COURSE TITLE	**ELECTRICAL MACHINE DESIGN**
COURSE CODE	**01EE1704**
COURSE CREDITS	**4**

Objective:

1 To develop knowledge on principles of design of static and rotating machines with application of Computer Aided Design of Electrical Machines and FEA software

Course Outcomes: After completion of this course, student will be able to:

1 Select the appropriate material for a given component of an electrical machine and justify the choice based on its properties.

2 Determine the dimensions and parameters of a three-phase transformer based on specifications.

3 Validate the final design specifications for rotating machines by interpreting the influence of design factors and operational constraints on cost, size, and overall performance

4 Simulate advanced electrical machines using Finite Element Analysis tool.

Pre-requisite of course: Basic Electrical Engineering, Electrical Machines - I & II

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**PRINCIPLES AND DESIGN OF ELECTRICAL MACHINES** Fundamental aspects of Electrical machine design, Brief study of magnetic, electric, dielectric and other materials, Modes of heat dissipation, Ambient temperature, hot spot temperature, cooling of rotating machines, types of duties and ratings of rotating machines.	4
2	**DESIGN OF TRANSFORMER** Design of distribution and power transformers, Types, Classification and specifications, Design and main dimensions of core, yoke, winding, tank (with or without cooling tubes) and cooling tubes, Estimation of leakage reactance, resistance of winding, No-load current, Losses, Voltage regulation and efficiency, Mechanical force developed during short circuits, Testing of transformers as per I.S.S., Numerical examples	12

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Contents : Unit	Topics	Contact Hours
3	**DESIGN OF THREE PHASE INDUCTION MOTOR** MAIN DIMENSIONS: Output equation, choice of specific loadings, separation of D and L, STATOR DESIGN: Stator winding design, Calculation of no. of turns per phase, Conductor's area, Shape of the stator slots, Area of stator slots, Stator teeth design, Depth of the stator core, Length of air gap, ROTOR DESIGN: Squirrel cage rotor – Selection of no. of rotor slots, Effect of harmonics and choice of rotor slots to minimize harmonics, vibration, noise and voltage ripples, Rules for selecting no. of rotor slots, Methods for reducing harmonic torque, Design of rotor bars and rotor slots. Design of end rings and rotor core, Wound rotor - Calculation of number of rotor slots, Number of turns, Cross-sectional area of rotor conductors, Types of rotor windings, Check for rotor tooth density, Design of rotor slot and rotor core, PERFORMANCE PARAMETERS EVALUATION: No load current calculation, Stator and rotor resistance and reactance calculation, Circle diagram, Dispersion coefficient – effect on maximum output power factor, Design aspects for large size machine, High voltage machine, High speed machine. Design of submersible motors	14
4	**DESIGN OF SYNCHRONOUS MACHINE** Output equation and design of main dimensions, Short Circuit Ratio (SCR) and its significance, Harmonics reduction	4
5	**COMPUTER AIDED DESIGN OF ELECTRICAL MACHINE** Difference between analytical analysis and numerical analysis, Overview of FEM, historical background, general applicability of the method,, Engineering applications of FEM, General description of FEM, Derivation of FE equations using direct approach, Solutions using finite element software	4
6	**DESIGN OF SPECIAL MACHINES** Design principle of SRM, BLDC etc	4
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment-1** Design of distribution transformer without cooling tubes	4
2	**Experiment-2** Design of power transformer with cooling tubes	4
3	**Experiment-3** Design of three phase squirrel cage induction motor	4
4	**Experiment-4** Design of three phase slip ring induction motor	2
5	**Experiment-5** Design of high-speed non-salient pole alternator (Turbo-alternator)	4

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
6	**Experiment-6** Design of salient pole low speed alternator (Hydro- Alternator)	2
7	**Experiment-7** Design of submersible motor	2
8	**Experiment-8** Practice problems on open-source software (FEMM)	2
9	**Experiment-9** Performance parameters evaluation using FEM software	2
10	**Experiment-10** Design of special purpose motor for specified application	2
Total Hours		**28**

Textbook :

1 A Course in Electrical Machine Design, A. K. Sawhney, Dhanpat Rai and Sons, 2016

2 The Performance and Design of Alternating Current Machines, M.G. Say, CBS publishers and Distributors Pvt. Ltd., 2005

References:

1 Principles of Electrical Machine Design - 5th edition, Principles of Electrical Machine Design - 5th edition, R. K. Agrawal, S.K. Kataria & Sons, 2024

2 Design Of Electrical Machines - 6th Revised Edition, Design Of Electrical Machines - 6th Revised Edition, V. N. Mittle, Standard Publishers Distributors, 2018

3 Design and Testing of Electrical Machines - 3rd edition, Design and Testing of Electrical Machines - 3rd edition, M. V. Deshpande, PHI Learning Pvt. Ltd., 2009

4 Electrical Machine Analysis Using Finite Elements - 1st Edition, Electrical Machine Analysis Using Finite Elements - 1st Edition, Nicola Bianchi, CRC Press, 2005

5 Electrical Machine Design Data Book - 2nd edition, Electrical Machine Design Data Book - 2nd edition, A. Shanmugasundarm, G,Gangadharam, R.Palani, New Age Publishers, 2018

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	25.00	25.00	10.00	10.00

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Instructional Method:

1. The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs, etc.
2. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom
3. Practical examinations will be conducted at the end of the semester to evaluate the performance of students in the laboratory.
4. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, and Virtual Laboratory

Supplementary Resources:

1. https://nptel.ac.in/courses/108/102/108102146/
2. https://www.coursera.org/specializations/introduction-to-electricity-magnetism
3. https://nptel.ac.in/courses/108/102/108102156/
4. http://www.femm.info
5. www.vlab.co.in

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