



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2005 Certified)

WINTER– 2018 Examinations

Subject Code: 17637

Model Answer

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Important suggestions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
- 4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A)	Attempt any THREE of the following :	12 Marks
a)	State the factors on which severity of electric shock depends.	
Ans:	(Any Four factors are expected from following or equivalent 1 Mark each ,Total 4 Marks) The severity of shock depends on following factors. <ol style="list-style-type: none">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. Frequency of supply5. Body resistance (If wet resistance of body reduces)6. General health of human contact with lives part.7. Path of current through body.8. The phase of the heart cycle when the shock occurs9. The presence of moisture in the environment.10. The magnitude of current passing through the body :- <div style="text-align: center;">If magnitude of current is above 25 milli ampere it gives painful shock it may stop breathing/ there is loss of muscular control.</div> <p style="text-align: center;">OR</p>	



S.No	The current strength	Effect on human system
1	A.C current of low frequency between 1m amp to 8 mA	Are just bearable does not cause any pains
2	8mA-15mA	Give painful shock without loss of muscular control.
3	20mA-50mA	If passes through chest, it may stop breathing
4	50mA-100mA	May result in ventricular cavity in body fibrillation.
5	100mA-200mA	May cause fibrillation of heart
6	Above -200mA	Causes death, severe burns

b) State any four advantages of preventive maintenance.

Ans: (Any Four advantages are expected from following or equivalent 1 Mark each ,Total 4 Marks)

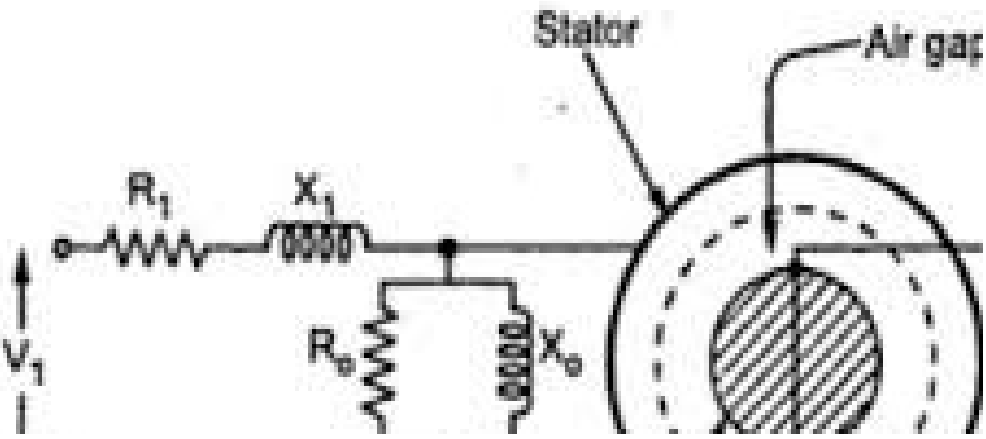
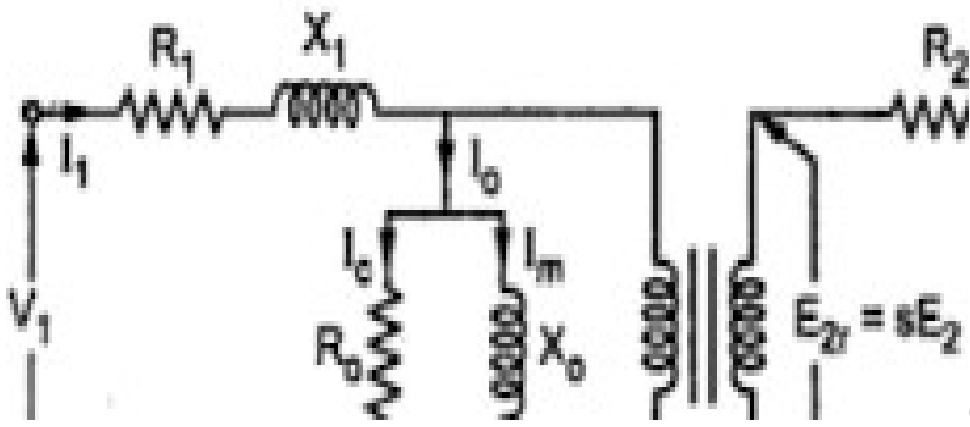
Following are the advantages of Preventive Maintenance:-

1. It increases life of machine/equipment.
2. It prevents premature failure.
3. It keeps the machine in good working condition by reducing wear and tear.
4. It prevents developing major breakdown or fault.
5. It provides greater safety & protection to the workers.
6. It reduces breakdown to a minimum and increases the efficiency of equipment's and machinery.
7. It reduces breakdown period.
8. It avoids unnecessary production loss
9. It avoids inconvenience.
10. It uses less standby equipment's.
11. It determines the need for major & minor repairs.
12. There will be energy saving if equipment or machine is well maintained.
13. For smooth running of production line
14. Due to PM, it reduces or eliminates repetitive failure.
15. It avoids multi damages due to in time proper maintenance.
16. Preventative maintenance is a cost effective way that improves the efficiency of both employees



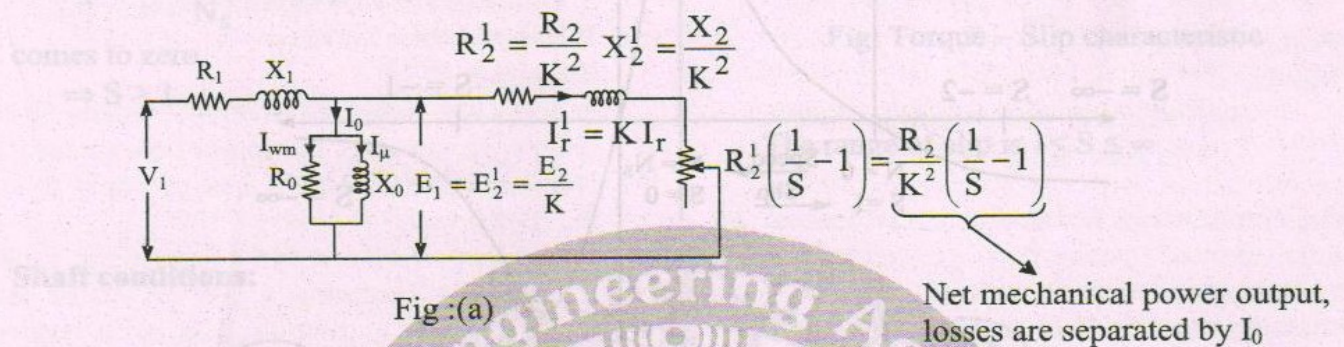
	and equipment. 17. “Emergency repairs are often three times more expensive than the same job done PM/pre-planned (and may take 10 times longer). “
c)	List any eight contamination agents of the transformer oil.
Ans:	(Any eight contamination agents are expected from following or equivalent 1/2 Mark each ,Total 4 Marks) The insulating oil gets contaminated when the following impurities are present in oil. <ol style="list-style-type: none">1. Presence of dissolved moisture content.2. Presence of water content.3. Presence of dissolved gases content.(Gasses are form due to decomposition of transformer insulating oil will get to dissolve in the oil.)4. Presence of acidic content.5. Presence of sludge content.(thick, soft, wet mud)6. Presence of carbon deposits content.7. Presence of dirt & dust content.8. Presence of sulphur content9. Presence of acetones content.10. Presence of dissolved oil decay products content
d)	State any one application of each tool : (i) Earth tester (ii) Megger (iii) Bearing puller (iv) Growler
Ans:	(1 Mark each application, Total 4 Marks) i) Earth Tester :- It is used to measure earth resistance. ii) Megger :- Megger is used to find out (measure) insulation resistance of electrical machine/equipment. iii) Bearing Puller:- Bearing puller is used for holding and removing the parts such as bearings, gears or pulleys from a shaft safely. iv) Growler:- A growler is an electrical device used to find out shorted turn faults in armature winding and stator winding of motor.



