Solution

Internal Assessment Test II – Oct .2019

Sub:	Testing and Commissioning of Power System Apparatus							**Code:**	15EE752
Date:	14/10/2019	Duration:	90mins	Max Marks:	50	**Sem:**	VII	**Branch:**	EEE

Note: Answer Any Five Questions

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Describe the techniques used in drying of windings in induction motors.

- List of all 5 the techniques used
- Elaborate any 4 methods (each 2 marks)

Drying of winding

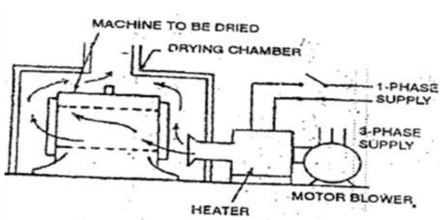
- The insulation of rotating machines will absorbs moisture from the atmosphere
- The moisture reduces the insulation resistance
- Drying out of induction motor by applying the heat to the windings.
- In the first phase the insulation resistance starts decreasing due to distribution of moisture in entire insulation.
- In the second phase is a steady temperature phase over certain time and insulation resistance remains almost constant.
- In the third phase the insulation resistance increases there by indicating the moisture is removed.

Drying of Induction Motor by drying chamber & resistance method

- The machine to be dried is housed in a drying chamber.
- The volume of drying chamber should be nearly four times the volume of the induction motor.
- The heated air by using resistor heaters is circulated by means of fans and air circulation system.
- The air temperature is measured using thermometers.
- The moisture is expelled from the machine is let out of the drying chamber through air outlet.

Drying of Induction Motor by drying chamber & resistance method

- The temperature is gradually raised not faster than 10°C per hour.
- It is required to preferably maintain steady temperature throughout the heating.



Drying out of induction motor by drying chamber and resistor heater

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8 M</td><td>10 M</td><td>10 M</td></tr>
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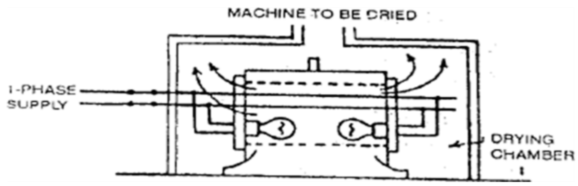
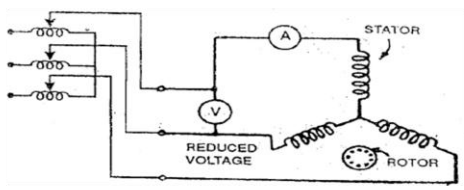
Drying out by Radiating Lamps

- This method is used for medium and small motors.
- The infrared lamps are located in chamber facing the motor winding with rotor removed.
- This method is applicable for dismantled motor for drying the stator and rotor winding separately.



Drying out by Circulating Short Circuit Current

- This is convenient method for drying out slip ring induction motor
- By short circuiting the rotor, large current passes through the windings, due to this current heat will be produced in the winding
- The current through the stator winding not to exceed 50% of the rated current.



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Explain the procedure of low slip test and method of calculation of Xq from the same.

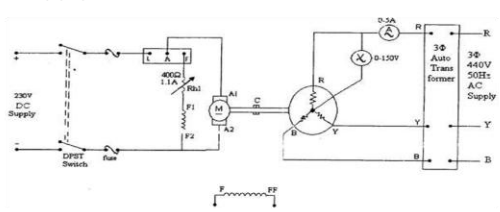
- Neat diagram
- Procedure
- Calculation method

Slip test

1. Field terminals of the alternator is kept open.
2. With shunt field rheostat R_{h1} in minimum resistance position, the motor is started using 3-point starter.
3. By adjusting the field rheostat R_{h1} of the motor, the alternator is run at a speed slightly less than the synchronous speed.
4. Now 3- phase AC supply switch is closed, and then applied voltage of say **40 Volts** by varying the autotransformer a reduced A.C voltage is applied to 3Φ stator winding of the alternator. By using phase sequence indicator, check the phase sequence of the alternator.
5. If the phase sequence of the supply is found incorrect, interchange any two supply lines.

Slip test

1. Note down the readings **I_{min}, I_{max}, V_{min}, V_{max}** from ammeter and voltmeter respectively.
2. Reduce the autotransformer output to zero.
3. The motor field rheostat is brought to initial position, the DC supply is switched OFF.



$$X_d = \frac{\text{Maximum voltage}}{\text{Minimum current}}$$

$$X_q = \frac{\text{Minimum voltage}}{\text{Maximum current}}$$

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5 M
2 M</td>
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3	a)	**Explain the sudden 3-φ S.C. test on a 3-φ generator. How to calculate Xd’ and Xd” and Xd or Xs from the sudden3-φ S.C. test.** • Neat diagram • Procedure • Calculation method	2 M 2 M 6 M	10 M	10 M

❖When an alternator is subjected to sudden short circuit, the current in all the three phases increases suddenly to a high value (10 to 8 time's full Load current) during the first quarter cycle.

