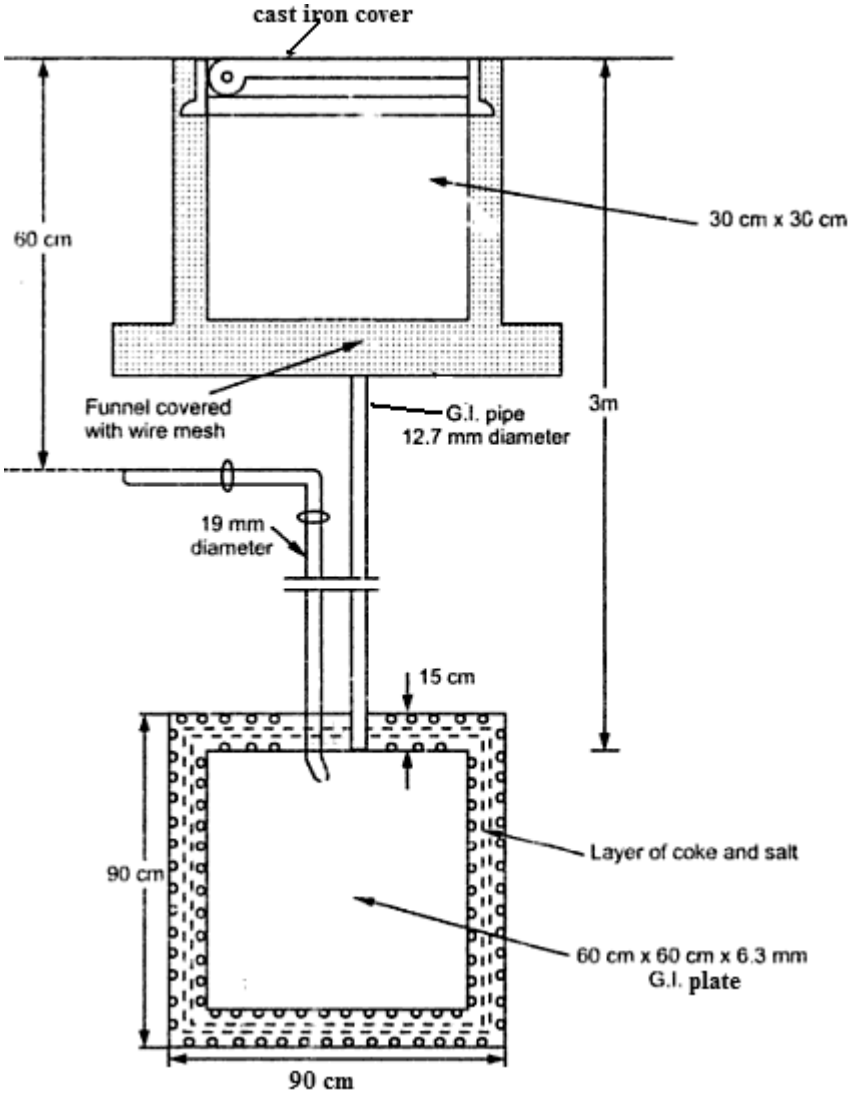
02 mark

4 d Explain with help of diagram plate earthing.

Ans:

Diagram:

