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**
1)	**State any four factors on which severity of shock depends**
Ans:	**(Any Four Points Expected 1 Mark to each point Total 4 Marks)** The effect of electrical shock on human bodies depends on following factors. 1. Magnitude voltage of the system. 2. The period or duration for which the area of contact with lives part. 3. It is also depends on supply system i.e. A.C or D.C. 4. Body resistance (If wet resistance of body reduces) 5. Shock may occur even when voltage (50V rms AC low or 75V DC sometimes OR Low voltage does not mean low hazard.) 6. Path of current through body. 7. The magnitude of current passing through the body
ii)	**State any four objectives of preventive maintenance of electrical equipments.**
Ans:	**(Any Four Points Expected 1 Mark to each point Total 4 Marks)** **Objective of preventive maintenance of electrical equipments:-** 1. To prevent minor faults from developing into major breakdown. 2. To reduce breakdown period.

	3. To keep the machine in good working condition by reducing wear and tear. 4. To provide greater safety & protection to the workers. 5. To use less standby equipments. 6. To increase life of machine. 7. To avoid inconvenience. 8. To increase productivity 9. To determine the need for major & minor repairs. 10. To develop maintenance schedule at low cost.
iii)	**State the factors on which life of Insulation depends.**
Ans:	**(Any Four Points Expected 1 Mark to each point Total 4 Marks)** **Life of insulations depends on following factor:-** 1. Water 2. Moisture 3. High Temperature 4. Mechanical Stress 5. High voltage stress 6. Dirt & Dust Particles 7. Improper Handling 8. Ageing 9. Effect of oxygen & humidity 10. Chemical action **OR** **Life of insulations depends on following factor:-** 1. **Water:** If insulation is near water for the long period than its life reduces. 2. **Moisture:** If insulation contains moisture for the long period than its life reduces. 3. **High Temperature:** Due to over loading insulation gets heated than its life reduces 4. **Mechanical Stress:** Any mechanical stress on insulation for the long period that its life reduces 5. **High voltage stress:** If insulation is used other than designed for voltage than there will be high voltage stresses it may reduces life of insulation. 6. **Dirt & Dust Particles:** If dirt & dust particles accumulated on insulation than it will absorb moisture in the air which will reduces the insulation resistance s its may cause the failure of insulation.

7. **Improper Handling:** If it is handle roughly than it may damage.

8. **Ageing:** After a long period it's dielectric strength reduces.

9. **Effect of oxygen & humidity:-**

Some organic or inorganic material decomposes presence in moisture & oxygen rubber oxidized and cracks when exposed to light reduces life of insulation.

10. **Chemical action:-**

In the soil due to chemical action, it causes corrosion of insulation. It will detoriates insulation material reduces life of insulation.

iv) State the permissible limits for variation of :1) Voltage 2) Current 3) Speed 4) Frequency

Ans: **(Each Point 1 Mark Total 4 Marks)**

No	Test Item	Permissible limits
1	Voltage	± 5 % or ± 6 %
2	Current	Not exceed +15% of guaranteed for load loss
3	Speed	Highest speed: - 3% and Lowest speed + 3 %
4	Frequency	+- 0.5 Hz

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

i) With the help of neat circuit diagram explain back to back test on transformer to determine efficiency and regulation.

Ans **(Circuit diagram -3 Marks, Procedure 2 Marks Calculations- 1 Mark,-Total 6 Marks)**

Circuit diagram:-

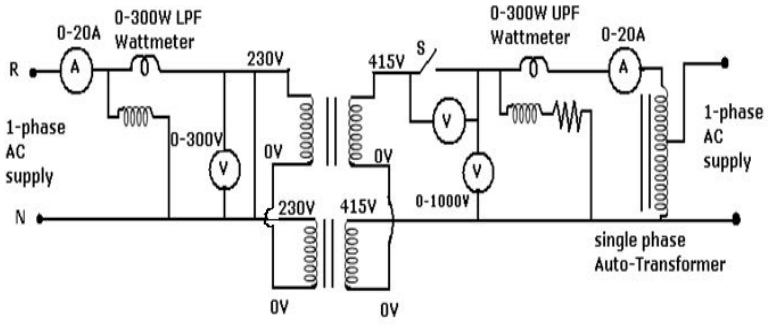
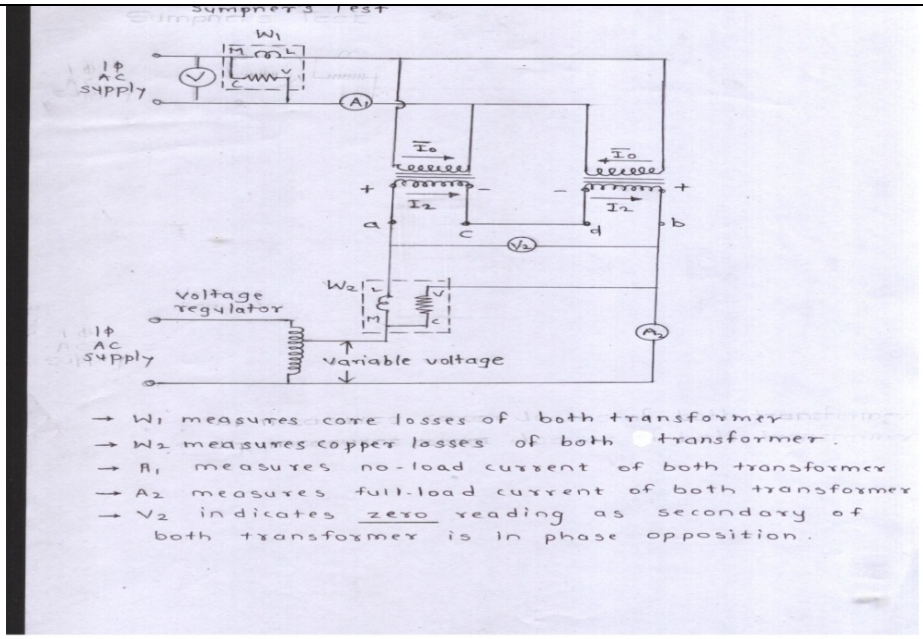


Fig. :Sumpner's test

OR



Procedure :-

- For this test two identical transformer are required.
- Primary of two transformers are connected in parallel and secondaries are connected in series opposition.
- Supply is given at rated voltage and rated frequency generally to LV winding similar to OC test.
- Now supply is given to HV winding with the help of auto-transformer (Regulating-transformer) till full load current is circulated in HV winding similar to short circuit test.
- To measure the temperature rise two transformers are kept under rated load conditions for several hours till maximum steady state temperature is reached.

