



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.
- 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) Some of the questions are not clearly indicative of the exact answer expected. In such cases, credit may be given by judgment of relevant answer based on candidate's understanding.

Page No: 1 to 21 Model Answer Paper Solution and Page No: 22 to 24 Question Paper & Summery of Marking Scheme

Q.1 Attempt any three of the following----- 12 Marks

A) Define following term w.r.t. electric accident: (Each definition 1 Marks)

i) Safety ii) Hazard iii) Accident iv) Accountability

i) Safety:-

The meaning of the term safety is being safe, not being dangerous or in danger **OR**

The any method or technique or process which can minimize unwanted events or accidents is called as Safety. **OR**

The preventive measures which are taken to avoid small or big accidents is known as safety.

ii) Hazard:-

Hazard is a probable a possible or possible cause of an accident. **OR**

Hazard is a potential condition a waiting to be converted in to an unwanted event or accident. **OR**

The things that arises without planning or random

iii) Accident:-

The event that happens unexpectedly & causes damage or injury is called as accident. **OR**

An unwanted event which can't be anticipated in advance may be termed as an accident. **OR**

Accident is an undesired event that causes damage or injury.

iv) Accountability:-

It means it is the accountability of a particular officer to do the work within specified time; also he is answerable & punishable for his failure, faults in the work he is carrying.

b) Define type test and routine test. Give two example of each of them.

(Each Definition 1 Mark & Example -2 Marks any two points expected)

i) Type Test:-



These tests are carried out on few machines from the lot of the machines of same design and specification. The test results of the few tested machines are treated same, for the complete lot of the machine. Say, if one hundred units are manufactured then random any 2 or 3 units are taken for testing.

ii) Routine test:-

These tests are carried out on each and every machine/equipment during manufactured in industry before dispatch.

Examples:- (Expected Any Two)

S. No	Type test	Routine test
1	Temperature rise test	Ratio & Polarity
2	Impulse voltage test	Load losses
3	Noise Level test	Impedance measurement
4	Insulation resistance	Insulation resistance
5	Momentary over load test	Resistance of winding
6	High voltage test	No-load losses
7	Resistance of winding	No-load current
8	Performance test	Winding Voltage tests- a) separate source b) induced overvoltage
9	Moisture proofness test	Core insulation voltage test

c) State four conditions that are essential for parallel operation of 3 phase transformer.

(Any Four point expected- 1 Mark each point)

Essential conditions for parallel operation of 3 phase Transformer:- (Any Four point)

- i) The polarity should be the same.
- ii) The voltage ratio should be same.
- iii) The percentage impedance should be equal.
- iv) The phase rotation should be the same.
- v) The vector diagrams and the phase displacement should be the same.

d) i) Explain meaning of insulation resistance

(2 Marks)

ii) State how insulation resistance of a transformer is measured. (2 Marks)

i) Explain meaning of insulation resistance:



Insulation resistance of electrical equipment refers to the resistance between conducting part and earth, expressed in mega-ohms. **OR** The insulation resistance can be also measured between two circuits separated by insulations.

ii) State how insulation resistance of a transformer is measured:-

- Insulation resistance is measured by Megger. **OR**
- Megger consists of a built in mega ohm meter and a D.C generator. The generator is driven by hand or by a motor The scale of megger is graduated from zero to infinity in terms of megaohms **OR**

The insulation resistance of a transformer is measured as follows:-

- Between the winding collectively (i.e. with all windings being connected together) and the ground tank.(ground)
- Between each winding and the tank, the rest of the winding being grounded.

B) Attempt any one of the following----- 6 Marks

a) Given Data:-

(Give stepwise Marks as mention below)

$$V_L = 6.6KV \quad \cos\phi = 0.8 \quad \text{Impedance for } m/c 'A' = 0.5 + j10\Omega \quad \& \quad m/c 'B' = 0.4 + j12\Omega$$

$$\text{Total KW} = \frac{\sqrt{3} V_L I_L \cos\phi}{1000} \text{----- (1 Mark)}$$

$$I_L = \frac{3000 \times 1000}{\sqrt{3} \times 6600 \times 0.8}$$

$$I_L = 328.04 \text{ Amps}$$

$\therefore I_L$ can be written in j forms as,

$$I_L = 328.04 (0.8 - j0.6)$$

$$I_L = 262.43 - j196.82$$

$$\text{Now, Phase voltage of alternator } V_{ph} = \frac{6000}{\sqrt{3}} = 3810.5V$$

Consider phase voltage as reference, it can be written as $V_{ph} = (3810.5 + j0)$



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As the load shared by alternators is equal, load shared by alternator 'A' will be 1500KW and that by 'B' 1500 KW. But this load is supplied by alternator 'A' by delivering 150 amps; hence its P.F. of delivering the load can be determined

$$I_A = \frac{KWA}{\sqrt{3} \times KV \times \cos\phi} \text{-----(1/2 Marks)}$$

$$I_A = \frac{1500}{\sqrt{3} \times 6.6 \times 0.8}$$

$$I_A = 150A$$

$$\therefore \cos\phi_A = 0.874 \text{ lag or } \phi_A \text{ power factor angle} = 29.073^\circ \text{-----(1/2 Marks)}$$

I_A can be written in j forms as,

$$I_A = 150 (0.874 - j0.485)$$

$$I_A = 131.1 - j72.83 \text{-----(1/2 Marks)}$$

\therefore current shared by alternator 'B' will be $I_L - I_A$

$$\text{i.e. } (262.43 - 196.32) - (131.1 - j72.83) \text{ OR } I_B = (131.33 + j124.19)$$

$$\text{Or } I_B = 180.75 \text{ amps } \angle 43.3^\circ \text{-----(1/2 Marks)}$$

$$\text{Or } \cos\phi_B = 0.726 \text{ Lag} \text{-----(1/2 Marks)}$$

\therefore The e.m.f. of alternator 'A' can be determined from $E_A = V_L + I_A Z_A$
where V_L is load voltage/ phase -----(1/2 Marks)

$$E_A = (3810.1 - j0) + (131.1 - j72.83) (0.5 + j10)$$

$$\text{Or } E_A = 4602.35 + j1274.64$$

$$E_A = 4775.52 \angle 15.48^\circ \text{-----(1/2 Marks)}$$

i.e angle ϕ_A between V and $E_A = 15.48^\circ$

$$\text{Line value } E_A = \sqrt{3} \times 4775.52 = 8271.78V$$

$$\text{Similarly, } E_B = V_L + I_B Z_B \text{-----(1/2 Marks)}$$

$$E_B = (3810.5 + j0) + (131.33 - j124.19)(0.4 + j12)$$



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$$E_B = 5352.1 + j1522.88 = 5564 \text{ -----(1/2 Marks)}$$

Or $\angle \phi_B = 15.88^\circ$ or ϕ_B the angle between V_L and $E_B = 15.88^\circ$

$$\text{Line value of } E_B = \sqrt{3} \times 5564 = 9638 \text{ V -----(1/2 Marks)}$$

b) Given Data:-

(Give stepwise Marks as mention below)

5KVA 200/1000V, $F = 50\text{Hz}$ single phase transformer

O.C test (L.V side) : $V_1 = 200\text{V}$, $I_0 = 1.2\text{A}$ & $W_0 = 90\text{W}$

S.C test (H.V side) : $V_{SC} = 50\text{V}$, $I_{SC} = 5\text{A}$ & $W_{SC} = 110\text{W}$

Since the data is taken by conductive S.C test on H.V side. The parameters are referred to secondary side or H.V side

$$I_w = \frac{W_0}{V_1} = \frac{90}{200} = 0.45\text{A} \text{ -----(1/2 marks)}$$

$$I_c = \sqrt{I_0^2 - I_w^2} = \sqrt{(1.2)^2 - (0.45)^2} = 1.1124 \text{ A -----(1/2 Marks)}$$

$$R_0 = \frac{V_1}{I_w} = \frac{200}{0.45} = 444.44 \Omega \text{ -----(1/2 Marks)}$$

$$X_0 = \frac{V_1}{I_c} = \frac{200}{1.1124} = 179.79 \Omega \text{ -----(1/2 Marks)}$$

$$R_{02} = \frac{W_{SC}}{I_{SC}^2} = \frac{110}{(5)^2} = 4.4 \Omega \text{ -----(1 marks)}$$

$$Z_{02} = \frac{V_{SC}}{I_{SC}} = \frac{50}{5} = 10 \Omega \text{ -----(1 Marks)}$$

$$X_{02} = \sqrt{Z_{02}^2 - R_{02}^2} = \sqrt{(10)^2 - (4.4)^2} = 8.9799 \Omega \text{ -----(1 Mark)}$$

$$\text{The parameters referred to L.V.Side :- } K = \frac{V_2}{V_1} = \frac{1000}{200} = 5$$

$$R_{01} = \frac{R_{02}}{K^2} = \frac{4.4}{(5)^2} = 0.1776 \Omega \text{ -----(1/2 Mark)}$$

$$X_{01} = \frac{X_{02}}{K^2} = \frac{8.96}{(5)^2} = 0.3591 \Omega \text{ -----(1/2 Mark)}$$



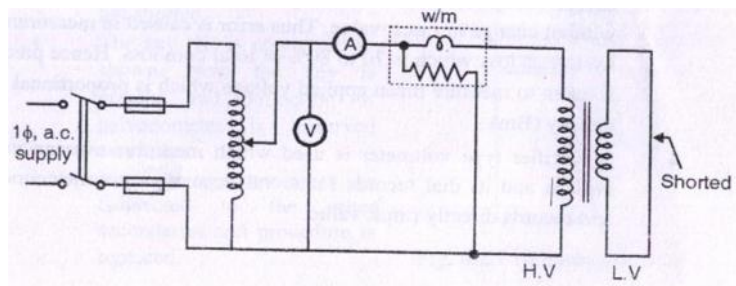
$$Z_{01} = \frac{Z_{02}}{K^2} = \frac{10}{(5)^2} = 0.4 \Omega$$

Q.2 Attempt any Four of the following-----16 Marks

a) Explain how S.C test is performed on single phase transformer.

(Figure 2 Marks & Procedure-2 Marks)

Circuit Diagram:-



This test is conducted to find out copper losses of the transformer at full load condition. This test is conducted generally on HV side of the transformer and LV winding is shorted.

Procedure:-

- Make the connection as per circuit diagram shown in above experimental setup.
- Make sure the input voltage applied to transformer is Zero, initially.
- With the help of auto transformer increase the applied voltage in steps, till it circulates full load current in HV side.
- Take the corresponding readings of wattmeter, Ammeter and voltmeter. These reading can be utilize to find out parameters, regulation & efficiency.

b) State any four equipments used for lifting heavy electrical machines during installation.

