PHY 335: Electronics and Instrumentation Laboratory

Fall 2016

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 performing useful tasks. These circuits contain DC and AC voltage sources, resistors, capacitors, transformers, diodes, transistors and operational amplifiers. You will learn to use essential measuring instruments such as digital multi-meters and digital oscilloscope with its many features. As the course progresses, we will increase the content of our electronics "tool box". All of it will be based on the laws of electricity you studied previously, these basics being reviewed at various points in the course. Experience shows that electricity is fully understood only when its concepts are applied to practical situations; in this sense, we could call this course "Understanding Electricity". As one example of what can be done in the lab, we will perform a serious Physics measurement made easy with the intelligent use of a few simple circuits: you will accurately measure diode's current-voltage characteristic over 8 orders of magnitude in current, from about 300 mA to a few nA, and compare the result with the theoretical (Shockley) formula. We will use Excel to collect, graph and fit the data. In addition, you will learn the ideas and tools specific to electronics, such as Thevenin equivalents and the powerful principle of negative feedback. Towards the end of the course you will see how familiar circuits can be improved with the use of operational amplifiers and negative feedback.

The course consists of two three-hour laboratories per week. Some lab sessions will start with a ~45 minute lecture. 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); using diodes for clipping and rectification
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, Op-Amp differential amplifier)

Time and place: Section 01: Tuesday and Thursday, 1:00 p.m. to 3:50 p.m., in A-127, Physics
Section 02: Monday and Wednesday, 1:00 p.m. to 3:50 p.m., in A-127, Physics

Instructor: Prof. Michael Wilking, office D-106, michael.wilking@stonybrook.edu

Teaching Assistants (TAs): Teaching Assistants will be helping you in class with practical questions, and they will also grade all of your Reports. The exams are graded by Prof. Wilking.

Sec. 01 Darin Mihalik, office hours held in A-127, Tuesday and Thursday from 4-5pm
Sec. 02 Xinzhong Chen, office hours held in A-127, Wednesday from 4-6pm

Since Prof. Wilking will be available most weeks during the afternoon lab sessions, there are no additional scheduled office hours. However, please feel free to schedule an appointment if you wish to meet privately.

Books and other course materials: Students are not required to buy any books for this course. Essential material will be posted on Blackboard throughout the semester. Students can download Units (each Unit contains assignments and detailed explanations) from Blackboard. Nonetheless, reading relevant books is encouraged. 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*", *the latest edition,* (Cambridge University Press, 1989); [ISBN 0-521-37095-7 for the 2-nd edition]
3. Hayes and Horowitz, "*Student manual for the Art of Electronics*" (Cambridge University Press, 1989); ISBN 0-521-37709-9
4. Curtis A. Meyer, *Basic Electronics: An Introduction to Electronics for Science Students*, Carnegie Mellon University, 2009, 2010.
5. Giorgio Rizzoni, "*Principles and Applications of Electrical Engineering*" 4th Edition (McGraw-Hill, 2004); ISBN 0-07-288771-0

Required: One laboratory notebook and a scientific calculator.

Raw data and lab notes are important parts of a Report: We will ask you to submit a copy of the lab notebook pages containing the raw data along with each report. This data can be recorded by hand, or, if you so desire, with the use of a laptop or a tablet. We encourage you to use handwritten notes; indeed, drawing circuit diagrams is an important part of this process, and it is much easier to draw them by hand. It is essential to sketch circuits and enter component values for each report. It is also essential to indicate units of everything you are measuring. However you do it, we will need to see a complete record of your lab work, whether recorded by hand or with the use of a computer. The completeness and quality of the raw data, circuit diagrams and of the notes taken during the experiment contributes to your grade. The lab notes need not be "neat", they are reflecting real work in progress that you have done in the lab; they may contain mistakes, corrections, markups; they may show alternative ways of doing things. Nevertheless, they should be clear enough to be understandable by yourself and by your graders. Make short notes, comments and explanations to accompany data.

Lab reports: There will be 5 lab reports in the Semester, each describing a portion of your work on one of the 5 units. Reports should contain essential theory, circuits, essential data, and your analysis of the specified unit assignments to be covered in the report. To better organize a report, we ask you to include the texts of the actual assignments (taken from the manual) as headings in your report. Relevant theory may follow these headings; sometimes, general theory, which relates to more than one assignment, can be separated and presented in the introduction. A copy of the raw data you collected for all assignments will need to be included with the report, since the TAs will use this information to grade the assignments not covered in the formal portion of the report.

The report need not be excessively long: use concise, scientific, rather than colloquial, language when writing a report. Try not to exceed 15 pages. The report should be formatted with page numbers, assignment titles, and contain good figures (circuit diagrams, graphs), some of which may be photographs taken by a student (using digital camera, cell-phone or laptop cameras). Pictures rather than hand-made sketches of the oscilloscope screen are encouraged, however, we request that these pictures are clear enough for reading the scales and evaluating the data. It should be written in grammatically correct English. It should be done so that a grader will be able to understand what you have done and judge your work. Reports that lack in logic, physics, and common sense will be graded accordingly. All five reports are needed to pass the course.

General organization of the course:

You will be doing the lab work in groups of 2 per setup. All students should make the best effort to participate equally in the experimental part. Collaboration and consultation with your partner or anybody else in the class are encouraged. However, each student will write his or her *individual* lab report after completion of each unit. Except for the raw data, which you will take and share with your partner, the reports are expected to reflect individual work. Copying of any part of a report (except for the raw experimental data which is expected to be shared by the partners) is unacceptable and will automatically lead to zero report 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 just made up); if this will be discovered, the punishment may be severe. In the real world, this type of behavior (which, thankfully is extremely rare in physics) has cost people their jobs and careers.

Exams: There will be *First Exam* will be held in class on October 19th for section 2, and October 20th for section 1. The *Second Exam* will be held the last day of class. Careful reading of the material provided in the Units, study of the notes you will take in mini-lectures, as well as active and alert participation in experimental work will prepare you for the exams. It will also be helpful to work through some sample problems related to the concepts we discuss in class.

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. We will also collect your Unit 5 reports on the day of the second exam. Therefore, it will take us about a week to complete all of the grading and to assign grades.

Grading policy

All the five Units (with reports) and the two exams must be completed to pass this course. The **course grade** will be calculated as follows: ***75% Units (Report grades) + 10% 1st exam + 15% 2nd exam.*** The letter grade intervals will have slight variations semester-to-semester, but generally end up close to the following scale:

A	90-100
A-	85-90
B+	80-85
B	75-80
B-	70-75
C+	65-70
C	60-65
C-	55-60
D	45-55
F	0-45

DISABILITY SUPPORT SERVICES (DSS) STATEMENT

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. [*In addition, this statement on emergency evacuation is often included, but not required:* Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

ACADEMIC INTEGRITY STATEMENT

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 are 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/uaa/academicjudiciary/

CRITICAL INCIDENT MANAGEMENT

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs 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.