Course Name : Electrical Engineering Group

Course Code : EE / EP

Semester : Sixth

Subject Title : Testing and Maintenance of Electrical Equipments

Subject Code : 17637

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	04	03	100	50#	--	25@	175

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

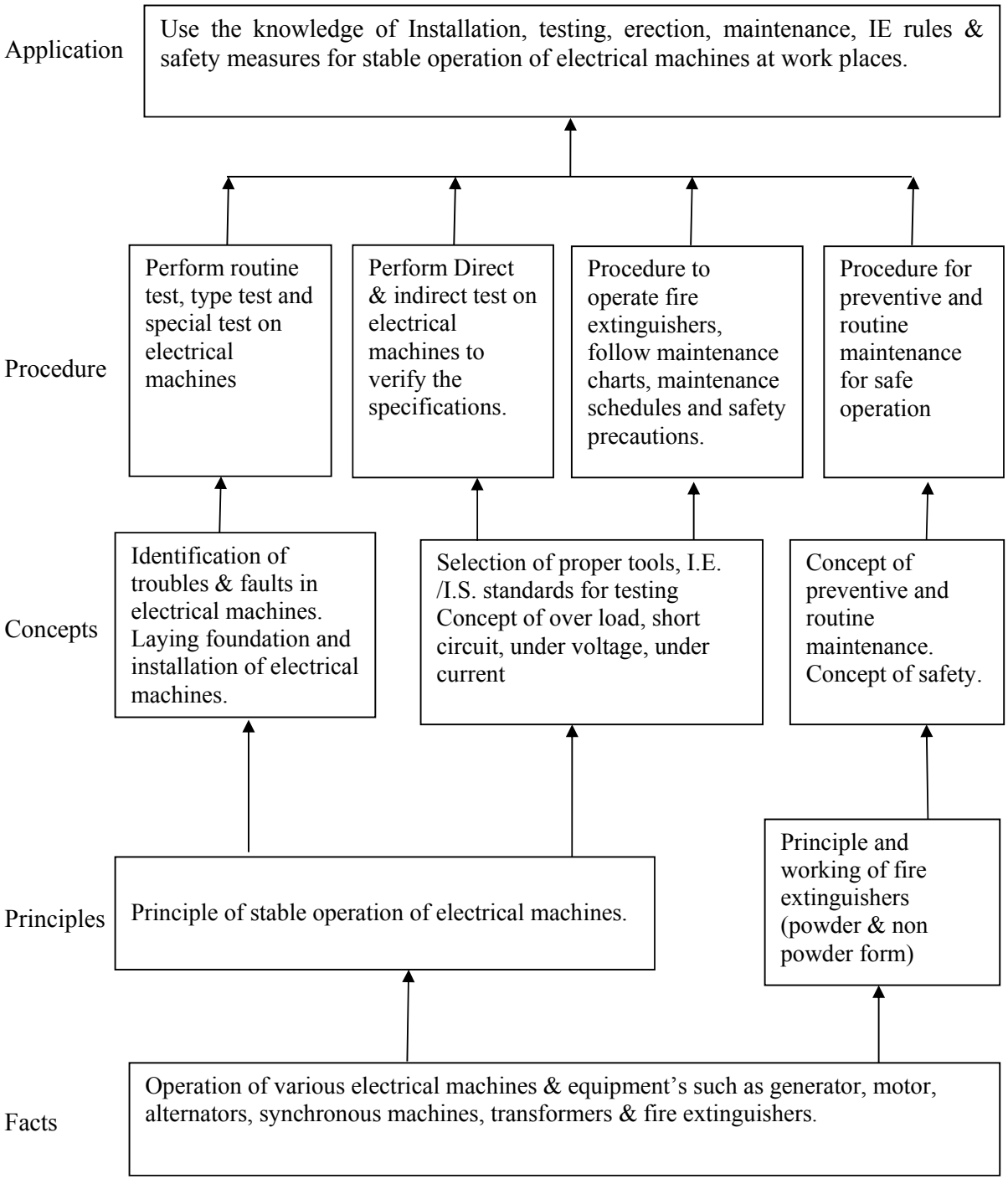
This course is under applied technology courses. Most of the diploma electrical engineers are working either in industries, power plants or in state electricity board as a supervisor / technician/procurement engineer. They have to understand instructions from superiors and pass on the same to the skilled workers working under them. The knowledge of testing, maintenance, erection and installation of electrical equipment's in industries, power plants and state electricity board is essential. This subject provides the detailed guidelines as per I.S. codes/I.E. Rules for testing, maintenance, erection and installation of electrical equipment's. As scope of business/Industry is at global level it is also essential that the student should be well conversed about international codes. They should be made aware about importance of preventive maintenance for efficient and effective functioning of electrical machines.

