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

Course Overview

Expected Implementation in Academic Year (New format)	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1 Semester 2
Course Author * Faculty proposing/revising the course	Van Thi My Hien
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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

If you are a physics student preparing to transition from structured learning to independent, project-based research, this course is designed specifically for you. Our purpose is to immerse you in the complete scientific lifecycle, empowering you to formulate original hypotheses, run computational simulations, and actively design, fabricate, and test your own experimental setups. By taking this course, you will gain invaluable, hands-on proficiency with advanced research instrumentation while developing the some experimental practices professional scientists rely on. Ultimately, this experience bridges the gap between theoretical concepts and real-world discovery, equipping you with the technical skills and problem-solving autonomy needed to excel in academic research or industries.

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
ILO 9	Ethically collaborate with GenAI and experiment how to integrate AI in your learning journey to achieve your learning objectives.

Course Content

This course provides you with advanced training in experimental physics by bridging highly precise, hands-on laboratory techniques with modern computational methodologies. It equips you with the critical thinking, technical proficiency, and metacognitive skills necessary to execute complex experiments, troubleshoot advanced apparatuses, and rigorously validate empirical data against predictive models. Furthermore, gradually you will be given the opportunities to ethically collaborate with GenAI and experiment how to integrate AI in your learning journey to achieve your learning objectives.

The course covers a wide variety of advanced scientific topics, including:

- Computational Physics, Data Science, and Simulation
- Classical Mechanics, Thermodynamics, and Fluid Mechanics
- Advanced Optics, Optical Imaging, Fourier Optics, and 3D Digital Holography
- Quantum Mechanics, Photonics, and Quantum Information (e.g., Heralded Single-Photon Sources)
- Solid-State Physics, Semiconductor Devices, Circuit Theory, and Electronics
- Nanotechnology, Surface Physics, Mechanics, and Atomic Force Microscopy
- Particle Physics, Statistical Physics, and Monte-Carlo Simulations

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	Delivery Mode	Activities	Readings
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?
Active Inquiry Pre-lab and in-class discussion	Instead of providing rigid, step-by-step instructions, you are encouraged to do your own literature review to establish the conceptual boundaries of the system and the experiment themselves. You will learn to explicitly justify theoretical assumptions and predictive expectations prior to actual running of experiment and data collection.
Practice authentic and critical thinking in hands-on and physical engagement with learning tools, peers and instructors.	During the laboratory sessions, you are encouraged to take ownership of your learning journey following the scientific experimental practices, such as general investigation and troubleshooting, planning, executing, reflecting, coordinating theory and evidence/data of the experiment. This will be part of the in-class tasks and assessments.
Cultivate reflective and analytical decision-making by navigating challenges and documenting the learning process.	Instead of seeking immediate help from instructors, you are encouraged to treat any problems or issues that occur during lab sessions - or those intentionally designed by the instructor - as training opportunities to deepen your understanding. Additionally, you will be taught to document your analytical decisions and AI interactions using active, first-person narratives (e.g., 'We adjusted the sensor distance to reduce noise because...'), so that your personal scientific identity is emphasized.
Verify Understanding through Class Discussion and Oral Defence	Throughout the course, you will be prepared for real-time scientific argumentation to emphasize authentic thinking and validation. You will be continuously challenged to coordinate your empirical results with physical theory and to defend their conclusions based strictly on the evidence gathered. Furthermore, you will be guided to take absolute intellectual ownership of your knowledge-generation process.

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 1-9		10		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Others(In-class Assessment)	LO 1-9		30		Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Report/Case study(Lab Report)	LO 1-9		30		Individual	Analytic	Multistructural
4	Continuous Assessment (CA): Oral Test(Viva Voce)	ILO 1-9		30		Individual	Holistic	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 1-4 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. You 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
You 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.
You 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
You 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
You 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
You 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).

You 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.

PH3199 Physics Laboratory IIIa – Assessment Rubrics

The revised assessment framework is designed to provide a balanced evaluation of your conceptual understanding, practical and computational competency, scientific reasoning, and communication skills through a combination of pre-laboratory preparation, authentic in-class performance, metacognitive process reporting, and oral assessment. It deliberately shifts from a product-focused model to a dynamic, process-oriented framework that evaluates learner agency, resilience in problem-solving, and ethical human-in-the-loop AI collaboration.

