GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

Course Title: D C MACHINES AND TRANSFORMERS

(Code: 3330902)

Diploma Programme in which this course is offered	**Semester in which offered**
Electrical Engineering	3rd semester

1. RATIONALE

This course deals with single phase transformer and DC Machines which are widely used in power systems, industries and commercial applications. This course will enable the students to develop skills to select, install, operate, and maintain various types of DC machines and transformers. Practical aspects of the course will make the students capable of performing various tests on these machines. It is therefore very important for every electrical engineer to learn this course if he/she wants to excel in his/her professional life.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course content should be taught and with the aim to develop different types of skills so that students are able to acquire following competency

- **Maintain various types of DC machines and single phase transformers safely.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			**Total Credits (L+T+P)**	**Examination Scheme**				
				Theory Marks		**Practical Marks**		**Total Marks**
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	
04	00	04	08	70	30	40	60	**200**

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

Note: The institute heads are responsible for the **online entry** of the marks of each student of **PA of Theory as** well as **ESE** and **PA of Practical Exercises** into the **GTU Portal** at the end of each semester within the dates specified by GTU.

4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Energy Conversion Principles	1a. Explain law of conservation of energy and role of electrical energy	1.1 Law of conservation of energy 1.2 Role of electrical energy and uses
	1b. State the conditions for EMF production 1c. Differentiate between singly and doubly excited electrical machines	1.3 Electro-mechanical energy conversion principle and EMF 1.4 Singly excited and doubly excited electrical machines.
Unit – II DC Generators	2a. Describe function of different parts of DC machine with sketches. 2b. Derive emf equation of DC generator 2c. Explain the working DC Generator. 2d. Different types of armature winding.	2.1 Construction and materials used for various parts of DC generator. 2.2 Functions of various parts of DC generator. 2.3 EMF equation of DC generator 2.4 Working principle of DC generator 2.5 Simplex lap and wave winding.
	2e. Classify different types of DC generator with sketches 2f. Describe performance characteristic of different types of DC Generators 2g. Calculate losses and efficiency. 2h. Explain armature reaction and commutation 2i. Given the data diagnose the problems of DC generators	2.6 Different types of DC generators 2.7 Characteristics of various types DC generators. 2.8 Efficiency and losses of DC generator. 2.9 Armature reaction and its effects and commutation
Unit – III DC Motors	3a. Explain working of DC motor 3b. Derive torque equation of DC motor 3c. Justify the need of DC motor starter 3d. Explain working of DC motor starter	3.1 Working principle of DC motor, back emf. 3.2 Torque equation for DC motor. 3.3 Need DC motor starters 3.4 Construction and working of DC motor starters
	3e. Classify different types of DC motors 3f. Compare performance of different types of DC motors 3g. Explain the speed control of DC motor	3.5 Series, Shunt and Compound DC motors 3.6 Performance characteristics of DC Series, Shunt and Compound motor. 3.7 Speed control of D.C. motor
	3h. Calculate the losses and efficiency 3i. State the need of Brake test, Swinburne's test and field test. 3j. List the applications of various types of DC motors 3k. Given the data diagnose the	3.8 Losses in DC motors and its computation 3.9 Brake test, Swinburne's test, field test. 3.10 Applications of DC Series, Shunt and compound motor.

	problems of DC machines	
Unit	**Major Learning Outcomes**	**Topics and Sub-topics**
Unit – IV **Single Phase Transformers**	4a. Explain the working of a single phase transformer with sketches 4b. Derive EMF equation of transformer and transformation ratio 4c. Differentiate between core and shell type transformer with sketches. 4d. State the materials used for the different parts of the transformer	4.1 Single phase transformer: Working principle, construction, materials used for different parts 4.2 EMF equation and transformation ratio. 4.3 Core and shell type of transformers.
	4e. Explain the performance of the transformer on no load, resistive, inductive and capacitive loads with phasor diagrams 4f. Explain various losses in transformer. 4g. Derive expression for efficiency and the condition for maximum efficiency of a single phase transformer	4.4 Phasor diagram for load and different types of loads 4.5 Losses in transformer: Iron loss, Copper loss, Hysteresis loss and eddy current loss 4.6 Efficiency Condition for maximum efficiency of single phase transformer.
	4h. Describe the significance of voltage regulation 4i. Explain the various parameters for the transformer equivalent circuit 4j. Solve numerical problems with respect to the performance and maintenance of single phase transformer.	4.7 Voltage regulation 4.8 Equivalent circuit of single phase transformer.
Unit – V **Testing of Single Phase Transformers**	5a. State the need for conducting different types of tests on single phase transformers. 5b. State the steps for conducting the OC and SC tests of the single phase transformer	5.1 Direct load test, OC and SC test and Sumpner Test along with connection diagrams, efficiency and regulation of transformer 5.2 Derivation of equivalent circuit and its related parameters
	5c. Describe the need and conditions for parallel operation of transformers 5d. Solve numerical on various tests of single phase transformers	5.3 Need of parallel operation, essential and desirable conditions for parallel operation. 5.4 Parallel operation and load sharing of single phase transformer
	5e. Describe working of an autotransformer with sketches. 5f. Distinguish between autotransformer and welding transformer	5.5 Construction and working of autotransformer; welding transformer

