GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE04020021
Subject Name: Electro Mechanical Energy Conversion

w.e.f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

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

Course Outcomes: At the end of the course, students will be able to:

Sr. No.	CO statement	Marks% weightage
CO-1	Make Use of different principles of electromechanical energy conversions.	**A25**
CO-2	Examine construction and working of different rotating electrical machines.	**N25**
CO-3	Evaluate different rotating electrical machines.	**E25**
CO-4	Summarize use of different rotating electrical machines and special electrical motors for various applications.	**U25**

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
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**

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**
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**
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, 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.	**14**
5	**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.	**08**
6	**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.	**06**
	TOTAL	**45**

Suggested Specification table with Marks(Theory):(For B.E. only)

Distribution ofTheory Marks					
RLevel	ULevel	ALevel	NLevel	ELevel	CLevel
	25%	25%	25%	25%	

R: Remembrance; U: Understanding; A: Application; N: Analyze;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	Electrical Technology – Vol II by B L Theraja, S Chand Publications
2	Electric Machines by Nagrath I J and Kothari D P, Tata McGraw Hill
3	Electromechanical Energy Conversion by VembuGaurishankar, McGraw Hill
4	Electrical Machines byGupta J B, S K Kataria Publications

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	Performances of 3 phase induction motor under unbalanced supply.
12	To perform open circuit test on synchronous generator.

Major Equipment:

List of Open Source Software/learning website:

Supplementary learning Material:	
1	NPTEL and Coursera Resources

- **List of suggested activities for Term Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the correctness of submitted assignment.

4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication

16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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