Ref No:

Sri Krishna Institute of Technology
Bengaluru-560090

COURSE PLAN

Academic Year - 2019-2020

Program:	B E – Electrical&Electronics Engineering
Semester :	6
Course Code:	17EE64
Course Title:	Electrical Machine Design
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	SHWETA B

Academic Evaluation and Monitoring Cell

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Table of Contents

Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EE
Semester:	6	Academic Year:	2019-20
Course Title:	Electrical Machine Design	Course Code:	17EE64
Credit / L-T-P:	4 / 4-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	50 Hours	SEE Marks:	60 Marks
CIA Marks:	40 Marks	Assignment	1 / Module
Course Plan Author:	Shweta B	Sign ..	Dt:
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : 64%	SEE Target:	94%

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Fundamental Aspects of Electrical Machine Design:** Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques. **Electrical Engineering Materials:** Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.	10	Fundamental aspects Electrical Engineering materials	L2 Understand L2 Understand
2	**Design of DC Machines:**Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.	10	Armature Dimensions Design Field winding Design	L4 Analyze L4 Analyze
3	**Design of Transformers:** Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.	10	Main dimensions Design performance parameters	L4 Analyze L3 Apply
4	**Design of Three Phase Induction Motors:** Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.	10	Main dimensions Design Rotor design	L4 Analyze L4 Analyze
5	**Design of Three Phase Synchronous Machines:** Output	10	Stator Design	L4

	Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.		Rotors Design	Analyze L4 Analyze
-	**Total**	**50**	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1-5	A course in Electrical Machine design, A.K.Sawhney,DhanpatRai ,6 th Edition, 2013	1,2,5,9, 10 and 11	In Lib / In Dept
			In Lib/ In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
	Performance and Design of Alternating Current Machine ,M.G. Say ,CBS Publisher ,3 rd Edition, 2002		In Lib
1-5	Design Data Handbook ,A. Sanmugasundaram Et al ,New Age International,1 st Edition, 2011 .	2,4,5,7	In Lib
			In lib
C	**Concept Videos or Simulation for Understanding**	-	-
C3	Armature Design: https://www.youtube.com/watch?v=1OfLgpFq6Rc&list=PLLQiBbMXygz5TcorunVq3wQB4sOTkB8lt		
C4	Field Design https://www.youtube.com/watch?v=Z9W0F9I6R2k&list=PLLQiBbMXygz5TcorunVq3wQB4sOTkB8lt&index=3		
C5	Main Dimensions Design https://www.youtube.com/watch?v=XZMArOR7u1g		
C6	Performace Parameters: https://www.youtube.com/watch?v=XZMArOR7u1g		
C7	Stator Desgn: https://www.youtube.com/watch?v=dZyO5gcWP-o&list=PLLQiBbMXygz7zALKpbP87g4QaS9YGesZ5		
C8	Rotor Design: https://www.youtube.com/watch?v=GayRzjl_imk&list=PLLQiBbMXygz7zALKpbP87g4QaS9YGesZ5&index=4		
C9	Stator Design: https://www.youtube.com/watch?v=b24jORRoxEc&list=PLLQiBbMXygz7zALKpbP87g4QaS9YGesZ5&index=5		
C10	Rotor Design: https://www.youtube.com/watch?v=b24jORRoxEc&list=PLLQiBbMXygz7zALKpbP87g4QaS9YGesZ5&index=5		
	Lab : https://www.youtube.com/watch?v=P9e7hUNPGVs -		
D	**Software Tools for Design**	-	-
E	**Recent Developments for Research**	-	-
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
1			

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
2,3,4,5	17EE33	Transformerand Generator	1. Complete syllabus	3		L3
3,4,5	17EE44	Electric motors	2. Complete syllabus	4		L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
1				
3				
3				

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	17EE64.1	Understand the fundamental aspects of machine design.	5	Fundamental Aspects	Lecture	Assignment Unit Test & IA	L2 Understanding
1	17EE64.2	Understand the desirability of engineering material	5	Electrical Engineering materials	Lecture	Assignment Unit Test & IA	L2 Understanding
2	17EE64.3	Design of armature of DC machines.	6	Armature Design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
2	17EE64.4	Design of field windings of DC machines.	4	Field windings design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
3	17EE64.5	Design of core, field winding and tank of transformer.	7	Main Dimensions Design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
3	17EE64.6	Analyze the performance of transformer	3	Performance Parameters	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
4	17EE64.7	Design of stator of induction motor.	6	Stator Design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
4	17EE64.8	Design of rotor of induction motor.	4	Rotor Design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
5	17EE64.9	Design of stator of synchronous machines.	6	Stator Design	Lecture &	Assignment Unit Test &	L4 Analyze

					PPT	IA	
5	17EE64.10	Design of rotor of synchronous machines.	4	Rotor Design	Lecture & PPT	Assignment Unit Test & IA	L4 Analyze
-	-	**Total**	**54**	-	-	-	**L2-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Wires for magnet coils and windings of machines, laminations	CO1	L2
1	Transformer and rotating electrical machines design	CO2	L2
2	DC Generators - generation of power in small back up & standby generating plants, mini hydro-electric plants	CO3	L4
2	DC Motors – traction system, drives for process industries, battery driven vehicle, machine tools, appliances, automatic control	CO4	L4
3	Isolate two circuits, impedance matching	CO5	L4
3	Step up and step down the voltage level in generation, transmission and distribution	CO6	L4
4	Electric train engine, Printing machines.	CO7	L4
4	Chimneys at power plants, irrigation.	CO8	L4
5	Generation of power	CO9	L4
5	Paper mills, constant speed motor and it is used as reactive power control in large power systems	CO10	L4

3. Mapping and Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required accomplishing it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	2	Apply the Knowledge of fundamental aspects of electrical machinein design of electrical machines.	L2
1	CO2	PO1	2	Apply the Knowledge of electrical engineering materials in design of electrical machines.	L2
2	CO3	PO1	2	Apply the knowledge of construction of armature in designing of armature DC machine.	L2
2	CO3	PO2	2	Analysis of design of armature requires working of armature of DC machine.	L4
2	CO3	PO3	2	Design of armature is a part of DC machine design	L4
2	CO4	PO1	2	Apply the knowledge of construction of field winding in designing of field winding.	L2
2	CO4	PO2	2	Analysis of design of field winding requires working of field winding of DC machine.	L4
2	CO4	PO3	2	Design of armature is a part of DC machine design	L4
3	CO5	PO1	2	Apply the knowledge of construction of core and winding in design of transformer.	L2
3	CO5	PO2	2	Analysis of design of core and winding requires working of transformer.	L4
3	CO5	PO3	2	Design of core and winding is a part of transformer design	L4
3	CO6	PO1	2	Apply the knowledge of voltage regulation in design of transformer	L2
3	CO6	PO2	2	Analysis of problem in designing of transformer requires knowledge of voltage regulation.	L4
4	CO7	PO1	2	Apply the knowledge of construction of stotor in design of	L2

				induction motor.	
4	CO7	PO2	2	Analysis of design of stator requires working of stator of induction motor.	L4
4	CO7	PO3	2	Design of statoris a part of induction motor design.	L4
4	CO8	PO1	2	Apply the knowledge of construction of rotor in design of induction motor .	L2
4	CO8	PO2	2	Analysis of design of rotor requires working of rotor of induction motor.	L4
4	CO8	PO3	2	Design of rotor is a part of induction motor design	L4
5	CO9	PO1	2	Apply the knowledge of construction of stator in design of synchronous machine.	L2
5	CO9	PO2	2	Analysis of design of stator requires working of stator of synchronous machine.	L4
5	CO9	PO3	2	Design of stator is a part of synchronous machine design.	L4
5	CO10	PO1	2	Apply the knowledge of construction of rotor in design of synchronous machine .	L2
5	CO10	PO2	2	Analysis of design of rotor requires working of rotor of synchronous machine.	L4
5	CO10	PO3	2	Design of rotor is a part of synchronous machine design.	L4

