

4106 - TRANSFORMERS										
Teaching Schedule Per Week			Progressive Assessment		Examination Schedule (Marks)					
Lectures	Practical	Credits			Theory		Practical Ex.		Total	
4	2	6	25	25	3 Hrs	100	50		200	
Pre-requisite		Source	Semester	Theory	Test	Total	TW	PR	Gr Total	4
Nil		ELL		75	25	100	25	50	175	

Rationale: This subject is intended to develop the competency in the field of identification of various component transformer Application installation and operation of transformer for transmission distribution of power and for supplying various load such as welding, furnace etc. The student will also achieve knowledge in the field of analysis of various parameter and characteristics.

COURSE CONTENTS	Hrs	Mks
1. INTRODUCTION	6	8
Definition of transformer, Ideal two winding transformer – Principles of operation, E.M.F. Equation of transformer (derivation) , Voltage ratio, current ratio, and turns ratio of transformer, calculation of rated currents. , Terms related to transformer such as primary secondary, H.V., L.V., step up, step down, Core type, Shell type, Concept of leakage flux, its effect on the working of transformer.		
2. CONSTRUCTION OF TRANSFORMER	14	16
Construction of transformer core-core material types of lamination and clamping of core laminations, stepped core and core joint, - Winding materials used, Types of windings, Distributed crossover, Spiral, Continuous disk, helical. Insulation material used (inter turn, layer to layer, core to winding), Terminals, bushings and terminal marking, Cooling system – Different types of cooling systems, Components of oil-naturally cooled transformer and their functions., Main tanks with various valves, Conservator, Breather, Level Indicator and temperature Indicator. Tap changer – Tapping, number of taps and their grading, connections with windings. Operation of OFF Load and ON Load tap Changer		
3. PHASOR DIAGRAM AND EQUIVALENT CIRCUIT	14	24
PHASOR DIAGRAM AND EQUIVALENT CIRCUIT OF A PRACTICAL TRANSFORMER (Single phase & three phase)No load operation – No load current and its components, phasor diagram and circuit representation. On load operation – effect of winding resistance and leakage reactance, Phasor diagram and circuit representation, equivalent resistance, reactance and impedance referred to either side (equivalent). Definition of of per unit quantity, calculation of per unit		

resistance, reactance and impedance on low and high voltage side.

4. PERFORMANCE

12 24

Voltage regulation and its importance. Method of expression (up and down, regulation), calculation of impedance voltage and voltage regulation, Condition for maximum and minimum (Zero) voltage regulation. Losses – constant and variable, loss. Effects of voltage and frequency on the performance of transformer. Efficiency – commercial & all day efficiency condition for maximum efficiency, Salient feature of distribution and power transformer, Effect of failure of cooling system on the performance of transformer.

5. PARALLEL OPERATION OF TRANSFORMERS

8 16

Vector group and their importance, Essential and necessary conditions of parallel operation of three phase transformers, Connection of three phase transformers in Parallel, Analysis of load sharing.

6. AUTOTRANSFORMERS

4 4

Construction, Principle of operation. Advantages and disadvantages. Over two winding transformers and potential divider.

7. SPECIAL TRANSFORMERS

6 8

Welding transformer – special features in respect of construction and characteristics, Construction & connection of single phase 400 V & three phase transformer (Scott connection, open delta / V connection). Special features of Furnace transformer and high frequency transformer in respect of construction and characteristics

Total

64 100

LIST OF EXPERIMENTS

1. Insulation resistance and polarity test on a three-phase transformer,
2. Continuity of coil, phasing out and ratio test on 3-phase transformer
3. To perform open circuit test with different voltages, measurement of No load current and No load losses and study of variations of losses with voltage in case of three-phase transformer.
4. To perform short circuit test and measurement of impedance voltage and load copper losses in case of three phase transformer, B) Measurement of D.C. resistance of the windings.
5. Calculation of parameters of equivalent of circuit (Drawing of equivalent circuit), efficiency and regulation of the transformer from open circuit and short circuit test conduct in expt. 3 And 4.
6. Parallel operation of two transformers and observation of the load shared by each transformer
7. To study the effect of: a) Single phase or two-phase failure on primary side of three phase transformer. B) Open circuit fault in any of the primary winding (2 turns)
8. To study the welding transformer with respect to: a) Construction of core, b) Placement of winding, c) Current controller, d) Cooling system.
9. Direct load test on a three-phase transformer and measurement of its voltage regulation and its efficiency.
10. Scott connection for balanced and unbalanced load-operation.

REFERENCE BOOKS:

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| 1. Transformers | B.H.E.L. |
| 2. Electrical machinery | S.k.Bhattacharya |
| 3. Electrical Technology | B.L. Theraja Vol II |
| 4. Design and testing of electrical machines | M.V. Deshpande |