❖The flux crossing the air gap is Large during first couple of cycles.

❖The reactance during this period is least and the short circuit current is high.

❖This reactance offered during sub transient period is called as sub transient reactance Xd".

❖The first few cycles are covered under sub transient state.

❖After few cycles the decrement in rms value of short circuit current is less rapid than that during the first few cycles.

❖This state is called as Transient state and the reactance offered during this period is called as transient reactance Xd'.

❖The circuit breaker contacts open during this period.

❖Finally the transient dies out and the current reaches

a steady sinusoidal state called the steady state and the reactance offered during this state is called as steady state reactance Xd.

❖Since the short circuit current lag the voltage by 90°, the reactance involved is direct axis reactance.

❖The sudden 3phase short circuit test is conducted at rated speed and at desired no load voltage.

❖The 3 phases are shorted suddenly.

❖To measure the short circuit current storage oscilloscope with proper probe multiplier is used.

❖The terminal voltages of the machine, the excitation

current and winding temperature are measured just before the short circuit.

❖To obtain quantities corresponding to the unsaturated state of the machine, the test is performed at several armature voltage of 0.1 to 0.3 pu rated value.

Oscillogram of current in the phase having zero dc components

OA,OB,OC are the intercept of X-axis as shown. **Ea=+ve sequence emf/phase -rms** value, the emf induced by the Generator.

The current & reactance are given by the expressions:

I=OA/√2=Ea/Xd; Xd=Ea/I;

I’=OB/√2=Ea/Xd’;Xd’=Ea/I’

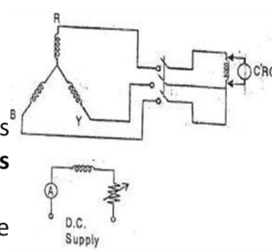
I”=OC/√2=Ea/Xd”;Xd”=Ea/I”;

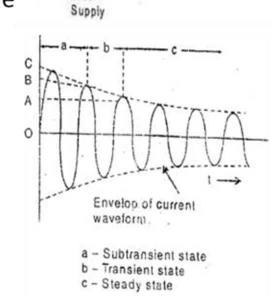
(I=Steady I’=Transient I”=Sub-transient state SC current)

Xd=Direct axis (synchronous)reactance

Xd’=Transient reactance (Direct axis)

Xd”=Sub-transient reactance (direct axis)

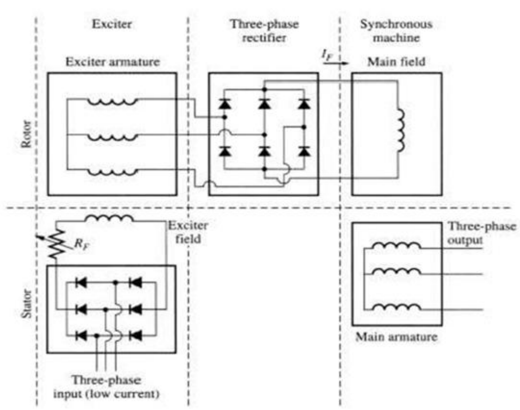
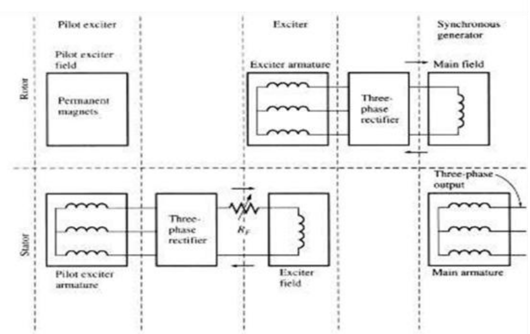




Q. No.		Question			
4	a)	**State and explain the various abnormal conditions in synchronous generator and their effects. Also state protections.** • State the abnormal conditions • Explain 7 conditions and protection methods used (Each 1 mark)	3 M 7 M	10 M	10 M

