GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: DESIGN PARAMETERS OF ELECTRICAL EQUIPEMENT AND MACHINES
(COURSE CODE: 3360905)

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	Sixth

1. RATIONALE

Technical personnel operating any electrical equipment and machines in an industry should be well aware of the basic design principles and key design parameters for better understanding of the functioning of those machines. This knowledge may be used to improve operating efficiency of the machines. Knowledge about design parameters also helps in maintaining those machines in a better way. In case of breakdown, knowledge of design parameters helps in selection of proper replacement materials and components. In some cases if specified components are not available then knowledge of design parameters may help in finding out alternative solutions. This course attempts to create the awareness of these parameters in diploma holders so that they can apply the general principles of design and knowledge of design parameters for better operation and maintenance of electrical equipment and machines. Knowledge so gained would also help students in deciding the specification of the equipment/machines to be purchased for some expansion or new projects. Studying this course will also enable a diploma pass out student to start his/her own business venture independently

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Apply the general principles of design and knowledge about design parameters for selection, operation and maintenance of electrical equipment and machines.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Analyze the general aspects of design of electrical equipment and machines
ii. Design different types of starter, field regulator, choke and control panel.
iii. Design different types of electromagnets
iv. Design small transformer, understand the procedural steps to design a 3 phase transformers
v. Design capacitor start single phase induction motor and understand the procedural steps to design a 3 phase Squirrel cage induction motor
vi. Calculate various performance parameters for transformers and induction motor.

4. 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	
3	0	2	5	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I. General Electrical Design Principles	1a. Explain the term design and its limitations in electrical machines. 1b. State the properties of conducting, magnetic and insulating materials used in electrical machines. 1c. Describe the effect of heating and cooling on the performance of electrical machine. 1d. State the factors on which the specific magnetic and electric loadings depends. 1e. State the factors on which the output of an electrical machine depends. 1f. State the factors affecting the size of a rotating machine.	1.1 Design, Limitations of design, modern trends in design of electrical machines 1.2 Electrical properties of conducting, magnetic and Insulating Materials and its Classifications 1.3 Reasons for generation of heat in electrical machines. Concept of load and no load losses. 1.4 Heating and cooling of electrical machines 1.5 Specific magnetic and electric loading and their choice 1.6 Effect of type and quality of insulation on limits of allowed temperature rise and life of machine. 1.7 Output coefficient of DC and AC machine 1.8 Factor affecting size of machines 1.9 Duty cycle and equivalent ratings
Unit– II Design Parameters of Starters , Field Regulator and Control Panel	2a. State the parameters for designing an iron cored choke suitable for 5 amps inductive current. 2b. Derive the calculation of resistance steps of a motor. 2c. Estimate number of resistance section and resistance of each section for a DC shunt and series a motor. 2d. State the parameters for the design of a starter for a 3 phase slip ring induction motor. 2e. State the parameters on which the size of the wire for a particular current carrying capacity of a field regulator depends.	2.1 Design parameters of choke 2.2 Design parameters of A.C. and D.C. motor starters 2.3 Design parameters of Field regulator 2.4 Design of general purpose control panels

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit– III Design Parameters of Electromagnets	3a. Explain the function of an electromagnet. 3b. State the commonly used electromagnets and its applications. 3c. Write four fundamental equations on which the dimensions of various electro-magnets depend. 3d. Explain steps to design electromagnet.	3.1 Electromagnets and its types 3.2 Design of Magnet coils 3.3 Steps to Design small Flat-faced armature type circular magnet 3.4 Steps to Design large-faced armature type circular magnet 3.5 Steps to Design Horse shoe type magnet 3.6 Steps to Design plunger type magnet 3.7 Steps to Design magnetic clutches
Unit–IV Design Parameters of Transformers	4a. State the parameters of small transformer. 4b. Design small transformer. 4c. Compare power and distribution transformer from design point of view. 4d. Write the specifications of power and distribution transformer. 4e. Derive the output equation of a three phase transformer. 4f. Explain the effect of specific magnetic and electric loading on output of a transformer. 4g. Explain the effect of various electrical parameters on the performance of 3 phase transformer. 4h. Write the procedural steps for designing a three phase transformer.	Design of small Transformers 4.1 Core design 4.2 Winding design 4.3 Window area 4.4 Problem design of single phase transformer for 230V 50hz supply to deliver (3 to 5) amp at (12 to 50) volt Design Parameter of Three Phase Transformer 4.5 Power and distribution transformer from design point of view. 4.6 Specifications-Rating and performance expectation. 4.7 Output equation. Choice of Specific magnetic and electric loading. Core losses and copper losses. 4.8 Design of core, winding and main dimensions of frame, Electrical parameter -resistance, reactance, Magnetising current, Design criteria for tank. 4.9 Procedural steps for design of transformer.
Unit-V Design Parameters of Induction Motors	5a. Design the main dimensions of a single phase induction motor. 5b. Explain the basis on which air gap, number of stator and rotor slots are chosen. 5c. Write the procedural steps for designing a single phase capacitor start induction run motor.	5.1 Single phase induction motor -Design considerations and specification. 5.2 Material of core, conductor and insulation. 5.3 Design of core diameter and axial length. 5.4 Choice of air gap, number of stator slots, rotor slots. 5.5 Design of main winding. 5.6 Maximum torque. 5.7 Reactance. 5.8 Procedural steps for designing capacitor start induction run motor. 5.9 Sample examples
	5d. Explain basic considerations for design of a three phase induction motor	5.10 Three phase induction motor (no calculation) - Basic consideration for design.