Observation:-

V_1 in volt	I_1 in Amp	W_1 in watt	V_2 in volt	I_2 in Amp	W_2 in watt
Rated primary voltage	$= 2I_0$	$\approx 2\ w_i$	It is a voltage at which F.L. Current circulate through Sec $=2.V_2$	$= \mathbf{I_2}$ F.L. Current	$\approx 2\ w_{Cu}$ Full load copper losses

2. Note down the room temperature.
3. When steady state temperature is reached, take the temperature of oil with the help of thermometer.
4. Measure the resistance of winding when immediately after steady state temperature is

Calculations:-

1. For temperature measurement:

$$R_{t2} = R_{t1}\frac{234.5 + t_2\,^0C}{234.5 + t_1\,^0C}$$

2. For efficiency measurement:

Iron losses = Wi / 2 watt, Full load copper losses = Wcu / 2 watt.

Output = KVA x P.F

$$Efficiency = \frac{output\ (KVA) \times P.f}{output\ KVA \times P.f + W_1/2 + W_2/2} \times 100$$

OR

$$\%\ \text{full load efficiency of each transformer} = \frac{\text{output}}{\text{output} + \frac{W_1}{2} + \frac{W_2}{2}} \times 100$$

3. For regulation measurement:

$W_{cu}/2 = I_2^2 R_{02}$

$Z_{02} = Vsc / Isc = (V_2/2 / I_2)$

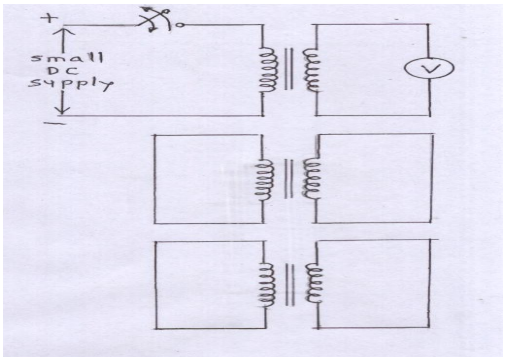
$X_{02} = \sqrt{Z_{02}^2 - R_{02}^2}$

% Regulation = $I_2 (R_{02} \cos\emptyset \pm X_{02} \sin\emptyset) / V_2$

ii) With the help of neat diagram explain phasing out test to be carried out on transformer.

Ans: **(Circuit diagram: 4 Marks, Procedure : 2 Marks,-Total 6 Marks)**

Circuit diagram:-



or equivalent figure

Procedure:-

- Short primary & secondary winding of other phases expect the one under test.
- Connect voltmeter to secondary winding.

	➢ A small DC current is circulated through the primary winding through switch. ➢ Now with the help of switch interrupt the DC supply instantly & repeatedly. ➢ If voltmeter indicator deflects than it indicates the two windings concerned belong to the same phase. ➢ If not deflect then two windings are not belong to same phase. ➢ Repeat the procedure by connecting voltmeter to secondary side to next secondary winding till voltmeter gives deflection. In this way we can search the phasing out.
Q.2	**Attempt any TWO of the following: 16 Marks**
a) i)	**State any six activities that are to be carried out for the person who received electrical shock.**
Ans:	**(For First Four Points 3 Marks and for next two points 1/2 Mark each point Total 4 Marks)** **(Any SIX Points Are Expected)** **Activities to be carried out for the person who received electrical shocks:-** 1. Switching OFF the supply: when a person comes in contact with live conductor, switch off the main supply immediately if it is nearby or cut the wires with insulated pliers from the wiring circuit. 2. Removing the person from the contact of current:- Push a person with a dry sticks of wood or pull him by using hands wear by insulated hand gloves, or use cotton thick cloths or use dry news paper folded of sufficient thickness. 3. Removing the person from fire: If a person's cloth catches fire, then wrap him in the blanket or coat & roll him on the ground to extinguish. 4. Keep the patient warm and comfortable, but not hot. In many cases, the only first aid measure necessary and possible is to wrap the patient under neath as well as on top to prevent loss of body heat. 5. Keep the patient's body horizontal or, if possible, position him or her so that the feet are 12–18 in. higher than the head. In any case, always keep the patient's head low. This patient should be kept horizontal with head slightly raised to make breathing easier. 6. Call to doctor immediately. 7. Before coming doctor, if any burns or wound occurs on the body of the person use proper oil/ medicine (first aid)

	8. If the person is not breathing, immediately start artificial respiration until the medical aid arrives. 9. Do not touch the person with bare hands. 10. Do not give liquid unit the patient is conscious. 11. Give artificial respiration to the person who received electrical shocks by any one method.
a) ii)	**State different methods of artificial respiration and explain any one of them.**
Ans:	**(For different methods of artificial respiration : 2 Marks and explanation anyone method: 2 Marks Total 4 Marks)** **Following are several methods of applying artificial respiration some of them are.** **(Any Two methods expected)** 1. Mouth to mouth method 2. Schafer's prone pressure method 3. Silvestre's method (Arm-lift-pressure method) 4. Nielson's arm lifts Back-pressure method. **Explanation:-** **(Explanation Of Any one method expected)** **1) Mouth to mouth Method:-** This method is particularly employed where the patient has suffered chest- injuries. Step 1:- Victim is laid on his back Step 2:- Remove / ensure that there is nothing in mouth of the victim. Step 3:- Put one hand under victim's neck & with the other hand lifts his chin point upward. Step 4:- Shut the nose of the victim. Step 5:- Put your mouth tightly over the mouth of the victim & then blow vigorously (Strongly) so as to expand the chest of the victim. (To avoid direct contact with the mouth of victim, make use hand kerchief) Step 6:- Remove your mouth to let returning air escape. Step 7:- Repeat this process 3 to 4 seconds.

Step 8:- This method supplies 10-12 times more volume of air in to the patient's lungs than any other method.

Step 7:- Repeat the process slowly 12-15 times in a minute till the breathing to the person is restored.

2) Schafer's Prone pressure method:-

Step 1:- Lay the victim on his stomach (belly) with his face to one side. One arm extend directly overhead, the other arm bent at elbow

Step 2:- Free his neck from clothing.

Step 3:- Kneel (to rest on knees) over the victim back.

Step 4:- Place both hands on his back near the lowest ribs. (bargaDI)

Step 5:- Now press gradually & slowly & swing forward slowly his back for about 2-3 sec. leaning yourself forwards with arms held straight.

Step 6:- Now relax the pressure slowly & come to the original position for about 2 sec. without lifting your hands from the victim.

Step 7:- Repeat the process slowly 12-15 times in a minute till the breathing to the person is restored.

Step 8:- Do not give liquid until the patient is conscious.

b) Give the maintenance schedule of distribution transformer as per IS 10028 (Part III) - 1981.

Ans **(Any eight points are expected: 1 Mark to each point, Total 8 Marks)**

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

OR

Actions to restore transformer to its original condition.

1. **Hourly:-**
    1. Check & measure Voltage & current.
    2. Check & measure ambient temperature.
    3. Check & measure Oil & winding temperature.
2. **Daily:-**
    1. Check Oil level in transformer.
    2. Check the air passage of breather is clear.
    3. Check Condition of relief diaphragm.
    4. Check the colour of Silica gel in breather.
    5. Checks tap changer.
    6. Check tank and radiator against oil leakage.
    7. Check the cooling system.
    8. Check the ground connection (earthing).
3. **Monthly:-**
    1. Check Oil level in transformer.
    2. Check the temperature indicators
    3. Breathing holes in silica gel breather should also be checked monthly and properly cleaned if required, for proper breathing action.

