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 a)	**Attempt any THREE of the following:**	**12 Marks**
a)	**Draw any two safety symbols used in industry and also write what the symbols stand for.**	
Ans:	**Safety symbols used in industry:**	**(Any Two Symbols expected: 2 Mark each)**


DANGER
ELECTRICAL EQUIPMENT
AUTHORIZED PERSONNEL ONLY
WARNING
ARC FLASH AND SHOCK HAZARD
Appropriate PPE Required.
Failure to comply can result in death or injury.
SAFETY FIRST
Proper maintenance and inspection is necessary for safe operation
WARNIN
ELECTRICAL SHOCK HAZA
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZE
IN THE OPEN POSITION
DC VOLTAGE IS ALWAYS PRESE
WHEN SOLAR MODULES
ARE EXPOSED TO SUNLIGHT
CAUTION
230
volts
Explosive
CAUTION
RISK OF ELECTRIC SHOCK
DO NOT OPEN
WARNING
RISK OF ELECTRICAL SHOCK
DANGER!
HIGH VOLTAGE
CAUTION
DANGER!
DANGER
HIGH VOLTAGE
UNAUTHORIZED PERSONNEL
KEEP OUT
DANGER
HIGH VOLTAGE
DANGER
HIGH VOLTAGE
Danger
Electric shock risk
No. 5017
No. 5018
No. 5019
No. 5020
DANGER
Electrical shock hazard
DANGER
CONSTRUCTION AREA
KEEP OUT
HIGH VOLTAGE
DANGER
DO NOT OPERATE
ELECTRICIAN AT WORK

b) **State the types of maintenance to be undertaken for electrical machines. Explain in brief the purpose of any two types of maintenance.**

Ans: **Types of maintenance to be undertaken for electrical machines:-**

(Any three types of maintenance names are expected ---2 Marks)

1. Preventive Maintenance
   - Routine Maintenance

- Periodic Maintenance

2. Maintenance on Fault/ Break down Maintenance
3. Overhaul
4. Productive maintenance

OR

1. Preventive Maintenance
2. Routine Maintenance
3. Periodic Maintenance
4. Maintenance on Fault/ Break down Maintenance
5. Overhaul
6. Productive maintenance

Explanation :- **(Any two types of maintenance explanation expected---2 Marks)**

1.Routine Maintenance:-

- Routine maintenance means checking/Cleaning/Repairing/Replacement of parts which carried out daily.
- Routine maintenance is carried out without dismantling the equipment, but it must always be disconnected from supply before any repairs are undertaken.
- The maintenance schedule of each equipment / machine is maintained in separate log sheet on which maintenance history is recorded.
- Also fault diagnosis / analysis should be recorded.

2.Periodic Maintenance:-

- It should be carried out weekly, fortnightly, monthly, quarterly or half yearly depending upon the equipments and condition of the machine.
- It depends on condition of the machine/equipment and its working hours and its importance.

➢ It includes inspection of loose connection, ventilation, replacement of worn parts, change of oil, checking of insulation etc.

3.Maintenance on Fault / Breakdown Maintenance:-

Maintenance carried out when machine or equipment fails to run or not working satisfactory

4.Overhaul:-

➢ Overhaul means dismantling of machine / equipment repair and reassemble.
➢ It should be carried out half yearly or yearly, or it depends on its working hours & conditions.

5.Productive maintenance:-

➢ Productive maintenance means the maintenance which carried out when a machine or equipment fails to run without carrying out preventive maintenance.

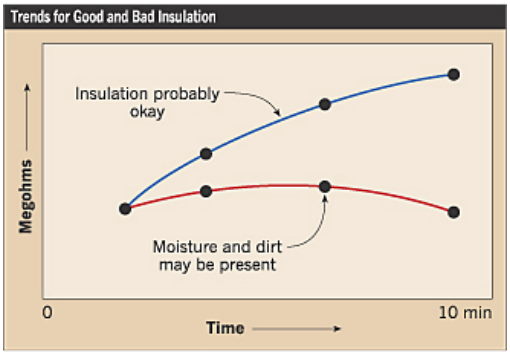
➢ Productive maintenance is preferred under following circumstances:-

a) Demand of the product is more so machine may not find to put for PM.

b) When profit of production is more than the cost of breakdown maintenance.

c) Draw the dielectric absorption curve. How is it used for interpreting the condition of insulation?

Ans: **Dielectric absorption curve:-** **(2 Mark)**



Interpreting the condition of insulation :- **(2 Mark)**

DAR(dielectric absorption ratio) **gives information about moisture content absorbed by insulating material .**If value of DAR is less than 1.25 Recondition of insulation is necessary.

A general guide to interpreting the DAR test results are as follows:

DAR	Insulation Condition
<1.25	Questionable
≤ 1.6	Adequate
>1.6	Good

d) State any one application of the following tools :
(i) Earth tester (ii) Megger (iii) Dial test indicator (iv) Spirit level.

Ans: **(1 Mark each Total 4 Marks)**

(i) Earth tester:- It is used to measure earth resistance.

(ii) Megger:- It is used to find out insulation resistance of electrical machine/equipment

(iii) Dial test indicator:- It is used to check the run-out (Unbalance) of rotating parts and indicators can also use to check the alignment of shaft in electrical machines.

(iv) Spirit level:- It is used to check the level of horizontal surface. ***OR*** It is used to check the level of instrument.

Q.1 B) Attempt any ONE of the following: 06 Marks

a) What is meant by tolerance '! Write the values of tolerance level of any five quantities of power transformers as per IS 2026.

Ans What is meant by tolerance :- **(1 Mark)**

Maximum or minimum allowable limits of different parameters are called as tolerance.

Tolerance in case of Power transformers as per IS 2026:-
(Any five quantities are expected 1 Mark each Total 5 Marks)

No	Test Item	Tolerance
1	Measurement of winding Resistance	HV winding within ± 8 % and LV winding within ± 12 %
2	Measurement of voltage ratio (Ratio of Transformer) OR The permissible tolerance for turns ratio.	± 0.5 % for each tap
3	No-load current	± 30 % of the declare value

4	No-load losses	Not exceed +15 % of guaranteed for No-load loss
5	load losses (Copper Losses)	Not exceed +15% of guaranteed for load loss
6	Maximum permissible temperature rise over ambient while delivering full load continuously	Oil - $45^{o}C$ Winding- $55^{0}C$
7	Load current harmonics	Less than 5% of rated current.
8	Total losses	+ 10% of the total losses declared
9	Measurement of short circuit impedance	Not exceed ± 10% of guaranteed impedance
10	Measurement of insulation resistance	> 2000 M.ohm between HV-LV > 2000 M.ohm between HV-GND > 500 M.ohm between LV-GND

b) Study the following incorrect figure No : 1 of phasing out test of three phase translOnner and answer the following questions.