(Write Any Four equipment – 1Mark to each equipment)

Equipment used for lifting heavy electrical machine:- (Expected Any Four)

- Stationary Cranes:
- Overhead or Gantry Cranes
- Mobile Cranes:
- Truck Mounted Crane:
- Steam Crane:
- Chain pulley Block:
- Chain Hoist:
- Electric Hoist



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- ix)Screw Jacks
- x) Winches horses
- xi)Tripods
- xii)Ceiling ropes

c) State any four troubles in batteries. Suggest any two remedies for each trouble. (Expected Any Four)
(Write Any Four points – 1 Mark to each point)

S.No	Troubles	Causes	Remedies
1	Battery is not registering charging current	a) Discontinuity in charging on account of blown fuses, loose connections	a) Check charging circuit thoroughly, replace blown fuse, tighten connection and repair breaks
2	Battery is giving low output than its rated capacity	a) Plates have outlived their life. b) Active material has got detached from positive plates. c) contaminated electrolyte d) Sulphation of plates. e) Heavy self discharge. f) Low operating temperature.	a) Change plates. b) Change plates if shedding is considerable. c) Wash out the cell and fill it with non contaminated electrolyte. d) Battery may be charged to restore the capacity. e) Inspect the cells, clean and dry them. f) To avoid loss of heat use lagging increase specific gravity of the electrode.
3	Cell does not register voltage across its terminals	a) Short circuited. b) Heavy leakage or self discharge. c) Sulphation	Remove the cause of the short circuit of the cell. Clean and dry it and charge the cell.
4	Very high temperature being experienced during charging.	a) Charging rate very high. b) Regulator i.e ampere hour meter not set coeectly. c) Charging has not stopped automatically. d) Short circuit in the cell e) Heavy sulphation	a) Discontinue charging and reduce the charging voltage. b) Check and correctly set the meter. c) Check timing mechanism and take remedial measures. d) Remove the cause of short circuit. e) De-sulphation charging be resorted to.
5	Heavy gassing during early stage of charging	a) Sulphation b) Heavy charging current. c) Battery is being charged at very low temperature.	a) De-sulphation charging be resorted to. b) Reduce charging currents. c) Warm the surrounding so as to increase the temperature of battery.
6	Very high temperature being experienced on discharge	a) Ambient temperature too high. b) Loads are excessive and	Take the remedial measures for decreasing ambient temperature of installation of correct size of battery



		capacity of the battery is less c) Battery not fully charged before it is put into service. d) Level of the electrolyte is low.	or topping of cells.
7	Heavy gassing during discharging	Contaminated electrolyte	Replace the electrolyte
8	Level of the electrode gets low too early	a) Cracked cell jars b) Topping has been overlooked. c) Heavy charging.	a) Check and replace jar. b) Topping should be done regularly. c) Reduce charging rates.
9	Cell voltage unequal	a) Over discharge. b) One of the cells has got short circuit. c) Electrolyte level low. d) Positive plates worn out. e) Too much active material has been shedded.	a) Give equalization charge. b) Remove short circuited. c) Pay attention to the topping of the cells. d) Replace the plates or the cell. e) Replace the plates or the cell.
10	Unequal specific gravity in various cells	a) Cracked jars. b) Strength of the electrolyte different in various cells. c) Neutralization material in the cells	a) Replace the jars. b) Replace the electrolyte and add correct electrolyte. c) Replace the electrolyte. Jars should be cleaned and dried.

d) Explain the filtering process for transformer oil filtration.

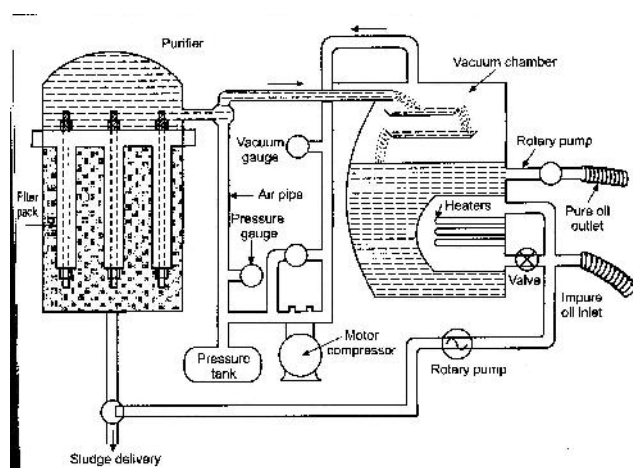
(Explanation-2 Marks & Figure-2 Marks)

Two types of oil purifiers are in common use:- (Expected Any one type)

1. Stream Line Purifiers

2) Centrifugal Purifiers

1. Stream Line Purifiers:-

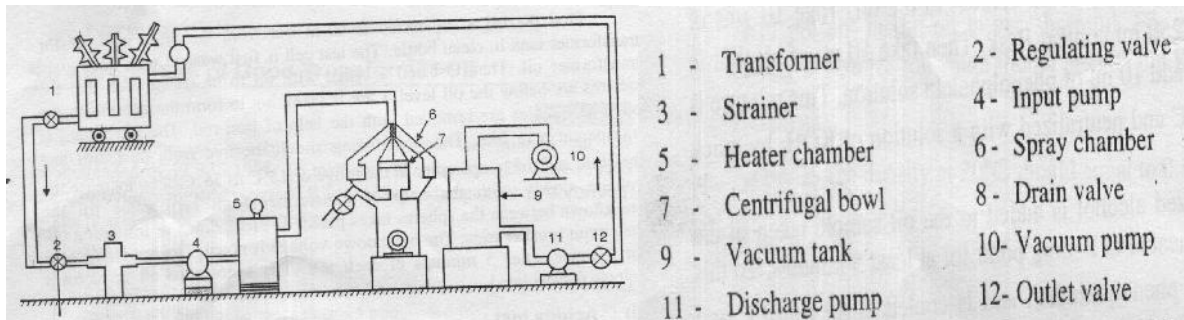


- In this process oil under high pressure is passed through very thin paper-discs (Filter packs).
- The purified oil will go down and impurities remain in paper-discs.



- Compressed air is passed to release the collected impurities. (deposited dirt & carbon)
- This type of purifier is most efficient to remove the moisture from oil.

2) Centrifugal Purifiers:-



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

e) Explain why indirect tests are carried out. Give one example.

