City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester B 2022/23

Part I Course Overview

Course Title:	**Physics at Nanoscale**
Course Code:	**PHY6504**
Course Duration:	**One Semester**
Credit Units:	**3**
Level:	**P6**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**PHY3251 Quantum Mechanics or equivalent**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**PHY8504 Physics at Nanoscale**

Part II Course Details

1. Abstract

This course is the introductory course on nanoscience for the MSc and PhD Students in Applied Physics Programme and is designed to familiarize the students to the interdisciplinary aspects of nano-science by integrating important components of the broad research field. While focusing on physics, this integrated approach will cross the traditional disciplines of materials science, biology, chemistry, and electrical engineering. Fundamental properties of materials at the nanoscale, synthesis of nanoparticles/nanomaterials, characterization tools, and properties of nanoscale devices and systems will be covered.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe the unique interactions and effects occurring at the nanoscale.	25		✔	
2.	Describe how quantization in nanomaterials impacts electrical, optical, and magnetic properties.	25		✔	
3.	Describe how nanomaterials are synthesized and integrate nanomaterials in applications, particularly in the fields of: electronics, energy devices, and medicine/medical devices.	25	✔		
4.	Demonstrate the capacity for self-directed learning on topics related to nanoscience and nanotechnology.	25			✔
		100%			

A1: *Attitude*
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: *Ability*
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lecture	Explain key concepts and theory of topics of the course	✔	✔	✔				2
Tutorial	Explain how some problems are solved and the techniques used.	✔	✔	✔	✔			1
Assignments	Homework and Projects	✔	✔	✔	✔			

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4				
Continuous Assessment: 100%								
Coursework	✔	✔	✔				30%	Bi-weekly assignments
Oral Presentation	✔	✔	✔	✔			30%	Oral presentation on the group project studying a specific nanoscience phenomenon
Final Report	✔	✔	✔	✔			40%	Final Report on the group project
							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Coursework	1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate correct understanding of key concepts.	Student completes all assignments, and demonstrates excellent understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes at least 80% of assignments, and demonstrates understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes at least 50% of assignments, but can only demonstrate brief understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes less than 50% of assignments. Or, fails to accurately describe the scientific principles governing the behaviour at the nanoscale.
2. Final Report	1. Demonstrate correct understanding of key concepts. 2. Expand on learned concepts via self-learning.	Student can thoroughly identify and describe how the principles are applied to science and technology. Student's work shows strong evidence of original thinking, as well as ability to utilize information sources other than taught material. Student is able to communicate ideas effectively via text and oral presentation.	Student can identify and describe how the principles are applied to science and technology. Student's work shows evidence of original thinking, as well as ability to utilize information sources other than taught material. Student is generally able to communicate ideas via text and oral presentation.	Student can provide only brief descriptions how the principles are applied to science and technology. Student's work shows little evidence of original thinking, and no use of information sources other than taught material. Student is able to poorly, but accurately to communicate ideas via text and oral presentation.	Student fails to demonstrate how the principles are applied to science and technology. Student's work shows evidence of plagiarism. Student fails to complete the assignment.

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Coursework	1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate correct understanding of key concepts.	Student completes all assignments, and demonstrates excellent understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes at least 80% of assignments, and demonstrates understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes at least 60% of assignments, and shows some of the scientific principles governing the behaviour at the nanoscale.	Student completes at least 50% of assignments, but can only demonstrate brief understanding of the scientific principles governing the behaviour at the nanoscale.	Student completes less than 50% of assignments. Or, fails to accurately describe the scientific principles governing the behaviour at the nanoscale.
2. Final Report	1. Demonstrate correct understanding of key concepts. 2. Expand on learned concepts via self-learning.	Student can thoroughly identify and describe how the principles are applied to science and technology. Student's work shows strong evidence of original thinking, as well as ability to utilize information sources other than taught material. Student is able to communicate ideas effectively via text and oral presentation.	Student can identify and describe how the principles are applied to science and technology. Student's work shows evidence of original thinking, as well as ability to utilize information sources other than taught material. Student is generally able to communicate ideas via text and oral presentation.	Student provides simple but accurate evaluations of how the principles are applied to science and technology. Student's work shows some evidence of original thinking, as minimal as ability to utilize information sources other than taught material. Student is able to communicate ideas via text and oral presentation.	Student can provide only brief descriptions how the principles are applied to science and technology. Student's work shows little evidence of original thinking, and no use of information sources other than taught material. Student is able to poorly, but accurately to communicate ideas via text and oral presentation.	Student fails to demonstrate how the principles are applied to science and technology. Student's work shows evidence of plagiarism. Student fails to complete the assignment.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

- Physical properties of nanomaterials: electrons in nanostructures, photons in nanostructures, electronic transport in mesoscopic devices.
- Introduction to the quantum Hall effects.
- Major classes of nanomaterials: quantum dots, nano-wires/nano-tubes, thin films and atomically-thin materials
- Synthesis of nanomaterials: thin film fabrication (thermal evaporation, e-beam evaporation, pulsed-laser deposition, molecular-beam epitaxy, sputtering), bottom-up fabrication (epitaxy, CVD, self-assembly), electron-beam lithography
- Characterization of nanomaterials: electron microscopy, atomic force microscopy, spectroscopy (Raman), crystallography
- Application areas: electronics, quantum computing, energy applications, nano-biology

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Edward L. Wolf, *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, Wiley-VCH, 2nd ed. (2006).
2.	David K. Ferry, *Transport in nanostructures*, Cambridge University Press, 2nd ed. (2009).

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	S. M. Lindsay, Introduction to Nanoscience.
2.	C. Binns, Introduction to Nanoscience and Nanotechnology.
3.	Supriyo Datta, Electronic Transport in Mesoscopic Systems.
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