4. Quarterly:-.

1. Bushing is checked.
2. Oil strength (dielectric) is checked.
3. Cooling arrangement.
4. Operating mechanism.

5. Half Yearly:-

1. Check conservator.
2. Check the acidity of oil in transformer.
3. Test oil filled in bushing.
4. Check the gasket joints.
5. Check the terminals and connections in the boxes.
6. Examine the lighting arrestor.
7. Examine relay and alarm contacts there operations, fuses etc.
8. Check the earth resistance.
9. Check the insulation resistance.

10. Check cooling system.
11. Internal inspection.
12. Check the foundation.
13. Test for pressure.
14. Check On-load tap changer and driving gear.

6. Yearly:-

1. Check Oil in transformer.
2. Check Oil filled bushings.
3. Check Gasket joints.
4. Check Cable boxes.
5. Check Surge diverter & gap.
6. Check Relay alarm & their circuits.
7. Check Earth resistance.

7. **Two Yearly:-**

Check oil conservator, Buchholz relay & transformer oil.

OR

Transformer Inspection and Maintenance

General inspection items	*Frequency*
Load current	Hourly or use recording meters
Voltage	Hourly or use recording meters
Liquid level	Hourly or use recording meters
Temperature	Hourly or use recording meters
Protective devices	Yearly
Protective alarms	Monthly
Ground connections	Every 6 months
Tap changer	Every 6 months
Lightning arresters	Every 6 months
Pressure-relief devices	Every 3 months
Breather	Monthly
Auxiliary equipment	Annually
External inspection	Every 6 months
Internal inspection	5 to 10 years
Insulating liquid	*Frequency*
Dielectric strength	Annually
Color	Annually
Neutralization number	Annually
Interfacial tension	Annually
PF test	Annually
Moisture content	Annually
Gas-analysis test	Annually
Solid insulation (winding)	*Frequency*
IR	Annually
PF	Annually
FRA	Annually
PI	Annually
Hi-pot (AC or DC)	Five years or more
Induced voltage	Five years or more
Polarization recovery voltage	Annually
DC winding resistance	Annually

c) State four possible causes for each of the following troubles of a 3 phase Induction motor. (i) Motor switch 'ON' but does not start. (ii) Motor overheat (iii) Motor runs slow (iv) Motor stalls

Ans: **(2 Marks for each causes for each troubles two points are expected Total 8 Marks)**

S.No	Type of fault/abnormal conditions/Troubles	Causes
i)	Motor f Switch 'ON' but does not start circuit)	1. Terminal voltage too low 2. Blowing of fuse/single phasing. 3. Check that any, over current or over voltage protection devices has been tripped 4. Short circuit in supply cable. 5. Open circuit in supply cable. 6. Defective starting mechanism 7. The motor controller will not operate. 10. Loose contact. 11. Motor rotor, bearings or driven load is locked. 12. Overloaded 13. Bearing is seized (Frozon). **If ask Squirrel cage I.M. add this point** 13. Inspect the rotor bars endings. **If ask Slip ring I.M. add this point** 14. In case of SR motors, check the rotor resistance circuit and control. **If ask Single phase motor add this point** 1. Open in auxiliary winding. 2. Open in main winding. 3. Open capacitor. 4. Shorted capacitor.
ii)	Motor Overheat	1. Single phasing. 2. Overload 3. Over/Under voltage. 4. Unbalance voltage 5. Over/Under frequency 6. Poor motor ventilation/ Air flow obstructed or Inadequate ventilation. 7. Ventilating Fan is not working 8. rotor rubbing on stator 9. Worn bearings 10. High ambient temperature at the motor controller. (above 40^0C (104^0 F) 11. Excessive core loss. 12. Stator winding is in correct connected (Wrong connection) 13. It may be due to internal faults inside the winding

			or for winding to earth. 14. Check the correct starting time and duty cycle. 15. Broken rotor bars 16. Shorted stator coils 17. Dirt in motor
	iii)	Motor Runs Slow	1. Low voltage. 2. Low frequency. 3. Single phasing. 4. Overload 5. Stator connected in star instead of delta. 6. One motor terminal was by mistake connected to neutral instead of phase 7. Improper connection of motor leads to supply line 8.Shorted stator coils 9. Open Stator coil 10.Broken rotor bars
	iv)	Motor stalls	1. Over load 2. low Voltage

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

a) **List any four internal and external causes for the abnormal operation of electrical equipments.**

Ans: **(2 Marks for Internal and 2 Marks for external causes, Total 4 Marks)**

Internal and external causes for the abnormal operation of electrical equipments:

Internal Faults Causes:- (Any Four points are expected from the following)

1. Insulation break down between winding & earth
2. Insulation breaks down between different phases.
3. Insulation breaks down between adjacent turns i.e. inter-turn fault.
4. Open circuit (either in H.V or L.V)
5. Short circuit (between in H.V and L.V)
6. Ground fault (between H.V and core)
7. Ground fault (between H.V and supporting structure)
8. Shorted turns (either in H.V or L.V)
9. Presence of moisture in transformer oil.
10. Failure of magnetic circuit
11. Transformer core fault.

Externals Faults Causes:- (Any Four points are expected from the following)

1. External short circuit ,the short circuit may occurs in two or three phases of electrical power system
2. High voltage disturbance

3. Sustained Power frequency over voltage
4. Lighting Surges
5. Switching Surges (There may be always a chance of system over voltage due to sudden disconnected of large load.)
6. Arcing Grounds
7. Travelling Waves
8. Sudden Changes in system condition
9. Resonance
10. Under frequency effect in power transformer**:** If frequency reduces in a system the flux in the core increases ($\phi \alpha \frac{V}{f}$), it causes similar effect that of the over voltage.

b) State the roles of Bureau of Indian standards in testing of Electrical equipment.

Ans: **(Any Two points are expected from the following : 2 Mark to each point Total 4 Marks)**

Roles of Bureau of Indian Standards (BIS) in testing of electrical equipment's

The Bureau of Indian Standards (BIS), the National Standards Body of India responsible for formulating Indian Standards was established under The Bureau of Indian Standards Act, 1986.

- To protect the interest of consumers,
- BIS operates a Product Certification Scheme. Under the scheme, BIS grants licenses to such manufacturers who are capable of producing goods on continuous basis as per relevant Indian Standards.
- Testing being necessary adjunct to product quality evaluation, the need for making available required testing facilities arises.

c) Compare direct, indirect and regenerative type of testing (any four points).