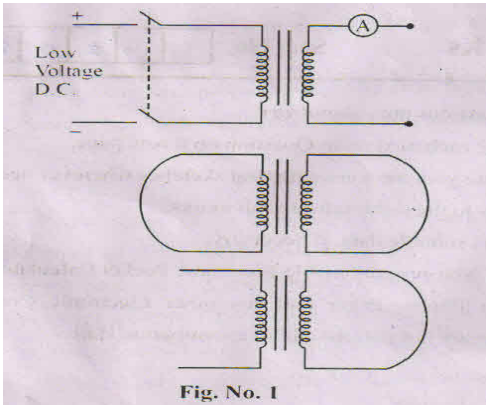


Fig. No. 1

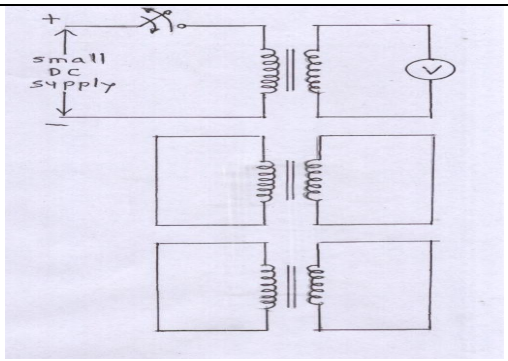
(i) Identity the two mistakes in the above figure.
(ii) Draw the correct figure for the same.
(iii) State the significance of this test.

Ans:

i) Following are mistakes in the above figure:- **(2 Marks)**

- No Tap Switch is connected in primary winding of first transformer
- Voltmeter or galvanometer should be connected instead of ammeter
- Third transformer primary winding is not short

(ii) The correct figure for the same:- **(2 Marks)**



iii) Significance of this test:- **(2 Marks)**

This test is carried out to identify primary & secondary winding terminals belong to same phase.

Q.2	**Attempt any TWO of the following: 16 Marks**
a) i)	**List out any four precautions to be taken to avoid tire caused by electrical reasons.**
Ans:	**Following Precautions should be taken to avoid fire due to electrical reasons:**

(Any Four Expected : 1/2 Mark Each , 2 Marks)

1. Overloading on cables/wires/machine should be avoided
2. Correct rating of fuse/MCB/switch gear etc. should be used in the circuit.
3. Replace deteriorated cables, wires, etc. by new one.
4. Maintain clearance as per voltage level
5. There should not be any loose connection in the electrical installation to avoid sparking.
6. Joints in wiring must be sound.
7. Use of superior quality of material ISI mark.
8. Replace Wiring that becomes defective with the passage of time / Replace faulty electrical installation and outdated appliances./ Replace Old electrical sockets and unsafe appliances
9. Do not store highly flammable liquids near (close to) electrical oven/furnace to avoid fire.
10. Do not kept electric heaters near curtains or furniture.
11. Avoid electrical cords laying (running) under carpet.
12. Electrical installation & equipments used in hazards area should be satisfied the specification/type of protection.

a) ii)	**State the type of fire extinguisher used on live electrical circuit.**
Ans:	**Type of fire extinguisher used on Live electrical circuit :-** **(2 Marks)** 1) Dry powder fire extinguisher 2) Carbon dioxide (Co_2) fire extinguisher.
a) iii)	**Why is CCI4 not recommended to be used as a tire extinguisher in less ventilated spaces''.**
Ans:	**Reason CCI4 not recommended to be used as a tire extinguisher in less ventilated spaces''** **(2 Marks)** ➢ Due to the heat of fires, CCI4 will be decomposed into heavy poisonous fumes. These fumes are dangerous to persons and directly affect the lung function. ➢ Hence CCI4 fire extinguishers are not used in less ventilated spaces.
a) iv)	**Describe the operation of-fire extinguisher briefly.**
Ans:	**Operation of fire extinguishers:-** ---------- **(2 Marks)** Stand 6 to 8 feet away from the fire and follow the four-step ➢ Pull the safety pin from the handle. ➢ Aim the extinguisher nozzle at the base of the fire. ➢ Squeeze the handle or lever slowly to discharge the agent. ➢ Sweep side to side over the fire until expanded.
b)	**In an industrial sub-station a distribution transformer of rating 750 kVA, 33/11 kV is available. Prepare a complete maintenance schedule chart for the same as per IS 100 28 (Part-111) — 1981.**
Ans:	**(Any Eight points are expected from following schedule: 1 mark each point, Total 8 Mark)** **1. Hourly Maintenance** ➢ Check & measure Voltage & current. ➢ It should be compared with rated figures given on name plate. ➢ Check & measure ambient temperature. ➢ Check & measure Oil & winding temperature. ➢ Ensure that temperature rise within permissible limit. **2. Daily Maintenance**

After completing the activities during Hourly schedule following activities are necessary in Daily schedule

- Check Oil level in transformer.
- Check the air passage of breather is clear see that there is no dirt , dust accumulated at air passage.
- Check the colour of Silica gel in breather.
- Check tank and radiator against oil leakage.
- Check the cooling system.
- Check position of relief diaphragm fitted at the end of explosion vent against detoriated or damaged.
- Check physical condition of transformer.
- Check tap changer and oil position
- Cleanliness in the substation yard should be done
- Check the ground connection (earthing).

3. Monthly Maintenance

After completing the activities during daily schedule following activities are necessary in monthly schedule

- Check the temperature indicators
- Breathing holes in silica gel breather should also be checked monthly and properly cleaned if required, for proper breathing action.

4. Quarterly Maintenance

After completing the activities during Monthly schedule following activities are necessary in Quarterly schedule

- Examine the Bushing for Dirt and dust deposit.
- Check Oil strength (dielectric).
- Check operating mechanism.

5. Half Yearly Maintenance

After completing the activities during Quarterly schedule following activities are necessary in Half yearly schedule

- Check the acidity of oil in transformer.

- Check oil filled in bushing.
- Check the gasket joints.
- Check the terminals and connections in the boxes.
- Examine relay and alarm contacts there operations, fuses etc.
- Check the foundation.
- Check the earth resistance & insulation resistance.
- Check the oil against moisture content in OLTC.
- Check conservator see that level of oil is at marking.
- Check the cable box
- Examine the lighting arrestor.
- All connections of HV & LV side should be tight and replace lugs if required.

