The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6040 ADVANCED SOLID STATE DEVICES

Credits: 10

Course Description including Aims

1. Introduce the physical factors affecting operating speed in electronic devices.
2. Describe the effects and limitations of miniaturisation in CMOS devices.
3. Investigate limitations on device performance due to noise and power dissipation problems.
4. Demonstrate the range of present and future device performance and functional improvements possible using heterojunctions and newer semiconductor materials and devices.
5. Explore the possible upper limitations on frequency performance of new electronic devices and how they may solve current demands for ever increasing bandwidth systems.

Outline Syllabus

Electron and hole transport in semiconductors, band structure. Review of the FET family of transistor devices, design parameters affecting speed. Figures of merit f_T and f_{max}. Scaling effects in CMOS. Moore's Law. International Technology Roadmap for Semiconductors. Speed limits on CMOS and technology to overcome these. Compound semiconductors. Semiconductor heterojunctions, III-V and Si-Si/Ge heterojunction bipolar transistors (HBTs). BiCMOS, MESFET, HEMT. Impact ionisation, IMPATT.

Time Allocation

22 lectures plus 12 hours of additional support material.

Recommended Previous Courses

EEE207 "Semiconductor Electronics and Devices"

Assessment

2 Hour Examination. Candidates must choose any three out of four questions.

Recommended Books

Ben G. Streetman and Sanjay Banerjee	*Solid state electronic devices 5th ed*	Prentice Hall
D.L.Pulfrey	*Modern Transistors and diodes*	Cambridge
S.M. Sze	*Semiconductor devices: physics and technology 1st or 2nd ed)*	Wiley

Objectives

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

1. Demonstrate understanding of speed-related issues of CMOS and fundamental physical limits to high-speed performance.
2. Describe the range of new CMOS based technologies being used to increase speed.
3. Demonstrate knowledge of non-silicon based devices and how these can improve on past technology, particularly related to increased frequency performance.
4. Show an awareness of devices that might become available in the future to solve current problems in high-speed electronics.
5. Specify a CMOS device design to operate at a particular bit rate.
6. Design HBTs suitable for a use in a high frequency amplifier circuit.