4. Articulation Matrix

CO – PO Mappingwith mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	Level
1	17EE64.1	Understand the fundamental aspects of machine design.	2															L2
1	17EE64.2	Understand the desirability of engineering material	2															L2
2	17EE64.3	Design of armature of DC machines.	2	2	2													L4
2	17EE64.4	Design of field windings of DC machines.	2	2	2													L4
3	17EE64.5	Design of core, field winding and tank of transformer.	2	2	2													L4
3	17EE64.6	Analyze the performance	2	2	2													L4

		of transformer																
4	17EE64.7	Design of stator of induction motor.	2	2	2													L4
4	17EE64.8	Design of rotor of induction motor.	2	2	2													L4
5	17EE64.9	Design of stator of synchronous machines.	2	2	2													L4
5	17EE64.10	Design of rotor of synchronous machines.	2	2	2													L4
-	**CS501PC**	**Average attainment (1, 2, or 3)**																**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Content

Topics &contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

6. Content beyond Syllabus

Topics &contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1						
1						

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Fundamental Aspects of Electrical Machine Design	10	2	-	-	1	1	2	CO1, CO2	L2, L2
2	Design of DC Machines	10	2	-	-	1	1	2	CO3, CO4	L4, L4
3	Design of Transformers	14	-	2	-	1	1	2	CO5, CO6	L4, L4
4	Design of Three Phase Induction Motors	10	-	2	-	1	1	2	CO7, C08	L4, L4
5	Design of Three Phase Synchronous Machines	10	-	-	4	1	1	2	CO9, CO10	L4, L4
-	**Total**	**54**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2.Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	15	CO1, CO2, CO3,Co4	L2, L2, L4, L4
3, 4	CIA Exam – 2	15	CO5, CO6, CO7,Co8	L4, L4, L4, L4
5	CIA Exam – 3	15	CO9, CO10	L4, L4
1, 2	Assignment - 1	05	CO1, CO2, CO3,Co4	L2, L2, L4, L4
3, 4	Assignment - 2	05	CO5, CO6, CO7,Co8	L2, L4, L2, L4
5	Assignment - 3	05	CO9, CO10	L4, L4
1, 2	Seminar - 1		-	-
3, 4	Seminar - 2		-	-
5	Seminar - 3		-	-
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-	CO9, CO10	L2,L2
	Final CIA Marks	**20**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	**1. Fundamental Aspects of Electrical Machine Design** **2. Electrical Engineering Materials**	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the fundamental aspects of machine design.	CO1	L2
2	Understand the desirabilities of engineering material	CO2	L2
b	***Course Schedule***		-
Class No	**Module Content Covered**	**CO**	**Level**
1	Design of Machines, Design Factors	C01	L2
2	Limitations in design	CO1	L2
3	Modern Trends in design, manufacturing Techniques.	CO1	L2
4	Desirabilities of Conducting Materials	CO2	L2
5	Comparison of Aluminium and Copper wires.	CO2	L2
6	Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials	CO2	L2
7	Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel.	CO2	L2
8	Insulating Materials: Desirable Properties	CO2	L2
9	Temperature Rise and Insulating Materials	CO2	L2
10	Classification of Insulating materials based on Thermal Consideration.	CO2	L2
c	**Application Areas**	**CO**	**Level**
1	Wires for magnet coils and windings of machines, laminations	CO1	L2
2	Transformer and rotating electrical machines design	CO2	L2
d	**Review Questions**	-	-
1	What are the considerations to be made while designing a electrical machines?	C01	L2
2	List some limitation of the design.	C01	L2
3	What are the factors that decide the choice of specific magnetic loading?	C01	L2
4	What are the major considerations to evolve a good design of electrical	C01	L2

	machine?		
5	What are the fundamental requirements of high conductivity materials?	C02	L2
6	Why hard drawn copper wires are used in electrical machines?	C02	L2
7	What are the types of magnetic materials? Give examples	C02	L2
8	What is CRGO steel? what are its uses?	C02	L2
9	Discuss briefly about electrical properties of insulating materials.	C02	L2
10	What are the classifications of insulating materials?give examples.	C02	L2
11	Which insulating material is used in modern electric machines?	C02	L2
12	Write a short note on insulating materials for transformer.	C02	L2
e	**Experiences**	-	-
1			
2			
3			
4			

Module – 2

Title:	**Design of DC Machines**	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design of armature of DC machines.	CO3	L4
2	Design of field windingof DC machines.	CO4	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Output Equation	CO3	L4
2	Choice of Specific Loadings and Choice of Number of Poles	CO3	L4
3	Main Dimensions of armature	CO3	L4
4	Main Dimensions of armature	CO3	L4
5	Design of Armature Slot Dimensions	CO3	L4
6	Design of Commutator and Brushes	CO3	L4
7	Estimation of Ampere Turns for the Magnetic Circuit.	CO4	L4
8	Dimensions of Yoke, Main Pole and Air Gap.	CO4	L4
9	Design of Shunt and Series Field Windings.	CO4	L4
10	Design of Shunt and Series Field Windings.	CO4	L4
c	**Application Areas**	**CO**	**Level**
1	DC Generators - generation of power in small back up & standby generating plants, mini hydro-electric plants	CO3	L4
2	DC Motors – traction system, drives for process industries, battery driven vehicle, machine tools, appliances, automatic control	CO4	L4
d	**Review Questions**	-	-
1	Explain the concept of determining the temperature gradients in conductors placed in slots. What are the limitations of design of electrical apparatus? Explain them.	CO3	L4
2	Define the terms specific electric loading and specific magnetic loading as applied to electrical machines. What are the considerations in the choice of these for D.C machines?	CO3	L4
3	Explain the real and apparent flux densities. Discuss about the various leakage fluxes.	CO3	L4
4	Discuss quantitatively the effects of slots and ventilating ducts upon the reluctance of the air gap of a D.C machine.	CO3	L4
5	Draw the magnetic circuit of a D.C machine. Derive an expression for the total	CO3	L4

	mmf per pole.		
6	What are the major groups of electrical conducting materials? Describe the properties and applications of those materials.	CO3	L4
7	Describe the methods of measurement of temperature rise in various parts of an electrical machine.	CO3	L4
8	Explain in detail the various cooling methods of electrical machines.	CO3	L4
9	What is the relation between the power developed in armature and the power output in the dc machine?	CO3	L3
10	Write the output equation of a dc machine.	CO3	L3
11	What is the range of specific magnetic loading in a dc machine?	CO3	L2
12	What are the factors to be considered for the choice of specific magnetic loading?	CO3	L2
13	What is the range of specific electric loading in dc machine?	CO4	L3
14	What are the factors to be considered for the choice of specific electric loading?	CO4	L4
15	What is the purpose of constructing the pole body by laminated sheets?	CO3	L4
16	What are the factors to be considered for the selection of number of poles in dc machine?	CO3	L4
17	List the advantages of large number of poles.	CO3	L3
18	List the disadvantages of large number of poles	CO3	L3
19	Why square pole is preferred?	CO3	L4
20	Mention guiding factors for the selection of number of poles	CO3	L2
21	What are the advantages of large length of air gap in dc machine?	CO3	L2
22	What are the factors to be considered for estimating the length of air gap in dc machine?	CO3	L4
23	Mention the factors governing the choice of number of armature slots in a dc machine.	CO3	L4
24	What is the purpose of slot insulation?	CO3	L4
25	What are the factors to be considered for deciding the slot dimensions?	CO3	L4
26	What factor decides the minimum number of armature coils?	CO3	L4
27	Mention the two types of winding used in the dc machines.	CO3	
28	What is meant by equalizer connections?	CO4	L4
29	What is the length of mean turn of filed coil?	CO4	L4
30	Mention the factors to be considered for the design of shunt field coil?	CO4	
31	Discuss the parameters governing the length of commutator.	CO4	L4
32	What are the factors that influence the choice of commutator diameter?	CO4	L4
33	What is the need for brushes in dc machine?	CO4	L2
34	What are the materials used for brushes in dc machines?	CO4	L4
35	What are the effects of armature reaction?	CO4	L2
36	What is meant by magnetic circuit calculations.	CO4	L2
37	Discuss the total design steps of D.C.machines. Briefly describe each step	CO4	L2
e	**Experiences**	-	-
1			
2			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	17EE64	Sem:	6	Marks:	30	Time:	75 minutes
Course:	Electrical Machine Design						

