University of Engineering and Technology, Lahore

EE 461 Design of Electric Machines

Fall 2016

Instructor	Arsalan A Rahim
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Course Basics				
Credit Hours	3 (3+0)			
Lecture(s)	Number of Lectures(s) per Week	2	Duration	150 minutes (total)
Recitation (per week)	Number of Lectures(s) Per Week	0	Duration	N/A
Lab (per week)	Number of Lectures(s) Per Week	0	Duration	N/A

Course Distribution	
Core	N
Elective	Y
Open for Student Category	Electrical Engineering 7th Semester
Close for Student Category	Students upto third year

COURSE DESCRIPTION

The objective of this course is to introduce students, the basic design concepts of Transformer Design and Rotating Electric Machine Design but not limited to just Distribution Transformers & Induction Motors but also introduce them to sophisticated Power Transformer Design and Synchronous Machines. Apart from the designing, this course also enhances the Hardware skills by giving emphasis on Small Transformer Fabrication and Windings of Small Motors.

COURSE PREREQUISITE(S)

• EE 250	• Electric Machinery Fundamentals

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COURSE OBJECTIVES	
1.	Study the basic principles of Magnetic Circuits linked with Transformers and Rotating Machines
2.	Understanding the basic design principles of Distribution Transformers with its Types and
3.	Understanding the design Principles of Power Transformers with Different Types of Winding Design with Ampere-Turn Balancing for Protection of Equipment
4.	Understanding the design principles of Rotating Electric Machines for Different class of Machines
5.	Understanding the design methodology of Different Winding Techniques for Rotating Electric Machines
6.	Understanding the design of Salient and Non-Salient Rotors for Induction and Synchronous Machines
7.	Design of practical Small VA Rating Transformer and its Fabrication
8.	Practical Re-winding for a Small Induction Motor to grasp the concept of Different Types of Windings employed

LEARNING OUTCOME	
1	Understanding the need, use, analysis, design of efficient Electric Machines
2	Linkage of Proper Design Process for Transformers and Rotating Electric Machines keeping the efficiency and Power Requirement under control with parameters such as Temperature, Size, Cost in Control

Course Learning Outcomes	
	The students should be able to:
CLO1:	Understand basic principles of Magnetic Circuits with Emphasis on Losses Modeling & Calculations
CLO2:	Development of the Philosophy of the Transformer Design
CLO3:	Understanding the design Principles of Power Transformers with Different Types of Winding Design with Ampere-Turn Balancing for Protection of Power Transformers as a Basic Block
CLO4:	Understanding the design methods of Rotating Electric Machines with Losses approach and Deterministic Design
CLO5:	Winding Design with Emphasis on Salient Pole Windings, Compensating Windings and Rotor Windings of Modern Day Motors & Alternators
CLO6:	Dimension Selection of Rotating Electric Machines and Transformer for Cooling Processes
CLO7:	Use of Simulation Tool for Rotating Machine Design and Computational Tool for Iterative Design Procedures
CLO8:	Apply knowledge to develop a Small VA Rating Transformer
CLO9:	Re-winding a Small Induction Motor to grasp the concept of Windings Employed

Relation to EE Program Outcomes

EE-452 CLOs	Related PLOs	Levels of Learning	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	High	Instruction, Quiz, Assignments	Midterm, Final
CLO2	PLO2	High	Instruction, Quiz, Assignments	Midterm, Final
CLO3	PLO2	Medium	Instruction, Quiz, Assignments	Midterm, Final
CLO4	PLO3	High	Instruction, Quiz, Assignments	Midterm, Final
CLO5	PLO2	Low	Instruction, Quiz, Assignments	Midterm, Final
CLO6	PLO1	Medium	Instruction, Quiz, Assignments	Midterm, Final
CLO7	PLO5	Low	Instructions, Handouts	Assignment
CLO8	PLO11, PLO9	High	Instructions, Videos	Project Submission
CLO9	PLO4	Medium	Instructions, Videos	Project Submission

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Grading Breakup and Policy

Assignment(s): → 5%
Quiz(s): → 15%
Class Participation → 5%
Attendance: At least 75% to earn a passing grade
Midterm Examination: 01 → 25%
Final Examination: Comprehensive → 35%
Project: →15%

Examination Detail

Midterm Exam	Yes/No: Yes Combine/Separate: Combined Duration: 1 hrs 30 min Preferred Date: During Mid-week Exam Specifications: Closed book, closed notes, 1 A4 double sided, calculators, Formula Sheets and Tables
Final Exam	Yes/No: Yes Combine/Separate: Combined Duration: 02 hrs Preferred Date: During Final-week Exam Specifications: Closed book, closed notes, 1 A4 double sided, calculators, Formula Sheets and Tables

COURSE OVERVIEW

Week	Topics	Recommended Readings	Related CLOs & Additional Remarks
1	**Transformer Types, Main Parts, Types based on Cooling, Load and etc**	Chapter 7 (Agarwal)	CLO1
2	**Introduction to transformer parameters and core design of transformer**	Chapter 7 (Agarwal)	CLO2
3	**Stepped Core Design + Types of Windings**	Chapter 7 (Agarwal)	CLO2
4	**Design of LT windings (Spiral, Cylindrical)**	Chapter 4 (Dasgupta)	CLO2
5	**Design of HT side Windings (Helical, Cross Over)**	Chapter 5 (Dasgupta)	CLO2
6 & 7	**Disc Winding (HT and LT) Power Transformer**	Chapter 6,7 (Dasgupta)	CLO3
7 & 8	**Ampere-Turn Balancing + Losses Calculations**	Chapter 6,7 (Dasgupta)	CLO3
9	**Percentage Impedance , Efficiency Calculations + Tank Designs with Small VA Transformer Design**	Chapter 7 (Agarwal & Dasgupta)	CLO1, CLO3,
10 & 11	**Basics of Induction Motor & Dimension Selection with Stator Slot and Teeth Design + Flux Density Calculations**	Chapter 9 (Agarwal)	CLO4
12 & 13	**Windings Designs of Stator (Concentrated, Distributed, Fractional, Full-Pitch, Integral & Fractional Slot) with Winding Project Details to be Discussed**	Chapter 9 (Agarwal) + Chapter 3,4,5 (Juha) + Notes	CLO5, CLO9
14	**Rotor Design + Efficiency & Performance Calculations for Induction Machine**	Chapter 9 (Agarwal)	CLO6
15	**Salient Pole + Cylindrical Alternator Design**	Chapter 10 (Agarwal)	CLO4
16	**Salient and Cylindrical Windings of Alternator**	Chapter 5 (Juha) + Notes	CLO6 & CLO5

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Textbook(s)/Supplementary Readings

Textbook:

- "Design of Transformers" By Indrajit Dasgupta Tata McGraw-Hill Education, 2002
- "Design of Rotating Electrical Machines" By Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova 2009 John Wiley & Sons, Ltd
- "Principles of Electric Machine Design"By R.K. Agarwal
  First Edition Feb 1992 Fourth Edition Jan 2000

Supplementary Reading:

- Transformer Design Principles: With Applications to Core-Form Power Transformers, Second Edition 2nd Edition by Robert M. Del Vecchio (Author), Bertrand Poulin (Author), Pierre T. Feghali (Author), Dilipkumar M. Shah (Author), Rajendra Ahuja (Author)

- Application Notes, Additional Documents from Different Vendors and Some Links to be Supplied

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