General Objectives:

After completing this course students will be able to-

1. Know I.S. codes/I.E. Rules & safety measures related to electrical machines.
2. Identify / Locate common troubles in electrical machines.
3. Plan & carry out routine & preventive maintenance
4. Prepare trouble-shooting charts for electrical machines.
5. Ascertain the condition of insulation & revarnishing if necessary.
6. Initiate total productive maintenance.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Safety Measures & Prevention of Accidents Specific Objectives: ➢ To follow electrical safety measures ➢ To rescue electrocuted person and follow artificial respiration methods ➢ To use fire extinguisher for fire due electrical causes Contents: 1.1 Concept of electrical safety, electrical accidents, its causes & preventions. 1.2 Safety signs and symbols used in industry. 1.3 Electrical shocks and factors affecting the severity of it, method of rescuing electrocuted person & different methods of artificial respiration. 1.4 Electrical safety as per I.E. Rules 1956. 1.5 Do's & don'ts regarding safety while working on electrical installations. 1.6 Concept of Permit system, its preparation & regulation for attending to electrical work. 1.7 Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers, types of fire extinguishers.	08	12
Topic 2: Testing of Electrical Machines Specific Objectives: ➢ To perform tests on various electrical machines as per Indian Standards Contents: 2.1 Objectives of testing. 2.2 Roles of Bureau of Indian Standards (BIS) in testing of electrical equipment's. 2.3 Types of tests: Routine, type, supplementary & special tests. 2.4 Methods of testing - Direct/ Indirect/ Regenerative testing. 2.5 Concepts of tolerances. • Tolerances for rotating machines as per IS 4722-2001 • Tolerances for power transformers as per IS 2026 (part-I) - 2011 2.6 Testing of transformer as per IS 2026 (Part-I)-2011 • Routine tests, Type tests and Special tests. 2.7 Testing of three-phase Induction motor as per IS 4029 - 2010 and IS 325 - 1996. • I.M. as a generalized transformer with vector diagram • Equivalent circuit of 3-phase IM (No numerical) • performance of open circuit test and short circuit (blocked rotor) test to find various quantities by drawing circle diagram with various conditions such as • at full load • maximum torque • maximum output • maximum input 2.8 Numericals on 2.6 & 2.7. 2.9 Testing of single-phase induction motor as per IS 7572-2009. 2.10 Testing of synchronous machines as per IS 7132-1973.	22	32

Topic 3: Maintenance of Electrical Machines Specific Objectives: ➢ To plan routine and preventive maintenance schedule ➢ To prepare maintenance schedules for electrical equipments as per IS ➢ To identify different faults developed due to poor maintenance of electrical machines Contents: 3.1 Concept of maintenance, types of maintenance, Routine, preventive & breakdown maintenance. 3.2 Causes of failure of electrical machines. 3.3 Preventive maintenance • Advantages • Procedure for developing preventive maintenance schedules for electrical machines 3.4 Factors affecting preventive maintenance schedules. 3.5 Identification of different types of faults developed such as mechanical, electrical and magnetic faults due to poor maintenance. 3.6 Maintenance schedules of the following as per I.S.S. • Distribution transformer and Power transformer as per IS 10028 (Part-III)-1981 • Single phase & three phase Induction motors as per IS 900-1992 • Synchronous machines • Batteries IS 14782-2000	10	12
Topic 4: Testing and Reconditioning of Insulating Materials Specific Objectives: ➢ To follow the methods of reconditioning of insulation ➢ To test insulating oil as per IS ➢ To measure insulation resistance by different methods Contents: 4.1 Factors affecting life of insulating materials, classifications of insulating materials as per IS 1271-1985. 4.2 Measuring insulation resistance by different methods such as i) Polarization, ii) Dielectric absorption, iii) Megger • To predict the condition of insulation • Meaning of infinity and zero reading 4.3 Reconditioning of insulation • Cleaning and drying the insulation • Re-varnishing • Construction and working of vacuum impregnation plant 4.4 Insulating oil • Properties of insulating oil • Causes of deterioration of oil • Testing of transformer oil as per IS 1866-2000 • Method of purification and filtration of insulating oil	08	16
Topic 5: Fault Finding and Troubleshooting of Electrical Machines Specific Objectives: ➢ To use various tools for fault finding in electrical machines ➢ To locate faults in electrical machines ➢ To prepare trouble shooting charts for rotating machines and	08	12

transformers Contents: 5.1 Limits of voltage, current, frequency & speed for safe working of electrical machines. 5.2 Internal & external causes for failure and abnormal operation of equipments. 5.3 List of mechanical faults, electrical faults & magnetic faults in the electrical equipments. 5.4 Use of tools like bearing puller, filler gauges, dial test indicator, spirit level, megger, earth tester, and growler. 5.5 Common troubles in electrical equipments and machines. Preparation of trouble shooting charts for • D.C. Machines • AC Machines • Transformers [IS 10028 (Part-III) - 1981]		
Topic 6: Installation and Earthing of Electrical Machines Specific Objectives: ➢ To install static and rotating electrical machines ➢ To use the devices and tools for handling of electrical equipments ➢ To level and align different coupled drives ➢ To reduce the resistance of earth electrode by different methods Contents: 6.1 Concept of foundation for machinery installation. Requirements of foundation for static & rotating electrical machinery. 6.2 Concept and procedure of leveling & aligning. • Alignment of direct coupled drive • Effects of misalignment 6.3 Installation of transformer as per IS 10028 (part-II) -1981. 6.4 Requirements of installation of pole mounted transformer. 6.5 Requirements of installation of rotating electrical machines as per IS 900 - 1965 6.6 Devices and tools required for loading, unloading, lifting, and carrying heavy electrical equipment's & precautions to be taken while handling them. 6.7 Earthing • Importance of earthing • Difference between installation earthing & system grounding • Types of earthing as per IS 3043 - 1987 • Earthing resistance values for different types of installations • Factors affecting earth resistance • Methods of reducing earth resistance • Provision of earthing as per I.E. rule-61 & I.E.rule-90	08	16
Total	**64**	**100**

