Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Fourth Year Bachelor of Engineering (Electrical Branch)

With effect from: Academic Year 2020-21

Subject Code: EE702-N	Subject Title: **Electrical Machine Design-I**

Course Objective:

- To present a problem oriented introductory knowledge of Economics and planning of Electrical Machine Design Engineering systems.
- To understand basic concepts of Electrical Design and costing of Electrical Engineering.

A. Teaching / Examination Scheme

Teaching scheme				Total Credit	Evaluation Scheme					Total Marks
L	T	P	Total		Theory		IE Marks	CIA Marks	Pract. Marks	
Hrs	Hrs	Hrs	Hrs		Hrs	Marks				
3	0	2	5	4	3	70	30	20	30	150

B. Outline of the Course

1.General Aspects for Design of Machines:

Main Dimensions , Electric and Magnetic Loading , Output Equation for DC Machines & AC Machines, Output coefficient , factor affecting size of machines , Choice of B_{av} & ac **,** Examples based on B_{av} & ac, Variation of Output and losses with Linear Dimensions, Separation of D & L.

2.Design of Transformers:

a.Construction Details:

Introduction, Types of transformers, position of HV and LV windings, core and yoke cross sectional area, Modern core Construction. Importance of mitered joints, Different types of transformers windings. Different methods for cooling of transformer, Different positions of Tappings and Tap Changing.

b.Design:

Output equation for 3 phase transformers, . Relation between emf per turn and transformer rating, Optimum Design of Transformer, Design of Core, Selection of Core area and type, window space factor, factors affecting window space factor, Selection of flux density and current density, Selection of windings, Design of Insulation, stacking factor, Window dimensions, Yoke dimensions and overall core dimension calculations, examples. Design of HV and LV windings (No. of turns and area of cross section).

c. Operating Characteristics:

Estimation of operating characteristics, Primary and secondary winding resistance. Leakage reactance calculation of only cylindrical coil with equal height, Leakage reactance of unequal windings and height, No load current calculations for 3 phase transformers. Temperature rise of transformer, design of tank with tubes, examples, calculation of dimension of tank, examples, Overall Design Problems.

d. Design of current Transformer

Introduction, construction Design principles OF C.T & P.T., winding design, Behavior of transformer under normal and abnormal condition.

3. Design of Three Phase Induction Motors

Output equation, Main Dimensions (D & L), Electric and Magnetic Loading (B_{av} & ac), separation of D & L, Stator winding design, Calculation of no. of turns per phase, conductor's area, shape of the stator slots, factors to be considered while deciding no of stator slots, Area of stator slots, stator winding resistance, stator teeth design, depth of the stator core, examples related to above topics, Length of the air gap.
Rotor design

a. Squirrel cage rotor – selection of no. of rotor slots, harmonic induction torque, Harmonic synchronous torque, vibration and noise, voltage ripples, rules for selecting no. of rotor slots, Methods for reducing harmonic torque, design of rotor bars and slots, calculation of rotor bar current, area of rotor bars, shape of rotor slots, examples, Design of end rings, Calculation of end rings current, cross-sectional area of end rings.

b. Design of wound rotor - calculation of number of rotor slots, no. of turns, cross sectional area of rotor conductors, types of rotor windings, Design of rotor core, examples. Estimation of operating characteristics- no load current calculation, short circuit current calculation, stator and rotor resistance and reactance calculation, examples, circle diagram, Dispersion coefficient – effect on maximum output power factor Performance calculation Design aspects for large size machine.

4. Design of Single Phase Motors:

Types of motors, Design of main dimensions, design of stator, Design of rotor, calculation of operating characteristic (rotor resistance, stator resistance, iron loss, friction and windage loss etc, Design of auxiliary winding, starting torque, circle diagram, design of capacitance for maximum torque.

