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**
i)	**How will you prevent electrical accidents? (Any four points expected : 01 Mark for each point)**
Ans:	**Following points are to be considered to prevent the electrical accidents:** 1. Safety book/ Training should be given to all persons working in plants. 2. Only qualified men do the work, 3. Untrained person should not allow handling electrical equipment. 4. While working on live equipment obey the proper instructions. 5. Give proper instructions for super vision. 6. Do not allow visitors & unauthorized persons to touch or handle electrical equipment. 7. Know the work content and work sequence, especially all safety measures. 8. Do not work if you are not sure or knowledge of the condition of equipment/ machine. 9. Do not perform, or continue to perform, any work when you are in doubt about the safety procedure to be followed, 10. Insulate yourself on the insulating material like wood, plastic etc. before starting the work on live main.

11. Well insulated & proper size of wires with ISI mark should be used.
12. Always use proper insulated tools & safety devices during working.
13. Test rubber gloves, safety equipments, insulated tools periodically.
14. Avoid use of sub-standard material or defective material.
15. Inspect all electrical equipment & devices to ensure there is no damage or exposed wires that may causes a fire or shock.
16. Avoid using electrical equipment near wet, damp areas.
17. Correct rating of fuse/MCB/switch gear etc. should be used in the circuit.
18. Place Warning board /caution Notice/ Danger board/Safety tagging while working.
19. Make habit to look out for danger notice, caution board, flags, and tags.
20. Always operate switches /Isolators by dry hands.
21. Your hand & feet must be dry (not wet) while working on live main.
22. Avoid working on defective equipment.
23. Always keep safe distance from HV / equipment / conductor.
24. Do not make safety devices inoperative.
25. Use preventive devices such as ground fault circuit interrupters(Earth fault Relay/ELCB)
26. Avoid working on live parts.
27. Never speak to any person working upon live mains.
28. Make sure while working on line that the capacitor is fully discharged.
29. Avoid working in unfavorable conditions such as rain fall, fog or high wind.
30. Avoid working when there is improper illumination such as insufficient light or unsuitable location producing glare or shadows.

31. Do not carrying pipe, conduit, reinforced rods umbrellas, & other conducting material vertically in switchyard or near live electrical equipments or conductor
32. Avoid sacrificing safety for speed while working.
33. Wear appropriate clothing (loose clothing is avoided).
34. Do not wear suspended Necklace, arm bands, finger ring, key chain, and watch with metal parts while working.
35. When using ladder it should be held firmly by another person & must be placed at safe angle about 75^0 with the horizontal.
36. Do not work alone; work with another worker or employee at all times.
37. Do not spliced two ladders together (use of step ladder above 6 meter is prohibited.)
38. Use safety belt while working with overhead line/ above ground level.
39. Electrical installation & equipments used in hazards area should be satisfied the specification/type of protection.
40. Make a habit of turning your face away whenever an arc or flash may occur (Use transferred glass goggle or safety goggle)
41. Do barricading to hazard area.
42. Do not take support of any structure, pole equipment in the yard by person.
43. Use extreme care when breaking an inductive circuit as dangerous high voltage is likely to result.
44. Use shoes with rubber soles to avoid shock.
45. Interlock system should not be made inoperative unless authorized by the engineer- in charge.
46. All anticipated hazards should be pointed out to workers.
47. Not allowing person to do work if not feeling well (ill)
48. Do not hang cloths or any other type of material on electrical equipment/pole etc.
49. Replace Old wiring.
50. Avoid cords lying under carpet.

ii)	**Define Break down maintenance. State any four causes of breakdown of electrical equipments.**
Ans:	**Breakdown Maintenance:-** **(2 Mark)** The maintenance carried out when machine or equipment fails to run or not working satisfactory is called break down maintenance. **Causes of Breakdown of electrical equipments:** **(Any Four causes Expected: 1/2 Mark each Total Mark 2)** The following main causes of breakdown 1.Transit damage 2. Faulty design construction 3. Incorrect installation or use 4.Lack of installation check 5. Negligence on maintenance. 6.Ageing effect 7.Wear and Tear 8.Accident 9.Overload for long period 10. Poor workmanship 11. Bad quality of raw material. 12. Bad atmospheric condition and surrounding around the equipment.
iii)	**List out any eight contaminations agents of transformer oil.**
Ans:	**Causes of contamination of transformer oil:** **(Any eight causes expected: 1/2 Mark each)** The insulating oil gets contaminated when the following impurities are present in oil. 1. Presence of water. 2. Presence of dissolved moisture. 3. Presence of carbon deposits. 4. Presence of dirt & dust.

5. Presence of sludge.
6. Presence of sulpher.
7. Presence of gases.
8. Presence of acids.
9. Presence of acetones.

iv) State any four troubles in case of D.C. machines

Ans: **Following troubles in case of D.C. machines: (Any four troubles expected: 1 Mark each)**

No	Troubles in DC machines
1	Fail to start
2	On starting, it starts, then change direction of rotation
3	Motor does not pick up rated speed
4	Motor runs high speed
5	Motor does not slow down due to increase in load
6	Motor runs very slow
7	Motor runs very hot
8	Field winding get hot
9	Brushes are sparking
10	Brush are getting worn out very fast
11	Unusual vibration which indicate unbalance
12	Giving unusual noise

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

i) Compare direct and in-direct method of testing. (Any two points) Also write any two advantages and two disadvantages of indirect testing.

Ans (Any two points Expected 1 Mark each point- Total 2 Marks)

Sr No.	Parameter	Direct Testing	Indirect Testing
1	Type of testing	The m/c is actually loaded	The m/c is not actually loaded
2	Suitability	Suitable for m/c of low 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
4	Time period	It requires more time	It requires less time
5	Calculation	Calculations are less & Simple	Calculations are more & complicated
6	Accuracy	This method gives the most accurate results	This method gives less accurate result.
7	Assumption	Generally no assumptions are made	Generally some assumptions are to be considered
8	Type of connections	The connection are more and difficult	The connections are less and Simple
9	Load required	Actual load is required	Actual load is not required
10	Equipments/Apparatus	It requires more number of equipments	It requires less number of equipments
11	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.
12	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
13	Space required	Space required is more	Space required is less
14	Location	It is suitable for indoor testing i.e. in industry or lab	It is suitable for outdoor testing i.e. on the site
15	Example	To find regulation and efficiency of alternator by direct loading method	To find regulation and efficiency of alternator by synchronous impedance method.

