### Electronics and Instrumentation Laboratory PHY335 (Junior Lab) Fall 2021

*Prerequisite:* PHY 251 with lab (PHY252)

**Course Description:** PHY 335 (Electronics and Instrumentation Laboratory, or Junior Lab) is a laboratory-based course covering *analog* Electronics fundamentals as viewed by an experimental physicist. We will not venture into *digital* electronics; there is no time for that in this one-semester course. Instead, we will try to understand how analog electronics works based on fundamental physical principles and laws. You will be designing and building basic DC and AC circuits which perform some useful function. These circuits will involve resistors, capacitors, transformers, diodes, transistors, and operational amplifiers. You will also learn to use essential laboratory instruments such as power supplies, digital multi-meters, and digital oscilloscopes with their many features. The course always refers to the laws of electricity you studied previously. We will periodically review these electricity basics. You will learn to analyze simple electronic circuits, particularly using the method of *load line* analysis. Ideas and tools specific to electronics, such as the principle of negative feedback, will be introduced when appropriate. An example of a difficult measurement made easy with electronics will be provided: we will measure the diode's current-voltage characteristic over eight orders of magnitude in current and compare the result with the theoretical (Shockley) formula. You will learn to use Excel to display and fit the data. At the end of this course, you should be comfortable with simple electronic circuits and with laboratory instruments. Above all, you will understand the physics fundamentals that underly all the above.

The course consists of two three-hour laboratories per week. Most labs will start with a lecture which will be 45 – 60 minutes long. The rest of the three hours will be devoted to experimental work. Professor Gurvitch will deliver the lectures. A Teaching Assistant will supervise the lab.

**Topics (Units) to be covered:**

1. Lab instruments; measurements; internal resistances of a DC power supply, ammeter, and voltmeter; simple DC circuits; voltage dividers; Thevenin theorem and Thevenin equivalents.
2. AC signals; use of an oscilloscope; AC circuits; RC filters; RC differentiators and integrators.
3. Diodes and diode circuits; detailed measurement of a diode I-V characteristic over 8 orders of magnitude in current (an example of a physics measurement).
4. Transistors and basic transistor circuits (current source, amplifier). Negative feedback and how it improves a transistor-based current source.
5. Operational Amplifiers (OpAmps) and negative feedback; OpAmp circuits (follower, amplifier, current source). Time permitting: Op-Amp-based integrators.

**The practical realities of this course**

Professor Gurvitch will lecture, and a TA will supervise students in the lab. TA will hold office hours to allow students to finish some unfinished work and to answer practical questions. Each of the five Units may take from 2 to 4 weeks to be finished. At the end of each Unit, students will be given one week to write a detailed Report, these Reports graded by the TA-s. There will be two three-hour exams, one after Unit 3 and another after Unit 5. The date of the first exam will materialize when we see when we finish Unit 3. The second exam is given on the last day of classes. These exams will be administered in the classroom, proctored by TAs and Prof. Gurvitch, who will grade them. Exams are serious, and they constitute 50% of the grade. Students will be able to do well in them only if they understand the material. This course is all about understanding; it cannot be passed by just doing lab work without thinking. Unfortunately, I have seen time and again that some students get decent grades for their lab reports but fail the exams. Please do not allow this to happen to you – study the underlying theory.

**Time and place**: **Group 335 – L01:** Tu and Th 1:15 – 4:05

**Group 335 – L02:** M and W 1:00 – 3:50

in A-127 and A-125, Physics Building, level A.

**Instructor:** Prof. Michael Gurvitch, michael.gurvitch@stonybrook.edu

**Teaching Assistants (TAs):** TBA

**Books and other course materials:** Students are *not required* to buy books for this course; essential material will be posted on the Blackboard by the Professor during the semester; students will have to download and print out the Units, each Unit containing assignments and detailed explanations.

