AIR UNIVERSITY
SPRING 2008
Faculty of Engineering
Department of Electronics Engineering
Course Information

Course Title: EE 3.304 Electrical Machines **Credit hrs: 4**	**Lab Compulsory**
Prerequisites For this Course: EE211 Electricity & Magnetism	
This Course is Prerequisite For: Higher Studies in the field of Electrical power system	
Instructor: Syed Farhan Raza	
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Text Book: Stephen J Chapman, Electrical Machinery Fundamentals, 4th Edition	
Reference Book(s): P C Sen, Principles of Electric Machines and Power Electronics **B.L.Theraja, A text book of Electrical Technology**	

Course Outline

This course teaches the principles by which most of the worlds electricity is, generated and utilized. The aim of the course is to provide students with an understanding of the physical principles which govern electromechanical motion. Applying this knowledge, students also learn techniques to allow them to analyze the performance of a range of electrical machines. Basic principles of electromagnetism and simple machines, AC machine Fundamentals, Three phase synchronous machines, induction machines, Dc machinery fundamentals, and other types of electrical machine will be the topics covered in this course.

Grading and General Course Policies:

Grading:

- **Assignments and quizzes (15%)**
- **Sessional (20%)**
- **Laboratory (20%)**
- **Final Exam (45%)**

Aims and Learning Outcomes of the course:

Aims

- To identify the differences between the most common types of dc and ac electric machines
- To be able to analyze electrical machines using simple models and to understand the relationship between the model and an actual machine
- To understand the interaction between mechanical systems, machine operation and the power system
- To investigate the operation of industrial machines and to learn the importance of safety when working with electrical power and electromechanical equipment

Learning Outcomes

Knowledge and Understanding

Having successfully completed the course, you will be able to demonstrate knowledge and understanding of:

- Theory of electromechanical energy conversion
- Concepts of fundamental torque equation and rotating and oscillating fields
- Principles of operation of electrical generators and motors
- Fundamental characteristics of various types of machines
- The concept of the equivalent circuit
- Construction and design issues associated with electrical machines
- Simple testing of electromechanical devices

Intellectual Skills

Having successfully completed the course, you will be able to:

- Appreciate the complexity of design of electromechanical devices
- Identify different types of electrical machines
- Derive equations describing operation of machines
- Formulate relevant equivalent circuits
- Compare and contrast the operation of different types of machines
- Analyse simple problems related to operation of electrical machines

Practical Skills

Having successfully completed the course, you will be able to:

- Tackle problems of analysis of performance
- Explain the shape of characteristics of actual machines
- Apply equivalent circuits to performance prediction
- Interpret results and correlate them with theoretical predictions
- Perform simple tests on machines

Lecture Plan:

Week	Topic
1	Introduction to the course, course objectives, Teaching and assessing methods. Introduction to machinery Principles. 1. The magnetic field and field properties 2. Principles for motor, generator and transformer action 3. Amper's law 4. Permeability and relative permeability 5. Magnetic circuits, series and parallel combination 6. Energy losses in ferromagnetic core
2	7. BH curve 8. Hysterisis loop and magnetic domain theory 9. Faraday's and Lenz's law 10. Production of induced force on a wire 11. Induced voltage on a wire moving in a magnetic field Examples and exercise problems
3	Transformers 1. Types and construction of transformer 2. The ideal transformer 3. Impedance transformation through a transformer 4. Analysis of circuits containing ideal transformers 7. Theory of operation of real single phase transformer 8. The magnetization current in a real transformer
4	9. The current ratio on a transformer and the dot convention 10. Relation of magnetomotive force and the dot convention. 11. The equivalent circuit of a transformer 12. Approximate and exact equivalent circuit of a transformer 13. Open and short-circuit tests
5	14. Transformer voltage regulation and efficiency 15. Effect of power factor on vr and eff 16. Instrument transformers (potential and current transformer) 17. Three phase transformers 18. Applications of three phase transformers Examples and exercise problems
6	Ac machinery fundamentals 1. Types of ac machines 2. Diff in synchronous and induction machines 3. Induced voltage and torque on a coil moving in a magnetic field 4. The rotating magnetic fields concept and its proof 5. Relation between electrical frequency and the speed of magnetic field rotation
7	6. Reversing the direction of magnetic field 7. Induced voltage in ac machines 8. Induced torque in ac machines 9. Ac machinery power flow and losses 10. Voltage regulation and speed regulation Examples and exercise problems
8	Synchronous generator 1. The speed of rotation of a synchronous generator 2. The internal generated voltage of a synchronous generator, torque and power 3. The equivalent circuit of a synchronous generator, the open and short circuit tests 4. The phasor diagram of synchronous generator
9	5. The effect of loading on a synchronous generator 6. Parallel operation of synchronous generator

	7. Synchronous gen. transients 8. Synchronous gen. ratings Examples and exercise problems
10	Synchronous motor 1. The basic principle of motor operation 2. The eqt. cct of a synchronous motor 3. The steady state synchronous motor operation 4. Effect of load changing 5. Effect of field current changing 6. The synchronous motor and pf correction. 7. Starting synchronous motors Examples and exercise problems
11	Induction motor 1. Construction 2. Rotor types 3. Basic concepts and equivalent circuit 4. Power and torque relation 5. Losses and power the flow 6. Torque speed characteristics
12	7. Max. Torque 8. Variation in torque speed characteristics of induction motor 9. Starting methods of induction motor 10. The induction generator 11. Advantages and disadvantages of induction motor 12. Nameplate information's Examples and exercise problems
13	Dc machinery fundamentals 1. A simple rotating loop b/t curved pole faces. The voltage induced in a rotating loop / getting dc voltage out of the rotating loop , the induced torque in the rotating loop 2. Commutation in a simple four-loop dc machine
14	3. Problems with commutation in real machine 4. The internal generated voltage and induced torque equation in real dc machine 5. The construction of dc machine 6. Power flow and losses in real dc machine Examples and exercise problems
15	Dc machine as a motor 1. Introduction 2. Equivalent circuit 3. Magnetization curve 4. Separately excited dc motor
16	5. Shunt dc motor 6. Permanent magnet dc motor 7. The series dc motor 8. The compounded dc motor 9. Starters Examples and exercise problems
17	Dc machine as a generator 1. Introduction 2. The separately excited dc generator 3. The shunt dc generator
18	4. The series dc generator 5. The cumulative compounded dc generator 6. The differentially compounded dc generator Examples and exercise problems