

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Electrical Machine-I
Course Code:	1ET1090301
Pre-requisite Course:	Elements of Electrical Engineering

Course Objectives:

1. In this subject student will learn concept regarding to DC Machines and Transformer.
2. The major objective of the subject is to understand working and performance of DC Machines and Transformer.
3. To make students aware about importance of DC Machines and Transformer, its applications in industries and Substation.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	-	2	5	28	70	12	30	12	30	08	20	150

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Electromechanical Energy Conversion: EMF induced in a coil rotating in a magnetic field, Elementary concept of an electrical machine, Voltage generated in an electrical machines, Generalized torque equation of rotating machines, Electrical & Mechanical degree.	09	16
2	D.C. Generator: Principle, Construction, Types, E.M.F. equation, methods of excitation, Voltage build up process, Critical resistance & critical speed, Characteristics, DC windings: Basic terms related to armature windings, Lap & wave windings, Generated EMF in full pitched coil, Generated EMF in a short pitched coil, Distribution factor and Pitch factor. Performance equation and efficiency, No load & load characteristics, Performance of shunt, series and compound generators, effects of armature reaction, demagnetizing & cross magnetizing ampere-turns, compensating windings, inter poles, commutation, methods to improve commutation, Losses and efficiency, power flow diagram, parallel operation, applications of DC generators.	12	24
3	D.C. Motor: Principle, Significance of back emf, Voltage equation, Torque equation, performance characteristics of shunt, series and compound motors, Losses and efficiency, Condition for maximum efficiency, Effect of saturation and armature reaction on losses, Starter, Speed control, Electric Braking, Testing: Brake Test, Swinburne's test, Hopkinson's test, Separation of losses, Retardation test, Field test, Applications of DC motor.	11	21

4	Single Phase Transformer: Construction, Principle, Operation at no load and on load, Vector diagram, Equivalent circuit, Losses, Efficiency and regulation, Direct load test, open circuit test, short-circuit test, Back to back test, Separation of hysteresis and eddy current losses, Polarity test, Parallel operation, Autotransformers - Construction, Principle, Applications and Comparison with two winding transformer, All day efficiency.	11	21
5	Poly-phase Transformer: Construction, various types of connection and their comparative features, 3-phase transformer connections - Δ - Δ , Y-Y, Δ -Y, Y- Δ , Terminal marking, Nomenclature, Vector diagram, Phase groups, vector groupings Yy0, Dd0, Dz0, Yy6, Dd6, Dz6, Yd1, Dy1, Yz1, Yd11, Dy11, Yz11, Scott and Open Delta connection, Tertiary winding, Testing of transformers, Efficiency, Parallel operation, Voltage regulation, Off load and on load tap changers. Special Transformers: Potential transformer, Current transformer.	09	18

Text Books:

1. Theraja B L, Electrical Technology – Vol II, S Chand Publications.
2. Nagrath I J and Kothari D P, Electric Machines, Tata McGraw Hill.
3. Ghosh, Electrical Machine, Pearson Education.
4. P.S. Bhimbra, Electrical Machinery, Khanna Publishers.
5. Clayton & Hancock, Performance & Design of DC machines, ELBS.

Reference Books:

1. MG Say, Theory, Performance & Design of A.C. Machines, CBS Publishers.
2. Irving L. and Kosow, Electric Machinery and Transformers, Prentice-Hall of India.
3. George Mcpherson, "An Introduction to Electrical Machines and Transformers", John Wiley & Sons, NY.
4. Fitzgerald A.E and Kingsley, Electrical Machinery, Tata McGraw Hill.
5. Langsdorf A S, Theory of A C Machinery, Tata McGraw Hill.
6. K. Murukesh Kumar, DC machines and Transformers, Vikas Publishing house Pvt Ltd.

List of Experiments:

1. To obtain Magnetizing Characteristics, Internal & External Characteristic of Self Excited DC Shunt Generator. Also obtain the critical field resistance of the machine from magnetizing Characteristics.
2. To conduct 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.
3. To obtain Speed-Torque characteristics of DC Series Motor and DC Shunt Motor.
4. To determine the efficiency of two similar shunt machines by regenerative method. (Hopkinson's Test.)
5. To perform field test on D.C. series motor.
6. To determine the various losses in a D.C. machine and separation of its core losses.
7. 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.
8. 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.
9. 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.

10. To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
11. To make Scott connection of two single phase transformer and to verify the current relation by drawing phasor diagrams for (a) Balanced and (b) Unbalanced resistive loads.
12. To conduct open circuit and short circuit test on a three phase three winding transformer and determine the equivalent circuit parameters.
13. To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
14. Speed control of DC Shunt Motor using a) Armature control and b) field control methods. Also perform Swinburne's test on DC Shunt Motor.

List of Open Source Software/learning website:

- Open Source Software:
 - LTSpice for circuit simulation,
 - KiCAD for CAD application
- Web-based tools for design:
 - <http://www.fairchildsemi.com/support/design-tools/power-supply-webdesigner/>
 - <http://www.ti.com/lscds/ti/analog/webench/overview.page>
- Circuit Lab:
 - <https://www.circuitlab.com/editor/>
- Learning website
 - <http://www.electrical-engineering-portal.com/>
 - <http://nptel.iitm.ac.in/courses.php>
- Virtual Lab Website
 - www.vlab.co.in

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand working principle, performance, control and applications of DC Machines.	2 Understanding
CLO2	Carry out test and conduct performance experiments on DC machine.	3 Applying 4 Analyze
CLO3	Identify, formulate and solve DC machine related problems.	3 Applying 5 Evaluate
CLO4	Know working principle, performance and applications of transformer.	1 Remembering
CLO5	Understand test and conduct performance experiments on transformer.	2 Understanding
CLO6	Formulate and solve transformer related problems.	3 Applying 5 Evaluate

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1		L		H		M						M				L
CLO2	H				L	H		M		L			L		H	
CLO3				M			L				M		M			L
CLO4		L		H		M						M				L
CLO5				M			L				M		M			L
CLO6	H			H	L	M		M				M	L		H	L

H: High, M: Medium, L: Low