(Explanation-3 Marks & Example-1 Marks any one example expected)

Indirect test are carried out generally on all types of machine/equipments from low to high capacity.

In such test it is not necessary to connect the load. The power consumption is small as compare to direct load test. It also requires less time to test. The calculations are simple & test results are almost accurate (approximately)

Generally these tests are done on high capacity rating machines/equipments. Because it is very inconvenient or not possible practically to test such large capacity equipments on full load

Example:-

- i) O.C. and S.C test on transformer **OR**
- ii) O.C. and S.C test on Alternator **OR**
- iii) Swinburn test on DC machine

f) State any six activities that are carried during maintenance of LV switchgear.

(Write First Four points – 3 Mark & for reaming one point 1/2 Marks)



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The following activities **or equivalent activities** are carried out during maintenance of LV Switchgear:- **(Expected Any Six)**

- i) Use correct size of rating of switchgear.
- ii) Detect the cause required to do maintenance & switchgear.
- iii) Cleaning & lubrication of structure of LV switchgear.
- iv) To check the bolts and terminals screws. (Lose connection)
- v) Insulation resistance test should be carried out.
- vi) Setting of Relays should be tested.
- vii) Check whether all the moving parts of switchgear are operating freely.
- viii) Check the tripping mechanism of over current relay particularly free moving magnetic trip device.
- ix) In case of dashpots the oil must be clean and flows freely.

Q.3 Attempt any Four of the following-----16 Marks

a) State any four factors on which severity of shock depends.

(Write Any Four points – 1 Mark to each point)

The effect of electrical shock on human bodies depends on following factors.

- i) Voltage of the system.
- ii) The magnitude of current passing through the body.
- iii) The period for which the area of contact with live part.
- iv) It is also depends on supply system i.e. A.C or D.C.
- v) Body resistance (If wet resistance of body reduces)

OR- (Any four expected-1 Mark each)

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 fibrillation.
5	100mA-200mA	May cause fibrillation of heart
6	Above -200mA	Causes death, severe burns

b) State function of following tools: i) Spirit level ii) Growler iii) Bearing Puller iv) Megger

(Each Function of Tools-1 Mark Each)

i) Spirit Level:-

- It is a common instrument to test or adjust horizontal surface.
- It is essential in all erection work or in repair work. The level may be moved in both horizontal and vertical directions



ii) Growler:-

- It is a equipment used for finding shorted turns of armature coil or stator/rotor winding. It is essentially a single winding transformer.
- It is available in two forms called as external growler and internal growler and can be used to find out shorted turn faults in armature winding or rotor and stator winding of induction motor.

iii) Bearing Puller:-

- Bearing puller is used for removing from the shaft of the motor and generator.

iv) Megger:-

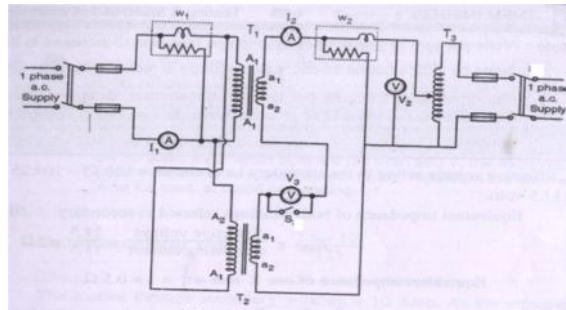
- Megger is used to find out insulation resistance of electrical machine/equipment
- Meggers (mega ohm meter) are available for DC voltage of 500V to 2500V. Generally in practice 500V meggers are used.

c) Explain how back to back test is performed on single phase transformer.

(Figure-2 Marks & Procedure-2 Marks)

Back to Back test is conducted on two identical transformers. This test is used to find regulation, efficiency and temperature rise of transformer.

Experimental Setup:-



Procedure:-

- Make the connection as per circuit diagram shown in above experimental setup.
- The primary is connected in parallel while secondaries are connected in series opposition.
- Keep switch "S" open, set auxiliary transfer supply voltage to Zero.
- Apply rated voltage to the primary side and NO-Load readings on primary side.
- Make sure voltmeter across switch 'S' reads Zero.
- Close switch 'S' and increase the auxiliary supply voltage in steps to circulate ,full load current in secondary & take the reads of wattmeter, ammeter and injected voltmeter on secondary side.

d) State any six factors on which schedule of routine maintenance depend.

(Write First Four Point-3 Marks & For reaming two points-1/2 Mark each point)

It depends on following Factors: (Any Six points expected)



- Type of machine & its working condition.
- Working environment of industry.
- Load cycle or operating cycle of equipment or machine.
- Large capacity machine or equipments are used in industry it require a sound policy for maintenance.
- Aging of machine.
- Cost of the maintenance.
- The maintenance schedule is usually in the form of log sheets on which weeks, months of the year are tabulated.
- Histories are provided for each major equipment.
- Availability of trained & skilled technician.
- Availability of spares & raw material.

e) State any two tests that are preferred on induction motors. Explain these tests in brief.

(Types of test – 2-Marks & Explanation-1 Marks each type)

Following tests preferred on induction Motor:- (Any Two type expected)

- i) Measurement of DC Resistance :
- ii) Measurement of Insulation Resistance:
- iii) Open circuit voltage test
- iv) No-load Test:
- v) Starting Tests:
- vi) Locked-Rotor Test (Short-circuit test)
- vii) Load Test:
- viii) Temperature Rise Test:
- ix) Measurement of slip
- x) Insulation Test

i) No-load test (free running test) :-

This test is conducted on three phase induction motor at No-load or free running condition. It is conducted to find out No-load losses. The procedure is as follows.