Ans: **(Any Four points are expected from the following 1 Mark to each point Total 4 Marks)**

Sr No.	Parameter	Direct Testing	Indirect Testing	Regenerative type testing
1	Type of testing	The m/c is actually loaded	The m/c is not actually loaded only 1 to 2 simple tests are carried out	This nothing but back to back test
2	Suitability	Suitable for m/c of low rating	Suitable for m/c of high rating	Suitable for m/c of high rating

3	Power Consumption	In this testing large power is consumed	In this testing small power is consumed	In this testing less power is consumed
4	Time period	It requires more time	It requires less time	It requires less time
5	Calculation	Calculations are less & Simple	Calculations are more & complicated	Calculations are more & complicated
6	Accuracy	This method gives the most accurate results	This method gives less accurate result. The result obtained are either less or more than the actual	This method gives less accurate result. The result obtained are either less or more than the actual
7	Assumption	Generally no assumptions are made	Generally some assumptions are to be considered	Generally some assumptions are to be considered
8	Type of connections	The connection are more and difficult	The connections are less and Simple	The connection are more and difficult
9	Load required	Actual load is required	Actual load is not required	Two similar machine are connected to back to back
10	Equipments/Apparatus	It requires more number of equipments	It requires less number of equipments	It requires more number of equipments
11	Method of testing	This is simple	This is complicated	This is complicated
12	Technical Skill	The technical skill and knowledge is must but it is less required.	The technical skill and knowledge is must but it is more required.	The technical skill and knowledge is must but it is more required.
13	Safety	It is less safe as a high current actually flows through the circuit	It is more safe as actual current does not flow through the circuit	It is less safe as a high current actually flows through the circuit
14	Space required	Space required is more	Space required is less	Space required is more
15	Location	It is suitable for indoor testing i.e. in industry or lab	It is suitable for outdoor testing i.e. on the site	It is suitable for indoor testing i.e. in industry or lab
16	Example	To find regulation and efficiency of alternator by direct loading method	To find regulation and efficiency of alternator by synchronous impedance method.	Hopkinson's test for shunt & Series machines and For transformer Back to Back Test

d) State the classification of insulating materials as per IS 1271-1985.

Ans: **(Any four classification are expected :1 Mark to each point Total 4 Marks)**

Insulating material can classified as following:

S.No.	Insulation Classes	Maximum permissible temperature (^{0}C)
1	Class-Y or O	90^0
2	Class- A	105^0
3	Class- E	120^0
4	Class- B	130^0
5	Class- F	155^0
6	Class- H	180^0
7	Class- C	Over 180^0

OR

Sr.No.	Type of insulating material	Max. operating temperature	Examples
1	Class-Y insulation	Up to 90^{o}C	Cotton, silk, paper, press board, wood ,cellulose-,PVC,VIR etc.
2	Class-A insulation	Up to 105^{o}C ;reinforced	Cotton, silk or paper impregnated with natural resin ,cellulose easter
3	Class-E insulation	Up to 120^{o}C	Synthetic resin enamels , cotton fabric and paper laminations with formaldehyde bonding
4	Class-B insulation	Up to 130^{o}C	Glass fiber, asbestos, mica, asbestos laminates.
5	Class-F insulation	Up to 155^{o}C	Made of Class-B materials that are upgraded with adhesives, asbestos laminates , Glass fiber, asbestos, Mica, , built up mica.
6	Class-H insulation	Up to 180^{o}C	Made of inorganic material glued with silicon resin or adhesive of equivalent performance such as mica, glass fiber .
7	Class-c insulation	Above 180^{o}C	Made of 100% inorganic material E.g. mica, porcelain, ceramics, glass quartz, asbestos, treated glass fiber or treated asbestos etc.

e)	**State different methods for measurement of insulation resistance and explain any one of them.**
Ans:	**(Methods of insulation resistance-2 Marks and explain any one method: 2 Marks, Total 4 Marks)** **Methods for measurement of insulation resistance:** 1) Megger 2) Step Voltage Method **Explanation:** **1) Megger:-** A 5000Vor 2500V or 1000V or 500V motor driven meager is used to measure the insulation resistance. **For example transformer measurement of insulation resistance:** ➢ First disconnect all the line & neutral terminals of the transformer ➢ To check the IR, megger should be crancked (rotate) at a speed indicated in its certificate (usually 120 rpm). ➢ First, Megger leads to connected to HV bushing studs & LV bushing studs. This measure insulation resistance value in between the HV windings & LV bushing ➢ Megger leads to connected to HV bushing studs & transformer tank earth point. This measure insulation resistance value in between the HV windings & earth. ➢ Megger leads to connected to LV bushing studs & transformer tank earth point. This measure insulation resistance value in between the LV windings & earth. **OR** • A 2500V or 1000V or 500V motor driven meager is used to measure the insulation resistance. ➢ Two readings, one after 15 sec. & the other after 60 sec. ➢ If the material is sound, The value of R_{60} is higher than value of R_{15} **2) Step Voltage Method:-** ➢ In this test DC voltage in steps of 1KV, or 2 KV is applied between winding & earth. ➢ The voltage can be raised up to a test value & a current flowing through circuit is recorded.

	Precaution:- ➢ The step voltage is maintained for a small time interval. **Calculation:-** ➢ Calculate value of insulation resistance from V & I reading. **Graph:-** Then graph is plotted between calculated value of resistance & applied test voltage.
Q.4 a)	**Attempt any THREE of the following: 12 Marks**
i)	**What precautions should be taken to avoid fire due to electrical reasons?**
Ans:	**(Any Four Points Expected 1 Mark to each point Total 4 Marks)** **Fire due to electric reason can be prevented by taking the following precautions:** 1. Use superior quality of material (ISI mark) 2. Well insulated & proper size of wires, cables should be used. 3. By the use of proper rating protective devices with the electrical circuits. 4. Overloading of electrical installation & equipment should be avoided. 5. The joints in the electrical system should mechanically & electrically sound. 6. There should not be any loose connection in the electrical installation & these should be checked periodically. 7. Electrical installation & equipments used in hazards area should be satisfied the specification/type of protection. 8. Clearances should be maintain as per Voltage level. 9. Avoid use of too many device plugged into a circuit, causing heated wire & possible a fire.
ii)	**List out the tests to be carried out on transformer as per IS 2026 and state the objective of heat run on test on transformer.**
Ans:	**(Any Two names of test are expected: 1 Mark to each point and Objective of heat run test-2 Marks, Total 4 Marks)** **List of the tests to be carried out on transformer :-** **Routine tests of transformer include** :- 1.Transformer winding resistance measurement. 2.Transformer ratio test. 3.Transformer vector group test. 4.Measurement of impedance voltage/short circuit impedance (principal tap) and load loss

(Short circuit test).
5. Measurement of no load loss and current (Open circuit test)
6. Measurement of insulation resistance.
7. Dielectric tests of transformer.
8. Tests on on-load tap-changer.
9. Oil pressure test on transformer to check against leakages past joints and gaskets.

Type tests of transformer includes :-

1. Transformer winding resistance measurement
2. Transformer ratio test.
3. Transformer vector group test.
4. Measurement of impedance voltage/short circuit impedance (principal tap) and load loss (Short circuit test).
5. Measurement of no load loss and current (Open circuit test).
6. Measurement of insulation resistance.
7. Dielectric tests of transformer.
8. Temperature rise test of transformer.
9. Tests on on-load tap-changer.
10. Vacuum tests on tank and radiators.

