# City University of Hong Kong Course Syllabus

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

# Part I Course Overview **Physics at Nanoscale Course Title:** PHY8504 **Course Code: One Semester Course Duration:** 3 **Credit Units: R8** Level: **English** Medium of **Instruction: English** Medium of **Assessment: Prerequisites:** Nil (Course Code and Title) **Precursors**: PHY3251 Quantum Mechanics or equivalent (Course Code and Title)

Nil

PHY6504 Physics at Nanoscale

**Equivalent Courses**: (Course Code and Title)

**Exclusive Courses:** 

(Course Code and Title)

### **Part II Course Details**

#### 1. **Abstract**

This 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.

#### **Course Intended Learning Outcomes (CILOs)** 2.

No.	CILOs	Weighting  *  (if applicable)	curricu learnin (please approp	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			AI	A2	A3	
1.	Describe the unique interactions and effects occurring at the nanoscale.	25		<b>~</b>		
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	<b>*</b>			
4.	Demonstrate the capacity for self-directed learning on topics related to nanoscience and nanotechnology.	25			<b>\</b>	
* If we	righting is assigned to CILOs, they should add up to 100%.	100%		•	'	

If weighting is assigned to CILOs, they should add up to 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.

### 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)

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

# 4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.				Weighting*	Remarks		
	1	2	3	4				
Continuous Assessment: 100%	Continuous Assessment: 100%							
Coursework	<b>~</b>	<b>~</b>	<b>\</b>			30%	Bi-weekly assignments	
Oral Presentation	~	*	~	<b>&gt;</b>		30%	Oral presentation on the group project studying a specific nanoscience phenomenon	
Final Report	<b>&gt;</b>	<b>~</b>	~	>		40%	Final Report on the group project	
* The weightings should add up to 100%.					100%			

# 5. Assessment Rubrics

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

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

# Applicable to students admitted before Semester A 2022/23

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

### **Part III Other Information**

### 1. Keyword Syllabus

- 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

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

## 2.2 Additional Readings

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