Advantages of indirect testing: (Any two points Expected 1 Mark each point- Total 2 Marks)

1. Power consumption is less.
2. Time required is less.
3. Efficiency at any desired load condition, even over loads can be determined by this test.

Disadvantages of indirect testing: (Any two points Expected 1 Mark each point- Total 2 Marks)

1. Calculations are more & complicated
2. This method gives less accurate result.
3. The technical skill and knowledge is must but it is more required.

ii)	**State the objectives of testing of electrical equipments. (Any four) Also define:** **1) Type test 2) Special test**
Ans:	**Following are the objectives of testing of electrical equipments:** **(Any Four points Expected 1 Mark each point- Total 4 Marks)** 1. To confirm whether machine/equipment/ product is manufactured as per design data or not. 2. To confirm whether the performance of machine/equipment/ product is as per design data or not. 3. To determine that the machine/equipment/ product appears to be working as stated in the specifications 4. To confirm whether the results obtain during testing are within tolerance limits specified by BIS / ISS 5. If the variations in results are not within tolerance limit it is necessary to modify design & material used. 6. To provide an indication of the product reliability and quality. 7. To ensure the quality of material used & workmanship. 8. To find an error in machine/equipment/ product. 9. To find defects in machine/equipment/ product. 10. Testing in all respect is also required when a new design or modified design is used, to check whether the new product works as per the revised designed or not. **Definition of following tests** **1) Type Test (Unit test):-** **(1 Mark)** These tests are carried out on 2 or 3 randomly selected machines from the lot / batch of the manufactured machines of same design and specification. The test results of the few tested machines are treated same, for the complete lot of the machine. **2) Special Test:-** **(1 Mark)** These are preformed for specific purpose only as per demand of customer, and these tests are carried out in the presence of customer..

Q.2	Attempt any TWO of the following: 16 Marks
a)	State any eight precautions to be taken to avoid of electrical fire.
Ans:	Following are precautions to be taken to avoid of electrical fire: **(Any Eight points Expected 1 Mark each point- Total 8 Marks)**

1. Frequently checking of electrical cables, wires appliances, and closely inspect cords and plugs.
2. Overloading on cables/wires/machine should be avoided.
3. Do not use of too many device plugged into a circuit.
4. Correct rating of fuse/MCB/switch gear etc. should be used in the circuit.
5. Joints in wiring must be sound.
6. There should not be any loose connection in the electrical installation.
7. Replace deteriorated cables, wires, etc. by new one.
8. Use ground fault protection. like ELCB/earth fault relay.
9. Test electrical safety devices.
10. Do not make safety devices inoperative.
11. Electrical installation & equipments used in hazards area should be satisfied the specification/type of protection.
12. Replace Wiring that becomes defective with the passage of time.
13. Maintenance should be done strictly as per schedule.
14. Use of superior quality of material ISI mark.
15. Replace faulty electrical installation and outdated appliances.
16. Replace Old electrical sockets and unsafe appliances.
17. Maintain clearance as per voltage level between two equipments etc.
18. Do not store highly inflammable liquids/material near (close to) electrical oven/furnace to avoid fire.
19. Do not keep electric heaters near curtains or furniture.

b) Discuss any six factors which effect the preventive maintenance schedule.

Ans: **It depends on following Factors: (Any Six factors Expected - Total 8 Marks)**

1. Load cycle / Operating cycle of equipment or machine, or whether the machine is continuously working or otherwise.
2. Type of machine & it's working condition.
3. Cost of the maintenance.
4. Availability of spares & raw material.
5. Availability of trained & skilled technician.
6. It depends on production requirement.
7. Working environment of industry.(Presence of dust, dirt, chemical fumes, moisture in the air)
8. If the machine is continuously overload it needs early maintenance it will also need suitable time for preventive maintenance.
9. If the machine fails, how mush loss of money it will cause due to its down period.
10. Aging of machine
11. The machine used in the production work comes under essential equipments and they need suitable time for preventive maintenance.

c) Prepare a trouble shooting chart for transformer as per IS 10028-1981.

Ans **(Any Four points Expected 2 Marks each trouble - Total 8 Marks)**

Sr.no	Troubles	Causes	Remedial Measures
1.	Transformer becomes overheating	➢ It may be due to overloading. ➢ Failure of cooling System. ➢ High ambient temperature. ➢ Low liquid level.	Rectify the Cause
2.	Over temperature	➢ Over current, ➢ Over voltage, ➢ Insufficient cooling, ➢ Low liquid level, ➢ Sludge in the transformer liquid, ➢ High ambient temperature ➢ Short-circuited core.	Rectify the Cause
3.	Excessive core heating	➢ Due to high magnetizing current ➢ High inrush current	Rectify the Cause

4.	Transformer does not show output voltage	➢ Primary side fuses blown out or circuit breaker may trip. ➢ Failure of primary winding. ➢ Tap changer, loose connection. ➢ Wire connection may be open in bushing.	Rectify the Cause
5.	Incorrect secondary voltage	➢ Improper turns ratio ➢ Abnormal primary voltage ➢ Shorted turns in the transformer.	Rectify the Cause
6.	Phase voltage unequal (Non-Symmetrical voltage on secondary side)	➢ Unequal Loading. ➢ Single phasing.	Rectify the Cause
7.	High exciting current	➢ Usually, high exciting currents are due to short circuited core ➢ open core joints	Rectify the Cause
8.	Transformer body gives shock	➢ Insulation resistance reduced. ➢ Any live wire touches the transformer tank (Earth fault).	Rectify the Cause
9.	Low insulation resistance	➢ Moisture in the oil.	Rectify the Cause
10.	Winding insulation failure	➢ Failure may be due to a short-circuit Fault, ➢ Lightning, ➢ Overload ➢ Over current condition, ➢ Transformer liquid containing moisture and contaminants.	Rectify the Cause
11.	Unexpected voltage to earth measurement	➢ Earth failure on one phase.	Rectify the Cause
12.	External Short circuit	➢ It may be due to insufficient clearance on overhead line. ➢ Accumulation of dust on insulator (Transformer bushing).	Rectify the Cause
13.	Internal Short circuit	➢ Continuous overloaded transformer, due to this temperature increases so, possibility of insulation failure. ➢ Fault in tap changer. ➢ Loose connections, causing local	Rectify the cause.