C. Lesson Planning

SR No.	Lectures (Hours)	Weight-age in % in Exam	Topic
1	2	10	Main Dimensions, Electric and Magnetic Loading, Output Equation for DC Machines & AC Machines, Output coefficient.
2	3		factor affecting size of machines , Choice of B_{av} & ac **,** Examples based on B_{av} & ac, Variation of Output and losses with Linear Dimensions, Separation of D & L.
3	5	50	**Construction Details:** Introduction, Types of transformers, position of HV and LV windings, core and yoke cross sectional area, Modern core Construction. Importance of mitered joints, Different types of transformers windings. Different methods for cooling of transformer, Different positions of Tappings and Tap Changing.
4	8		**Design:** Output equation for 3 phase transformers, . Relation between emf per turn and transformer rating, Optimum Design of Transformer, Design of Core, Selection of Core area and type, window space factor, factors affecting window space factor, Selection of flux density and current density, Selection of windings, Design of Insulation, stacking factor, Window dimensions, Yoke dimensions and overall core dimension calculations, examples. Design of HV and LV windings (No. of turns and area of cross section).
5	6		**Operating Characteristics:** Estimation of operating characteristics, Primary and secondary winding resistance. Leakage reactance calculation of only cylindrical coil with equal height, Leakage reactance of unequal windings and height, No load current calculations for 3 phase transformers. Temperature rise of transformer, design of tank with tubes, examples, calculation of dimension of tank, examples, Overall Design Problems.
6	3		**Design of current Transformer** Introduction, construction Design principles OF C.T & P.T., winding design, Behavior of transformer under normal and abnormal condition.
7	4	30	**Design of Three Phase Induction Motors** Output equation, Main Dimensions (D & L), Electric and Magnetic Loading (B_{av} & ac), separation of D & L, Stator winding design, Calculation of no. of turns per phase, conductor's area, shape of the stator slots, factors to be considered while deciding no of stator slots, Area of

			stator slots, stator winding resistance, stator teeth design, depth of the stator core, examples related to above topics, Length of the air gap.
8	5		**Rotor design** A. Squirrel cage rotor – selection of no. of rotor slots, harmonic induction torque, Harmonic synchronous torque, vibration and noise, voltage ripples, rules for selecting no. of rotor slots, Methods for reducing harmonic torque, design of rotor bars and slots, calculation of rotor bar current, area of rotor bars, shape of rotor slots, examples, Design of end rings, Calculation of end rings current, cross-sectional area of end rings.
9	5		**Design of wound rotor** - calculation of number of rotor slots, no. of turns, cross sectional area of rotor conductors, types of rotor windings, Design of rotor core, examples. Estimation of operating characteristics- no load current calculation, short circuit current calculation, stator and rotor resistance and reactance calculation, examples, circle diagram, Dispersion coefficient – effect on maximum output power factor Performance calculation Design aspects for large size machine.
10	4	10	**Design of Single Phase Motors:** Types of motors, Design of main dimensions, design of stator, Design of rotor, calculation of operating characteristic (rotor resistance, stator resistance, iron loss, friction and windage loss etc, Design of auxiliary winding, starting torque, circle diagram, design of capacitance for maximum torque.
	45	100	

D. Term Work:

- Design of three phase transformer
- Drawing sheet of three phase transformer
- Design of 3-phase Induction Motor
- Design of 1-phase Induction motor
- Drawing Sheet Induction Motor components.
- Tutorial on General aspects and C.T, P.T.

E. Instructional Method & Pedagogy

- At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.
- Attendance is compulsory in lectures, which may carries five marks in overall evaluation.
- One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.

- Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
- Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

F. Students Learning Outcomes

On successful completion of the course

- The student can be acquired the basic knowledge of Economics and planning of Electrical Design.
- The students will be able to effectively employ electrical systems and lead the exploration of new applications and techniques for their use by design Implementation**.**

Reference Books:

1. Electrical Machine Design by A. K. Sawhney, Dhanpat Rai & sons. Pub.
2. Electrical Machine Design by R. K. Aggrawal.
3. Electrical Machine Design by V. N. Mittle, TMH publications.
4. Electrical Machine Design by S. K. Sen, Oxford Publications.