- i) The motor is kept at No-load condition.
- ii) Keep the auto transformer at zero volt position initially.
- iii) Increase the input voltage to the stator with the help of auto transformer upto rated value
- iv) Machine will run close to the synchronous speed due to no-load ($N \cong N_s$).
- v) Take the corresponding readings of input voltage under No-load (V_0), No-load input current (I_0) and No-load input power (W_0)
- vi) The above test results are utilized for finding the parameters, performance of 3-ph induction motor.

ii) Locked-rotor (Short circuit) Test:-



This test is type test. This test is conducted on three phase induction motor to find full load copper losses. The procedure is as follows:

- i) Hold the rotor under short circuit condition stationary with the help of jaw/clamps.
- ii) Keep the auto transformer at zero volt position initially.
- iii) Increase the applied voltage to the stator with the help of auto transformer in steps till it circulate full load current.
- iv) Take the corresponding readings of input voltage under short circuit (V_{SC}), input current (full load current) under short circuit (I_{SC}) and input power under short circuit.
- v) The above test results and test results of free running test can be utilized for finding performance & the parameters of equivalent circuit of 3-ph induction motor.

Q.4 A) Attempt any Three of the following-----12 Marks

a) Explain preventive maintenance and breakdown maintenance (Each Explanation -2 Marks)

Preventive maintenance:-

Preventive maintenance means proper maintenance and is carried out to reduce the failure of equipment to minimum. It consists of adoption of measures to know before breakdown and prevent them before they occur than allowing breakdowns to happen & then take actions. Following are the functions of preventive maintenance.

- i) Periodic visual inspection of various equipments to locate initial condition leading to breakdown.
- ii) Up keep of equipment and plant & repair defects at their initial Stage.
- iii) To attend major breakdown and repairs.

Breakdown maintenance:

When industrial plants or electrical machines are running and stop incidentally, it is known as breakdown. Breakdown maintenance is carried out when machine fail to run. The following are the main recommendations for implementation to breakdown maintenance.

(Any Two Points Are Expected)

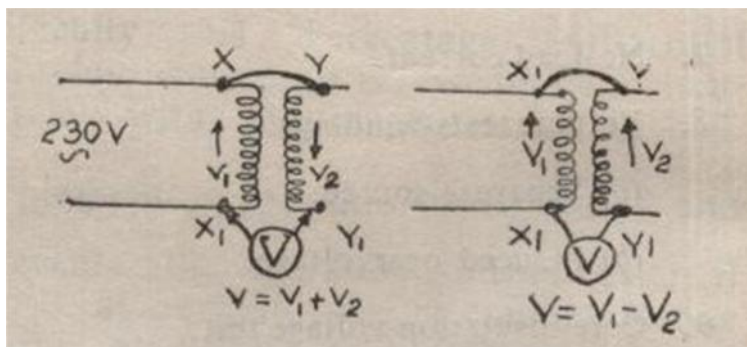
- i) **Engineering Records:** The timely fulfillment of breakdown maintenance depends to a great extent upon the way in which the work is recorded.
- ii) **Inspection:-** Inspection must be carried out by senior & competent person, who has got through knowledge of maintenance work.
- iii) **Servicing:-** This refers cleaning, adjustment, lubrication and maintenance functions without dismantling the equipment.
- iv) **Testing:-** This testing of the electrical equipments must be done very carefully, because the performance of the equipments specially protective device.
- v) **Engineering Analysis:-** It is observed that a few equipments require more frequent repairs as compared to other.



- vi) **Tools & Tackles:-** proper tools and tackles are more essential for the continuously operating units.
- vii) **Inventory control of stores and spares:-** It is also necessary for maintenance section to make the inventory of all the spares required and should be made readily available for use whenever required.

b) Explain how polarity test is carried on single phase transformer.

(Figure-2 Mark & Explanation-2 Marks)



- Consider V_1/V_2 single phase transformer shown in figure.
- The primary and secondary are supposed to have the same polarity. When the turns in both winding go round the core in the same direction and the start and end leads are marked in same way.
- If 'X' and 'Y' are connected together the voltage across X_1 and Y_1 will be found to $V = V_1 + V_2$ the polarity of the terminals is additive as the voltages V & V added corresponding to the series connection. It means opposite polarity.
- If 'X' and 'Y' are connected together the voltage across X_1 and Y_1 will be found to $V = V_1 - V_2$ and the polarity is said to be subtractive. It means same polarity.

c) Explain meaning of drying out of electrical machine, State necessity of drying out of electrical machine.

(Explanation- 2 Marks & Necessity- 2 Marks)

Dry out of electrical machine:-

- The insulation of electrical machine have a tendency to absorb moisture when not carrying currents and kept idle.
- This moisture reduces the insulation resistance and electrical withstand values of the winding.

State necessity of drying out of electrical machine

- Before commissioning of electrical machine/equipment, the drying-out is essential, particularly for high voltage machines (above 1000V rating) and for machines kept in damp/flood condition. Drying out is also necessary prior to recommissioning after a prolonged idle period.



d) i) State three basic requirements of machine foundation----- (2 Marks)

ii) State function of foundation bolt and bed plate ----- (2 Marks)

i) State three basic requirements of machine foundation

Following are the basic requirements of machine foundation:- (Any three point expected)

- i) Horizontal Level
- ii) Rigidity or Safe bearing capacity
- iii) Freedom from vibrations. or The capacity of absorption of vibration
- iv) Type of machine-static or dynamic
- v) Sufficient frictional resistance to withstand the possible horizontal thrust.

ii) State function of foundation bolt and bed plate

Foundation Bolt:-

- The foundation bolts fix-up the bed –plate into the concrete foundation. The lower portion of foundation-bolts has an eye-shape (hook type) or saw-tooth shape to provide grip in the foundation.
- The foundation-bolt should be located with the bed-plate hole before lowering the bed-plate.
- The foundation bolts is inserted in the holes of bed-plate with the spring washer and the plan packing washer between the nut& bed-plate flange.