6. Yearly Maintenance

After completing the activities during Half yearly schedule following activities are necessary in Yearly schedule

- Check Oil in transformer against acidity, resistivity, sludge formation and tanδ.
- Check Oil filled bushings.
- Check lubricating oil in gear box of driving mechanism.
- Check Surge diverter & gap.
- All valves should be checked for any leakage and for open/close operation.
- All activities mention above after 6 months are to be done

7. Two Yearly Maintenance

After completing the activities during Yearly schedule following activities are necessary in Two Yearly schedule

- Conservator tank should be cleaned inside
- Check the angle of buchholz relay
- Check the transformer oil filtration process is to be done to restore the quality of oil.

- Filter oil of OLTC
- Examine the Contacts of OLTC
- Check the radiator against any bend or dents
- Check the operating condition of buchholz relay.
- Leakage joints in transformer tank should be repaired by welding
- Gasket may be replaced if necessary.
- The level of oil in thermometer packets should be checked
- All nuts, bolts, fasteners, should be checked
- Paint the transformer to avoid rusting.

8. Five Yearly Maintenance

After completing the activities during Two Yearly schedule following activities are necessary in Five Yearly schedule

- Overall inspection of core & winding by removing from transformer tank

OR

S.**No**	**Frequency of maintenance**	**Inspection**
1	Hourly	Current, Voltage, temperature,
2	Daily	Dehydrating breather
3	Monthly	Oil level in transformer
4	Quarterly	Bushing
5	Half yearly	Conservator
6	Yearly	a) oil in transformer b) Earth resistance c) Relay, alarms and their circuits etc
7	Two Yearly	Non-conservator transformer
8	Five Yearly	Overall inspection of core & winding by removing from transformer tank

c) State four possible causes for each of the following trouble of a 3 phase slip ring induction motor. (i) Motor runs hot (ii) Motor runs slow (iii) Motor fails to start (iv) Excessive sparking between brushes and slip rings.

Ans **(Any Four causes are expected from following troubles, 1/2 Mark each, Total 8 Marks)**

Sr.No	Type of fault/abnormal conditions/Troubles	Causes (Any Two causes are expected)
1	Motor Runs Hot	➢ Single phasing. ➢ Overload ➢ Over/Under voltage. ➢ Unbalance voltage ➢ Over/Under frequency ➢ Poor motor ventilation/ Air flow obstructed or inadequate ventilation. ➢ Ventilating Fan is not working ➢ Rotor rubbing on stator ➢ Worn bearings ➢ High ambient temperature at the motor controller. (above 40^0C) ➢ Excessive core loss. ➢ Stator winding is in correct connected (Wrong connection) ➢ It may be due to internal faults inside the winding or for winding to earth. ➢ Check the correct starting time and duty cycle. ➢ Broken rotor bars ➢ Shorted stator coils ➢ Dirt in motor
2	Motor Run Slow	➢ Low voltage. ➢ Low frequency. ➢ Single phasing. ➢ Overload ➢ Stator connected in star instead of delta. ➢ Improper connection of motor leads to supply line ➢ Shorted stator coils ➢ Broken rotor bars
3	Motor Fails to Start	➢ Terminal voltage too low ➢ Blowing of fuse/single phasing. ➢ Defective starting mechanism ➢ protection devices has been tripped ➢ The motor controller will not operate ➢ Short circuit in supply cable. ➢ Open circuit in supply cable.

			➢ Loose contact. ➢ Motor rotor, bearings or driven load is locked. ➢ Overloaded ➢ Bearing is seized (Frozon). ➢ Check the rotor resistance circuit and control.
		4	Excessive Sparking between brushes & slip ring in slipring I.M.	➢ Line current is more ➢ Brushes are bedding or sticking in holders-not properly ➢ Dirt is accumulated on brushes ➢ Improper pressure and spring tension.

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

a) **What are the external causes for the abnormal operation of electrical equipments '?**

Ans: **External causes for the abnormal operation of electrical equipments:-**

(Any four causes expected 1 Mark each Total 4 Marks)

1. Overvoltage/ under voltage
2. Unbalanced voltage
3. Over frequency / under frequency
4. Single phasing from supply side
5. Lightning surge
6. Overloading for long time
7. Unbalanced loading
8. High ambient temperature
9. Loose connection
10. Short circuit fault in supply system.

b) **Describe the procedure for conducting polarity test of a single phase transformer with the necessary circuit diagram.**

Ans: **Procedure :-** **(2 Marks)**

- Take a 1-phase transformer. There are two primary terminals, say P1 and P2 (can be marked arbitrarily) and two secondary terminals S1 and S2.
- Now, which one is S1 and which is S2? You cannot fix it arbitrarily just as you did for P1 and P2. (If this transformer is not to be paralleled or is not to be a part of a 3-phase connected transformer, you can fix S1 and S2 also arbitrarily.)

- It is important to mark that terminal as S1, which will have the same instantaneous polarity as P1.
- So a polarity test is done to identify and mark the terminals as below.

OR

For Additive polarity-

- Temporly externally short the terminal P2 and S1.
- Connect the voltmeter in terminal P1 and S2.

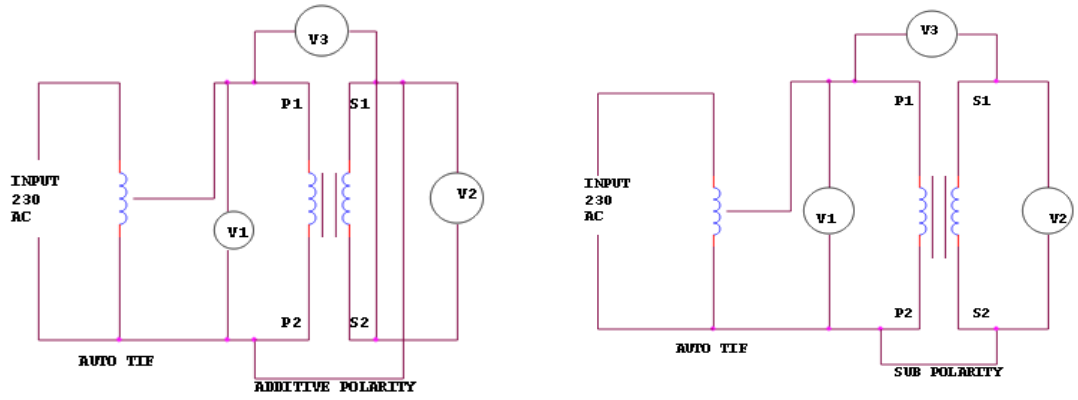
$V_3 = V_1 + V_2$

For subtactive polarity-

- Temporly externally short the terminal P2 and S2.
- Connect the voltmeter in terminal P1 and S1.

$V_3 = V_1 - V_2$

Polarity test of a single phase transformer circuit diagram:- **(2 Marks)**



c) Explain the method of babing of insulation with internal heat in detail.