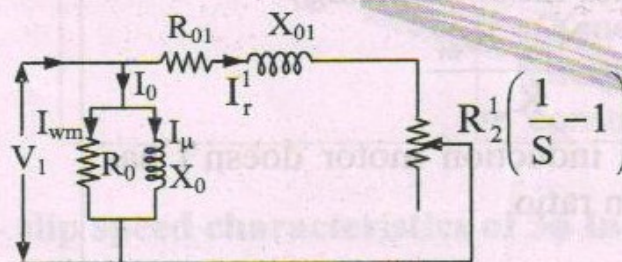
Q.1 B)	Attempt any ONE of the following :	6 Marks
a)	Derive an equivalent circuit of 3 phase Induction motor step by step. Write equations related to circuit and explain in brief	
Ans	<p style="text-align: center;">(Step by step equivalent circuit 4 Marks, Equations 2 Marks , Total 6 marks)</p> <p><u>Equivalent circuit of I.M. :-</u> Where, R_1 is the stator resistance per phase X_1 is the stator reactance per phase R_2' is the equivalent rotor resistance referred to stator per phase, X_2' is the equivalent rotor reactance referred to stator per phase R_c is the resistance representing core loss ,X_m is the magnetizing reactance per phase V_1 is the per phase supply voltage to the stator ,s is the slip of the motor</p> <div style="display: flex; justify-content: space-around; align-items: center;">  <p>or equivalent Figure</p> </div> <div style="display: flex; justify-content: space-around; align-items: center;">  <p>or equivalent Figure</p> </div>	

The exact equivalent circuit model of an Induction motor refer to stator is-

Equivalent circuit of machine w.r.t stator:



Approximate equivalent circuit for fig(a):



Equation:-

$$\overline{V_1} = -\overline{E_1} + \overline{I_1 R_1} + j \overline{I_1 X_1} = \overline{E_1} + \overline{I_1} (\overline{R_1} + j \overline{X_1}) = -\overline{E_1} + \overline{I_1} \overline{Z_1}$$

$$\therefore \overline{E_{2r}} = \overline{I_{2r} R_2} + j \overline{I_{2r} X_2} = \overline{I_{2r}} (\overline{R_2} + j \overline{X_2}) = \overline{I_{2r}} \overline{Z_{2r}}$$

b) State the objective of testing. Explain the role of BIS (Bureau of Indian Standards) in testing of electrical machines.

Ans: (Objective of testing 3 Marks, Role of BIS 3 Marks , Total 6 Marks)

Following are the objectives of testing:- **(Any Three objectives are expected from following or equivalent)**

1. Objective of testing is to finding error/ defects in machine/equipment/ product.
2. To confirm whether the results obtain during testing are within tolerance limits specified by BIS / ISS



3. To provide an indication of the product reliability and quality.
4. To determine the quality of material used & workmanship.
5. To avoid in convinces, accidents, minimize risk & for safety purpose.
6. To confirm whether machine/equipment/ product is manufactured as per design data or not.
7. To confirm whether the performance of machine/equipment/ product is as per design data or not.
8. To determine that the machine/equipment/ product appears to be working as stated in the specifications
9. Testing of equipment/machinery is also done after major maintenance of machine/equipment
10. Testing in all respect is also required when a new design or modified design is used,
11. To check whether the new product works as per the revised designed or not.

Role of BIS in testing of electrical machines:-

(Any Three Role of BIS are expected from following or equivalent)

Roles of Bureau of Indian Standards (BIS) in testing of electrical equipment's are as below:-

1. To specifies the standards for particular in machine/equipment/ product / materials etc.
2. To gives limit of losses& efficiency for particular in machine/equipment/ product
3. To provide an indication about the product reliability and quality.
4. To issue licenses or Certification (**ISI Mark**) to manufacturers whose products are as per BIS/ISS specified standards.
5. To avoid in convinces & accidents BIS plays important role.



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Q.2	Attempt any TWO of the following :	16 Marks
a)	State any eight safety precautions to be followed while working with an electric installation.	
Ans:	(Any eight safety precautions are expected from following or equivalent 1 Mark each ,Total 8 Marks) Following are some safety precautions to be taken to followed:- <ol style="list-style-type: none">1. Safety training / book should be given to all persons working in plant.2. Only qualified and trained person do the work, untrained person should not allow handling electrical equipment.3. Do not work without authority & do not operate the switches without knowledge.4. Know the work content, work sequence and especially all safety measures before starting the work.5. Do not Do the work if you are not sure or knowledge of the condition of equipment/ machine.6. Always use proper insulated tools & safety devices. / Always use proper insulated tools, rubber gloves, safety devices while working.7. Always take the permit to shut down the supply, from authority during major maintenance work.8. Avoid / do not allow working in unfavorable conditions such as high rain fall, fog or high wind.9. Avoid / do not allow working in improper illumination such as in sufficient light or unsuitable location producing glare or shadows.10. Do not Use defective material.11. Do not allow working on defective equipment.12. Keep safe distance from HV / equipment / conductor.13. Do not make safety devices inoperative14. Make habit to use / look out for danger notice, caution board, flags, and tags.	



	<ul style="list-style-type: none">15. Never speak to any person working upon live mains.16. Provide (Do) barricading to hazards area.17. Use safe clothing./ Wear appropriate clothing (loose clothing is avoided)18. Lock Open switches / Isolator19. Do not sacrifice safety for speed.20. Replace worn out / defective equipment / Insulator / Insulation / Cable/wire etc.21. Do not operate switches /Isolators with wet hands.22. Do not go carelessly near running belts on machines.23. Do not make safety devices inoperative.24. Maintenance schedule should be strictly followed.25. Do not allot the work to the person who is not feeling well (ill)
b) i)	(i) Describe the factors affecting preventive maintenance schedule.
Ans:	<p>(Any four factors are expected from following or equivalent 1 Mark each ,Total 4 Marks)</p> <p>Following factors affect the PM schedule:-</p> <ul style="list-style-type: none">1. Non availability of spares & raw material.2. Non availability of tools, trackless, jacks, fixture required for PM.3. Non availability of trained & skilled technician.4. Operating cycle of equipment or machine affect the maintenance schedule.5. If the machine is continuously overload it affects maintenance schedule.6. Production requirement.7. Ageing of machine/equipment (If the breakdown takes place, the cost of the repair will be more than the cost of the machine, and whether it can be replaced by a new one.)8. Cost of the maintenance.9. Importance of the machine/equipment.10. Working environment of industry.(Presence of dust, dirt, chemical fumes, moisture in the air, atmospheric temperature)11. Due to accident, fires, worker strike the work is held up for certain period. This is also a cause of disturbing a PM schedule.



b) ii)	(ii) State the procedure for developing preventive maintenance schedule.
Ans:	<p data-bbox="193 434 1538 517">(Any four points are expected from following procedure or equivalent 1 Mark each ,Total 4 Marks)</p> <p data-bbox="268 539 695 577">Procedure of PM is as below:-</p> <p data-bbox="209 613 491 651">Step 1:- Inspection:</p> <ul data-bbox="268 689 1465 943" style="list-style-type: none">➤ What to inspect and how to inspect?➤ Maintenance engineer / team should inspect the plan under working condition.➤ Prepare the check list for what to inspect and how to inspect, it should be cross checked so that no inspection point will be missed out <p data-bbox="209 976 512 1014">Step 2:- Frequencies:</p> <ul data-bbox="268 1052 1477 1525" style="list-style-type: none">➤ How often to inspect?➤ Frequency of inspection depends on<ol data-bbox="268 1205 1477 1525" style="list-style-type: none">1. Age, condition and importance of machine/equipment2. Working hours of machine/equipment3. If the cost of PM is greater than saving then reduce the frequency of inspection.4. Equipment / machine and its importance; important machine should be checked daily. <p data-bbox="209 1563 660 1601">Step 3:- Time for maintenance:</p> <ul data-bbox="268 1639 1497 2011" style="list-style-type: none">➤ When to do?➤ Preventive maintenance operations are planned by maintenance department and communicated to production department.➤ Generally PM is during lunch hours or when there is no load on machine.➤ Ensure that PM consumes least productive time➤ Do the PM on the day reserved for maintenance purpose



- Plan major repairs during holidays

Step 4:- Maintenance schedule:

Maintenance schedule is divided into three parts

- a) Routine Maintenance
- b) Periodically Maintenance (Weekly, fortnightly, monthly, quarterly or half yearly) Or according to service manual provided by manufacturer.
- c) Maintenance on fault as and when fault occurs

Step 5:- Records:

- What to record and how to record?
- Each equipment / machine is maintained in separate log sheet on which maintenance history is recorded.
- Reason and analysis of fault is also recorded.

Step 6:- Store Inventory:-

- Check the availability of spares & raw material required for maintenance before starting the work

Step 7:- Availability of T&P:-

- Check the availability of tools, trackless, jacks, fixture required for maintenance before starting the work

Step 8:- Availability of man power:-

- Check the availability of trained & skilled technician to do maintenance before starting the work.



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c) Prepare troubleshooting chart for transformer as per IS- 10028-1981 (4 trouble) and Induction motor (4 troubles).

