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) Average value ii) RMS value of an AC Wave.**

Ans:

i) Average value: **(1 Mark)**

The average value is defined as "the average of all instantaneous values during one alternation". That is, the ratio of the sum of all considered instantaneous values to the number of instantaneous values in one alternation period.

ii) RMS value value of an AC Wave: **(1 Mark)**

The r.m.s value of an alternating current is that steady current (d.c) which when flowing through a given resistance for a given time produces the same amount of heat as produced by the alternating current when flowing through the same resistance for the same time. **OR**

$\therefore$ RMS Value = Form Factor $\times$ Average Value **OR**

RMS Value = $0.707 \times$ maximum value

b **Give two differences between MI and PMMC instrument.**

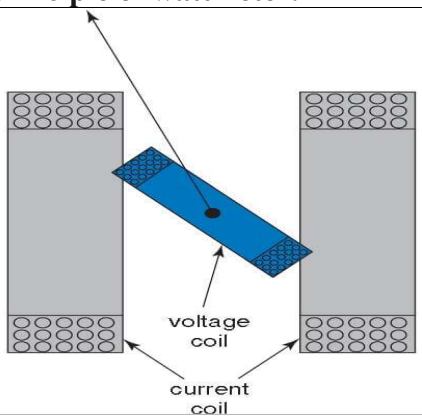
Ans: **(Any Point expected: 1 Mark each, Total: 2 Marks)**

Sr. no	MI Instrument	PMMC Instrument
1	It works on the principles of magnetism.	It works on the principle of DC motor

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

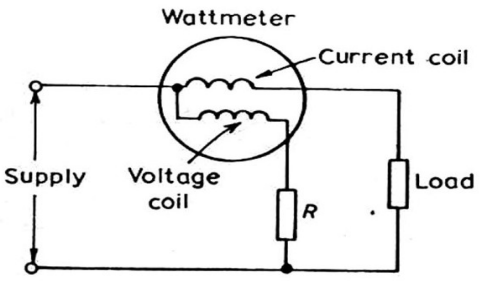
c) State the principle of wattmeter.

Ans:



OR

Dynamometer Type Wattmeter



Working Principle of Wattmeter: **(2 Marks)**

It consists of two stationary coils, called current coils and one moving coil, called

voltage or potential coil. 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.

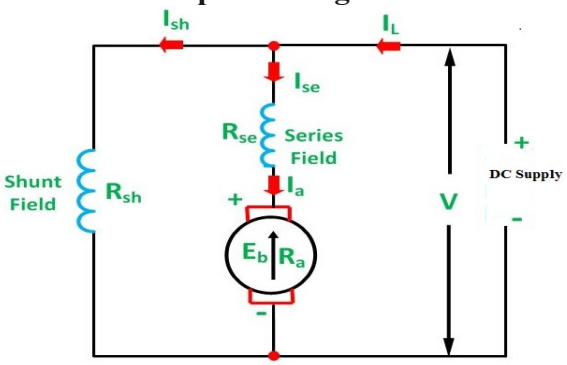
The interaction between two magnetic fields causes the production of force on moving system, which is proportional to the product of voltage and current i.e. power. The meter can be calibrated directly to indicate the power in watts.

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.

d) Draw schematic diagram of DC compound long shunt motor.

Ans: **Schematic diagram of DC compound long shunt motor:** **(2 Marks)**



or equivalent Figure

e) List the losses occurred in transformer.

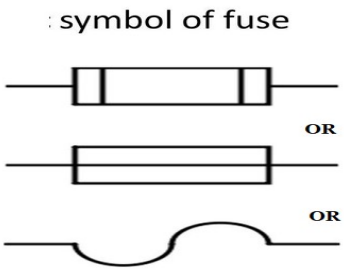
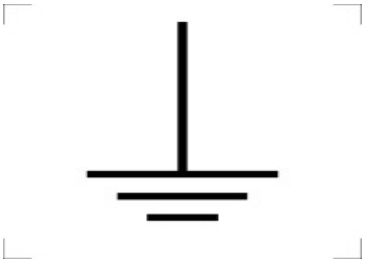
Ans: List various losses that occur in a transformer: **(Types of losses 2 Marks)**

1) Copper losses
2) Core or Iron losses:
   a) Hysteresis loss
   b) Eddy current loss

f) State the working principle of transformer.

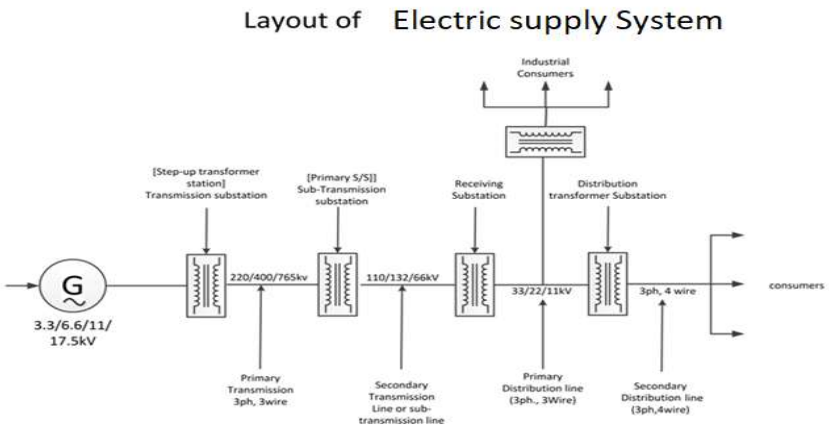
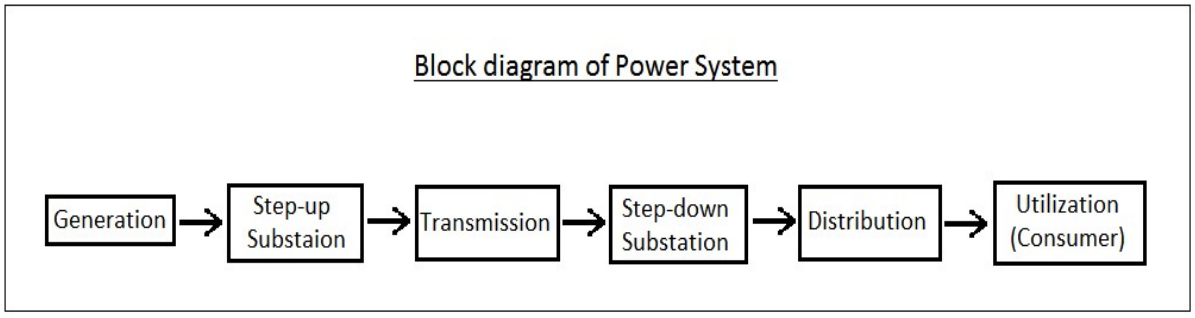
Ans: **Working Principle of Transformer: - ---------- (2 Marks)**

- The primary winding is connected to AC supply current starts flowing through primary winding.
- The primary current produces an alternating flux in the core.

	➢ These flux gets linked with the secondary winding through the core ➢ The alternating flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction.
g)	**Write four applications of servomotor.**
Ans:	**Applications of servo motor :** **(Two application expected: 1 Mark each, Total 2 Mark)** 1. Robotics 2. Conveyor Belts 3. Camera Auto Focus 4. Robotic Vehicle 5. Solar Tracking System 6. Metal Cutting & Metal Forming Machines 7. Antenna Positioning 8. Wood working/CNC 9. Textiles 10. Printing Presses/Printers 11. Automatic Door Openers
h)	**Draw the symbols of following : i) Fuse ii) Earthing.**
Ans:	**i) Fuse :** **ii) Earthing.** **(Each Symbol: 1 Mark)**  
i)	**State the function of any two safety tools used in electrical workshop.**
Ans:	**(Following or equivalent safety tools Any Two expected: 1 Mark each, Total 2 Marks)** 1. **Circuit Testers:** You need to have a voltage tester of some type for electrical work, and one that you trust is working properly

	2. **Electrical Tape:** Every electrical tool kit should have at least a roll of black electrical tape, and having a few colours like red and blue helps as well for identifying wires, etc. 3. **Duct Tape:** Every tool kit, electrical or otherwise, must have the universal repair tool that is a roll of duct tape! 4. **First aid box (Bandages):** No matter how careful you are, accidents happen. Have a first aid kit handy, just in case! 5. **Flashlight/Headlamp:** For when you need some extra light for dark places, or when the power is off while working on existing systems. **6. Insulated plier :** Diagonal cutting pliers sometimes called side snips or dikes, are used to cut wire. 7. **Insulated Matting:** for use in front of electrical panel, at switchboards and transformers and in other high voltage areas 8. **Insulated Gloves/** gloves, clothes and shoes: Linesman Leather Over gloves, to protect from shock 9. **Fire Extinguishers:-**To extinguished fire **10. Smoke Alarms:-** Some types of fire safety equipment are designed for detection. 11. **Wooden ladder:-** working with high level
j)	**State any four advantages of three phase induction motor.**
Ans:	**Advantages of three phase induction motor:** **(Following or equivalent Any Two Advantages are expected: 1 Mark each, Total 2 Marks)** 1. The most important advantage of an induction motor is that its construction is quite simple in nature.