			overheating. ➢ Vibration on Insulation resulting internal short circuit	
	14.	Short circuit between adjacent turns (Turn to turn fault)	➢ Reason of external short circuit. ➢ Fluctuating load. ➢ Transient overvoltage. ➢ Moisture in oil	Rectify the cause.
	15.	Rapid deformation of oil	➢ Poor Quality of transformer oil. ➢ Presence of water. ➢ Presence of dissolved moisture. ➢ Presence of carbon deposits. ➢ Presence of dirt & dust. ➢ Presence of sulpher. ➢ Presence of dissolved gases. ➢ Presence of acids. ➢ Breakdown voltage of oil reduces. ➢ It may be due to excessive overheating.	Rectify the causes.
	16.	Moisture in oil /Low dielectric strength	➢ Moisture in the oil while filling. ➢ Breather gets saturated. (Colour of silica gel becomes pink). ➢ It may be due to defective seals (gasket). ➢ Penetration of moisture due to improper ventilation ➢ Broken relief diaphragm ➢ Leaks around transformer Accessories ➢ Cooling coil leakage.	Rectify the Cause
	17.	Pressure-relief diaphragm broken	➢ Due to an internal fault causing excessive internal pressures ➢ The transformer liquid level being too high ➢ Excessive internal pressure due to over loading of transformer.	
	18.	Carbon & other conducting particles in oil	➢ Sparking. ➢ Excessive temperature of oil	Rectify the Cause
	19.	Oxidation of oil	➢ Mainly due to exposure to air ➢ High operating temperatures.	Rectify the Cause
	20.	Discoloration of transformer liquid	➢ Mainly caused by carbonization of the liquid due to switching ➢ Contaminations	Rectify the Cause

21.	Incorrect oil level (oil level to low)	➢ Due to leakages through gasket or tank or drain valve. ➢ Leaks around transformer Accessories ➢ Leakage can occur through screw joints, welds, casting, pressure-relief device, and so on. ➢ The main causes are improper assembly of mechanical parts ➢ Poor joints ➢ Defects in the material used ➢ Insufficient tightness of mechanical parts.	Rectify the Cause
22.	Leakage of transformer liquid:	➢ Leakage can occur through screw joints, around gaskets, welds, casting, pressure-relief device, and so on. ➢ The main causes are improper assembly of mechanical parts ➢ Poor joints ➢ Defects in the material used ➢ Insufficient tightness of mechanical parts.	Rectify the Cause
23.	Internal arcing	➢ Low liquid level ➢ Loose connections, ➢ Failure of the transformer dielectric.	Rectify the Cause
24.	Noise/vibration	➢ Magnetostriction. ➢ Loose clamping of core. ➢ Mechanical vibrations of tank valves. ➢ Damping	Rectify the Cause
25.	Bushing failure	➢ Caused by flash over due to Dirt accumulation ➢ Lightning strikes.	Rectify the Cause
27.	Transformer switching equipment troubles	➢ May be excessive wearing of contacts, ➢ Mechanism Over travel, ➢ Moisture condensation in mechanism liquid.	

Q. 3	Attempt any FOUR of the following: 16 Marks
a)	State any four internal causes for the abnormal operation of electrical equipments.

Ans:

(Any Four points Expected 1 Mark for each cause - Total 4 Marks)

Internal causes for the abnormal operation of electrical equipments:-

1. Open circuit
2. Short circuit
3. Earth fault
4. Improper maintenance

OR students may write these causes

Internal causes for the abnormal operation of electrical equipments:-

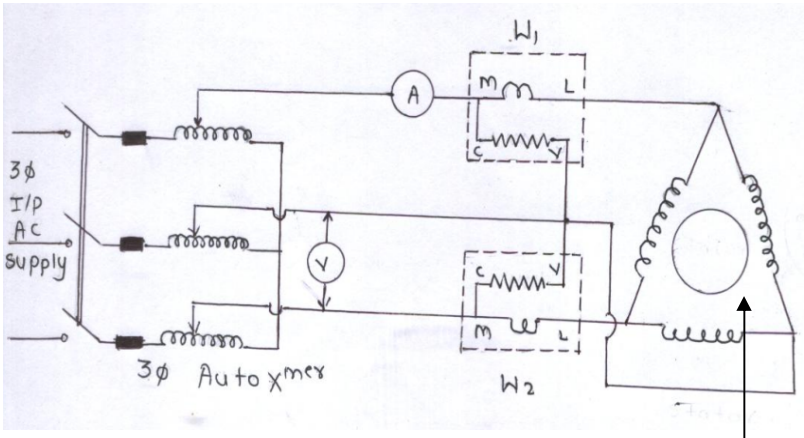
1. Open circuit (either in H.V or L.V)
2. Short circuit (between in H.V and L.V)
3. Ground fault
4. Insufficient oil level
5. Poor quality of transformer oil
6. Failure of magnetic circuit.

OR students may write these causes

Internal causes for the abnormal operation of electrical equipments

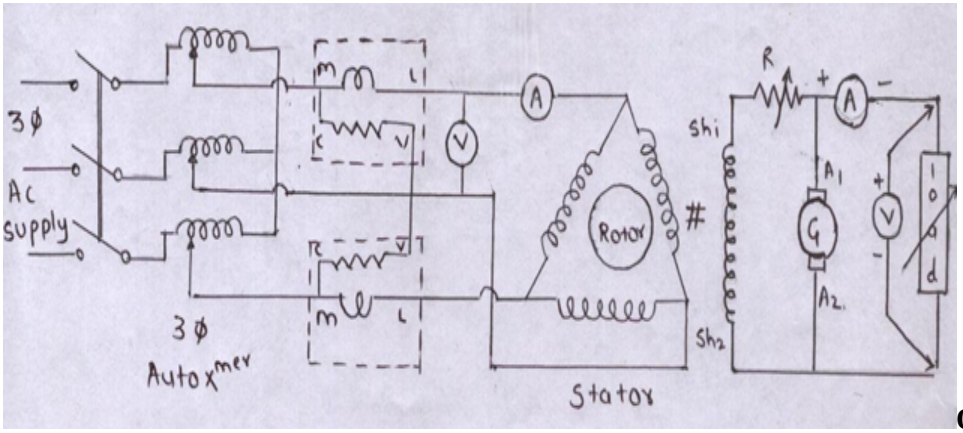
1. Open circuit
2. Short circuit
3. Earth fault
4. Failure of magnetic circuit
5. Uneven air gap
6. Failure of bearing
7. Rotor imbalance
8. Fault in rotor.