Special Tests of transformer include :-

1. Dielectric tests.
2. Measurement of zero-sequence impedance of three-phase transformers
3. Short-circuit test.
4. Measurement of acoustic noise level.
5. Measurement of the harmonics of the no-load current.
6. Measurement of the power taken by the fans and oil pumps.
7. Tests on bought out components / accessories such as buchholz relay, temperature indicators, pressure relief devices, oil preservation system etc.

Following Objective of heat run on test on transformer:

- This test is primary intended to determine the actual maximum temperature attained on different parts of the transformer while running at full load.
- This test is also used to find regulation, efficiency of transformer.

iii)	**What are the factors to be considered in designing the machine foundation?**
Ans:	**(Any Four Points Expected 1 Mark to each point Total 4 Marks)** **Following factors to be considered in designing the machine foundation:-** ➢ The foundation should absorb the vibrations created by the machine while operating at its full capacity. ➢ The foundation should spread over as much area that will not exceed the intensity of load over the soil more than its safe bearing capacity. ➢ The frictional resistance between foundation block and the soil should be sufficient to withstand the possible horizontal thrust caused by machine while in operation. ➢ The foundation block should be so spread that the resultant of all the forces should pass within the foundation block.
iv)	**State the various requirements of installation of rotating machines.**
Ans:	**(Any Four Points Expected: 1 Mark to each point ,Total 4 Marks)** **Following are the basic requirements of machine foundation:-** i) Horizontal Level ii) Rigidity or Safe bearing capacity iii) Freedom from vibrations. or The capacity of absorption of vibration iv) Type of machine-static or dynamic v) Sufficient frictional resistance to withstand the possible horizontal thrust.
Q. 4 b)	**Attempt any ONE of the following: 06 Mark**
i)	**Why filtering of transformer oil is required? Explain with neat sketch any one method of filtering transformer oil.**
Ans:	**(For Reason for filtering of transformer oil Four Points Expected: 1 Mark to each point Total 4 Marks and for Explanation with neat sketch any one method: 2 Marks, Total 6 Marks.)** **Reason for filtering of transformer oil is required because of :** **(Any Four Points Expected 1 Mark to each point Total 4 Marks)**

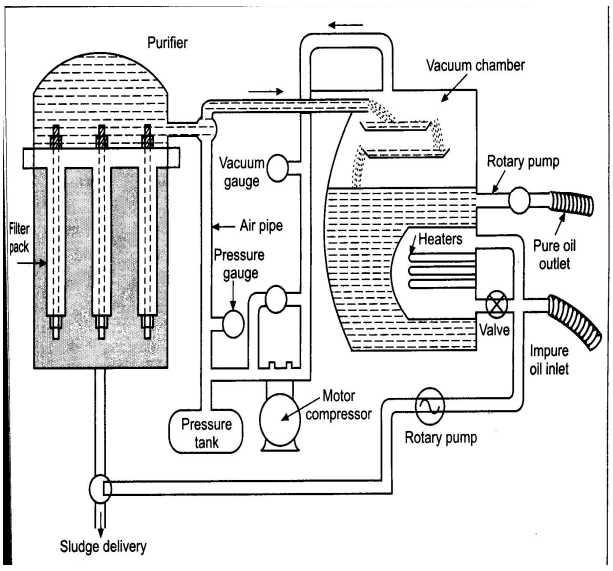
1. To Remove dissolved moisture, free water (dehydration)
2. To Remove solid impurities **OR**
3. Drying, degassing & de-aerating transformer oil.
4. Drying out new or old transformer if it is not used for long period.
5. The improvement of the insulation resistance of transformer in service.
6. The bulk treatment of either new or used oil in strong or make up tanks.

Explanation of method of filtering transformer oil :

(Explanation with neat sketch any one method : 2 Marks)

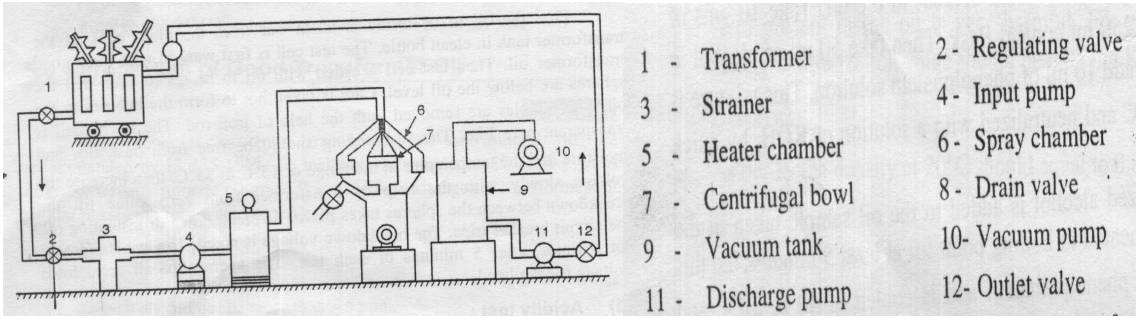
1. Stream Line Purifiers:-

- In this process oil under high pressure is passed through very thin paper-discs (Filter packs).
- The purified oil will go down and impurities remain in paper-discs.
- Compressed air is passed to release the collected impurities. (deposited dirt & carbon)
- This type of purifier is most efficient to remove the moisture from oil.



or equivalent figure

2) Centrifugal Purifiers:-

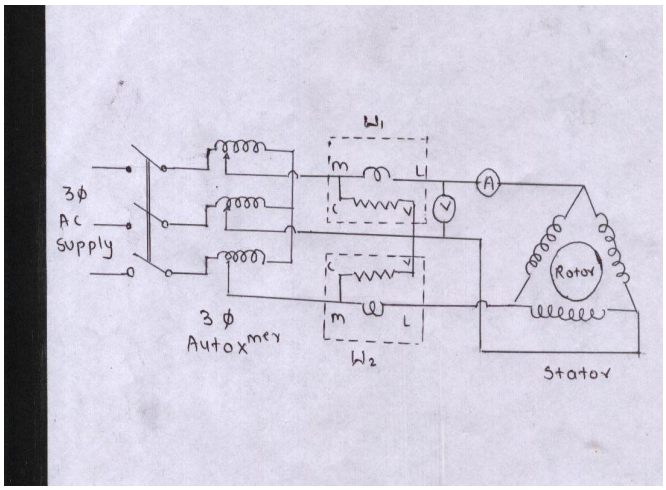


- In this purifier the impurities are separated by making use of minor differences between the specific gravities of the oil and impurities like water which are heavier than oil.
- The assembly rotated very high speed of 6000 to 8000 rpm by an electric motor.
- Due to this high centrifugal forces are created, due these heavier particles thrown out of bowl directly and purified oil remains in bowl.
- The moisture & dissolved gases are also removed from oil, when it is centrifuged at high speed

ii) Draw the circuit diagram to perform the reduced voltage run up test on 3 phase induction motor and describe the objective of test.