Ans: ➤ Troubleshooting chart for transformer as per IS- 10028-1981:-

(Any four troubleshooting are expected from following or equivalent 1 Mark each ,Total 4 Marks)

Sr.no	Troubles	Causes	Remedial Measures
1.	Transformer does not show output voltage	1. Primary side fuses blown out 2. Circuit breaker may trip. 3. Loose contact of tap changer, 4. Loose connection at bushing 5. Connection may be open in bushing. 6. Failure of primary winding.	Rectify the Cause
2.	Incorrect secondary voltage	1. Improper turns ratio 2. Abnormal primary voltage 3. Shorted turns. Wrong setting of 4. Faulty OLTC	Rectify the Cause
3.	Unequal voltage on secondary side	1. Unbalance Loading. 2. Single phasing. 3. Unsymmetrical fault	Rectify the Cause
4.	Overheating of transformer	1. High input voltage 2. Overloading. Low liquid level. 3. More accumulation of sludge in oil. 4. Failure of cooling System. 5. High ambient temperature.	Rectify the Cause
5.	High exciting current	1. Short circuited core 2. Open core joints 3. Poor magnetic coupling 4. Low/high frequency 5. Shorted turns	Rectify the Cause
6.	Short circuit between adjacent turns (Turn to turn fault)	1. Insulation failure between turn to turn 2. Fluctuating load. 3. Transient overvoltage. 4. Moisture in oil Over heating	Rectify the cause.



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7.	Rapid deformation of oil/Low dielectric strength of oil	<ol style="list-style-type: none"> 1. Presence of dissolved moisture content. 2. Presence of water content. 3. Presence of dissolved gases content. 4. Presence of acidic content. 5. Presence of sludge content 6. Presence of carbon deposits content. 7. Presence of dirt & dust content. 8. Presence of sulphur content 9. Presence of acetones content. 10. Presence of dissolved oil decay products content 	Rectify the causes.
8.	Incorrect oil level (oil level to low)/Leakage of transformer liquid	<ol style="list-style-type: none"> 1. Due to leakages through gasket or tank or drain valve. 2. Leaks around transformer Accessories 3. Leakage can occur through screw joints, welds, casting, pressure-relief device, and so on. 4. The main causes are improper assembly of mechanical parts 5. Insufficient tightness of mechanical parts. 	Rectify the Cause
9.	Noise/vibration	<ol style="list-style-type: none"> 1. Loose clamping of core. 2. Bad/loose foundation nut bolts 3. Magnetostriction. 4. Mechanical vibrations of tank valves. 5. Low/high input frequency 	Rectify the Cause
10.	Bushing failure	<ol style="list-style-type: none"> 1. Flash over due to dirt accumulation on bushing. 2. Lightning stroke. 3. Mechanical injury to bushing 4. Improper bolting of bushing 5. Harsh environmental condition 	Rectify the Cause
11.	Excessive core heating	<ol style="list-style-type: none"> 1. Due to high magnetizing current 2. High inrush current 	Rectify the Cause



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12.	Transformer body gives shock	1. Insulation resistance reduced. 2. Any live wire touches the transformer tank (Earth fault).	Rectify the Cause
13.	Winding insulation failure	1. Failure may be due to a short-circuit Fault, 2. Lightning, Overload 3. Over current condition, 4. Transformer liquid containing moisture and contaminants.	Rectify the Cause
14.	Unexpected voltage to earth measurement	➤ Earth failure on one phase.	Rectify the Cause
15.	External Short circuit	1. It may be due to insufficient clearance on overhead line. 2. Accumulation of dust on insulator (Transformer bushing).	Rectify the Cause
16.	Internal Short circuit	1. Continuous overloaded transformer, due to this temperature increases so, possibility of insulation failure. 2. Fault in tap changer. 3. Loose connections, causing local overheating. 4. Vibration on Insulation resulting internal short circuit	Rectify the cause.
17.	Pressure-relief diaphragm broken	1. Due to an internal fault causing excessive internal pressures 2. The transformer liquid level being too high 3. Excessive internal pressure due to over loading of transformer.	Rectify the cause and replace Pressure-relief diaphragm
18.	Carbon & other conducting particles in oil	1. Sparking. 2. Excessive temperature of oil	Rectify the Cause
19.	Oxidation of oil	1. Mainly due to exposure to air 2. High operating temperatures.	Rectify the Cause



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20.	Internal arcing	1. Low liquid level 2. Loose connections, 3. Failure of the transformer dielectric.	Rectify the Cause
21.	Transformer switching equipment troubles	1. May be excessive wearing of contacts, 2. Mechanism Over travel, 3. Moisture condensation in mechanism liquid.	

➤ **Troubleshooting chart for I.M. :-**

(Any four troubleshooting are expected from following or equivalent 1 Mark each ,Total 4 Marks)

Sr.No .	Type of fault/abnormal conditions/Troubles	Causes	Remedies
1.	Motor fails to start or not accelerate (Faults in starting supply circuit) Motor Switch ON but does not start	1. Blowing of fuse/tripping of MCB 2. Terminal voltage too low 3. Defective starting mechanism 4. Protection devices has been tripped 5. The motor controller will not operate 6. Open circuit in supply cable. 7. Overloaded 8. Loose contact. 9. Motor rotor, bearings or driven load is locked. 10. Bearing is seized (Frozen). If ask Single phase motor add this point 11. Open in auxiliary winding. 12. Open in main winding. 13. Open capacitor. 14. Shorted capacitor.	Rectify The Cause



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2.	Motor stalls	1. Terminal voltage too low 2. Over load 3. Wrong application 4. Single phasing	Rectify the Cause
3.	Motor does not pick up rated speed / Motor runs but dies down/ Motor does not come up to speed	1. Starting load is high 2. Low Voltage 3. Low frequency 4. Broken rotor bars or loose rotor	Rectify the Cause
4.	Run Slow (Motor starts Sluggishly)	1. Low voltage. 2. Low frequency. 3. Overload 4. Single phasing. 5. Stator connected in star instead of delta. 6. Improper connection of motor leads to supply line 7. Shorted stator coils	Rectify the Cause
5.	Run Hot/ Thermal overload/ Motor overheating/ Motor frame Hot to touch (Winding Overheating)	1. Over/Under voltage. 2. Unbalance voltage 3. Over/Under frequency 4. High ambient temperature 5. Ventilating Fan is not working 6. Poor motor ventilation/ Air flow obstructed or inadequate ventilation. 7. Overload 8. Single phasing. 9. Worn bearings	Rectify the Cause
6.	Vibration	1. Loose iron core 2. Dynamic unbalance of the rotor 3. Mis-alignment 4. Due to bent shaft (Run out to shaft) 5. Worn out bearings 6. Incorrect Leveling 7. Loose foundation bolts	Rectify the Cause



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7.	Noise	<ol style="list-style-type: none">1. Mis-alignment2. Due to bent shaft (Run out to shaft)3. Bearing properly not fit.4. Worn out bearings5. Incorrect Leveling6. Loose foundation bolts7. Cooling fan is touching on stationary part.8. Non uniform air gap or rotor rubbing on stator.9. Rotor unbalanced10. Foreign matter in air gap.11. Gears and gear trains are among the principal sources of noise.	Rectify the Cause
8.	Bearings continuously fail	<ol style="list-style-type: none">1. Mis-alignment2. Due to bent shaft (Run out to shaft)3. Bearing properly not fit.4. Worn out bearings5. Unbalanced load/ Overloaded bearing.6. Use of poor quality of grease/lubricating oil7. No grease/lubricating oil	Rectify the Cause
9.	Bearing overheating	<ol style="list-style-type: none">1. Mis-alignment2. Due to bent shaft (Run out to shaft)3. Bearing properly not fit.4. Worn out bearings5. Unbalanced load/ Overloaded bearing.6. Use of poor quality of grease/lubricating oil7. No grease/lubricating oil8. Oil level too high/ low.9. Too much grease/ No grease10. Foreign matter in grease.11. Excessive belt pull.	Rectify the Cause