	2. The working of the motor is independent of the environmental condition. This is because the induction motor is Robust and mechanically strong. 3. Induction motor cost of the motor is quite low. 4. Due to the absence of Brushes, there are no sparks in the motor. It can also be operated in hazardous conditions. 5. 3 phase induction motor has a high starting torque, good speed regulation and reasonable overload capacity. 6. An induction motor is a highly efficient machine with full load efficiency varying from 85 to 97 percent.
k)	**Classify single phase induction motors.**
Ans:	**Types of single phase induction motors:** **(Any Two Types expected: 1 Mark each)** 1. Split phase induction motor**.** 2. Capacitor start **inductor** motor**.** 3. Capacitor start **capacitor** run **induction motor.** 4. Permanent split capacitor motor. 5. Shaded pole induction motor**.**
l)	**What are the factors to be considered while selection of motors for different drives?**
Ans:	**(Following or equivalent Any Two factor are expected: 1 Mark each factor)** Following Factors 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.
Q.2	**Attempt any Four of the following :** **16 Marks**
a)	**Draw the single line diagram of electrical power supply system and show its different stages.**
Ans:	**Single line diagram of an Electric supply system:** **(4 Marks)**  **OR Equivalent Figure** **OR** 
b)	**Define the terms related to a.c. supply with waveform :** **i) Instantaneous value ii) Time period iii) Amplitude iv) Phase difference.**
Ans:	**i) Instantaneous value:** **(1 Mark)** The instantaneous value is "the value of an alternating quantity (it may ac voltage or ac current or ac power) at a particular instant of time in the cycle". **OR** The value of alternating quantity (emf, voltage or current) at any particular instant is called the instantaneous value.

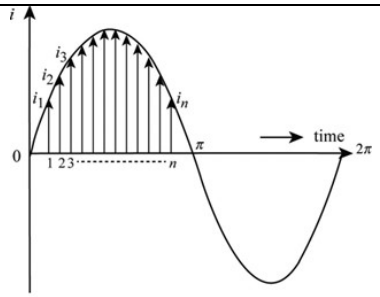
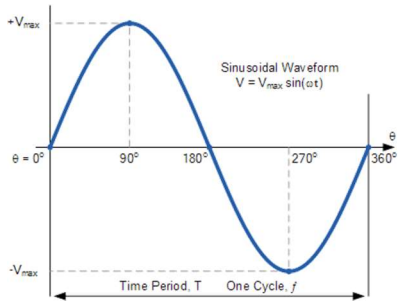


Figure 1 **or equivalent figure**

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

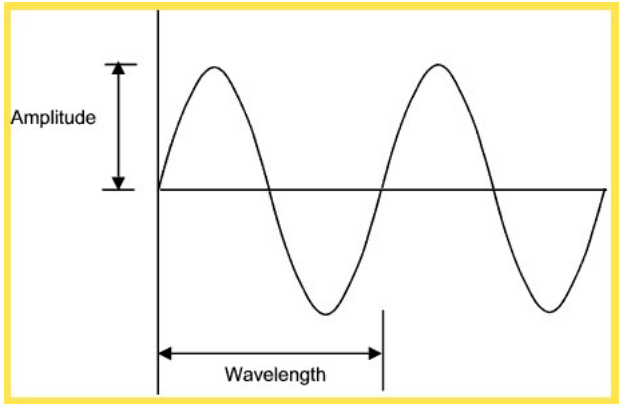
The time (in sec) required by an alternating quantity to complete its one cycle is known as time period.



or equivalent figure

iii) Amplitude: **(1 Marks)**

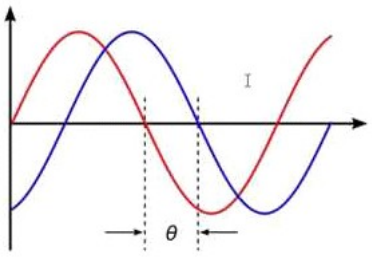
It is defined as the maximum or peak value attained by an alternating quantity during its positive or negative half cycle.



or equivalent figure

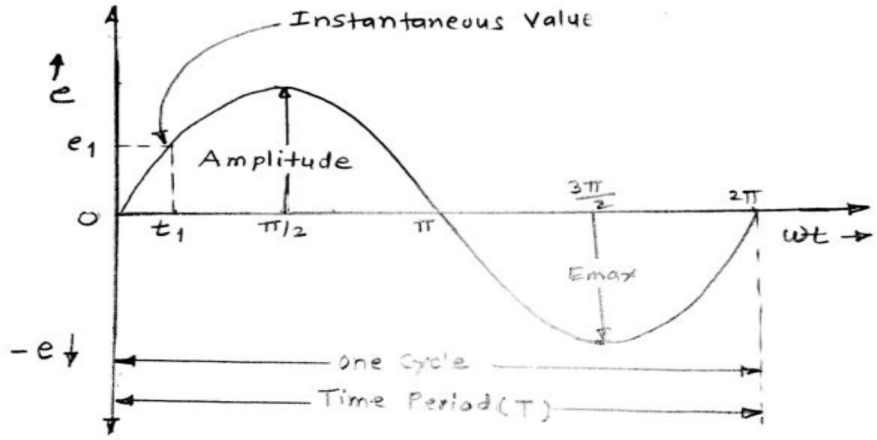
iv) Phase difference: **(1 Marks)**

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



or equivalent figure

OR only one wave form showing i) Instantaneous value ii) Time period iii) Amplitude



or equivalent figure

c) **A capacitor having a capacitance of 20 microfarad is connected in series with a non-inductive resistance of 120 ohm across 100V, 50 Hz supply. Calculate i) Current ii) Impedance iii) Phase difference iv) Power.**

Ans: Given Data;

i) To Find Impedance =

$$X_C = \frac{1}{2\pi FC}$$

$$X_C = \frac{1}{2\pi \times 50 \times 20 \times 10^{-6}}$$

$$X_C = 159.15\,\Omega$$

$$\therefore \quad Z = \sqrt{R^2 + X_C{}^2}$$

$$\therefore \quad Z = \sqrt{(120)^2 + (159.15)^2}$$

$$Z = 199.32\,\Omega$$

OR

$Z = 120 - j\,159.15\ \Omega$

$Z = 199.32 \angle -52.98\ \Omega$

---------- **(1 Mark)**

ii) To Find Current:

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

$$I = \frac{100 \angle 0}{199.32 \angle -52.98}$$

$I = 0.50 \angle 52.98^0\ \ Amp$

---------- **(1 Mark)**

iii) Phase difference :

Current leads voltage by 52.98^0

Phase difference = 52.98^0

---------- **(1 Mark)**

iv) Power =

$P = V\ I\ Cos\phi$

$P = 100 \times 0.5 \times Cos\ 52.98$

$P = 31.10\ \ watt$

---------- **(1 Mark)**

OR

$\varphi = V\ I \sin\phi$

$\varphi = 100 \times 0.5 \times \sin(52.98)$

$\varphi = 39.92\ \ VAR$

---------- **(1 Mark)**

OR

$S = V\ I$

$S = 100 \times 0.5$

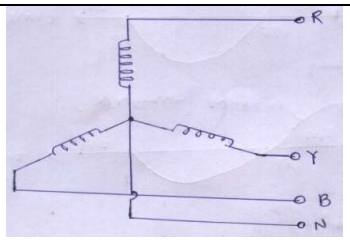
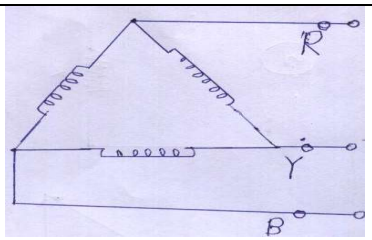
$S = 50\ \ VA$

---------- **(1 Mark)**

d) Compare star connected load with delta connected load.

Ans:

(Each Point : 1 Mark)

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

e) A balanced star connected load is supplied from 400 V, 3-ph 50 Hz supply, the resistance per phase is 20Ω. Calculate : i) line voltage ii) phase voltage iii) line current iv) power consumed.