-	-	Note: Answer any 3 questions, each carry equal marks.	Marks	CO	Level
1	a	List the recognized classes of insulating materials and the temperature assigned to them. Mention at least two examples for each type.	7	C01	L2
	b	What are the major considerations accounted for the good design of electrical machines? What are the factors those limit the design of a	8	C01	L2

		machine?			
		OR			
2	a	Make a brief comparison chart between copper and aluminium when used in electrical machine windings. Discuss briefly about electrical properties of insulating materials.	8	C02	L2
	b	What is CRGO steel? What are its uses? Explain briefly with the help of directional properties of CRGO transformer steel.	7	C02	L2
3	a	With usual notations derive the output equation of a D.C machines. Mention the various factors that affect the choice of number of poles of a D.C machine.	9	C03	L3
	b	A 5KW, 250V, 4 pole, 1500rpm shunt generator is designed to have a square pole face. The loadings are average flux density in the air gap = 0.42wb/m^2, ampere conductors /meter = 15000. Find the main dimensions of the machine. Assume full load efficiency = 0.87 and ratio of pole arc to pole pitch is 0.66.	6	C03	L4
		OR			
4	a	Define specific loadings and discuss in brief the factors influencing the choice of specific electric and magnetic loadings in D.C machines.	8	C04	L3
	b	Calculate the diameter and length of armature for a 7.5kw, 4pole, 1000rpm, 220v shunt motor. **Given:** full load efficiency = 0.83; maximum gap flux density = 0.9Wb/m^2; specific electric loading =30000ampere conductors per meter; field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the fie3ld current is 2.5% of rated current. The pole face is square.	7	C03	L4

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EE64	Sem:	6	Marks:	5	Time:	90 – 120 minutes
Course:	Electrical Machine Design						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001	What are the considerations to be made while designing a electrical machines?	7	C01	L2
2	1KT16EE003	List some limitation of the design.	5	C01	L2
3	1KT16EE004	What are the factors that decide the choice of specific magnetic loading?	8	C01	L3
4	1KT16EE006	What are the major considerations to evolve a good design of electrical machine?	5	C01	L3
5	1KT16EE007	What are the fundamental requirements of high conductivity materials?	5	CO2	L2
6	1KT16EE011	Why hard drawn copper wires are used in electrical machines?	5	CO2	L3
7	1KT16EE013	What are the types of magnetic materials? Give examples	8	CO2	L3
8	1KT16EE014	What is CRGO steel? what are its uses?	6	CO2	L3
9	1KT16EE016	Discuss briefly about electrical properties of insulating materials.	6	CO2	L3
10	1KT16EE017	What are the classifications of insulating materials?give examples.	8	CO2	L3
11	1KT16EE020	Which insulating material is used in modern electric machines?	8	CO2	L3
12	1KT16EE021	Write a short note on insulating materials for transformer.	5	CO2	L3
13	1KT16EE023	Explain the real and apparent flux densities. Discuss about the various leakage fluxes.	6	CO3	L3
14	1KT16EE025	Discuss quantitatively the effects of slots and ventilating ducts upon the reluctance of the air gap of a D.C machine.	7	CO3	L3
15	1KT16EE026	Draw the magnetic circuit of a D.C machine. Derive an expression for the total mmf per pole.	8	CO3	L3
16	1KT16EE005	What are the major groups of electrical conducting materials? Describe the properties and applications of those materials.	7	CO3	L3

17	1KT16EE019	Describe the methods of measurement of temperature rise in various parts of an electrical machine.	5	CO3	L3
18	1KT14EE030	Explain in detail the various cooling methods of electrical machines.	8	CO3	L3
19	1KT14EE034	What is the relation between the power developed in armature and the power output in the dc machine?	5	CO3	L3
20	1KT15EE011	Write the output equation of a dc machine.	5	CO3	L4
21	1KT15EE013	What are the factors to be considered for estimating the length of air gap in dc machine?	5	CO3	L4
22	1KT15EE015	Mention the factors governing the choice of number of armature slots in a dc machine.	8	CO3	L4
23	1KT15EE017	Mention the factors to be considered for the design of shunt field coil?	6	CO3	L4
24	1KT16EE402	Discuss the parameters governing the length of commutator.	6	CO3	L4
25	1KT16EE404	What are the factors that influence the choice of commutator diameter?	8	CO3	L4
26	1KT16EE410	What is the need for brushes in dc machine?	8	CO3	L4
27	1KT16EE001	What are the materials used for brushes in dc machines?	5	CO3	L4
28	1KT16EE003	What are the effects of armature reaction?	6	CO3	L3
29	1KT16EE004	What is meant by magnetic circuit calculations.	7	CO3	L3
30	1KT16EE006	Discuss the total design steps of D.C.machines. Briefly describe each step	8	CO3	L2
31	1KT16EE007	What are the advantages of large length of air gap in dc machine?	7	CO3	L2
32	1KT16EE011	What are the factors to be considered for estimating the length of air gap in dc machine?	5	CO3	L3
33	1KT16EE013	Mention the factors governing the choice of number of armature slots in a dc machine.	8	CO3	L4
34	1KT16EE014	What is the purpose of slot insulation?	5	CO3	L4
35	1KT16EE016	What are the factors to be considered for deciding the slot dimensions?	5	CO3	L4
36	1KT16EE017	What factor decides the minimum number of armature coils?	5	CO3	L3
37	1KT16EE020	Mention the two types of winding used in the dc machines.	8	CO3	L3
38	1KT16EE021	What is meant by equalizer connections?	6	CO3	L4
39	1KT16EE023	What is the length of mean turn of filed coil?	6	CO3	L2
40	1KT16EE025	Mention the factors to be considered for the design of shunt field coil?	8	CO3	L2
41	1KT16EE026	What are the factors to be considered for estimating the length of air gap in dc machine?	8	CO3	L4
42	1KT16EE005	Mention the factors governing the choice of number of armature slots in a dc machine.	5	CO4	L4
43	1KT16EE019	What is the purpose of slot insulation?	6	CO4	L4
44	1KT14EE030	What are the factors to be considered for deciding the slot dimensions?	7	CO4	
45	1KT14EE034	Mention guiding factors for the selection of number of poles	8	CO4	L4
46	1KT15EE011	Explain the concept of determining the temperature gradients in conductors placed in slots. What are the limitations of design of electrical apparatus? Explain them.	7	CO4	L4
47	1KT15EE013	Define the terms specific electric loading and specific magnetic loading as applied to electrical machines. What are the considerations in the choice of these for D.C machines?	7	CO4	L4
48	1KT15EE015	Mention guiding factors for the selection of number of poles	5	CO4	L4
49	1KT15EE017	Explain the concept of determining the temperature gradients in conductors placed in slots. What are the limitations of design of electrical apparatus? Explain them.	8	CO4	L4
50	1KT16EE402	What are the factors to be considered for deciding the slot dimensions?	5	CO4	L2
52	1KT16EE404	What factor decides the minimum number of armature coils?	5	CO4	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	Design of Transformers	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design of core, field winding and tank of transformer.	CO5	L4
2	Analyze the performance of transformer	CO6	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Output Equations of Single Phase and Three Phase Transformers	CO5	L4
2	Choice of Specific Loadings, Expression for Volts/Turn,	CO5	L4
3	Determination of Main Dimensions of the Core	CO5	L4
4	Determination of Main Dimensions of the Core	CO5	L4
5	Determination of Main Dimensions of the Core	CO5	L4
6	Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings	CO5	L4
7	No Load Current.	CO6	L3
8	Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation.	CO6	L3
9	Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation.	CO6	L3
10	Design of Tank and Cooling (Round and Rectangular) Tubes.	CO6	L3
c	**Application Areas**	**CO**	**Level**
1	Isolate two circuits, impedance matching	CO5	L4
2	Step up and step down the voltage level in generation, transmission and distribution	CO6	L4
d	**Review Questions**	-	-
1	What are the various types ofTransformers?	CO5	L2
2	Derive an expression of leakage reactance of a transformer with primary and secondary coils of equal length.	CO5	L2
3	Explain the determination of temperature rise in a transformer with plain walled tank and the transformer with tank with oil tubes and the determination of number of oil tubes required.	CO5	L2
4	Derive the equation for calculation of no load current of single phase transformer.	CO5	L2
5	What is the range of efficiency of transformers?	CO5	7
6	What are distribution transformers?	CO5	5
7	What are power transformers?	CO5	8
8	Distinguish between core and shell type transformer.	CO5	5
9	What are the advantages of shell type transformer over core type transformers?	CO5	5
10	In transformers, why the low voltage winding placed near the core?	CO5	5
11	What is window space factor?	CO5	8
12	Write down the output equation for the1phase and 3 phase transformer.	CO5	6
13	How will you select the emf per turn of a transformer?	CO5	6
14	Why circular coils are preferred in transformers?	CO5	8
15	What are the advantages of stepped cores?	CO5	8
16	What are the disadvantages of stepped cores?	CO5	5
17	What do you meant by stacking factor (iron space factor)?	CO5	6
18	What are the factors to be considered for choosing the type winding for a core type transformer?	CO5	7

