Nanoscience Course Outline - 2006
Lecturers: Professor David. R. McKenzie, Dr Vicki Keast, Professor Ben Eggleton

Nanoscience is the study of the materials and devices fabricated on the nanometre scale, where the properties or principles rely on phenomena that occur only at the nanometre scale. Creating these structures requires methods for manipulating matter on these scales, and there are two approaches: top-down and bottom-up. These techniques can be applied to the fabrication and operation of devices in areas such as nanoelectronics, quantum computing, optoelectronics and photonic crystals. Nanoscience is a very broad and interdisciplinary field and this lecture course will focus on a few specific examples where the physics at the nanoscale is fundamentally altered.
The student who successfully completes this course will:

- Have a knowledge of the fundamental physics of nanoscience;
- Have a knowledge of examples of nanoscience as applied to technology;
- Be able to carry out calculations relevant to quantum systems, photonic systems and nanoparticles.
- Be able to specify processes necessary to achieve desired nanoscale structures.
- Be able to specify appropriate characterisation methods to observe nanoscale structures.

The course structure is as follows:

Tuesday March 7, 12:00 Lecture 1, *V. Keast*
Introduction
- What is Nanoscience?
- Historical perspectives.
- Current applications and future trends
- How the physics at the nanoscale is different and important.

Wednesday March 8, 9:00 am Lecture 2, *V. Keast*
Light Emission from Quantum Confined Systems I

Thursday March 9, 11:00 am Lecture 3 *V. Keast*
Light Emission from Quantum Confined Systems II

Tuesday March 14 12:00 Lecture 4, *V. Keast*
Light Emission from Quantum Confined Systems III

Wednesday March 15, 9:00 am Lecture5, *B. Eggleton*
Nanophotonics

Thursday March 16, 11:00 am Lecture 6 *B. Eggleton*
Photonic bandgap structure: Enabling Nanophotonics

Tuesday March 21, 12:00 Lecture 7 *B. Eggleton*
Photonic bandgap fibres

Wednesday March 22, 9:00 am Lecture 8 *B. Eggleton*
Lithographic techniques applied to Nanophotonic components

Thursday March 23 11:00 am Lecture 9, *B. Eggleton*
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Tuesday March 28, 12:00 Lecture 10 *B. D. McKenzie*
Nanoparticles and Scattering I

The electromagnetic problem of a sphere in a plane wave field
Small spheres-the quasistatic limit and the Maxwell Garnet formula
Spheres as colour generators in a medium

Wednesday March 29, 9:00 am Lecture 11, *D. McKenzie*
Nanoparticles and Scattering II
Spheres as confined electron systems-plasmon effects
The general ellipsoid
Self organisation of spheres into arrays
Applications of nanoparticle arrays in materials physics
Applications of nanoparticles in medicine

Thursday March 30, 11:00 am Lecture 12 *D. McKenzie*
Limits to Miniaturisation
Limits to miniaturization of random access memory devices
Quantum limit
Thermal limit
Combined Limits on speed of operations and power requirements

Tuesday April 4, 12:00 Lecture 13 *D. McKenzie*
The Quantum computer I

Wednesday April 5, 9:00 am Lecture 14 *D. McKenzie*
The Quantum Computer II

Thursday April 6 11:00 am Lecture 15 *D. McKenzie*
The Quantum Computer III

Tuesday April 11, 12:00, Lecture 16 *V. Keast*
Characterisation of Nanostructures I

Wednesday April 12, 9:00 am, Lecture 17 *V. Keast*
Characterisation of Nanostructures II

Thursday April 13, 11:00 am, Lecture 18 *V. Keast*
Characterisation of Nanostructures III

April 14-23 – mid-semester break
April 25 – Anzac Day

Wednesday April 26, 9:00 am, Lecture 19
Final Lecture and Wrap-Up

Assignments

Assignment 1
Distributed March 14 Due March 28
Two Questions set by V Keast
One Question set by B Eggleton

Assignment 2
Distributed April 13 Due April 27 V. Keast
One Question set by B Eggleton
Two Questions set by D. McKenzie