02 mark



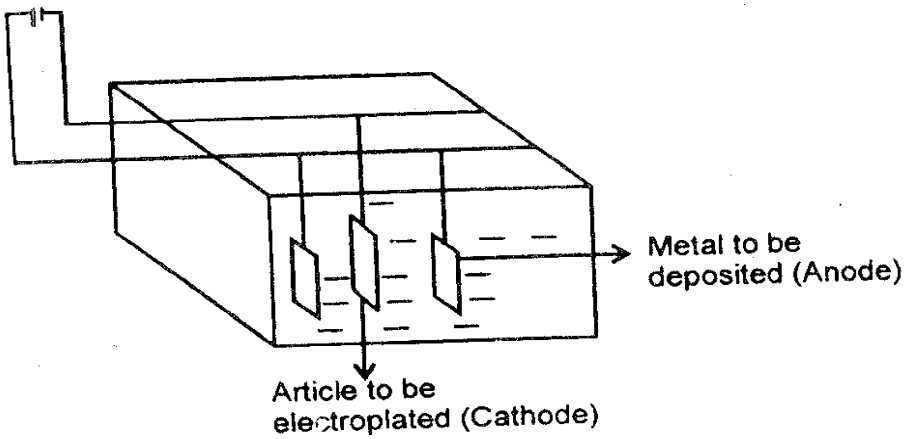
For diagram

02 mark

Electrode should be of size 60 cm x 60 cm x 6.3mm thick (for GI plate) or 60cms X 60 cms X 3.18 mm thick (for copper). The plate for earthing shall be buried deep in the ground with its face vertically and top not less than 3m. below ground. A cast iron/MS frame with cover having locking equipment shall be suitable embedded in the brick masonry to protect the watering arrangement (funnel with mesh and 20 mm diameter G.I. pipe of medium class quality fixed on the top of the electrode) and the earth pit from mechanical damages. The brick masonry enclosures should be not less than 30 cms x 30 cms x 30 cms. Layers of charcoal/coke and salt are to be made in the earth pit after putting the electrode in its place. Earth electrode should have a resistance less than three ohms measured by an earth resistance meter.

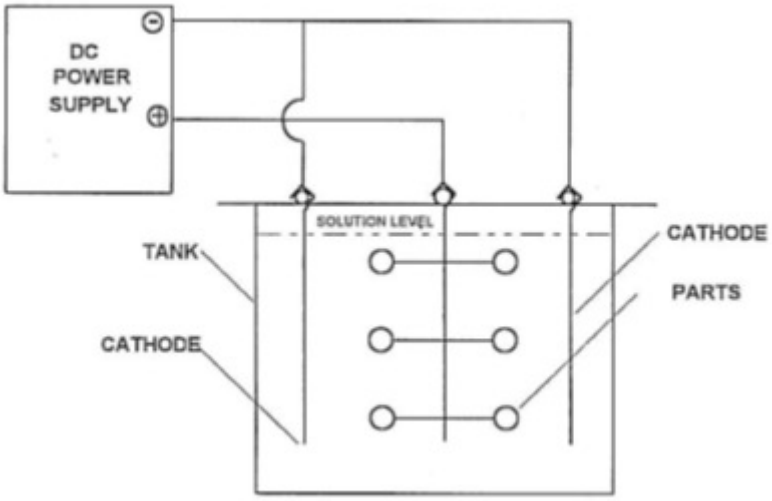
4 e State and explain working principle of electroplating.

Ans: Principle of Electroplating:



Any one diagram or equivalent = 2 marks

OR



- Process of depositing metal on articles for decoration / protective layering using electricity is electroplating.
- Electrolysis is used to carry out the coating / deposition as shown in figures.

Control of current is used to regulate/control of deposition.

Explanation = 02mark

eg. For zinc:

At cathode $Zn2^{+}(aq) + 2\ e^{-} \longrightarrow Zn(s)$

At anode $Zn(s) \longrightarrow Zn2^{+}(aq) + 2\ e^{-}$

Faraday's laws of electrolysis govern the amount of metal deposited.