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10.	Excessive sparking at brushes/slip rings	<ol style="list-style-type: none"> 1. Loose contact 2. Worn out brushes/slip rings 3. Improper pressure and spring tension. 4. Brushes are bedding or sticking in holders-not properly 5. Dirt is accumulated on brushes/slip rings 6. Grade of brushes/slip rings material is of bad quality. 	Rectify the Cause
11.	Motor runs high speed	<ol style="list-style-type: none"> 1. Voltage available is more than rated voltage 2. Load is too less. 	Rectify the Cause
12.	Motor runs in the wrong direction	<ol style="list-style-type: none"> 1. Incorrect wiring. 2. Phase sequence of supply changed 3. Improper connection of motor leads to supply line 	Rectify the Cause
13.	Motor has been running, then fails to start	<ol style="list-style-type: none"> 1. Fuse or circuit breaker tripped. 2. Motor overloaded. 3. Stator is shorted 4. Capacitor failure. 5. Starting switch has failed 	Rectify the Cause
14.	Motor takes too long to accelerate	<ol style="list-style-type: none"> 1. Voltage too low 2. Defective Capacitor. 3. Starting switch has failed 4. Bad bearings 	Rectify the Cause
15.	Regular clicking (Short sound)	<ol style="list-style-type: none"> 1. Foreign matter in air gap. 2. Dirt in motor. 	Rectify the Cause
16.	Scraping Noise	<ol style="list-style-type: none"> 1. Fan rubbing 2. Fan striking insulation 3. Loose bed plate nut bolt 	
17.	Motor hums a) During Start up b) When running	<ol style="list-style-type: none"> 1. Unequal phase resistance 2. Open circuit 3. Inter turn short circuit on motor. 4. Short circuit between turn to turn or parts of stator winding. 	Rectify the Cause



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			5. Earth fault (Winding to frame short circuit)	Rectify the Cause
	18.	Abnormal Supply conditions	1. Loss of supply voltage. 2. Unbalanced supply voltage. 3. Phase sequence reversal of supply voltage. 4. Over /Under frequency 5. Over /Under Voltage 6. Single Phasing	Rectify The Cause
	19.	High input current in all 3 phases	1. Line voltage 10% or above /below the motor nameplate voltage. 2. Motor overloaded.	Rectify The Cause
	20.	Unbalanced line current on poly phase motors during normal operation.	1. Unequal terminal voltage. 2. Single phase operation 3. Unbalanced voltage	Rectify the Cause

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

a) List any four internal causes for abnormal operation of electrical equipment's.

Ans: **(Any four internal causes are expected from following or equivalent 1 Mark each ,Total 4 Marks)**

Internal causes:-

1. Open circuit
2. Short circuit
3. Earth fault
4. Loose connection
5. Deposit of dirt and dust near ventilation passage
6. Low insulation resistance
7. Improper maintenance
8. Poor ventilation
9. Wrong connection
10. Thermal stresses due to thermal overload



	<ul style="list-style-type: none">11. Magnetic stresses as result of electromagnetic forces12. Residual stresses caused by manufacturing problems13. Failure of cooling system14. Excess wear and tear of internal parts15. Ageing.
b)	List routine tests to be conducted on 3 phase transformer as per IS-2026-2011.
Ans:	<p>Following tests are conducted/carried out on Transformer as per IS 2026</p> <p>Routine tests of transformer include:-</p> <p>(Any four Routine tests are expected from following or equivalent 1 Mark each ,Total 4 Marks)</p> <ul style="list-style-type: none">1. Winding resistance measurement.(Both HV and LV winding)2. Measurement of insulation resistance.(Between HV and LV winding, HV and ground/tank, LV and ground/tank)3. Measurement of voltage ratio/Turns ratio4. Open circuit test (To determine no load loss, no load current /magnetizing current and shunt parameters of equivalent circuit)5. Short circuit test (To determine full load losses, impedance voltage/short circuit impedance and series parameters of equivalent circuit.)6. Polarity test7. Phasing out test8. Dielectric test of transformer or High Voltage Test.<ul style="list-style-type: none">a. Power Frequency voltage with stand test or separate source voltage withstand test of transformerb. Induced voltage test of transformer. or DVDF (Double voltage double frequency)c. Impulse Voltage withstand test.9. Vector group test.10. Tests on on-load tap-changer, where appropriate.11. To check against leakages through gaskets.



c) State and explain properties of transformer oil.

Ans: (Any four properties are expected from following or equivalent 1 Mark each ,Total 4 Marks)

Following are the properties of transformer oil:-

1. Dielectric strength :-

It should be have a high dielectric strength

2. Specific resistance:-

It should be have a high Specific resistance.

3. Dielectric dissipation factor (DDF) ($\tan\delta$):-

It should be as low as possible.

5. Relative permittivity (Dielectric constant):-

It should be 2.2

4. Flash Point :-

Oil should have very high flash point. (160°C minimum, or greater than 140°C)

5. Fire point -

It should have high fire temperature (not less than 200°C) it should be 25% greater than flash point.

6. Pour Point: - (Indicates the lowest temperature at which the insulating oil will flow.)

It should be low (Pour point of transformer oil is an important property mainly at the places where climate is extremely cold.)(- 6°C to - 40°C)

7. Viscosity:-

Oil should have low viscosity at 100°C 34 say bolt

8. Density:-

Oil should have low density. Density of oil at 20°C should be 0.89 gm/cm³.

9. Moisture content:-

Oil should be free from moisture (moisture content should be less than 10 ppm (Parts per million) Water content in oil is allowed up to 50 ppm

10. Dissolved gas:-

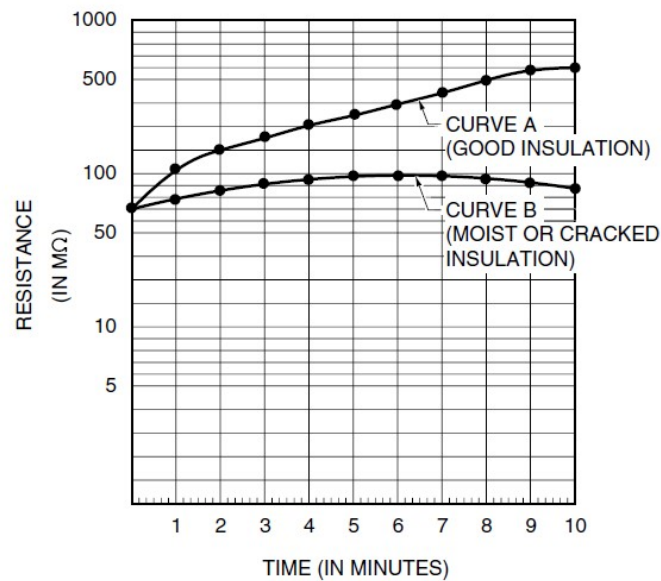
Oil should be free from dissolved gas.



	<p>11. Acidity content:- Oil should be chemically stable. Acidity content should be very low. (0.03mg KOH/mg Maximum)</p> <p>12. The oil should be clear & plane in colour, transparent & free from suspended matter.</p> <p>13. For mineral oil, the power factor of new oil should not exceed 0.05 percent at 25⁰c.</p> <p>14. It should be not contain impurities such as sulphur & its compounds to avoid rusting & sludge formation.</p>
d)	State the methods used to measure insulation resistance and explain Dielectric Absorption method.
Ans:	<p>(Any methods from following or equivalent 2 Mark , explain Dielectric Absorption method 2 Mark, Total 4 Marks)</p> <p>There are three types of tests for measuring insulation resistance: (2 Marks)</p> <ol style="list-style-type: none">1. Spot test reading or Short Time test2. Time-resistance test or Dielectric absorption test or Testing methods based on the PI & DAR3. Step voltage test <p>Explanation to measure insulation resistance by Dielectric Absorption method:- (2 Marks)</p> <ul style="list-style-type: none">➤ The megger is connected across the insulation.➤ Take successive readings at fixed time interval➤ For this method, two readings are taken at 30 seconds and 60 seconds respectively to calculate DAR➤ And also for 1 minute and 10 minutes, respectively to calculate PI.➤ The PI and DAR are commonly used to quantify the time resistance test result.➤ A curve is plotted from the readings.➤ Good insulation shows a continuous increase in the resistance value over a period of time and if value of PI is greater than 2 or 4 and value of DAR is greater than between 1.25 to 1.6➤ If reading is stagnant and it does not increase as expected, the insulation may be weak



and service may be needed and if value of PI is less than 2 and value of DAR is less than 1.25

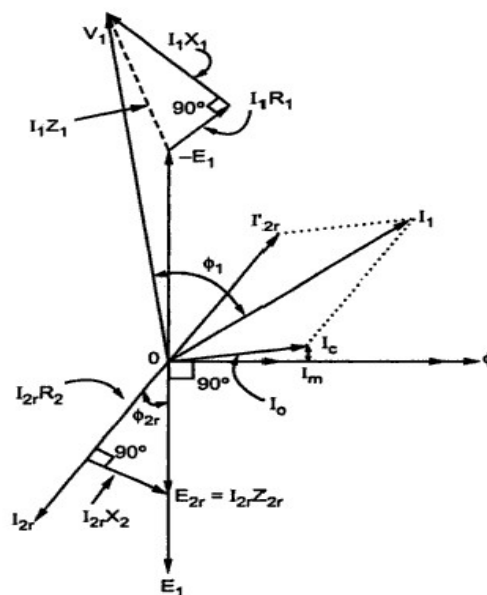


Dielectric absorption test measurement data is recorded on a test graph

e) Draw vector diagram of 3 phase induction motor as a generalized transformer & name it.

