



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3150910

Semester –V

Subject Name: Electrical Machine- II

Type of course: Professional Core Course

Prerequisite: NA

Rationale: Electrical power sector is the backbone of industries, agriculture, irrigation, urban development and almost all the segments of society. In view of this, the rotating electrical equipments play a vital role for the society. This subject deals with the theory and performance analysis of various electrical machines.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Induction Machines: Revision of the concept of rotating magnetic field. Construction, working and types of induction motor (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. No-load & blocked rotor test, Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Induction generator operation. Self-excitation of induction generator. Double cage induction motor. Circle diagram of induction motor. Effect of harmonics, Cogging & Crawling, Effect of unbalanced voltages on performance of motor.	16
2	Single-phase induction motors: Constructional features double revolving field theory, equivalent circuit, Determination of parameters. Split-phase starting methods and applications. Universal motor. Repulsion motor. Shaded pole single phase motor.	08
3	Synchronous machines: Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Methods to find voltage regulation: Synchronous impedance method, MMF method, ZPF method. Operating characteristics of synchronous machines, Salient pole machine – two reaction theory, power angle characteristics. Parallel operation of alternators - synchronization and load division.	16



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4	Synchronous motors: Methods of starting of synchronous motors, Different torques in Synchronous motor, Stability, Synchronous condenser, Synchronous phase modifiers, V-curves of Synchronous motors, Auto Synchronous Motor: Construction, principle of operation, equivalent excitation current for various rotor connections, circle diagram.	08
5	Special machines: Magnetic levitation principle, advantages and applications of linear induction motor. Introduction to axial flux machines. Construction, working and applications of Permanent magnet brushless DC motor, Stepper motor and Switched reluctance motor.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	20	20	20	00

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

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.

Reference Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. I J Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. J B Gupta, "Theory and Performance of Electrical Machines", Katson Publication, 2009.
4. B L Theraja, "Electrical Technology – Part II", S Chand Publications, 2011
5. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
6. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
7. G C Garg, "Electrical machines – II", Khanna Publishers,
8. S K Sen, "Principle of Electrical Machine Design with Computer Programs" Oxford & IBH

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the construction, working principle and applications of induction machines and synchronous machines	30



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CO-2	Analyze the performance of rotating electrical machines using the tools like equivalent circuit, phasor diagram and circle diagram	30
CO-3	Evaluate the performance parameters of rotating machines with different operating conditions	30
CO-4	Illustrate the construction, working, applications and advantages of special machines	10

List of Experiments:

- To perform no load and blocked rotor test on three phase induction motor to obtain the parameters of equivalent circuit
- To perform no load and blocked rotor test on three phase induction motor to evaluate the performance parameters using circle diagram
- To perform no load and blocked rotor test on single phase induction motor to obtain the parameters of equivalent circuit
- To obtain the performance parameters of three phase induction motor using direct load test.
- To find out the voltage regulation of three phase alternator using direct load test
- To perform open circuit, short circuit and resistance measurement tests on alternator to find out its voltage regulation using synchronous impedance method and MMF method.
- To perform open circuit, short circuit, zero power factor and resistance measurement tests on alternator to find out its voltage regulation using ZPF method.
- To perform synchronization of alternator using dark lamp method, two bright one dark lamp method and synchroscope.
- To obtain direct axis and quadrature axis reactance of salient pole synchronous machine using slip test.
- To obtain the v-curves of a synchronous motor.
- To study the construction and working of special electric machines like stepper motor, permanent brushless DC motor and switched reluctance motor.

Major Equipments:

Required number of machines, panels, meters, accessories and instruments etc... to be provided to conduct the above experiments in a group of maximum 4 students. Charts and cut section models of various machines should be provided for better understanding.

List of Open Source Software/learning website:

- <http://www.scilab.org/>
- <http://www.gnu.org/software/octave/>
- <http://www.vlab.co.in>
- <http://www.femm.info>