4 f Explain the purpose of –

i) Conservator

ii) Breather in a transformer

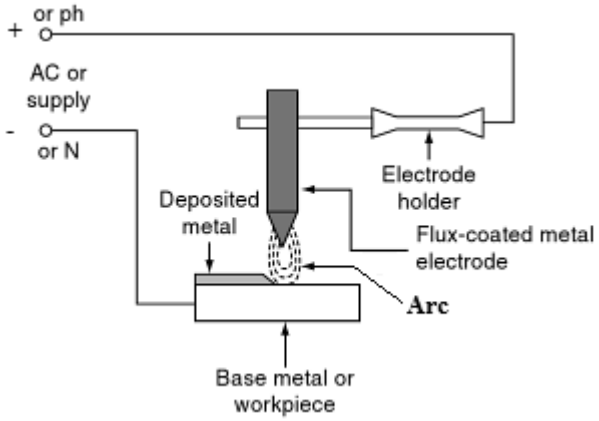
Ans-

Conservator: The Conservator is designed to act as a reservoir for the transformer oil. The level of the oil in the transformer can rise and fall due to temperature variations. The conservator provides space for this volume increase (rising temperature) or volume decrease (falling temperature) of the oil. Thus the pressure in the transformer tank is maintained else high pressure due to expanded oil can create leakages or damage the tank. 02 mark

Breather in a transformer tank: As the level of oil rises and falls inside the conservator, air enters and leaves the chamber. The air may carry moisture which may cause the oil to deteriorate. Breathers filled with silica gels are provided to separate moisture from the aspirated air. The silica gel turns blue when it becomes saturated with moisture after which it needs to be replaced. 02 mark

5 Attempt any four of the following. 04 X 4= 16

5 a Describe electric arc welding. Also state its types.



Neat labeled diagram (or equivalent) 02 marks

Electric arc welding is the process of joining two metallic pieces or jobs using the heat produced due to electric arc struck which melts the metals to join. An electric arc is formed whenever electric current is passed between two metallic electrodes which are separated by a short distance from each other. The arc is started by momentarily touching the positive electrode (anode) to the negative metal (or plate) and then withdrawing it to about 3 to 6 mm from the plate. When electrode first touches the plate, a large short circuit current flows and as it is later withdrawn from the plate, current continues to flow in the form of spark across the air gap so formed. Due to this spark (or discharge), the air in the gap becomes ionized i.e. is split into negative electrons and positive ions. Air becomes conducting and current is able to flow across the gap in the form of an arc. 01 mark

Types of electric arc welding- Any four types 01 mark

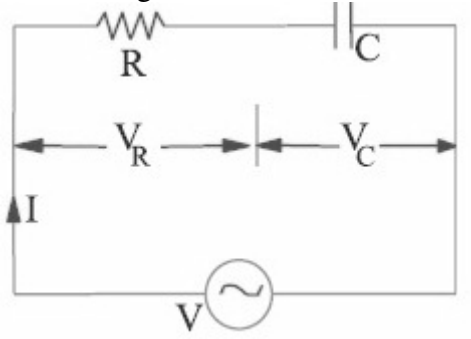
1) Carbon arc welding
2) Metal arc welding
3) Atomic hydrogen welding
4) Inert gas metal arc welding
5) Submerged arc welding.

5 b For R-C series circuit :

i) Draw circuit diagram
ii) Its phasor diagram
iii) Waveform of voltage and current
iv) Impedance triangle

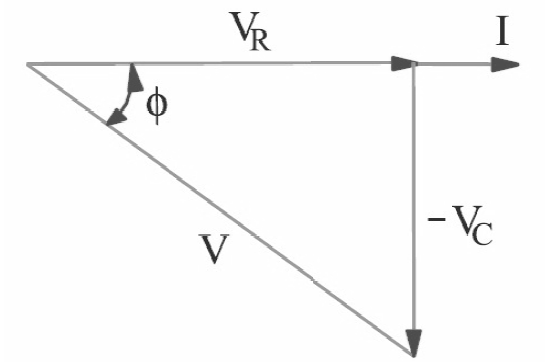
Ans:

