

PHYS 320L
Electronics for Scientists
Spring 2023

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Prerequisite: PHYS 122/122H and 122L

Lecture Hours: Tuesday, Thursday 13:00-13:50 PM
Classroom: Performing Arts & Humanities 123

Lab Hours: Thursday 14:30-18:20 PM
Classroom: PHYS 209

Textbook: Dennis L. Eggleston, *Basic Electronics for Scientists and Engineers*, ISBN: 978-0521154307 (available on Blackboard)

Software: *Circuit Lab* found at: <https://www.circuitlab.com/>

Overview: This course is designed to give an introduction of analog and digital electronics. The course will introduce the electric circuit components, designs, and analysis techniques relevant to the linear systems (i.e., linear circuits) and integrated circuits. Particular focus will be on methods for analyzing AC-inputs to linear circuits. The course aims to develop your ability to construct, measure, and analyze various types of electronic circuitry and provide hands-on experience in building and debugging circuits.

Course Objectives: By the end of the semester, you will be able to:

1. Understand the physics of electrical components, including inductors, capacitors, resistors, transistors and digital integrated circuits (IC)
2. Design simple passive and active DC, AC, and digital circuits,
3. Apply mathematical techniques to analyze electrical circuits and circuit diagrams,
4. Construct, troubleshoot and operate various types of basic electrical circuits including active integrated circuit elements,
5. Use oscilloscopes and others instruments to monitor and collect experimental data,
6. Analyze experimental data to verify proper circuit operation.

Course Philosophy:

“Any sufficiently advanced technology is indistinguishable from magic.” (Arthur C. Clarke)

Nowadays, nearly everything around us involves some electronic component. Having a working knowledge of the principles and limitations of electronics is becoming essential for daily life as well as many professions. Your job in the future may involve sophisticated electronic instruments or you may encounter applications requiring custom electronics to be designed. Hopefully, by the end of this course, the “magic” will have become an understanding of the principles that govern electrical circuits.

This will be one of your first laboratory courses that is not a straightforward “cookbook” lab where everything is already built for you before the lab. A large part of this course is for you to work with your partner to determine how to go about solving your issues, with minimal help from the instructor and teaching assistant (however, we are always going to be there to help/guide). Although each lab has a set of steps that you are to follow, many times things will most probably not work out correctly on the first try. At times, you may feel as if you are not sure what to do next. It is crucial that you carefully read through the lab ahead of time and make sure to answer some of the questions in the lab before you come to the class. Doing the electronics circuit simulations to run through the lab ahead of time allows you to see what the results should look like. In all cases, it is great to know where you are headed before you start down the road. Please take your time and think through what you are doing and what the next step should be during lab classes. This is the main reason why the lab class is four hours.

There are many free or inexpensive circuit simulators that are available on the internet. They can be used to check your homework solutions and to understand what might happen when you build your circuit correctly (or wrong) in the lab. In many instances, there will be pre-lab assignments that require some simulations performed, to ensure you have adequately prepared and understand what we are going to experiment for the lab. For this course, I would like you to use CircuitLab, which is available at <http://www.CircuitLab.com>. It is very user friendly, and it costs \$24. You should use the CircuitLab Micro Plan to get one-year access. If you need any basic help using it, you can contact me and refer to their website for very useful tutorials. When you buy the student micro version, you can set up an account there so you will be able to save, cut & paste, and print your circuit’s simulations.

The aim of this course is to make you comfortable working with electronic circuitry and familiar with various electrical controlling and measuring devices. You will learn the basic skills necessary to troubleshoot more complicated circuitry. Generally, the more organized you are in your layout of circuits (including color-coding wires, etc.), the less trouble you will have both in the initial setup of your circuit and any necessary troubleshooting. Some electrical components can get hot and overloaded integrated circuits (IC’s) have been known to fail catastrophically. Be sure you know what you are doing before you turn on the power to your circuit or ASK FOR HELP. You are encouraged to experiment in this lab. I also encourage you to provide any relevant feedback regarding lectures, quizzes, homework, labs, etc. The course is under constant revision to make things more clear and to improve your understanding. I am always learning, too, and appreciate your thoughtful comments

Grading:

Your final grade will be determined by:

| | |
|-----------------|-----|
| Final Lab Exam: | 10% |
| Mid-Term Exam: | 15% |

Homework, pre-labs, quiz: 15 %
 Lab Reports 60%

Your letter grade will depend on the total score. If your total grade is:

≥ 90 , your letter grade will be "A"
 $90 > X \geq 80$, then "B"
 $80 > X \geq 70$, then "C"
 $70 > X \geq 60$, then "D"
 $60 > X$, then "F"

Please focus on learning the material rather than the grades.

Midterms and Final Exam: The mid-term exam will take place during the semester, during the scheduled class time. The date of the mid-term exam is in the week of March 27th, 2023. This date may be subject to change. The exam will include all discussions up to week 8 indicated in the "Topics to be covered" section. The date of the final exam is determined by the university, and it will be on May 23rd, 2023 (1:00 PM-3:00 PM). The exam will include all the course material covered up to the day of the exam, if not informed otherwise. All of the exams will be closed book. At least one question of the exam will be similar to the ones assigned in homework.

