

Course Syllabus

[Jump to Today.](#)

1. Course Overview

This course consists of two parts.

In part I, students are required to complete **TWO** predesigned modern physics experiments in the first half of the term. Of the two experiments, one experiment is chosen from the list of Group 1 experiments (work must be carried out independently without a lab partner) and one experiment is chosen from the list of Group 2 experiments given below (you may work with a lab partner). This part of the course emphasizes the acquisition of good laboratory techniques in four critical areas of experimental physics including the use of modern instrumentation, careful logging of experimental data, proper statistical analysis of data, and scientific writing and presentation of the experimental results.

In part II, students are required to complete **ONE** open-ended research project either in experiment or in theory in the second half of the term. Available research projects are given below. Students are expected to perform independent research including literature search on the historical background, significance and impact of the experiment. Upon completion of the project, students are required to submit a project report that complies with contemporary scientific standards and deliver an oral presentation.

List of Experiments for Part I:

Group 1 (typically 12 - 15 hours are needed to finish an experiment)

- 1.1 Photoelectric effect
- 1.2 Franck-Hertz experiment
- 1.3 Muon Physics
- 1.4 Electron spin resonance
- 1.5 Fourier synthesis and analysis of electronic signals
- 1.6 Computer interfacing and data acquisition
- 1.7 X-Ray diffraction and emission
- 1.8 X-Ray penetration and absorption spectrum
- 1.9 Image processing
- 1.10 Sonic band gap

Group 2 (typically 16 - 22 hours are needed to finish an experiment)

- 2.1 Coaxial transmission line
- 2.2 Zeeman effect
- 2.3 Millikan's oil drop experiment
- 2.4 Fiber optics and applications
- 2.5 Holography
- 2.6 Lock-in detection of weak fluorescent signals
- 2.7 Magnetic moment of ferric ions
- 2.8 Alpha/Beta/Gamma spectroscopy
- 2.9 Chaos in a driven resonant circuit
- 2.10 Dynamic light scattering study of Brownian motion
- 2.11 Sonoluminescence
- 2.12 Optical Tweezers

List of Projects for Part II (To be confirmed):

- 3.1 Scanning tunnelling microscope (STM)

- 3.3 Superconductivity
- 3.4 X-ray diffraction of solid materials
- 3.5 Gamma spectroscopy and Compton scattering
- 3.6 Hall Effect
- 3.7 Photolithography and device fabrication
- 3.8 Optical pumping
- 3.9 LabVIEW interface in the Frank-Hertz experiment
- 3.10 Imaging of a falling sphere
- 3.11 Thermal conductivity of solids at low temperature
- 3.12 Atomic force microscope (AFM)
- 3.13
- 3.14

2. Intended Learning Outcomes

By the end of the course, you will be able to

1. Plan and conduct experimental investigations of phenomena in several areas of physics using modern instrumentation,
2. Execute experimental measurements with proper techniques and safety practices,
3. Practice careful record keeping of experimental work and research findings,
4. Analyse experimental data using statistical or other appropriate methods and judge whether the results support a given theoretical model,
5. Explain the theoretical background, experimental methods, data analysis and results in formal scientific writing form and oral presentation.

The course will also give you an opportunity to

1. Build and practice teamwork skills through group projects,
2. Plan and suggest improvements of experiments.

3. Course Requirements

3.1 Working hours

Students are expected to attend all the scheduled lectures and three lab sessions per week (8 hours per week) until you finish all the course requirements, including oral presentation and project report. For the attendance policies of this course, please refer to the [Course Rules](https://canvas.ust.hk/courses/62621/pages/Course%20Rules) (<https://canvas.ust.hk/courses/62621/pages/Course%20Rules>) for more details.

3.2 Lab notebooks

Two lab notebooks will be used in alternate experiments. The function of the lab notebooks is to provide a record of all significant events occurred during an experiment. There is a certain minimum amount of information required, but an effort should be made to exceed the minimum. Read the [Grading Policy \(in Modules\)](https://canvas.ust.hk/courses/62621/modules/219716) (<https://canvas.ust.hk/courses/62621/modules/219716>) for details about the notebook format and contents as well as the requirements for the experimental summary.

Notebooks will be examined briefly and initialed at the end of each lab session. The experimental summary must be finished within one week of completion of data-taking. The notebook will be collected within one week after the experiment is done, so that a TA or IA could return the notebook (containing your experimental summary) to you on time for your next experiment.

At the completion of **first** experiment, you should provide a experimental summary to summarize the main results of the experiment and discuss any problems, referring to the relevant pages in the notebook. The experimental summary should be **pasted in the same notebook**, which records the experimental data and should not exceed **two typewritten pages** (size A4, single line spaced, 12pt fonts). Whereas spot checks will be made on the laboratory notebooks in general, the experimental summary will be carefully examined.