i) Circuit diagram



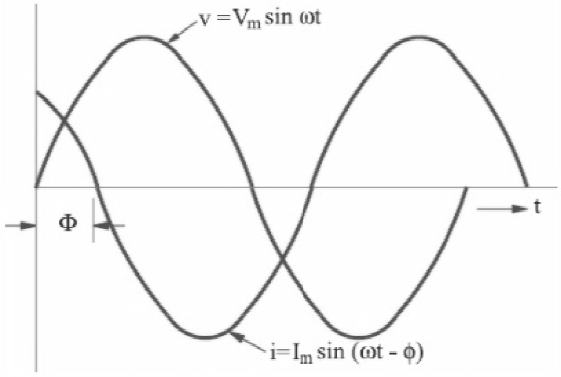
01 mark

ii) Phasor diagram



01 mark

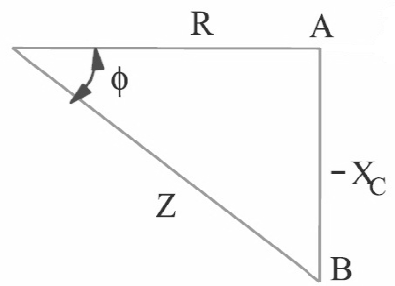
iii) Waveform of voltage and current



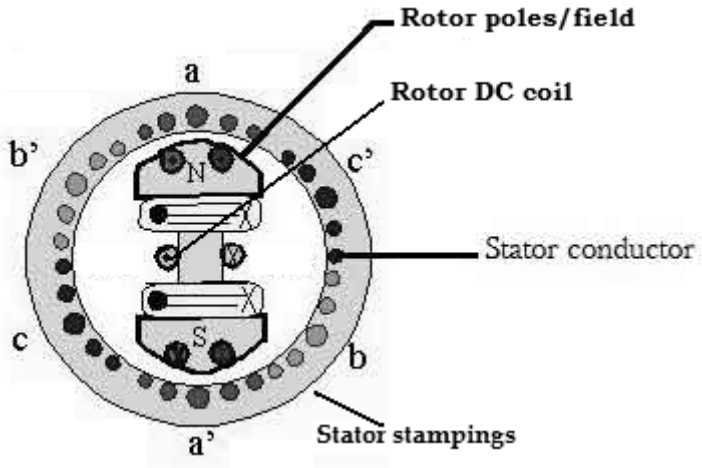
01 mark

iv) Impedance triangle

01 marks

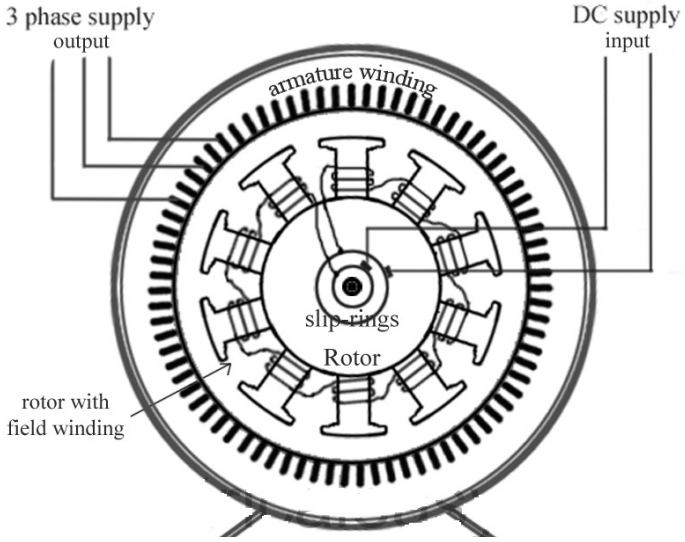


5 c Draw and label various parts which show constructional details of an alternator.



Neatly drawn and labeled 04 marks, else 3 to 1 mark as per the labeling and diagram completeness expected as shown in the adjoining diagrams

OR



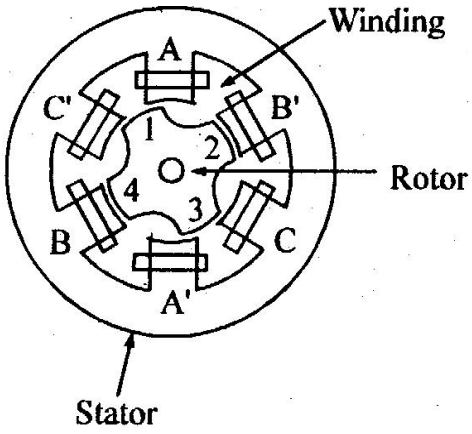
5 d Explain working principle, construction and applications of stepper motor.

