ECE 735-001
Wide Band Gap Semiconductor Power Devices

Instructor(s): B. Jayant Baliga (bjbaliga@ncsu.edu)

Objective or Description: The new course provides students with an in-depth knowledge of power devices built from wide bandgap semiconductors. The design of high breakdown voltages, a key distinguishing parameter for power devices, with limitations imposed by the edges, is reviewed. The physics of unique power rectifier structures suitable for SiC material is analyzed. The operating principles for unique SiC power MOSFETs, and GaN HEMT devices is discussed. The development of bipolar power devices from SiC to achieve ultra-high voltage performance is described. The performance of wide bandgap semiconductor power devices is compared with advanced silicon devices.

Prerequisites: ECE553 Semiconductor Power Devices

Textbook: 'Gallium Nitride and Silicon Carbide Power Devices'
Author: B. Jayant Baliga
Publisher: World Scientific Publishers – 2017
ISBN: 9789813109407

'Fundamentals of Power Semiconductor Devices'
Author: B. Jayant Baliga
Publisher: Springer Science – 2008
ISBN: 978-0-387-47313-0

Topics:

Introduction	1 lecture
Material Properties	2 lectures
Breakdown Voltage	2 lectures
Schottky (JBS) Rectifiers	3 lectures
P-i-N & MPS Rectifiers	3 lectures
SiC JFET & Baliga Pair	2 lectures
Si GD-MOSFET and COOLMOS	1 lecture
SiC Power MOSFET	3 lectures
GaN HEMT	2 lectures
SiC BJT	1 lecture
SiC GTO	1 lecture
SiC IGBT	2 lectures
Comparison of Devices	1 lecture

Grading:

The final course grade will be determined by the weighted average of:

Home Work Assignments	= 25 % of total final grade
Mid-Term Exam	= 25 % of total final grade
Final Exam	= 25 % of total final grade
Project Report and Presentation	= 25 % of total final grade

More than half of all the electricity used in the world is controlled by power semiconductor devices. All solid state and power electronics students should have a basic knowledge of the various types of power semiconductor devices used by the industry. The analysis, performance, and design of Silicon power semiconductor devices is covered in ECE553.

The ECE735 course provides students with an in-depth knowledge of power devices built from wide bandgap semiconductors. The design of high breakdown voltages, a key distinguishing parameter for power devices, with limitations imposed by the edges, is reviewed. The physics of unique power rectifier structures suitable for SiC material is analyzed. The operating principles for unique SiC power MOSFETs, and GaN HEMT devices is discussed. The development of bipolar power devices from SiC to achieve ultra-high voltage performance is described. The performance of wide bandgap semiconductor power devices is compared with advanced silicon devices. Applications and social impact is discussed.