Ans:

i) Line Voltage : $V_L = 400$ Volt ---------- **(1 Mark)**

ii) Phase Voltage =

$$\therefore V_L = \sqrt{3}\, V_{ph}$$

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

$$\therefore V_{ph} = 230.94 \ volt$$ ---------- **(1 Mark)**

ii) Line Current =

$$\therefore I_{ph} = \frac{V_{ph}}{R_{ph}}$$

$$\therefore I_{ph} = \frac{230.94}{20}$$

$$\therefore I_{ph} = 11.54 \ Amp$$ ---------- **(1/2 Mark)**

In Star Connection : $\therefore I_L = I_{ph}$

$$\therefore I_L = 11.54 \ Amp$$ ---------- **(1/2 Mark)**

Power Consumed P :

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

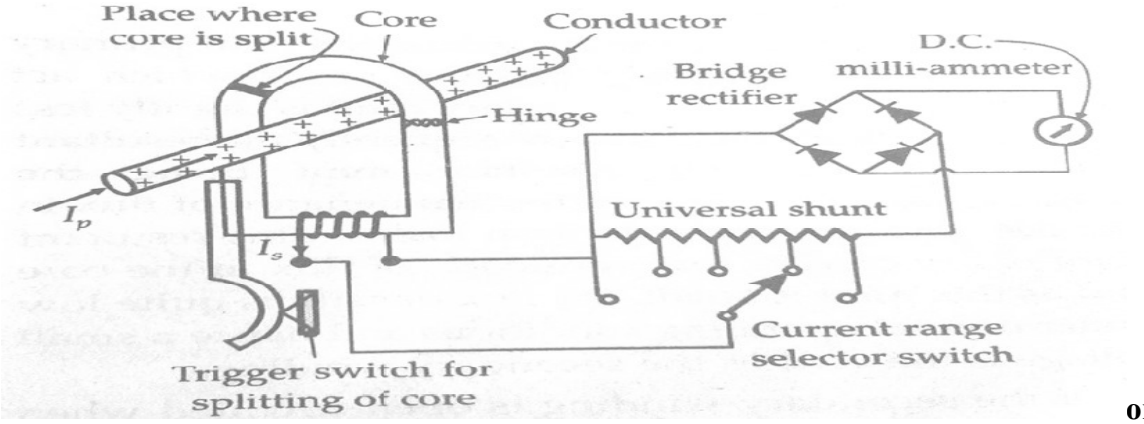
$\therefore P = \sqrt{3} \times 400 \times 11.54 \times 1$

$\boldsymbol{P = 7995.14\ Watt}$------- ---------- **(1/2 Mark)**

f) Draw the construction diagram of clip on meter and state its principle.

Ans: **Construction diagram of clip on meter:**

(Diagram: 2 Marks & Principle : 2 Marks, Total 4 Marks)



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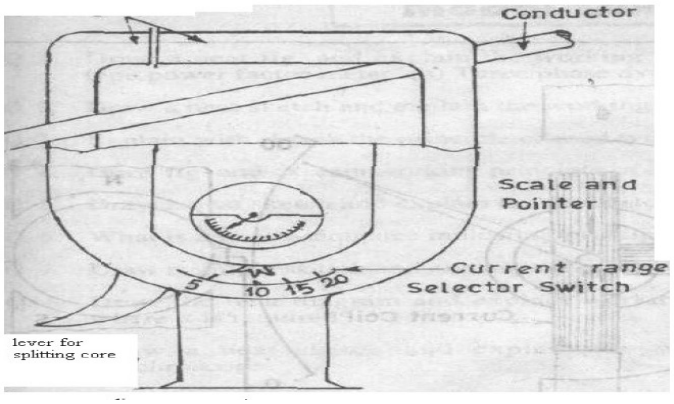


or equivalent figure

Parts Of Clamp Meter

A Clamp on meter works on the principle of Faradays laws of electromagnetic induction. When their primary conductor is connected to a.c. supply, a current flows through it. This current flowing through the primary conductor produces an alternating magenetic flux .This flux links with secondary winding through the magenetic core & induces an emf in it according to the faraday's laws of electromagnetic induction.

Q.3	**Attempt any Four of the following : 16 Marks**
a)	**State the function of following parts of DC motor : i) Yoke ii) Poles iii) Field winding iv) Commutator.**

Ans: **Function :** **(Each Parts of Function: 1 Mark, Total 4 Marks)**

i) Yoke: The yoke serves the following two purposes.

i) It supports the other components such as poles and provides mechanical protection for whole machine.

ii) It forms a part of the magnetic circuit & provides the path of low reluctance for the magnetic flux.

ii) Pole:

The pole shoe serves two purposes

i) They spread out flux in the air gap & their large cross section reduces the reluctance of the magnetic path

ii) They support the exciting coils or field coils.

iii) Field winding:

For excitation of poles

iv) Commutator:

The function of the commutator is to reverse the current in each conductor of the armature as it passes from one pole to another and thus to help the motor to develop a continuous and unidirectional torque

b) Explain efficiency of transformer. What is full load and half load efficiency ?

Ans: **Efficiency of Transformer :-** **(2 Mark)**

It is the ratio of output power to the input power of the transformer.

OR

$$Transfomer \quad Efficency = \frac{Output \ power}{Input \ power} \times 100$$

OR

$$\% \ \eta \text{ at any load} = \frac{n \times (VA \ rating) \times \cos\phi}{n \times (VA \ rating) \times \cos\phi + W_o + n^2 W_{sc}} \times 100$$

Full load efficiency:- **(1 Mark)**

$$Transfomer \quad Efficency = \frac{KVA \times PF}{KVA \times PF + \ Copper \ losses \ at \ FL + Iron \ losses} \times 100$$

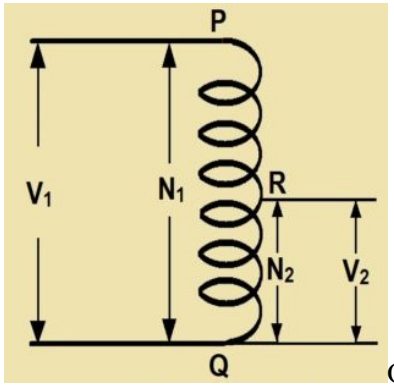
Half load efficiency: **(1 Mark)**

Copper losses are variable losses and iron losses are constant losses.

$$Transfomer \quad Efficency = \frac{1/2 \ \ KVA \times PF}{1/2 \ \ KVA \times PF + (1/2)^2 \times Copper \ losses \ at \ FL + Iron \ losses} \times 100$$

c) Explain construction and working of auto transformer.

Ans: **Diagram:** **(Figure: 2 Mark & Working: 2 Mark)**



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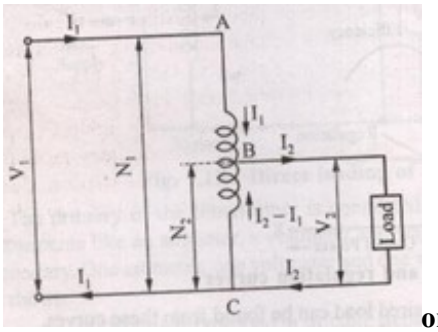


or equivalent figure

working & Construction of principle:-

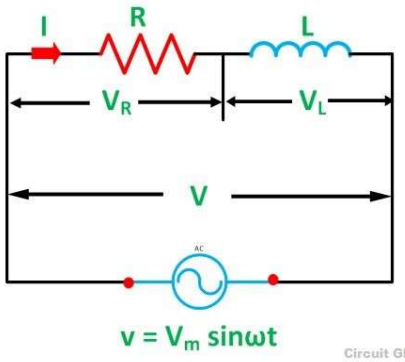
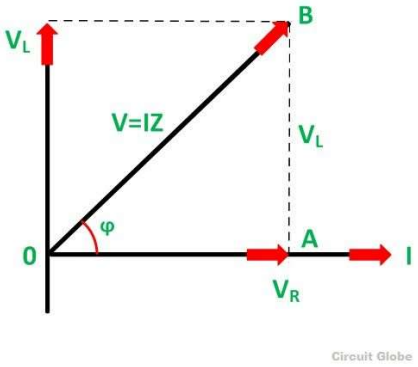
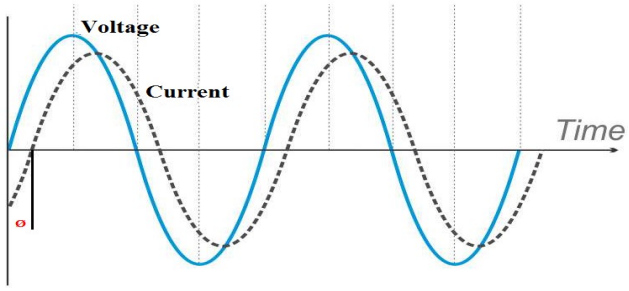
Principle of operation of the transformer is the same as the one of the common transformer, then the relation between input and output voltages and input and output currents and the ratio of number of turns between the primary and the secondary winding is the same.