Ans-

Principle & working of stepper motor:

- Converts series of electrical pulses (input) into discrete angular movements (definite angular steps) i.e one step for each pulse input.
- Stator is constructed of laminated silicon steel.

- As shown the stator has six salient poles or teeth on which coils are placed with opposite poles having series connected coils to which voltage pulses are given through the switching circuit as shown. 01 marks
- Rotor is also of laminated silicon steel with the no. of poles/teeth being four but has no coils.
- The switching is done sequentially to obtain rotation.
- When poles A & A' are excited by closing Switch S_{w1} the rotor teeth nearest to these align to have minimum reluctance between the A-A' stator poles. (poles A and A' are opposite in nature).
- Next if poles B & B' are excited by opening S_{w1} and closing Switch S_{w2} then the rotor moves anticlockwise angularly by 30^o to align with these poles.
- Thus if we provide 12 such voltage pulses sequentially by proper opening and closing of switches we get one full rotation in 12 equal steps.
- If the sequence of application of these pulses is A/A' – C/C' – B/B' then we obtain clockwise rotation.
- By changing the no of rotor teeth proportionally we can have smaller angular steps.



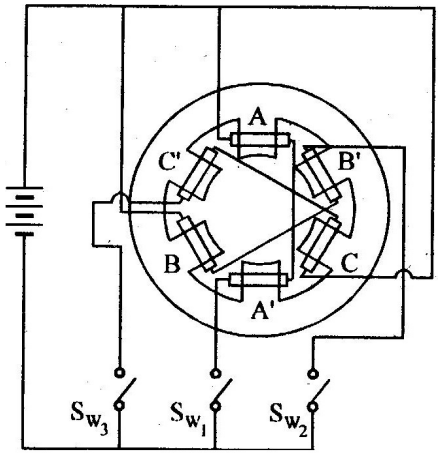


Diagram (or equivalent fig) 02 marks

Applications:

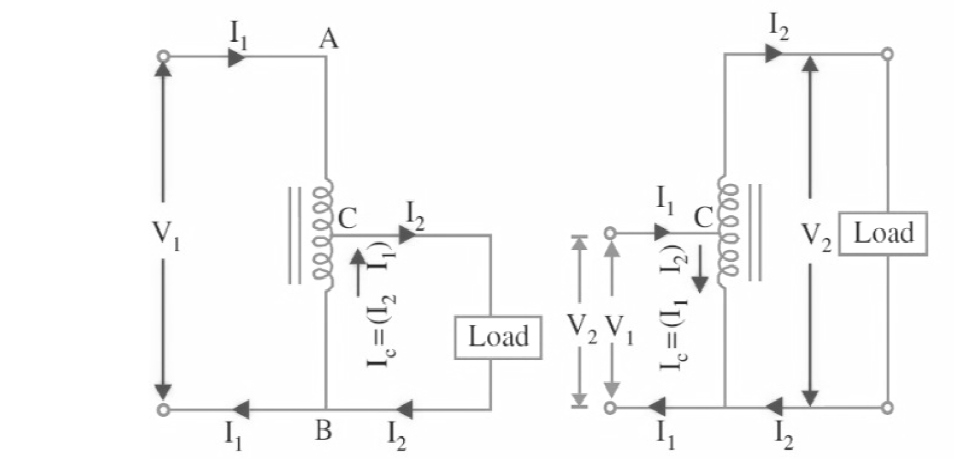
1) Wall Clocks
2) C.D.Drives
3) Robots
4) Printers
5) Scanners
6) C.N.C. Machines, etc.

½ mark each any two = 1 marks

5 e Explain copper saving by autotransformer instead of two winding transformer.

