Lahore University of Management Sciences
EE352+L – Electromechanical Systems + Lab
Spring 2016 – 17

Instructor	Nauman Ahmad Zaffar
Room No.	9-213A
Office Hours	TBA
Email	nauman.zaffar@lums.edu.pk
Telephone	X8311
TA	TBA, Khawaja Samad Shah (Lab Engineer)
TA Office Hours	TBA
Course URL (if any)	

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes each
Recitation (per week)	Nbr of Lec(s) Per Week	0	Duration	N/A
Lab (per week)	Nbr of Lec(s) Per Week	1	Duration	150 minutes

Course Distribution	
Core	Y
Elective	N
Open for Student Category	Electrical Engineering, Physics
Close for Student Category	

COURSE DESCRIPTION

This course introduces the fundamentals of DC and AC electromechanical systems to be used for variety of applications. The course starts with the study of fundamental physical laws of electrical devices and appropriate mathematical models are developed to understand their operation and design. The physical construction, operation and mathematical design of transformers, DC machines, and AC machines will be discussed in detail. The speed control of rotating machines will also be introduced.

COURSE PREREQUISITE(S)

• EE242	• Circuits II (recommended)
• PHY102	• Electricity and magnetism (required)
• EE330	• Electromagnetic Fields and Waves (recommended)

COURSE OBJECTIVES

1.	Study the basic principles of electromechanical System such as electromagnetic actuators, rotating electrical machines and transformers
2.	Understand fundamental principles governing structure and operation of electric machines
3.	Study the basics of single phase and three phase ac systems for use with electromechanical systems

Course Learning Outcomes

EE352: The students should be able to:

CLO1: Understand and apply the principles of electromagnetic induction in power circuits.

CLO2: Learn the principles governing operation, characterization and design of ideal and non-ideal single phase and three phase transformers as examples of electromagnetic circuits.

CLO3: Understand the principles of rotating magnetic field, electromagnetic torque and machine action for synchronous ac machine

CLO4: Understand the principles of machine action for ac induction machine as motor and generator

CLO5: Understand the principles of machine action for dc machines as motor and generator

CLO6: Apply the knowledge in lab environment working as a group

Relation to EE Program Outcomes

EE-352 CLOs	Related PLOs	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	Instruction, Tutorial, Assignments	Midterm, Final

Lahore University of Management Sciences

CLO2	PLO3	Instruction, Tutorial, Assignments	Midterm, Final
CLO3	PLO2	Instruction, Tutorial, Assignments	Midterm, Final
CLO4	PLO2	Instruction, Tutorial, Assignments	Midterm, Final
CLO5	PLO2	Instruction, Tutorial, Assignments	Final
CLO6	PLO9	Instruction, Labs	Lab Exam

Grading Breakup and Policy
Assignment(s): Home Work: → 10% Quiz(s): 10-12 → 15% Class Participation: N/A Attendance: N/A Labs (Performance + Report): 15% (8% + 7%) Midterm Examination: 01 → 20% Lab Exam: 10% Final Examination: Comprehensive → 30%

Examination Detail	
Midterm Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Preferred Date: During Mid-week Exam Specifications: Closed book, closed notes, 1 A4 double sided, hand written help sheet, calculators
Final Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Exam Specifications: Closed book, closed notes, 1 A4 double sided, hand written help sheet, calculators

COURSE OVERVIEW

Lecture	Topics	Recommended Readings	Related CLOs & **Additional Remarks**
1.	- Introduction to Machinery Principles, Laws governing linear and rotational motion - The Magnetic Field, Magnetic circuits	Chapman: 1.1, 1.2, 1.3, 1.4	CLO1, CLO2
2.	- Electric losses in ferromagnetic materials - Interaction of changing magnetic fields - Transformer - Motor and generator principle basics	Chapman: 1.4, 1.5, 1.6, 1.7	CLO2
3.	- The Ideal Transformer - Theory of Operation of single phase transformer	Chapman: 2.3, 2.4	CLO2
4.	- Equivalent Circuit of a Transformer - Transformer Voltage Regulation and Efficiency	Chapman: 2.5, 2.7	CLO2
5.	- Per-unit system - Auto Transformers	Chapman: 2.6, 2.9	CLO2
6.	- A simple loop in a uniform magnetic field - The rotating magnetic field	Chapman: 4.1, 4.2	CLO1, CLO3
7.	- Induced voltage in an AC machine - Induced torque in an AC machine	Chapman: 4.3, 4.4, 4.5	CLO1, CLO3
8.	- AC Machines power flows and losses - Voltage and Speed regulation	Chapman: 4.7, 4.8	CLO1, CLO3
9.	- Speed of rotation of a synchronous generator - Internally generated voltage of a synchronous generator	Chapman: 5.2, 5.3	CLO3
10.	- Equivalent circuit of a synchronous generator	Chapman: 5.4, 5.5, 5.6	CLO3

