Physics 232 – Modern Physics Laboratory

2025 – 2026, Winter Term 2

General Info

Course:	Physics 232 (3 credits)
Pre-reqs:	MATH 101 and one of PHYS 121, PHYS 122
	PHYS 231 recommended
Lecture:	Wed & Fri 13:00–14:00 (FIP 140)
Laboratory:	L01 Mon 12:30–15:30 (SCI 241)
	L02 Tue 10:00–13:00 (SCI 241)
	You **must** register in one of the lab sections
URL:	https://people.ok.ubc.ca/jbobowsk/phys232.html

Instructor:	Jake Bobowski
Office:	SCI 266
Email:	jake.bobowski@ubc.ca

Overview

In this course you will perform a set of experiments designed to compliment your theoretical physics education and to enhance your abilities as an experimentalist. Each experiment will be different such that a range of topics and phenomena are covered (modern physics, waves, thermodynamics, ...). You will have two lab periods to complete each experiment. A variety of experimental techniques and data analysis methods will be encountered.

The lecture portion of the course will be used to discuss the treatment of uncertainties and data analysis methods. Attendance is mandatory for both the seminars and laboratory sessions.

Learning Objectives

The lab-based learning objectives are to develop a set of skills that will allow you to:

- Conduct experiments that probe modern physics concepts that do not have classical analogs (photoelectric effect, blackbody radiation, discrete atomic energy levels)
- Use sophisticated software packages (Python and Jupyter notebooks) to quantitatively analyze experimental data to extract meaningful physical results
- Estimate and analyze uncertainties and interpret the meaning of those uncertainties
- Maintain a thorough and organized lab notebook that documents your experimental activities, data analysis methods, physical models, insights into the system under study, final results, and possible extensions
- Connect experimental observations with theoretical models to deepen understanding of modern physics phenomena
- Apply principles of transparency and reproducibility in data analysis and reporting
- Collaborate effectively with lab partners to design, conduct, and interpret experiments
- Communicate all details of an experiment, from concept to completion, in a concise yet rigorous, technical report

The lecture-based learning outcomes are designed to allow you to:

- Explain the connections and differences between the binomial, Poisson and Gaussian distributions
- Complete propagation of error analyses and combine uncertainties of uncorrelated measurements using a weighted mean
- Understand how the method of maximum likelihood enables fitting models to data to extract best-fit parameters and associated uncertainties
- Have a basic understanding of how the Monte Carlo method uses probability and randomness to evaluate discrete integrals and simulate physical systems

In the Lecture & Lab

We will do our best to present material and respond to questions in a clear and logical way. However, you must take responsibility for your own learning. Come to the lab prepared. *Read* and *study* the manual before coming to the lab , *ask* questions, *ask* for clarification, *contribute* to discussions, *offer* ideas, . . . There will be assignments throughout the term. The assignments will allow you to apply what you've learned in the lectures and from the textbook. You will not be permitted to work on assignments during the lectures or labs.

Be considerate of fellow students: no cell phones, texting, reading email, web browsing, social networking, . . . during class.

Lab Tasks

The data collection portion of many of the experiments can be completed well within the 3-hour lab period. You are expected to work on data analysis and lab notebook write up during the scheduled lab time.

If you want to leave the lab early, you must show your TA or instructor your completed data analysis and lab notebook write up.

Students that are chronically late to the lab will have marks increasingly deducted from their "Lab Notebook" grade. **Students that miss a lab will not be permitted to analyze someone else's data, even if they are your lab partner**.

Lab Notebook

Your lab notebook is a very important part of the course. Your notebook should be a complete log of what you do in the lab. It should contain enough information that a knowledgeable person could reproduce your measurements and analysis based solely on what you wrote in your notebook (without having the lab manual!). Your notebook should also discuss the theory/physics relevant to your experiment and should include a discussion of the analysis methods and results. Reasonable conclusions should be drawn from the results of the analysis. Your notes should be complete and coherent enough that if you were to come back to your notebook several months (or years!) later, you would be able to understand exactly what you did in the lab and why you did it. You need to write things down in your lab book as you do them (i.e. not on scrap paper and not sometime "later").

Pre-Lab Assignments

Pre-lab assignments are due at the *start* of the lab. Late pre-labs assignments will not be graded and you will not be permitted to work on pre-lab assignments during the lab. All pre-lab assignments will graded a scale of 0 to 2.

There is also an online sign up sheet that will be used for selecting that labs that you will complete. For each lab that you sign up for before the specified due date, you will be given credit towards your final grade.

Textbook

The required textbook for the course is: *Basic Concepts of Data and Error Analysis* by Panayiotis Nicos Kaloyerou. You do **NOT** have to purchase a physical copy of this textbook. A pdf copy of the textbook can be downloaded from the online UBC library for free without violating copyright laws.