SL.NO	ABNORMAL CONDITIONS	EFFECT	PROTECTION
1	Thermal overloading Continuous overloading Failure of cooling system	Overheating of stator winding and insulation failure.	Thermocouples or resistance thermometer embedded in stator slots and cooling system. Stators overload protection with over current relays.
2	External fault fed by generator,	Unbalanced loading stresses on windings	Negative phase sequence protection for large machines.
3	Unbalanced load	And shaft, excessive heating for prolonged short-circuit.	Small generators.
4	Stator faults, phase to phase, phase to earth, inter-turn	Winding burn-out, welding of core laminations, shut down.	Biased differential protection, Sensitive earth fault protection and inter-turn fault protection.
5	Rotor earth faults	Fault causes unbalanced magnetic forces	Rotor earth fault protection.
6	Loss of field. Tripping of field circuit breaker.	Generator runs as induction generator deriving excitation currents from bus- bar. Speed increases slightly	'Loss of field' or 'Field failure' protection.
7	Motoring of generator. When input to prime mover stops, the generator draws power from bus-bars and runs as synchronous motor in the same direction.	Effect depends upon type of prime mover and the power drawn from the bus during motoring.	Reverse power protection by directional power relays.
8	Over voltage surges.	Insulation failure.	Lightning arrestor connected near generator terminals.
9	Over fluxing of transformers in generating stations.	Heating of core bolts, core bolt insulation.	Over fluxing protection by v/f relay for generator transformer unit.

5	a)	**Enumerate the various steps of installation of a synchronous machine.** • Give all the steps (Each 1 mark)	10 M	10 M	10 M

		1. Install bedplate with leveling of bed plate. 2. Install bearing pedestals& leveling of the bearing pedestals. 3. Check on stator & rotor. 4. Assembly of the rotor onto the shaft. 5. Installation of the stator. 6. Installing the rotor in the stator. 7. Checking of airgap between stator & rotor. 8. Preparation of shaft coupling. 9. Mounting of shaft coupling on shaft. 10. Preparation of shaft & alignment of shaft. 11. Installation of cooling system 12. Drying out 13. Testing 14. Commissioning.			
6	a)	**Explain the function and principle of brushless excitation system.** • Neat diagram • Purpose and types • Working **Brushless Excitation System** **Requirement:** ❑Separate AC generator. ❑Mounted on the motor shaft. ❑Located at the non-drive end. ❑Fixed speed motor excitation control & related protection based on a separate excitation control system. ❑System also include: ❑Excitation field application logic. ❑Minimum & maximum field protection. ❑Too long start protection. A brushless exciter: a low 3-phase current is rectified and used to supply the field circuit of the exciter (located on the stator). The output of the exciter's armature circuit (on the rotor) is rectified and used as the field current of the main machine.  To make the excitation of a generator completely independent of any external power source, a small pilot exciter is often added to the circuit. The pilot exciter is an AC generator with a permanent magnet mounted on the rotor shaft and a 3-phase winding on the stator producing the power for the field circuit of the exciter. 	2 M 2 M 2 M	6 M	10 M

	b)	**Explain the methods of reduction of noise of the running generator.** • 8 points (Each ½ marks) **Methods to reduce noise:** 1. By reducing magnetic loading 2. By increasing number of armature slots 3. By skewing slots 4. By continuously grading main pole gap 5. By increasing air gap length 6. By providing brace commutating poles against main poles 7. By using 12 pulse thyristor for speed control instead of 6 pulse converter 8. Semi enclosed slots or totally closed slots for compensating windings	4 M	4 M	
7	a)	**State the various types of enclosures for rotating electrical machines and types of cooling adopted in them** • Classification of enclosures • Purpose of each enclosures with types of cooling included in them (each carries 1 mark) The different types of enclosures are as follows i) Open ventilated, motor ii) Ventilated motor iii) Drip proof motor iv) Water protected motor v)Totally enclosed motor vi) Totally enclosed fan cooled motor vii) Environment proof motor viii) Weather proof motor ix) Hose proof motor The method of cooling is closely related to the construction and the type of enclosure of the machine. **Open - pedestal:** In this the stator and rotor ends are open to the outside ambient air, the rotor being supported on pedestal bearings mounted on the bed plate. **Open end bracket:** In this the bearings forms part of the end shields which are fixed to the stator housing. The air is in comparatively free contact with the stator and rotor through the openings. This is common for small and medium size motors and generators. **Protected or end-covertype with guarded openings:** The protector may be screen or fine-mesh over. **Drip, splash or hose proof:** This is a protected machine with the openings in the end shield for cooling. The end shields are designed to prevent entry of falling water or dirt or jets of liquid. **Pipe or duct cooled:** With end covers closed except for flanged openings for connection to cooling pipes.	2 M 8 M	10 M	10 M

		Totally enclosed: The air will not be in contact with the ambient air. The machine is totally air tight. Total enclosure may be associated with an internal rotor fan, an external fan, cooling or closed air circuit cooling in which the air is circulated to a cooler and returned to the machine. **Flame proof or explosion proof:** This motor is used in hazardous location such as industries mines, chemical etc.			