Ans: **(Note:-** In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.)

- Insulation is heated by passing short circuit current through circuit. Heat will produce due to I^2R.
- After some time resistance will be measure by megger.

$PI = R_{60}/R_{15}$

OR

$PI = R_{600}/R_{60}$

- It will identify the condition of the insulation.

OR

The method of baking of insulation with internal heat:

- The baking of insulation with internal heat is very simple producers of dying the insulation.
- In this method a correct amount of D.C current is being circulated through armature or field winding whichever is available.
- This circulated Dc current generate heat due to I^2R effect. This generated heat is being utilized for drying the insulation.

d) State the meaning of the f011owing terms related to transformer oil : (i) Viscosity (ii) Fire point (iii) Flash point (iv) Purity

Ans: **NOTE-** In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.

(1 Mark each Total 4 Marks)

(i) Viscosity:-

Viscosity is a measure of a fluid's resistance to flow. Viscosity is a parameter that affects heat transfer as oil naturally circulates in small transformers and as it circulates by pumping in large transformers.

OR

Viscosity of transformer oil can be said that viscosity is the resistance of flow, at normal condition.

OR

Viscosity of transformer oil **is low.**

OR

The opposition force are between two different fluid mateirals is calld as the viscous force. And that property is called as the viscosity.

OR

Viscossity means thickness of liquidity.

(ii) Fire point:-

The fire point is the lowest temperature at which, on further heating beyond the flash point, the sample will support combustion for 5 seconds.

OR

The temperature at which all (Total Volumetric oil) oil catches fire.

(iii) Flash point:-

The flash point is defined as the lowest temperature at which the vapor formed above a pool of the liquid ignites in air at a pressure of 1 atmosphere. OR **Flash point of transformer oil** is the temperature at which oil gives enough vapors to produce a flammable mixture with air.

OR

The temperature of the oil at which the only surface gets fire i.e. gets sparked.
The flash point of the oil should have high value and in between 130^0c to 140^0c.

(iv) Purity:-

Whose breakdown strength is more than 70 KV & It should not contain impurities such as sulphur and its compounds

OR

The transformer oil must be pure and transpernt in colour. It should not have any contents of moisture and other suspended material.

e) FolloWing, test results were obtained in a single phase 2.75 kVA. 250/125 V transformer on a short circuit test with S_1 and S_2, shorted conducted at test temperature of 30 "C. current = 8A: Voltage applied = 36 volts. Power = 128 watts. Find (i) Percentage resistance (ii) Percentage impedance both at 75 "C.

Ans:

Given Data:

1-ph: 2.75 KVA Transformer 250/125 Volts Vsc = 36 V Isc = 8 A Ws_C = 128 W

Solution:

1. Resistance at 30^0C $\mathbf{W_{SC} = I_{SC}^2 R_{01}}$

$$R_{01}\ at\ (30^0 C) = \frac{W_{SC}}{I_{SC}^{\ 2}} = \frac{128}{(8)^2}$$

$$R_{01}\ at\ (30^0 C) = 2\ \Omega$$ ---------- **(1/2 Mark)**

2. $Z_{01} = \frac{V_{SC}}{I_{SC}} = \frac{36}{8} = 4.5\ \Omega$ ---------- **(1/2 Mark)**

$$\therefore X_{01} = \sqrt{(Z_{01})^2 - (R_{01})^2}$$ ---------- **(1/2 Mark)**

$$\therefore X_{01} = \sqrt{(4.5)^2 - (2)^2}$$

$$\therefore X_{01} = 4.0311\Omega$$ ---------- **(1/2 Mark)**

3. Resistance at 75^0C :

$$\frac{R_2}{R_1} = \frac{t_2 + 234.5}{t_1 + 234.5}$$ ---------- (1/2 Mark)

$$\therefore R_{01}\ at\ (75^0 C) = R\ at\ (30^0 C) \times \frac{234.5 + 75}{234.5 + 30}$$

$$\therefore R\ at\ 75^0 C = 2.3402\ \Omega$$ ---------- **(1/2 Mark)**

There will be no effect on inductive reactance, The value of inductive reactance will be remain the same

$$\therefore X_{01}\ at\ (75^0C) = X_{01}(30^0C) = 4.0311\,\Omega$$

4. Impedance at 75^0C :

$$\therefore Z_{01}\ at\ (75^0C) = \sqrt{R_{01}(75^0C)^2 + X_{01}(75^0C)^2}$$ ---------- **(1/2 Mark)**

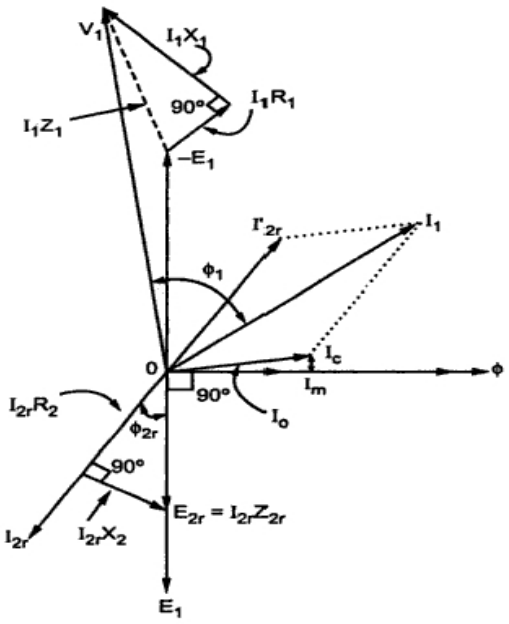
$$\therefore Z_{01}\ at\ (75^0C) = \sqrt{(2.3402)^2 + (4.0311)^2}$$

$$\therefore Z_{01}\ at\ (75^0C) = 4.6611\,\Omega$$ ---------- **(1/2 Mark)**

Q.4 A) Attempt any THREE of the following: 12 Marks

a) Draw the vector diagram of three phase induction motor and justify that three phase induction motor is a generalised transformer.

Ans: **Vector diagram:-** **(2 Mark)**



Justification phase induction motor is a generalised transformer.- **(2 Mark)**

An induction motor is similar to a transformer in many respects. In view of these similarities, an induction motor is called as a generalized transformer & it is for this reason that the stator winding of an induction motor is treated as its primary and the rotor winding as its secondary.

