PHY 335: Electronics and Instrumentation Laboratory

Fall 2020

Prerequisite: PHY 251 with lab (PHY252)

Course Description (syllabus): PHY 335 (Electronics and Instrumentation Laboratory, or Junior Lab) is a laboratory-based course covering analog Electronics fundamentals as viewed by an experimental physicist. You will be designing and building basic DC and AC circuits which perform some useful function and which are used in Physics measurements. These circuits will involve resistors, capacitors, transformers, diodes, transistors and operational amplifiers. You will also learn to use essential laboratory instruments such as DC and AC power supplies, digital multi-meters, and digital oscilloscope with its many features. All of the above will be taught with the reference to the laws of electricity you studied previously, these basics reviewed and reminded at various points in the course. Ideas and tools specific to Electronics, such as the principle of negative feedback, will be introduced in a context of their usefulness in improving electronic circuits. An example of a difficult Physics measurement made easy with the use of Electronics will be provided: we will measure diode's current-voltage characteristic over 8 orders of magnitude in current and compare the result with the theoretical (Shockley) formula. This will require understanding of the capabilities and limitations of our instruments coupled with some measurement techniques dictated by the task at hand. You will learn to use Excel to collect, display and fit the data.

The course consists of two three-hour laboratories per week. Each lab will start with a lecture which will be 45 – 60 minutes long. The rest of the three-hour period will be devoted to experimental work.

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 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 typical physics measurement)
4. Transistors and basic transistor circuits (follower, current source, amplifier)
5. Operational Amplifiers (OpAmps) and negative feedback; OpAmp circuits (follower, two types of amplifiers, current source, OpAmp-based integrator)

Some practical aspects dictated by the COVID-19 epidemics

This will be a hybrid course. Professor Gurvitch will lecture via Zoom, and his lectures will be later available for a review. He will meet with the TAs before each class and detail with them the experimental work that must be done in the lab. TAs then will supervise the work of students in the labs. Professor Gurvitch will be available by Zoom should his input be required at that stage. At the

end of each Unit students will be given one week to write detailed Reports of their work, these Reports graded by Professor Gurvitch and possibly by the TAs.

All students and TAs will be required to wear masks at all times while in class.

Time and place: Tu and Th, 1:00 p.m. to 3:50 p.m., in A-127, Physics

Instructor: Prof. Michael Gurvitch, office B-147, x 2-7298, michael.gurvitch@stonybrook.edu
Professor can be reached in each class by Zoom; no special office hours are planned.

Teaching Assistants (TAs): TBA

Books and other course materials: Students are not required to buy any books for this course; essential material will be posted in 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 which 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*", *2-nd edition,* (Cambridge University Press, 1989); ISBN 0-521-37095-7
3. Hayes and Horowitz, "*Student manual for the Art of Electronics*" (Cambridge University Press, 1989); ISBN 0-521-37709-9

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. 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. Extensions of lab time may be arranged with the TA by prior mutual agreement, but 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's time. 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 with 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 by Zoom usually in the first hour. We recommend taking notes during these lectures.

You will be doing the lab work individually, supervised by a TA, and 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.

The worst thing that a student may do is to *make up* data (that is, to pretend that some values were measured when actually they were not).

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. 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 of practical nature. The exams will be given in class, and they will be proctored by the TAs. The second exam will be given in the last day of classes, which, according to the Academic Calendar, will be before the Thanksgiving Break in November. That second exam will be 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 a permission of the Dean to conduct the second exam in 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 of the material in this course is essential, we will consider a missing Unit report, or a missing exam as a sufficient cause for assigning a failing grade.

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

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

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.