Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY 2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1 Semester 2
Course Author * Faculty proposing/revising the course	David Wilkowski, Zhisong Qu
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Course Title	Physics Laboratory IIIa
Course Code	PH3199
Academic Units	2
Contact Hours	38
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	PH2198 and PH2199
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This course aims to:

a. build a basic understanding of experimentation in advanced topics of Physics.

b. provide foundation knowledge for experimental physics.

c. build observational skills of physical phenomena.

d. prepare you for project based work in physics.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Discuss deviations between theory and experiment.
ILO 2	Perform moderately sophisticated optical alignment.
ILO 3	Use CAD-based software to design basic prototype experimental components.
ILO 4	Use programming for basic simulations and computation.
ILO 5	Design simple experiments to answer scientific or practical questions.
ILO 6	Explain the fundamental mechanisms of observed phenomena using relevant equipment.
ILO 7	Gain proficiency in material and characterization.
ILO 8	Use of statistical methods for data analysis

Course Content

This course provides you with advanced training in experimental physics and covers a wide variety of topics:

- Classical Mechanics, Waves
- Thermodynamics, Fluid Mechanics
- Electronics, Circuit Theory, Semiconductor Physics
- Nanotechnology, Surface Physics, Mechanics
- Solid-State Physics, Semiconductor Devices, Computational
- Particle Physics, Statistical Physics
- Optics, Optical Imaging
- Quantum Mechanics, Photonics, Quantum Information

Reading and References (if applicable)

You will be provided with lab manuals that include the required readings and references for each experiment. In addition, you are expected to conduct your own research relevant to the experimental context.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introductory Lecture and Experiment Booking	1,8		In-person	General lab briefing and experiment booking
2	Week 2-10: Lab sessions (based on assignment by Year 3 Lab Manager)	1-8		In-person	Hands-on experiments, report writing and vivas.
3	Week 11-13: Make-up lab sessions (as required)	1-8		In-person	Hands-on experiments, report writing and vivas.

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Pre-lab quiz	The pre-lab quiz covers key concepts, safety protocols, and error analysis to help you prepare effectively for the experiment. By reviewing the material in advance, you'll gain a clearer understanding of the objectives and procedures, leading to safer, more efficient lab work and deeper engagement with the learning topic.
Full Laboratory Experiment Reports	Writing full lab reports reinforces your understanding of core concepts and builds essential scientific skills. It helps you explain theory, analyze data critically, and assess the accuracy of your results. The process also strengthens your ability to communicate clearly, understand experimental design, and maintain academic integrity—preparing you for future scientific work and research.
Viva Voce / presentation	Vivas with Teaching Assistants reinforce your learning by encouraging you to explain your reasoning, discuss your methods, and reflect on your results. It helps clarify concepts, provides immediate feedback, and strengthens your critical thinking and communication skills—building confidence in presenting and defending your work.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Pre-lab Quiz)	LO 1-8		10		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Report/Case study(Full Laboratory Reports)	LO 1-8		55		Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Oral Test(Viva Voce / presentation)	LO 1-8		35		Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

- You will be assessed by online tests (NTULearn), Teaching Assistant(s) and faculty member(s) from NTU.
- The shown weightages for Components 1-3 are the cumulative weightage over 3 different experiments.

Formative Feedback

Formative feedback is provided through multiple channels: written comments on lab reports via Turnitin on NTULearn, verbal feedback during lab sessions, and discussions during viva assessments.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Collaboration	Intermediate
Learning Agility	Advanced
Critical Thinking	Advanced
Design Thinking	Advanced
Systems Thinking	Advanced

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

1. Attendance and Punctuality
Attendance for all scheduled lab sessions is mandatory. Students must arrive on time and be prepared to begin promptly.
Absences must be supported by valid documentation (e.g., medical certificate) and communicated in advance where possible.
Missed labs may be made up at the discretion of the course coordinator, subject to availability.

