The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6215 NANOSCALE ELECTRONIC DEVICES

Credits: 15

Course Description including Aims

The course aims to provide students with an understanding of the science and technology which underpins modern electronic device technology, with an emphasis on integrated electronic devices at the nanoscale. The course begins with a discussion on the need for advanced electronic devices and systems, the present-day commercial application sectors and future perspectives. Following a short resume on semiconductor electronic properties the course will introduce basic transistor device types including the bipolar junction transistor, the metal-semiconductor FET and the metal-oxide FET; describing their structure, fabrication method and electronic characteristics. The high speed/high power performance capabilities of these approaches will be described. The use of semiconductor heterojunctions to create advanced bipolar and FET devices will be discussed. The course goes on to describe integrated circuits based on CMOS technology, discussing the historical scaling of device size, the current state of the art in device structure and properties and the challenges faced for future high speed IC developments. The course finishes with a discussion of the present state of the art in advanced devices including the physical properties, technological realization and potential future developments for semiconductor devices at the nanoscale.

Course Objectives

On successful completion of this module the students should be able to:

1. Understand the major application areas of modern electronic devices and have knowledge of the present market and future technological needs.
2. Have knowledge of the basic structural, electronic and optical properties of semiconductor materials of relevance to transistor operation
3. Describe the basic structure, physical operation and the device characteristics of various transistor types
4. Demonstrate an understanding of the performance, systems capability and limitations advanced electronic devices
5. Gain knowledge on how advanced materials and advanced device geometries may be used to create high speed or high power electronic devices.
6. Have knowledge of the principles behind Integrated Circuit development and of device scaling, including an understanding of the key scientific and technological issues at present.
7. Understand modern CMOS technology and its application in different sectors (eg: CPU, MCU, memory, image sensors)
8. Discuss other types of semiconductor electronic devices used in high performance circuits.
9. Gain knowledge on how photonic devices may play a role in future high speed electronic systems
10. Have an understanding of the current state of the art and of future trends in high-speed electronic device development.

Recommended Previous Courses

Students are required to have a background which covers basic semiconductor device properties together with some elements of semiconductor technology. Previous knowledge of the basic properties of semiconductor materials such as the crystal structure, doping control of conduction, electron mobility, optical band gap and of the operation of simple devices such as pn-diodes, bipolar transistors and field effect transistors is important for this course. Students should have either taken the previous modules EEE118 “Electronic Devices” and EEE225 “Analogue and Digital Devices” or have taken external courses with equivalent learning outcomes.

Assessment

2 Hour Examination the end of semester 2. Candidates must choose any three out of four questions (75% total marks)

Students will be provided with a short interim test or written assignment after completion of individual sections which will account for 25% of the module score

Recommended Books

S.M.Sze and M.J Lee	*Semiconductor Devices: Physics and Technology*	Wiley
D.L.Pulfrey	*Understanding Modern Transistors and diodes*	Cambridge
S.M. Sze and K.K. Ng	*Physics of semiconductor devices*	Wiley
B.G. Streetman and S. Banerjee	*Solid state electronic devices*	Prentice Hall
Y.Taur and T.H Ning	*Fundamentals of modern VLSO devices*	Cambridge