	The only difference is the secondary of induction motor is rotating and short circuited while transformer secondary is stationary and connected to load. The load on induction motor is mechanical while load on transformer is electrical.
b)	**Explain any four factors affecting earth resistance.**
Ans:	**Following factors affect earth (soil) resistance (resistivity):-** **(Any four factors are expected 1 Mark each total 4 Marks)** 1. Temperature of soil 2. Soil Condition 3. Dissolved salts in soil 4. Moisture content in soil 5. Physical Composition of soil 6. Effect of grain size and its distribution 7. Quality of Coal / Charcoal used in the earth electrode pit. 8. Climate Condition 9. Depth of electrode embedded in the earth. 10. Size of earth electrodes 11. Metal of earth plate and earth wire. 12. Location of Earth Pit 13. Obstractions in under ground 14. Lengthen the earth electrode in the earth. 15. Resistance of the electrode itself and connections to it. 16. Contact resistance between the electrode and the soil adjacent to it. 17. Resistance of the surrounding earth. 18. Earth resistance can be reduced by increasing number of earth electrodes inter connected in parallel. 19. Area Available 20. Size and spacing of earth plate and size of conductor. 21. Leakage **Current Magnitude** **OR**

Following factors affect earth (soil) resistance (resistivity)

(1) **Temperature of soil:**

Increase in temperature reduces resistivity of soil.

(2**) Soil Condition:**

If soil is dry then soil resistivity value will be very high.

(3) **Moisture:**

Increase or decrease of moisture content determines the increase or decrease of soil resistivity.

The resistance of soil drops quickly to a more or less content in soil.

(4) Dissolved salts:

Increase in salts in water reduces soil reduces resistivity of soil.

(5) Climate Condition:

In dry whether resistivity will be very high and in monsoon months the resistivity will be low.

(6) Physical Composition**:**

Different soil composition gives different average resistivity. for rocky or gravel soils resistivity of clay is more than soft soil.

(7) Location of Earth Pit:

Choose a location of earth pit that is naturally not well drained.

(8) Effect of grain size and its distribution:

Grain size, since they control the manner in which the moisture is held in the soil.

(9) **Area Available**:

- Single electrode rod or strip or plate will not achieve the desired resistance alone.
- If a number of electrodes could be installed and interconnected the desired resistance could be achieved.

(10) **Obstructions**:

Obstructions like concrete structure near about the pits will affect resistivity.

(11) **Depth of electrode embedded in the earth**:-

A ground rod is driven deeper into the earth, its resistance is reduced.

(12) **Size and spacing of earth plate and size of conductor**.

Doubling the diameter of the ground rod reduces resistance.

(13) **Metal of earth plate and earth wire**:-

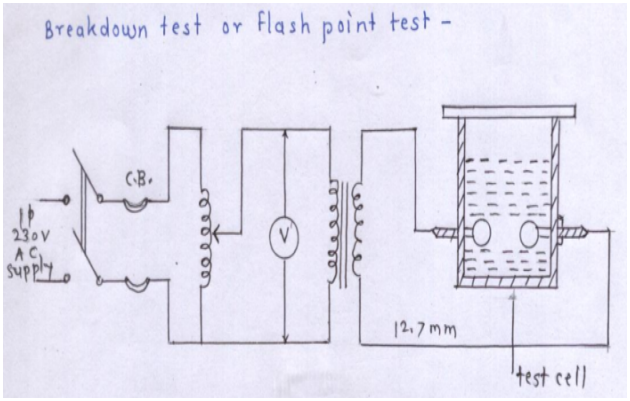
Use of copper material for earthing reduces resistance than use of aluminum material

	(14) Quality of Coal / Charcoal used in the earth electrode pit. (15) Leakage Current Magnitude: A current of significant magnitude and duration will cause significant drying condition in soil and thus increase the soil resistivity.
c)	**State any four requirements of foundation of rotating machines.**
Ans:	**(Any four points are expected 1 Mark each total 4 Marks)** 1. The foundation should be strong/ rigid . 2. The foundation should be able to absorb the vibration while operating at its full capacity. 3. The foundation should be able to withstand against erecting weight, accessories weight, operating weight etc. 4. For concrete foundations use concrete ratio of 1:2:4. 5. The foundation should be well cure before machine put on it. 6. The dimension of foundation should be more than actual requirement. 7. Depth of foundation should be proportional to the bearing capacity of soil. 8. The surface of foundation must be protected from machine oil by means of suitable chemical coating or suitable chemical treatment. 9. Level of foundation should be above the maximum flood level of the site. 10. There should be easy accesses towards machine foundation 11. The foundation should be sufficiently rigid to maintain proper alignment between the motor and the driven machine.
d)	**State and explain any four circumstances under which the competent authority should not issue the 'permit to work' card ?**
Ans:	**(Any four points are expected 1 Mark each total 4 Marks)** Under following circumstances authority should not issue the "Permit-to-work" :- 1. If unauthorized person demanding permit 2. If untrained/unqualified person demanding permit 3. For minor maintenance work

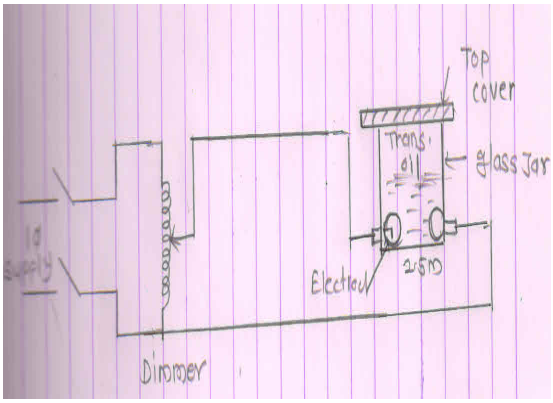
4. Lack of safety tools like discharge rod
5. Under improper illumination condition
6. In Unfavorable atmospheric condition such as high wind pressure, high rain falls etc.
7. When workers' demands to work alone.
8. If persons health is not good i.e. not feeling well.

Q. 4B)	**Attempt any ONE of the following:**	**06 Mark**
a)	**Explain the procedure of the test to be undertaken for measuring dielectric strength of transformer oil. Draw the necessary circuit set up for the same.**	

Ans: **Circuit diagram of dielectric strength of transformer oil:** ---------- **(2 Marks)**



OR



OR (Any equivalent figure.)

