PHY8401: ADVANCED INSTRUMENTATION AND MEASUREMENT METHODS FOR EXPERIMENTAL PHYSICS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Instrumentation and Measurement Methods for Experimental Physics

Subject Code
PHY - Physics
Course Number
8401

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
PHY6501 Advanced Instrumentation and Measurement Methods for Experimental Physics

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Acquire in-depth knowledge about different scattering techniques with emphasis on neutron and X-ray techniques.	25		x	
2	Be able to operate analytical instruments and employ measurement methods. Understand the limitations and compromises of the instruments and methods.	25	x	x	
3	Describe the principles, operations, and structure of large-scale, shared facilities.	25	x		
4	Observe specific case-studies for better understanding the practical applications.	25	x		x

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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Explain key concepts and theory of topics of the course	1, 2, 3	2
2	Tutorial	Explain how some problems are solved and the techniques used.	1, 2, 3, 4	1
3	Project	Hands-on experience with analysis of real-world data.	1, 2, 3, 4	1

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3, 4	50	Weekly assignments	No
2	Term Paper	1, 2, 3, 4	25	-	No

Continuous Assessment (%)

75

Examination (%)

25

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

0

Minimum Examination Passing Requirement (%)

0

Assessment Rubrics (AR)

Assessment Task

Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.

Excellent

(A+, A, A-) 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.

Good

(B+, B, B-) 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.

Fair

(C+, C, C-) 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.

Marginal

(D) 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.

Failure

(F) Student completes less than 50% of assignments. Or, fails to accurately describethe scientific principles governingthe behaviour.

Assessment Task

Term paper (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.

Excellent

(A+, A, A-) Demonstrates excellent understanding of the scientific principles governing the behaviour. Student is able to communicate ideas effectively via text and visual aids.

Good

(B+, B, B-) Demonstrates understanding of the scientific principles governing the behaviour. Student is generally able to communicate ideas via text and visual aids.

Fair

(C+, C, C-) Shows some of the scientific principles governing the behaviour. Student is able to communicate ideas via text and visual aids.

Marginal

(D) 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.

Failure

(F) Fails to accurately describethe scientific principles. Student’ s work shows evidence of plagiarism. Student fails to complete the asignment.

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate Correct understanding of key concepts.

Excellent

(A+, A, A-) Student can thoroughly identify and describe how the principles are applied towards successful completion of experiments.

Good

(B+, B, B-) Student can identify and describe how the principles are applied towards successful completion of experiments.

Fair

(C+, C, C-) Student provides simple but accurate evaluations of how the principles are applied towards successful completion of experiments.

Marginal

(D) Student can provide only brief descriptions how the principles are applied to towards successful completion of experiments.

Failure

(F) Studentfails to demonstrate how the principlesare appliedtowards successful completionof experiments.

Assessment Task

Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.

Excellent

(A+, A, A-) 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.

Good

(B+, B) 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.

Marginal

(B-, C+, C) 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.

Failure

(F) Student completes less than 50% of assignments. Or, fails to accurately describe the scientific principles governing the behaviour.

Assessment Task

Term paper (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1. Demonstrate Correct understanding of key concepts. 2. Expand on learned concepts via self-learning.

Excellent

(A+, A, A-) Demonstrates excellent understanding of the scientificprinciples governing the behaviour. Student is able to communicateideas effectively via text and visual aids.

Good

(B+, B) Demonstrates understandingofthe scientificprinciples governing the behaviour. Student is generally able to communicate ideas via text and visual aids.

Marginal

(B-, C+, C) Shows some of the scientificprinciples governing the behaviour. Student is able to communicate ideas via text and visual aids.

Failure

(F) Fails to accurately describe the scientific principles. Student’ s work shows evidence of plagiarism. Student fails to complete the assignment.

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1. Capacity for using physics knowledge and theory to solve Problems. 2. Demonstrate Correct understanding of key concepts.

Excellent

(A+, A, A-) Student can thoroughly identify and describe how the principles are applied towardssuccessful completionof experiments.

Good

(B+, B) Student can identify and describe how the principles are applied towards successful completion of experiments.

Marginal

(B-, C+, C) Student provides simple but accurate evaluations of how the principles are applied towards successful completionof experiments.

Failure

(F) Student fails to demonstrate how the principles are applied towards successful completion of experiments.

Part III Other Information

Keyword Syllabus

- 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.

Reading List

Compulsory Readings

	Title
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

Additional Readings

	Title
1	de Groot & Kotani, Core Level Spectroscopy of Solids, CRC Press, 2008.
2	Duke, Synchrotron Radiation: Production and Properties, Oxford, 2008.
3	Handbook of Accelerator Physics and Engineering, World Scientific, 2013