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	5e. Design main dimensions of a three phase induction motor 5f. Write procedural steps for designing a three phase squirrel cage induction motor.	5.11 Frame. 5.12 Rating. 5.13 Duty and rating. 5.14 Temperature rise. 5.15 Output equation, choice of specific electric loading. 5.16 Relation between L and D for best power factor. 5.17 Procedural steps for design of a 3 Phase Squirrel Cage Induction Motor.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	General Electrical Design Principles.	6	4	4	2	10
II	Design Parameters of Starter , Field Regulator & Control Panel	8	4	3	7	14
III	Design Parameters of Electromagnets	8	6	2	4	12
IV	Design Parameters of Transformers	10	7	4	7	18
V	Design Parameters of Induction Motors	10	5	4	7	16
	Total	**42**	**26**	**17**	**27**	**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.

7. SUGGESTED PRACTICALS/EXERCISES

The practical should be properly designed and implemented with an attempt to develop different types of skills **(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 outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx Hours. Required
1	I	Prepare a brief report of various methods of cooling of transformer which are used in industries, power station and substation. (along with their ratings) (different group of students can visit different industries,	4

S. No.	Unit No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx Hours. Required
		power station and substation and prepare a brief report)	
2	II	Design a control panel for your college. (Electrical Engineering laboratory, workshop, or control panel for complete college)	4
3	II	Design a.c. / d.c. starter for any motor which is present in your laboratory.	4
4	III	Design small flat faced armature type circular magnet using the given data. Also draw the above using AutoCAD.	4
5	III	Design large faced armature type circular magnet using given data. Also draw the above using AutoCAD.	4
6	III	Design Horse shoe type magnet using the given data. Also draw the above using AutoCAD.	4
7	III	Design large faced armature type circular magnet using the given data. Also draw the above using AutoCAD.	4
8	IV	Design single phase transformer for 230V 50hz supply to deliver (3 to 5) amp at (12 to 50) volt. Also draw the above using AutoCAD.	4
9	IV	Design single phase transformer using software.	2
10	IV	Design Distribution Transformer in your college premises or using relevant data. Also draw the above using AutoCAD.	4
11	IV	Prepare Flow chart for designing transformer	2
12	V	Design single phase induction motor used to fill an overhead tank. Also draw the above using AutoCAD	4
13	V	Design single phase induction motor using software.	2
14	V	Design 3-phase induction motor which is present in your laboratory. Also draw the above using AutoCAD	4
15	V	Design 3-phase induction motor using software	2
16	V	Prepare Flow chart for designing induction motor	2
		Total Hours	**54**

NOTE: Perform any of the practical exercises for total minimum of 28 hours from above list depending upon the availability of resources so that skills matching with the most of the outcomes in the all units are developed.

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Prepare chart displaying various parts of transformer, motors etc.
iii. Using internet find different material used for construction of transformer and motors in recent trends.
iv. Survey the market and compare design of induction motors from different manufacturers based on materials used (in winding, insulation, frame, slip rings/squirrel cage, etc.) Losses, efficiency, expected life, temperature rise, type of bearings, noise level, type of cooling, cost etc.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation film to demonstrate the working principles, constructional features, testing and maintenance of different electric machines.
ii. Arrange a visit to nearby manufacturer of electrical machines such as motors/transformers
iii. Arrange expert lectures of design engineers working in nearby electric machine manufacturing companies.
iv. Give mini projects to students about design of simple machines.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Design and testing of electrical machines	Deshpande M. V.	Wheeler Publishing, latest edition
2.	Electrical Machine Design	Mittle V. N. & Mittal Arvind	TMH publications, latest edition
3.	Electrical Machine Design	Shawney A. K.	Dhanpatrai & sons. Pub, latest edition
4.	Electrical Estimating & Costing	Alagappan N. & Ekambaram S. (TTTI, Madras)	Tata McGraw hill Ltd., latest edition
5.	Electrical Estimating & Costing	Surjit Singh	Dhanpat Rai & sons, latest edition
6.	Electrical Design, Estimating & Costing	Raina K.B. & Bhattacharya S.K. (TTTI, Chandigarh)	Wiley Eastern Ltd., latest edition
7.	Electrical Installation, Estimating & Costing	Gupta J.B.	S. K. Kataria & Sons, latest edition
8.	Electrical Machine Design	Agrawal R. K.	S.K.Kataria & Sons, latest edition
9.	Electrical Machine Design	Sen. S. K.	Oxford Publications, latest edition
10.	Electrical Machine Design	Gray A.	McGraw Hill publications, latest edition

B) Major Equipment/ Instrument with Broad Specifications

i. AutoCAD Electrical software : Latest version
ii. MATLAB/SIMULINK : Latest version
iii. Electrical CAD software: Latest version
iv. Venire calipers: Suitable for measuring dimension of motor and transformer
v. Models Showing cross section of different types of motors and transformers.

C) List of Software/Learning Websites

i. www.nptel.iitm.ac.in
ii. www.youtube
iii. www.howstuffworks.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. H. C. Chawda**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad
- **Prof. R. N. Shah**, Lecturer in Electrical Engineering, Govt. Polytechnic Patan.

Coordinator and Faculty Members from NITTTR Bhopal

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