Procedure: - ---------- **(4 Marks)**

- The sample of oil is taken from near the top & bottom of the transformer.
- In this kit, there are two electrodes separated by small gap of 2.5 mm or 4mm between them.
- The cup is filled with sample of oil to be tested up to about 1 cm above the electrodes.
- The cup top is covered with clean glass plate.
- Now slowly raise the voltage between the electrodes till breakdown of oil occurs or sparking starts between the electrodes. And note down voltage reading.
- Repeat the procedure by taking same sample of oil 3 to 6 times

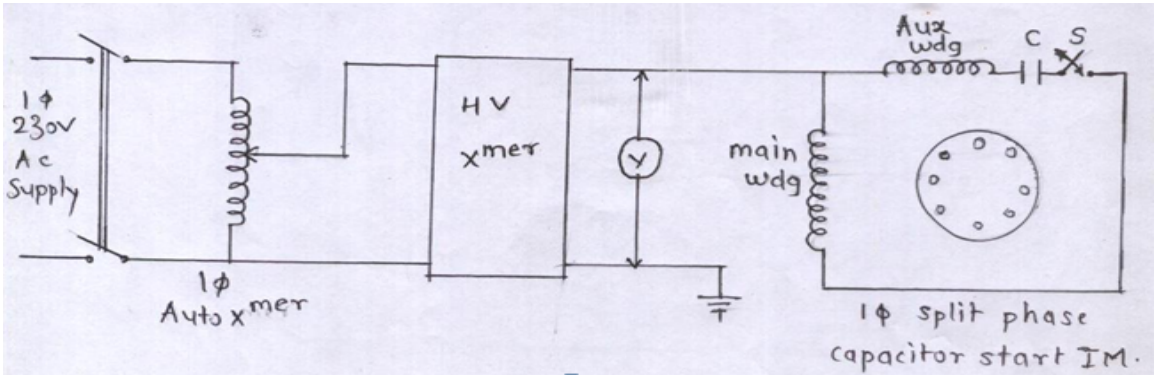
& Calculate average of all results to finalize the breakdown voltage of oil sample.

Result:-

- For good **transformer oil** or **dielectric strength of transformer oil** is above 75Kv.
- If dielectric strength of oil is lower than 30 KV than it indicates presence of impurities in oil & it is not safe for use for Transformer.

b) Write the correct procedure of conducting (i) High voltage test (ii) Quiet running test on a single phase induction motor.

Ans: **(i) High voltage test:-** ---------- **(3 Marks)**



OR (Any equivalent figure.)

A high voltage is applied between windings and frame of the motor. The high voltage test should be applied once and once only to a new and completed motor in normal working condition. The high voltage test should not be applied when the insulation resistance is less than the required value.

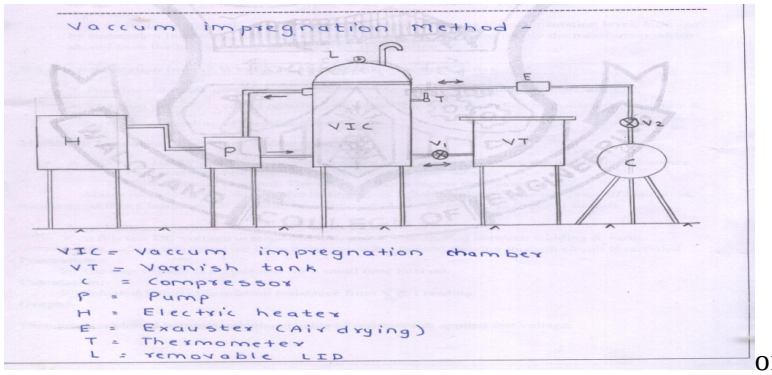
The high voltages are as under: For duration of 60 sec.

S.No.	Rated Voltage of Motor	Test Voltage
1	50 Volts or less	500 Volt
2	Above 50V up to and including 250V	1000 Volt

(ii) Quiet running test:- ---------- **(3 Marks)**

When running with the load the motor creates noise, which should be below the specified noise level.

Q.5	**Attempt any TWO of the following: 16 Marks**
a)	**Draw a neat figure of vacuum impregnation plant and write the stepwise procedure of revarnishing the insulation.**
Ans:	**Figure of vacuum impregnation plant : (3 Marks)**



or equivalent figure

Steps /procedure for Vacuum Pressure Impregnation of the winding:- (5 Marks)

1. The surfaces of all coils windings are perfectly clean and it should be free from dirt & dust, oily matters etc.
2. For the moisture removal heat the winding with the help of lamp (carbon filament) or in an oven till all moisture get evaporated.
3. A pre dried winding is placed into a processing chamber (tank).
4. A vacuum is created in the process tank

   To remove all air, including air within the small air gaps of the winding.

5. Then Varnish is transferred from varnish storage tank to the processing tank till the entire winding is submerged.

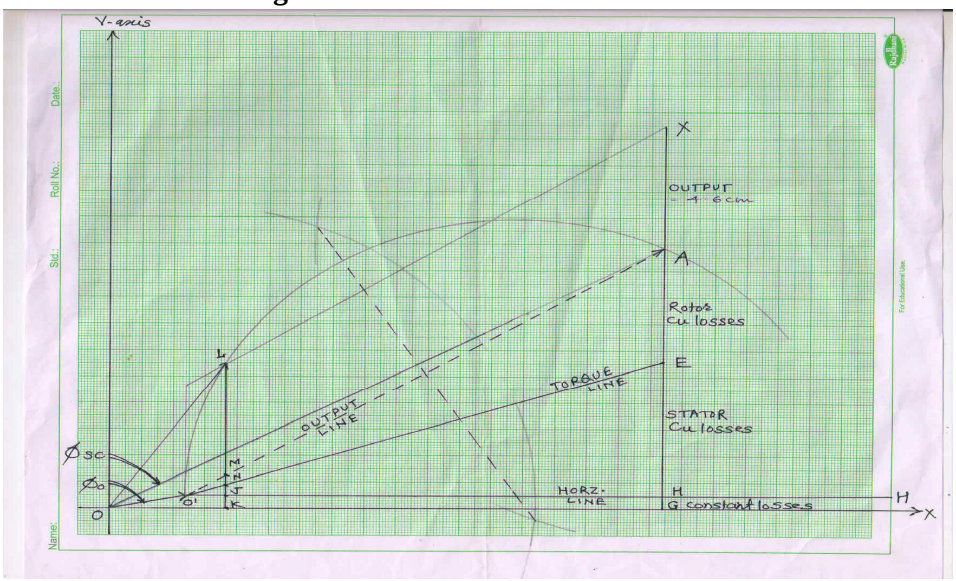
	After that vacuum is released and desired pressure is applied into the processing tank above the varnish level using compressed air or nitrogen. Due to high pressure varnish is now forced in to the all air pockets inside the winding. 6. After desired amount of time, the pressure is released and the varnish is drained back into the varnish storage tank. 7. Then coil is removed and applies finishing gel (varnishes) by brushing or spraying over winding for better protection against moisture, chemical fumes and dust. 8. It is then kept in a baking oven till it gets set properly and become dry.
b)	**As per the procedure of installation of transformer (IS 1002K) discuss about the following aspects : (i) Location (ii) Cabling (iii) Facilities for maintenance**
Ans:	Following is the **procedure of** installation of Transformer with respect to : **(Any eight points are expected aomongest (i) Location (ii) Cabling (iii) Facilities for maintenance 1 Mark each point , Total 8 Marks)** **(i) Location (ii) Cabling (iii) Facilities for maintenance**:- 1. **Location-** ➢ It should be near load center. ➢ Easy access for incoming and outgoing line. ➢ Easy access towards Transformer ➢ There should be sufficient place all around the transformer and also for future expansion. ➢ Transformer area should be free earth quake. ➢ The transformer area should have well ventialation available. 2. Cable- ➢ The underground cable should be used. ➢ The cable should be selected as per requirement of load and should have good quality. ➢ Shortcut rout not used in laying of cable. ➢ The used cable should have high mechanical strength to prevent from mechanical injury. ➢ Easy access for transmission lines. ➢ There should not be any complication of the interconnection between the cable

terminal.