19	List some methods of cooling of transformers.	CO5	8
20	What are the factors to be considered for choosing the method of cooling?	CO5	L3
21	How the heat dissipates in a transformer?	CO6	L2
22	Why transformer oil is used as a cooling medium?	CO6	L4
23	Why cooling tubes are provided?	CO6	L2
24	How the heat dissipation is improved by providing the cooling tubes?	CO6	L2
25	What is a breather?	CO6	L2
26	Why silica gel is used in breather?	CO6	L4
27	What is conservator?	CO6	L3
28	How the leakage reactance of the transformer is reduced?	CO6	L2
29	Discuss the importance of the choice of value of k= √ 4.44 f (m /AT) x 10 3 in a transformer design with respect to, type, service conditions, cost and losses.	CO6	L4
30	Calculate the proportions of the cruciform section of minimum area for the core of a transformer. Show that the gross area of a core of a cruciform section is 79% of the area of the circum circle.	CO6	L4
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 4

Title:	**Design of Three Phase Induction Motors**	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design of stator of induction motor.	CO7	L4
2	Design of rotor of induction motor.	CO8	L4
b			
Class No	**Module Content Covered**	**CO**	**Level**
1	Output Equation	CO7	L3
2	Choice of Specific Loadings,Main Dimensions of Stator.	CO7	L3
3	Main Dimensions of Stator	CO7	L4
4	Design of stator slots and Winding	CO7	L3
5	Design of stator slots and Winding	CO7	L4
6	Design of Rotor Bars and End Ring.	CO8	L4
7	Design of Slip Ring rotor	CO8	L4
8	Choice of Length Air Gap	CO8	L3
9	Estimation of Number of Slots for Squirrel Cage Rotor.	CO8	L4
10	Estimation of No Load Current and Leakage Reactance.	CO8	L3
c	**Application Areas**	**CO**	**Level**
1	Electric train engine, Printing machines.	CO7	L4
2	Chimneys at power plants, irrigation.	CO8	L4
d	**Review Questions**	-	-
1	What are the different types of induction motor and how differ from each other?	CO7	L2
2	Why wound rotor construction is adopted?	CO7	
3	What is rotating transformer?	CO7	L2
4	What are the advantages of cage rotor over slip ring induction motor?	CO7	L2
5	Name the materials used to insulate the laminations of the core of induction motor.	CO7	L4
6	What are the advantages of slip ring motor over squirrel cage motor?	CO7	L2
7	Write the expression for the output equation and output coefficient of induction motor.	CO7	L2

8	What are the factors to be considered for choosing the specific magnetic loading?	CO7	L4
9	What are the factors to be considered for the choice of specific electric loading?	CO7	L4
10	What are the main dimensions of an induction motor?	CO7	L2
11	How the induction motor can be designed for best power factor?	CO7	L2
12	What types of slots are preferred for the induction motor?	CO7	L2
13	What are the factors to be considered for selecting number of slots in induction machine stator?	CO8	L2
14	Which part of induction motor has the maximum flux density? What is the maximum flux density in that part?	CO8	L4
15	What are the factors to be considered for estimating the length of air gap.	CO8	L2
16	What are the advantages and disadvantages of large air gap length in induction motor?	CO8	L2
17	List out the methods to improve the power factor of the induction motor.	CO8	L1
18	Why the air gap of an induction motor is made as small as possible?	CO8	L2
19	Discuss the relative merits and demerits of open and closed slots for induction motor.	CO8	L2
20	What is crawling and cogging?	CO8	L2
21	What are the methods adopted to reduce harmonic torques?	CO8	L2
22	What is skewing?	CO8	L2
23	Explain the design of rotor bars and end rings of induction motor.	CO8	L2
24	Explain the design of induction motor using circle diagram.	CO8	L2
25	Discuss the various factors to be considered in the design of induction motor. Discuss the end ring current briefly	CO8	L4
26	Derive an expression for the equivalent resistance of cage rotor referred to stator per phase of three-phase induction motor.	CO8	L4
27	State and discuss the factors, which influence the ratio of length to diameter of the armature core of a 3phase induction motor.	CO8	L4
28	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	CO8	L4
29	Derive an expression for the rotor resistance in terms of its stator winding for a squirrel cage induction motor.	CO8	L4
e	**Experiences**		
1			
2			
3			
4			
5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	17EE64	Sem:	6	Marks:	30	Time:	75 minutes
Course:	Design and Analysis of Algorithms						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Show that For minimum cost design of transformer, cost of iron =cost of conductor.	5	CO5	L2
	b	For minimum copper loss, current density in primary winding=current density in secondary winding	5	CO5	L3
	c	Determine the main dimensions of a 3 limb core transformer of 350KVA, 11000/33000V, star- delta 3 phase, 50 Hz transformer. Assume Volts/turn is 11 V, Maximum flux density is 1.25 wb/m^2, net cross section of core is 0.62d , window space factor is 0.27, window proportion is 3:1, current density is 250 A/cm2.	5	CO5	L4
		OR			

