ECE 5234: Si and Wide Band Gap Power Devices

Course Description

Basic design and operation of Si and Wide Band Gap (WBG: SiC, GaN and ultra wide band gap semiconductors) power devices and the applications of commercial devices in power electronics applications. Trade-offs between various devices. Static and dynamic operation. Comparison of Si and SiC devices and design differences.

Prior Course Number: 5194.07
Transcript Abbreviation: Si/WBG Power Dev
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Junior, Senior, Masters, Doctoral
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: 3030 or grad standing in engineering or physics.
Exclusions: Not open to students with credit for 5194.07
Cross-Listings:

Course Rationale: Update and expand curriculum to include modern power devices.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

Course Goals

Provide an introduction to basic operation of Si and wide band gap power devices
Students master design principles of power devices
Students become competent with specifications of commercial power devices

Students are exposed to the processing details of power devices
Students become familiar with reliability issues and testing methods

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Introduction to basic power devices, characteristics and applications	2.0							
Material Properties of Si and wide band gap semiconductors	2.0							
Design for Breakdown Voltage various edge terminations	2.0							
Ideal Specific On-Resistance for Si and WBG device	2.0							
Schottky Diodes: Forward conduction and reverse blocking	2.0							
Design of Schottky Diodes	1.0							
Commercial specifications of Schottky Diodes	1.0							
PiN Diodes: Forward conduction and reverse blocking	2.0							
Design of PiN Diodes	1.0							
Commercial specifications of PiN Diodes	1.0							
Planar power MOSFETs: Forward conduction and forward blocking	1.0							
Channel mobility	1.0							
Design of Si and SiC planar power MOSFETs	2.0							
Dynamic operation	1.0							
Unclamped inductive switching and short circuit time	1.0							
Latch up and Safe Operating Area (SOA)	1.0							
Commercial specifications of Si and SiC planar power MOSFETs	1.0							
Reliability issues	1.0							
Trench MOSFETs	1.0							
Super Junction MOSFETs	1.0							
GaN and Ultra WBG Lateral Power HFETs	2.0							
Si and SiC IGBTs: Structure and Operation	2.0							
Symmetric and Asymmetric designs	1.0							
Forward conduction	1.0							
Forward blocking	1.0							
Dynamic operation and dependence on lifetime	2.0							
Latch up and Safe Operating Area (SOA)	1.0							
Design and processing of SiC power devices	3.0							

Representative Assignments

Midterm
Final
Homework

Grades

Aspect	Percent
Hoemwork	40%

Aspect	Percent
Midterm	30%
Final	30%

Representative Textbooks and Other Course Materials

Title	Author
Gallium Nitride and Silicon Carbide Power Devices	Jayant B

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
**	a	An ability to apply knowledge of mathematics, science, and engineering.
*	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
***	c	An ability to design a system, component, or process to meet desired needs.
*	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
*	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
**	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
**	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Additional Notes or Comments

The course has been revised to include GaN devices. SiC has been replaced with wide band gap (WBG).

Prepared by: Anant Agarwal