Ans-

01 marks



Volume and weight of copper is proportional to length and area of the cross section of the conductors.
Now, length of the conductors is proportional to the number of turns and cross-section depends upon the current. 01 marks
Hence, weight is proportional to the product of the current and number of turns.
From above fig.
Wt.of copper in section AC is α $(N_1-N_2)\ I_1$
Wt.of copper in section BC is α $(N_2\ (\ I_2-I_1)$
Therefore, total wt. of copper in auto transformer α $(N_1-N_2)I_1-N_2(I_2-I_1)$

If a two winding transformer is considered then,
Wt.of copper on its primary then,
Wt.of copper on its primary α N_1I_1
Wt.of copper on its primary α N_2I_2
Total wt. of copper α $N_1I_1 + N_2I_2$

01 marks

$$\frac{wt.of\ copper\ in\ autotransformer}{wt.of\ copper\ in\ ordinary\ transformer} = \frac{(N_1 - N_2)I_1 + (I_2 - I_1)N_2}{N_1I_1 + N_2I_2}$$

$$= 1 - \frac{\left(2\frac{N_2}{N_1}\right)}{1 + \frac{N_2}{N_1}X\frac{I_2}{I_1}} = 1 - \frac{2K}{2} = 1 - K$$

01 marks

wt. of copper in auto transformer (Wa) = (1-K) X (wt of copper in ordinary transformer Wo)

thus, Saving = Wo- Wa
=Wo – (1-K) Wo = KWo

Saving = K X (wt of copper in ordinary transformer)
Hence, saving will increase as K approaches unity.

5 f Explain in brief concept of energy conversion.
Ans-

Statement-

The transformation of energy from forms provided by nature to forms that can be used by humans.

A fundamental law that has been observed to hold for all natural phenomena requires the conservation of energy—i.e., that the total energy does not change in all the many changes that occur in nature. 01 mark

The law of conservation of energy is applied not only to nature as a whole but to closed or isolated systems within nature as well. Thus, if the boundaries of a system can be defined in such a way that no energy is either added to or removed from the system, then energy must be conserved within that system regardless of the details of the processes going on inside the system boundaries. 01 mark

As the total amount of energy in nature is limited it is essential to conserve it in whatever it exists so that its use can be prolonged and the energy saved leading to saving in its cost incurred. Such measures of conserving energy also lead to avoidance of pollution arising due to burning of fuels, green house gases and the resulting harmful effects on all living beings on the earth. This can be affected by using energy saving devices and implementation of energy saving measures. 02 marks

6 Attempt any FOUR of the following. 16

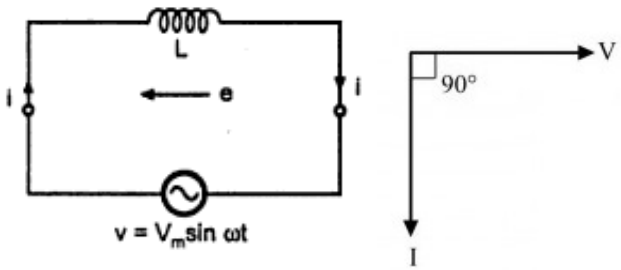
a Compare rating and applications of Florescent, CFL and LED lamps.

Ans-

Sr. No.	Parameters	Florescent	CFL	LED
1	Wattage Ratings	15 watt to 100s watt	5 watt to 100s watt	¼ watt to 100s watt 2 marks
2	Applications	Only for indoor application. (Eg- home, shops, offices etc.)	Indoor (Eg- home, shops, offices etc.) & outdoor application with enclose (Eg- Rail way yard, street light, etc.)	Indoor (Eg- home, shops, offices etc.) & outdoor application with enclose (Eg- Rail way yard, street light, etc.) 2 marks

6 b Draw and explain the labeled circuit and phasor diagram for purely inductive circuit. What is power factor of the circuit?