Bed-Plate:-

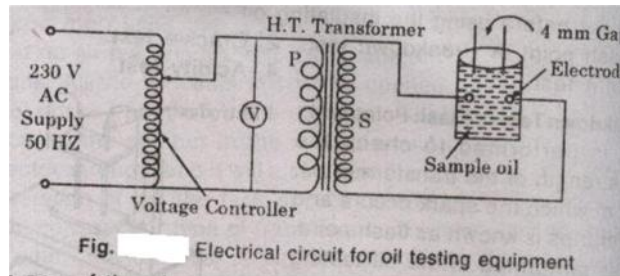
- Medium and large rotating machines are installed on bed-plates.
- The bed-plates are secured to the concrete foundation by means of foundation bolts.
- The machines are bolted to the bed-plate securely.
- The bed-plates for large machines are fabricated from thick sheet steel or rolled.
- The bed-plate has necessary stiffeners and ribs provided in structure.

Q.4 B) Attempt any Three of the following----- 6 Marks

a) Explain how following tests are carried for transformers. i) Testing of dielectric strength of transformer oil ii) Crackle Test

(Explanation of each Testing - 2 Marks & Figure of each testing -1 Mark)

i) Testing of dielectric strength of transformer oil: (Explanation- 2 Mark & Figure-1 Marks)



Explanation:-

- The gap of the electrode is first checked with a gauge.
- The cup is then filled with sample oil to be tested upto about one cm. above the electrodes.
- The cup top is covered with a clean glass plate.
- The supply is switched on and voltage is raised gradually by the variac.
- The stage comes when the final breakdown of the oil takes place and the circuit breaker is got tripped which disconnects the transformer from the main supply.
- The value is noted down which must be 30KV (r.m.s) for 4 mm & 0.02 gap and 20 KV (r.m.s) for 2.5 mm gap.
- The test is performed with two or three consecutive samples of oil turn by turn.
- With interval of one minute to allow the bubbles to escape.
- Average of all subsequent tests is considered as the breakdown voltage of oil sample.

ii) Crackle Test:-

(Explanation- 2 Mark & Figure-1 Marks)

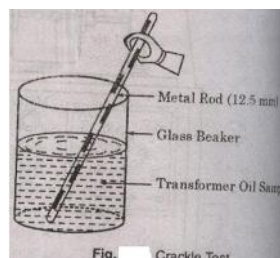


Fig. is not compulsory

- This test is performed to check the presence of moisture in the insulating oil.
- To perform this test, a sample oil of 250 ml is taken in a breaker.
- One iron rod of 12.5 mm is made red hot and dipped in this sample of oil.
- If there is any hissing sound coming through the oil in the breaker, it indicates the presence of moisture contents in the oil. Which will be considered not suitable for the use

b) State any four causes of following troubles in single phase induction motor.

(Each point- 1 Mark & Any Two Causes expected)

i) Fails to start ii) Runs Hot iii) Runs Slow

S. No.	Troubles in 1-phase induction motor	Cause
1	Fails to start	1. Open in auxiliary winding.



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		2. Open in main winding. 3. Overload 4. Open capacitor. 5. Shorted capacitor. 6. Blown fuses 7. Defective starting mechanism.
2	Run Hot	1. Overload 2. Starting mechanism does not open. 3. Low voltage. 4. High Voltage. 5. Low frequency. 6. Rotor rubbing on starter 7. Shorted stator coils 8. Dogged ventilating ducts 9. Worm bearing
3	Run Slow	1. Overload 2. Broken rotor bars 3. Shorted stator coils 4. Low voltage 5. Low frequency

Q.5 Attempt any Two of the following-----16 Marks

a) Given Data:

(Give stepwise mark)

Note:- Unit of Diameter of pulley given in problem is in meter which is incorrect, Problem is solved by considering the unit of diameter of pulley in Centimeter. If student are solved problem as per given data, then also consider & marks are allotted as per steps

Effective load = 38.1 Kg effective diameter = 63.5 cm Speed N= 12 rps, I= 49A & Volt V= 220V

$$\text{The effective load} = (F_1 - F_2)$$

$$\text{The effective load} = 38.1 \text{ kg} \quad \text{The effective diameter of pulley} = 63.5 \text{ cm}$$

$$r = \text{effective radius} = \frac{d}{2} = \frac{63.5 \times 10^{-2}}{2} = 31.75 \times 10^{-2} \text{ m} \quad \text{-----}(1 \text{ Marks})$$

$$\text{Torque} = (F_1 - F_2) \times r \times 9.81 \text{ N-m} \quad \text{-----}(1 \text{ Marks})$$

$$\text{Torque} = (38.1) \times (31.75 \times 10^{-2}) \times (9.81) \text{ N-m}$$

$$\text{Torque} = 11866.91 \times 10^{-2} \text{ N-m} \quad \text{-----}(1 \text{ Marks})$$



$$output = 2f NT \text{-----}(1\text{- Marks})$$

$$\therefore output = 2 \times 3.142 \times 12 \times 11866.91 \times 10^{-2}$$

$$\therefore output = 894860 \times 10^{-2} \text{ watts} \text{-----}(1\text{ Marks})$$

$$\therefore Input = VI = 220 \times 49 = 10780 \text{ watts} \text{-----}(1\text{ Marks})$$

$$\%y = \frac{o/p}{Input} \times 100 \text{-----}(1\text{ Marks})$$

$$\%y = \frac{894860 \times 10^{-2}}{10780} \times 100$$

$$\%y = 83.01\% \text{-----}(1\text{ Marks})$$

b) State any eight activities for each of following maintenance of rotating electrical machines

i) Daily maintenance ii) Monthly maintenance (Each Maintenance activities-1/2 Marks)

i) Daily maintenance activities:- (Expected Any eight point)