3.3 Formal paper and project report

In addition to the lab notebook and experimental summary, you are required to submit a **formal paper of the second experiment in Part I** and a **project report in Part II** both with a **format similar to scientific papers**. Details about the format of the formal paper/project reports are given in the Guidelines on Formal Paper and

Presentation. The first paper is intended for your exercise and counts 12% of your final grade. The second paper counts 20%. It should be based on your research project. The due dates of the formal papers are given in the PHYS4191 Calendar .

Efforts should be made to keep your papers complete, organized, and concise. The bulk text of each paper (excluding references, tables, figure captions, figures, and the title page containing the abstract) should not exceed seven typewritten pages (size A4, double spaced, 12pt fonts). The abstract should be less than 120 words and for each paper the total number of figures and tables should not exceed six.

3.4 Oral presentations

Each student is required to give one oral presentation based on his/her project report. The presentation dates are given in the PHYS4191 Calendar. The primary purpose of the presentation is to provide an opportunity for each student to give a talk in a professional setting. The duration of the presentation is 10 minutes followed by a 3 minute question and answer session.

4. Grading

The final grade will be determined based on (i) two experiments in Part I (50%) and (ii) a research project in Part II (50%).

Your grade in Part I is further divided in (i) lab performance (14%), (ii) lab notebook (book keeping 14%), (iii) experimental summary for the first experiment (10%), and (iv) formal paper for the second experiment (12%).

Your grade in Part II is further divided in -

For Experimental Project: (i) lab performance (8%), (ii) lab notebook (book keeping 8%), (iii) oral presentation (14%), and (iv) project report (20%);

For Theoretical Project: (i) performance (16%, to be evaluated by the project supervisor), (ii) oral presentation (14%), and (iii) project report (20%).

5. Prerequisites, Course Structure, and General Rules

The prerequisite of this course is PHYS 3152 and 3153. Usually the course is organized with two three-hour and one two-hour laboratory sessions per week, a weekly lecture by the instructor, a weekly meeting with TA/IA during the lab session, and pre-lab reading and preparation outside the lab sessions. In each week, every student group (you and your lab partner) will have a 20-30 min meeting with your TA/IA during the lab session to discuss your performance on the previous week's lab, prelab questions, and procedural issues for the upcoming lab. This meeting is designed to help you to communicate with your TA/IA more effectively and have a one on one time to ask various questions you may have during the experiment. However, the meeting is not designed for you to sit there expecting the TA/IA to explain everything to you because you did not do any reading or lab preparation. Such behavior will definitely affect your lab performance grade. For the general rules about this course, please refer to the [Course Rules \(https://canvas.ust.hk/courses/62621/pages/course-rules\)](https://canvas.ust.hk/courses/62621/pages/course-rules) for more details.

6. Lab Preparation and Data Analysis

It cannot be over-emphasized that pre-lab preparation is an important part of the experiment. Before you start a new experiment, it is essential for you to read through the relevant materials, review the related physics, and think about how you are going to do the experiment. Your pre-lab preparation will be examined and discussed during the weekly meeting with your TA/IA.

Appropriate data analysis including data graphing, curve fitting, and error analysis, is an important part of the experiment. Therefore, you are required to complete the data analysis during the lab session. The lab notebook showing your data analysis will be examined and initialed by your TA/IA at the end of each experiment. This requirement will also allow you to recognize early if you need to repeat some or do more measurements before working on your experimental summary and formal paper.

It is also an excellent idea to stop several minutes before the end of each lab session and summarize in your notebook what you have done and the remaining problems to be solved, etc.

7. Safety

- This is a laboratory environment and it is important to retain your common sense regarding safety. You should be aware of potential dangers including voltage and/or current sources, lasers, high-pressure or vacuum systems, radioactive sources, and harmful chemicals.
- Please come to your lab session wearing appropriate clothes for laboratory work.
- Food or drink is not allowed in the laboratory.
- Wash your hands after leaving lab. Experiments involving radioactive material are performed in this laboratory, and there is always a chance that some surfaces may be contaminated with lead or other potentially harmful substances.
- If you have any questions regarding safety, feel free to ask.
- Please refer to the [Safety handout \(in pdf format\) \(https://canvas.ust.hk/courses/62621/files/9966469/download?wrap=1\)](https://canvas.ust.hk/courses/62621/files/9966469/download?wrap=1) for more details.

Course Summary:

Date	Details	Due
	 1st exp notebook https://canvas.ust.hk/courses/62621/assignments/364027	
	 1st exp performance https://canvas.ust.hk/courses/62621/assignments/364028	
	 2nd exp notebook https://canvas.ust.hk/courses/62621/assignments/364029	
	 2nd exp performance https://canvas.ust.hk/courses/62621/assignments/364030	
	 Experimental summary https://canvas.ust.hk/courses/62621/assignments/364031	
	 Formal Paper https://canvas.ust.hk/courses/62621/assignments/364032	
	 late/absent penalty (how many % will be deducted from final grade) https://canvas.ust.hk/courses/62621/assignments/364034	
	 Project report https://canvas.ust.hk/courses/62621/assignments/364033	