The currents of the primary and secondary windings are flowing on the opposite directions, so the total current flowing through the common part of the winding is equal to the difference between the current on the low-voltage winding and the current on the high-voltage winding. In order for an autotransformer to work properly, the two windings should have the same winding sense.

d) Compare AC and DC supply (four points)

Ans: **(Any Four Point Expected: 1 Mark each, Total 4 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	Cause of the direction of flow of electrons	Rotating magnet along the wire.	Steady magnetism along the wire.
3	Frequency	The frequency of alternating current is 50Hz or 60Hz depending upon the country.	The frequency of direct current is zero.
4	Direction	It reverses its direction while flowing in a circuit.	It flows in one direction in the circuit.
5	Current	It is the current of magnitude varying with time	It is the current of constant magnitude.
6	Flow of Electrons	Electrons keep switching directions - forward and backward.	Electrons move steadily in one direction or 'forward'.
7	Obtained from	A.C Generator and mains.	Cell or Battery.
8	Passive Parameters	Impedance.	Resistance only
10	Types	Sinusoidal, Trapezoidal, Triangular, Square.	Pure and pulsating.

e)	**Draw circuit diagram, waveform, phasor diagram and comment on the phase relationship between voltage and current in RL series circuit.**
Ans:	**(Diagram: 1 Mark, Phasor Diagram: 1 Mark, Waveform: 1 Mark , Equation : 1 Mark)** **1) Circuit diagram of RL circuit** **2) Phasor diagram of RL series circuit**   **or equivalent diagram** **3) Waveforms**  **or equivalent diagram** 1. Equation for voltage V= V_m sin ωt 2. Equation for current I = I_m sin (ωt- φ) **4) Phase relationship:** Current lags voltage by angle Ø, the phase angle for a series RL circuit is between 0° to 90°
f)	**A single phase, 50 Hz, 230/115 volts draw a primary current of 4 amperes at full load. Find i) KVA rating of transformer ii) Secondary full load current.**
Ans:	$V_1 = 230\,V$ $V_2 = 115\,V$ $N_1 = ?$ $I_1 = 4$ $I_2 = ?$ **i) To Find KVA rating of Transformer:-** $I_1 = \frac{KVA \times 10^3}{V_1\ volt}$ ---------- **(1 Mark)**

$KVA = I_1 \times V_1$

$KVA = 0.92\ KVA$ ---------- **(1 Mark)**

ii) To Find Secondary full load Current I_2:

$$I_2 = \frac{KVA \times 10^3}{V_2\ volt} \quad \text{..... (1 Mark)}$$

$$I_2 = \frac{0.92 \times 10^3}{115}$$

$I_2 = 8\ \ Amp$ ---------- **(1 Mark)**

Q.4	**Attempt any Four of the following :**	**16 Marks**
a)	**Derive the emf equation of transformer.**	

Ans:

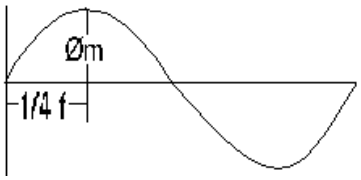
➢ **EMF equation of single phase Transformer:-** **(04 Marks)**

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

➢ $\frac{\phi m}{1/4f} = 4\ f\phi m$ (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.

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

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

$E_1 = 4.44\ f\ \phi_m N_1$

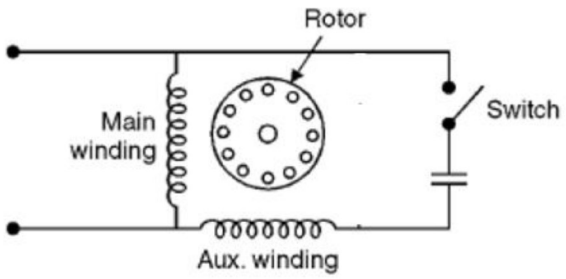
$E_1 = 4.44\ f\ B_m A N_1$

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

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

b) Explain the working of a single phase capacitor start induction motor.

Ans: **Single phase capacitor start induction motor:** **(Figure: 2 Mark & Explanation : 2 Mark)**



or Equivalent Figure

working principle of capacitor start single phase induction motor:

- In this motor, auxiliary winding is in series with a capacitor and remains in the circuit only during starting.
- Due to capacitor, the phase difference of approximately 90^0 is obtained between main and auxiliary winding currents which results in production of rotating magnetic field.
- This rotating magnetic field is cut by stationary rotor conductors; emf is induced in it, so according to faradays law of electromagnetic induction motor starts rotating.
- After attaining 75-80% of rated speed, centrifugal switch in series with auxiliary winding get opened and auxiliary winding gets disconnected.
- The motor then continues to run without capacitor & only with main winding in the circuit.

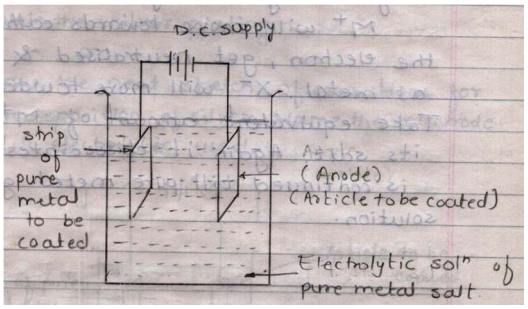
c) Compare variable reluctance and permanent magnet motors.

Ans: **(Following or equivalent Any Four Point Expected: 1 Mark each, Total 4 Marks)**

S.No.	Variable reluctance Motor	Permanent magnet motors
1	The rotor is not magnetised	The rotor is magnetised
2	High torque to inertia ratio	Low torque to inertia ratio
3	High rates of acceleration	Low rates of acceleration
4	The dynamic response is fast	Very low dynamic response
5	Maximum stepping rate can be as high as 1200 pulses per second	Maximum stepping rate can be as low as 300 pulses per second
6	If can be manufactured for large number of poles	If can be manufactured for large number of poles due to difficulties in construction.
7	Very small step angle is possible	The step angles are high in the range of 30^0 to 90^0
8	It does not have a detent torque	It main advantage is the presence of a detent torque
9	The rotor has salient pole construction	The rotor has mostly smooth cylindrical type of construction.

d) With the help of neat diagram. explain the concept and principle used in 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.

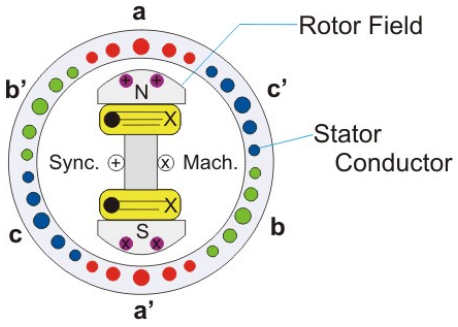
The solution used for electrolysis due to which electroplating is to be carried out is known as electrolyte or salt solution. In such a solution each molecule of the substance dissolved is negatively charged.

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) Explain the construction of alternator with neat diagram.

Ans: **Diagram:** **(2 Marks)**



or equivalent figure

Construction of three phase alternator: **(2 Marks)**

Construction wise, an alternator generally consists of field poles placed on the rotating fixture of the machine i.e. rotor as shown in the figure above. In most practical construction of alternator, it is installed with a stationary armature winding. There are mainly two types of rotor used in construction of alternator,

1. Salient pole type.
2. Cylindrical rotor type.

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

Ans: Given data:

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

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

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

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

$N_S = 1000\ rpm$

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

$$N = N_S\,(1-S)$$
$$N = 1000\,(1-0.04)$$
$$N = 960\ \ rpm$$

Q.5	**Attempt any Four of the following :** **16 Marks**
a)	**State the starters used in case of 3 phase induction motor and explain any one of them.**

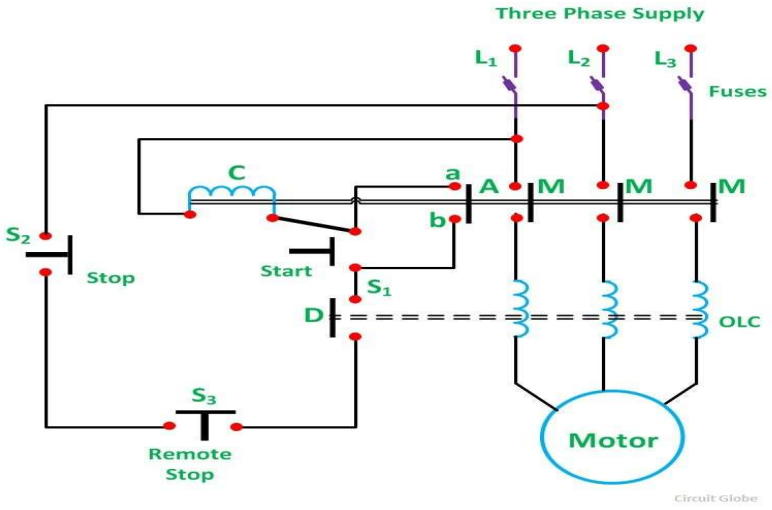
Ans: **Starters used in 3 -ph I.M:-** ---------- **(2 Marks)**

1. Direct ON-Line Starter (DOL)
2. Star Delta Starter
3. Soft Starter
4. Auto Transformer

Explanation:- **(Any one method explanation 2 marks)**

1. Direct ON-Line Starter (DOL)

The motor is connected through a starter across the full supply voltage. The Direct On Line Starter Method figure is shown below. It consists a coil operated contactor C controlled by start and stop push button as shown in the connection diagram below.



or equivalent figure

The start button is held open by a spring. On pressing the START pushbutton S1, the contactor C is energized from two line conductors L1 and L2.

The three main contacts M and the auxiliary contact A are closed. The terminals a and b

are short-circuited. The motor is then connected to the supply mains. The S1 button moves back under the spring action as soon as the pressure is released. The coil C remains energized through ab.

Thus, the main contact M remains closed, and the motor continues to get supplies. Therefore, contact A is known as Hold-On-Contact. The stop button S2 is normally held closed by the spring. If the S2 button is pressed to STOP the motor, the supply through the contactor coil C is disconnected. As the coil C is de-energized, the main contacts M and the auxiliary contact A are opened. The supply to the motor is disconnected, and the motor is stopped.