Ans: Vector diagram of 3 phase induction motor as a generalized transformer:

(4 Marks)

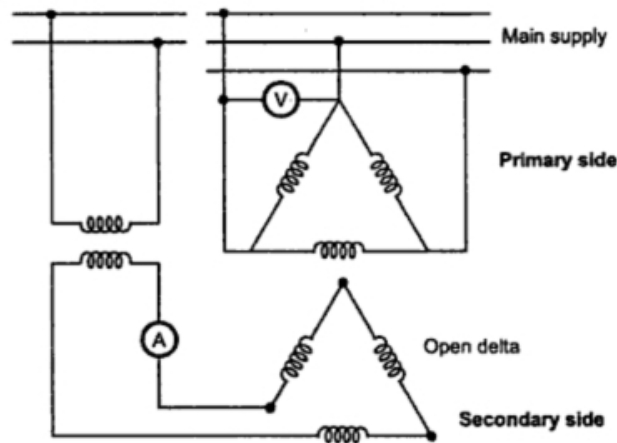


or equivalent figure

Where,



	<p>R_1 is the stator resistance per phase X_1 is the stator reactance per phase R_2' is the equivalent rotor resistance referred to stator per phase X_2' is the equivalent rotor reactance referred to stator per phase R_c is the resistance representing core loss, X_m is the magnetizing reactance per phase V_1 is the per phase supply voltage to the stator, s is the slip of the motor</p>	
Q.4 A)	Attempt any THREE of the following :	12 Marks
a)	Explain open Delta (Delta/ Delta) test on transformer.	
Ans:	<p style="text-align: right;">(Circuit diagram 2 Mark, Explanation 2 Mark, Total 4 Marks)</p> <p>Open Delta (Delta/ Delta) test on transformer is conducted to find maximum temperature rise of transformer at full load.</p> <p>Explanation:-</p> <p>Objective:-</p> <ol style="list-style-type: none">1. Temperature rise tests are used to make sure that a product does not get overheated above permissible limit during F.L. operation.2. To verify the worst case average temperature rise in the transformer winding at F.L.3. This test is used to find maximum temperature rise of transformer at full load.4. To find out guaranteed temperature rises for oil & winding.5. It is also used to understand the possible overheated locations inside & outside the winding.6. To see whether the rise in temperature is as per designed value or not.7. To see whether temperature rise is within permissible limits or not.8. To see that transformer & its cooling arrangements are effectively designed or not.9. To see that class of insulation used is with standing with highest temperature reached by transformer at F.L. <p>Circuit diagram open Delta (Delta/ Delta) test on transformer:-</p> <div style="text-align: center;"></div> <p style="text-align: right;">OR</p>	



or equivalent figure

- This method is applicable in case of a delta to delta connected transformer.

Heat run test is similar to that of back to back test which can be conducted on the transformers. Voltmeter is used to measure the primary applied voltage and ammeter to measure current in the secondary side. The arrangement of the transformers in connection for heat run test is shown in the Fig. above

The primary side is excited at normal voltage and frequency. The secondary side is connected in open-delta. A single-phase transformer can be employed to circulate full-load current from auxiliary single phase transformer.

- During heat run test following Temperature could be directly measured:-
 1. Ambient temperature
 2. Top oil temperature
 3. Bottom oil temperature
 4. Hot - Spot temperature, hottest winding temperature (If fiber optic sensors are installed)
- To measure the temperature rise, the transformer is kept under rated load condition for several hours till maximum steady temperature is attained of winding and oil.
- During the test, hourly readings of top oil temperature are taken from the thermometer already placed in the pocket of top cover.
- When steady state temperature is reached, take the temperature of oil with the help of thermometer.
- After that switch off the supply and connection to the HV side and LV side are opened.



- Measure the resistance of winding when immediately after steady state temperature is reached to calculate temperature of winding.

From this value, t_2 , the winding temperature at the instant of shut down can be determined by the formula given below-

$$t_2 = \frac{R_2}{R_1} (235 + t_1) - 235$$

Where, R_1 is the cold resistance of the winding at temperature t_1 .

- For determining winding temperature rise we have to apply the above discussed indirect method. That means hot winding resistance is measured and determined first and then from that value we have to calculate the winding temperature rise, by applying resistance temperature relation formula.

Conclusion:-

- This temperature rise must be within permissible limits.
- In general, more efficient transformers tend to have lower temperature rise, while less efficient units tend to have higher temperature rise.

b) Describe Effect of misalignment of direct coupled drives.

Ans: **(Any four effects are expected from following or equivalent 1 Mark each ,Total 4 Marks)**

Following are the effects of misalignment of direct coupled drives:-

1. There will be excess vibrations.
2. Increase in noise level.
3. Increases in friction loss.
4. The shaft will bent.
5. There will be premature failure of bearing and coupling
6. It will increases maintenance cost.
7. It will increases temperature of bearings.
8. It will increases energy consumption
9. It will reduces overall performance of machine.
10. It will reduces motor efficiency
11. Loose or broken foundation bolts and coupling bolts
12. Increases stresses on coupling & shaft.
13. Early wear & tear of both driving & driven machine.



c)	State the basic requirements of foundation for :(i) Static equipment's (ii) Rotating equipment's
Ans:	<p>(Any four requirements are expected from following or equivalent 1 Mark each ,Total 4 Marks)</p> <p>NOTE:- Answer written common to both or separately may be accepted</p> <p>Following are the basic requirements of foundation to be considered in designing the machine foundation for :(i) Static equipment's (ii) Rotating equipment's</p> <ol style="list-style-type: none">1. Depth of foundation should be proportional to the bearing capacity of soil.2. The foundation should be able to carry weight which includes:-<ul style="list-style-type: none">➤ Weight of machine➤ Erection weight➤ Operating weight➤ Super imposed load weight➤ Accessories weight3. The foundation should be able to absorb the vibration while operating at its full capacity.4. The foundation should be sufficiently rigid:-<ul style="list-style-type: none">➤ To maintain proper alignment between the motor and the driven machine.➤ To withstand the possible horizontal thrust caused by machine while in operation.5. The combined center of gravity of machine and foundation should be as far as possible, be in the same vertical line.6. Level of plinth of foundation should be above the maximum flood level of the site.7. There should be sufficient space all around the machine.8. The surface of foundation should be perfectly plane.9. The surface of foundation must be protected by means of suitable chemical coating or suitable chemical treatment.10. The foundation should be well cure before machine put on it.11. The dimension of foundation should be proportional to safe bearing capacity of soil.



12. Use a quality concrete / for concrete foundations use concrete ratio of 1:2:4.

13. 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

d) State any eight causes of fire.

Ans: (Any eight causes are expected from following or equivalent 1/2 Mark each ,Total 4 Marks)

Following are the Causes of electrical Fires:-

1. Overloading on cables/wires/ machine causes possibility of fire.
2. Use of too many device plugged into a circuit, causing heated wire & possible a fire.
3. The majority of fires are caused due to selection of incorrect rating of the fuses or use of incorrect rating MCB/RCCB or incorrect setting of safety switch.
4. If insulation damage/deterioration, a short circuit may occur causing fire.
5. Poor joints in wiring/cables may cause overheating & lead to fire.
6. Due to loose connection in the electrical installation may produces spark causes fire.
7. Failing to replace worn out / defective equipment / Insulation / Cable/wire
8. Due to old wiring and unsafe appliances
9. Stored highly flammable liquids near electric oven/furnace.
10. Kept electric heaters near curtains/furniture.
11. Electrical faults inside appliances are a common cause of electric fire.



12. Fires may be caused if the installations are not maintained properly.
13. Due to use of poor quality of material also causes electric fire.
14. Faulty electrical installation may cause fire.
15. If clearances are not maintain as per voltage level there is possibility of sparking leads to fire.
16. Electrical installation & equipment's used in hazards area are not used as per the specification/type of protection.

