

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: INSTALLATION, COMMISSIONING AND MAINTENANCE
(COURSE CODE: 3360902)**

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	Sixth

1. RATIONALE

Electrical Power system consists of a number of transformers, circuit breakers and other equipments which require installation, commissioning and regular maintenance to prevent permanent break down. Many times an engineering diploma holder has to carryout/supervises installation, commissioning and maintenance of various electrical equipments in power stations, substations and industry. This course will enable the diploma pass out student to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipments in power stations, substations and industry.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Undertake installation, commissioning and maintenance of various power system components and equipment**

3. COURSE OUTCOMES (COs):

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

- Unload the electrical equipments/machines based on scientific procedure
- Commission various electrical equipment/machines
- Prepare maintenance schedule of different equipment and machines
- Prepare trouble shooting chart for various electrical equipment, machines and domestic appliances
- Carry out different types of earthing
- Apply electrical safety regulations and rules during maintenance.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	6	70	30	20	30	150

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit – I. Installation of Electrical Equipment	1a. Describe the planning before unloading of heavy electrical equipments at site. 1b. Select appropriate tools for installation of electrical equipment 1c. Explain the procedure for handling, inspection, storage and installation of static and rotating electrical equipment.	1.1 Unloading of electrical equipment at site 1.2 Inspection of electrical equipment at site 1.3 Storage electrical equipment at site 1.4 Foundation electrical equipment at site 1.5 Alignment of electrical machines 1.6 Tools/Instruments necessary for installation 1.7 Technical report, Inspection, storage and handling of transformer, switchgear and motors
Unit– II Commissioni ng and Testing	2a Describe various commissioning tests on electrical equipment/machines 2b Describe the specific test on electrical equipment/machines 2c Explain the standard tests performed on insulation oil 2d Determine the insulation resistance of electrical equipment/machines 2e Explain the procedure of drying the winding of electrical equipment/machines 2f Explain the various factor affecting the insulation resistance 2g Explain the need for gradual loading of electrical equipment	2.1 Tests before commissioning of electrical equipment- Electrical and Mechanical test, Preparations before commissioning of power transformer, Instruments required for testing 2.2 Specific tests on - Transformer, Induction motor, alternator, synchronous motor 2.3 Commissioning of power transformer, three phase induction motor and switchgear 2.4 Transformer insulation oil: Properties as per IS, sampling, testing and filtering/purifying, standard tests as per IS, classification of insulation resistance 2.5 Measurement of insulation resistance and Polarization Index, Factors affecting the insulation resistance of insulating materials 2.6 Drying the winding of electrical equipment and its record 2.7 Tests after and before commissioning the machine 2.8 Test report on commissioning and test certificate 2.9 Gradually loading of electrical equipment

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit– III Maintenance of Electrical Equipment	3a Explain the need of different types of maintenance 3b Explain the reason of failure of electrical equipment due to poor maintenance 3c Prepare maintenance schedule of different equipment 3d State the probable faults due to poor maintenance in various electrical equipment	3.1 Functions of the Maintenance Department; Reasons of failure of electrical equipment 3.2 Preventive maintenance: need, classification, advantages, activities Frequency of maintenance 3.3 Breakdown maintenance: concept, advantages, activities 3.4 Factors for preparing maintenance schedule 3.5 Maintenance schedule of transformer below and above 1000kVA 3.6 Maintenance schedule - induction motor, circuit Breaker, overhead line, storage Battery 3.7 Probable faults due to poor maintenance in transformer, induction motor, circuit breaker, overhead lines and battery

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit-IV Troubleshooting	4a. State various internal and external faults that occur in electrical equipment 4b. State common troubles in various electrical equipment and machines 4c. Prepare trouble shooting chart for various electrical equipment, machines and domestic appliances.	4.1 Causes of faults in electrical equipment (Internal and external) 4.2 Instruments and tools for trouble shooting 4.3 Common troubles in electrical equipment – DC Machines, AC Machines, Transformers, Circuit-breaker, underground cable, electrical Installation 4.4 Need of trouble shooting chart, 4.5 Trouble shooting chart for DC Motor, DC Generator, Transformer, Synchronous Motor, Induction Motor, Circuit-breaker 4.6 Trouble shooting chart for Domestic appliances- electrical iron, ceiling fan, Washing machine, Air cooler, Vacuum cleaner, Fluorescent tube light: Construction, working and troubleshooting chart
Unit-V Earthing	5a Explain the need of earthing and the different methods of earthing 5b Explain the various factors affecting the earth resistance 5c Describe the various methods of measuring the earth resistance 5d Differentiate between equipment earthing and system grounding 5e Explain the earthing procedure in different types of electrical installations	5.1 Necessity of earthing 5.2 System earthing : advantage of neutral earthing of generator in power station 5.3 Equipment earthing: Objective 5.4 Types of earth electrodes 5.5 Methods of earthing : plate earthing ,pipe earthing and coil earthing 5.6 Earthing in extra high voltage and underground cable, Earthing resistance-factors affecting, Determination of maximum permissible resistance of the earthing system 5.7 Measurement of earth resistance: voltmeter-ammeter method, earth tester method, ohm meter method and earth loop tester method 5.8 Comparison between equipment earthing and system grounding 5.9 Earthing procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit-VI Electrical Accidents and Safety	6a. Explain the causes of electrical accidents 6b. Describe the procedure for shutting down of substation and power lines 6c. Explain the operation of different types of fire extinguishers	6.1 Causes of electrical accidents 6.2 Factors affecting the severity of electrical shock 6.3 Actions to be taken when a person gets attached to live part 6.4 Safety regulations and safety measures 6.5 Indian electricity supply act 1948-1956 6.6 Factory act 1948 6.7 Sub-station shut down Procedure 6.8 certificate of (i) requisition for shut down (ii) Permit to work and (iii) Line clear certificate 6.9 Instruction for the safety of persons working on a job with a permit to work 6.10 Fire extinguishers-Fixed installation and portable devices