Ans: **(For Circuit Diagram – 4 Marks and objective of test -2Marks, Total 4 Marks)**

Circuit Diagram:

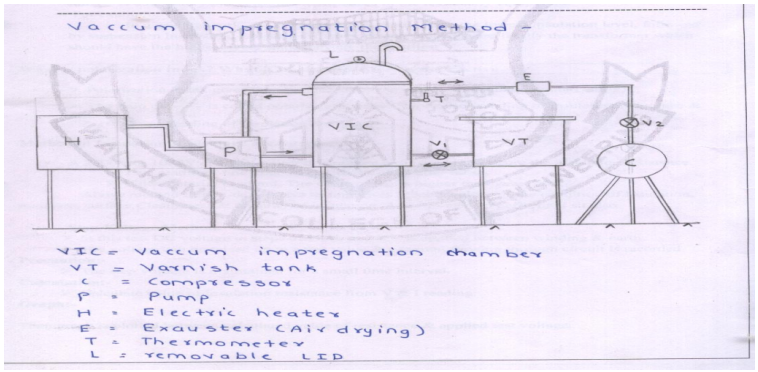


or equivalent figure

	Objectives of reduced voltage run up test:- ➢ The test is applied to squirrel cage motors. ➢ The test is made to check the ability of motor to run equal and nearly equal to rated speed of the motor even at reduced voltage. ➢ The aim of test is to see whether there is any tendency of crawling presents in the motor. ➢ This test is also conducted to check the noisy running of motor(which may be due to damaged bearings, also the presence of loose bars and wrong connection stator winding)
Q.5	**Attempt any TWO of the following: 16 Marks**
a)	**What do you mean by revarnishing of insulation'? When it is required? Explain with neat sketch, vacuum impregnation method of varnishing.**
Ans:	**(Meaning of revarnishing- 1 Mark, reasons for revarnishing- 4 Marks, Explanation of method of varnishing- 3 Marks, Total 8 Marks)** **Meaning of revarnishing of insulation:** Covering of any liquid insulating material over old winding is known as revarnishing. **Revarnishing of insulation s required due to following reason (Any four points are expected)** ➢ Coils are made up of insulated wires, the covering consisting of cotton, silk or enamel etc. ➢ Which are hygroscopic, i.e they tend to absorb and retain moisture. The insulation provided between layers as well as the space between turns in the interior of the coil contain considerable amount of air spaces. ➢ If the coils are not covered by any insulating varnish, moisture tends to accumulate in this air space. Not only will it lower the insulation strength, but may ultimately lead to a breakdown and internal short-circuit. ➢ By covering the coils with good insulating varnish, the air spaces are filled up and sealed; the windings get protected against ingress of moisture and thereby they will give much better service. ➢ This process of coating electrical windings with insulating varnish is called ‘impregnation’

Explanation of vacuum impregnation method of varnishing.

Figure:-



or equivalent figure

- The plant consists of a large air tight chamber, varnish is stored in Tank and The compressor to create vaccum or pressure.
- In vacuum impregnation all the air is removed, so varnish occupies all such spaces. After this if proper baking is done the varnishing is perfect and through.

b) **A 415 V, 40 h.p. (29.84 kW), 50 Hz delta connected motor gave the following test data. No load test: 415 V, 21 A, 1250 W , Locked rotor test : 100 V, 45 A, 2730 W Construct the circle diagram and determine : (i) the line cement and power factor for rated output. (ii) maximum torque**

Assume stator and rotor Cu losses equal at standstill.

Ans:

No load test: 415 V, 21 A, 1250 W,

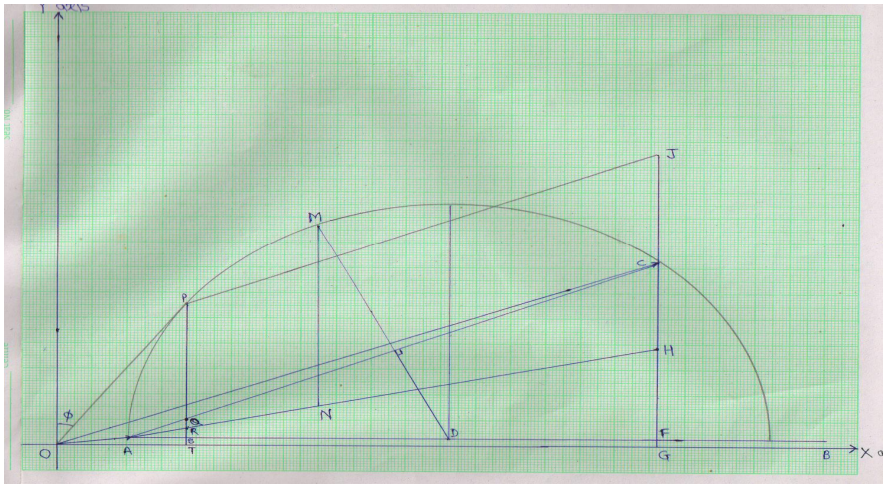
Locked rotor test : 100 V, 45 A, 2730 W

Draw a circle diagram and determine:

i) Line current and power factor at rated output

ii) Maximum O torque

Solution:-



-------2Mark)

Given data: 3-ph, 415V, 40 HP (29.84 kW), 50Hz

1) No load Test: V_0 = 415V, I_0 = 21A, W_0 = 1250 watt

Vector 00' *represents* $I_0 \angle \phi_0$

$$\phi_0 = Cos^{-1}\left(\frac{W_0}{\sqrt{3} V_0 I_0}\right)$$

$$\phi_0 = Cos^{-1}\left(\frac{1250}{\sqrt{3}\times 415\times 21}\right)$$

$\phi_0 = 85.25^0$ *Elec.* ---------- **(1/2Mark)**

2) Blocked Rotor Test: - V_{SC} = 100V, I_{SC} = 45A & W_{SC} = 2730 watt

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

$$I_{SN} = I_{SC}\ \left(\frac{V}{V_{SC}}\right)$$

$$I_{SN} = 45\ \left(\frac{415}{100}\right)$$

$I_{SN} = 186.75\ A$ ---------- **(1/2Mark)**

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

$$\phi_{SC} = Cos^{-1}\left(\frac{2730}{\sqrt{3}\times 100\times 45}\right)$$

$\phi_{SC} = 69.49^0$ *Elec.* ---------- **(1/2Mark)**

3) Let, the Current scale: - 1 cm = 10A

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

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

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

$W_{SN} = 2730(\frac{415}{100})^2$

$W_{SN} = 47016$ *watts* ---------- **(1/2Mark)**

Form circle diagram length of FH in cm = 3.5 cm

Power scale:- 1 cm = $\sqrt{3} \times 415 \times 10$

$= 7.18$ *Kwatts* ---------- **(1/2Mark)**

5) Length of JC in cm $= \frac{Output\ in\ watts}{power\ scale}$

$= \frac{29840}{7180}$

$= 4.155$ *cm* ---------- **(1/2Mark)**

6) Line current at rated O/p is represented by line OP:-

= 6.7 cm x10

Line current at rated output = 67 A ---------- **(1Mark)**

7) Power factor at full load = $Cos\phi = Cos\,35^0$

Power factor at Full load = 0.819 *Lag* ---------- **(1Mark)**

8) Maximum Torque : MN = 7 x 7.18 = 50.26 x 1000 = 50260 Syn. Watts --------- **(1Mark)**

c) What is the effect of misalignment on the performance of machine? Explain the procedure to be followed in aligned two shaft-in direct coupled drive.