2. Pre-Lab Requirements
Students are expected to complete all pre-lab activities, such as quizzes and readings before attending the lab.
Failure to complete pre-lab requirements may result in exclusion from that lab session.

3. Safety
Strict adherence to laboratory safety rules is required at all times.
Students must wear appropriate personal protective equipment (e.g., lab coat, covered shoes, safety goggles).
Unsafe behavior may result in removal from the lab and disciplinary action.

4. Lab Conduct and Participation
Students must actively participate in all lab activities, including setup, data collection, and cleanup.
Collaboration is encouraged, but all submitted work must be individual and original unless group submission is explicitly stated.

5. Reporting and Documentation
Full lab reports must be submitted according to the schedule provided.
Late submissions may incur penalties unless due to valid, pre-approved reasons.
Reports must demonstrate clear scientific communication, proper data analysis, and academic integrity.

6. Viva Voce and Presentations
Students are required to undergo a viva voce or give presentations to assess understanding and communication skills.

These assessments contribute to the final grade and must be taken seriously.

7. Assessment and Grading
Course components may include pre-lab quizzes, lab performance, reports, viva/presentations, and final evaluations.
Grading criteria will be transparent and consistently applied across all lab sections.

8. Academic Integrity
Plagiarism, data fabrication, or any form of academic dishonesty will result in disciplinary action per university policy.
Collaboration must follow the guidelines provided for each task.

9. Feedback and Improvement
Students will receive formative feedback through written comments, in-lab discussions, and assessment reviews.
Constructive feedback should be used to improve performance in future labs.

10. Communication
Important updates and materials will be posted on the course's learning management system (e.g., NTULearn).

Students are responsible for checking announcements regularly and contacting TAs or instructors for clarification when needed.

Policy (Absenteeism)

Absence Due to Medical or Other Reasons
If you are sick and unable to attend your laboratory or viva sessions, you have to:
1. Send an email to the lab manager regarding the absence and request for a replacement / make-up laboratory or viva session.
2. Submit the original Medical Certificate* or official letter of excuse to administrator.
3. Attend the assigned replacement session (subject to availability).

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:
- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;

- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Appendix 1: Examiner's Assessment Rubrics for PH3199 Physics Laboratory IIIa
Part 1: Laboratory Full-Report

Sections of the Laboratory Full Report	**Far Exceeds Expectations** (22 - 25)	**Exceeds Expectations in some areas** (16 - 21)	**Meets Expectations** (11 - 15)	**Meets Expectations in some areas** (6 - 10)	**Below Expectations** (0 - 5)	**Score**
Introduction, Theory & Procedure Section suggested consideration point(s); • Did the student state the explicit, and any implicit, goals of their experiment? • Did the student have additional experimental procedures aside from those provided in the lab manual? • Is the student able to provide a pictorial overview of their experiment for the ease of understanding?	All of the experiment goal(s) were stated. Extensive procedural details provided, referenced the lab manual's procedure steps specifically as needed. Excellent attempts to reduce or deduce experimental error.	All of the experiment goal(s) were stated. Lots of procedural details provided, referenced the lab manual procedures. Appreciable attempts to reduce or deduce experimental error.	Most of the experiment goal(s) were stated. Some procedural details provided, copied directly from the lab manual. Some attempts to reduce or deduce experimental error.	Some of the experiment goal(s) were stated. Few procedural details provided copied directly from the lab manual. Some attempts to reduce or deduce experimental error.	None of the experiment goal(s) were stated. Little or no procedural details provided. Absence of attempts to reduce or deduce experimental error.	/ 25
	(26 - 30)	(21 - 25)	(14 - 20)	(6 - 13)	(0 - 5)	
Results Section suggested consideration point(s); • Did the student present all the experimental results as required in that experiment's lab manual? • Did the student investigate certain physical aspects of the experiment outside the requirements of the lab manual? • Are the results presented in an organised and coherent style with named diagrams & tables for easy reference? • If an experiment requires so, is the student able to perform error propagation correctly? • Is the student able to obtain uncertainties within the reasonable bounds of the apparatus used or from calculations? • Has the student included experimentally obtained errors in their tabulated results in the form of uncertainties? If presenting graphical results, in the form of error bars?	All of the required results were presented. Presented results were well-organised, tabulated. Considerable initiative investigating phenomena outside the requirements. ---------- All of the required uncertainties were presented. Uncertainties obtained were contextually realistic. Explanation was provided. Correct uncertainties from error propagation. Method was provided.	All of the required results were presented. Presented results were well-organised and tabulated. Appreciable initiative investigating phenomena outside the requirements. ---------- All of the required uncertainties were presented. Uncertainties obtained were contextually realistic. Correct uncertainties from error propagation. ----------	Most of the required results were presented. Presented results were organised and tabulated. Some initiative investigating phenomena outside the requirements. ---------- Most of the required uncertainties were presented. Uncertainties obtained were contextually unrealistic. ---------- The required data plots were presented. Fitting results were presented.	Some of the required results were presented. Presented results were disorganised and not tabulated. Some of the required uncertainties were presented. Uncertainties obtained were contextually unrealistic. The required data plots were presented. No fitting results were presented.	None of the required results were presented. Any presented results were messy and not tabulated. No uncertainties were presented. No data plots nor fitting results were presented.	/ 30