3. Facilities for maintenance-
   - Maintenance department should make proper maintenance schedule.
   - Availability of skilled technian.
   - Availability of tools and tackles.
   - Availability of raw material.

OR

1. Near load centre :
   Transformer should be located near load center to reduce cost of Transmission and distribution lines and to reduce losses in it.
2. Easy access for transmission Line :
   There should be easy access for incoming and outgoing line.
3. Easy access towards Transformer:-
   There should be easy access towards for Transformer for transportation of equipment & manpower etc.
4. Space(Land) available : Transformer
   The land proposed for a Transformer should be normally level and open from all sides
5. Bearing capacity of land (Hard land) :
   To reduce erection cost and for better foundation of Transformer land should be have high bearing capacity (hard soil.)
6. Area free from earthquake :
   To avoid damage to Transformer area should be free earth quake.
7. Transformer should be installed only on poles strong enough to carry their weight.
8. Transformer poles should be straight.
9. There should be sufficient place all around the transformer.
10. The maximum height of installation must not exceed 1000 m above sea level.
11. There should be easy accessibility provided to all indicating and protecting devises.
12. Level of plinth should be above the maximum flood level of the site.
13. Sufficient and minimum standard electrical clearances of all live parts of the transformer from earth and other live bodies are also to be provided.
14. The tank of the transformer should be permanently grounded.
15. Neutral of transformer should be permanently grounded.
17. Oil drainage facility in the transformer should be provided in the design in case of any fire hazard.

c)	**The following results were obtained from the tests on a 3.5 kW. 3 phase, 220 V. 50 Hz. 4 poles star connected induction motor.** **No load test: 220 V, 5A, 385 W Blocked rotor test : 110 V, 20A, 1870 W.** **Assume stand still stator copper losses to be 55° of total copper losses. Draw the circle diagram and find out. full load current. efficiency, power factor.**
Ans:	**Given Data:** No load test:- 220 V; 5 Amp; W_0 = 385 W; Blocked rotor test:- 110 V; 20Amps; W_{SC} = 1870 W; Draw a circle diagram and determine: i) Find Full load current, Efficiency, and power factor at rated output **Solution the Circle diagram:-**  ----- **(1Mark)** **Given data:** 3-ph, 220V, 3.5 kW, 50Hz **i) No load Test:** V_0 = 220V, I_0 = 5A, W_0 = 385 watt *Vector* 00' *represents* $I_0 \angle \phi_0$ $\phi_0 = Cos^{-1}\left(\frac{W_0}{\sqrt{3}V_0\ I_0}\right)$ ---------- **(1/2Mark)** $\varphi_0 = Cos^{-1}\left(\frac{385}{\sqrt{3}\times 220\times 5}\right)$

$\varphi_0 = 78.34^0$ *Elec.* ---------- **(1/2Mark)**

ii) Blocked Rotor Test: - $V_{SC} = 110V$, $I_{SC} = 20A$ & $W_{SC} = 1870$ watt

Vector $0K'$ *represents* $I_{SN} \angle \phi_{SC}$

$$I_{SN} = I_{SC} \left(\frac{V}{V_{SC}}\right)$$ ---------- **(1/2Mark)**

$$I_{SN} = 20 \left(\frac{220}{110}\right)$$

$I_{SN} = 40\ A$ ---------- **(1/2Mark)**

$$\phi_{SC} = Cos^{-1}\left(\frac{W_{SC}}{\sqrt{3} V_{SC}\ I_{SC}}\right)$$

$$\varphi_{SC} = Cos^{-1}\left(\frac{1870}{\sqrt{3} \times 110 \times 20}\right)$$

$\varphi_{SC} = 60.61^0$ *Elec.* ---------- **(1/2Mark)**

iii) Let, the Current scale: - 1 cm = 2A

The vector 00' represent : $I_0 \angle \phi_0$ $I_{SN} \angle \phi_{SC}$

iv) Power scale:- $= \dfrac{W_{SN}}{Lenght\ at\ \ AG\ in\ cm}$

$$W_{SN} = W_{SC}\left(\frac{V}{V_{SC}}\right)^2$$

$$W_{SN} = 1870\left(\frac{220}{110}\right)^2$$

$W_{SN} = 7480\ \ watts$ ---------- **(1/2Mark)**

Power scale : $= \dfrac{W_{SN}}{Lenght\ at\ \ AG\ in\ cm}$

Power scale : $= \dfrac{7480\ watts}{9.8\ cm}$

Power scale : = 763.27 *watts / cm*

v) Length of output line, AX is output = $\frac{Output\ in\ watts}{power\ scale}$

= $\frac{3.5 \times 10_3}{763.27}$

= 4.6 *cm* ---------- **(1/2Mark)**

From circle diagram : Point 'L' represent the full load condition of I.M :

1) full load current = Length of 'OL' in cm x Current scale

= 6.8 cm x 2 A/cm

= 13.6 Amp ---------- **(1 Mark)**

2) Power factor at full load = $\frac{length\ (LM)\ in\ cm}{length\ (OL)\ in\ cm} = \frac{5.8}{6.8}$

Power factor at Full load = 0.85 *Lag* ---------- **(1Mark)**

3) Full load % efficiency = $\frac{l\ (LM)}{l\ (LK)} \times 100$ ---------- **(1/2Mark)**

