

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**MECHATRONICS ENGINEERING (20)**  
**ELECTRO MECHANICAL ENERGY CONVERSION**  
**SUBJECT CODE: 2152001**  
**B.E. 5<sup>th</sup> SEMESTER**

**Type of course:** Engineering Science (Mechatronics)

**Prerequisite:** N.A.

**Rationale:** Principles of energy conversions are discussed in this subject. Applications of various motor drives are covered to explore the utility of the subject.

**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)		
PA	ALA	ESE		OEP						
4	0	2	6	70	20	10	20	10	20	150

**Content:**

Sr. No.	Content	Total Hrs	% Weightage
1	Review of Principles and Terminology of Electromagnetics And Electromagnetic Induction: Ampere's law, Magnetic flux and flux density, Self inductance and Mutual inductance, Properties of magnetic materials. Faraday's and Lenz's law, Generated and induced emf.	05	10
2	Direct and Alternating current Excitation of Ferromagnetic Structures: Magnetization, Hysteresis and hysteresis loop, Methods of analysis of ferromagnetic circuits, Fringing and Leakage effects of air gap, Eddy current, eddy current and hysteresis losses, Equivalent circuits of iron core reactors, Saturable reactors.	06	12
3	Energy Conversion in Singly and Doubly Excited Electromagnetic Systems: Energy Balance in Nonlinear and Linear magnetic systems, Field energy and Mechanical force in singly excited systems, Doubly excited magnetic systems, Forces/torques in systems with permanent magnets, Dynamical equations of electromechanical systems.	06	12
4	Rotating Electrical Machines: DC Machines (Both Generators and Motors): Construction, Basic principle of operation , Types of DC machines, EMF and Torque equations, characteristics of DC machines and their applications, various losses, efficiency and power flow diagrams. 3-Phase Induction Motors: Rotating magnetic fields, Construction and working principle, Torque in standstill and running conditions, Torque-Slip characteristics, various losses, efficiency and power flow diagrams. Synchronous Machines (Both Generators and Motors): Construction,	14	30

	Operating Principle, EMF equation of alternator, Method of starting of synchronous motor, Motor on load with constant and variable excitations, Power flow within a synchronous motor.		
<b>5</b>	Single phase Electrical Motors: Types, Single Phase Induction Motors, Double field revolving theory, Methods of starting, Equivalent circuit, Various types of single phase Induction motors and their characteristics, Shaded pole Motor, Repulsion motor, AC series motor, Universal motor, Reluctance motor and Hysteresis motor.	<b>08</b>	<b>15</b>
<b>6</b>	Special Electrical Motors: Stepper Motor: Types, construction, operating principle, characteristics and applications Permanent Magnetic DC (PMDC) Motors, Brushless DC (BLDC) motor, AC and DC servo motors.	<b>06</b>	<b>14</b>

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>45</b>	<b>20</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>-</b>

**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. Theraja B L, Electrical Technology – Vol II, S Chand Publications
2. Nagrath I J and Kothari D P, Electric Machines, Tata McGraw Hill
3. Electromechanical Energy Conversion, Vembu Gaurishankar, McGraw Hill.
4. Gupta J B, Electrical Machines, S K Kataria Publications

**Course Outcome:**

After learning the course the students should be able to:

1. Understand different principles of electromechanical energy conversions.
2. Understand construction and working of different rotating electrical machines.
3. Analyze different rotating electrical machines.
4. Study usage of different rotating electrical machines for various applications.

**List of Experiments:**

1. To study the construction of electromechanical relay and to observe chattering phenomena in AC relays.
2. To study and observe switching waveforms of relay during opening and closing.
3. To design driver circuit of electromechanical relays.
4. To obtain magnetization characteristics of separately excited DC generator.
5. To perform load test on DC shunt generator.
6. To study about starters of DC motors.

7. To perform field test on DC series motor.
8. To perform direct load test on DC shunt motor.
9. To perform direct load test on a three phase induction motor to find out its performance parameters at different load conditions.
10. To study about starters of 3 phase induction motors.
11. Performance of 3 phase induction motor under unbalanced supply.
12. To perform open circuit test on synchronous generator.

**Design based Problems (DP)/Open Ended Problem:**

1. To analyze method of separation of iron losses in different electrical machines.
2. To identify and analyze common problems and faults occur in different electrical machines.
3. To study various speed control and direction reversal methods for different rotating electric machines.

**Major Equipment:**

Lab set up of following machines

- (1) Different DC machines
- (2) 3 phase Induction motors
- (3) 3 phase synchronous generator

Etc.

**List of Open Source Software/learning website:**

Learning website

- <http://www.electrical-engineering-portal.com/>

- <http://nptel.iitm.ac.in/courses.php>

Virtual Lab Website

[www.vlab.co.in](http://www.vlab.co.in)

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.