2. **Star -Delta starters.**

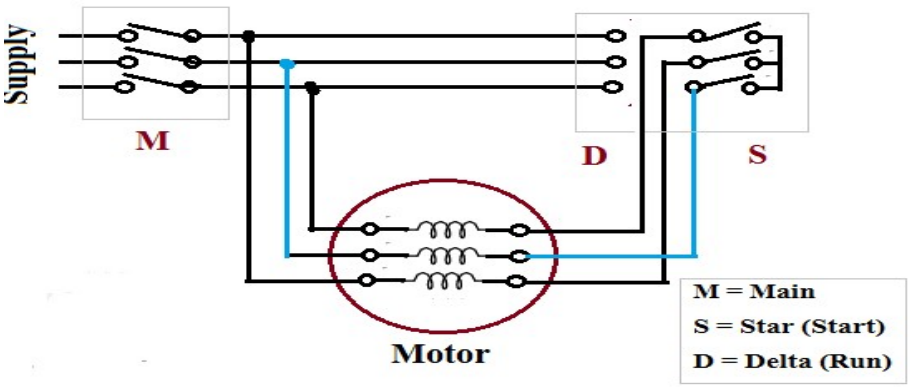
- At Starting, the stator winding is connected in star connection.

At the time of starting in star connection, $Iph = \frac{Vph}{Z_{SC}}$ and $Vph = \frac{V_L}{\sqrt{3}}$

Therefore starting current controlled to a safe value.

- After the motor has reaches nearly steady state speed, the change over switch is thrown to connect motor in delta

Diagram of Star -Delta starters:

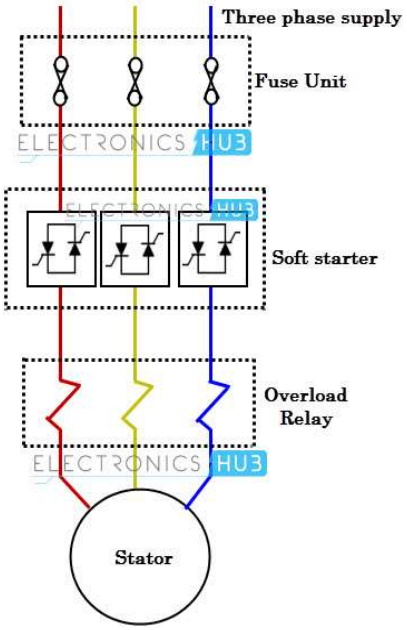


or equivalent figure

3. **Soft Starter**

In this method, semiconductor power switches are employed for reducing the starting current to the induction motor. It is another type of reduced voltage starter and it connected in series with the line voltage applied to the motor. The schematic diagram of soft starter is shown in

figure below.



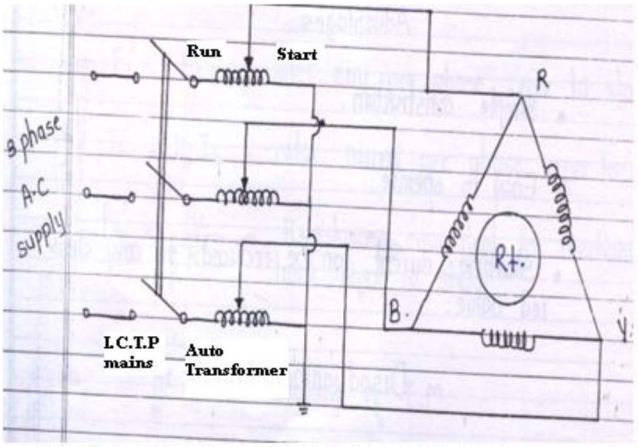
or equivalent figure

This starter consists of back to back thyristors or TRIACs in each phase of the stator winding. By controlling the firing angle to these thyristors, the voltage applied to the motor will be reduced steplessly. This type of voltage reduction gives a smoother operation as compared to other methods.

This results the absence of torque pulsations and hence there no jerking when starting of the motor. Once the motor gets the normal speed, the firing angle to the thyristors is applied such that they allow full voltage to the motor.

4. Auto Transformer

Diagram for Autotransformer starter :



OR

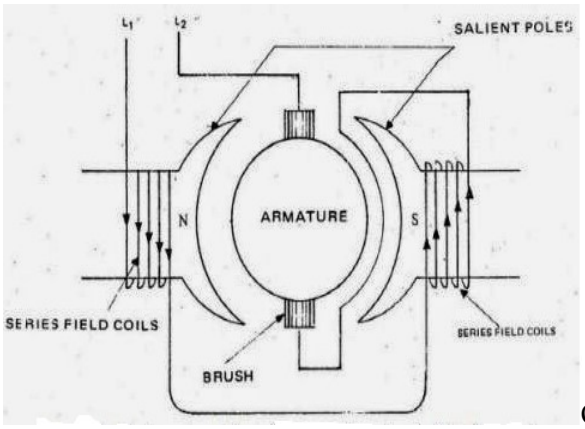
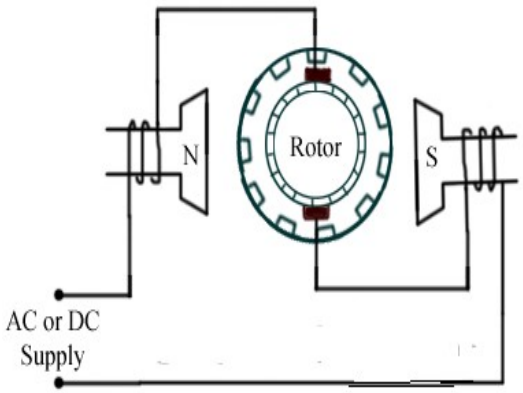
Construction and working of a auto-transformer starter used for starting 3-phase induction motor :

- The **autotransformer** reduced-voltage **starter** places the motor on the secondary of the **autotransformer** while starting. The taps on the **autotransformer** limit the voltage applied to the motor to 50%, 65% or 80% of the nominal voltage. The difference between line and motor current is due to the **transformer** in the circuit.
- It is provided with a number of tappings. The starter is connected to one particular tapping to obtain the most suitable starting voltage. A double throw switch S is used to connect the auto transformer in the circuit for starting. When the **handle H** of the switch S in the **START** position. The primary of the auto transformer is connected to the supply line, and the motor is connected to the secondary of the auto transformer.
- When the motor picks up the speed of about 80 percent of its rated value, the handle H is quickly moved to the **RUN** position. Thus, the auto transformer is disconnected from the circuit, and the motor is directly connected to the line and achieve its full rated voltage. The handle is held in the **RUN** position by the under voltage relay.
- If the supply voltage fails or falls below a certain value, the handle is released and returns to the **OFF** position. Thermal overload relays provide the overload protection.

b) Compare squirrel cage and slip ring rotor on the basis of : i) Rotor construction ii) Starting torque iii) Efficiency iv) Applications.

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

S.No	Point of Basis	Squirrel cage I.M	Slip ring I.M
i	Rotor construction	Rotor is permanently short circuited	Rotor is not permanently short circuited
ii	Starting torque	Starting torque is of fixed	Starting torque can be adjust
iii	Efficiency	High efficiency	Low efficiency
iv	Applications	For driving somehow constant load eg. Lathe Machine, Workshop Machine and water pump	For driving heavy load where high starting torque is required eg. Lift, Crane, Elevators, conveyor belts etc

c)	**State the meaning of electric drive. Give classification of electric drive.**
Ans:	**Electric Drive:** **(2 Marks)** It is a machine which gives mechanical power. e.g. drives employing electric motors are known as electric drives. **Classification of Electric Drives:-** **(2 Marks)** 1. Group Drive 2. Individual Drive 3. Multimotor Drive
d)	**Explain in brief the working of universal motor and state its application.**
Ans:	**Figure of Universal motor:** **(Figure : 1 Marks & Explanation : 2 Marks & Application: 1 Marks, Total 4 marks)**  OR  **OR Equivalent figure** **Working of universal motor:** **(Following or equivalent working is to be accepted)** ➢ A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due to this mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule.

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

i) Application of Universal Motor : **(Any Two application expected : 1 Mark)**

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

e) Enlist any four advantages of induction heating.