Ans-



Pure inductive circuit. Phasor diagram. 01 mark

Whenever an alternating voltage is applied to purely inductive coil, a back emf is produced due to the self-inductance of the coil. The back emf at every step, opposes the rise or fall of the current through the coil. As there is no ohmic voltage drop, the applied voltage hase to overcome this self-induced emf 'e' only.

$$v = -e = L\frac{di}{dt}$$

Now $v = V_m \sin \omega t$

$$V_m \sin \omega t = L\frac{di}{dt}$$ 01 mark

$$di = \frac{V_m}{L}\sin \omega t$$

Integrating both sides, we get $i = \frac{V_m}{L}\int \sin \omega t \, dt$

$$= \frac{V_m}{\omega L}\cos \omega t$$

$$= \frac{V_m}{X_L}\sin(\omega t - \frac{\pi}{2})$$

Max. value of i is $I_m = \frac{V_m}{X_L}$ $when$ $\sin(\omega t - \frac{\pi}{2})$ $is\ unity$

Hence equation of current becomes $i_m = I_m \sin(\omega t - \frac{\pi}{2})$ 01 mark

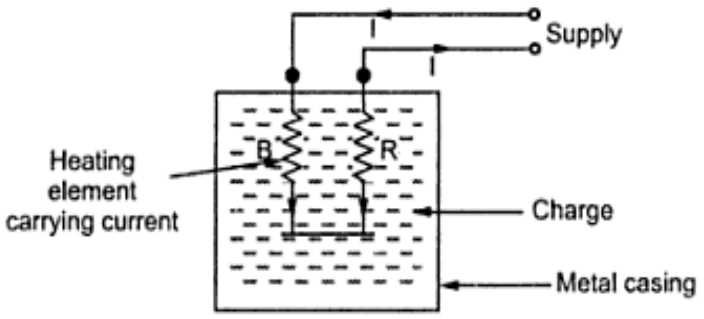
Power factor of circuit is zero lagging for pure inductive circuit. 01 mark

6 c Explain in brief resistance heating.

Ans-

Resistance heating: heat dissipated by a conductor carrying current (I^2Rt), is utilized to heat the required jobs. Conductors are alloys such as NiCr, NiFe, CuNi etc.

Example: Electric oven:



02 marks

It is indirect resistance heating. Highly resistive strip conductor is used to produce the heat as per Joules law ($H = I^2Rt/4.2$ calories). The heat produced reaches the job to be heated by way of radiation and convection. Fans are used to obtain even and speedily spread of heat produced. Temperature control is obtained by using thermostats and controllers. 02 mark

6 d State any two applications of following motors:
a) Servomotor b) Universal motor

Ans-

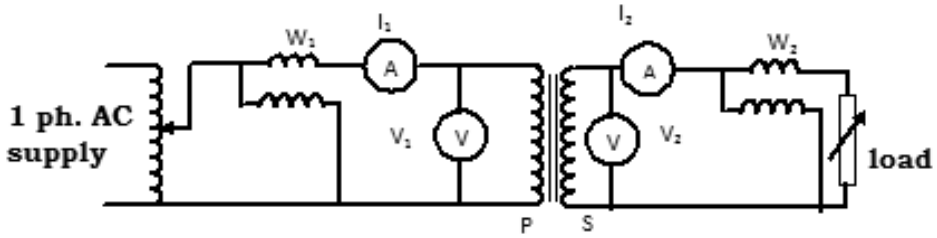
a) Servomotor applications: ½ mark each any 4 application s = 2 marks
1) CNC machines
2) Machine Tool (Metal Cutting)
3) Machine Tool (Metal forming)
4) Antenna Positioning
5) Packaging
6) Woodworking
7) Textiles
8) Printing etc.

b) Universal motor applications: ½ mark each any 4 application s = 2 marks
1) vacuum cleaners,
2) drink and food mixers
3) Domestic sewing machine
4) portable drills,
5) Blenders etc.

(any other valid appls may be considered)

6 e With the helf of connection diagram explain load test for determination of efficiency & regulation of transformer.

