

Physics 231 – Introduction to Electronics

2024 – 2025, Winter Term 1

General Info

Course: Physics 231 (3 credits)
Section: 001
Pre-reqs: One of MATH 101, MATH 103 & one of PHYS 121, PHYS 122
Lecture: MW 13:00–14:00 (FIP 124)
Laboratory: L01 Thu. 09:00–12:00 (SCI 241)
Laboratory: L02 Thu. 13:00–16:00 (SCI 241)
You **must** register in the lab section
URL: <https://cmps-people.ok.ubc.ca/jbobowsk/phys231.html>



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

Calendar Entry

Design and analysis of analog AC circuits, digital circuits, and analog-to-digital conversion methods. Basic physics laboratory skills including data collection, presentation of results, and analysis of uncertainties. [2-3-0]

Overview

In this course you will study, build, and then analyze a variety of analog and digital circuits. In most cases you, will build your circuits and collect the required data in a single lab period. At the end of the term you will use what you have learned to build a more sophisticated circuit that makes use of both analog and digital components. This end-of-term project will span several classes (at least three).

In physics, the vast majority of experimental data are derived from electronic signals that must be acquired and processed. In this course, you will encounter all aspects of practical circuits – from design and construction to testing and debugging. Other skills that you will develop include: working with standard test equipment (multimeters, function generators, and oscilloscopes), data analysis, and keeping a thorough and neat log of your work that succinctly describes the technical details of each task that you complete. Each of these skills are required to be successful in any experimental physics laboratory.

The lecture portion of the course will be used to develop a theoretical understanding of electronics. Methods used to analyze practical circuits will be emphasized. The lectures will also present the background information relevant to the circuits that you will study in the laboratory. Some topics covered in PHYS 121/122 may be reviewed, but they will not be repeated in great detail. Attendance is mandatory for both the lecture and laboratory sessions.

In the Lecture & Lab

The lab TA and I 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. They will also prepare you for upcoming labs. You will not be permitted to work on assignments during the lectures or labs. Please be considerate of fellow students: no cell phones, texting, reading email, web browsing, social networking, ... during class.

Textbook

Electronics for Scientists by Daniel F. Santavicca. You do **NOT** have to purchase a textbook. You can download a pdf copy of *Electronics for Scientists* for free through the UBC Library:

<https://www.library.ubc.ca/>

You are also required to have **two** yellow or blue bound lab books (available from the UBCO bookstore). Material submitted on loose pages (stapled or not) will not be graded.

Useful resources include:

1. *Basic Electronics for Scientists and Engineers* by Dennis L. Eggleston
2. Any other electronics textbook, *The Art of Electronics* by Horowitz and Hill, for example
3. *An Introduction to Error Analysis* (Taylor)
4. *Data Reduction and Error Analysis for the Physical Sciences* (Bevington & Robinson)
5. Any calculus-based first-year physics textbook

Office Hours

My office is SCI 266. Formal office hours will be announced in class and published online:

(<https://people.ok.ubc.ca/jbobowsk/schedule/Jake%20-%202024-2025%20schedule%20-%20Term%201.pdf>)

Otherwise, email me to schedule an appointment.

Learning Outcomes

If you invest the appropriate amount of time and effort into this course, by the end of PHYS 231 you will have developed the following skills:

From the *lecture* . . .

- Set up differential equations that can be solved for the time evolution of voltages and currents in a circuit (time-domain analysis).
- Use complex algebra and the concept of impedance to determine the frequency dependence of amplitudes and phases of signals (voltage and current) in an ac circuit (frequency-domain analysis).
- Apply the two Golden Rules to analyze op-amp circuits. Understand when the Golden Rules are applicable. Design practical op-amp circuits that perform useful tasks.
- Understand how doped semiconductors can be used to make diodes (one-way valves for current) and transistors (electric switches).
- Use transistor switches to design binary logic gates. Appreciate the advantages of digital electronics. Combine logic gates to perform useful tasks such as binary addition and counting.

From the *lab* . . .

- Be able to construct sophisticated and practical analog and digital circuits.
- Use test equipment (power supplies, function generators, multimeters, oscilloscopes) to collect high-quality data from your circuits.
- Analyze the data that you collect from your circuits to extract meaningful results that can be compared to theoretical predictions.
- Make use of Jupyter Notebooks and Python to analyze data that you collect in the lab.
- Apply proper error analysis methods (propagation of errors) to attach uncertainties to your measured data, the results of your analysis, and your theoretical predictions.
- Keep a detailed and clear log of your lab activities, analysis methods, and conclusions in an organized lab notebook.

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.

Lab Notebook

Your lab notebook is a very important part of the course. Your notebook should contain a complete log of what you do in the lab. It should include enough details that a knowledgeable person could reproduce your experiments and data analysis methods based solely on what you wrote in your notebook (without having the lab manual!). It 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. You need to write things down in your lab book as you do them (i.e. not on scrap paper and not sometime “later”). The notes in your log book should not refer readers to the lab manual.

At the beginning of the lab period the lab notebook containing the data and analysis from the circuit of the previous week will be collected. You will use your other notebook (remember, you need **two**) for the current experiment. Graded lab notebooks will also be returned at the start of the lab period.

Piazza

There will be a PHYS 231 Piazza page (<https://piazza.com/>). It will be used to post information and notices that are relevant to physics students, but not directly tied to the PHYS 231 course. You can also use it to ask questions related to PHYS 231 homework assignments, labs, and lecture material and/or to initiate discussions with your classmates. To enroll in the PHYS 231 Piazza page:

- log in to the PHYS 231 Canvas shell
- retrieve the PHYS 231 Piazza access code
- follow the link provided in the Canvas shell to complete the registration

Evaluation

Note that, the grading scheme below may evolve.

Assignments: 20%

Lab Notebook: 40%

Final Exam: 40%

*****IMPORTANT*****

You must receive at least 50% on the final exam to pass PHYS 231.

*Materials submitted via email will **not** be graded.*

*Assignments submitted without a staple will **not** be graded.*

*Assignment will be due at the **start** of class. Late assignments will **not** be graded.*

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 also not be tolerated.

Tentative Schedule

Week	Topic
1	Error Analysis & DC Circuits Review
2	AC Circuits
3	Complex Numbers in Electronics
4	Complex Numbers in Electronics
5	Operational Amplifiers
6	Operational Amplifiers
7	Semiconductors & Diodes
8	Bipolar Junction Transistors
9	Bipolar Junction Transistors
10	Digital Electronics
11	Digital Electronics
12	Digital Electronics Applications
13	Analog-to-Digital Converter (ADC)

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-discipline/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 cmeps.depthhead@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/>