Q. 4B) Attempt any ONE of the following : 6 Marks

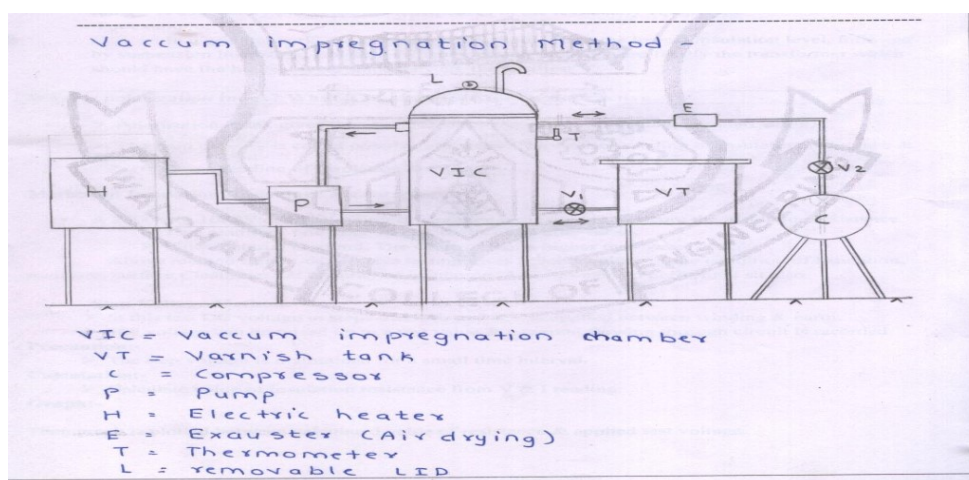
a) Explain vacuum impregnation method used for Re-varnishing of insulation with neat diagram.

Ans:

(Figure 2 Marks, Explanation 4 Marks, Total 6 Marks)

Figure of process of vacuum impregnation:-

(2 Marks)



Explain the process of vacuum impregnation:-

(4 Marks)

The plant consists of:

1. A large air tight chamber (VIC) i.e. processing or impregnation chamber.
2. The varnish is stored in Tank (VT) i.e. varnish storage tank.
3. Electric heater (H) i.e. preheater.
4. Pump for transfer of varnish from VT to VIC
5. The compressor can create vacuum or pressure in processing chamber when



required.

6. Curing tank with electric heater

Procedure for Vacuum Pressure Impregnation (VPI) of the winding:-

➤ **Step 1:-**

Perfectly clean the surfaces of all coils windings it should be free from dirt, dust and oily matters etc.

➤ **Step 2:-**

Coil / winding should be free from moisture. For the moisture removal heat the winding with the help of high wattage lamp or in an oven till all moisture get evaporated.

➤ **Step 3:-**

A pre dried winding is placed into a processing chamber.

➤ **Step 4:-**

A vacuum is created in the processing chamber to remove all air, including air within the pores (Air gaps) of the winding.(this is called dry vacuum)

➤ **Step 5:-**

Then Varnish is transferred from storage tank to the processing chamber till the entire job is submerged.

➤ **Step 6:-**

Again for another time vacuum is created in the processing chamber (this is called wet vacuum.)

➤ **Step 7:-**

After that vacuum is released and desired pressure is applied into the processing tank above the varnish level using compressed dry air/nitrogen for better penetration of the varnish resin in to the air pockets of winding and this is maintained for a stipulated time.

➤ **Step 8:-**

After desired amount of time, the pressure is released and the varnish is drained back into the varnish storage tank.



➤ **Step 9:-**

The coil (Job) is then taken out from processing chamber and kept on an iron grill tray to drain out excess varnish.

➤ **Step 10:-**

Then coil is applies additional coating of finishing gel by brushing or spraying to job for additional protection against moisture, chemical fumes and dust.

➤ **Step 11:-**

It is then kept in a electric baking oven till it gets set properly and become dry (i.e. completely cured)curing temperature varies from 90°C to 110°C for 10-20 minutes in some cases one to two hours.

- b) Following test results were obtained on 250/125 V transformer having 2.5 kVA rating on S.C. Test at 30 °C $I = 8A$, $V = 36V$, Power = 128 W. Equivalent Resistance winding is 1.8 Ω. Calculate % Resistance % impedance & full load loss of transformer at full load working temperature of 75 °C.

Ans: Given Data:

1-ph: 2.5 KVA Transformer 250/125 Volts $V_{sc} = 36 V$ $I_{sc} = 8 A$ $W_{sc} = 128 W$
Equivalent Resistance winding is 1.8 ohm

Solution:

1. Resistance at 30°C $W_{sc} = I_{sc}^2 R_{01}$

$$R_{01} \text{ at } (30^\circ C) = \frac{W_{sc}}{I_{sc}^2} = \frac{128}{(8)^2}$$

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

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

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

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

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

3. Resistance at 75°C :



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

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

$$\therefore R \text{ at } 75^\circ C = 2.3402 \Omega \text{ ----- (1/2 Mark)}$$

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

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

3. % Resistance at 75°C :

$$= \frac{I_1 R_{01}}{V_1} \times 100 \text{ ----- (1/2 Mark)}$$

$$= \frac{I_1 R_{01}}{V_1} \times 100 \text{ Where } I_1 = \frac{KVA \times 10^3}{V_1}$$

$$I_1 = \frac{KVA \times 10^3}{V_1}$$

$$I_1 = \frac{2.5 \times 10^3}{250}$$

$$I_1 = 10 \text{ Amp}$$

$$\text{----- (1/2 Mark)}$$

$$\therefore \% \text{ Resistance at } 75^\circ C = \frac{I_1 R_{01}}{V_1} \times 100$$

$$= \frac{10 \times 2.3402}{250} \times 100$$

$$= 9.33608 \%$$

$$\text{----- (1/2 Mark)}$$

4. Impedance at 75°C :

$$\therefore Z_{01} \text{ at } (75^\circ C) = \sqrt{R_{01}(75^\circ C)^2 + X_{01}(75^\circ C)^2}$$



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

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

$$\begin{aligned} \therefore \% \text{ Impedance at } 75^{\circ}C &= \frac{I_1 Z_{01}}{V_1} \times 100 \\ &= \frac{10 \times 4.6611}{250} \times 100 \\ &= 18.6444 \% - \text{----- (1/2 Mark)} \end{aligned}$$

5. full load loss at 75°C :

$$\begin{aligned} &= W_{sc} \text{ at (room temperature)} \times \frac{234.5 + 75}{234.5 + (\text{Room temperature})} \\ &= 128 \text{ at } (30^{\circ}C) \times \frac{234.5 + 75}{234.5 + 30} \end{aligned}$$

$$\text{Full load loss at } 75^{\circ}C = 149.776 \text{ Watt} \text{ ----- (1/2 Mark)}$$

OR

5. Full load Losses at 75°C ::

$$\therefore = I_{sc}^2 \times R_{01} (75^{\circ}C)$$

$$\therefore = (8)^2 \times 2.3402$$

$$\therefore \text{Full Load Losses at } 75^{\circ}C = 149.7728 \text{ Watt}$$

Q.5 Attempt any TWO of the following : 16 Marks

a) Classify the insulating materials as per operating temperature. Give two examples of each type.

Ans:

(8 Marks)

Sr.No.	Insulation Classes	Maximum permissible temperature (°C)	Insulating Material
1	Class-Y or O	90°	Cotton, silk, paper, press board, wood, cellulose-, PVC, VIR. (Cotton, silk, paper, cellulose, wood etc. Neither impregnated nor immersed in oil comes



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				under this class.)
2	Class- A	105 ⁰		Cotton, silk and paper suitably impregnated with natural resins or immersed in oil come under this class.
3	Class- E	120 ⁰		Laminated Cotton, Laminated paper Synthetic resin enamels.
4	Class- B	130 ⁰		Mica, glass fibers, asbestos with suitable bonding substances comes under this class.
5	Class- F	155 ⁰		Laminated asbestos, Glass fiber, and asbestos with suitable bonding substances of high thermal stability come under this class.
6	Class- H	180 ⁰		Mica, glass fibers, asbestos with suitable bonding substances such as silicones come under this class. Or adhesive coating.
7	Class- C	Over 180 ⁰		Porcelain, ceramics, glass, quartz.

b) State the methods of Neutral Grounding. State difference between Earthing and grounding.