- i) Examine visually earth connections and motor leads.
- ii) Check motor winding for overheating (the permissible maximum temperature is above that which can be comfortably felt by hand)
- iii) Watch out for excessive vibrations.
- vi) Examine control equipment.
- vii) Examine bearing to see that oil rings are working in the case of oil ring lubricated motor.
- viii) Note temperature of bearing in case of oil ring lubricated motor.
- ix) Add oil, if necessary in case of oil ring lubricated motor.
- x) Check end play in case of oil ring lubricated motor.
- xi) Check coupling connections in case of oil ring lubricated motor.

ii) Monthly maintenance :- (Expected Any eight point)

- i) Overhaul controllers.
- ii) Inspect and clean oil circuit breaker.
- iii) Renew oil in high speed bearing in damp and dusty locations.
- iv) Wipe brush holders and check bedding of brushes of slip ring motors.
- v) Clean winding by vacuum pump & check the winding for their proper insulation.
- vi) Commutator surface should be examined for high mica and high bar, scratches and roughness



- vii) Check the bearing weariness, end play and its surface.
- viii) Oil in the gear box should be checked for the flow for the presence of sand, water or metal scale. If the oil is not found in good condition, drain it out, flush and refill it.
- ix) Changing load conditions should be observed. i.e. controlling devices troubles, poor handling or wrong adjustments

c) Explain any eight methods of cleaning of insulation of electrical machines.

(Each Point- 1 Mark)

Following methods of cleaning of insulation of electrical machines:-

- i) Removal of loose dust by blower, the pressure of forced/suction air should be moderate.
- ii) Removal of loose dust by vacuum cleaner,
- iii) Dry dust can be removed by soft brush.
- iv) Clean open dust/dirt on open cables by cotton waste.
- v) Sticky dirt can be removed by fibrous scraper smoothly.
- vi) Oily viscous films can be removed with approved petroleum solvent & then cleaned by cotton cloth.
- vii) Particularly 'H' Class insulation can be cleaned with fresh water & detergent.
- viii) The cleaning should be done as quick as possible & excess moisture can be cleaned by dry cloth & machine should be booked dry in oven.

Q.6 Attempt any Four of the following----- 16 Marks

a) Explain procedure of alignment of shaft of electrical machine.

(Procedure- 4 Marks- one 1 mark each point)

There are three steps in the alignment of the shafts.

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

Procedure of alignment of shaft of electrical machine:

- i) Align the motor and the driven machine on bed-plate in their final position with shims under their feet.
- ii) Mark both half-coupling by means of chalk line. Make accurate measurement between the gaps between the faces of the vertical surfaces. Turn the motor shaft through 90^0 , 180^0 , 270^0 and 360^0 and note the reading of the gap.
- iii) The excess difference is reduced below 0.05 mm by adjusting the shims.
- iv) Likewise the difference in the high's of axis of drive coupling and driven coupling is gauged by suitable method. One of the method of gauging the gap between vertical surfaces of coupling and the difference in heights is by using single point turn point Run over Gauge.

b) State causes and remedy of the following failures in 3-phase transformers.

(Each point-1 Mark)



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i) Overheating ii) Internal short circuited iii) Moisture in oil iv) Vibration in core

S. No.	Causes of Trouble	Remedies
1	Overheating	Check cooling system, whether fans are operating whether cooling oil/water is circulated. Reduce the load on the transformer. If temperature of oil to high, switch off transformer till safe temperature reached. If over-load problem is occurring for long durations, install another transformer in parallel. If ambient temperature is higher than that considered in specifications of transformer de-rate the transformer.
2	Internal short circuited	Buchholz relay should operate and sound alarm. Over current and differential protection should operate and open the circuit breaker.
3	Moisture in oil	Oil should be filtered. Silica jel should be replaced, gaskets be replaced. Transformer should be dried out.
4	Vibration in core	The loose core clamping bolts and bolts between core and structure results in vibration of core. This results in weak core insulation

c) State any four objective of preventive maintenance of electrical equipments.

(Each objective-1 Mark)

Objective of preventive maintenance of electrical equipments:- (Expected any four)

- i) To prevent minor faults from developing into major breakdown.
- ii) To reduce breakdown period.
- iii) To keep the machine in good working condition by reducing wear and tear.
- iv) To provide greater safety & protection to the workers.
- v) To develop maintenance schedule at low cost.
- vi) To determine the need for major & minor repairs.
- vii) To use less standby equipments.
- viii) To increase life of machine.

d) State any six activities that are to be carried out for the person who received electrical shock. (Write First Four Point-3 Marks & For reaming two points-1/2 Mark each point)

Activities to be carried out for the person who received electrical shocks:- (Expected Any Six)

- i) Switching OFF the supply: when a person comes in contact with live conductor, switch off the main supply immediately if it is nearby or cut the wires with insulated pliers from the wiring circuit.



