

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRICAL ENGINEERING (09)

### TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS

SUBJECT CODE: 2180901

B.E. 8<sup>th</sup> SEMESTER

**Type of Course:** Electrical Engineering

**Prerequisite:** Fundamentals of Electrical Machines, Electrical Measurements

**Rationale:** Power Systems and Industrial Plants consist of number of electrical drives, transformers, circuit breakers and other equipments which require installation, commissioning and regular maintenance to prevent permanent break down. It is required to carryout/supervises installation, commissioning and maintenance of various electrical equipments in power stations, substations and industry. This course will enable the students to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipments in power stations, substations and industry.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
3	0	2	5	70	20	10	20	10	20	150

**Content:**

Sr. No.	Content	Total Hrs.	% Wtg.
1.	<b>Safety Management:</b> Objectives, Safety Management during Operation and Maintenance, Clearance and Creepages, Electric Shock, need of Earthing, different methods of Earthing, factors affecting the Earth Resistance, methods of measuring the Earth Resistance, Equipment Earthing and System Grounding, Earthing Procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line.	5	12
2.	<b>Installation of Electrical Equipment:</b> Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, Technical report, Inspection, storage and handling of transformer, switchgear and motors.	4	10
3.	<b>Testing of Transformer, Plant and Equipment:</b> General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of no-load loss and current; Measurement of insulation	13	28

	resistance; Dielectric tests; Temperature-rise, insulation and HV test, dielectric absorption, switching impulse test. testing of Current Transformer and Voltage Transformer, power transformer, distribution transformer, CVT and special transformer with reference to Indian Standard (IS). Drying out procedure for transformer. PI index, Commissioning steps for transformer, Troubleshooting & Maintenance of transformer. [Ref: IS 2026:Part_1-10-Power Transformers: Methods of Test; IS 13956:1994-Testing Transformers]		
4.	<b>Installation and Commissioning of Rotating Electrical Machines:</b> Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures, rating of industrial rotating electric machine, installation, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, insulation resistance measurement, site testing and checking, care, services and maintenance of motors, commissioning of synchronous generator, protection and automation of synchronous generator, synchronous motor, D.C. generator and motor with reference to Indian Standard (IS). [Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors; IS 7132:1973-Guide for Testing Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines]	12	26
5.	<b>Transmission line:</b> Commissioning of A.C transmission line and HVDC transmission, galvanize steel structure, towers and insulator for transmission and distribution line, tower footing resistance, substation equipment, bus bar system, power cable, low power control cable, Contactor, GIS (gas insulated substation).	4	12
6.	<b>SWITCH GEAR &amp; PROTECTIVE DEVICES</b> Standards, Classification, specification, rating and duties of CB, installation, commissioning tests, maintenance schedule, type & routine tests. Operation of s/s (steps) for line Circuit breaker maintenance. Location of lightning arrester with reasons	4	12

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	30	15	5	-

**Reference Books:**

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi
2. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.
3. Singh Tarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K. Kataria and Sons, New Delhi,
4. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGraw-Hill, 2003.

5. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipments/machines.

**Course Outcome:**

After learning the course, the students will be able to Undertake installation, commissioning and maintenance of various electrical equipments, including:

1. Preparation of maintenance schedule of different equipment and machines
2. Trouble shooting chart for various electrical equipment, machines and domestic appliances
3. Procedure of different types of earthing for different types of electrical installations
4. Familiar about electrical safety regulations and rules during maintenance.

**List of Experiments:**

1. Interpret IE rules pertaining to safety, Show the action to be taken when a person comes in contact with a live wire, undertake drill operation for using fire extinguisher for safety against fire
2. Measure insulation resistance of a winding/cables/wiring installation
3. Types of earthing & Measurement of earth resistance of installation of building and appliances by different methods
4. Study of Power Quality and Harmonics due to various type of load using Power Analyzer.
5. To study of drying out process of Transformer and The procedure of drying out of electrical equipment
6. Perform various tests on insulating oil
7. To study various Test of Induction Motor and their significance
8. To study various Test of Synchronous Machine and their significance
9. To carry out routine tests on a given contactor used in the 3-phase supply
10. To find out Phase shift in a transformer
11. To find out reflection of fault current on opposite side of the transformer

**Open Ended Problems/ Suggested Student Activities:**

- Arrange a visit to nearby industry/substation to observe installation/commissioning and troubleshooting of various electrical equipment and machines.
- Arrange expert lectures of the professional engineers involved in installation, commissioning and testing of heavy power equipments/machines.
- Use Flash/Animations to demonstrate installation of various electrical equipment and devices.

**Major Equipments:**

1. Experimental Test rig for Transformer, Induction Motor, Synchronous Motor.
2. Digital Multi-meter & Clamp on Meter
3. Digital Tachometer
4. Oil testing kit.
5. Megger
6. 3-phase Power Analyzer

**List of Open Source Software/learning website:**

1. <http://www.bis.org.in/index.asp>

2. <http://164.100.105.199:8071/php/BIS/IndStndrdLocatr/StandrdsSelection.php>
3. [http://www.ieee.org/publications\\_standards/publications\\_standards\\_index.html](http://www.ieee.org/publications_standards/publications_standards_index.html)
4. <http://www.nema.org/Standards/About-Standards/pages/default.aspx>
5. <http://www.electricalsafetyfirst.org.uk/guides-and-advice/around-the-home/first-aid/>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.