Books that are *recommended* as supplementary material (they can be found on reserve in the Physics Library) are:

1. Any basic course on E&M, for example Giancoli, *Physics for Scientists and Engineers*, 4-th Edition, Chapters 21, 23, 24 – 26.
2. Horowitz and Hill, "*The Art of Electronics*", *3-d edition,* (Cambridge University Press, 2015); $100 on Amazon; it is a good book to have if you are planning to continue studying electronics.
3. Hayes and Horowitz, "Learning the Art of Electronics (lab manual), same publisher, about $60 on Amazon; it is also a good book to have if you are planning to continue studying electronics.

**Required:** One laboratory *science notebook* (the one that contains graph paper pages), or a regular notebook and separate loose sheets of graph paper; scientific calculator; computer (laptop or tablet) to prepare reports and to log in for Zoom meetings (if they take place). We will ask you to attach to the Report a copy of the pages containing the raw data. It is also allowed to use a laptop or a tablet to collect the data; in that case, we will ask you to provide us with a copy of the raw data as it has been entered into the laptop.

**General organization of the course:**

All material is divided into *Units*, with each Unit covering internally related topics (see above). Each Unit will occupy several lab periods; some units may be much longer than others. Extensions of lab time may be arranged with the TA by prior mutual agreement, but this should be done only under exceptional circumstances. Otherwise, no substitution of regularly scheduled lab periods is possible. After each Unit is finished, students will be expected to submit a Report on that Unit in one week. The Report should be done on a computer; it should be well-written (good English grammar; precise scientific language), with theoretical and experimental sections, and good quality figures, some of which may be photographs of an oscilloscope screen. Students can use digital cameras, cellphones, or laptop cameras. These photos should be clear and legible, including axes and scales.

Students should come to class on time for a lecture which will be delivered in the first hour. We recommend taking notes during these lectures and reviewing them afterward.

You will be doing the lab work individually, supervised by a TA, and you will write your *individual* lab report after completion of each Unit. Copying of any part of a report from another student or from any outside source is unacceptable and will automatically lead to a zero score as a first warning.

One of the worst things a student may do is *makeup* data (that is, to pretend that some values were measured when they were not). Again, if we detect that form of cheating, the penalty will be severe.

**Exams:** There will be *a First Exam* during the semester (after Unit 3), and a *Second Exam* in the last day of classes after Unit 5 (not in the Exam week). A careful reading of the material provided in the Units, study of the notes you will take in lectures, as well as experimental work will prepare you for the exams. Both exams will be theoretical (no lab work required during the exam), but many questions will be practical. The exams will be given in class, and they will be proctored. No formula sheets or any other material is allowed: only you, your scientific (non-graphing) calculator, and the printed exam in front of you. The second exam is cumulative, covering the whole course, but otherwise similar in format to Exam #1. There will be no Final in the "finals" week.

**Note:** we have the permission of the Dean to conduct the second exam on the last day of classes rather than in the Finals week.

**Grading:**

All the Units (with reports) and the two exams must be completed to pass this course. Because the number of Units is relatively small, and because all the material in this course is essential, we will consider a missing report or a missing exam as a sufficient cause for assigning a failing grade. **We also reserve the right to give an “F” grade if the second exam score is below 20/100 points, independent of all the other scores.**

The **course grade** will be calculated as follows: ***50% Units (Report grades) + 20% 1-st exam + 30% 2-nd exam.***

There will be no “curving”; each student will get a grade he/she deserves based on scores. The “cuts” for the letter grades may change, but in the previous years they were as follows:

90 - 100 A

85 - 90 A-

80 - 85 B+

75 - 80 B

70 – 75 B-

65 – 70 C+

60 – 65 C

55 – 60 C-

45 – 55 D

0 – 45 F

**Various Statements**

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at [http://www.stonybrook.edu/commcms/academic\_integrity/index.html](https://www.stonybrook.edu/commcms/academic_integrity/index.html)

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.