The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6206 POWER SEMICONDUCTOR DEVICES

Credits: 15

Course Description including Aims

1. Introduce and develop an understanding of power semiconductor devices - physics, technologies, design, fabrication and characterisation.
2. Evaluate suitability of various semiconductor device concepts for specific power electronic applications.
3. Device integration concepts such as device assembly, packaging and thermal constraints.

Outline Syllabus

Introduction to power semiconductor devices. Review of semiconductor device physics: properties of semiconductors, energy band diagrams, carrier statistics, carrier transport, continuality and Poisons equations. **Bipolar device technologies** Power diodes, transistors and thyristors: basic structures, breakdown mechanisms, on-state / transient behavior, state-of-the-art structures i.e. soft recovery processes, high voltage Schottky junctions. **Unipolar and MOS bipolar device technologies:** MOSFET and IGBT device physics, modes of operation, static and dynamic characteristics. Physical limits of MOSFET device technologies and evolution of the IGBT. **Power device processing:** Fabrication techniques, power IC and discrete technologies, design rules, device active area and terminations zones. **Power device packaging and evaluation:** How to read datasheets, power loss analysis and cooling, discrete and multi-chip packaging design and processes. **Future power device technologies:** Wide band gap semiconductors, GaN and SiC device technologies, long term future device materials for packaging and power devices.

Time Allocation

35 lectures plus 62 hours of independent study

Assessment

2 hour examination (60%): Candidates must choose any three out of four questions. Multiple Choice Test (20%). Assignment (20%).

Recommended books

B. G. Streetman	Solid state electronic devices
S. M. Sze	Semiconductor devices: physics and technology
B. J. Baliga	Power semiconductor devices
D. K. Schroder	Semiconductor material and device characterisation
V. Benda	Power semiconductor devices: theory and application
N. Mohan	Power electronics converters, applications and design
B. J. Baliga	Silicon carbide power devices
V. Khanna	Insulated gate bipolar transistor: theory and design

Objectives

By the end of this module successful students will be able to:

1. To demonstrate an in depth understanding of power device technologies and physical fundamental limits imposed to them.
2. To synthesize the role of power semiconductor device in an application and how these influence overall system design.
3. To analyse device operation in terms of material physics and how these effect the device during on state and switching transients.
4. To be able to design devices for target applications and comment on their electrical characteristics.
5. Show an in depth understanding of non-silicon based technologies and have knowledge of future technologies.
6. To be able to evaluate the performance of a semiconductor device in a typical application and understand the impact of modifying device parameters upon system performance.
7. Link datasheet parameters to physical device performance and understand ratings for specific applications.