b)	**With a neat sketch, explain the procedure to find out temperature rise of winding of a 3-ph I.M. using resistance measurement method.**
Ans:	**(Any One Circuit Diagram 2 Marks)** **Circuit diagram of Temperature rise test for 3-ph I.M :-**

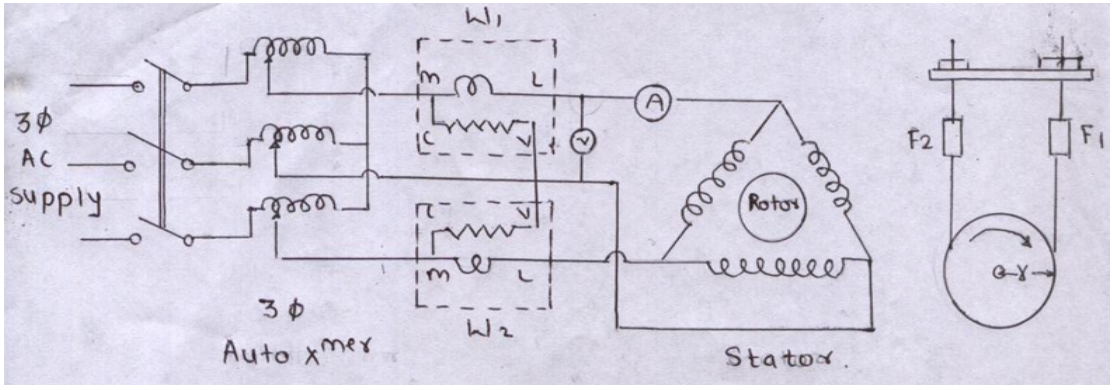


During this test rotor is blocked

OR



OR



Procedure:- **(1 Mark)**

- Connection are made in as shown in figure,
- Keep the auto transformer at zero volt position initially.
- Increase the applied voltage to the stator gradually up to its rated value.
- Now increase load gradually up to its full load.
- Motors are kept under rated load conditions for several hours till maximum steady state temperature is reached.

- **Resistance Method: -** **(1 Mark)**

When the temperature of winding is determine by resistance method, the temperature of winding (ambient temperature) should be recorded before loading machine.

This method is used for determination of temperature-rise of the windings. This method involves the measurement of resistance, cold and hot, and estimation of average temperature rise from the relation

Where, R_1 is resistance at $t_1{}^0C$ (ambient temperature) and R_2 is resistance at $t_2{}^0C$,

$$\frac{R_2}{R_1} = \frac{t_2 + 234.5}{t_1 + 234.5}$$

The unknown temperature $t_2{}^0C$ is calculated by using above formula

Temperature Rise = $t_2{}^0C - t_1{}^0C$

c) State any eight causes of contamination of transformer oil.

Ans: **Causes of contamination of transformer oil: (Any eight causes expected: 1/2 Mark each)**

The insulating oil gets contaminated when the following impurities are present in oil.

1. Presence of water.
2. Presence of dissolved moisture.
3. Presence of carbon deposits.
4. Presence of dirt & dust.
5. Presence of sulpher.
6. Presence of gases.
7. Presence of acids.
8. Presence of acetones.
9. Presence of sludge.

d) Give the classification of insulating materials as per the operating temperature with two examples of each type.

Ans: **(Any Four classification with their operating temperature with exmaple: 1 Mark each Total 4 Marks)**

Sr.No.	Insulation Classes	Maximum permissible temperature (^{0}C)	Insulating Material
1	Class-Y or O	90^0	Cotton, silk, paper, press board, wood ,cellulose-,PVC,VIR .
2	Class- A	105^0	Cotton, silk or paper impregnated paper & cellulose Easter.
3	Class- E	120^0	Laminated Cotton, Synthetic resin enamels and paper laminations .
4	Class- B	130^0	Glass fiber, asbestos, mica, asbestos laminates.
5	Class- F	155^0	Laminated asbestos, Glass fiber, and asbestos, Mica, built up mica.
6	Class- H	180^0	Made of inorganic material glued with silicon resin or adhesive coated on mica, glass fiber.
7	Class- C	Over 180^0	Made of 100% inorganic material E.g. mica, porcelain, ceramics, glass quartz, asbestos.

e) Draw a neat circuit diagram to perform sumpners test on single ph. transformers with all the meter ratings marked for a 2 KVA 230/115 V single phase transformer.

Ans: **(Circuit Diagram 2 Marks and meter ratings 2 Marks Total 4 Marks)**

Neat Circuit Diagram:

