

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MAINTENANCE OF TRANSFORMER AND CIRCUIT
BREAKER
(COURSE CODE:3360907)

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

1. RATIONALE

Power system consists of a number of transformers, circuit breakers and other components which require regular maintenance to prevent permanent break down. Many times a engineering diploma holder has to supervise testing and maintenance of various electrical equipment 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 testing and maintenance of electrical equipment in power stations, Substations and industry.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Maintain Transformers and Circuit Breakers.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Undertake /apply preventive maintenance
- Maintain power transformers.
- Commission different types of transformers
- Maintain different types of circuit breakers.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme1				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	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 DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. Preventive Maintenance	1a. State the types of maintenance. 1b. Explain the significance of Preventive maintenance. 1c. Describe the economy of maintenance.	1.1 Maintenance and its types - Preventive and Breakdown 1.2 Advantages of preventive maintenance 1.3 Scope of preventive maintenance 1.4 Economics of preventive maintenance
Unit– II Maintenance of Transformers	2a. Understand maintenance of different parts of power transformer. 2b. Explain the different factors affecting the life of transformer. 2c. Prepare maintenance schedule of different types of transformer. 2d. Understand the importance of quality of transformer oil. 2e. Describe the transformer filtration procedure 2f. Describe Trouble shooting procedure of power transformer. 2g. Inspect and maintain distribution and power transformer.	2.1 Significance of transformer maintenance 2.2 Parts of transformer- tank. Core, winding, conservator, radiators, bushings, terminals, temperature measurement system, safety valves, tap changers and accessories/ fittings etc. 2.3 Factors affecting the life of transformer-moisture, water oxygen, solid impurities, varnish, slackness of windings and dust. 2.4 Inspection-sensory, records and electrical test. 2.5 General/Typical maintenance schedule of power transformers- up to 1000 kVA and above 1000 kVA 2.6 Maintenance of transformer oil-characteristic, interpretation of tests, procedure of testing BDV, filtering plant. 2.7 Causes of failures of power transformers and preventive actions. 2.8 Detective devices-Buchholz relay, Pressure relief device, Differential relay, Dial thermometer alarm contact, Overcurrent relay, ground fault relay, voltmeter, ammeter, Human senses 2.9 Check list of maintenance of power transformers

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		<p>2.10 Causes and methods to reduce Audible Noise (AN) from transformer</p> <p>2.11 Maintenance of distribution transformer</p> <p>i. Reasons for failure of Distribution Transformers and the remedial measures thereof</p> <p>ii. Inspection & Maintenance Schedule for Distribution Transformers:</p> <p>iii. Inspection & Maintenance of transformer and accessories within the sub-station and its proximity.</p> <p>2.12 Procedure of measuring the insulation resistance of transformer windings.</p>
<p>Unit– III Commissioning and Recharging of Transformers</p>	<p>3a. Understand the procedure of commissioning of power transformer.</p> <p>3b. Perform required test after commissioning of transformer.</p> <p>3c. State do's and don'ts for power transformer.</p> <p>3d. Describe the procedure of loading the transformer.</p>	<p>3.1 Concept of commissioning and recharging of transformer.</p> <p>3.2 General checks</p> <p>3.3 Insulation resistance test</p> <p>3.4 Measurement of oil characteristics</p> <p>3.5 Off circuit tap switch</p> <p>3.6 Continuity test</p> <p>3.7 Measurement of winding resistance</p> <p>3.8 Voltage ratio tests</p> <p>3.9 Magnetizing current</p> <p>3.10 Charging of the transformer</p> <p>3.11 Do's and Don'ts for transformer</p> <p>3.12 Various commissioning tests on a power transformers</p> <p>3.13 Procedure of loading the transformers.</p> <p>3.14 Transformer grounding.</p>