Ans: **(Following or equivalent Any Four point expected: 1 Mark each, Total: 4 Marks)**

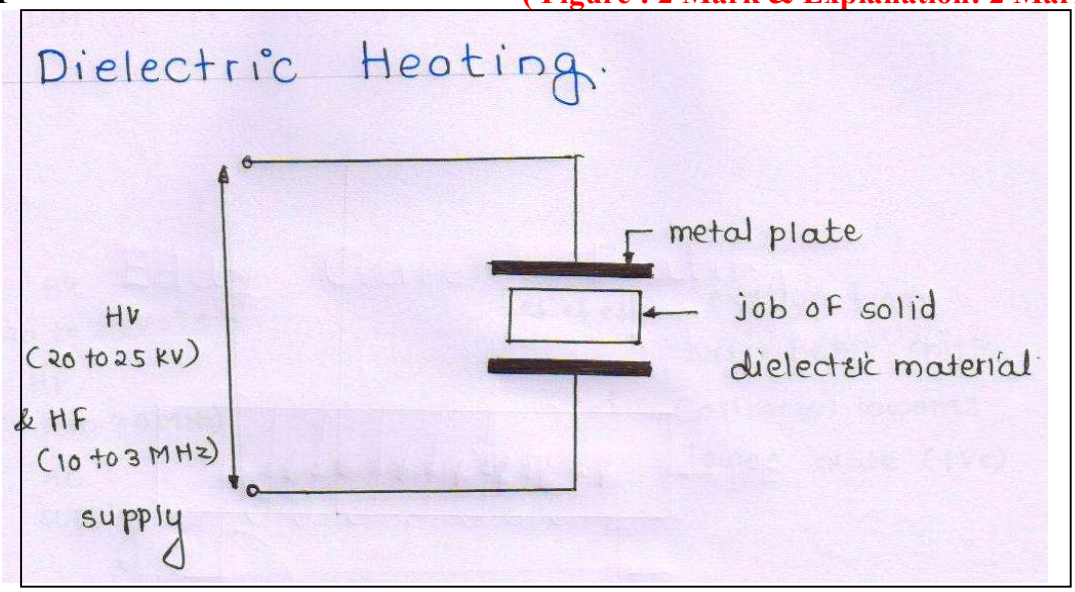
Advantages of Induction heating:

1. Quick heating: Higher heating rates than the convection and radiation processes.
2. Fast start-up: Allows much quicker start-up.
3. Energy savings: when not in use the induction power supply can be turned off because of quick restarting. (Avoid long start-ups)
4. High production rates: As heating time is less induction heating increases production and reduces labor costs.

5. Ease of automation and control
6. It required less floor space
7. Quick, safe and clean working conditions
8. Less maintenance

f) Explain dielectric heating with suitable diagram.

Ans: **Figure: 1** **(Figure : 2 Mark & Explanation: 2 Marks)**



Principle of Dielectric heating:

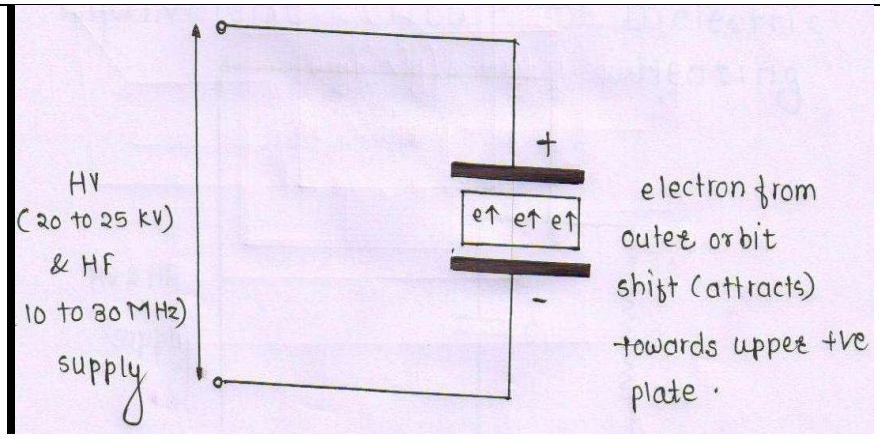
For heating non-metallic material (dielectric material) for e.g. Glass, plastic, wood, etc. dielectric heating is used.

Material to be heated is placed between two metallic plates as shown in figure (1) across which a high voltage (20 to 25 KV) and high frequency (10 to 30 MHz) AC supply is given.

Material is heated due to dielectric loss taking place inside the job.

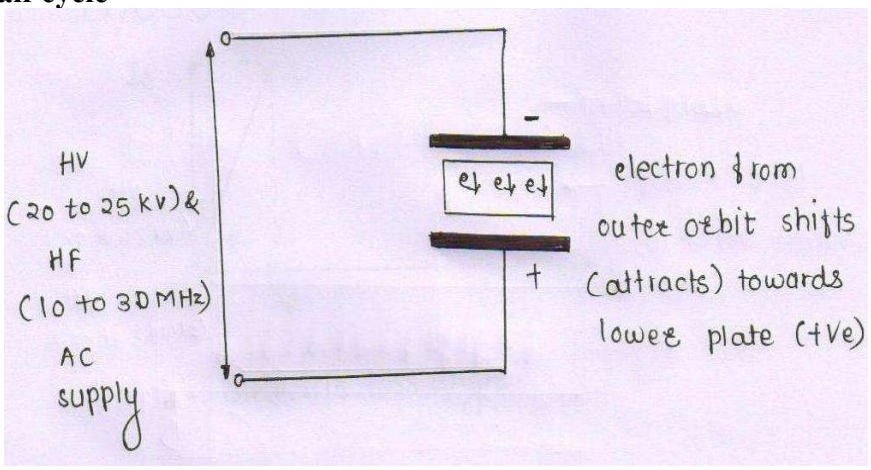
Operation :-

1.During (+) ve half cycle



Material to be heated is placed between two metallic plates, if upper plate is **+ Ve**, most of electrons from its outer orbit (of job) gets attracted towards **+ Ve** plate.

2. During (-) ve half cycle



During **- Ve** half cycle field is reversed i.e. bottom plate becomes **+ Ve**. At that time most of electrons from its outer orbit gets attracted towards bottom electrode.

Effect:-

Due to inter atomic friction caused by repeated (due to frequency) deformation and rotation of atomic structure, Dielectric loss takes place inside the job which produces heat.

Q.6	**Attempt any Four of the following :**	**16 Marks**
a)	**Enlist any four types of enclosures with their applications.**	
Ans:	**Types of enclosures & their Applications:**	

(Any Four Expected: 1 Mark each, Total 4 Marks)

i) Open type enclosure:-

It is used where motor is installed in clean atmosphere and in closed room.

ii) Screen Protected enclosure:-(*Guarded enclosure:***)**

Here screen is provided for rotating parts for better protection. It is also used where motor is installed in clean atmosphere and in closed room.

iii) Drip proof (moisture) enclosure:-(*Weather-protected type 1 enclosure, Weather-protected type 2 enclosure, Waterproof enclosure,)*

This type of enclosure is used in very damp atmospheric condition such as water pumping station motor on ship sub-merssible motors, etc.

iv) Flame (Fire) proof enclosure:- (*Splash-proof enclosure, Dust-ignition-proof enclosure***)**

It is used where motors are installed in explosive atmosphere like chemical plants, mines etc.

v) Totally enclosed type enclosure:-

It is used where there is dusty atmosphere such as saw mill, stone crushing plant, coal handling plant, cement manufacturing plant, cotton industry etc.

As it is totally enclosed it requires special cooling arrangement.

vi) Pipe ventilated totally enclosed type enclosure:

It is used where there is dusty atmosphere such as saw mill, stone crushing plant, coal handling plant, cement manufacturing plant, cotton industry etc.

As it is totally enclosed it requires pipe ventilation, clean and cold air is circulated through pipe forcefully for cooling of motors and hot air is taken out through pipe.

b) Write short notes on fire extinguishing methods adopted in electrical engineering.

Ans: Following are the fire extinguishing methods adopted in electrical engineering:- **(2 Marks)**

1. Dry Powder fire extinguishers
2. Carbon Dioxide (CO_2) fire extinguishers

Short Note:- ---------- **(2 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

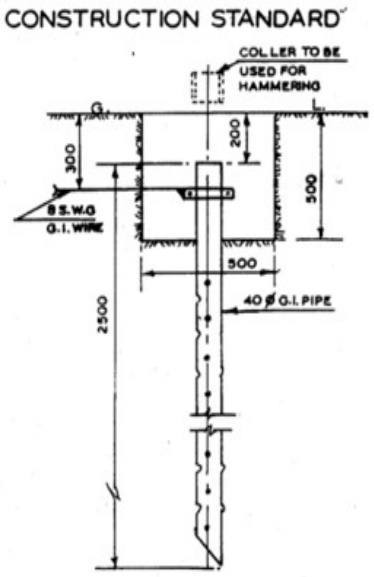
c)	**Why earthing is essential in electrical installation '? Explain any one type of earthing.**
Ans:	**Following reasons earthing is essential in electrical installation :**

