Nanoelectronics

Module code: 0730221 ***Year: 3*** ***Term: 7 (Autumn)***
Credit Units: 10
Stream: Nanotechnology
Level: H

Aims and Objectives:

Aims:

- To introduce the students to nanoelectronics, nanodevices, spintronics and molecular electronics.
- To identify quantum mechanics behind nanoelectronics.
- To describe the principle and the operation of nanoelectronic devices.
- To explain the principle and application of spintronic devices.

Objectives (learning outcomes):
On completion of this module students are expected to be able to:

- Explain the fundamental science and quantum mechanics behind nanoelectronics.
- Explain the concepts of a quantum well, quantum transport and tunnelling effects.
- Differentiate between microelectronics and nanoelectronics.
- Describe the superposition of eigenfunctions and probability densities.
- Describe the spin-dependant electron transport in magnetic devices.
- Calculate the energy levels of periodic structures and nanostructures.
- Calculate the *I-V* characteristics of nanoelectronic devices.
- Simulate the magnetoresistance response of 2-dimensional structures.
- Summarise the applications of nanotechnology and nanoelectronics.
- Understand the impact of nanoelectronics onto information technology, communication and computer science.

Indicative content (Syllabus)

- Fundamental physics and quantum mechanics: electrons in one atom, the photoelectric effect, the uncertainty principle, wave function, Schrödinger equation, eigenfunctions, quantum numbers, superposition of eigenfunctions, probability densities, angular momentum, spins, Hermitean operators, two particle system, a nanocluster with tens of atoms, quantum well, and tunneling.
- Nanoelectronic and spintronic devices: quantum dots, nanowires, nanopillars, quantum transport and tunneling effects, magnetoresistance, spin-dependent electron transport, molecular electronics, and single electron transistors.
- Examples of applications.

Course prerequisites:
Year 1 and year 2 nanotechnology courses

Teaching methods

(a) Types and quantities of teaching activities:
In order to the learning outcomes, the following teaching methods are used:

Teaching activity	Number of hours	Comments
Lecture	18	
Workshops	5	Literature review and tutorial questions

(b) Teaching and learning materials

The following teaching and learning materials are used to support the teaching of this module:

Material type	Yes/No	Comments
Copy of lecture slides	Yes	With notes and diagrams
Tutorial questions	Yes	
Literature review	Yes	

(c) Types of student learning activities

In order to achieve the learning outcomes, students are expected to undertake the following activities as part of or during this module:

Student activity	Yes/No	Comments
Note taking	Yes	Expected to fill the gap of handouts
Reading	Yes	
Practical works	Yes	
Report writing	Yes	

(d) Feedback mechanisms to students

Student receive feedback on how they are performing during this module through the following mechanisms:

Feedback mechanism	Yes/No	Comments
Worked solutions of tutorial questions	Yes	
Discussion after lectures	Yes	
Discussion during the practical works	Yes	

Assessment:

Examination	Please refer to the Statement of Assessment
Continuous Assessment	Please refer to the Statement of Assessment and the Assessment and Feedback Summary

Reading list:

Key to recommended books:

** Strongly recommended for purchase (available from the University bookshop)

* Recommended purchase

++ Essential library reading

\+ Supportive library reading

Nanoelectronics ++ Robert Eisberg and Robert Resnick, “Quantum Physics,” Wiley, 1985, ISBN 0-471-87373-X

Nanoelectronics ++ Karl Goser, “Nanoelectronics and Nanosystems,” Springer, 2004, ISBN: 3-540-40443-0

Contribution to EA1 and EA2:

EA1: Information storage and microelectronics

Name and details of module lecturer:

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