	- Phasor diagram of a synchronous generator		
11.	- Synchronous generator operation - Parallel operation of AC Generators	Chapman: 5.8, 5.9	CLO3
12.	- Basic principles of motor operation - Steady-state synchronous motor operation	Chapman: 6.1, 6.2	CLO1, CLO3
13.	- Effect of load changes on a synchronous motor - Power-factor correction - Starting synchronous motors	Chapman: 6.2, 6.3, 6.4	CLO3
	Midterm		
14.	- Basic induction motor concepts - Equivalent circuit of induction motor	Chapman: 7.2, 7.3	CLO4
15.	- Power and Torque in Induction motors	Chapman: 7.4	CLO4
16.	- Torque-speed characteristics	Chapman: 7.5	CLO4
17.	- Speed control of induction motors - The induction generator	Chapman: 7.9, 7.12	CLO4
18.	- A simple rotating loop between curved pole faces - Commutation in a simple four-loop DC machine	Chapman: 8.1, 8.2	CLO1, CLO5
19.	- Problems with commutation in real machines - The internal generated voltage and induced torque equations of DC machines	Chapman: 8.4, 8.5	CLO5
20.	- The construction of DC Machines - Power flow in DC machines - Losses in DC Machines	Chapman: 8.6, 8.7	CLO5
21.	- Equivalent circuit – DC machines - Magnetization curve – DC machines	Chapman: 9.2, 9.3	CLO5
22.	- Separately excited and shunt DC Motors - Permanent Magnet DC Motor	Chapman: 9.4, 9.5	CLO5
23.	- Series DC Motor - Compound DC Motor - DC motor efficiency calculations	Chapman: 9.6, 9.7, 9.10	CLO5
24.	- Separately excited DC Generator - Shunt DC Generator	Chapman: 9.12, 9.13	CLO5
25.	- Series DC Generator - Compounded DC Generators	Chapman: 9.14, 9.15, 9.16	CLO5
26.	- Single phase motors - Universal motor	Chapman: 10.1	CLO1, CLO3
27.	- Single phase induction motor	Chapman: 10.2	CLO4
28.	- Starting single phase induction motors	Chapman: 10.3	CLO4

Textbook(s)/Supplementary Readings

Textbook:

Electric Machinery Fundamentals (4th Edition) by Stephen J. Chapman

Supplementary Reading:

Electric Machinery (6th Edition) by A.E. Fitzgerald; Charles Kingsley, Jr; Stephen D. Umans

	Labs (1+n weeks → simulation + performance)		
1	Design of an Inductor using Ferrite Core using different core shapes - Toroid shape - E-I shape - E-E shape	1 week	CLO6
2	Voltage Regulation in a Single Phase Transformer and Auto transformer for - Resistive Load - Capacitive Load	1 week	CLO6

3	Measure Equivalent circuit parameters of a Single Phase Transformer - Open Circuit Test - Short Circuit Test	1 week	CLO6
4	Magnetic characteristics (Open Circuit Characteristics): - Separately Excited DC Generator - Shunt Generator	1 week	CLO6
5	Load Characteristics of a DC Shunt Generator (Self excited generator)	1 week	CLO6
6	Load Characteristics of a series DC Machine - As a motor - As a generator	1 week	CLO6
7	Load Test - DC shunt motor - Separately Excited Motors	1 week	CLO6
8	Voltage drops inside a DC Shunt Generator at different loads	1 week	CLO6
9	Load Characteristics of a Single Phase Capacitor Start Induction Motor	1 week	CLO6
1	Load Characteristics of a 3-Phase Squirrel Cage Induction Motor	1 week	CLO6
1	Use of Induction Motor as an Induction Generator	1 week	CLO6
1	Synchronization of an Synchronous Generator (Alternator) with WAPDA Bus Bar	1 week	CLO6