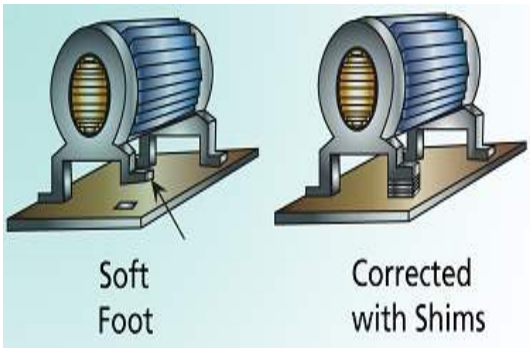
= $\frac{4.6\ cm}{5.8\ cm} \times 100$

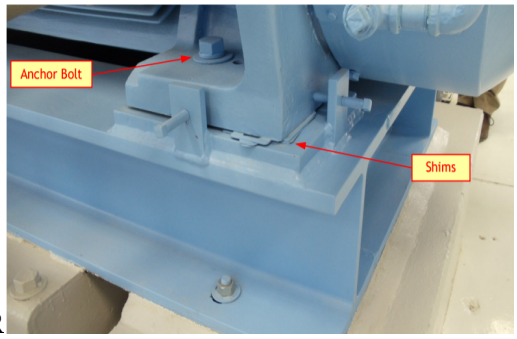
Full load % efficiency = 79.31 % ---------- **(1Mark)**

Q.6	**Attempt any four of the following : 16 Marks**
a)	**What are the points to be considered while selecting the site for the location of rotating electrical machines as per IS 900'? (any four point)**
Ans:	Following points should be consider while selecting site for the location of rotating electrical machine:- **(Any four point expected 1 Mark each, Total 4 Marks)** 1. Level of plinth should be above the maximum flood level of the site. 2. Install the motor in a well-ventilated area. 3. There should be easy accessibility provided to all indicating and protecting devises. 4. There should be sufficient place all around the machine.

	5. Precautions should be taken to prevent leakage of water into machine room. 6. Direct sunlight, rain, water, dust, gases, smoke should be not be present in the room. 7. There should not be air pollution. 8. Information about condition of soil:- • Bearing capacity of soil • Soil density • Ground water table location etc. Should be study while selecting site 9. The foundation should be rigid. 10. The foundation should have withstand at vibrations produced at full load capacity. 11. It should be able to carry all weights of machine such as • Erection weight • Operating Weight • Superimposed weight • Accessories weight.
b)	**Discuss the procedure of levelling and aligning of direct coupled drives. Also draw the figure showing the position of packing materials.**
Ans:	**Procedure:-** **(Procedure for 3 marks and Figure for 1mark)** ➢ Align the motor and the driven machine on bed-plate. ➢ Firstly aligned center axis of both the shafts in the same line ➢ Aligned both the shafts correctly in the horizontal plane. ➢ Aligned both the shafts correctly in the vertical plane. ➢ Aligned both the shafts correctly on the same center axis. ➢ Any variation in levels is corrected by adding or removing **shims** ➢ To check alignment there are three methods:- 1. By visual inspection, combined with straightedge or ruler:- This method has less accuracy. 2. By use of Dial Indicator: - This method has high accuracy. 3. By use of Laser- guided tools: - This method has highest accuracy.

Figure showing the position of packing materials:-



OR 

c) Describe the procedure of conducting high voltage test on a three phase induction motor as per IS 4029-2010.

Ans: **Objective:-** **(1 Mark)**

- To determine the weakness of insulation, damaged insulation or insufficient clearances etc.
- To determine the level of insulation of the motor.

OR

- To identify the condition insulation used,
- To identify the quality of insulation used.
- To identify the withstand capacity of the insulation at high voltage for short duration.
- To check the insulation property between-
  - Stator and earth.
  - Rotor and earth
  - Stator and rotor

Procedure:- **(2 Mark)**

- The test voltages should be of power frequency and as far as possible should have a sine wave shape.
- This test consists in applying the specified test voltage between the various windings and earth.

No.	Description	Test Voltage (for 60 sec.)
1	Stator Windings	1000V + **Twice rated** voltage with a minimum of 1500 Volts
2	Rotor windings of slip ring induction motors (unidirectional)	1000V + **Twice open** circuit standstill voltage as measured between slip rings with (unidirectional) rated voltage applied to stator windings
3	For motors to be reversed or braked while running , rotor winding	1000 V+ **Four times** open circuit standstill voltage

Conclusion :- **(1 Mark)**

- During high voltage test if no failure of insulation occurs at full test voltage then test is successful.

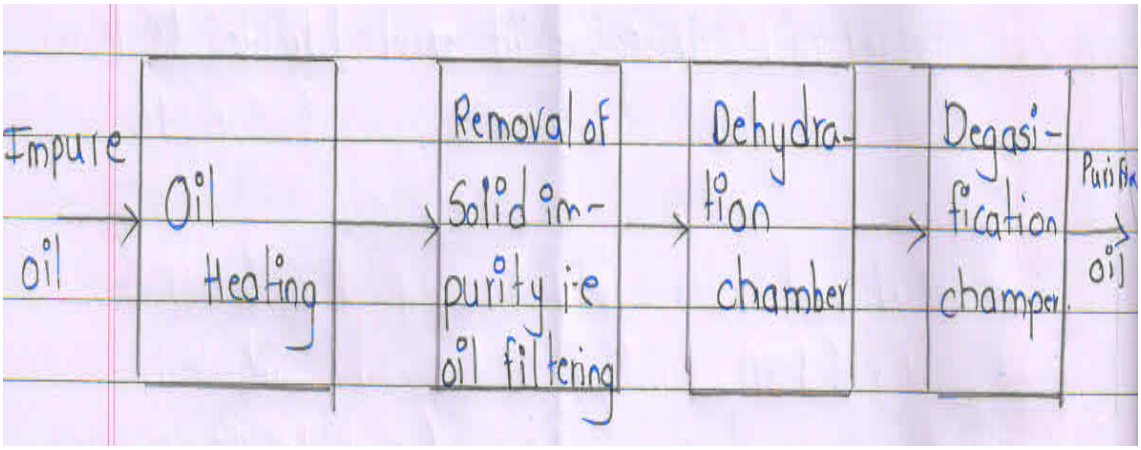
  i.e. quality & level of insulation is good.

d) Discuss in detail any four factors affecting preventive maintenance schedule.

Ans: **It depends on following Factors: (Any four points are expected 1 mark for each Total 4 Marks)**

1. Availability of trained & skilled technician.
2. Availability of spares & raw material.
3. Availability of tools & trakles required for maintance.
4. It depends on production loading.
5. Operating cycle of equipment or machine affect the maintenance schedule.
6. It depends on equipment/ machine & it's importance.
7. Type of machine & it's working condition.
8. Working hours of equipment/ machine.
9. Aging of machine
10. Cost of the maintenance.

	11. Working environment of industry.(Presence of dust, dirt, chemical fumes, moisture in the air)
e)	**Draw the general line diagram of a centrifugal purifier for purifying transformer oil.**
Ans:	**General line diagram of a centrifugal purifier for purifying transformer oil ----------(4 Marks)**



OR Any equivalent figure.

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