(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)**



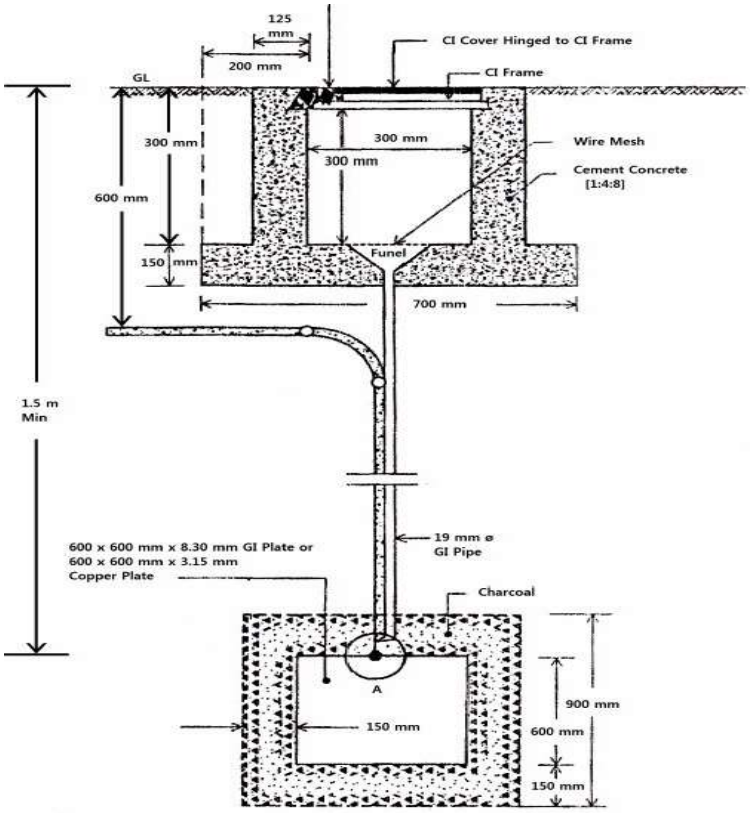
or equivalent figure

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:

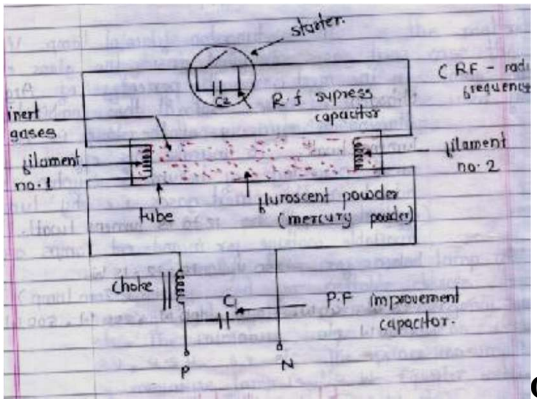
- Excavation on earth for a normal earth Pit size is 1.5M X 1.5M X 3.0 M.
- **Specifications:** Generally for plate type earthing normal Practice is to use GI earthing plate of size mentioned below as per requirement.

- 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.

d) Draw the wiring diagram of fluorescent tube. Explain the working of choke and starter.

Ans: **Fluorescent lamp:-** **(Diagram: 2 Marks & Explanation: 2 marks)**



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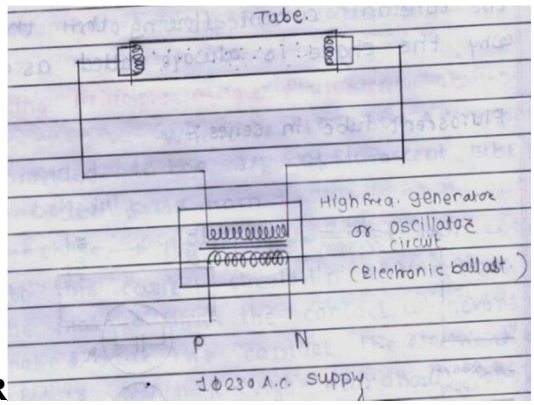


Operation:-

When switch is ON current flows through the choke-filament no1- starter-filament no. 2- to neutral, At that time choke induces high voltage which is applied to two filaments and ionized gas, Due to this there will be high voltage ionization so that light will be emitted through the tube. Choke is acting as ballast starter is used for make and break the circuit. To operate the fluorescent lamp, need a ballast (choke) to limit the current & provide the necessary starting voltage and starter for starting the tube.

OR

i) Choke: For providing high voltage at the time of starting.

ii) Starter: To make and break the circuit to start the tube.

e)	**Describe with a neat diagram, the process of any one type of electric welding.**

Ans:

Type Of welding:-

i) Resistance Welding:-(Plastic / Non- Fusion / Pressure Welding)

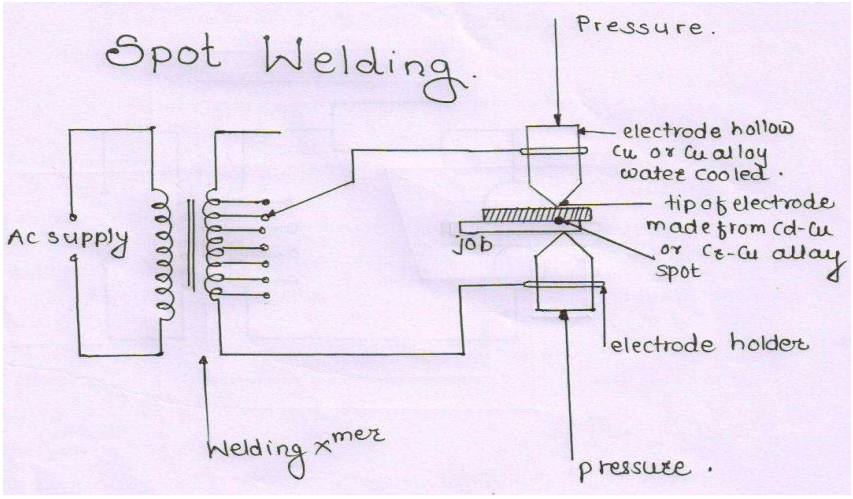
1) Spot welding
2) Seam welding
3) Projection Welding
4) Butt Welding
5) Flash Butt welding

ii) Arc welding (Fusion/Non pressure welding):-

1) Carbon Arc Welding
2) Metal Arc Welding

Explanation : (Any One Explanation expected : Digram:2 Mark & Explanation: 2 Marks)

i) Spot Welding:



or equivalent figure

Explanation

Spot welding means the joining of two metal sheets at suitable spaced interval.

It consists of:

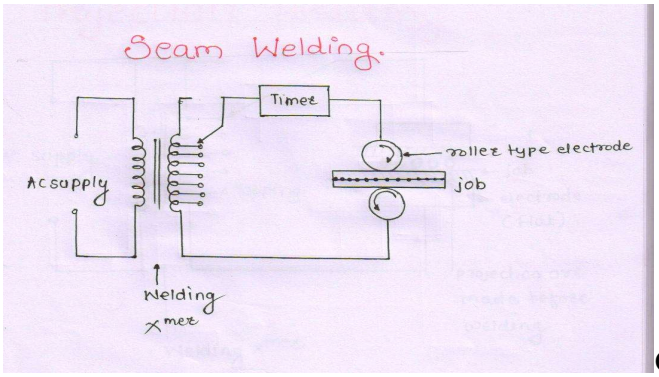
- Transformer used for spot welding is designed for low voltage and high current secondary.
- Transformer is oil cooled and portable
- There are two electrodes one is fixed and other is movable
- The electrodes are hollow and water cooled.

- Electrodes are made from copper or copper alloys and tips of electrodes are made from Cd-Cu or Cr-Cu.

Working:

- As shown in fig. Job to be welded is placed one over the other between two electrodes under pressure
- Sufficiently heavy current at low voltage is passed directly through two metals in contact to be welded.
- Heat is produced due to I^2R losses where 'R' is the contact resistance.
- This heat is utilized to obtain welding temperature (to become a plastic state)
- When welding temperature is reached supply is cut down and external pressure is applied simultaneously across the job to complete weld.
- Magnitude of current varies from 1000A to 10000A.and the voltage between electrodes is usually less than 2V.
- The period of flow of current and magnitude of current depends upon thickness of sheet (job) to be welded.

ii) Seam Welding:



OR

or equivalent figure

Explanation:

Seam welding is nothing but series of continuous spot welding

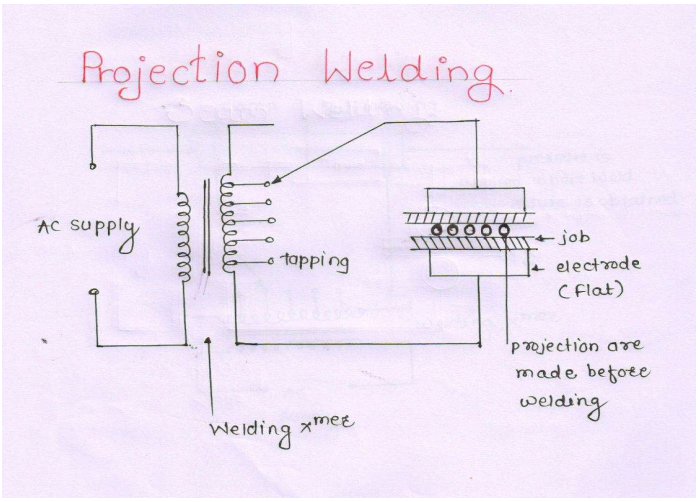
It consists of:

- Transformer used for seam welding is designed for low voltage and high current secondary.
- Transformer is oil cooled
- There are two electrodes, in this type beam or roller type electrodes are used.

