Course Outline

NANO3001

Advanced Nanomaterials

Materials Science and Engineering

Science

T1, 2020

-Magnetic properties: diamagnetism, paramagnetism, antiferromagnetism, ferrimagnetism and ferromagnetism; magnetic anisotropy and magnetostriction; magnetic materials and devices.
-Superconductivity and superconducting materials.
-Optical properties.

Introduction to nanotechnology: definitions and background, a brief history, scales and sizes, size effects, elegant examples from nature and materials science, nanotechnology as business - jobs and products.

Nanomaterials applications: 2D, 1D, and 0D - Thin films and interfaces, nanotubes, nanowires and nanoparticles, bio-nanotechnology and medical applications, surface coatings, sensors, energy applications - batteries, supercapacitors, water splitting, fuel cells, H2 storage, catalysis, nano-optics - near field optics, plasmonics; nanoelectronics - dimensionality, Coulomb blockade, resonant tunnelling, electron localisation.

Nanomaterials characterization: Spectroscopy (UV-VIS-IR, THz, Raman, XRD, XAS, XPS/UPS, EPR/ESR/NMR, RBS, SIMS), Microscopy (SPM, TEM, SEM,…).

Nanomaterials synthesis: a brief history of human history and materials, energy and matter - units and terminology, Fabrication techniques: nanolithography/imprint, MBE, PLD, ALD, VLS, sputtering, thermal/e-beam evaporation, CVD, arc synthesis, liquid based synthesis, self-assembly, Langmuir-Blodgett technique.

Nanotechnology - Environmental, health and safety: pollutant classifications, nanoparticle hazards, environmental and health impact. en16(912(nopar)-8(aw912(nopare13(hum)-21(,)-1(MB)2(E)912(nopar)-8(aTc 0.01

2.4 Relationship between cours e and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Enhanced critical thinking, analytical and problem-solving skills in materials science and engineering	1, 2, 3 4, 5 & 7	all
CLO 2	A basic understanding of nanomaterials concepts and their application to a broad range of materials	1, 2, 3 4, 5 & 7	all
CLO 3	An understanding of the modern physical principles underlying fabrication and characterisation of nanomaterials	1, 2, 3 4, 5 & 7	all
CLO 4	An appreciation of a "materials" contributions and importance in electronic systems	1, 2, 3 4, 5 & 7	all

3. Strategies and approaches to learning

3.1 Learning and teaching activities

(based on UNSW Learning Guidelines)

- Students are actively engaged in the learning process.

  It is expected that, in addition to attending classes, students read, write, discuss, and are engaged in solving problems on the electronic properties of materials, and in analysis and evaluation of materials' electron-related properties in the context of modern theories of physics. Advanced nanomaterials concepts will be discussed in class discussions.

- Effective learning is supported by a climate of inquiry where students feel appropriately challenged.

  Problems involving electron theory are challenging; students will be given assignments that will motivate deep analysis of various physical phenomena in materials science and engineering. Assignments include tasks where students need to do some literature search regarding nanomaterials.

- Learning is more effective when students' prior experience and knowledge are recognised and built on.

This course is built on prior courses in mathematics, physics and chemistry.

- Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts

4. Course schedule and structure

This course consists of 52 hours of class contact hours. You are expected to take an additional 98 hours of non-class contact hours to complete assessments, readings and exam preparation.

Week	Topics	Activ ity
1-2	PART I- Fundamenta ls of electron theory	
1	• Introduction to the course • Shortcomings of classical physics • Particle and wave nature of matter • Introduction to the Schrödinger equation • The Schrödinger equation-model of the hydrogen atom • Quantum description of the atom	
2	• The Schrödinger equation • Handling multiple electrons in a crystal • Methods of describing electron energy levels in crystals	
3-5	PART II- Electr ical properties of materials	
3	• Electrical conduction in solids • Quantum model of electrical conduction • Intrinsic semiconducting elements	

and nanoparticles

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Assessment criteria and standards for each assessment tasks are available on the course Moodle page.

5.3 Submission of assessment task s

- UNSW operates under a Fit to Sit/ Submit rule for all assessments. If a student wishes to submit an application for special consideration for an exam or assessment, the application must be submitted prior to the start of the exam or before an assessment is submitted. If a student sits the exam/ submits an assignment, they are declaring themselves well enough to do so. Information on this proceion

8. Administrative matters

School Office: Room 137, Building E10 School of Materials Science and Engineering
School Website: http://www.materials.unsw.edu.au/
Faculty Office: Robert Webster Building, Room 128
Faculty Website: http://www.science.unsw.edu.au/

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.it.unsw.edu.au/students/index.html
- Assessment Implementation Procedure: https://www.gs.unsw.edu.au/policy/documents/assessmentimplementationprocedure.pdf