Practical:
Skills to be developed:

Intellectual Skills: 1. Select appropriate meters and equipment.
2. Recollect testing and maintenance procedures.

Motor Skills: 1. Accuracy of measurement.
2. Proper connections.
3. Draw characteristics.

List of Practicals:

Sr. No.	Title of Practical/Lab.Work/Assignments
1	Measure Impedance, Voltage and Load losses of Three phase Transformer.
2	Perform reduced voltage running up test on Three Phase Induction Motor as per IS 325:1967.
3	Perform No Load and Blocked Rotor Test on Three Phase Induction Motor as per IS 325:1967. And Draw Circle diagram and Calculate performance Indicator.
4	Calculate Regulation and Efficiency bye Back to Back connection of single phase Transformer.
5	Determine Breakdown Strength of Transformer Oil by using Oil Testing Kit.
6	Measure Insulation resistance of Transformer winding , Stator and Rotor of A.C. Rotating Machines using Megger.
7	Measure the Resistance of Earth Electrode using Earth Tester.
8	Understand the operation of Fire Extinguisher by giving Demonstration.
9	Prepare Troubleshooting Charts for Single Phase and Three Phase Induction Motor
10	Use different maintenance tools such as Bearing Puller, Growler, Dial-Test Indicators, Filler Gauge, Spirit Level, etc.

List of Assignments:

1. To demonstrate artificial respiration methods for shock affected persons.
2. To visit transformer repairing workshop/ electrical machine workshop.

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
1.	B.V.S. Rao	Operation & Maintenance of Electrical Equipments Vol-I & II	Media promoters and publisher Ltd. Mumbai
2.	M.V. Deshpande	Design & Testing of Electrical Machines	PHI learning private Ltd. New Delhi
3.	Sunil S. Rao	Switchgear & Protection	Dhanpat Rai and Sons, New Delhi
4.	Bhattacharya	Electrical Machines	Tata McGraw Hill
5.	V.K. Mehata & Rohit Mehata	Principles of Electrical Machines	S. Chand & Company Ltd.
6.	Tarnekar & Kharbanda	Laboratory Experiments in Electrical Engineering.	S. Chand & Company Ltd.
7.	B. L.Theraja	A Textbook of Electrical Technology Vol.-II	S. Chand & Company Ltd.
8.	Edward Hughes	Electrical and Electronics Technology	ELBS publications
9.	Kothari & Nagrath	Electrical Machines	Tata McGraw Hill

2. CDs, PPTs, Models, Charts etc. :

PPTs:

- www.lanl.gov/safety/electrical/docs/skilled_worker_module_6.ppt
- www.sandia.gov/.../Electrical/Sand_2009_1947_P_Non-Electrical

3. IS Codes and I.E Rules:

I.E. Rules 1956	: Safety
IS 4722-2001	: Rotating Electrical Machines – Specification
IS 2026 (part-I) -2011	: Power transformers: Part 1 General
IS 2026 (Part-II)-2010	: Power transformers: Part 2 Temperature-rise
IS 2026 (Part-III)-2009	: Power Transformers: Part 3 Insulation Level, Dielectric Tests and External Clearances in Air
IS 2026 (Part-IV)-1977	: Power transformers: Part 4 Terminal marking, tappings and Connections
IS 4029 – 2010	: Guide for testing three-phase induction motors
IS 325-1996	: Three phase Induction motors- specifications
IS 7572-1974	: Guide for testing single-phase ac and universal electric motors
IS 7132-1973	: Guide for testing synchronous machines
IS 10028 (Part-III)-1981	: Code of practice for selection, installation and maintenance of transformers: Part 3 Maintenance
IS 900-1992	: Code of practice for installation and maintenance of induction motors (first revision)
IS 1271-1985	: Thermal evaluation and classification of electrical insulations
IS 1866-2000	: Code of practice for electrical maintenance and supervision of mineral insulating oil in equipment
IS 3043 – 1987	: Code of practice for earthing
IS 15429-2004	: Storage installation and maintenance of dc motors-code of Practice
IS 9320-1979	: Guide for testing d.c. machines
IS 14782-2000	: Code of Practice for Maintenance and Testing of Large Lead acid Batteries for Generating Stations and Substations
I.E. rule-61	: Earthing
I.E.rule-90	: Earthing

4. Websites:

- www.bis.org.in
- www.standardsbis.in
- www.civilengineer.co.in