Working:

- Job is kept in between two electrodes under pressure. This pressure is kept constant throughout.
- In this type intermittent current is used, it means current is ON for definite time and OFF for another time interval with the help of timer.
- If current is continuously passes then heat produced may cause burning of job.
- Heat is produced due to I^2R losses where 'R' is the contact resistance.
- This heat is utilized to obtain welding temperature (to become a plastic state)
- When welding temperature is reached supply is cut down and external pressure is applied simultaneously across the job to complete weld.

iii) Projection Welding:



or equivalent figure

Explanation:

It is modified form of spot welding, before welding projections are made to job on both or one part to be welded by mechanical means. Hence it is called as a Projection Welding.

It consists of:

- Transformer used for projection welding is designed for low voltage and high current secondary.
- Transformer is oil cooled
- There are two electrodes .In this type flat electrodes are used as shown in figure.
- Therefore it is possible to join several welding points (spots) simultaneously

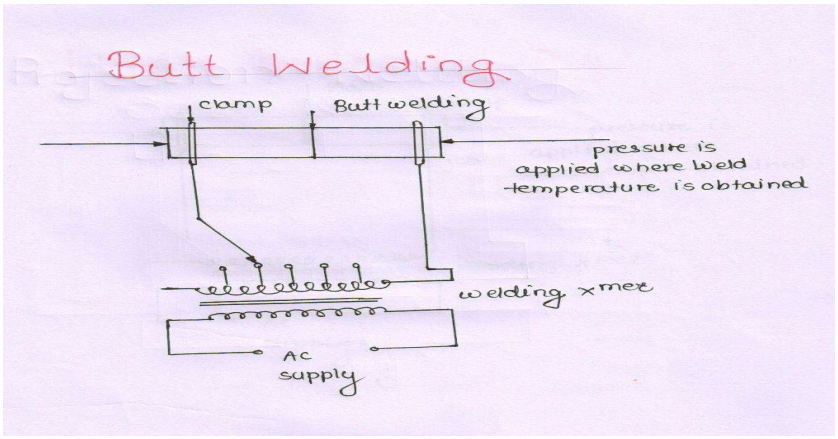
Working:

- Job is kept in between two electrodes under pressure. This pressure is kept constant throughout.
- Sufficiently heavy current at low voltage is passed directly through two metals in contact to

be welded.

- Heat is produced due to I^2R losses where 'R' is the contact resistance.
- This heat is utilized to obtain welding temperature (to become a plastic state)
- When welding temperature is reached supply is cut down and external pressure is applied simultaneously across the job to complete weld

iv) Upset Butt Welding:

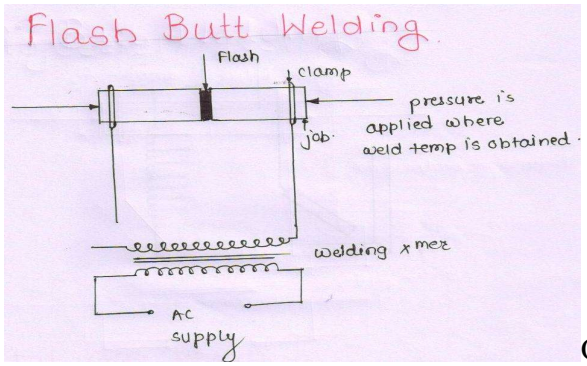


or equivalent figure

Explanation:

- Transformer used for welding is designed for low voltage and high current secondary.
- Transformer is oil cooled
- The job is clamped as shown in fig. two parts which are to be welded are brought together
- Sufficiently heavy current is passed through joints by welding transformer,
- which creates necessary heat at joints due to I^2R
- When welding temperature is reached supply is cut down.
- And external pressure is applied simultaneously across the job to complete weld

v) Flash Butt welding: -



OR **or equivalent figure**

Explanation:

- The job is clamped as shown in fig. two parts which are to be welded are brought near to each other by keeping small air gap,
- When welding transformer is made ON, due to heavy currents flash (arc) is produced between joints.
- This arc will produce heat which will create welding temperature.
- When welding temperature is reached, supply is cut down and at the same time mechanical pressure is applied for final weld.

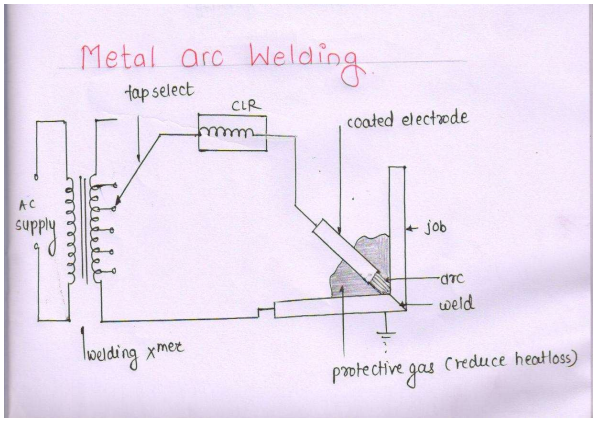
2) Electric Arc Welding:-

i) Metal Arc Welding:

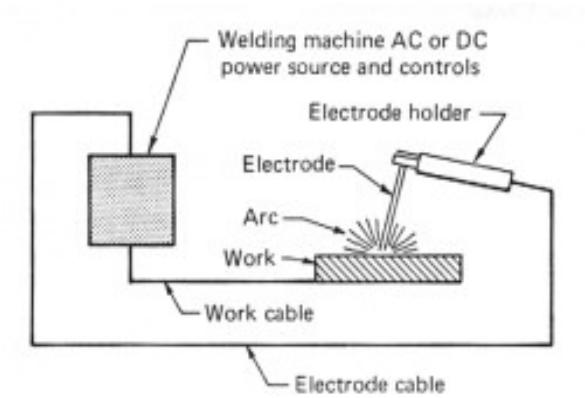
Principle of arc welding:

- The process in which two metal parts to be welded are brought to a molten state and then allowed to solidify is called as arc welding. Melting of metal is obtained due to heat developed by an arc struck between an electrode (Filler material) and metal to be welded (job)

Figure:



OR



or equivalent figure

- Type of supply used:

  Both AC/DC Supplies can be used but generally A.C. Supply is used because it has more advantages.

- Supply Equipment used: Welding Transformer designed for low voltage high current secondary.
- Arc Stability: Series Reactor is used for arc stability.
- Temperature obtain: Less as A.C. supply is used.
- Possibility of arc blow is less.
- Capital Cost: Less since welding transformer is used as a supply equipment.
- Running cost: Less
- Maintenance cost **:**Less
- Stand by losses: Less
- Efficiency: More
- Voltage required: 72 to 100 volt A.C
- Types :Shielded & unshielded welding

Application: For welding Ferrous Metals, Can be used for vertical & overhead welding.

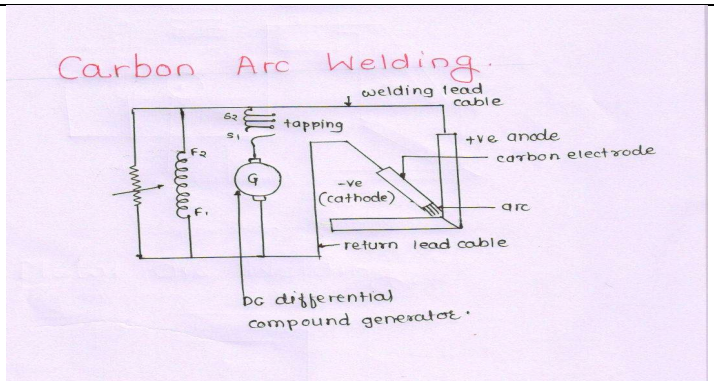
ii) Carbon Arc Welding:

It is explain on following points

Principle of arc welding:

The process in which two metal parts to be welded are brought to a molten state and then allowed to solidify is called as arc welding. Melting of metal is obtained due to heat developed by an arc struck between carbon electrode and metal to be welded (Job) and the additional metal is deposited in the weld from a filler rod.

Figure:



or equivalent figure

- Type of supply used: Only DC supply is used.
- Type of Electrode: Carbon Electrode are used.
- Supply Equipment used: D.C Differential component Generator or Rectifier
- Arc Stability: D.C Differential component. Generator has dropping characteristics.
- Temperature obtain: More
- Possibility of arc blow is more. More
- Capital Cost: More
- Running cost: More
- Maintenance cost: More
- Stand by losses: More
- Efficiency: Less
- Voltage required: 50 to 60 volt D.C
- Types: Flux is used and flux is not used
- Application: For welding non ferrous metals
- Limitation: Not suitable for overhead welding

f) State the function of : i) MCCB ii) ELCB iii) MCB iv) Switch.

Ans: **i) MCCB:** **(1 Mark)**

Molded Case Circuit Breaker (MCCB) is a circuit breaker and trip device assembled in a mould case. Also it can automatically cut off electric power in case of overload and short circuit.

	ii) Function of ELCB: **(1 Mark)** The ELCB detects fault currents from live to the Earth (ground) wire within the installation it protects. **iii) Function of MCB:** **(1 Mark)** Miniature circuit breaker operates automatically at the time of fault or over load. And it is used for the protection of electrical installation. **iv) Switch.:** **(1 Mark)** The purpose of a switch in a series circuit is to make it easy to open or close the electrical circuit, turning the flow of electricity on or off.

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