- ii) Removing the person from the contact of current:- Push a person with a dry sticks of wood or pull him by using hands wear by insulated hand gloves, or use cotton thick cloths or use dry news paper folded of sufficient thickness.
- iii) Removing the person from fire: If a person's cloth catches fire, then wrap him in the blanket or coat & roll him on the ground to extinguish.
- iv) Call to doctor immediately.
- v) Before coming doctor, if any burns or wound occurs on the body of the person use proper oil/ medicine (first aid)
- vi) If the person is not breathing, immediately start artificial respiration until the medical aid arrives.

e) State any eight activates that are done during preventive maintenance of induction motors
(Each Activities- 1/2 Marks)

Following activates are done during preventive maintenance of Induction motor:- **(Expected Any Eight points)**

- i) To check motor terminals & connections.
- ii) To check motor earthing.
- iii) To check accessories like starter, relays etc and control equipments.
- iv) To check input condition like voltage, frequency at their permissible limits.
- v) To check output conditions (particularly input current)
- vi) To normal working temperature with bear hand touching.
- vii) To check the vibration.
- viii) To check the mechanical coupling.
- ix) To check oil bearing by noise level.
- x) To check belt tension and condition.
- xi) To check slip-rings & brushes for their proper shape and tension.
- xii) To check oil level in rotor resistance starter if used.
- xiii) To check DC resistance of stator winding if necessary.
- xiv) To check the insulation resistance by megger if necessary.

END



Question Paper & Summary of Marking Scheme

Q.1 Attempt any three of the following----- 12 Marks

A) Define following term w.r.t. electric accident: **(Each definition 1 Marks)**

i) Safety ii) Hazard iii) Accident iv) Accountability

b) Define type test and routine test. Give two example of each of them.

(Each Definition 1 Mark & Example -2 Marks any two points expected)

c) State four conditions that are essential for parallel operation of 3 phase transformer.

(Any Four point expected- 1 Mark each point)

d) i) Explain meaning of insulation resistance

(2 Marks)

ii) State how insulation resistance of a transformer is measured. **(2 Marks)**

B) Attempt any one of the following----- 6 Marks

a) Given Data:-

(Give stepwise Marks as mention below)

$$V_L = 6.6KV \quad \cos\phi = 0.8 \quad \text{Impedance for } m/c 'A' = 0.5 + j10\Omega \quad \& \quad m/c 'B' = 0.4 + j12\Omega$$

b) Given Data:-

(Give stepwise Marks as mention below)

Q.2 Attempt any Four of the following-----16 Marks

a) Explain how S.C test is performed on single phase transformer.

(Figure 2 Marks & Procedure-2 Marks)

b) State any four equipments used for lifting heavy electrical machines during installation.

(Write Any Four equipment – 1Mark to each equipment)

c) State any four troubles in batteries. Suggest any two remedies for each trouble. (Expected Any Four)

(Write Any Four points – 1 Mark to each point)

d) Explain the filtering process for transformer oil filtration.

(Explanation-2 Marks & Figure-2 Marks)

Two types of oil purifiers are in common use:- (Expected Any one type)

1. Stream Line Purifiers

2) Centrifugal Purifiers



e) Explain why indirect tests are carried out. Give one example.

(Explanation-3 Marks & Example-1 Marks any one example expected)

f) State any six activities that are carried during maintenance of LV switchgear.

(Write First Four points – 3 Mark & for remaining one point 1/2 Marks)

Q.3 Attempt any Four of the following-----16 Marks

a) State any four factors on which severity of shock depends.

(Write Any Four points – 1 Mark to each point)

b) State function of following tools: i) Spirit level ii) Growler iii) Bearing Puller iv) Megger

(Each Function of Tools-1 Mark Each)

c) Explain how back to back test is performed on single phase transformer.

(Figure-2 Marks & Procedure-2 Marks)

d) State any six factors on which schedule of routine maintenance depend.

(Write First Four Point-3 Marks & For remaining two points-1/2 Mark each point)

e) State any two tests that are preferred on induction motors. Explain these tests in brief.

(Types of test – 2-Marks & Explanation-1 Marks each type)

Q.4 A) Attempt any Three of the following-----12 Marks

a) Explain preventive maintenance and breakdown maintenance **(Each Explanation -2 Marks)**

b) Explain how polarity test is carried on single phase transformer.

(Figure-2 Mark & Explanation-2 Marks)

c) Explain meaning of drying out of electrical machine, State necessity of drying out of electrical machine.

(Explanation- 2 Marks & Necessity- 2 Marks)

d) i) State three basic requirements of machine foundation----- **(2 Marks)**

ii) State function of foundation bolt and bed plate ----- **(2 Marks)**

Q.4 B) Attempt any Three of the following----- 6 Marks

a) Explain how following tests are carried for transformers. i) Testing of dielectric strength of transformer oil ii) Crackle Test

(Explanation of each Testing - 2 Marks & Figure of each testing -1 Mark)

b) State any four causes of following troubles in single phase induction motor.

(Each point– 1 Mark & Any Two Causes expected)



- i) Fails to start ii) Runs Hot iii) Runs Slow

Q.5 Attempt any Two of the following-----16 Marks

a) Given Data: (Give stepwise mark)

Note:- Unit of Diameter of pulley given in problem is in meter which is incorrect, Problem is solved by considering the unit of diameter of pulley in Centimeter. If student are solved problem as per given data, then also consider & marks are allotted as per steps

b) State any eight activities for each of following maintenance of rotating electrical machines

- i) Daily maintenance ii) Monthly maintenance **(Each Maintenance activities-1/2 Marks)**

c) Explain any eight methods of cleaning of insulation of electrical machines.

(Each Point- 1 Mark)

Q.6 Attempt any Four of the following----- 16 Marks

a) Explain procedure of alignment of shaft of electrical machine.

(Procedure- 4 Marks- one 1 mark each point)

b) State causes and remedy of the following failures in 3-phase transformers.

(Each point-1 Mark)

- i) Overheating ii) Internal short circuited iii) Moisture in oil iv) Vibration in core

c) State any four objective of preventive maintenance of electrical equipments.

(Each objective-1 Mark)

d) State any six activities that are to be carried out for the person who received electrical shock.

(Write First Four Point-3 Marks & For remaining two points-1/2 Mark each point)

e) State any eight activities that are done during preventive maintenance of induction motors

(Each Activities- 1/2 Marks)