Ans:

(Methods of Neutral Grounding 3 marks difference 5 marks, Total 8 Marks)

Neutral Grounding connections are of three types:

(1 Mark each total 3 Marks)

1. Solid earthing
2. Resistance earthing
3. Reactance earthing



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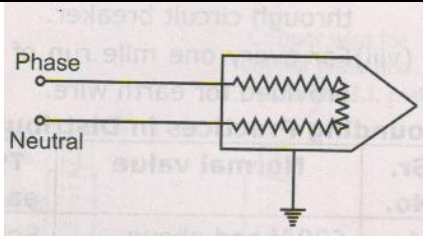
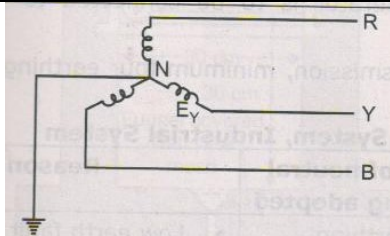
Model Answer

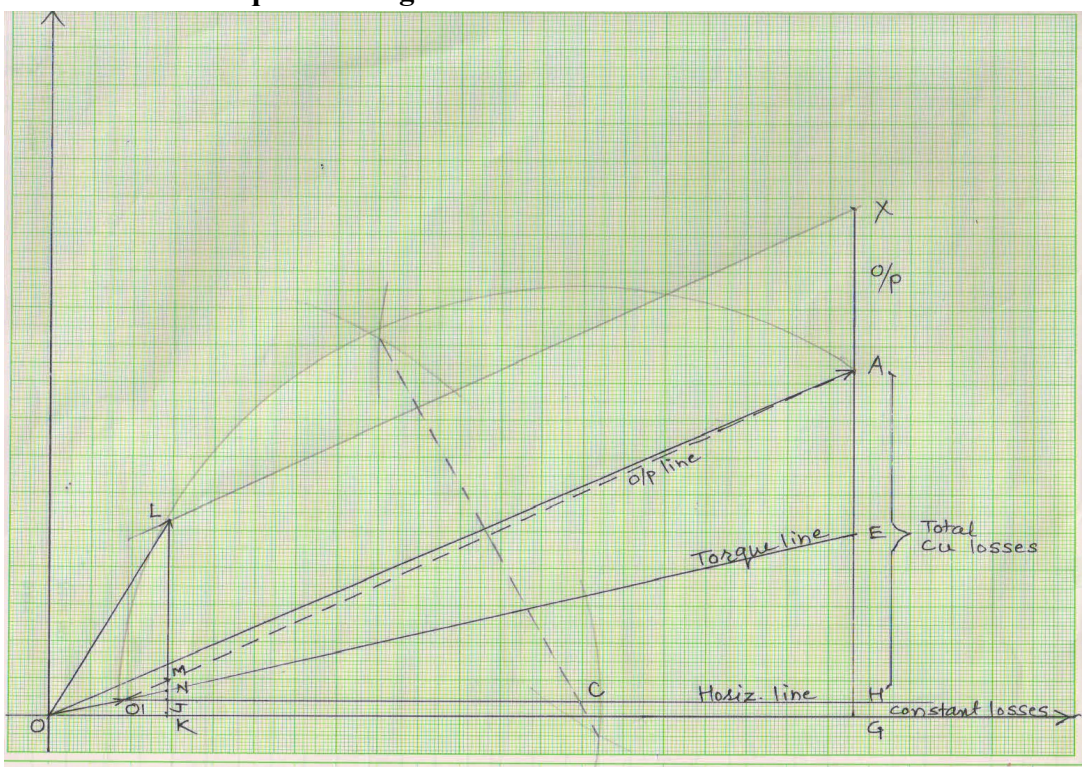
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Difference between Earthing & grounding (Any Five points are expected 1 mark each total 5 marks)

SR. NO.	Earthing	Grounding
1	Earthing means connecting the dead part (it means the part which does not carries current under normal condition) to the earth for example electrical equipment's frames, enclosures, supports etc.	Grounding means connecting the live part (it means the part which carries current under normal condition) to the earth for example neutral of transformer.
2	It is equipment earthing.	It is source or system earthing.
3	Earthing is an alternate low resistance path for leakage current.	Grounding is a source for unwanted currents and also as a return path for main current for protection of delicate equipments.
4	The purpose of earthing is to minimize risk of receiving an electric shock if touching metal parts when a leakage current is present.	Grounding is done for the protections of power system equipment and to provide an effective return path.
5	The purpose of earthing is to minimize risk of receiving an electric shock to human.	It is provided for eliminating arcing ground and over voltage surge.
6	Generally Green wire is used for this as a nomenclature.	Generally Black wire is used for this as a nomenclature.
7	Earthing connections are of four types: <ul style="list-style-type: none">• Plate earthing• Pipe earthing• Rod earthing• Strip earthing	Grounding connections are of three types: <ul style="list-style-type: none">• Solid earthing• Resistance earthing• Reactance earthing
8	It is nothing to do with the system stability.	It increases stability of the system.



9	It does not provide any means for protection system against earth fault.	This earthing provides suitable means for earth fault protecting system.
10 FIG		

c)	<p>A three phase 400 V I.M. gave following readings : No Load Test : 400 V, 1260 W, 9A Short Circuit Test : 140 V, 4000 W, 38A Draw circle diagram and find current, p.f and slip at full load, if Motor rating is 14.9 kW.</p>	
Ans:	<p>(Procedure is given only for examiner for reference of the terminology used in circle diagram) Given Data: No load test:- $V_1 = 400 \text{ V}$; $I_o = 9 \text{ Amp}$; $W_o = 1260 \text{ W}$; Short circuit test:- $V_{SC} = 140 \text{ V}$; $I_{SC} = 38 \text{ Amps}$; $W_{SC} = 4000 \text{ W}$ Solution:- OR Equivalent figure</p> <div style="text-align: center;"></div> <p style="text-align: right;">----- (2 Mark)</p>	



3-Ph, 400V, 14.9 kW I.M

1) **No Load Test :** $V_1 = 400 \text{ V}$; $I_o = 9 \text{ Amp}$; $W_o = 1260 \text{ W}$;

$$\phi_o = \cos^{-1} \left(\frac{W_o}{\sqrt{3} V_1 I_o} \right)$$

$$\phi_o = \cos^{-1} \left(\frac{1260}{\sqrt{3} \times 400 \times 9} \right)$$

$$\phi_o = 78.34^\circ \text{ Elec. - } \text{-----} \quad \textbf{(1/2 Mark)}$$

The vector OO' represents - $I_o \angle \phi_o$

2) **Short Circuit (Blocked Rotor) Test:** - $V_{SC} = 140 \text{ V}$, $I_{SC} = 38 \text{ A}$ & $W_{SC} = 4000 \text{ watt}$

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

$$\phi_{SC} = \cos^{-1} \left(\frac{4000}{\sqrt{3} \times 140 \times 38} \right)$$

$$\phi_{SC} = 64.27^\circ \text{ Elec. - } \text{-----} \quad \textbf{(1/2 Mark)}$$

3) **The vector OA represents -** $I_{SN} \angle \phi_{SC}$

$$I_{SN} = I_{SC} \left(\frac{V_1}{V_{SC}} \right)$$

$$I_{SN} = 38 \left(\frac{400}{140} \right)$$

$$I_{SN} = 108.57 \text{ A} \quad \text{-----} \quad \textbf{(1/2 Mark)}$$

4) **Current scale:** - $1 \text{ cm} = 5 \text{ A}$

5) Draw the vector OO' and vector OA lag behind V_1 by ϕ_o and ϕ_{SC} respectively. Draw output line O'A (Shown in dotted). Draw the perpendicular bisector of O'A. It will intersect the O'H line at C. Take the radius O'C or CA and draw the semi circle.

6) Drop the perpendicular AG on X axis:

7) **Power scale:-** $= \frac{W_{SN}}{\text{Length at AG in cm}} \text{ in watts / cm}$



$$W_{SN} = W_{SC} \left(\frac{V_1}{V_{SC}} \right)^2$$

$$W_{SN} = 4000 \left(\frac{400}{140} \right)^2$$

$$W_{SN} = 32653.06 \text{ watts} \text{ ----- (1/2 Mark)}$$

$$\text{Power Scale} = \frac{W_{SN} \text{ in Watts}}{\text{Length of AG from graph paper in cm}}$$

$$= \frac{32653.06}{9.4 \text{ cm}}$$

$$= 3473.73 \text{ watt / cm} \text{ ----- (1/2 Mark)}$$

$$8) \text{ length of AX (output) in cm} = \frac{\text{Output in watts}}{\text{Power Scale}}$$

$$= \frac{14.9 \times 10^3}{3473.73}$$

$$= 4.3 \text{ cm} \text{ ----- (1/2 Mark)}$$

9) Draw the line parallel with output line O'A from point X. it will intersect the semi-circle at L. point L represent full load condition on circle diagram

10) Draw torque line O'E separating total copper losses AH.