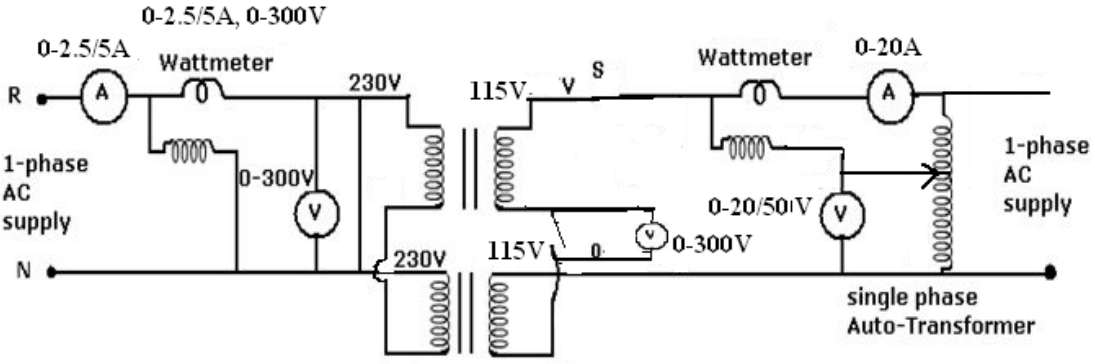


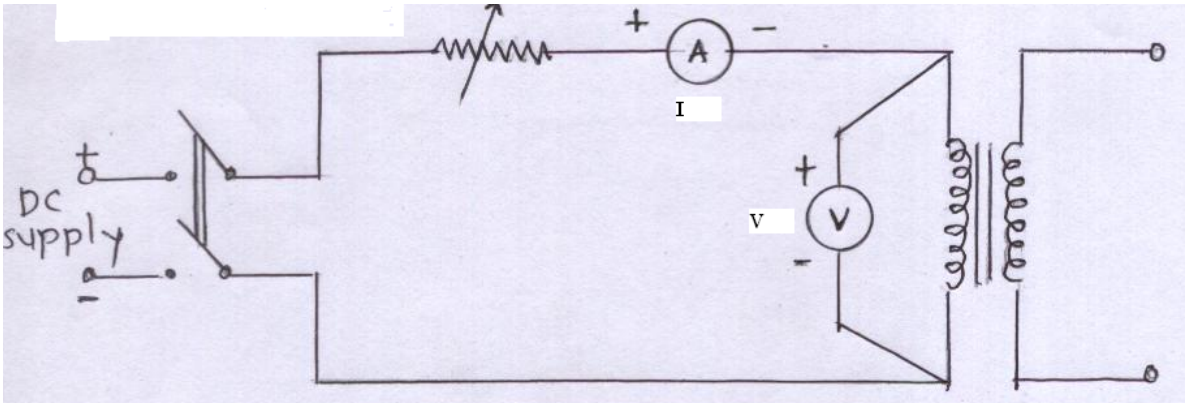
Fig. :Sumpner's test

Q.4 a)	Attempt any THREE of the following: 12 Marks
i)	**How will you measure the dc resistance of a two winding transformer? Draw the necessary circuit diagram.**

Ans: **(Circuit Diagram 3 Marks and How will you measure 1 Mark Total 4 Marks)**

Circuit diagram for measure the dc resistance of a two winding transformer:

In this method of measurement of winding resistance, the test current is injected to winding & corresponding voltage drop across the winding is measured..By applying ohm's law $R_X = \frac{V}{I}\Omega$



Procedure:- (Any Two points are expected)

1) Check the temperature of transformer oil to see that transformer is cool down or not.
2) The measurement shall be carried out after voltage and current are stable
3) In case of voltmeter & ammeter method, calculated value of winding resistance must be converted to A.C. resistance (because of skin effect)

   Resistance per winding = 1.6 x measure value (1.6 is due to skin effect)
4) The resistance is measured at ambient temperature & then converted to resistance at 75^0C for all practical purpose of comparison.

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

Winding resistance at temperature of 75^{0C}. $R_{75} = R_t \frac{234.5 + 75}{234.5 + t_1}$

Where, R_{t1} = Winding resistance at temperature t_1.

t_1 = Winding temperature at the time measurement (Ambient temperature)

ii)	**State the factors that affect the value of earth resistance. (Any four)**
Ans:	**(Any Four factors expected : 1 Mark each ,Total 4 Marks)**

Following factors affect the value of earth resistance (resistivity):-

1. Depth of electrode embedded in the earth.
2. Lengthen the earth electrode in the earth.
3. Size of earth electrodes
4. Resistance of the electrode itself and connections to it.
5. Contact resistance between the electrode and the soil adjacent to it.
6. Resistance of the surrounding earth.
7. Earth resistance can be reduced by increasing number of earth electrodes inter connected in parallel.
8. Temperature of soil
9. Soil Condition
10. Dissolved salts in soil
11. Climate Condition
12. Moisture content in soil
13. Physical Composition of soil
14. Effect of grain size and its distribution
15. Area Available
16. Location of Earth Pit
17. Obstructions in under ground
18. Size and spacing of earth plate and size of conductor.
19. Metal of earth plate and earth wire.
20. Quality of Coal / Charcoal used in the earth electrode pit.
21. Leakage Current Magnitude

OR

Following factors affect the value of earth 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.
iii)	**State any eight devices and tools used for lifting, loading/unloading and carrying heavy electrical machines during installation.**
Ans:	**(Any Eight names of devices and tools expected : 1/2 Mark each ,Total 4 Marks)** **Equipment used for lifting heavy electrical equipments:-** 1) Stationary Cranes 2) Overhead or Gantry Cranes 3) Mobile Cranes 4) Truck Mounted Crane 5) Steam Crane 6) Chain pulley Block 7) Chain Hoist 8) Electric Hoist 9) Screw Jacks 10) Winches 11) Hoses & tripods (For temporary supports) 12) Ceiling ropes.
iv)	**State any eight causes of fire.**
Ans:	**(Any Eight causes expected : 1/2 Mark each ,Total 4 Marks)** **Following are the causes of fire:** 1. Electrical faults inside appliances are a common cause of electric fire. 2. Overloading on cables/wires/machine.

3. Use of too many device plugged into a circuit, causing heated wire & possible a fire.

4. Majority of fires cause due to not using correct rating of fuse/MCB/switch gear etc. should be used in the circuit.

5. Poor joints in wiring may cause overheating & lead of fires.

6. Due to loose connection in the electrical installation.

7. If insulation deteriorate due to ageing, a short circuit may occur causing fire.

8. If a ground fault takes place between live wire & frame or body.

9. Not testing electrical safety devices.

10. Marked safety devices inoperative.

11. Electrical installation & equipments used in hazards areas are not satisfied the specification/type of protection.

12. Wiring that becomes defective with the passage of time.

13. If proper maintenance are not taken of the electrical installations, equipments, machines etc. it will result into electric fires.

14. Due to use of poor quality of material.

15. Faulty electrical installation and use of outdated appliances may cause fire.

16. Old electrical sockets and unsafe appliances.

17. Not maintained clearance as per voltage level between equipment etc.

18. Store highly inflammable liquids near(close to) electrical oven/furnace. A simple spark can initiate a fire.

19. Kept electric heaters near curtains or furniture.

Q. 4b)	Attempt any ONE of the following: 06 Mark
i)	State the methods of Re-varnishing of insulation and give the procedure of vacuum impregnation method. (Diagram not necessary.)
Ans:	**(Methods of Re-varnishing 3 Marks and procedure of vacuum impregnation method. 3 Marks , Total 6 Marks)**

Following are the methods of Re- varnishing: (Any Three Methods Expected)

1. Hot-dip method / Flood impregnation.
2. Vacuum impregnation method.
3. Trickle Impregnation method.
4. By using brush.
5. By spraying method.