• If an experiment requires so, o is the student able to perform curve fitting using the recommended software? o Has the student utilised the correct fitting function & results based on the experiment's theoretical considerations? o Has the student provided the fitting results?	---------- -- The required data plots were presented. Fitting results were presented. Choice of fitting function & fitting results were presented and explained.	The required data plots were presented. Fitting results were presented. Choice of fitting function & fitting results were presented.	Choice of fitting function & fitting results were not presented.			

Sections of the Laboratory Full Report	**Far Exceeds Expectations** (35 - 40)	**Exceeds Expectations in some areas** (30 - 34)	**Meets Expectations** (16 - 29)	**Meets Expectations in some areas** (6 - 15)	**Below Expectations** (0 - 5)	**Score**
Discussion Section suggested consideration point(s); • Is the student able to relate their obtained experimental results with the experiment's theoretical predication through the use of an appropriate quantifier (e.g. % differences, p-values, etc.) ? • Is the student able to explain and make educated benchmarks of the experiment's accuracy and precision from the provided apparatus? • Is the student able to compare their obtained experimental results against the benchmarks of accuracy and precision? • Is the student able to identify trends in their results or data (e.g. asymmetry, skewed results towards a particular value, etc.) through suitable quantifiers of errors (e.g. % differences, uncertainties, etc.)? • Has the student done only a qualitative analysis of the identified errors? • Has the student identified possible errors from observing the trend of errors? • Is the student able to identify one or two major causes of error in this experiment? • Has the student made an attempt at quantifying the impact of possible errors after identifying them?	Required quantifiers used. Well-reasoned attempts at benchmarking the experiment's accuracy & precision. Successful attempts at identifying error trends in presented results. Excellent attempts at quantifiable error analysis. In-Depth qualitative error analysis. Well-reasoned discussion on the experimental impact of errors.	Required quantifiers used. Reasonable attempts at benchmarking the experiment's accuracy & precision. Determined attempts at identifying error trends in presented results. Appreciable attempts at quantifiable error analysis. Considerable qualitative error analysis. Considerable discussion on the experimental impact of errors.	Required quantifiers used. Some attempts at benchmarking the experiment's accuracy & precision Some attempts at identifying error trends in presented results. Some attempts at quantifiable error analysis. Considerable qualitative error analysis. Some discussion on the experimental impact of errors.	Required quantifiers used. No attempts at benchmarking the experiment's accuracy & precision Brief and short qualitative error analysis. Brief discussion on the experimental impact of errors.	Absence of any quantifiers used. Omission of any attempts at determining the apparatus accuracy & precision. Error analysis was completely omitted.	/ 40

