

# 16EE307 TRANSFORMERS AND INDUCTION MOTORS



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	8	40	-	8	5	-

## Course Description and Objectives:

This course is aimed to provide knowledge on construction, operation, types and applications of transformers and 3-phase induction motors. The objective of the course is to understand the construction, operation and make performance analysis of transformers and 3-phase induction motors by conducting suitable tests.

## Course Outcomes:

The student will be able to:

- understand the operation of transformers and induction motors.
- perform suitable tests on transformers to analyze the characteristics.
- perform suitable tests on induction motors to analyze the characteristics.
- understand different starting methods of three phase induction motors.
- understand different speed control techniques of three phase induction motors.

## SKILLS:

- ü Identify the specifications of the given transformer.
- ü Obtain the equivalent circuit of single phase transformer.
- ü Test the transformer and analyze its performance.
- ü Identify the specifications of the given 3-phase induction motor..
- ü Identify suitable starting method for a 3-phase induction motor based on the application.
- ü Suggest a suitable speed control technique for a 3-phase induction motor based on the application.

**UNIT - 1**

**L-9**

**SINGLE PHASE TRANSFORMERS:** Constructional features and principle of operation, Concept of ideal transformer, Types and operation of single phase transformer under no load and loaded conditions, Minimization of eddy current and hysteresis losses, Equivalent circuit, Practical transformer rating, Voltage regulation - Definition and importance, Derivation of expression.

**UNIT - 2**

**L-10**

**PERFORMANCE AND EQUIVALENT CIRCUIT ANALYSIS OF SINGLE PHASE TRANSFORMERS:** Losses and efficiency, Condition for maximum efficiency, All-day efficiency, Effect of variation of frequency and supply voltage on iron losses, O.C. and S.C. tests, Sumpner's test, Determination of equivalent circuit parameters, Predetermination of efficiency and regulation, Separation of losses, Parallel operation with equal and unequal voltage ratios, Autotransformer - Principle of operation, Advantages and disadvantages over a two winding transformer.

**UNIT - 3**

**L-8**

**THREE PHASE TRANSFORMERS:** Constructional details, Different connections of phasor groups, Unbalanced operation of three phase transformers, Open delta or V connection, Three phase to two phase conversion (Scott Connection), Tap changing transformers, Excitation phenomena, Numerical Problems.

**UNIT - 4**

**L-9**

**THREE PHASE INDUCTION MOTOR:** Elementary balanced 3-phase distributed winding and production of revolving magnetic field, Comment on its strength, Speed and direction of rotation, Constructional features and principle of operation, Types of induction motors, Definition of slip and its importance, Relation between stator and rotor frequencies, Per phase equivalent circuit, Relation between air gap power, Rotor copper losses and mechanical power developed.

**UNIT - 5**

**L-9**

**STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR :** Expression for electromagnetic torque developed, Expressions for starting and maximum torque, Torque slip characteristic - For supply voltage, Rotor resistance and frequency variation; Phasor diagram, Crawling and cogging, Basic principle of starting induction motor - Direct on line, Reactor, Autotransformer, Star-delta and Rotor resistance starters; Methods of speed control – Stator voltage control, Variable frequency control; Change of poles and methods of consequent poles, Cascaded connection, Rotor resistance control and injection of emf into rotor circuit.

**ACTIVITIES:**

- *Choose a transformer rating for a given application.*
- *Convert a Single Phase Transformer to Auto Transformer with required polarity.*
- *Design a simple Armature winding of three phase induction motor to observe rotating magnetic flux.*
- *Verify the relation between phase sequence and direction of Induction motor.*
- *Design Rheostat circuits for slip ring induction motors to attain required speeds.*
- *Design simple Star-Delta Starter for induction motor.*

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## LABORATORY EXPERIMENTS

### LIST OF EXPERIMENTS

Total hours: 30

1. Scott connection of Transformers
2. OC and SC test on single phase Transformer
3. Sumpner's test on a pair of single phase Transformers
4. Separation of core losses in a Transformer
5. Parallel operation of two single phase transformers
6. Separation of no-load losses in three phase induction motor
7. Conversion of two winding transformer in to step up/down auto-transformer
8. Load test on three-phase squirrel cage induction motor
9. Load test on three-phase slip ring induction motor
10. Circle diagram of a three phase induction motor

### TEXT BOOKS:

1. P.S.Bimbra, "Electrical Machines", 7<sup>th</sup> edition, Khanna Publications, 2007.
2. I.J Nagrath and D.P Kothari, "Electric Machines", 3<sup>rd</sup> edition, Tata Mc-Graw Hill, 2009.

### REFERENCE BOOKS:

1. P.S.Bimbra, "Generalized theory of Electrical Machines", 5<sup>th</sup> edition, Khanna Publications, 2009.
2. S.K.Bhattacharya, "Electrical Machines", 2<sup>nd</sup> edition, Tata Mc-Graw Hill, 2007.
3. M.G Say, "Performance and Design of A.C Machines", 3<sup>rd</sup> edition, BPB Publishers, 2002.
4. A.E.Fitzgerald, C Kingsley and S Umans, "Electric Machinery", 6<sup>th</sup> edition, Mc-Graw Hill, 2006.