Procedure for Vacuum Impregnation Method of the winding:-

1. The surfaces of all coils windings are perfectly clean and it should be free from dirt & dust, oily matters etc.
2. Coil / winding should be free from moisture. 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 pores (Air gaps) of the job.
5. Then Varnish is transferred from storage tank to the processing tank till the entire job is submerged.
6. After that vacuum is released and desired pressure is applied into the processing tank above the varnish level using compressed air/nitrogen.
7. The varnish is now forced into porous spaces inside the coil due to high pressure.
8. After desired amount of time, the pressure is released and the varnish is drained back into the varnish storage tank.
9. Then coil is removed and applies finishing gel (varnishes) by brushing or spraying to job for additional protection against moisture, chemical fumes and dust.
10. It is then kept in a baking oven till it gets set properly and become dry

ii)	**Following readings are obtained in a back to back test on two identical 100 KVA, 1-ph transformers. Reading of wattmeter connected on supply lines is 2 kw. Reading of wattmeter connected in secondary circuit, when full load current circulates through the secondary is 4 kw. Calculate the efficiency of each transformer: 1) At full load and unity p.f. 2) At 1/2 full load and unity p.f.**
Ans:	**Solution:-** Wi = Iron loss of both transformer = Iron loss of the one transformer = $\frac{Wi}{2}=\frac{2}{2}=1\,kW$ ---------- **(1 /2 Mark)** Wc = Full load Copper loss of the both transformer = Copper loss of the one transformer = $\frac{Wc}{2}=\frac{4}{2}=2\,kW$ ---------- **(1/2 Mark)** **Efficiency of the transformer at full load unity Power factor :-** $Output = KVA \times P.f = 100 \times 1$ $Output = 100\ KW$ $Efficiency\ \eta = \frac{output}{Input} \times 100$ ---------- **(1 /2Mark)** $Efficiency\ \eta = \frac{KVA \times Cos\phi}{(KVA \times Cos\phi) + Wi + Wc} \times 100$ ---------- **(1/2 Mark)** $Efficiency\ \ \eta = \frac{100 \times 10^3 \times 1}{(100 \times 10^3 \times 1) + 1 + 2} \times 100$ ---------- **(1/2 Mark)** $Efficiency\ \ \eta = 97.0873\ \%$ ---------- **(1/2 Mark)** **Efficiency of the transformer at Half full load and unity Power factor :-** $Output = \frac{KVA}{2} = \frac{100}{2}$ $Output = KVA \times P.f = 50 \times 1$ $Output = 50\ KW$ ---------- **(1/2 Mark)**

$$Copper\ Losses\ at\ half\ Full\ load = (\frac{1}{2})^2 \times Copper\ 1oss\ at\ \ full\ load$$

$$Copper\ Losses\ at\ half\ Full\ load = (\frac{1}{2})^2 \times 2$$

$$Copper\ Losses\ at\ half\ Full\ load = 0.5\ KW$$ ---------- **(1/2 Mark)**

No change in Iron Losses = 1KW

$$Efficiency\ \eta = \frac{output}{Input} \times 100$$ ---------- **(1 /2Mark)**

$$Efficiency\ \eta = \frac{KVA \times Cos\phi}{(KVA \times Cos\phi) + Wi + Wc} \times 100$$ ---------- **(1/2 Mark)**

$$Efficiency\ \ \eta = \frac{50 \times 10^3 \times 1}{(50 \times 10^3 \times 1) + 1 + 0.5} \times 100$$ ---------- **(1/2 Mark)**

$$Efficiency\ \ \eta = 97.0873\ \ \%$$ ---------- **(1/2 Mark)**

Q.5	**Attempt any TWO of the following: 16 Marks**
a)	**State the necessity of drying out of transformers. Give the procedure of drying out of transformers both by external and internal heat methods.**

Ans: **(Necessity of drying out 4 Marks and Procedure of drying out 4 Marks , Total 8 Marks)**

Necessity / Reason of Drying out of Transformer;- (Any Four Reasons Expected)

1. Insulation has tendency to absorb moisture when not carrying current and kept idle.
2. This moisture reduces the insulation resistance, which create problems (short circuits), when the equipment is put into service without removing moisture.
3. If the equipment remains idle for long time.
4. If equipment is out of use for long period.
5. When the equipment is re-commissioning after maintenance.
6. When the equipment is kept in damp/flooded condition.

7. If P.I. is found less than 1.5& DAR is found less than 1.25 indicates a need drying out.

8. Drying out is necessary particularly for high voltage machines (above 1000V rating)

The procedure of drying out of transformers both by external and internal heat methods:

(Any Four Steps are Expected)

1. Preliminary arrange the set-up, measurement equipments etc.
2. Heat is applied gradually by one of the following methods.
   - Circulating hot oil with high vacuum filter machine.
   - Circulating hot air
   - Hot oil spray under vacuum
   - Heating by induction coil.(Induction heating method)
   - Heating by short circuit method
3. The increases in temperature should be very gradual *(up to the value not exceeding values of oil temperature 85^0C and winding 95^0C.)*
4. The transformer should be watched constantly during drying period.
5. Measure the insulation resistance values. The insulation resistance is measured by means of megger (DC insulation Tester).
6. During drying out process, the reading of temperatures and IR value shall be recorded every two hours.
7. Two reading ,one after 15 sec & other after 60 seconds **OR** one after 60 sec & other after 600 seconds should be taken

Calculate: Polarization Index = $\frac{R_{60}}{R_{15}}$ or $\frac{R_{600}}{R_{60}}$

8. To calculate DAR measurements are taken after 30 seconds and 60 seconds.
   The dielectric absorption ratio (DAR) is calculated,

$$DAR = \frac{R_{60}}{R_{30}}$$

9. The drying stopped when desired value of hot IR, P.I. & DAR are achieved.

	10. After drying out, air drying varnish should be applied by brush on the winding surface only. 11. Varnish should be only applied when winding is in hot condition to prevent absorption of moisture. 12. Then cooling down of transformer after test is also gradual.
b)	**What are the basic requirements of foundation for: (i) Static equipments (ii) Rotating machines?**
Ans:	**(Basic requirements of foundation for: (i) Static equipments 4 Marks (ii) Rotating machines. 4 Marks , Total 8 Marks)** **Basic requirements of foundation for: (i) Static equipments: (Any Four points expected)** 1. Drawings of **equipments** from foundation design point of view ➢ Dimension of the **equipments** ➢ Plan dimension **equipments** base ➢ Its length & width 2. Height of **equipments** 3. Information about condition of soil:- ➢ Bearing capacity of soil ➢ Soil density ➢ Ground water table location 4. Weight of **equipments**:- ➢ Erection weight ➢ Operating weight ➢ Imposed weight ➢ Accessories weight 5. **Equipments** Center of Gravity location in empty condition and operating condition **Basic requirements of foundation for: (ii) Rotating machines: (Any Four points expected)** Following information is required to start the foundation:- 1. Drawings of machine from foundation design point of view 2. Dimension of the machine:- ➢ Plan dimension machine base ➢ Its length & width