• Has the student suggested improvements to experimental procedure to reduce said identified errors or supported current procedures?						
	(5)	(4)	(2 - 3)	(1)	(0)	
Conclusion Section suggested consideration point(s); • Has the student evaluated the success of their experiment via obtained experimental goals and suitable quantifiers? • Has the student identified the most prominent source of error and had given suggestions to improve the experiment? Conclusion Section is at most 2 paragraphs.	Experiment's goals are fully met. Detailed mention of any concluding evaluations, has interesting observations .	Experiment's goals are fully met. Some mention of any concluding evaluations.	Brief. Experiment's goals are fully met. Little mention of any concluding evaluations.	Very brief. Experiment's goals are not fully met. Absence of any concluding evaluations .	The conclusion section was completely omitted.	/ 5
					[1]Total :	/ 100

[1]Normalised to 100%.

Appendix 2: Examiner's Assessment Rubrics for PH3199 Physics Laboratory IIIa
Part 2: Experiment(s)' Viva

	Far Exceeds Expectations (21 - 25)	**Exceeds Expectations in some areas** (16 - 20)	**Meets Expectations** (11 - 15)	**Meets Expectations in some areas** (6 - 10)	**Below Expectations** (0 - 5)	**Score**
Experiment Theoretical Understanding suggested consideration point(s); • Did the student have a firm grasp of the physical theories behind the experiment? • Does the student understand the scientific significance of their experiment?	Demonstrated extremely thorough understanding of the experiment's physics.	Demonstrated thorough understanding of the experiment's physics.	Demonstrated considerable understanding of the experiment's physics.	Demonstrated limited understanding of the experiment's physics.	Demonstrated completely no understanding of the experiment's physics.	/ 25
Understanding of Experimental Methodology suggested consideration point(s); • Did the student have a good understanding of the experimental design, instrumentation and data acquisition? • Did the student explain and perform any additional procedures	Demonstrated an expert understanding of the experiment's methodology. Significant number of additional procedures, supported with	Demonstrated through understanding of the experiment's methodology . Appreciable number of additional procedures,	Demonstrated considerable understanding of the experiment's methodology . Limited number of additional	Demonstrated limited understanding of the experiment's methodology .	Demonstrated completely no understanding of the experiment's methodology.	/ 25

outside of the lab manual's instructions?	detailed explanations	supported with simple explanations	procedures, supported with simple explanations			
Analysis of Experimental Data suggested consideration point(s); • Is the student able to support their analysis from their obtained data or observed data trends? • Is the student able to use their analysis to support their experimental deductions (e.g. errors of significance, prove of existence, etc.)?	Able to extensively support their analysis through use of appropriate data. Deduced aspects are strongly supported by their analysis.	Able to support their analysis through use of appropriate data. Deduced aspects are somehow supported by their analysis.	Able to support their analysis through use of reasonably appropriate data. Deduced aspects are weakly supported by their analysis.	Able to weakly support their analysis through use of reasonably appropriate data. Few to none deduced aspects. Deduced aspects are weakly supported by their analysis.	No Analysis. Unable to support their analysis through use of data. Absence of any deduced aspects.	/ 25
Communication Skills suggested consideration point(s); • Did the students understand the questions and answer to the point? • Were the students confident of their answer? • Were the students able to engage in a meaningful & civil discussion with the faculty member?	Very productive discussions and deep analyses. Ideas were presented very clearly.	Productive discussions and analyses. Ideas were presented clearly.	Some discussions and analyses. Ideas were presented some-what clearly.	Little discussions and analyses. Ideas were mostly unclear.	Absence of a response, discussions or analyses Ideas were not presented clearly.	/ 25
					[1]Total :	/ 100

[1]Normalised to 100%.