11) Drop the perpendicular from L on X axis

12) Answers from Circle Diagram:

i) Full load current = Length of vector OL x Current scale

$$= 6 \text{ cm} \times 5 \text{ amp/cm}$$

$$= 30 \text{ amp} \text{ ----- (1 Mark)}$$

ii) Full load P.F =

$$= \frac{\text{length (LK)}}{\text{Length (OL)}}$$

$$= \frac{5.3}{6}$$

$$= 0.88 \text{ lag} \text{ ----- (1 Mark)}$$



iii) Full Load Slip =

$$= \frac{\text{length (MN)}}{\text{Length (LN)}}$$

$$= \frac{0.3}{4.6}$$

$$= 0.065 \text{ or } 6.5 \%$$

----- (1 Mark)

Q.6 Attempt any FOUR of the following :

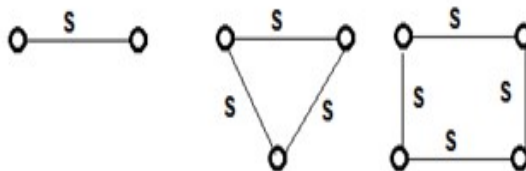
16 Marks

a) Describe any four methods used to reduce earth resistance.

Ans: (Any Four points/methods are expected from following or equivalent 1 Mark each ,Total 4 Marks)

To reduce earth resistance following steps/methods are necessary:

1. Earth pit of more depth & width- breadth should be made.
2. Use of higher size/cross section of earthing material like earthing plate, earthing rod, earthing pipe, earthing wire/strip reduces earth resistance.
3. Use of copper material for earthing reduces earth resistance than use of aluminum material
4. Earth pit are generally filled with alternate layer of charcoal & salt up to 4 feet from the bottom of the pit.
5. Poured sufficient salt water in earth electrode pit.
6. Use chemical or coke/charcoal to increase conductivity,
7. Use earth conductor without joint in between.
8. Tighten the earth connections.
9. Remove Oxidation on joints.
10. Earth resistance can be reduced by increasing number of earth electrodes inter connected in parallel.
11. The electrodes and earth continuity conductor used in the circuit should be of same material i.e. copper or galvanized.
12. Electrodes should be placed in the earth in the upright vertical position.



Earthing Rod Arrangement

b) Explain importance and purpose of earthing.

Ans: **(Any Four importance and purpose are expected from following or equivalent 1 Mark each ,Total 4 Marks)**

Importance and purpose of earthing is as below:-

1. To provide an alternative path for the leakage current to flow towards earth.
2. To save human life from danger of electrical shock due to leakage current.
3. To protect high rise buildings structure against lightening stroke lightening arrester is used for this there is necessity of earthing.
4. To provide stable platform for operation of sensitive electronic equipments there is necessity of earthing.
5. For proper working of earth fault protection system, there is necessity of earthing.
6. To keep the potential of equipment body (frame) below the earth potential in the event of fault from safety point of view.

c) Compare direct and Indirect method of testing.

Ans: **(Any Four points are expected from following or equivalent 1 Mark each ,Total 4 Marks)**

Sr No.	Parameter	Direct Testing	Indirect Testing
1	Nature of loading	The m/c is actually loaded at full load.	The m/c is not actually loaded but machine run on N.L.
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



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	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. The result obtained are either less or more than the actual
	7	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
	8	Assumption	Generally no assumptions are made	Generally some assumptions are to be considered
	9	Type of connections	The connection are more and difficult	The connections are less and Simple
	10	Equipment's/ Apparatus	It requires more number of equipment's	It requires less number of equipment's
	11	Method of testing	This is simple	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.
	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	1. With the help of rake arrangement, 2. Coupling a machine to its shaft for loading purpose.	1. O.C. and S.C test on transformer/ Alternator / I.M. , 2. Swinburne test on DC machines.
d)	State types of maintenance. Explain each with example.			
Ans:	(Types of maintenance 3 Marks, Explain each with example 1 Mark , Total 4 Marks) Maintenance are classified as below:- (Any three names are expected 1 mark each total 3 mark) 1. Preventive Maintenance (PM) 2. Routine /daily maintenance			



3. Periodic maintenance/Time based maintenance (TBM)
4. Predictive maintenance (PDM)
5. Breakdown Maintenance / maintenance on fault / Corrective maintenance
6. Productive maintenance/ Total productive maintenance (TPM)
7. Overhaul maintenance / Zero hours maintenance

Explain each with example:-

(1 Mark)

1. Preventive maintenance: -

PM means systematic inspection, detection, correction and take action to prevent a problem from occurring or reoccurring. OR It can also be defined as “anything that increases the life of equipment, and helps it runs more efficiently.”

2. Routine maintenance is a simple, small-scale activities (usually requiring only minimal skills or training) which is carried out daily to keep and general upkeep of an equipment, machine, plant, or system in good working condition.

3. Time based maintenance or Periodic maintenance consists of periodically (at pre-determined intervals) inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.
Periodic maintenance is pre-set schedule activity which is carried out weekly, fortnightly, monthly, quarterly or half yearly interval depending upon the equipment's and condition of the machine or as per manual provided by manufacturer.

4. Predictive maintenance is a maintenance to monitor, predict and prevent occurrences of failure of equipment, OR Predictive maintenance is a maintenance to replace components just before they fail. OR This is a method in which the service life of important part is predicted based on inspection or diagnosis
e.g. it is necessary to identify physical variables such as temperature, vibration, power consumption, etc. If these variation is indicative (abnormal) than there is a problem to be appearing on the equipment so suitable action is taken before major failure.

5. Breakdown maintenance means is carried out when an equipment fails or does not work satisfactory OR It is a maintenance which is carried out when machine fail to run.

6. TPM means the maintenance which is carried out only when equipment / machine fail to run.

TPM is preferred under following circumstances:-

- Demand of the product is more so machine may not find time to put the machine



for preventive maintenance

7. **Overhaul** means complete shutdown, dismantling, repair and reassembly of equipment/machine.

It is carried out depending upon working hours of machine & conditions or as directed in service manual provided by the manufacturer. It involves partial or complete dismantling of the equipment/machine and overhaul.

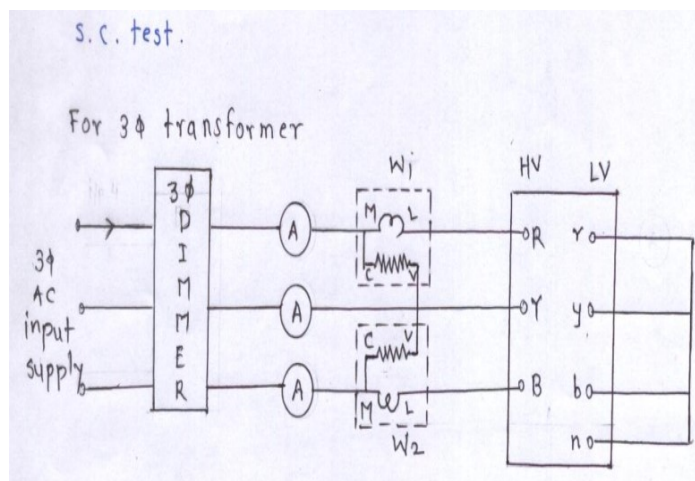
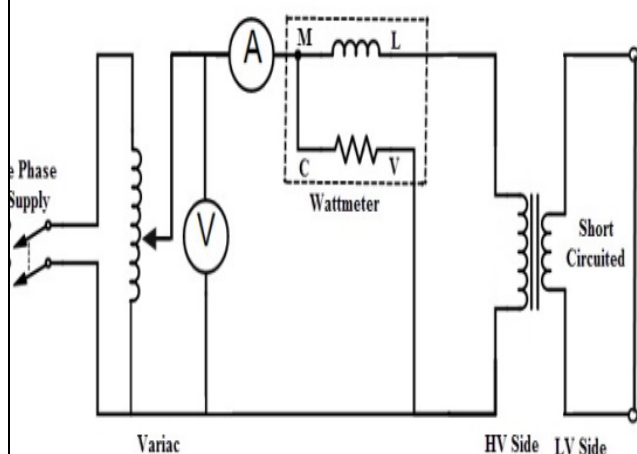
e) Explain the procedure to perform S.C. Test on 1-ph transformer with circuit diagram.

Ans:

(Procedure 2 Marks, Circuit Diagram 2 Marks, Total 4 Marks)

Circuit Diagram: -

(Circuit Diagram 2 Marks)



Procedure:-

(2 Marks)

- Supply is given to HV winding & LV winding is short circuited.
- Increase applied voltage slowly with the help of auto transformer till full rated current is circulated.
- Take the corresponding readings of input voltage (V_{sc}), input current (I_{sc}) and input power (W_{sc})

Observation Table:-

V_{sc} in volts	I_{sc} in amp	W_{sc} (Ps) in watt