- Height of machine

3. Information about condition of soil:-
   - Bearing capacity of soil
   - Soil density
   - Ground water table location
4. Weight of machine:-
   - Erection weight
   - Operating weight
   - Imposed weight
   - Accessories weight
5. Center of Gravity location in static and operating condition

OR

Following factors to be considered in designing the machine foundation:-

(Any eight point expected : 1 Mark each)

1. Consider Static weight of the machine and accessories.
2. Also consider the operating weight.
3. The foundation should be able to carry the superimposed loads.
4. The foundation should be able to absorb the vibration while operating at its full capacity.
5. The foundation should be sufficiently rigid to maintain proper alignment between the motor and the driven machine.
6. The foundation should be sufficiently rigid to withstand the possible horizontal thrust caused by machine while in operation.
7. The dimension of foundation should be proportional to safe bearing capacity of soil.
8. The dimension of foundation block should be sufficient that the resultant of all the forces should pass within the foundation block.
9. The combined centre of gravity of machine and foundation should be as far as possible, be in the same vertical line.
10. For concrete foundations use concrete ratio of 1:2:4.
11. The foundation should be well cure before machine put on it.
12. Depth of foundation should be proportional to the bearing capacity of soil.
13. Level of plinth should be above the maximum flood level of the site.
14. The surface of foundation must be protected from machine oil by means of suitable chemical coating or suitable chemical treatment.
15. The following size of depth of foundation:

Sr. No.	Rating of Motor	Size of depth of foundation
1	Upto 10 H.P	7.5 to 10 cms deep
2	10 to 25 H.P	15 to 20 cms deep
3	25 to 50 H.P	20 to 25 cms deep
4	50 to 75 H.P	25 to 37.5 cms deep
5	75 to 100 H.P	37.5 to 60 cms deep

c) State the objective and procedure to perform a reduced voltage running up test on a 3-ph squirrel cage I.M. Draw the necessary circuit diagram.

Ans: **(Objectives -3 Marks , Procedure- 3 Marks ,Circuit Diagram -2 Marks , Total 8 Marks)**

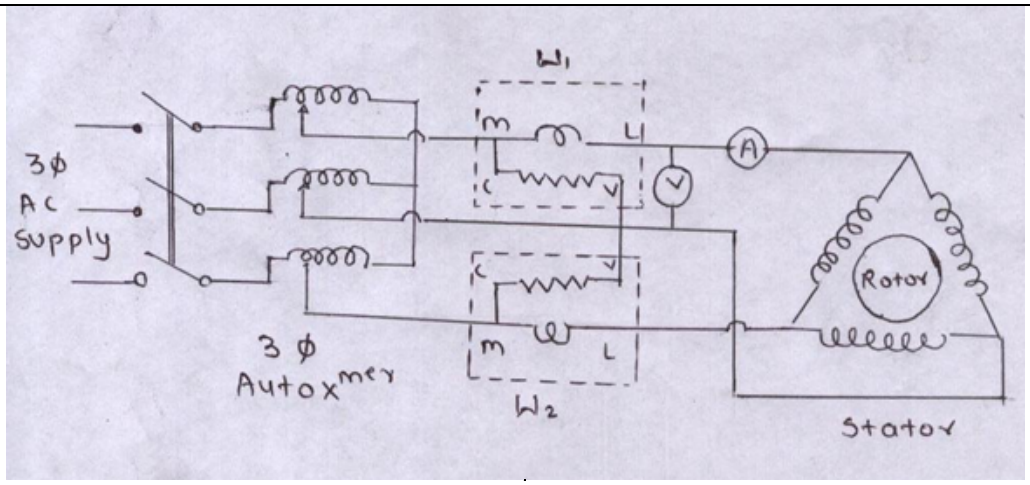
Objectives of reduced voltage running up test on a 3-ph squirrel cage I.M:-

- The test is applied to squirrel cage induction motors.
- To determine the ability of motor to run equal and nearly equal to rated speed of the motor even at reduced voltage in the both directions – forward & reverse.
- To see whether there is any tendency of cogging & crawling presents in the motor.
- This test is also conducted to check the noisy running of motor
- To see whether ,if noise level is more than tolerance limit which may be due to damaged bearings, also the presence of loose bars and wrong connection of stator winding.

Procedure of reduced voltage running up test on a 3-ph squirrel cage I.M:-

- The motor up to 37 KW shall be supplied with reduced voltage $1/\sqrt{3}$ of rated value for each direction of rotation with the help of auto transformer.
- For motors above 37 KW, the voltage shall be $1/\sqrt{3}$ of rated value or less but motor shall be run only in the specified direction of rotation with the help of auto transformer.
- The speed in this case is also recorded. In both the cases, the speed should be equal and nearly equal to rated speed of the motor.

Circuit Diagram of reduced voltage running up test on a 3-ph squirrel cage I.M:



OR Equivalent Diagram

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 indoor transformer as per IS 1886? (any four)**

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

Following factors should be considered while deciding location of site for indoor Transformer sub-station:- **(Any Four Points are Expected)**

1. Near load centre :

   Sub-station should be located near load centre 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 sub-station :-

   There should be easy access towards sub-station for transportation of equipments and manpower etc.

4. Space (Land) available :

   The land proposed for a substation should be normally level and open from all sides & sufficient land should be available for installation of sub-station and future expansion.

