

203146: Electrical Machines I

Teaching Scheme
Th : 04 Hrs/ Week
PR : 02 Hrs/ Week

Credits
Th/Tut: 04
PR:01

Examination Scheme [Marks]
In Sem (Online) : 50 Marks
End Sem : 50 Marks
Practical : 50 Marks
Term Work : 25 Marks

Prerequisite:

- Magnetic circuit, mutual induced EMF, Dynamically induced EMF, Direction of magnetic field in current carrying conductor, Flemings LHR & RHR, Electromechanical energy conversion.

Course Objective:

- To understand energy conversion process.
- To understand selection of machines for specific applications.
- To test & analyze the performance of machine.
- To understand the construction, principle of operation of transformers, DC Machine & Induction Machine.

Course Outcome: Upon successful completion of this course, the students will be able to :-

- Apply energy conversion principles to different machines.
- Select machine for specific applications.
- Test the various machine for performance calculation.

Unit 01 : Transformers:

(8 Hrs)

Single phase Transformer: Concept of ideal transformer. Corrugated core transformer. Toroidal core Transformer Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & Frequency on no load losses Efficiency and condition for maximum efficiency. All day Efficiency. Open circuit and short circuit tests, determination of equivalent circuit parameters from the test data and determination of voltage regulation and efficiency. Autotransformers, their ratings and applications. Comparison with two winding transformer with respect to saving of copper and size.

Unit 02 : Transformers:

(8 Hrs)

Polarity test. Parallel operation of single phase transformers, conditions to be satisfied, load sharing under various conditions. & Welding Transformer

Three Phase Transformers: Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V connections. Three winding (tertiary windings) transformers

Unit 03 : D.C. Machines:

(8 Hrs)

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, magnetization curve, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Descriptive treatment of armature reaction.

Unit 04 : D.C. Machines:**(8 Hrs)**

Characteristics and applications of D.C. Shunt and Series Motors, Starting of DC motors, study of starters for series and shunt motor, solid state starters, speed control of various types of DC motors.

Commutation: Process of commutation, time of commutation, reactance voltage, straight line commutation, commutation with variable current density, under and over commutation, causes of bad commutation and remedies, inter poles, compensating windings. (Descriptive treatment only)

Unit 05 : Three Phase Induction Motor:**(8 Hrs)**

Production of rotating mmf by 3-phase balanced voltage fed to a symmetrical 3-phase winding. Construction: Stator, Squirrel cage & wound rotors. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram. Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency.

Unit 06 : Three Phase Induction Motor:**(8 Hrs)**

Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. **Computation of performance characteristics from the equivalent circuit and circle diagram.** Performance curves. Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors; stator resistance starter, auto transformer starter, star delta starter and rotor resistance starter. D.O.L. starter and soft starting, with their relevant torque and current relations. Comparison of various starters. , testing of three phase induction motor as per IS 325 & IS 4029.

Guidelines for Instructor's Manual

- Prepare 4/5 sets of standard experiments. It must contain title of the experiment. Also, Aim, Apparatus including name of machines with their specifications, rheostats, ammeter, voltmeter, wattmeter if used along with their ratings / ranges and whether moving coil or moving iron etc.
 - **Theory:** Brief theory explaining the experiment
 - **Circuit / connection diagram** or construction diagram must be drawn either manually using geometrical instruments or using software on A-4 size quality graph paper / plain white paper.
 - **Procedure:** Write down step by step procedure to perform the experiment.
 - **Observation table:**
 - **Sample calculation:** For obs. number ---
 - **Result table:**
 - **Nature of graph:**
 - **Conclusion:**
 - **Comments if any:**
 - **Questions / Answers:** Write minimum 5/ 6 questions / answers based on each experiment.

Theory part must be typed on A-4 good quality paper on single side. Put these pages of experiments / circuit diagram in plastic folder and provide it to a group of 4/5 students.

Guidelines for Student's Lab Journal

1. Students should write the journal in his own hand writing.
2. Circuit / Connection diagram or construction diagram must be drawn either manually using or using software. [Do not use Xerox copy of standard journal]
3. Hand writing must be neat and clean.
4. Journal must contain certificate indicating name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
5. Index must contain sr. number, title of the experiment, page number, and the signature of staff along with date.
6. Put one blank page in between two experiments. Prepare the parallelogram at the center of page and write experiment number, date and title of the experiment in separate line.
7. Use black or blue ink pen for writing.

Guidelines for Laboratory Conduction

1. Check whether the MCB / ELCB / main switch is off.
2. Make connections as per circuit diagram. Use flexible wire for connection of voltmeter and pressure coil connection of wattmeter. For rest of the connections, use thick wire. Do not keep loose connection. Get it checked from teacher / Lab Assistant.
3. Perform the experiment only in presence of teacher or Lab Assistant.
4. Do the calculations and get it checked from the teacher.
5. After completion of experiment, switch off the MCB / ELCB / main switch.
6. Write the experiment in the journal and get it checked within week.

Guidelines for Lab /TW Assessment

1. Do the continuous assessment. The experiment performed in a particular week, should be checked within same week or at the most in next week.
2. While assessment, teacher should put the remark by writing word "Complete" and not simply "C". Put the signature along with date at the end of experiment and in the index.
3. Assign 10 marks for each experiment as per following format
Timely completion = 03 marks
Neat and clean writing = 02 marks
Depth of understanding = 03 marks
Regular attendance = 02 marks
4. Maintain continuous assessment sheet. At the end of semester, convert these marks out of as prescribed in syllabus structure and display on the notice board.

List of Experiments:

Compulsory Experiments:

1. O.C. and S.C. test on single phase Transformer.
2. Polarity test on single phase and three phase transformer
3. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedances.

Any five experiments are to be conducted of following experiments:

1. Speed control of D.C. Shunt motor and study of starters.
 2. Brake test on D.C. Shunt motor
 3. Load characteristics of D.C. series motor.
 4. Hopkinson's test on D.C. shunts machines.
 5. Load test on 3-phase induction motor.
 6. No load & blocked-rotor test on 3-phase induction motor :
 - a) Determination of parameters of equivalent circuit.
 - b) Plotting of circle diagram.
 7. Calculation of motor performance from (a) & (b) above.
 8. Determination of sequence impedance of the transformer
 9. To study Sumpner's test.
 10. Measurements of non-sinusoidal current waveform of transformer at no load
- Swinburne Test on DC shunt Motor.

Industrial Visit:

- Minimum One visit to above machines manufacturing industry (mentioned in syllabus) is recommended.
- Assignment based on IS 2026.

Text Books:

- [T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
- [T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai & Sons.
- [T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
- [T4] Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
- [T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
- [T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

- [R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
- [R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", Tata McGraw Hill Publication Ltd., Fifth Edition.
- [R3] A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
- [R4] M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
- [R5] Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
- [R6] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.