Ans: **(Any six effect of misalignment : 1 Mark to each point total: 6 Marks and for the procedure of alignment 2 Marks, Total 8 Marks)**

Following are the effect of misalignment on the performance of machine

Effect of misalignment on the performance of machine: (direct coupled)

(Any six points are expected)

1. Increase load on bearing.
2. Increase in vibration.
3. Increase noise level
4. Increases stresses on coupling & shaft.
5. Final effect of this the bending of shaft, damages to bearing & overloading of driving

machine causing it failure
6. Overall performance of machine reduces
7. It reduces the machine's life and causes a decrease in motor efficiency,
8. Misalignment phenomenon is one of main causes for economic losses in industry.

OR

Effect of misalignment on the performance of machine: (indirect coupled)

1. The life of belt, rope , chain & gear is shorted.
2. Produces distribute vibration.
3. Increase noise level.
4. Bent shaft.
5. Worn out bearing.
6. Final effect of this is early wear & tear of both driven & driving machine

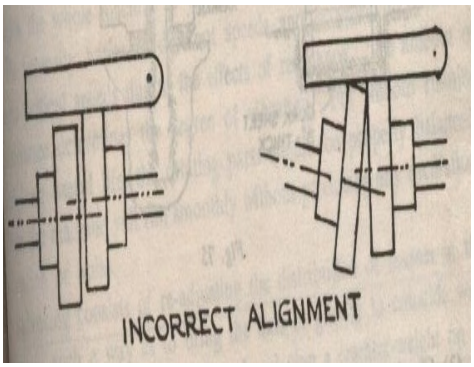
The procedure to be followed in aligned two shaft-in direct coupled drive.

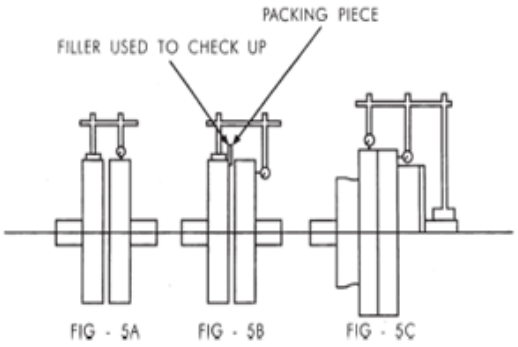
The shafts of driven and driving machine are aligned by various methods. The most common one is the alignment by flexible coupling method. There are three steps in the alignment of the shafts.

i) Axial positioning of the shafts.
ii) Paralleling of shafts axis.
iii) Centering of shaft axis

1. Align the motor and the driven machine on bed-plate in their final position.
2. The two shafts must be in line, the two shafts should be on the same centre.
3. The driven shaft is leveled 1st that is the shaft must be in line. In case of belt or gear drives, they must be parallel.
4. Turn the motor shaft through 90^0,180^0, 270^0 and 360^0 and note the reading of the gap.
5. The gap can be readily seen if a light is placed on the opposite side.
6. This can be checked by measuring the gap between the flange face at four points. i.e. top, bottom, front, back.
7. Any variation in levels is corrected by suitable steel shims. The excess difference is reduced below 0.05 mm by adjusting the shims (steel packing plates). it is leveled by adding or removing shims
8. The alignment should not only be correct in the vertical and horizontal planes but the axis of both the shafts should be in the same line and not make an angle with each other.
9. The lining up is checked by making measurements with steel tape, from the centre of the

driven shaft to the centre of the motor shaft.





Q.6	**Attempt any four of the following : 16 Marks**
a)	**What are the different routine tests and type test of single phase induction motor?**

Ans: **(Any Two names of test are Expected from routine tests and type test 1 Mark to each point- Total 4 Marks)**

1) Following are the routine test for 1-Phase Induction Motor:-

1) No- load Test
2) Locked Rotor test,
3) Quiet Running test
4) Insulation Resistance test
5) High Voltage test
6) Resistance measurement test

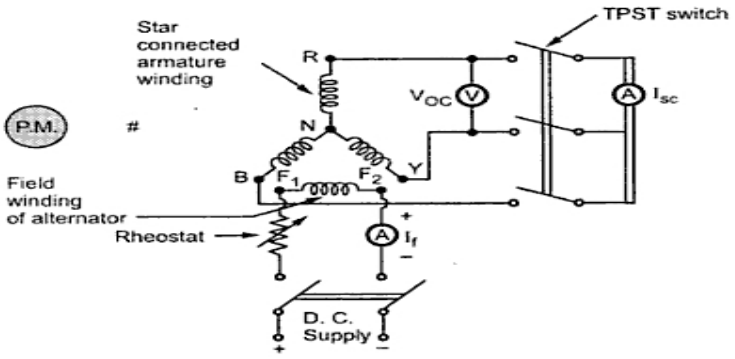
2) Following are the Type test for 1-Phase Induction Motor:-

1. No- load Test
2. Locked rotor test,
3. Quiet Running test
4. Resistance measurement test
5. Insulation Resistance test
6. High voltage test
7. Pull- out torque test
8. Full load Test

9. Temperature rise test
10. Momentary overload test
11. Moisture-proofness test
12. Leakage current test
13. Test for overload in torque (for refrigeration motors only)

b) Describe the procedure of synchronous impedance method to find regulation of alternator.

Ans: **(For figure -2 Marks and for procedure 2 Marks , Total 4 Marks)**



Open Circuit Test or synchronous impedance method to find regulation of alternator

Procedure to conduct this test is as follows :

1. Start the prime mover and adjust the speed to the synchronous speed of the alternator.
2. Keeping rheostat in the field circuit maximum, switch on the d.c. supply.
3. The T.P.S.T switch in the armature circuit is kept open.
4. With the help of rheostat, field current is varied from its minimum value to the rated value. Due to this, flux increasing the induced e.m.f. Hence voltmeter reading, which is measuring line value of open circuit voltage increases. For various values of field current, voltmeter readings are observed.