2	a	Derive output equation for a 1 and 3 phase transformer with the details of symbols used.	5	CO5	L2
	b	Show that: 1) Losses in transformer are proportional to the cube of its linear dimensions. 2) For a stepped core type Ratio = $\frac{Netcorearea}{Areaofcircumscribing\circ}$ = 0.71	5		L3
	c	Show that the output of 3 phase core type transformer is $5.23fB_mHd^2H_WX10^{-3}$KVA where 'f' is the frequency, 'Bm' the maximum value of flux density in Weber/m², 'd'is the effective diameter of the core in meters, 'H' is the magnetic potential gradient in the limit in amperes/meter and 'H_W' is the height of the window in meters.	5	CO5	L3
3	a	**With usual notations derive the output equation of a 3-phase Induction motor.**	5	CO8	L3
	b	Discuss the factors to be considered while deciding the length of air gap and number of stator slots.	5	CO8	L2
	c	Determine the main dimensions, turns per phase, number of slots, conductor cross-section and slot area of a 250hp, 3 phase, 50hz, 400v, 1410rpm slip ring induction motor. Assume B_{av} = 0.5Wb/m², ac=30000A/m, efficiency=0.9, and power factor= 0.9, winding factor=0.955, current density= 3.5 A/mm². The slot space factor is 0.4 and the ratio of core length to pole pitch is 1.2. The machine is delta connected.	5	CO8	L4
		OR			
4	a	Define specific magnetic loading and specific electric loading for three phase AC machines. Explain with briefly.	5	CO8	L3
	b	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	5	CO8	L3
	c	A single phase, 400volts, 50 Hz, transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5m, the area of cross-section of the core is $2.5x10^{-3}$ m² and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. The iron loss at the working flux density is 2.6W/kg. Iron weighs $5.8x10^{-3}$ kg/m³, stocking factor is 0.9.	5	CO8	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EE64	Sem:	6	Marks:	10 / 10	Time:	90 – 120 minutes
Course:	Electrical Machine Design						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001	What are the various types of Transformers?	3	CO7	L2
2	1KT16EE003	Derive an expression of leakage reactance of a transformer with primary and secondary coils of equal length.	8	CO7	L2
3	1KT16EE004	Explain the determination of temperature rise in a transformer with plain walled tank and the transformer with tank with oil tubes and the determination of number of oil tubes required.	8	CO7	L2
4	1KT16EE006	Derive the equation for calculation of no load current of single phase transformer.	6	CO7	L3
5	1KT16EE007	What is the range of efficiency of transformers?	2	CO7	L2
6	1KT16EE011	What are distribution transformers?	2	CO7	L2
7	1KT16EE013	What are power transformers?	2	CO7	L2
8	1KT16EE014	Distinguish between core and shell type transformer.	3	CO7	L2
9	1KT16EE016	What are the advantages of shell type transformer over core	3	CO7	L2

		type transformers?			
10	1KT16EE017	In transformers, why the low voltage winding placed near the core?	2	CO7	L2
11	1KT16EE020	What is window space factor?	1	CO7	L2
12	1KT16EE021	Write down the output equation for the1phase and 3 phase transformer.	2	CO7	L2
13	1KT16EE023	How will you select the emf per turn of a transformer?	2	CO7	L2
14	1KT16EE025	Why circular coils are preferred in transformers?	2	CO7	
15	1KT16EE026	What are the advantages of stepped cores?	2	CO7	L2
16	1KT16EE005	What are the disadvantages of stepped cores?	2	CO7	L2
17	1KT16EE019	What do you meant by stacking factor (iron space factor)?	1	CO7	L2
18	1KT14EE030	What are the factors to be considered for choosing the type winding for a core type transformer?	2	CO7	L2
19	1KT14EE034	List some methods of cooling of transformers.	2	CO7	L2
20	1KT15EE011	What are the factors to be considered for choosing the method of cooling?	4	CO7	L2
21	1KT15EE013	How the heat dissipation is improved by providing the cooling tubes?	2	CO7	L2
22	1KT15EE015	What is a breather?	1	CO7	L2
23	1KT15EE017	Why silica gel is used in breather?	1	CO7	L2
24	1KT16EE402	What is conservator?	1	CO7	L2
25	1KT16EE404	How the leakage reactance of the transformer is reduced?	1	CO7	L2
26	1KT16EE410	Discuss the importance of the choice of value of k= √ 4.44 f (m /AT) x 10 3 in a transformer design with respect to, type, service conditions, cost and losses.	5	CO7	L3
27	1KT16EE001	Calculate the proportions of the cruciform section of minimum area for the core of a transformer. Show that the gross area of a core of a cruciform section is 79% of the area of the circum circle.	5	CO8	L4
28	1KT16EE003	Name the materials used to insulate the laminations of the core of induction motor.	5	CO8	L2
29	1KT16EE004	What are the advantages of slip ring motor over squirrel cage motor?	5	CO8	L3
30	1KT16EE006	Write the expression for the output equation and output coefficient of induction motor.	5	CO8	L2
31	1KT16EE007	What are the factors to be considered for choosing the specific magnetic loading?	5	CO8	L3
32	1KT16EE011	What are the factors to be considered for the choice of specific electric loading?	5	CO8	L2
33	1KT16EE013	What are the main dimensions of an induction motor?	2	CO8	L3
34	1KT16EE014	How the induction motor can be designed for best power factor?	2	CO8	L2
35	1KT16EE016	What types of slots are preferred for the induction motor?	5	CO8	L3
36	1KT16EE017	What are the factors to be considered for selecting number of slots in induction machine stator?	5	CO8	L2
37	1KT16EE020	Which part of induction motor has the maximum flux density? What is the maximum flux density in that part?	5	CO8	L3
38	1KT16EE021	What are the factors to be considered for estimating the length of air gap.	5	CO8	L2
39	1KT16EE023	What are the advantages and disadvantages of large air gap length in induction motor?	5	CO8	L3
40	1KT16EE025	List out the methods to improve the power factor of the induction motor.	5	CO8	L2
41	1KT16EE026	Why the air gap of an induction motor is made as small as possible?	5	CO8	L2

42	1KT16EE005	Discuss the relative merits and demerits of open and closed slots for induction motor.	5	CO8	L3
43	1KT16EE019	What is crawling and cogging?	5	CO8	L2
44	1KT14EE030	What are the methods adopted to reduce harmonic torques?	5	CO8	L3
45	1KT14EE034	What is skewing?	2	CO8	L2
46	1KT15EE011	Explain the design of rotor bars and end rings of induction motor.	8	CO8	L3
47	1KT15EE013	Explain the design of induction motor using circle diagram.	8	CO8	L2
48	1KT15EE015	Discuss the various factors to be considered in the design of induction motor. Discuss the end ring current briefly	6	CO8	L2
49	1KT15EE017	Derive an expression for the equivalent resistance of cage rotor referred to stator per phase of three-phase induction motor.	8	CO8	L3
50	1KT16EE402	State and discuss the factors, which influence the ratio of length to diameter of the armature core of a 3phase induction motor.	5	CO8	L2
51	1KT16EE404	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	6	CO8	L3

D3. TEACHING PLAN - 3

Module – 5

Title:	**Design of Three Phase Synchronous Machines**	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design of stator of synchronous machines.	CO9	L4
2	Design of rotor of synchronous machines.	CO10	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Output Equation,Choice of Specific Loadings	CO9	L3
2	Main Dimensions of Stator	CO9	L3
3	Main Dimensions of Stator	CO9	L4
4	Short Circuit Ratio	CO9	L3
5	Design of stator slots and Winding.	CO9	L4
6	Design of stator slots and Winding.	CO9	L4
7	Design of Salient Rotors	CO10	L4
8	Design of non- salient Pole Rotors	CO10	L4
9	Magnetic Circuit and Field Winding.	CO10	L3
10	Magnetic Circuit and Field Winding.	CO10	L4
c	**Application Areas**	**CO**	**Level**
1	Generation of power	CO9	L4
2	Paper mills, constant speed motor and it is used as reactive power control in large power systems	CO10	L4
d	**Review Questions**	-	-
1	Name the two types of synchronous machines.	CO9	L3
2	Distinguish between cylindrical pole and salient pole construction.	CO9	L3
3	Mention the uses of damper windings in a synchronous machine?	CO9	L3
4	List the factors to be considered for separation of D and L for salient pole	CO9	L3