Part 1: Pre-Laboratory Quiz (10%)

- **Conceptual Understanding & Preparation:** Assesses your understanding of key theoretical concepts, experimental objectives, apparatus, procedures, safety requirements, and expected data analysis methods prior to the laboratory session. It specifically evaluates your ability to independently establish the conceptual boundaries of the system and explicitly state theoretical assumptions before interacting with the equipment.
- **Readiness for Experiment:** Assesses your preparedness to conduct the experiment effectively through prior review of the laboratory manual and supporting materials. This ensures they approach both physical setups and computational scripts strategically, preventing the uncritical, mindless execution of step-by-step instructions.
- **Feedback for Learning:** Immediate feedback is provided through the online quiz system to help you identify knowledge gaps and areas requiring further preparation.

Part 2: In-Class Assessment (30%)

- **Hands-on Experimental Skills & Computational Orchestration:** Assesses your competency in operating equipment safely, setting up experiments correctly, and performing measurements independently. For manual setups, it evaluates non-digitizable physical dexterity and somatic intuition. For computational tasks, it assesses your ability to act as "intellectual directors" who actively debug complex physics scripts rather than passively consuming outputs.
- **Real-Time Problem Solving & Decision Making:** Assesses your ability to troubleshoot experimental issues, make informed decisions, and respond appropriately to unexpected observations. Evaluates your dynamic self-regulation in response to hardware feedback, pilot tests, and equipment constraints.
- **Active Participation & Engagement:** Assesses preparedness, initiative, teamwork, and active participation throughout the laboratory session.
- **In-Class Data Interpretation & Reflection:** Assesses your ability to analyze experimental observations, interpret preliminary results, and reflect on the outcomes during the laboratory session.

Part 3: Laboratory Full Report (30%)

- **Introduction, Theory & Procedure:** Assesses the clarity of experiment objectives, understanding of theoretical background, completeness of procedures, and consideration of experimental uncertainties and improvements. Crucially, it evaluates methodological transparency through your digital paper trail (Metacognitive Prompt Logs) and the honest declaration of any Generative AI assistance used.
- **Results:** Assesses the presentation, organization, accuracy, and completeness of experimental data, calculations, uncertainties, graphical analysis, and curve fitting where applicable. Evaluates the authentic reporting of raw, noisy datasets without manipulating, artificially smoothing, or hallucinating data to verify known constants.
- **Discussion:** Assesses your ability to interpret results, relate findings to theory, evaluate uncertainties and limitations, analyze sources of error, and propose improvements. It evaluates how effectively you navigates the "failure curriculum" to isolate systematic errors, and assesses your use of active, first-person narratives to demonstrate workflow stewardship and personal scientific identity.
- **Conclusion:** Assesses the effectiveness of the summary of findings, evaluation of experimental objectives achieved, and identification of key limitations or improvements. Evaluates absolute intellectual ownership to ensure conclusions are strictly supported by the empirical evidence gathered, and assesses the proposal of autonomous, goal-driven extensions.

Part 4: Viva Voce & Discussion (30%)

- **Experiment Theoretical Understanding:** Assesses your understanding of the physical concepts, principles, and scientific significance underlying the experiment. Evaluates your ability to take absolute intellectual ownership by defending these interpretations in real-time.
- **Understanding of Experimental Methodology:** Assesses your understanding of the experimental setup, instrumentation, procedures, data acquisition methods, and troubleshooting approaches. It requires you to defend your physical reasoning and code optimizations line-by-line.
- **Analysis of Experimental Data:** Assesses your ability to interpret data, identify trends, justify conclusions, evaluate uncertainties, and support experimental deductions using appropriate evidence.
- **Communication Skills:** Assesses clarity, confidence, responsiveness, and ability to engage in meaningful scientific discussion with the instructor. It evaluates your capacity for rigorous scientific argumentation that bypasses text-based AI vulnerabilities entirely.