SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology

B. Tech. Semester VII	
Subject Name: Electrical Machine Design	**Subject Code: BTEL10701**
Type of course:	Professional Core Course
Prerequisite:	Elements of Electrical Engineering, Electrical Machines, Elements of Electrical Design
Rationale:	Electrical machines serve as the backbone for the electrical power sector. The knowledge of electrical machines design is essential for manufacturing as well as the pre-installation performance analysis. The design is also essential for the practicing engineers in the research and development field. This subject deals with design of electrical machines including basics of computer aided design.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**GENERAL DESIGN ASPECTS:** Major considerations in electrical machine design, Electrical engineering materials, Main Dimensions, Specific electric loading and Specific magnetic loading; Output coefficient; Output equations of transformers and rotating machines; Factors affecting size of machines; Criteria for selection of specific loadings; Rating of Machines.	5	10

ESC: Engineering Science Course

2.	**DESIGN OF THREE PHASE TRANSFORMER:** Types of transformers; Position of HV and LV windings and its importance; Relation between core and yoke cross section area and its significance; Different types of transformer windings; Different positions of tapping; kVA output for single-phase and three-phase transformers, Window space factor; Factors affecting window space factor; Relation between emf per turn and transformer rating; Stacking factor. MAIN DIMENSIONS**:** Design of window dimensions, yoke dimensions and overall core dimensions; Numerical examples. DESIGN OF WINDINGS**:** Design of HV and LV windings (No. of turns and area of cross section); Selection of type of winding. Numerical examples, Methods for cooling of transformers.	**10**	**25**
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, Numerical problems related to above topics. ROTOR DESIGN: A. 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. B. 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, Numerical problems based on above topics.	**12**	**25**

ESC: Engineering Science Course

4.	**DESIGN OF SYNCHRONOUS MACHINE:** Types of Synchronous Machines, Prime movers for Synchronous Generators, Run-away speed, Construction of Hydro-generators & Turbo-alternators, Output equation and design of main dimensions, Short Circuit Ratio (SCR) and its significance, Length of air gap and shape of pole face. ARMATURE DESIGN: Armature winding (Single layer and double layer), Number of armature slots, Slot dimensions, Length of mean turn, Calculation of armature resistance and reactance. DESIGN OF FIELD SYSTEM: Design of magnetic circuit, Open circuit characteristic, Determination of full load field MMF, Design of field winding, Determination of direct and quadrature axis synchronous reactance, Short circuit characteristics.	12	**25**
5.	**COMPUTER APPLICATION IN ELECTRICAL MACHINE DESIGN:** Computer-aided Design of Three-phase Transformer, Three-phase Induction Motor & Synchronous Machines – Flow chart & Program code in C-language. Introduction to FEM, Application of FEM technique for design	6	**15**

ESC: Engineering Science Course

	problems. Use of open source FEM software for 2D design. Computation of performance parameters of machine using FEM software.		

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**20**	**30**	**25**	**10**	**-**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's 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.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	A Course in Electrical Machine Design	A. K. Sawhney	Dhanpat Rai and Sons	2006	6th Edition
2.	Principles of Electrical Machine Design	R. K. Agarwal	S. K. Kataria and Sons	2014	5th Edition
3.	Design of Electrical machines	V. N. Mittle	Standard Publishers Distributors	2009	5th Edition
4.	Computer Aided Design of Electrical Machines	K. M. V. Murthy	B.S. Publications	2008	1st Edition
5.	Electrical Machine Analysis using Finite Elements	Nicola Bianchi	Taylor and Francis	2005	1st Edition
6	Electrical machines and equipment design exercise examples usingAnsoft's Maxwell 2D machine design package				

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	*Select appropriate design parameters according to applications and rating of electrical machines.*	10
CO-2	*Design the Three-phase transformers of given specifications.*	20
CO-3	*Design the Three-phase Induction motor of given specifications.*	20
CO-4	*Design the Synchronous machines of given specifications.*	20
CO-5	*Prepare the detailed sketches of the designed machine.*	10
CO-6	*Formulate the optimum design problem and solve it with computer aided tools.*	20

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3	2	1	2	2	2	2	2	3		2
CO-2	3	3	3	3	3	2	1	2	2	2	2	2	3	3	2
CO-3	3	3	3	3	3	2	1	2	2	2	2	2	3	3	2
CO-4	3	3	3	3	3	2	1	2	2	2	2	2	3	3	2
CO-5	3	2	2	3	1	2	2	2	2	2			3	2	3
CO-6	3	3	3	3	3	2	1	2	2	3	2	2	3	3	3
Rationale*															

LIST OF PRACTICALS:

1. Electrical machine design problems should be given for practice to the students. At least 8-10 design problems with different ratings should be practiced by the students

2. Computer aided design problems 3-4 should be practiced by the students

3. 2D visualization of various electrical machine components should be demonstrated to students during lab sessions using open source softwares like FEMM etc.

Major Equipment:

1. Charts and cut section models of various electrical machines, CAD software like FEMM, ANSYS etc.

List of Open Source/learning website:

- E-materials available at the website of NPTEL- http://nptel.ac.in/

ESC: Engineering Science Course