	machines.		
5	Define pitch factor	CO9	L3
6	Define distribution factor.	CO9	L3
7	What are the factors to be considered for the choice of specific magnetic loading?	CO9	L3
8	What are the factors to be considered for the choice of specific electric loading?	CO9	L3
9	What is short circuit ratio?	CO9	L3
10	How the value of SCR affects the design of alternator?	CO9	L3
11	What are the advantages of large air gap in synchronous machines?	CO9	L3
12	Write the expression for length of air gap in salient pole synchronous machine	CO9	L3
13	List the influence of the air gap length on the performance of the synchronous machine.	CO9	L3
14	List the factors to be considered for the choice of slot in synchronous machines	CO9	L3
15	What is the limiting factor for the diameter of synchronous machine?	CO9	L3
16	Write the expression for air gap length in cylindrical rotor machines.	CO9	L3
17	What are the factors to be considered for selecting the number of poles in an alternator?	CO9	L3
18	Discuss how the ventilation and cooling of large high speed alternator is carried out.	CO9	L3
19	Mention the factors that govern the design of field system of the alternator.	CO9	L3
20	Mention the advantages of fractional slot winding.	CO9	L3
21	Write the output equation of a synchronous machine.	CO10	L3
22	Discuss briefly the factors, which influence the air gap length of a 3phase synchronous machine.	CO10	L3
23	Explain the factors taken into account in the design of field winding of a salient pole alternator.	CO10	L3
24	Describe the important constructional features of the rotating field systems of slow speed alternators and turbo alternators.	CO10	L3
25	List the considerations in the design of field windings of salient pole alternator.	CO10	L3
26	Explain what steps are taken to ensure that an alternator shall generate an emf, the waveform of which shall be close to approximation to a sine wave.	CO10	L3
27	Explain how the open circuit characteristics is to be obtained from the design data for a salient pole alternator.	CO10	L3
28	What is a short circuit ratio as connected with synchronous machines?	CO10	L3
29	Mention the usual values and also explain how this ratio affect the cost and performance of an alternator.	CO10	L3
30	In the case of alternators how to decide the length of air gap?	CO10	L3
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	17EE64	Sem:	6	Marks:	30	Time:	75 minutes
Course:	Electrical Machine Design						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	List the factors to be considered for separation of D and L for salient pole machines.	4	CO9	L2
	b	What are the factors to be considered for the choice of specific magnetic loading?	4	CO9	L2

	c	Determine suitable stator dimensions for a 500KVA, 50Hz, 3Φ, alternator to run at 375 rpm. Take mean gap density over the pole pitch as 0.55T, the electric loading as 250 amp. conductors per cm and assume a peripheral speed not exceeding 35m/s.	7	CO10	L4
		or			
2	a	What are the factors to be considered for the choice of specific electric loading?	5	CO9	L2
	b	What is short circuit ratio? How the value of SCR affects the design of alternator?	5	CO9	L2
	c	Determine for a 250KVA, 12 pole, 1100V, 500 rpm, 3-phase alternator i) air gap diameter ii) core length iii) no. of stator conductors iv) no. of stator slots v) cross section of stator conductors. Assume average gap density as 0.6wb/m2 and the specific electric loading 30,000 a.c/m. Assume $L/\tau = 1.5$	5	CO10	L4
3	a	What are the advantages of large air gap in synchronous machines?	5	CO9	L2
	b	List the influence of the air gap length on the performance of the synchronous machine.	5	CO9	L2
	c	A 500KVA, 3.3kV, 50Hz, 600 rpm, 3 Phase salient pole alternator ahs 200 turns per phase. Estimate the length of the air gap if the average flux density is 0.55T, the ratio of pole arc to pole pitch is 0.65, short circuit ratio is 1.5, gap expansion factor is 1.15, mmf required for the gap is 80% of noo load field mmf and the winding factor is 0.955.	5	CO10	L4
		OR			
4	a	List the factors to be considered for the choice of slot in synchronous machines.	5	CO9	L2
	b	What is the limiting factor for the diameter of synchronous machine? What are the factors to be considered for selecting the number of poles in an alternator?	5	CO9	L2
	c	A 2-pole 3000-rpm alternator has a core length of 2m. Selecting a mean flux density over the pole pitch of 0.55wb/m 2 , a specific loading of 260 amp. Conductors/cm, a peripheral velocity of 100m/sec and an air gap of 2.5cm determine the output obtainable when the average span of the stator coil is 2/3 of pole pitch.	5	CO10	L4

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EE64	Sem:	6	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Electrical Machine Design						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001	How the value of SCR affects the design of alternator?	5	CO9	L2
2	1KT16EE003	What are the advantages of large air gap in synchronous machines?	5	CO9	L2
3	1KT16EE004	Write the expression for length of air gap in salient pole synchronous machine	4	CO9	L4
4	1KT16EE006	List the influence of the air gap length on the performance of the synchronous machine.	4	CO9	L2
5	1KT16EE007	List the factors to be considered for the choice of slot in synchronous machines	4	CO9	L2
6	1KT16EE011	What is the limiting factor for the diameter of synchronous machine?	5	CO9	L2
7	1KT16EE013	Write the expression for air gap length in cylindrical rotor machines.	6	CO9	L2
8	1KT16EE014	What are the factors to be considered for selecting the number of poles in an alternator?	6	CO9	L2

9	1KT16EE016	Discuss how the ventilation and cooling of large high speed alternator is carried out.	5	CO9	L2
10	1KT16EE017	Mention the factors that govern the design of field system of the alternator.	5	CO9	L2
11	1KT16EE020	Mention the advantages of fractional slot winding.	5	CO9	L2
12	1KT16EE021	Write the output equation of a synchronous machine.	6	CO9	L2
13	1KT16EE023	Discuss briefly the factors, which influence the air gap length of a 3phase synchronous machine.	6	CO9	L2
14	1KT16EE025	Explain the factors taken into account in the design of field winding of a salient pole alternator.	5	CO9	L2
15	1KT16EE026	Describe the important constructional features of the rotating field systems of slow speed alternators and turbo alternators.	8	CO9	L2
16	1KT16EE005	List the considerations in the design of field windings of salient pole alternator.	6	CO9	L2
17	1KT16EE019	Explain what steps are taken to ensure that an alternator shall generate an emf, the waveform of which shall be close to approximation to a sine wave.	8	CO9	L2
18	1KT14EE030	Explain how the open circuit characteristics is to be obtained from the design data for a salient pole alternator.	8	CO9	L2
19	1KT14EE034	What is a short circuit ratio as connected with synchronous machines?	6	CO9	L2
20	1KT15EE011	Mention the usual values and also explain how this ratio affect the cost and performance of an alternator.	5	CO9	L2
21	1KT15EE013	Name the two types of synchronous machines.	3	CO9	L2
22	1KT15EE015	Distinguish between cylindrical pole and salient pole construction.	6	CO9	L2
23	1KT15EE017	Mention the uses of damper windings in a synchronous machine?	4	CO9	L2
24	1KT16EE402	List the factors to be considered for separation of D and L for salient pole machines.	6	CO9	L2
25	1KT16EE404	Define pitch factor	2	CO9	L2
26	1KT16EE410	Define distribution factor.	2	CO9	L2
27	1KT16EE001	What are the factors to be considered for the choice of specific magnetic loading?	5	CO10	L2
28	1KT16EE003	What are the factors to be considered for the choice of specific electric loading?	5	CO10	L2
29	1KT16EE004	What is short circuit ratio?	3	CO10	L2
30	1KT16EE006	How the value of SCR affects the design of alternator?	4	CO10	L2
31	1KT16EE007	Write the output equation of a synchronous machine.	6	CO10	L2
32	1KT16EE011	Discuss briefly the factors, which influence the air gap length of a 3phase synchronous machine.	5	CO10	L2
33	1KT16EE013	Explain the factors taken into account in the design of field winding of a salient pole alternator.	5	CO10	L2
34	1KT16EE014	Describe the important constructional features of the rotating field systems of slow speed alternators and turbo alternators.	7	CO10	L2
35	1KT16EE016	List the considerations in the design of field windings of salient pole alternator.	5	CO10	L2
36	1KT16EE017	Explain what steps are taken to ensure that an alternator shall generate an emf, the waveform of which shall be close to approximation to a sine wave.	7	CO10	L2
37	1KT16EE020	Explain how the open circuit characteristics is to be obtained from the design data for a salient pole alternator.	5	CO10	L2
38	1KT16EE021	What is a short circuit ratio as connected with synchronous machines?	5	CO10	L2
39	1KT16EE023	Mention the usual values and also explain how this ratio affect the cost and performance of an alternator.	6	CO10	L2
40	1KT16EE025	In the case of alternators how to decide the length of air gap?	4	CO10	L2
41	1KT16EE026	What are the advantages of large air gap in synchronous machines?	5	CO10	L2

