

GUJARAT TECHNOLOGICAL UNIVERSITY
POWER ELECTRONICS (24)
 Electrical Machines & Measurement
SUBJECT CODE: 2142407
 B.E. 4th Semester

Type of Course: Engineering Science (**Power Electronics**)

Prerequisite: N.A.

Rationale: N.A.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	2	6	70	20	10	20	10	20	150

Contents:

Sr. No.	Topic	Teaching Hours	Weightage
1	<p>Module 1</p> <p>Electromechanical Energy Conversion: Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system. Physical concept of torque production; Electromagnetic torque and Reluctance torque.</p> <p>Concept of General terms pertaining to Rotating Machines: Electrical & Mechanical degree, Pole pitch, Coil, Generated EMF in full pitched coil, Generated EMF in a short pitched coil, EMF polygon, Distribution factor, Pitch factor. MMF produced by Distributed Windings, MMF of a coil, MMF of single phase distributed Winding, MMF waveform of Commutator machine</p>	10	15
2	<p>Module 2</p> <p>D.C. Machines: Working principle, construction and methods of excitation. Armature Winding: Introduction of simplex lap and wave windings.</p> <p>DC generators: EMF equation – methods of excitation – separately and self-excited – shunt, series, compound - armature reaction – effects of armature reaction, voltage build-up – no load characteristics – load characteristics – losses and efficiency D.C. Motors: Principle of operation – back EMF – classification – torque equation – losses and efficiency – power flow diagram, performance characteristics of shunt, series and compound motors – starting of DC motors – necessity and types of starters– speed control – methods of speed control – solid state speed control (block diagram).</p>	16	20

3	Module 3 Transformers: Principle, construction and operation of single phase transformers, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency, Testing- Open & short circuit tests, Polarity test, Autotransformers - Construction, Principle, Applications and Comparison with two winding transformer, Three phase Transformer: Construction, various types of connection and their comparative features, 3-phase transformer connections - Δ - Δ , Y-Y, Δ -Y, Y- Δ , V-V –Parallel operation of single phase and three phase transformers.	14	20
4	Module 4 Philosophy Of Measurement- Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement & its analysis, Standards	03	5
5	Module 5 Analog Measurement of Electrical Quantities – Electro dynamic, Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters, Electro dynamic Wattmeter, Three Phase Wattmeter, Power in three phase system, errors & remedies in wattmeter and energy meter. Introduction to measurement of speed, frequency and power factor	10	15
6	Module 6 Measurement of Parameters - Different methods of measuring low, medium and high resistances, measurement of inductance & capacitance with the help of AC Bridges, Q Meter	05	10
7	Module 7 Digital Measurement of Electrical Quantities-Concept of digital measurement, block diagram Study of digital voltmeter, frequency meter Power Analyzer and Harmonics Analyzer; Electronic Multi meter	06	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	N Level	A Level	E Level
20	15	15	10	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. Nagrath I J and Kothari D P, Electric Machines, Tata McGraw Hill
2. Ghosh, Electrical Machine, Pearson Education
3. P.S. Bhimbra, Electrical Machinery, Khanna Publishers
4. Clayton & Hancock, Performance & Design of DC machines, ELBS
5. MG Say, Theory, Performance & Design of A.C. Machines, CBS Publishers.

6. A.K.Sawhney, A course in Elect. & Electronic Measurement and Instrumentation, Dhapat Rai & Co.
7. Golding & Widis, Electrical Measurement and Measurement instrument, Wheeler Books
8. H.S. Kalsi, Electronic Instruments, Tata Mc -Graw hill.
9. Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education.
10. D. Patranabis, Sensors & Transducers, PHI.

Course Outcomes:

After learning the course the students should be able to:

- Understand working principle, performance, control and applications of DC Machines and Transformer.
- Carry out test and conduct performance experiments on DC machine and Transformer.
- Identify, formulate and solve DC machine and Transformer related problems.
- Understand the working principal and construction of the measuring instruments and recorders.
- Measure various electrical and physical quantities and parameters using meters and transducers.
- Calibrate the measuring devices such as meters and transducers.

List of Practical including Open Ended Problems:

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 determine the various losses in a D.C. machine and separation of its core losses.
6. 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.
7. 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.
8. 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.
9. To conduct open circuit and short circuit test on a three phase three winding transformer and determine the equivalent circuit parameters.
10. Speed control of DC Shunt Motor using a) Armature control and b) field control methods. Also perform Swinburne's test on DC Shunt Motor
11. (a) Calibration of single phase energy meter by direct loading b) Calibration of single phase static energy meter.
12. Measurement of self and mutual inductance a) air cored coil b) iron cored coil.
13. (a) Determination of B-H curve b) Determination of hysteresis loop using six point methods.
14. Calibration of ammeter, voltmeter and wattmeter using vernier potentiometer

Design based Problems (DP)/Open Ended Problem:

- (1) List the commonly used rotating and stationary electrical machines around us. Identify which application uses which machine.
- (2) Identify the common problems/faults in these machines.
- (3) Suggest the possible solutions/remedies for these problems

- (4) List the different measuring instruments. Compare different instruments based on their construction, working principle etc.

Major Equipments:

Lab set ups should include following machines:

- (1) D.C. shunt machine connected to self excited DC generator (with appropriate starter)
 - (2) D.C. series machine connected to self excited DC generator (with appropriate starter)
 - (3) D.C. compound machine connected to self excited DC generator (with appropriate starter)
 - (4) Two identical single phase transformer.
 - (5) Two identical three phase transformer
- Digital multimeters, Ameters, Voltmeters, Wattmeters, Digital power meters, Techometers, Synchroscope, Lamp boards, Rheostates, Loading rheostates, DC variable voltage source of minimum 40A, 0 to 240 V rating
 - The necessary no. of Kits, breadboard, equipment, accessories and instruments etc... to be provided to conduct the above practical in a group of max. 4 students

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-web-designer/>
- <http://www.ti.com/lstds/ti/analog/webench/overview.page>

Circuit Lab:

- <https://www.circuitlab.com/editor/>

Open source Math Tools:

- <http://maxima.sourceforge.net/>
- <http://www.sagemath.org/>
- <http://www.scilab.org/>
- <http://www.gnu.org/software/octave/>

Learning website

- <http://www.electrical-Engineering-portal.com/>
- <http://nptel.iitm.ac.in/courses.php>

Virtual Lab Website

- www.vlab.co.in

Active Learning Assignments (ALA):

Preparation of power point slides, which may include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus can 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 faculty and the department