You may also find *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements* by Taylor to be a useful resource (not required).

You may also find *Data Reduction and Error Analysis for the Physical Sciences* by Bevington & Robinson to be a useful resource (not required).

You are also required to have **two** bound lab books (available from the UBCO bookstore). No coil-bound notebooks please. You may continue to use the lab notebooks that you were using in PHYS 231. Material submitted on loose pages (stapled or not) will not be graded.

Data Analysis

We will use Jupyter Notebooks and Python to analyze data that you collect during the lab. Here is a link to a set of tutorials that you can make use of to help you complete your data analysis.

Office Hours

My office is SCI 266. Formal office hours will be announced in class and published online: (https://cmps-people.ok.ubc.ca/jbobowsk/schedule/Jake%20-%202025-2026%20schedule%20-%20Term%202.pdf) Otherwise, email me to schedule an appointment.

Piazza

There will be a PHYS 232 Piazza page. It will be used to post information and notices that is relevant to physics students, but not directly tied to the PHYS 232 course. You can also use it to ask questions related to PHYS 232 homework assignments, labs, and lecture material and/or to initiate discussions with your classmates. To enrol in the PHYS 232 Piazza page:

- log in to the PHYS 232 Canvas shell
- follow the link provided in the Canvas shell to complete the registration

Evaluation

Note that, the grading scheme below may evolve.

Pre-Labs:	5%
Lab Sign Up:	2%
Assignments:	13%
Lab Notebook:	30%
Formal Report:	22.5%
Final Exam:	27.5%

⋆⋆⋆**IMPORTANT**⋆⋆⋆
You must receive at least 50% on the final exam to pass PHYS 232.

All of the material that you submit for grading must be your own work. Of course, you are encouraged to discuss and compare concepts, data, and analysis with others. However, all written text, plots, figures, calculations, . . . that you present must be your own work. Plagiarism from any source will not be tolerated. Making your work available for others to plagiarize will likewise not be tolerated.

Late Policy

Late assignments and lab notebooks will not be accepted. Assignments submitted by email will not be graded. **No exceptions**.

Official Policies of the Faculty of Science & CMPS Department

Missed Graded Work

Students who, because of unforeseen events, are absent during the term and are unable to complete tests or other graded work should generally discuss with their instructors how they can make up for missed work, according to written guidelines given to them at the start of the course (see Grading Practices). Instructors are not required to make allowance for missed tests or incomplete work not satisfactorily accounted for. If ill-health is an issue, students are encouraged to seek attention from a health professional. Campus Health and Counselling will usually provide the documentation only to students who have been seen previously at these offices for treatment or counselling specific to conditions associated with their academic difficulties. Students who feel that requests for consideration have not been dealt with fairly by their instructors may take their concerns first to the Head of the discipline and, if not resolved, to the Office of the Dean. Further information can be found at: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0. There will be no make-up midterm exams. If the absence is satisfactory, the weight of the student's final exam will be increased.

Grading Practices

Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to university, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,41,90,1014.

Final Examinations

The examination period for this term will be from Sunday, December 11th, 2022, to Thursday, December 22nd, 2022. Students will be permitted to apply for out-of-time final examinations only if they are representing the University, the province, or the country in a competition or performance; serving in the Canadian military; observing a religious rite; working to support themselves or their family; or caring for a family member. Unforeseen events include (but may not be limited to) the following: ill health or other personal challenges that arise during a term and changes in the requirements of an ongoing job. An examination hardship is defined as the occurrence of an examination candidate being faced with three (3) or more formal examinations scheduled within a 27-hour (inclusive) period.

Further information on Academic Concession can be found under Policies and Regulation in the Okanagan Academic Calendar: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise, and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences. A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar at:
https://okanagan.calendar.ubc.ca/campus-wide-policies-and-regulations/student-conduct-and-discipl
discipline-academic-misconduct.

Cooperation versus Cheating

Working with others on assignments is a good way to learn the material and we encourage it. However, there are limits to the degree of cooperation that we will permit. Any level of cooperation beyond what is permitted is considered cheating.

When working on programming assignments, you must work only with others whose understanding of the material is approximately equal to yours. In this situation, working together to find a good approach for solving a programming problem is cooperation; listening while someone dictates a solution is cheating. You must limit collaboration to a high-level discussion of solution strategies and stop short of writing down a group answer. Anything that you hand in, whether it is a written problem or a computer program, must be written by you, from scratch, in your own words. If you base your solution on any other written solution, you are cheating. If you provide your solution for others to use, you are also cheating.