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Energy Conversion Principles	04	02	02	00	04
II	DC Generators	14	06	06	06	18
III	DC Motors	14	06	06	06	18
IV	Single Phase Transformers	16	06	08	06	20
V	Testing of Single Phase Transformers	08	02	04	04	10
Total		**56**	**22**	**26**	**22**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs. Required
1	**II**	Identify various parts of DC machine	01
2	**IV**	Identify various parts of single phase transformer	01
3	**II**	Test the performance of DC compound machine	01
4	**II**	Maintain constant voltage of DC generator at different load conditions.	04
5	**II**	Test the performance of a separately excited DC shunt generator	04
6	**II**	Test the performance of DC series generator	04
7	**II**	Test DC compound generator for external and internal load characteristic.	04
8	**III**	Connect three point and four point starters for DC motor.	02
9	**III**	Control the speed of DC shunt motor by armature and field control.	04
10	**III**	Control the speed of DC series motor.	04
11	**III**	Perform Swinburne's test of DC machine.	04

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs. Required
12	**V**	Perform Load test on single phase transformer.	04
13	**V**	Perform OC and SC test of single phase transformer.	04
14	**V**	Perform polarity test on single phase transformer.	04
15	**V**	Operate two single phase transformers in parallel having i) Equal impedances ii) Different impedances.	04
16	**V**	Perform Sumpner's test on single phase transformer.	04
17	**II**	Troubleshoot DC shunt generator/motor	02
18	**II**	Troubleshoot DC series generator/motor	02
19	**II**	Troubleshoot DC compound machine	02
20	**IV, V**	Troubleshoot single phase transformers	02
		Total	**65**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities:

i. Prepare journals based on practical performed in laboratory.
ii. Assignments on solving numerical
iii. Identify different types of dc machine based on their winding arrangement
iv. Identify different types of transformer based on application
v. Prepare chart displaying the various parts of dc machine
vi. Prepare chart displaying the various parts of transformer
vii. Prepare chart displaying the various parts of a three and four point dc motor starter

8. SPECIAL INSTRUCTIONAL STRETAGIES (If Any):

(i) Students should be shown in animations/video films to explain the working concept of DC machines and transformers based on the principle of electromagnetic induction
(ii) Students should be taken to nearby industries/substation where medium or big size DC Machines/Transformers are installed. Students should be shown major parts/accessories and their features and functions should be explained to them.

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Books	Author	Publication
1.	Electrical Technology Vol-II	Theraja, B.L.	S. Chand, New Delhi, 2011 or latest
2.	Electrical Technology	Uppal, S.L.	Khanna Publication, New Delhi, 2011 or latest
3.	Electrical Machines	Despande, M.V.	Prentice Hall of India, New Delhi, 2011 or latest
4.	Electrical Machine	Nagrath, I.J. and Kothari, D.P.	Tata McGraw Hill, New Delhi, 2011 or latest
5.	Electrical Machine-I	Gupta, J. B.	S. K. Kataria & Sons, New Delhi, 2011 or latest

B) List of Major Equipment/Materials with Broad Specifications

i. DC shunt, series and compound motor – 230 V DC , 19 A, 1000 RPM, 5HP
ii. DC shunt motor-generator set – 230 V DC, 16 A, 1000 RPM, 5 HP
iii. Single phase transformer – 230 V / 115 V, 1 kVA 1-phase transformer
iv. Auto transformer : 0 – 230 V, 10 Amp
v. Welding transformer: 50 V, 50 /100 Amp

C) List of Software/Learning Websites

i. www.nptel.com/iitm/
ii. www.howstuffworks.com/
iii. www.vlab.com

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R.L. Patel**, Sr. Lecturer, Electrical engineering Department, Govt. Polytechnic, Jamnagar
- **Prof. M. J. Aghara**, Sr. Lecturer, Electrical Engineering Department, Govt. Polytechnic, Rajkot
- **Prof. A. P. Shah**, Lecturer, Electrical Engineering Department, B. & B. Institute of Technology, V.V.Nagar
- **Prof. V. C. Jagani**, Sr. Lecturer, Electrical Engineering Department, Govt. Polytechnic, Junagadh.
- **Prof. K. V. Dave**, Sr. Lecturer, Electrical Engineering Department, Govt. Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. (Mrs.) C.S. Rajeshwari**, Professor & Head, Department of Electrical and Electronics Engineering
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering