

Experimental Physics I Syllabus

Department of Physics and Atmospheric Science

PHYC 3000A Fall 2023

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Ines Hamam	Ines.Hamam@dal.ca	After lectures, Dunn Bldg. room 242
Ian Hill	Ian.Hill@dal.ca	During tutorials, Dunn Bldg. room 228

Detailed information

Office hours: In person: Any time after lectures to answer questions related to class materials or assignments.

Team's meeting: An invitation will be sent to the student for a meeting at a mutually agreed time.

E-mail: It will be used only to provide one-line answer to questions. I will respond within 24 hours.

Lectures: MWF 9:35 – 10:25, Dunn room 221C.

Electronic Laboratories: 1 workshop and 9 labs, 3 hours each to be held in Dunn room 107. Tuesdays 14:35 – 17:25 starting on Sept 19, 2023.

LabVIEW Lecture and Tutorial (13 sessions): Weekly 3 hours each to be held in Dunn room 208. Thursdays 14:35 – 17:25 starting on Sept 7, 2023.

Course delivery: In-person. The Electronics and LabVIEW lectures and demonstrations have been recorded and available on the course Brightspace. I strongly encourage you to watch them outside lecture time.

Course Description

This course introduces students to electronics and measuring techniques. Topics include digital electronics: logic gates, clocks, shift registers, counters, memory; analog electronics; R.C.L. circuits, operational amplifiers; electronic systems: A/D and D/A chips, computer chips, and displays. The course also introduces students to modern data acquisition methods (including LabVIEW), skills which will be applied in the design and execution of experiments that illustrate fundamental concepts in physics. This course is open to Honours students only.

NOTES: *This course has no final examination.*

Student evaluation is through the performance on 1 workshop, 9 assignments, 9 Electronics labs, 10 quizzes, 2 tests, 8 LabVIEW tutorials, and a final term project.

Course Prerequisites

PHYC 2150.03 and PHYC 2515.03, or permission of the instructor.

Course Exclusion

Credit cannot be obtained for both PHYC 3000A and PHYC 3340A

Learning Objectives

- 1) *To understand basic concepts in:*
 - *analog and digital electronics,*
 - *computer interfacing with experiment*

- 2) *With the assistance of resource people, the student will be able:*
 - *To design, and build some simple electronic circuits used in a research laboratory*
 - *To perform PC interfacing with laboratory instruments.*

Course Materials

- *Suggested textbook:*
“Introductory electronics for scientists and engineers”, 2nd Edition, by R. E. Simpson, Allyn and Bacon, Inc. 1987, ISBN 0-205-08377-3. It is out of print. There is a copy in the lab room 107 and a copy in the Physics office for approximately 2 h loan in exchange for your Dal card. The class notes are very detailed, complete and sufficient to present the concepts, and some examples. Additional exercises can be found online.

- *Laptop and mobile device (eg, cell telephone) are required for this course.*
The laptop will be used to install a 30 day version of LabVIEW for programming and data collection while, if necessary, the mobile device will be used as a document camera with the laptop to communicate written problem solution on paper to the rest of the class during tutorials.

- *Brightspace course page: PHYC 3340 & PHYC 3000 – Electronics (Sec 1) – 2022 Fall*

Course Content

Time permitting the topics are:

List of modules on Electronics, videos, and class notes within Brightspace

Module 1: Direct Current (DC) Circuits

Videos:

- 1.1 Ohm's and Kirchhoff's Laws, and Circuit Analysis
- 1.2 Voltage Divider and Thevenin's Theorem
- 1.3 Circuit Loading and Input and Output Resistance
- 1.4 Instruments

Module 2: Charging and discharging of a capacitor

Video:

- 2 Charging and Discharging of a Capacitor

Module 3: Alternative Current (AC) Circuits

Videos:

- 3.1 Introduction to AC Circuits
- 3.2 Circuits and the Bode Plot
- 3.3 LRC Resonant Circuits
- 3.4 Measurement of $|A|$ and Phase Angle
- 3.5 The Scope Probe - Another Form of an RC Circuit
- 3.6 Transformers

Module 4: Diodes and their Applications

Video:

- 4 Diodes and Their Applications

Module 5: Operational Amplifiers

Videos:

- 5.1 Introduction to Op-Amps and Circuit Analysis
- 5.2 Non-Inverting Op-Amp and Difference Op-Amp
- 5.3 Current Op-Amp and "Math" Op-Amps
- 5.4 Op-amp Comparator and the Schmitt Trigger
- 5.5 Low Pass, High Pass, and Band Pass Filters Revisited
- 5.6 Second Order Low Pass Op-Amp Filter
- 5.7 Second Order Sallen Key Low Pass and High Pass Filters
- 5.8 Chebyshev, Butterworth, and Bessel Filters
- 5.9 Op-Amp Imperfections - Input Bias Current and Input Offset Voltage
- 5.10 Op-Amp Imperfections: The Op-Amp Frequency Response and the Common Mode Gain

Module 6: Oscillators and Monostables

Video: 6. Oscillators and Monostables

Module 7: Combinational Logic

Videos: 7.1 Boolean Algebra and Gates
7.2 Application of Digital Gates
7.3 Design of a Digital Network and Circuit
7.4 The Digital Die
7.5 The Karnaugh Map
7.6 The Seven Segments Display

Module 8: Sequential Logic

Videos: 8.1 Basic Unit of Memory - The RS Flip Flop (FF) and Its Variations
8.2 Edge-Triggered FFs
8.3 Ripple Counters
8.4 Synchronous Counter
8.5 Counters and Other Digital Circuits

Module 9: ADC – DAC Conversion

Videos: 9.1 ADC and the Sampling Theorem
9.2 DAC and Analog Circuits
9.3 ADC Circuits, and Sample and Hold Circuits
9.4 Commercial ADCs and NI Data Acquisition Cards

Approximate schedule: *Half the term will be dedicated to Analog Electronics while the remaining half of the term will be on Digital Electronics.*

2 Introduction to graphical programming using LabVIEW and computer interfacing to laboratory instruments and sensors.**The topics are:**

- 2.1** The LabVIEW environment.
- 2.2** The Hall effect and virtual instrument.
- 2.3** Temperature sensors and data loggers using the LabVIEW structures.
- 2.4** Curve fitting and data analysis using arrays and clusters.
- 2.5** LabVIEW strings; the language of computer interfacing.

- 2.6 The stepping motor controller using the National Instrument Data Acquisition (DAQ) card.
- 2.7 Fluke 45 DMM and the IEEE 488 (GPIB) parallel communication port.
- 2.8 Sampling of time varying signals using the DAQ Card. The sampling theorem.

Approximate schedule: *The topics will be carried out during the first 8 tutorials of the course while the term project will be done during the last four tutorials of the term.*

Course Assessment

<u>Component</u>	<u>Weight</u>	<u>Date</u>
Electronics component		
• Electronics Workshop:	3 %	Tuesday Sept 19 th from 14:35 – 17:25
• Electronics Laboratories:	5 %	Tuesdays from 14:35 – 17:25
• Assignments (best 8 out of 9):	15 %	weekly due on Fridays at 9:35
• Quizzes (best 9 out of 10):	10 %	weekly on Wed from 9:35 to 9:50
• Two tests 15 % each:	30 %	to be held on Fri Oct 20 th and Mon Dec 4 th from 9:35 – 10:25
• Sub total:	63 %	
LabVIEW component		
• Tutorials (8):	5 %	Thursdays during the first 8 weeks
• Experimental physics project and term paper:	32 %	due on Wednesday Dec 13 th at 14:30
• Sub total:	37 %	
TOTAL:	100 %	

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

Course Policies

- Late assignment will receive a mark deduction of 10 %/calendar day and after 48 hours a mark of zero.

- If one week, an assignment is not submitted and the submission of the *Student Declaration of Absence form* is not submitted then the assignment will count as zero toward the calculation of the final grade. In the event that the *Student Declaration of Absence form* is submitted, all the graded assignments will be used toward the calculation of the final grade.
- **Collaboration on assignments:** It is expected that students discuss together assignments problems on **how to solve problems!** However, it is an academic offense to copy someone else solution. It is very easy to tell if copying occurred. Allegation of copying will be submitted to an Academic Integrity Officer of the Faculty of Science for evaluation and possible sanction. Minimum sanction: Zero on the assignment (2.5 % toward the final grade) which must be included in the calculation of the final grade and 5 % grade penalty toward the final grade. When caught, cheating is costly.
- If one week, a quiz is not submitted and the *Student Declaration of Absence form* is not submitted then the quiz will count as zero toward the calculation of the final grade. In the event that the *Student Declaration of Absence form* is submitted, all the graded quizzes will be used toward the calculation of the final grade.
- Note that a total of two (2) *Student Declaration of Absence forms* can only be used throughout the term.
- If a test cannot be done at the schedule time and the *Student Declaration of Absence form* is submitted, then the test will be rescheduled at a mutually agreed time. Otherwise, a grade of zero will be attributed to the test.
- A missed (or fraction thereof) Electronics lab will receive a mark deduction of 1 % toward the final grade.
- A missed (or fraction thereof) LabVIEW tutorial will receive a mark deduction of 1 % toward the final grade.
- A missed LabVIEW tutorial must be made up before the next tutorial. Otherwise, a penalty of 4 % toward the final grade will apply.
- A paper copy of the LabVIEW term paper is due in my office or Physics office on Wednesday Dec 13th at 14:30. If, instead, an electronic version is submitted a grade penalty of 5 % toward the final grade will be applied.

Assignment Policies

- **Assignments are due on Fridays at 9:35 on the due date.**
- **Late assignments will receive a 10 %/calendar day deduction for two calendar days and then it will not be marked.**

In order to facilitate marking of the assignments, please follow these guidelines:

- 1) Use 8 1/2" x 11" paper.
- 2) Write clearly. Can the lecturer read the solution?
- 3) Start each question on a new sheet of paper.
- 4) Clearly indicate the question number at the top right-hand corner of the page.

- 5) Use the same numbering as in the assignment sheet.
- 6) Whenever applicable, give the answer to three significant digits in either fixed or scientific notation.
- 7) Show the full solution to the problem; not only the answer. The TA wants to see that you understand the problem.
- 8) Submit your assignment with a cover sheet clearly showing your name, class number and assignment number.
- 9) Arrange your answers to the questions in the same order given in the questionnaire. Otherwise, the solutions will not be marked.
- 10) Submit a paper copy where all the solutions are oriented in the up position. Otherwise, the solution(s) will not be marked. An electronic submission will not be accepted.
- 11) Please verify your paper copy before submission to make sure that it follows the above guidelines.

Your assignment mark is final unless the above guidelines are followed.

Student Resources and Support

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates):

http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol:

https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

Dalhousie Grading Practices Policies:

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): <https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html>

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Indigenous Connection: <https://www.dal.ca/about-dal/indigenous-connection.html>

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student

Centre or contact the program at elders@dal.ca or 902-494-6803:

<https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf>

Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre.html

South House Sexual and Gender Resource Centre: <https://southhousehalifax.ca/about/>

LGBTQ2SIA+ Collaborative: <https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html>

Dalhousie Libraries: <http://libraries.dal.ca/>

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Dalhousie Student Advocacy Services: <https://www.dsu.ca/dsas?rq=student%20advocacy>

Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Human Rights and Equity Services: <https://www.dal.ca/dept/hres.html>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: <https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html>

Safety

Biosafety: <http://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <http://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Laser Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html>