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Installation of Electrical Equipment	6	2	2	4	8
II	Commissioning and Testing	14	4	6	6	16
III	Maintenance of Electrical Equipment	12	4	5	5	14
IV	Trouble Shooting	9	4	5	3	12
V	Earthing	9	2	5	5	12
VI	Electrical Accidents and Safety	6	2	3	3	8
	Total	56	18	26	26	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED EXERCISES/PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Hrs. required
1	I	Prepare layouts of wiring for installation of given machine with specification	2
2	II	Prepare test reports of an electrical machine after commissioning	2
3	II	Perform various tests on insulating oil	2
4	II	Measure insulation resistance of a winding/cables/wiring installation	2
5	III	Prepare maintenance schedule for power transformer	2
6	III	Prepare maintenance schedule for induction motor	2
7	IV	Trouble shoot a ceiling fan	2
8	IV	Dismantle and trouble shoot of fluorescent tube light	2
9	V	Measure earth resistance of installation of building/domestic wiring and appliances by different methods	4
10	V	Prepare plate/pipe earthing as per IS and measure the earth resistance	2
11	V	Interpret IE rules pertaining to safety	2
12	VI	Show the action to be taken when a person comes in contact with a live wire	2
13	VI	Undertake drill operation for using fire extinguisher for safety against fire	2
Total			28

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

- i. Prepare journals based on practical performed in laboratory.
- ii. Solving numerical from different books for practice
- iii. List various instruments and tools used for troubleshooting
- iv. Find troubleshooting techniques and steps to troubleshoot various electrical equipment and machines
- v. Prepare trouble shooting chart for various electrical equipments
- vi. Site visit for commissioning of Transformer

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Show video/animation film to demonstrate earthing, grounding
- ii. Arrange a visit to nearby industry/substation to observe installation/commissioning and troubleshooting of various electrical equipment and machines.
- iii. Use Flash/Animations to demonstrate installation of various electrical equipment and devices.
- iv. Arrange expert lectures of the professional engineers involved in installation, commissioning and testing of heavy power equipments/machines.
- v. Give Mini projects to students

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Testing Commissioning operation and maintenance of Electrical Equipments.	Rao. S	Khanna Publication (Latest edition), New Delhi
2.	Installation, commissioning and maintenance of Electrical equipment	Singh Tarlok	S.K.Kataria and Sons, New Delhi, Second edition-2012
3.	Electrical power system	Wadhwa C.L.	New Age international Publications, New Delhi
4.	Relevant IS Code for-Installation, maintenance and commissioning of electrical equipments/machines	-	Latest code

B) Major Equipment/ Instrument with Broad Specifications

1. Digital Multimeter 4 ½ digit hand held 9 V batteries operated, DC Voltage: 0 to 0.001 mV – 1000 V, AC Voltage: 0 to 0.01 mV – 1000 V, AC Current: 0 to 100 nA – 10 A, DC Current: 0 to 100 nA – 10 A,
2. Digital Tachometer Hand held, battery operated, 5 digit display contact Type, 60 to 50000 r.p.m.,
3. Oil testing kit. Mains Supply : 230V AC ±10%, 50Hz
Single Phase Variac : 230V/ 0-270V
High Voltage Source : 80kV, 20mA
Voltmeter : 0 to 100kV
4. Megger Insulation Testing:250V:500V:1000V:
1000 MΩ range, Auto-ranging, Auto discharge

5. Software/Learning Websites

- i. <http://cercind.gov.in/ElectSupplyAct1948.pdf>
- ii. www.lce.com/pdfs/The-PMPdM-Program-124.pdf
- iii. www.iapa.ca/pdf/prevent.pdf
- iv. <http://cercind.gov.in/ElectSupplyAct1948.pdf>
- v. www.pfeiffereng.com/Principals%20of%20Electrical%20Grounding.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R D Panchal**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad
- **Prof. C T Patel**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. (Mrs.) C.S. Rajeshwari**, Professor and Head, Department of Electrical and Electronics Engineering.
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electro