42	1KT16EE005	Write the expression for length of air gap in salient pole synchronous machine	6	CO10	L2
43	1KT16EE019	List the influence of the air gap length on the performance of the synchronous machine.	5	CO10	L2
44	1KT14EE030	List the factors to be considered for the choice of slot in synchronous machines	4	CO10	L2
45	1KT14EE034	What is the limiting factor for the diameter of synchronous machine?	5	CO10	L2
46	1KT15EE011	Write the expression for air gap length in cylindrical rotor machines.	5	CO10	L2
47	1KT15EE013	What are the factors to be considered for selecting the number of poles in an alternator?	5	CO10	L2
48	1KT15EE015	Discuss how the ventilation and cooling of large high speed alternator is carried out.	5	CO10	L2
49	1KT15EE017	Mention the factors that govern the design of field system of the alternator.	5	CO10	L2
50	1KT16EE402	Mention the advantages of fractional slot winding.	6	CO10	L2
51	1KT16EE404	What are the advantages of large air gap in synchronous machines?	6	CO10	L2
52	1KT16EE410	Write the expression for length of air gap in salient pole synchronous machine	7	CO10	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Electrical Machine Design					Month / Year	May /2018
Crs Code:	17EE64	Sem:	6	Marks:	100	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	List the recognized classes of insulating materials and the temperature assigned to them. Mention at least two examples for each type.	4	CO1	L2
	b	What are the major considerations accounted for the good design of electrical machines?	4	CO1	L2
	c	What are the factors those limit the design of a machine? What is CRGO steel? What are its uses?	4	CO1	L2
	d	Make a brief comparison chart between copper and aluminium when used in electrical machine windings.	4	CO1	L2
		OR			
-	a	Discuss briefly about electrical properties of insulating materials.	4	CO2	L2
	b	Explain briefly with the help of directional properties of CRGO transformer steel.	4	CO2	L2
	c	What are the major groups of electrical conducting materials? Describe the properties and applications of those materials.	4	CO2	L2
	d	What are the limitations of design of electrical apparatus? Explain them.	4	CO2	L2
2	a	With usual notations derive the output equation of a D.C machines. Mention the various factors that affect the choice of number of poles of a D.C machine.	6	CO4	L3
	b	Define specific loadings and discuss in brief the factors influencing the choice of specific electric and magnetic loadings in D.C machines.	5	CO4	L3
	c	A 5KW, 250V, 4 pole, 1500rpm shunt generator is designed to have a square pole face. The loadings are average flux density in the air gap = 0.42wb/m^2, ampere conductors /meter = 15000. Find the main dimensions of the machine. Assume full load efficiency = 0.87 and ratio of pole arc to pole pitch is 0.66.	5	CO3	L4
		OR			
-	a	Discuss the total design steps of D.C.machines. Briefly describe each step	5	CO4	L3
	b	What are the factors to be considered for deciding the slot dimensions?	5	CO4	L3
	c	Calculate the diameter and length of armature for a 7.5kw, 4pole, 1000rpm,	6	CO3	L4

		220v shunt motor. **Given:** full load efficiency = 0.83; maximum gap flux density = 0.9Wb/m^2; specific electric loading =30000ampere conductors per meter; field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the fie3ld current is 2.5% of rated current. The pole face is square.			
3	a	Show that For minimum cost design of transformer, cost of iron =cost of conductor.	4	CO6	L4
	b	For minimum copper loss, current density in primary winding=current density in secondary winding	4	CO5	L4
	c	Determine the main dimensions of a 3 limb core transformer of 350KVA, 11000/33000V, star- delta 3 phase, 50 Hz transformer. Assume Volts/turn is 11 V, Maximum flux density is 1.25 wb/m^2, net cross section of core is 0.62d , window space factor is 0.27, window proportion is 3:1, current density is 250 A/cm2.	8	CO5	L4
		OR			
	a	Derive output equation for a 1 and 3 phase transformer with the details of symbols used.	5	CO6	L4
-	b	Show that: 1) Losses in transformer are proportional to the cube of its linear dimensions. 2) For a stepped core type Ratio = $\frac{Netcorearea}{Areaofcircumscribing\,\circ}$ = 0.71	4	CO5	L4
	c	Show that the output of 3 phase core type transformer is 5.23fB_mH$d^2$$H_WX10^{-3}$KVA where 'f' is the frequency, 'Bm' the maximum value of flux density in Weber/m^2, 'd'is the effective diameter of the core in meters, 'H' is the magnetic potential gradient in the limit in amperes/meter and 'H_W' is the height of the window in meters.	7	CO5	L4
4	a	With usual notations derive the output equation of a 3-phase Induction motor.	5	CO8	L3
	b	Discuss the factors to be considered while deciding the length of air gap and number of stator slots.	5	CO8	L3
	c	Determine the main dimensions, turns per phase, number of slots, conductor cross-section and slot area of a 250hp, 3 phase, 50hz, 400v, 1410rpm slip ring induction motor. Assume B_{av} = 0.5Wb/m^2 , ac=30000A/m, efficiency=0.9, and power factor= 0.9, winding factor=0.955, current density= 3.5 A/mm^2 . The slot space factor is 0.4 and the ratio of core length to pole pitch is 1.2. The machine is delta connected.	6	CO7	L4
		OR			
-	a	Define specific magnetic loading and specific electric loading for three phase AC machines. Explain with briefly.	4	CO8	L3
	b	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	4	CO8	L3
	c	A single phase, 400volts, 50 Hz, transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5m, the area of cross-section of the core is 2.5x10^{-3} m^2 and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. The iron loss at the working flux density is 2.6W/kg. Iron weighs 5.8x10^{-3} kg/m^3, stocking factor is 0.9.	8	CO7	L4
5	a	List the factors to be considered for separation of D and L for salient pole machines.	5	CO10	L3
	b	What are the factors to be considered for the choice of specific magnetic loading?	5	CO10	L3
	c	Determine suitable stator dimensions for a 500KVA, 50Hz, 3Φ, alternator to run at 375 rpm. Take mean gap density over the pole pitch as 0.55T, the electric loading as 250 amp. conductors per cm and assume a peripheral speed not exceeding 35m/s.	6	CO9	L4
		or			

	a	What are the factors to be considered for the choice of specific electric loading?	5	CO10	L3
	b	What is short circuit ratio? How the value of SCR affects the design of alternator?	5	CO10	L3
	c	Determine for a 250KVA, 12 pole, 1100V, 500 rpm, 3-phase alternator i) air gap diameter ii) core length iii) no. of stator conductors iv) no. of stator slots v) cross section of stator conductors. Assume average gap density as 0.6wb/m2 and the specific electric loading 30,000 a.c/m. Assume L/τ = 1.5	6	CO9	L4

2. SEE Important Questions

Course:	Electrical Machine Design					Month / Year	May /2019-20
Crs Code:	17EE64	Sem:	6	Marks:	100	Time:	180 minutes