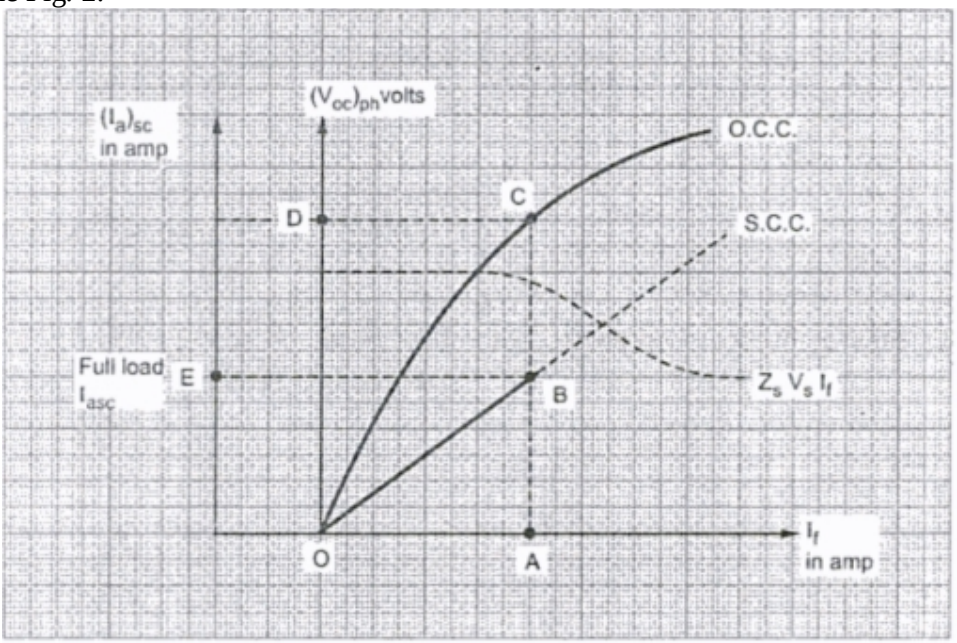
Observation table for open circuit test :

Sr. No.	I_f A	V_{oc} (line) V	V_{oc} (phase) = V_{oc} (line)/$\sqrt{3}$ V
1			
2			
:			
:			

From the above table, graph of $(V_{oc})_{ph}$ against I_f is plotted.

Note: This is called open circuit characteristics of the alternator, called O.C.C. This is shown in

the Fig. 2.



Short Circuit Test

After completing the open circuit test observation, the field rheostat is brought to maximum position, reducing field current to a minimum value. The T.P.S.T switch is closed. As ammeter has negligible resistance, the armature gets short circuited. Then the field excitation is gradually increased till full load current is obtained through armature winding. This can be observed on the ammeter connected in the armature circuit. The graph of short circuit armature current against field current is plotted from the observation table of short circuit test. This graph is called short circuit characteristics, S.C.C. This is also shown in the Fig. 2.

Observation table for short circuit test :

Sr. No.	I_f A	Short circuit armature current per phase (I_{asc}) A
1		
2		

The S.C.C. is a straight line graph passing through the origin while O.C.C. resembles B-H curve of a magnetic material.

Note: As S.C.C. is straight line graph, only one reading corresponding to full load armature current along with the origin is sufficient to draw the straight line.

Determination of From O.C.C. and S.C.C.

$$Z_s = E_{ph} / I_{asc}$$

$\therefore$ $E_{ph} = (V_{oc})_{ph}$ on open circuit

This is what we are interested in obtaining to calculate value of Z_s. So expression for Z_s can be modified as,

$$Z_s = \left.\frac{(V_{oc})_{ph}}{(I_{asc})_{ph}}\right|_{\text{for same } I_f}$$

Thus in general, $$\boxed{Z_s = \left.\frac{\text{Phase e.m.f. on open circuit}}{\text{Phase current on short circuit}}\right|_{\text{For same excitation current}}}$$

Regulation Calculations

Now $$Z_s = \sqrt{(R_a)^2 + (X_s)^2}$$

$$\therefore \quad \boxed{X_s = \sqrt{(Z_s)^2 - (R_a)^2}\ \Omega/\text{ph}}$$

s

So synchronous reactance per phase can be determined.

No load induced e.m.f. per phase, E_{ph} can be determined by the mathematical expression derived earlier.

$$\boxed{E_{ph} = \sqrt{(V_{ph}\cos\phi + I_a R_a)^2 + (V_{ph}\sin\phi \pm I_a X_s)^2}}$$

where V_{ph} = Phase value of rated voltage
I_a = Phase value of current depending on the load condition
$\cos\Phi$ = p.f. of load

Positive sign for lagging power factor while negative sign for leading power factor, R_a and X_s values are known from the various tests performed.

The regulation then can be determined by using formula,

$$\% \text{ Regulation} = \frac{E_{ph} - V_{ph}}{V_{ph}} \times 100$$

c) List internal and external causes for failure of equipments.

Ans: **(2 Marks for Internal and 2 Marks for external causes Total 4 Marks)**

Internal Faults Causes:- (Any Four points are expected from the following)

1. Insulation break down between winding & earth
2. Insulation breaks down between different phases.
3. Insulation breaks down between adjacent turns i.e. inter-turn fault.
4. Open circuit (either in H.V or L.V)
5. Short circuit (between in H.V and L.V)
6. Ground fault (between H.V and core)
7. Ground fault (between H.V and supporting structure)
8. Shorted turns (either in H.V or L.V)

	9. Presence of moisture in transformer oil. 10. Failure of magnetic circuit 11. Transformer core fault. **Externals Faults Causes:- (Any Four points are expected from the following)** 1. External short circuit ,the short circuit may occurs in two or three phases of electrical power system 2. High voltage disturbance 3. Sustained Power frequency over voltage 4. Lighting Surges 5. Switching Surges (There may be always a chance of system over voltage due to sudden disconnected of large load.) 6. Arcing Grounds 7. Travelling Waves 8. Sudden Changes in system condition 9. Resonance 10. Under frequency effect in power transformer**:** If frequency reduces in a system the flux in the core increases ($\phi \alpha \frac{V}{f}$), it causes similar effect that of the over voltage.
d)	**List out the tools required for loading and unloading the heavy equipments. Also state the use.**
Ans:	**Equipment used for lifting heavy electrical machine:-** **(Any four names of devices expected: 1Mark each, Total 4 Marks)** 1. Stationary Cranes : For lifting heavy equipment 2. Overhead or Gantry Cranes : For lifting and moving heavy equipment 3. Mobile Cranes : For lifting and moving heavy equipment on site 4. Truck Mounted Crane : For lifting and moving heavy equipment on site 5. Steam Crane : For lifting and moving heavy equipment on site 6. Chain pulley Block : For lifting heavy equipment

7. Chain Hoist : For lifting heavy equipment
8. Electric Hoist : For lifting and moving heavy equipment
9. Screw Jacks : For lifting heavy equipment
10. Winches : For lifting heavy equipment
11. Hoses & tripods : are the simplest temporary supports for heavy equipment
12. Ceiling ropes: For lifting heavy equipment

e) State the meaning of earth resistance. State the permissible values of earth resistance in case of
(i) Power station (ii) Substation (iii) Domestic Installation (iv) O.H. installation

Ans: **(1- Mark to each , Total 4 Marks)**

S.No	Earth resistance in following	Permissible values of earth resistance
1	Power station	0.5 Ω
2	Substation	1.0 ohm to 2.0 ohm
3	Domestic Installation	**5** Ω or less
4	O.H. installation	**5** Ω TO 10 Ω

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