<p>Unit-IV Maintenance of Circuit Breaker</p>	<p>4a. Understand the importance of maintenance of circuit breaker.</p> <p>4b. Understand the maintenance of Moulded circuit breaker.</p> <p>4c. Describe the frequency of maintenance and its procedure for various voltage rating of circuit breaker.</p> <p>4d. Describe the Maintenance of Oil, Air, Air blast , SF₆ and Vaccum circuit breaker.</p> <p>4e. State the causes of Failure of circuit breaker</p> <p>4f. Describe the trouble shooting procedure of circuit breaker.</p> <p>4g. Understand the operating mechanism of circuit breaker.</p>	<p>4.1 Steps in maintenance of CB</p> <p>4.2 Maintenance of moulded case circuit breakers -Frequency and routine maintenance tests</p> <p>4.3 Maintenance of low-voltage circuit breakers -Frequency and maintenance procedures</p> <p>4.4 Maintenance of medium-voltage circuit breakers – Air, Oil and Vaccum circuit breakers - Frequency of maintenance, safety practices and maintenance procedures for each of the above</p> <p>4.5 Maintenance of high-voltage circuit breakers - frequency of inspections, External and internal inspection guidelines, typical internal breaker problems, Influence of duty imposed, Types of tests performed.</p> <p>4.6 OIL CB, Post fault maintenance, Steps in maintenance of MOCB</p> <p>4.7 Maintenance for AIR CB and Frequency of maintenance.</p> <p>4.8 Maintenance of AIR BLAST CB</p> <p>4.9 Maintenance of SF₆ gas circuit breakers</p> <ul style="list-style-type: none"> i. Properties of SF₆ (sulphur hexafluoride) gas ii. Handling non faulted SF₆ iii. Handling faulted SF₆ iv. Procedure of filling SF₆ gas in single pressure puffer type SF₆ CB v. Gas monitoring system and gas handling system for SF₆ filled equipment vi. Types and function of SF₆ gas handling units. vii. Maintenance of SF₆ CB <p>4.10 Maintenance of VACCUM CB</p> <p>4.11 Life of arcing contacts in various CB in case of normal current switching and short circuit operation</p>
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Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		<p>4.12 Causes of failure of CB, trouble shooting and procedure of failure analysis.</p> <p>4.13 Typical Record card for maintenance work of CB</p> <p>4.14 Commissioning tests on HV a.c. CB</p> <p>4.15 Operating mechanism used in HV a.c. CB</p> <p>4.16 Safety precautions to be taken in maintenance of CB</p>

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	Preventive Maintenance	4	5	2	0	7
II	Maintenance of Transformer	18	8	10	10	28
III	Commissioning and Recharging of Transformers	8	6	4	4	14
IV	Maintenance of Circuit Breaker	12	6	7	8	21
	Total	42	25	23	22	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 LIST OF EXERCISES/PRACTICALS

The practical/exercises 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/exercises. However, if these practical/exercises 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)	Approx Hours. required

1	I	Prepare a technical report on the preventive maintenance of transformer which supply electrical power to your college.	2
2	I	Give comparison analysis between preventive and breakdown maintenance.	2
3	II	Prepare detail specifications data sheet for different transformer.(use name plate)	2
4	II	Prepare a technical report on various accessories and fitments on a power transformer in a substation.	2
5	II	Perform various tests applied to an insulating oil.	2
6	II	Prepare a technical report on various causes of troubles and failures of power transformer.	2
7	II	Prepare typical maintenance schedule for transformers up to 1000 KVA	2
8	II	Prepare typical maintenance schedule for transformers above 1000 KVA	2
9	II	Prepare a technical report on filtering process and filtering plant for transformer oil filtration.	2
10	III	Prepare test report of a power transformer after commissioning.	2
11	III	Read and interpret I.E. rules pertaining to testing of transformer.	2
12	III	Perform insulation resistance test of transformer.	2
13	III	Perform voltage ratio tests of three phase transformer.	2
14	III	Read and interpret I.E. rules pertaining to commissioning of transformer.	2
15	IV	Prepare detail specifications data sheet for different circuit breaker.(use name plate)	2
16	IV	Prepare a technical report on various types of tests performed on high voltage ac circuit breakers.	2
17	IV	Prepare a technical report on maintenance of air blast circuit breaker.	2
18	IV	Prepare a technical report on maintenance of SF ₆ circuit breaker.	2
19	IV	Prepare a technical report on maintenance of Vacuum circuit breaker.	2
20	IV	Prepare test report of tests on HVA.C. Circuit Breaker after commissioning.	2
Total Hours			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

- i. Prepare journals based on practical performed in laboratory.
- ii. Prepare chart displaying various parts of transformer etc.
- iii. Prepare chart displaying various parts of circuit breaker etc.
- iv. Visit nearby substation, transformer manufacturing & testing laboratories.
- v. Visit maintenance site / workshop of transformer and circuit breaker.

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Thesis on Self learning package on maintenance of 33 KV class transformer for diploma course in electrical engineering.	By Shri Chouhan R.P. Guided By Shri. Gupta S.K.	TTTI Western Region, Bhopal. (NITTTR)
2.	Testing Commissioning operation and maintenance of Electrical Equipments.	Rao S	Khanna Publication (latest edition)
3.	Relavent IS Code for-- Maintenance of Transformer, circuit breaker ,switchgears, insulating oil		Latest code

B) List of Major Equipment/ Instrument with Broad Specifications

i. Oil testing kit.	Mains Supply : 230V AC $\pm 10\%$, 50Hz Single Phase Variac : 230V/ 0-270V High Voltage Source : 80kV, 20mA Voltmeter : 0 to 100kV
ii. Megger.	Insulation Testing:250V:500V:1000V: 1000 M Ω range, Auto-ranging ,Auto discharge
iii. Model of transformer.	Wooden, Plastic, etc material.
iv. Voltage ratio test kit.	For small 3 phase transformer
v. Model of circuit breaker.	Wooden, Plastic, etc material.

C) List of Software/Learning Websites

- i. www.nptel.iitm.ac.in
- ii. www.youtube
- iii. www.howstuffworks.com
- iv. <http://electrical-engineering-portal/>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. H. C. Chawda**, 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

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