Ans-



02 mark

The load on the transformer is varied from no load to about 10 % overload in steps of around 15%. The readings are to be noted as below:

Primary volts V_1 (V)	Primary current I_1 (A)	Primary power W_1 (W)	Secondary terminal volts V_2(V)	Secondary current I_2 (A)	Secondary power W_2 (W)	Remarks
			V_{2NL}			No load
		W_{1FL}	V_{2FL}		W_{2FL}	Full load
						10% overload

- Calculation of efficiency for any load: ($W_1 = W_{1L}$, and $W_2 = W_{2L}$)
  For any load condition = $\%\eta = (W_{2L}/ W_{1L}) \times 100$. 01 mark

- Calculation of regulation for any load: ($V_2 = V_{2L}$)
  % regulation = $[(V_{2NL} - V_{2L})/(V_{2NL})] \times 100$ or

  % regulation = $[(V_{2FL} - V_{2L})/(V_{2FL})] \times 100$.

01 mark

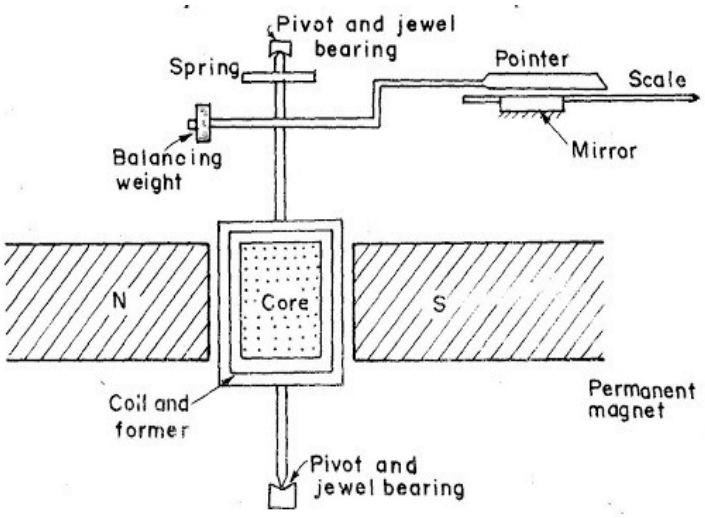
OR

OR

- Connect the circuit as shown in figure.
- Adjust primary voltage to its rated value.
- Increase the load gradually from no load to full load and note down all the meter readings.
- Calculate % Efficiency = $(W_2/W_1) \times 100$, where, W_2 = Output power and W_1 = Input power. 1 mark
- Calculate % Regulation = $(E_2 - V_2/E_2) \times 100$, where V_2 = secondary voltage on load and E_2 = secondary voltage on no load 1 mark

6 f Describe the working principle, construction and working of permanent magnet moving coil instrument. State its advantages & disadvantages.

Ans-



01 mark

Consists of the parts shown in the diagram. 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. ½ mark

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 ½ mark

angular deflection of the moving coil is directly proportional to current flowing through it (Θ α I) as the current increases the deflection of moving coil also increases. The deflecting torque is given by

∴ Td= NBIL

Where, N= no. of turns of coil,

B=Flux density,

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

Advantages

The various advantages of PMMC instruments are,

i) It has uniform scale.
ii) With a powerful magnet, its torque to weight ratio is very high. So operating current of PMMC is small.
iii)The sensitivity is high.
iv)The eddy currents induced in the metallic former over which coil is wound, provide v)effective damping.
vi)It consumes low power, of the order of 25 W to 200 mW.
vii)It has high accuracy.
viii)Instrument is free from hysteresis error.
ix)Extension of instrument range is possible.
x)Not affected by external magnetic fields called stray magnetic fields.

Any 2 = ½ mark each = 1 mark

Disadvantages.

i)PMMC is suitable for direct current based measurements only.
ii)Ageing of permanent magnet and the control springs introduces the errors.
iii)The cost is high due to delicate construction and accurate machining.
iv)The friction is due to jewel-pivot suspension.

Any 2 = ½ mark each = 1 mark