ELECTRICAL, COMPUTER, AND SYSTEMS ENGINEERING DEPARTMENT

ABET COURSE SYLLABUS

EPOW-4080: Semiconductor Power Electronics

Course Catalog Description:

The application of power semiconductor devices to the efficient conversion of electrical energy. Circuit analysis, signal analysis, and energy concepts are integrated to develop steady-state and dynamic models of generic power converters. Specific topics include AC/DC conversion, DC/DC conversion, DC/AC conversion, and AC/AC conversion. These generic converters are applied as controlled rectifiers, switching power supplies, motor drives, HVDC transmission, induction heating, and others. Ancillary circuits needed for the proper operation and control of power semiconductor devices are also discussed. Prerequisite: ECSE-2050. Fall term annually. 3 *credit hours*.

Pre-Requisite Courses:

Analog Electronics (ECSE-2050) or Electronics and Instrumentation (ENGR-4220).

Co-Requisite Courses:

None

Prerequisites by Topic:

1. DC and AC Circuits Steady State Analysis
2. Transient Response of RLC Circuits
3. Diodes, Bipolar Transistors, MOSFET, Op-Amps
4. Laplace Transform, Transfer Functions
5. Frequency Response and Basic Concept of Stability
6. Transformers
7. Fourier Analysis, Harmonics
8. Active and Reactive Power, Power Factor
9. Phasors
10. Three-Phase AC Circuits
11. Familiarity with PSpice and Matlab

Textbook:
(and/or other required material)

R.W. Erickson & D. Maksimovic, Fundamentals of Power Electronics", 2nd Ed. Kluwer Academic Publishers, 2001

References:

N. Mohan, T. Undeland, and W. Robbins, Power Electronics, John Wiley & Sons, Inc., 3rd Edition, 2003; Course Notes

Course Coordinator:

Jian Sun

Overall Educational Objective:

To introduce students to the fundamentals of electric energy processing by means of semiconductors and control.

Course Objectives:

1. Determine steady-state operation of circuits containing switches and energy storage elements (capacitors and inductors)
2. Analyze dc operation of dc-dc (isolated and non-isolated) converter in continuous and discontinuous conduction mode
3. Model dynamic behavior of dc-dc converters for feedback control design
4. Determine and understand steady-state operation and characteristics of single-phase uncontrolled rectifier
5. Determine and understand steady-state operation and characteristics of three-phase uncontrolled rectifier
6. Understand principles and applications of pulse-width modulated inverters

How Course Objectives are Assessed:

7 Homework Assignment	15%
1 Laboratory Project	10%
1 Midterm Exam	25%
Final Exam	50%

Relation to EE/CSE/EPE Outcomes

N = none
M = moderate
H = high

Outcome	Level	Demonstrate Proficiency
	N, M, H	e.g. Exams, projects, HW
Mathematics, science and engineering	H	Exams, Labs, HW
Basic disciplines in Electrical Engineering	N	
Depth in Electrical Engineering	H	Exams, Labs, HW
Basic disciplines in Computer & Sys. Eng.	N	
Depth in Computer and Systems Eng.	N	
Electromagnetics, electromechanics, power semiconductors	H	Exams, Labs, HW
Power system behavior	M	Exams, Labs, HW
Electrical energy conversion	H	Exams, Labs, HW
Conduct experiments and interpret data	M	Labs
Identify, formulate and solve problems	M	Exams, HW
Design a system, component or process	N	
Communicate in written and oral form	N	
Function as part of a multi-disciplinary team	N	
Preparation for life-long learning	N	
Ethical issues; safety, health, public welfare	N	
Humanities and social sciences	N	
Laboratory equipment and software tools	M	Labs
Variety of instruction formats	N	

Topics Covered:
(number of hours or classes for each)

1. Review of Basic Circuit Concepts and Analysis Techniques (1)
2. DC-DC Converter Topologies and Steady-State Operation (4)
3. Practical Aspects of DC-DC Converters (2)
4. Dynamic Modeling of DC-DC Converters (2)
5. Discontinuous Conduction Mode (2)
6. Single-Phase AC-DC Converters (2)
7. Three-Phase AC-DC Converters (2)
8. Harmonics, Power Factor, and Power Factor Correction (2)
9. Basic Principle and Circuit of DC-AC Inversion (2)
10. Pulse-Width Modulation (1)
11. Single-Phase PWM Inverters (1)
12. Three-Phase PWM Inverters (1)
13. Magnetic Components for Power Conversion Applications (1)
14. Transformer-Isolated DC-DC Converters (2)
15. Power Electronics Applications (2)

Computer Usage:

Students use PSpice to analyze different power converter circuits and control, and MATLAB for various purposes

Laboratory Experiences:

1. DC-DC Converters – Build a boost dc-dc converter and measure its steady-state operation characteristics (voltage transfer ratio, control characteristics, different voltage and current waveforms) and performance (efficiency)
2. AC-DC Rectifiers – Build a single-phase uncontrolled rectifier and measure its operation with different load configurations: capacitive filtering, inductive filtering with discontinuous current, and inductive filtering with continuous current; input current harmonics and power factor

Design Experiences:

1. Design of DC-DC converters with given input/output requirements

Independent Learning Experiences:

1. Laboratory projects require independent learning of different instruments used in the lab and characteristics of different passive and active components

Class/Lab Schedule:

Monday and Thursday Lectures 2-3:50pm. One week for Lab in the middle of the semester.

Contribution to the Professional Component:	(a) College-level mathematics and basic sciences:	0 credit hours
	(b) Engineering Topics (Science and/or Design):	3 credit hours
	(c) General Education:	0 credit hours

Prepared by:	Jian Sun
Date:	April 3, 2006