FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Electrical Engineering)**

Semester: **IV**

Course Code: **202050402**

Course Title: **Electrical Machines-I**

Course Group: **Professional Core Course IV**

Course Objectives: Course Objectives: Electrical power sector is the backbone of industries, agriculture, irrigation, urban development and almost all segments of society. Electricity is the primary requirement for the growth of Information and Communication Technology. In view of this, the static and rotating electrical equipment play a vital role for society. This subject deals with basic principles of electromechanical energy conversion, DC machines and Transformers.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50 / 18	50 / 17	25/9	25/9	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Magnetic fields, magnetic circuits and Principles of Electromechanical Energy Conversion:** Magnetic circuit, Flux, Reluctance, Magnetomotive Force (MMF), Electromagnetism, Flux Linkage, Ampere's law, Force on a conductor in a magnetic field & between two current carrying conductors, Statistically & Dynamically induced EMF, B-H Curve, Energy stored in electric and magnetic fields, Energy conversion in singly and multiply excited systems, Electromagnetic Torque.	06
2	**DC Machines:**	18

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	Review of construction and working of a DC machine, Visualization of magnetic field produced by the field winding excitation with armature winding open, Air gap flux density distribution, and flux per pole, Induced EMF in an armature coil; Armature winding and commutation; Elementary armature coil and commutator, Lap and Wave windings; Construction of commutator, Commutation; Derivation of back EMF Equation; Armature MMF wave, Derivation of torque equation; Armature reaction; Air gap flux density distribution with armature reaction; Armature circuit equation for motoring and generation; Types of field excitations – separately excited, shunt and series and compound. Open circuit characteristic of Separately excited DC Generator. Voltage build-up in a shunt generator V-I characteristics and Torque-Speed characteristics of Separately excited, Shunt, Series and Compound motors; Speed control methods; Losses and Efficiency in DC machines; Swinburne's test; Hopkinson's test; Field test; Separation of losses of a DC shunt machine. Construction, Permanent Magnet Materials: Characteristics, B-H loop and demagnetization characteristics, Residual flux density, Coercivity, Concepts of Maximum energy product and its unit MGO (Mega Gauss Oersted), Recoil line, Minor loop, temperature effects, Working principle of Permanent Magnet DC Motor.	
3	**Transformers:** Review of construction and working principle of Single-phase and Three-phase Transformers; Equivalent Circuit, Phasor diagram, Voltage Regulation, Losses and Efficiency; Testing:- Open circuit and Short circuit tests; Polarity test, Back-to-back test, Separation of Hysteresis and Eddy current losses; Three-phase Transformer: - Construction, Types of connection and their comparative features, Vector groups; Parallel operation of Single-phase and Three-phase Transformers; Auto-Transformers: - Construction, Principle, Applications and Comparison with Two Winding Transformers; Magnetizing current, Effect of nonlinear B-H curve of magnetic core material, Harmonics in Magnetizing current; Phase conversion - Scott connection, Three-phase to six-phase conversion; Tap-changing transformers - No-load and on-load Tap-changing of Transformers.	**18**

List of Practicals / Tutorials:

1	Determination of efficiency and voltage regulation of a single-phase transformer by direct load test.
2	To conduct open circuit and short circuit test on a single-phase transformer and determine the equivalent circuit parameters.
3	To conduct Sumpner's test on two identical single-phase transformers and determine their efficiency at various loads.
4	To separate hysteresis and eddy current losses of a single-phase transformer at rated voltage, frequency by conducting no load tests at different frequencies keeping V/f constant.
5	To operate two single phase transformers of different KVA ratings in parallel and plot the variation of currents shared by each transformer versus load current.

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6	To study the constructional details and working principle of DC generator and motor.
7	To obtain magnetizing characteristics, internal & external characteristics of self-excited DC shunt generator. Also obtain the critical field resistance of the machine from magnetizing characteristics.
8	To conduct the direct load test on a DC shunt and series Generators.
9	To conduct a direct load test on a D.C. compound generator with (a) shunt field alone (b) cumulative and differential compounding for short and long shunt connections.
10	To perform direct load test on a D.C. shunt motor and plot variation of (a) Input current (b) Speed(c) Torque (d) Efficiency versus output power.
11	To obtain Speed-Torque characteristics of DC series motor.
12	Speed control of DC Shunt Motor using (a) Armature control and (b) field control methods.
13	To determine the efficiency of two similar shunt machines by regenerative method. (Hopkinson's Test.)
14	To perform field test on identical D.C. series machines.
15	To make Scott connection of two single phase transformers and to verify the three- phase to two- phase conversion.

Reference Books:

1	B L Theraja, "Electrical Technology – Part II", S Chand Publications, 2011.
2	J B Gupta, "Theory and Performance of Electrical Machines", Katson Publication, 2009.
3	P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4	I J Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010
5	E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
6	M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
7	A E Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

Supplementary learning Material:	
1	https://electrical-engineering-portal.com/
2	https://www.electrical4u.com/
3	www.nptel.ac.in
4	https://interestingengineering.com/electrical-engineering-salaries-worldwide

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations

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- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Internal Evaluation: The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
30%	30%	20%	10%	10%	0%	

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.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%Weightage
CO-1	Describe the principles of magnetic circuit and electromechanical energy conversion.	**20**
CO-2	Comprehend the construction, working, testing, speed control and applications of DC machines and transformers.	**50**
CO-3	Analyze the performance of DC machines and transformers.	**20**
CO-4	Evaluate the operating parameters of machines under various load conditions.	**10**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	
Next Review on (Month-Year):	June-2025

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