City University of Hong Kong
Course Syllabus

offered by College/School/Department of Physics
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	**Advanced Instrumentation and Measurement Methods for Experimental Physics**
Course Code:	**PHY6501**
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)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**PHY8401 Advanced Instrumentation and Measurement Methods for Experimental Physics**

Part II Course Details

1. Abstract

The goal of the Advanced Instrumentation and Measurement course is to expand the student knowledge of experimental physics research beyond the basic knowledge with a focus on modern instrumentation and experiments, particularly in with respect to scattering techniques as well as use of large-scale facilities. In particular, this course focuses on neutron and X-ray sources such as synchrotrons and covers both diffraction and inelastic scattering.

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.	Acquire in-depth knowledge about different scattering techniques with emphasis on neutron and X-ray techniques.	25		✔	
2.	Be able to operate analytical instruments and employ measurement methods. Understand the limitations and compromises of the instruments and methods.	25	✔	✔	
3.	Describe the principles, operations, and structure of large-scale, shared facilities.	25	✔		
4.	Observe specific case-studies for better understanding the practical applications.	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 real-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. Learning and Teaching Activities (LTAs)

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

LTA	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
Project	Hands-on experience with analysis of real-world data.	✔	✔	✔	✔			1

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: 75%								
Assignments	✔	✔	✔	✔			50%	Bi-weekly assignments
Term Paper	✔	✔	✔	✔			25%	
Examination: 25% (duration: 2hrs)	✔	✔	✔	✔			25%	
							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 before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignments	1. Demonstrate Correct understanding of key concepts. 2.Expand on learned concepts via self-learning.	Student completes all assignments, and demonstrates excellent understanding of the scientific principles governing the behaviour. Student is able to communicate ideas effectively and clearly via text and visual aids.	Student completes at least 80% of assignments, and demonstrates understanding of the scientific principles governing the behaviour. Student is generally able to communicate ideas via text and visual aids.	Student completes at least 70% of assignments, and shows some of the scientific principles governing the behaviour. Student is able to communicate ideas via text and visual aids accurately but in a simple manner.	Student completes at least 60% of assignments, but can only demonstrate brief understanding of the scientific principles governing the behaviour. Student is able to poorly, but accurately to communicate ideas via text and visual aids.	Student completes less than 50% of assignments. Or, fails to accurately describe the scientific principles governing the behaviour.
2. Term paper	1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.	Demonstrates excellent understanding of the scientific principles governing the behaviour. Student is able to communicate ideas effectively via text and visual aids.	Demonstrates understanding of the scientific principles governing the behaviour. Student is generally able to communicate ideas via text and visual aids.	Shows some of the scientific principles governing the behaviour. Student is able to communicate ideas via text and visual aids.	Can only demonstrate brief understanding of the scientific principles governing the behaviour. Student is able to poorly, but accurately to communicate ideas via text and visual aids.	Fails to accurately describe the scientific principles. Student's work shows evidence of plagiarism. Student fails to complete the asignment.
3. Examination	1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate Correct understanding of key concepts.	Student can thoroughly identify and describe how the principles are applied towards successful completion of experiments.	Student can identify and describe how the principles are applied towards successful completion of experiments.	Student provides simple but accurate evaluations of how the principles are applied towards successful completion of experiments.	Student can provide only brief descriptions how the principles are applied to towards successful completion of experiments.	Student fails to demonstrate how the principles are applied towards successful completion of experiments.

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Assignments	1. Demonstrate Correct understanding of key concepts. 2.Expand on learned concepts via self-learning.	Student completes all assignments, and demonstrates excellent understanding of the scientific principles governing the behaviour. Student is able to communicate ideas effectively and clearly via text and visual aids.	Student completes at least 80% of assignments, and demonstrates understanding of the scientific principles governing the behaviour. Student is generally able to communicate ideas via text and visual aids.	Student completes at least 65% of assignments, and shows some of the scientific principles governing the behaviour. Student is able to communicate ideas via text and visual aids accurately but in a simple manner.	Student completes less than 50% of assignments. Or, fails to accurately describe the scientific principles governing the behaviour.
2. Term paper	1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.	Demonstrates excellent understanding of the scientific principles governing the behaviour. Student is able to communicate ideas effectively via text and visual aids.	Demonstrates understanding of the scientific principles governing the behaviour. Student is generally able to communicate ideas via text and visual aids.	Shows some of the scientific principles governing the behaviour. Student is able to communicate ideas via text and visual aids.	Fails to accurately describe the scientific principles. Student's work shows evidence of plagiarism. Student fails to complete the assignment.
3. Examination	1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate Correct understanding of key concepts.	Student can thoroughly identify and describe how the principles are applied towards successful completion of experiments.	Student can identify and describe how the principles are applied towards successful completion of experiments.	Student provides simple but accurate evaluations of how the principles are applied towards successful completion of experiments.	Student fails to demonstrate how the principles are applied towards successful completion of experiments.

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.)

- Fundamental scattering techniques: neutron diffraction, X-ray diffraction, scattering mechanisms, scattering theory.
- Advanced techniques: Inelastic neutron and X-Ray scattering.
- Spectroscopy of solids
- Instrumentation and operation of large scale facilities: Synchrotron radiation production and properties, neutron sources.
- Specific case studies in measurement and analysis of scattering data.

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.	Willis and Carlile, Experimental Neutron Scattering, Oxford University Press, 2013
2.	Warren, X-ray Diffraction, Dover, 1990
3.	Squires, Introduction to the Theory of Thermal Neutron Scattering, Cambridge U. Press, 2012

2.2 Additional Readings

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

1.	Cullity & Stock, Elements of X-Ray Diffraction, 3rd ed.; Prentice Hall, 2001.
2.	Schuelke, Electron Dynamics by Inelastic X-Ray Scattering, Oxford, 2007.
3.	de Groot & Kotani, Core Level Spectroscopy of Solids, CRC Press, 2008.
4.	Duke, Synchrotron Radiation: Production and Properties, Oxford, 2008.
5.	Handbook of Accelerator Physics and Engineering, World Scientific, 2013