

II Year – II SEMESTER**T P C**
3+1 0 3**ELECTRICAL MACHINES – II****Preamble:**

This course covers the topics on single-phase transformers, three-phase transformers and 3-phase induction motor which have wide application in power systems. The main aim of the course is to provide detail concepts, operation and performance of transformers and 3-phase induction motors. A complete design procedure for the design of transformers and 3-phase induction motors can be developed based on basic concepts discussed in unit-VI.

Learning objectives:

- i. Appreciate the concept of operation and performance of single-phase transformers.
- ii. Understand the methods of testing of single-phase transformer.
- iii. Distinguish between single-phase and three-phase transformers.
- iv. Understand the concept of operation and performance of 3-phase induction motor.
- v. Appreciate the relation between torque and slip, performance of induction motor and induction generator.
- vi. Understand the basic concepts of design of transformers and 3-phase induction motors.

UNIT-I**Single-phase Transformers**

Types and constructional details - principle of operation - emf equation - operation on no load and on load – lagging, leading and unity power factors loads - phasor diagrams of transformers – equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency.

UNIT-II**Single-phase Transformers Testing**

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses – parallel operation with equal voltage

ratios – auto transformer - equivalent circuit – comparison with two winding transformers.

UNIT-III

3-Phase Transformers

Polyphase connections - Y/Y, Y/ Δ , Δ /Y, Δ / Δ and open Δ -- Third harmonics in phase voltages - three winding transformers: determination of Z_p , Z_s and Z_t -- transients in switching - off load and on load tap changers -- Scott connection.

UNIT-IV

3-phase Induction Motors

construction details of cage and wound rotor machines - production of a rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their inter relationship – equivalent circuit – phasor diagram.

UNIT-V

Characteristics, starting and testing methods of Induction Motors

Torque equation - expressions for maximum torque and starting torque - torque slip characteristic - double cage and deep bar rotors - crawling and cogging - no load and blocked rotor tests - circle diagram for predetermination of performance - methods of starting – starting current and torque calculations – induction generator operation.

UNIT-VI

Design of transformer and 3-phase induction motor

Transformer: Design concept – output equation – choice of windings – calculation of number of turns – length of mean turn of winding - calculation of resistance and leakage reactance.

Three phase induction motor: Design concept – choice of specific electric and magnetic loadings – output equation – stator design – number of slots – conductor dimensions – type of winding – number of rotor slots – conductor dimensions.

Learning outcomes:

- i. Able to explain the operation and performance of single phase transformer.
- ii. Able to explain the regulation losses and efficiency of single phase transformer.

- iii. Able to explain types of three phase transformer connection, tap changing methods and 3-phase to 2-phase transformation.
- iv. Able to explain the operation and performance of three phase induction motor.
- v. Able to analyze the torque-speed relation, performance of induction motor and induction generator.
- vi. Able to explain design procedure for transformers and three phase induction motors.

TEXT BOOKS:

1. The performance and design of alternating current machines – M.G. Say, CBS publishers & distributors, New Delhi.
2. Electrical Machines – P.S. Bimbra, Khanna Publishers.

REFERENCE BOOKS:

1. Electrical Machines by J.B.Guptha, S.K.Kataria & Sons.
2. Electrical Machines by D. P.Kothari, I. J. Nagarth, Mc Graw Hill Publications, 4th edition.
3. Electrical Machines by R.K.Rajput, Lakshmi publications, Fifth edition.
4. Electrical Machine Design by Sawhney, Dhanpath Rai Publications.
5. Electrical Machines by Smarajit Ghosh, Pearson Publications.