GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL (09) /POWER ELECTRONICS (24)

DC MACHINE AND TRANSFORMER

SUBJECT CODE: 2130904

B.E. 3rd Semester

Type of Course: Engineering Science**(ELECTRICAL)**

Prerequisite: N.A.

Rationale: N.A.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	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

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE End Semester Examination; PA- Progressive Assessment.

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	Module 1. Electromechanical Energy Conversion: Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system. Physical concept of torque production; Electromagnetic torque and Reluctance torque. 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 machines.	8	10
2.	Module 2. D.C. Machines: Working principle, construction and methods of excitation. Armature Winding: Introduction of simplex lap and wave windings. DC generators: EMF equation – methods of excitation – separately and self-excited – shunt, series, compound - armature reaction – effects of armature reaction - demagnetizing & cross magnetizing ampere-turns – compensating windings – inter poles - commutation – methods to improve commutation - voltage build-up – no load characteristics – load characteristics – losses and efficiency - power flow diagram –parallel operation – applications of DC generators. D.C. Motors: Principle of operation – back EMF – classification – torque equation – losses and efficiency – power flow diagram –	24	40

	performance characteristics of shunt, series and compound motors – starting of DC motors – necessity and types of starters – design of starters – speed control – methods of speed control – solid state speed control (block diagram) – testing – Swinburne's test – Hopkinson's test – separation of losses – retardation test – field test of dc motors – application of DC motor.		
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, Sumpner's test, Separation of hysteresis and eddy current losses, 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 – vector groupings Yy0, Dd0, Yd1, Yd11, Dy1, Dy11, Scott connection – three winding transformer – tertiary winding – per unit impedance, Parallel operation of single phase and three phase transformers. Excitation phenomenon in transformers, Harmonics in single phase and three phase transformers, Tap changing Transformers - No load and on load tap changing of transformers, Cooling methods of transformers. Special Transformers: Potential transformer, Current transformer, Pulse transformer, Audio frequency transformer, Grounding transformer.	24	40

Note: 30%-40% weightage should be given to the Examples and Short/Multiple choice questions.

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. Irving L. and Kosow, Electric Machinery and Transformers, Prentice-Hall of India
7. George Mcphersion ,"An Introduction to Electrical Machines and Transformers", John Wiley & Sons, NY
8. Fitzgerald A.E and Kingsley, Electrical Machinery, Tata McGraw Hill
9. Langsdorf A S, Theory of A C Machinery, Tata McGraw Hill
10. K. Murukesh Kumar, DC machines and Transformers, Vikas Publishing house Pvt Ltd.

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.

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 filed 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 perform filed test on D.C. series motor.
6. To determine the various losses in a D.C. machine and separation of its core losses.
7. 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.
8. To separate hysteresis and eddy current losses of a single phase transformer at rated voltage, frequency by conducting no load tests at different frequencies keeping V/f constant.
9. 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.
10. To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
11. 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.
12. To conduct open circuit and short circuit test on a three phase three winding transformer and determine the equivalent circuit parameters.
13. To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
14. Speed control of DC Shunt Motor using a) Armature control and b) field control methods. Also perform Swinburne's test on DC Shunt Motor.

Major Equipments:

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-webdesigner/
- http://www.ti.com/lsds/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

Active learning Assignments (AL) : 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.