NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**B. Tech. in Electrical Engineering**
Semester:	**V**
Course Code:	**3EE102ME24**
Course Title:	**Testing and Commissioning of Electrical Equipment**
Course Type:	**Department Elective-I**
Year of Introduction:	**2024-25**

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. test various electrical equipment as per standards or guidelines and analyse results (BL3)
2. apply the process of commissioning (BL4)
3. evaluate various maintenance techniques (BL5)
4. comprehend the need of condition monitoring techniques (BL2)

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Introduction** Overview of maintenance schemes, testing program, types of tests, standard framing agencies – IEC, IEEE, CIGRE, BIS, standards for electrical equipment testing, information sharing on EMI-EMC – cyber norm compliance	**03**
Unit-II	**DC and AC Testing of Insulation of Electrical Equipment** Types and class of insulation, comparison between ac and dc testing, testing of cables, insulators, bushings, lightning arresters, result interpretation.	**05**
Unit-III	**Testing, commissioning and maintenance of Rotating Machines** Drying out methods, slot discharge test, temperature rise test, high voltage test, partial discharge test, IR test, efficiency tests as per IS, air-gap eccentricity, special care for variable frequency drive (VFD) fed motors, machine installation, commissioning in rotating machine, operating instructions & maintenance procedures.	**09**
Unit-IV	**Testing, commissioning and maintenance of Transformers** Polarity test, transformer turns ratio (TTR) test, vector group test, induced potential test, separate source voltage test, power frequency test on windings, impulse test, short circuit test, zero sequence test, noise level test, transformer oil test, transformer transportation issues, commissioning steps, general maintenance procedures.	**09**
Unit-V	**Testing, commissioning and maintenance of Electrical Equipment** **Earthing:** Earth resistance measurement, substation grid earthing, soil resistivity measurement.	**14**

Isolator: Temperature Resistance test, short circuit test, charging current making and breaking test, inductive current making and breaking test.

Circuit Breaker Testing of HV/LV Circuit Breaker: No load mechanical operation, mechanical endurance test, temperature rise test, impulse and surge testing, short time current test, short circuit making and breaking test, line charging current making and breaking test, cable charging and capacitor bank making and breaking test, electrical and mechanical endurance test for LT switch gear (MCB / MCCB / ELCB etc.), station batteries for DC supply, troubleshooting and maintenance of circuit breakers.

Cables: Maintenance of cables, cable failure and their analysis, field testing – IR and DC hi-pot test, AC hi-pot test, power factor and dissipation factor test, partial discharge test, cable fault locating methods.

Unit-VI **Introduction to condition monitoring techniques** **05**

Need of condition monitoring, off-line and online monitoring of electrical equipment, fault diagnostic method, non-electrical condition monitoring techniques, basics of remnant life analysis.

Self-Study: The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/ References:

- Paul Gill, *Electrical Power Equipment Maintenance and Testing*, CRC Press.
- Sivaji Chakravorti, et al, *Recent Trends in the Condition Monitoring of Transformers: Theory*, Implementation and Analysis, Springer.
- Hamid A. Toliyat, et al, *Electric Machines: Modeling, Condition Monitoring and Fault Diagnosis*, CRC Press.
- S. Rao, *Testing, Commissioning, Operation and Maintenance of Electrical Equipment*, Khanna Publications.
- G. C. Stone, E. A. Boulter, I. Culbert and H. Dhirani, *Electrical Insulation for Rotating Machines*, IEEE Press, Wiley Interscience.
- Indrajit Dasgupta, *Power Transformers Quality Assurance*, New Age Publishers.
- Prevalent standards, product literature and manuals.

Suggested List of Experiments: Laboratory work will be based on the above syllabus with a minimum 10 experiments to be incorporated. The students in a suitable group size will design and perform one experiment as a part of laboratory work.

Sr. No.	Name of Experiment	Hours
1.	To determine the efficiency of a DC machine by direct load test	2
2.	To obtain the efficiency of a DC machine by Swinburne's test.	2
3.	To determine the efficiency of two identical DC shunt machines by Hopkinson's test.	2
4.	To obtain the efficiency two identical DC series machines by Field test.	2
5.	To determine efficiency of a single-phase transformer by Sumpner's test.	2
6.	To obtain zero phase sequence impedance in 3-phase transformer.	2
7.	To assess the dielectric strength of transformer insulating oil.	2
8.	To determine the earth resistance and earth resistivity by using four terminal earth testers.	2

9.	To evaluate the insulation quality in rotating machine by measuring Insulation Resistance, PI and DAR.	2
10.	To evaluate the insulation quality in power transformer by measuring Insulation Resistance, PI and DAR.	2
11.	To identify the troubles and suggest the remedies for squirrel cage and slip ring induction motors.	2
12.	To identify the cable fault location	2