

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Electrical Machine-II
Course Code:	1ET1090402
Pre-requisite Course:	Elements of Electrical Engineering

Course Objectives:

1. In this subject student will learn concept regarding to AC machines
2. The major objective of the subject is to understand working and performance of synchronous machines and induction machines.
3. To make students aware about importance of AC Machines and its applications in industries and power plants.

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	Poly-phase Induction Motor: Introduction, Classification of ac motors, RMF theory, Working principle, Speed & slip, Various methods of measurement of slip, Starting & running torque, Maximum torque, Effect of change in voltage & frequency on torque, Torque-slip characteristics, Power Stages, No-load & blocked rotor test, Circle diagram, Analogy of an I.M. to a transformer, Effect of rotor resistance on performance of I.M., Double cage squirrel cage IM, Induction machine dynamics, Starters of I.M., principles & methods of speed control, Transients in induction machine, Magnetic levitations, Linear induction motor, Effect of harmonics, Cogging & crawling, Effect of unbalance voltages & frequency variation on operation of I.M. testing of induction motor as per IS(Indian Standard), Energy efficient induction motors. Induction Generator, Principle of operation and application.	20	30
2	Single phase A. C. motors: Double field revolving theory, Starting & running performance of 1-phase induction Motor, Equivalent circuit of 1phase induction motor, Types of single phase motors, Principle and operation of split phase, Resistance start, Capacitor start and capacitor start & run induction motor, Shaded pole induction motor, Fractional horse power motors.	06	15

3	Synchronous Generator: Principle, Construction, Cylindrical and salient pole type rotor, Armature windings, Distributed winding, Full pitched windings, Distribution and pitch factors, Chording, EMF equation, Alternator on load, Voltage regulation, Synchronous impedance method, MMF method, ZPF method or potier triangle method, Short circuit ratio, Two Reaction Theory, Load angle and Power flow equations, Parallel operation, Synchronization of alternator, Distribution of load, Hunting of synchronous machines and its prevention, Damper winding, Slip test for measurement of direct axis and quadrature axis reactance for salient pole machine.	11	25
4	Synchronous Motor: Principle, methods of starting, Excitation system, Equivalent circuit, Phasor diagram, Effect of change in excitation & load, Power flow equation, Power angle characteristics, 'V' and inverted 'V' curves, Power angle characteristics, Hunting, Synchronous condenser, Applications.	08	15
5	Introduction to Special Machines: Construction and working: Universal motor, Stepper motor, Reluctance motor, and Hysteresis motors, AC Servo motor, Permanent magnet synchronous motor and Brushless DC Motor.	07	15

Text Books:

1. Gupta J B, Electrical Machines, S K Kataria Publications.
2. Theraja B L, Electrical Technology – Vol II, S Chand Publications.
3. Nagrath I J and Kothari D P, Electric Machines, Tata McGraw Hill.
4. Ghosh Samarjit, Electrical Machines, Pearson Education.

Reference Books:

1. Bhimbra P S, Electrical Machinery, Khanna Publishers.
2. Say M G, Theory, Performance & Design of A.C. Machines, CBS Publishers.
3. Fitzgerald A.E and Kingsley, Electrical Machinery, Tata McGraw.

List of Experiments:

1. To perform no load and blocked rotor test on a three phase induction motor to find out its performance parameters with the help of (a) Equivalent circuit (b) Circle diagram.
2. To perform direct load test on a three phase induction motor to find out its performance parameters at different load conditions.
3. To study the construction of a three phase induction motor with the help of a cut section model.
4. To study about the starters of three phase induction motors.
5. To study about the speed control methods for three phase induction motors.
6. To observe and compare the performance of three phase motor with VVVF drive.
7. To perform no load and blocked rotor test on single phase induction motor to obtain its equivalent circuit.
8. To study about the induction generator.
9. To perform the speed control and power factor control of a Schrage motor.
10. To perform open circuit, short circuit and resistance measurement tests on a synchronous generator (alternator) and to find out its voltage regulation by different methods. (a) Synchronous impedance method (b) MMF method (c) ZPF method (d) AIEE method.
11. To obtain the direct axis and quadrature axis synchronous reactance of a salient pole machine with the slip test.

12. To perform the synchronization of two three phase alternators (or one alternator with grid) using different methods. (a) Lamps dark method (b) Two bright one dark method (c) Synchroscope.
13. To obtain the V-curves of a synchronous 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/lids/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 the construction, working principle, performance and applications of Single phase motors, Poly-phase induction motor.	2 Understanding
CLO2	Carry out test and conduct performance experiments on Single phase motors, Poly-phase induction motor.	3 Applying 4 Analyze
CLO3	Identify the need of these machines in the society.	4 Analyze
CLO4	Know working principle, performance and applications synchronous generator (Alternator), synchronous motor and commutator motors.	1 Remembering
CLO5	Understand test and conduct performance experiments on synchronous generator (Alternator), synchronous motor and commutator motors.	2 Understanding
CLO6	Identify, formulate and solve the numerical problems related to above machines.	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