Lahore University of Management Sciences

EE452 – Power Electronics

Fall 2013-14

Instructor	Nauman Ahmad Zaffar
Room No.	9-313A
Office Hours	WT 10-11am
Email	nauman.zaffar@lums.edu.pk
Telephone	X8311
TA	TBD
TA Office Hours	TBD
Course URL (if any)	

Course Basics				
Credit Hours	4			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 min each
Recitation (per week)	Nbr of Lec(s) Per Week	1	Duration	50 min
Lab (per week)	Nbr of Lec(s) Per Week	1	Duration	170 min

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

COURSE DESCRIPTION
This is the first course in Power Electronics. Students will learn about specific areas of application and the reasons Power Electronics is becoming popular in areas traditionally occupied by analog electronics. The course will cover applications in conversion and control of power using Power semiconductor devices, physics of their structure and operation and passive components in power circuits. Students will also learn the principles governing the operation of converters, different standard topologies, applications in power systems, motor drives, and applications in renewable energy sources.

COURSE PREREQUISITE(S)	
• EE340	• Devices and Electronics

COURSE OBJECTIVES	
1.	Understand large signal behavior of devices and applications in high power circuits
2.	Get hands-on experience on development of components and circuits within reasonable power limits
3.	Understand “form and function” of fundamental converter topologies and their application
4.	Design of practical converters/circuits based on specific needs

Learning Outcomes	
1.	Understand the need, use and limitations of Power Electronics
2.	Appreciate the linkage of Power Electronics with electromagnetics, circuits, devices, electronics, feedback, control, power systems, machines and emerging application areas like renewables, smart grids and high frequency applications.
3.	Understand the factors affecting choice of devices in power electronics

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4.	Learn various topologies that are prevalent and be able to extend the design to develop practical circuits based on application specifications

Grading Breakup and Policy
Assignment(s): N/A Home Work: 06 → 5% Quiz(s): 7-8 → 15% Class Participation: N/A Attendance: N/A Labs: 12 → 15% Midterm Examination: 01 → 25% Project: → 10% Final Examination: Comprehensive → 35%

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

Week	Topics	Recommended Readings	Objectives/Application
1.	Introduction: - Review of concepts - Application examples - Classification of Power processors - Elements of Power Electronics	Mohan: Chapter 1 Erickson: Chapter 1	
2.	Switch Realization - Types of switches - Overview of Power semiconductor devices - Comparison - Driver circuits Power Diodes - Structure - Switching characteristics	Mohan: Chapter 2 Erickson: Chapter 4 Mohan: Chapter 20	
3.	Power Mosfets - Switching characteristics - Operating limitations and safe operating areas	Mohan: Chapter 22	
4.	Thyristors - Basic Structure	Mohan: Chapter 23	

	- I-V characteristics and device operation - Switching characteristics IGBTs - Basic Structure - I-V characteristics and device operation - Switching characteristics	Mohan: Chapter 25	
5.	Steady State Converter Analysis - Inductor Volt-Sec Balance - Capacitor Amp-Sec Balance - CCM Analysis - Converter Analysis (Buck, Boost, Cuk, etc.) - Ripple estimation and design	Erickson: Chapter 2	
6.	DCM Analysis of converters - Conduction mode boundary - Converter Examples: Boost, etc.	Erickson: Chapter 5 Mohan: Chapter 7	
7.	Converter Circuits: Form and Function - Canonical cell model - Circuit Manipulation	Erickson: Chapter 6	
	Midterm		
8.	Transformer Isolation - Full Bridge, Half Bridge, Push-Pull and Flyback converters - Boost Derived converters - Isolated SEPIC and Cuk converters - Switch Stress and Utilization	Erickson: Chapter 6	
9.	AC-DC converters: - Rectifiers - 1-ϕ and 3-ϕ rectifiers - Inductive Load	Mohan: Chapter 5	
10.	Phase controlled rectifiers: - Use of Thyristors - 3-ϕ converters	Mohan: Chapter 6	
11.	Power and Signals in Non-Linear Circuits: - Basic magnetic theory - Electric Circuits - Power and Harmonics in Non-sinusoidal systems	Mohan: Chapter 3 Erickson: Chapter 16	
12.	Magnetics: - Magnetic Circuits - Transformer modeling - Loss Mechanisms - Eddy Currents	Erickson: Chapter 13	
13.	Inductor Design - Filter Inductor Design - Multiple winding magnetics design	Erickson: Chapter 14	
14.	Transformer Design - Basic Constraints and design process - Example designs - AC Inductor Design	Erickson: Chapter 15	

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Textbook(s)/Supplementary Readings
Textbook: Power Electronics Converters Applications and Design by Ned Mohan, Undeland, Robbins, 3rd Edition, John Wiley and Sons, 2003 Fundamentals of Power Electronics by Erickson and Maksimovic, 2nd Edition, Oxford University Press, 2005 **Supplementary Reading:**

Labs (1+n weeks → simulation + performance)		
1.	Switching characteristics of Devices – Power Diodes and Power Mosfets	1+1 weeks
2.	AC – DC Conversion: SCRs and Phase Controlled Rectifiers – Characteristics, Half wave controlled rectification, R-L Load, Full Bridge Rectification	1+2 weeks
3.	DC-DC Conversion: Buck Converter – Design, Simulation and Implementation of CCM and DCM operation. Effect of parasitics	1+1 weeks
4.	DC – AC Conversion: Inverter – Design, Simulation and Implementation of Square wave with resonant filter and PWM inverter with LP filter	1+2 weeks
5.	Course Project: Design, Simulation and Implementation of Application Specific PE converter	04 weeks
6.	DC Motor Drive – Optional extra lab	