

Engineering Tripos Part IB, 2P8: Electrical Engineering, 2018-19

Lecturers

[Dr S Sambandan and Professor A J Flewitt](#) [1]

Timing and Structure

Weeks 1-4 Easter term. 16 lectures including worked examples, 4 lectures/week.

Aims

The aims of the course are to:

- Give the student an appreciation of the scientific understanding, electronic materials, processing technology, and the design of the transistors, displays and storage devices inside a modern personal computer.

Objectives

As specific objectives, by the end of the course students should be able to:

- Understand the concepts of electronic motion in metals and semiconductors and doping in semiconductors.
- Understand the concepts in the design of a field effect transistor.
- Understand the relationship between switching speed and dimensions in transistor design.
- Give an overview of the technology of processing materials and the impact on transistor design.
- Give an overview of lithography techniques and the impact on transistor design.
- Understand the technological implications of increased speed and reduced dimensions of transistors
- Give a vision of potential future developments where transistors have atomic scales.
- Have an appreciation of the different technologies which can be used for flat panel displays.
- Have a basic understanding of liquid crystal displays and active matrix liquid crystal displays.
- Have a basic understanding of how a magnetic storage hard disk drive works, and materials used.

Content

Ubiquity of Semiconductor Devices (1L)

Semiconductor devices are hugely common in modern life, in cell-phones, computers, TVs, solar cells, lighting (light emitting diodes). How do they work inside?

Electronic devices in computers - Switches, logic, storage, DRAM, SRAM, idea of Moore's law

What is a Semiconductor (1L)

- Bonding in metals and semiconductors. Band gaps. Periodic table, Doping.
- The electron as a particle, a pin-ball model for conduction. Mobility, saturated velocity. Worked examples.

The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) (4L)

- Operating concepts of MOSFETs. Transit time. Switching speed. Gate control.
- MESFETs vs MOSFETs. Why Si not GaAs.
- Elementary discussion of Scaling and Moore's law.

Technological Challenges (5L)

- Material preparation, lithography - comparison of U.V., electron beam, X-ray.
- Oxidation of silicon
- Etching - wet and dry processes.
- Doping - diffusion, ion implantation, reduction/process limits, metallisation.
- Worked examples.

Magnetic storage technology (1L)

- Elementary principles of magnetic storage - BH loops, bits, writing, reading.
- The mechanical design of a modern hard disk drive.
- The material in a disk and read head.

Displays (3L)

- Display technologies - electricity into light.
- What are Liquid crystals.
- Active matrix liquid crystal displays.

Towards the Future (1L)

- How device dimensions and voltages reduce to give even smaller and faster transistors, towards and atomic scale.

Booklists

Please see the [Booklist for Part IB Courses](#) [2] for references for this module.

Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [3].

UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the ['Accreditation of Higher Education Programmes' \(AHEP\) document](#) [5] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links

[1] <mailto:ss698@cam.ac.uk>, ajf23@cam.ac.uk

[2] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364081&chapterid=44091>

[3] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[4] <http://www.engc.org.uk/ukspec.aspx>

[5] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>

[6] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>