5. Bearing capacity of land (Hard land) :

   To reduce erection cost and for better foundation equipments land should be have high bearing capacity (hard soil**.)**

6. Area free from earthquake :

	To avoid damage to sub-station area should be free earth quake.
b)	**State the effects of misalignment in rotating machines.**
Ans:	**(1 Mark for each point Total 4 Marks)** **The Following effects of misalignment in rotating machines: (Any Four Points are Expected)** 1. Excessive vibrations. 2. Increase noise level. 3. Premature bearing and coupling failure 4. Premature failure of belt in case of indirect drive. 5. High bearings temperature. 6. High lubricating oil temperature. 7. Loose or broken foundation bolts and coupling bolts 8. The shaft is breaking (or cracking) 9. Increases friction 10. Increases stresses on coupling & shaft. 11. Increases maintenance cost. 12. Increases energy consumption 13. It reduces motor efficiency 14. Overall performance of machine reduces. 15. Early wear & tear of both driving & driven machine. 16. Similar equipment has less vibration or has longer operation lifetime.
c)	**Following test results were obtained on a 1-ph, 2.5 KVA, 250/125 V transformer, short circuit test on high voltage side.** **Vsc = 36 V Isc = 8 A WsC = 128 W Calculate :** **Resistance and impedance of transformer at 75°C referred to high voltage side. The test is conducted at ambient temp. of 30°C.**
Ans:	**Given Data:** 1-ph: 2.5 KVA Transformer 250/125 Volts Vsc = 36 V Isc = 8 A Ws_C = 128 W **Solution:** **1. Resistance at 30^0C** $W_{SC} = I_{SC}^2 R_{01}$ $$R_{01}\ at\ (30^0 C) = \frac{W_{SC}}{I_{SC}^{\ 2}} = \frac{128}{(8)^2}$$ $R_{01}\ at\ (30^0 C) = 2\ \Omega$ ---------- **(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 :

$$\frac{R_2}{R_1} = \frac{t_2 + 234.5}{t_1 + 234.5}$$

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

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

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

$\therefore X_{01}\ at\ (75^0 C) = X_{01}(30^0 C) = 4.0311\,\Omega$ ---------- **(1/2 Mark)**

4. Impedance at 75^0C :

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

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

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

d) Prepare maintenance schedule for storage batteries.

Ans: **(Any Four Points are Expected From following 1 Mark each Total 4 Marks)**

Maintenance schedule of storage batteries:

1. Daily Maintenance: (Any Two Points are Expected From following)

1. Inspect the battery and the room for general cleanliness.
2. Check the height of the electrode.

3. Keep the record of the topping if done.
4. Check the voltage of the pilot cells.
5. Record and check the specific gravity and temperature of the electrolyte of the pilot cells.
6. Record and check the ambient temperature.

2. Weekly Maintenance: (Any Two Points are Expected From following)

1. Inspect the battery very carefully a) Remove dust or dirt if accumulated b) Keep the battery clean and dry.
2. Check the cells for cracks and electrolyte leakage if so take remedial measures.
3. Record and check the specific gravity, voltage and temperature of the pilot cells.
4. Check for plate bucking, collection of sediments at the bottom of the cell etc.
5. Give quick fleshing charge after every heavy discharge.

3. Fortnightly Maintenance: (Any One Points are Expected From following)

1. Carry out inspection schedule as laid down above.
2. Topping of all the cells be done with distilled water.

4. Quarterly Maintenance (Any Two Points are Expected From following)

1. Check specific gravity and temperature of each cell.
2. Check the voltage of the battery and each cell.
3. Check the level of electrolyte of each cell.
4. All the bolts and nuts should be checked for tightness. Petroleum jelly or Vaseline should be applied.
5. Check float and/or trickle charges.
6. Test the battery load and small continuously load.

5. Yearly Maintenance (Any Two Points are Expected From following)

In addition to the inspection schedule given above, check for the following.

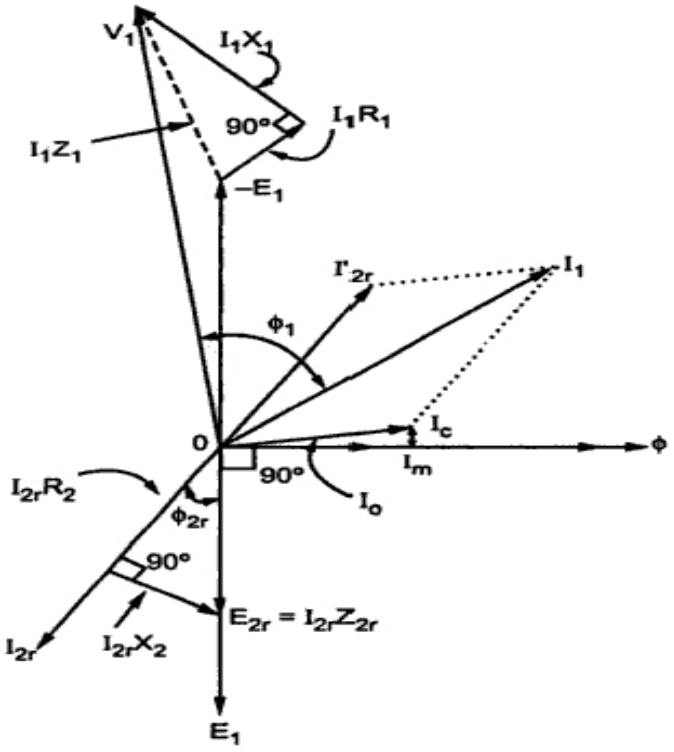
1. Condition of the individual cell.
2. Resistance i.e. terminal as well as cell to cell.
3. Inspection of battery rack.
4. Level of the sediments if collected at the bottom of the cell.
5. Paint afresh the racks, walls of the room with acid resistance paint if needed.

e)	Draw the vector diagram of 3 phase induction motor and write the equipments related to vector diagram.
Ans:	(Vector diagram – 3 Marks, Equation :- 1 Mark , Total 4 Marks)

Vector diagram:-

or any equivalent vector diagram

Equation :-



$$\overline{V_1} = -\overline{E_1} + \overline{I_1 R_1} + j\,\overline{I_1 X_1} = \overline{E_1} + \overline{I_1}\,(R_1 + j\,X_1) = -\overline{E}_1 + \overline{I}_1 \overline{Z}_1$$

$$\therefore \quad \overline{E}_{2r} = \overline{I_{2r} R_2} + j\overline{I_{2r} X_2} = \overline{I}_{2r}\,(R_2 + jX_2) = \overline{I_{2r}}\ \overline{Z_{2r}}$$

---------- END----------