Copyright Disclaimer

Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students (http://copyright.ubc.ca/requirements/copyright-guidelines/) and UBC Fair Dealing Requirements for Faculty and Staff (http://copyright.ubc.ca/requirements/fair-dealing/). Some of these figures and images are subject to copyright and will not be posted to Canvas. All material uploaded to Canvas that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing Requirements for Faculty and Staff. Access to the Canvas course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Grievances & Complaints Procedures

A student who has a complaint related to this course should follow the procedures summarized below:

The student should attempt to resolve the matter with the instructor first. Students may talk first to someone other than the instructor if they do not feel, for whatever reason, that they can directly approach the instructor.

If the complaint is not resolved to the student's satisfaction, the student should e-mail the Department Head Dr. Sylvie Desjardins at cmps.depthead@ubc.ca.

Student Service Resources

Disability Resource Centre

The Disability Resource Centre (DRC) facilitates disability-related accommodations and programming initiatives that ameliorate barriers for students with disabilities and/or ongoing medical conditions. If you require academic accommodations to achieve the objectives of a course, please contact the DRC at:

- room: UNC 215
- phone: 250.807.8053
- email: drc.questions@ubc.ca
- web: https://students.ok.ubc.ca/academic-success/disability-resources/

Equity & Inclusion Office

Through leadership, vision, and collaborative action, the Equity & Inclusion Office (EIO) develops action strategies in support of efforts to embed equity and inclusion in the daily operations across the campus. The EIO provides education and training from cultivating respectful, inclusive spaces and communities to understanding unconscious/implicit bias and its operation within in campus environments. UBC Policy 3 prohibits discrimination and harassment on the basis of BC's Human Rights Code. If you require assistance related to an issue of equity, educational programs, discrimination or harassment please contact the EIO.

- room: UNC 325H
- phone: 250.807.9291
- email: equity.ubco@ubc.ca
- web: `www.equity.ok.ubc.ca`

Office of the Ombudsperson for Students

The Office of the Ombudsperson for Students is an independent, confidential and impartial resource to ensure students are treated fairly. The Ombuds Office helps students navigate campus-related fairness concerns. They work with UBC community members individually and at the systemic level to ensure students are treated fairly and can learn, work and live in a fair, equitable and respectful environment. Ombuds helps students gain clarity on UBC policies and procedures, explore options, identify next steps, recommend resources, plan strategies and receive objective feedback to promote constructive problem solving. If you require assistance, please feel free to reach out for more information or to arrange an appointment.

- room: UNC 328
- phone: 250.807.9818
- email: ombuds.office.ok@ubc.ca
- web: `www.ombudsoffice.ubc.ca`

Sexual Violence Prevention and Response Office (SVPRO)

A safe and confidential place for UBC students, staff and faculty who have experienced sexual violence regardless of when or where it took place. Just want to talk? We are here to listen and help you explore your options. We can help you find a safe place to stay, explain your reporting options (UBC or police), accompany you to the hospital, or support you with academic accommodations. You have the right to choose what happens next. We support your decision, whatever you decide.

Visit `https://svpro.ok.ubc.ca` or call us at 250-807-9640.

Independent Investigations Office (IIO)

If you or someone you know has experienced sexual assault or some other form of sexual misconduct by a UBC community member and you want the Independent Investigations Office (IIO) at UBC to investigate, please contact the IIO. Investigations are conducted in a trauma informed, confidential and respectful manner in accordance with the principles of procedural fairness.

You can report your experience directly to the IIO by calling 604-827-2060.

- email: director.of.investigations@ubc.ca
- web: https://investigationsoffice.ubc.ca/

Student Learning Hub

The Student Learning Hub is your go-to resource for free math, science, writing, and language learning support. The Hub welcomes undergraduate students from all disciplines and year levels to access a range of supports that include **tutoring in math, sciences, languages, and writing, as well as help with academic integrity, study skills and learning strategies**. Students are encouraged to visit often and early to build the skills, strategies and behaviours that are essential to being a confident and independent learner. For more information, please visit the Hub's website.

- room: LIB 237
- phone: 250.807.8491
- email: learning.hub@ubc.ca
- web: https://students.ok.ubc.ca/academic-success/learning-hub/

Student Wellness

At UBC Okanagan health services to students are provided by Student Wellness. Nurses, physicians and counsellors provide health care and counselling related to physical health, emotional/mental health and sexual/reproductive health concerns. As well, health promotion, education and research activities are provided to the campus community. If you require assistance with your health, please contact Student Wellness for more information or to book an appointment.

- room: UNC 337
- phone: 250.807.9270
- email: healthwellness.okanagan@ubc.ca
- web: https://students.ok.ubc.ca/health-wellness/

Safewalk

Don't want to walk alone at night? Not too sure how to get somewhere on campus? Call Safewalk at 250-807-8076.

For more information, visit https://security.ok.ubc.ca/safewalk/