Module	Qno.	Important Question	Marks	CO	Year
	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
1	1	List the recognized classes of insulating materials and the temperature assigned to them. Mention at least two examples for each type.	4	CO1	2016
	2	What are the major considerations accounted for the good design of electrical machines?	4	CO1	2017
	3	What are the factors those limit the design of a machine? What is CRGO steel? What are its uses?	4	CO2	2010
	4	What are the major groups of electrical conducting materials? Describe the properties and applications of those materials.	4	CO2	2015
	5	What are the limitations of design of electrical apparatus? Explain them.	4	CO2	2017
2	1	Discuss the total design steps of D.C.machines. Briefly describe each step	6	CO4	2018
	2	What are the factors to be considered for deciding the slot dimensions?	5	CO4	2017
	3	With usual notations derive the output equation of a D.C machines. Mention the various factors that affect the choice of number of poles of a D.C machine.	5	CO4	2018
	4	Define specific loadings and discuss in brief the factors influencing the choice of specific electric and magnetic loadings in D.C machines.	5	CO4	2015
	5	Calculate the diameter and length of armature for a 7.5kw, 4pole, 1000rpm, 220v shunt motor. **Given:** full load efficiency = 0.83; maximum gap flux density = 0.9Wb/m^2; specific electric loading =30000ampere conductors per meter; field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the fie3ld current is 2.5% of rated current. The pole face is square.	5	CO3	2016
3	1	Show that For minimum cost design of transformer, cost of iron =cost of conductor.	4	CO6	2014
	2	For minimum copper loss, current density in primary winding=current density in secondary winding	4	CO6	2015
	3	Derive output equation for a 1 and 3 phase transformer with the details of symbols used.	4	CO6	2017
	4	Show that: 1) Losses in transformer are proportional to the cube of its linear dimensions. 2) For a stepped core type Ratio = $\dfrac{Netcorearea}{Areaofcircumscribing\,\mathring{\square}}$ = 0.71	4	CO5	2017
	5	Show that the output of 3 phase core type transformer is $5.23fB_mHd^2H_W X10^{-3}$KVA where ‘f’ is the frequency, ‘Bm’ the maximum value of flux density in Weber/m^2, ‘d’is the effective diameter of the core in meters, ‘H’ is the magnetic potential gradient in the limit in amperes/meter	8	CO5	2018

		and 'H_W' is the height of the window in meters.			
4	1	With usual notations derive the output equation of a 3-phase Induction motor.	4	CO8	2017
	2	Discuss the factors to be considered while deciding the length of air gap and number of stator slots.	4	CO8	2016
	3	Define specific magnetic loading and specific electric loading for three phase AC machines. Explain with briefly.	4	CO8	2015
	4	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	4	CO8	206
	5	A single phase, 400volts, 50 Hz, transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5m, the area of cross-section of the core is $2.5x10^{-3}$ m^2 and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. The iron loss at the working flux density is 2.6W/kg. Iron weighs $5.8x10^{-3}$ kg/m^3, stocking factor is 0.9.	8	CO7	2012
5	1	Define specific magnetic loading and specific electric loading for three phase AC machines. Explain with briefly.	5	CO10	2016
	2	Write the step-by-step design procedure for a wound rotor. Discuss various considerations to be taken into account while selecting the number of rotor slots in squirrel cage induction motor.	5	CO10	2014
	3	A single phase, 400volts, 50 Hz, transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5m, the area of cross-section of the core is $2.5x10^{-3}$ m^2 and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. The iron loss at the working flux density is 2.6W/kg. Iron weighs $5.8x10^{-3}$ kg/m^3, stocking factor is 0.9.	6	CO9	2014
	4	What are the factors to be considered for the choice of specific electric loading?	5	CO10	2016
	5	What is short circuit ratio? How the value of SCR affects the design of alternator?	5	CO10	2018

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques.	5	- L1 - L2	L2	- Remember - Understand	Lecture	Assignment Unit Test & IA
1	Desirability of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials,	5	- L1 - L2	L2	-Remember - Understand	Lecture	Assignment Unit Test & IA

	Classification of Insulating materials based on Thermal Consideration.						
2	Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes.	7	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
2	Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.	6	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
3	Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current.	8	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
3	Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.	6	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
4	Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding,	8	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
4	Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.	6	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
5	Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding.	8	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA
5	Design of Salient and non-salient Pole Rotors. Magnetic Circuit and Field Winding	6	- L2 - L3 -L4	L4	-Understand -Apply -Analyze	Lecture & PPT	Assignment Unit Test & IA

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. Ashort word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	- Study of Limitations in design, -Study of Modern Trends in design manufacturing Techniques.	- Limitations -Modern Trendz	Fundamental Aspects	Limitations in design and new trends in designing of electrical machines	1.Understand 2.the fundamental aspects of machine design.	Understand the fundamental aspects of machine design.
1	-Study ofDesirabilities of Conducting Materials. -Study of ferromagnetic Material. -Study of Insulating Materials.	-ferromagnetic Material. -Insulating Materials.	Electrical Engineering materials	Study of different magnetic and insulating materials.	1.Understand 2.the desirabilities of engineering material	Understand the desirability of engineering material
2	- Choice of Specific Loadings and Choice of Number of Poles -Main Dimensions of armature -Design of Commutator and Brushes.	-Specific loading s -Main dimensions of design -Commutator and Brushes design.	ArmatureDesign	Study of choice of specific electric and magnetic loading as wlel as number of poles. Determination of D and L of armature .	1.Design 2.armature of DC machines.	Design of armature of DC machines.
2	-Estimation of Ampere Turns for the Magnetic Circuit. -Dimensions of Yoke, Main Pole and Air Gap. -Design of Shunt and Series Field Windings.	-Design of yoke and pole -Design of Shunt and Series Field Windings.	Field windings design	Design of series and shunt field winding.	1.Design 2.Field of DC machine	Design of field windings of DC machines.
3	-Choice of Specific Loadings, -Determination	-Core design -Winding design -No Load	Main Dimensions Design	Design of square, rectangular and stepped core.	1.Design 2.various parts of transformers.	Design of core, field winding and tank of transformer.

	of Main Dimensions of the Core -Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings -Estimation of No Load Current.	Current.				
3	-Expression for the Leakage Reactance of core type transformer -calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.	-Leakage Reactance -Voltage Regulation. -Tank design	Performance Parameters	Derivation of leakage reactance and voltage regulation.Tank Design	1.Analyze 2.the performance of transformer	Analyze the performance of transformer
4	-Choice of Specific Loadings, -Main Dimensions of Stator. -Design of stator slots and Winding,	-Main dimension design -Slot and winding design	Stator Design	Determination ofmain Dimensions of Stator. Design of stator slots and Winding	1.Design 2.various parts of induction motor.	Design of stator of induction motor.
4	-Estimation of Number of Slots for Squirrel Cage Rotor. -Design of Rotor Bars and End Ring. -Design of Slip Ring rotor. -Estimation of No Load-Current and Leakage Reactance.	-Squirrel Cage Rotor design -Slip Ring rotor design	Rotor Design	Design of rotor and estimation of no liad current and leakage reactance.	1.Analyze 2.the performance of induction motor.	Design of rotor of induction motor.
5	-Choice of Specific Loadings, Short Circuit Ratio, -Main Dimensions of Stator. -Design of stator slots and Winding.	-specific loadings -main dimensions -slot and winding design	Stator Design	Determination ofmain Dimensions of Stator. Design of stator slots and Winding	1.Design 2.various parts of of synchronous machines.	Design of stator of synchronous machines.

5	**-**Design of Salient and non- salient Pole Rotors. -Field Winding	Rotor design -fileld winding design	Rotor Design	Design of Salient and non- salient Pole Rotors.	1.Analyze 2.the performance of synchronous machines	Design of rotor of synchronous machines.