Module Leader
Dr C Durkan

Lecturer
Dr C Durkan

Timing and Structure
Michaelmas term. 12 lectures (including examples classes) + coursework. Assessment: 75% exam/25% coursework

Prerequisites
3B5 and 3B6 useful

Aims
The aims of the course are to:

- Introduce the underlying concepts behind nanotechnology and look at examples of it in everyday use.

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

- explain basic principles of quantum mechanics.
- understand how wave phenomena of electrons can be predicted.
- understand the origin of band structure in solids.
- appreciate how nanoscale engineering allows for wave based electronic devices to be realised.
- prepare for design and research in solid state electronic/opto-electronic devices.

Syllabus
The aim of this module is to introduce the basic quantum mechanical principles which underpin the design and operation of modern electronic devices. Mathematical formalism is kept to the minimum required for quantitative analysis of solid state devices. No previous knowledge of quantum phenomena is assumed.

Nanotechnology & quantum phenomena

- Lecture 1. Introduction to Nanotechnology. The origins of Quantum Mechanics (QM).
- Lecture 2. Wave-particle duality, wave equation, momentum, energy and Schrodinger’s equation, probability density and normalisation.
- Lectures 3 & 4. QM expression for electron current, solutions to Schrodinger’s equation (finite potential well, infinite barrier-tunnelling). Atoms & molecules. Approximate methods in QM - example, Field Emission.
- Lecture 5. Atomic vibrations in materials - the simple harmonic oscillator as seen by QM - application to
understanding the thermal & electrical properties of materials
- Lectures 10 & 11. Basic device concepts utilizing particle and wave nature of electrons: Quantum wells, 2-D electron gas and high electron mobility transistors (HEMT), resonant tunnelling, ballistic, transistors, optically absorbing and radiating devices.

Further notes

The lectures can be found at the following moodle link:

https://www.vle.cam.ac.uk/course/view.php?id=69501

Coursework

4 hour interactive computer simulation on aspects of solid state and quantum electronics. A formal report of the simulation is required (approximately six hours’ work).

Booklists

Please see the Booklist for Group B Courses for references for this module.

Assessment

Please refer to Form & conduct of the examinations.

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) 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 which sets out the standard for degree accreditation.

The Output Standards Matrices 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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Source URL (modified on 31-05-16): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4b5-nanotechnology-2016-17

Links
[1] mailto:cd229@cam.ac.uk