Homework: Your preliminary homework for every class is to read the corresponding chapter/sections of the book. Homework assignments will be available on the Blackboard page and you will have a week to submit your solutions. No late assignments will be accepted. You are encouraged to study in groups and discuss the material and homework questions among yourselves. However, the homework solution should be your own work, not a group product. I plan to assign 6-7 homeworks. The lowest grade of these homeworks will not be taken into your final grade. This is meant to allow for things that come up unexpectedly.

Quizzes, Pre-labs: There is always the possibility for a quiz in both the lecture and lab sessions to ensure you are prepared. Each laboratory session has its own pre-lab assignments for you to complete. These assignments will ensure that you have the preliminary knowledge and a robust plan to follow during laboratory sessions.

Lab Sessions and Reports: There will be 12 laboratory sessions. For each of them, you will be given instructions to conduct the experiment and a week to write a report about it. No late submissions will be accepted. You can work and discuss your experimental reports with your partner, but you should write your own report in your own words and with your own analysis.

Course Material: All of the course material including lectures notes and slides, homeworks and quizzes will be uploaded to the Blackboard page of the course. Your duty is to check Blackboard regularly.

Topics to be covered:

| Week | Lab | Subject |
|------|----------------------|-------------------------------------------------------|
| 1 | - | Plotting & Fitting Data, Kirchoff's Laws |
| 2 | Meters and Ohm's Law | Measurement Devices, Power Capacitors and RC circuits |

| | | |
|----|-----------------------------------------------|-------------------------------------------------------------|
| 3 | Signal Generator and Oscilloscopes | Inductors, Oscilloscope, DC Resistive Circuits |
| 4 | Time Varying Signals | High-Pass and Low-Pass RC Filters, Phase angles and phasors |
| 5 | The Semiconductor Diode | Applications of AC circuits |
| 6 | Filters | Current diodes, Using IV curves |
| 7 | AC-Circuit Review | Semiconductor Junctions |
| 8 | The Integrated Circuits-Operational Amplifier | Operational Amplifiers (Op Amp) |
| 9 | OPAMP Potpourri | Op Amp Circuits |
| 10 | Active Low-Pass and High-Pass Filters | 555 Timers |
| 11 | 555 Times-Waveform Generation | 555 Timers |
| 12 | Circuits Practice Lab | Digital Logic |
| 13 | Digital Logic Circuits | Digital Logic Circuits |
| 14 | - | Practice Week |

Electronics 320L Rules

In this course, it is encouraged to collaborate and help clarify difficult concepts with your lab partner/friends. However, there are lines that cannot be crossed:

- Under no circumstances are you to copy or paraphrase answers from another student's assignments.
- Do not use previous years' assignments in any way.
- Falsifying lab data will not be tolerated and will result in a zero for that assignment.
- No collaboration of any kind can occur during the quizzes or exams.

There are still many ways in which collaboration can be very helpful:

- Ask other students to explain concepts rather than answers. One particularly useful way to explain concepts is to share an example problem with a slightly different configuration than the assigned problem.
- Ask other students clarifying questions about the interpretation of a problem or a laboratory procedure.
- If you gain insights to a problem or a section of a lab from another student, give a short credit (for example, "John Doe helped by explaining...").
- If you get help from other sources, then you must reference that source.

Student Responsibilities:

- Students are responsible for checking their academic e-mails and the Blackboard page of the course daily for getting updates about the course, grades, homeworks and class notes.

- If you need to take a make-up exam, please provide a university-approved excuse (such as a nurse/doctor signed document).

- In order to be successful in this course, you should attend all classes by having read the background material. Please be attentive and take notes during lectures. You are welcome to ask questions to clarify any point that is not clear, either during class or during my office hours. Please complete all homework on time and prepare for the exams.

COVID-19: Safety Expectations and Guidelines:

UMBC is a community where we look out for each other. You can find the current UMBC policy on Covid-19 related Safety Response [here](#). In this classroom, I ask that everyone wear a mask. There are those among us who are at higher risk than others, or who care for people who are at high risk, and wearing a mask is one way we can care for and protect each other. Please come to me with any concerns about this request.

Covid-related Classroom Absences: Class absences may take the form of not attending an in-person class or a scheduled synchronous online class; or not participating in online class activities (synchronous or asynchronous). Students who are absent from class due to COVID-19-related situations are expected to communicate directly with the course instructor. Students should submit notification of the absence in writing to their instructor either prior to the absence or as soon afterwards as possible. If the COVID-19 related absence coincides with graded work (e.g., homework, in-class activities, quizzes, presentations, activities, etc.), students should work with the instructor to arrange for an academic accommodation. It is important to affirm that class absences, COVID-19-related or not, do not alter the academic requirements of any course and students remain responsible for information and material missed during the absence. Additionally, COVID-19-related absences are not considered a “disability” and as such do not require that students seek accommodations from the Office of Student Disability Services.

Technology: Access, Requirements, Resources, Support:

To help ensure that UMBC students are equipped for academic success, the Division of Information Technology (DoIT) provides a wealth of resources and support, including tips for getting online and minimum specifications to consider when purchasing a computer (doit.umbc.edu/students). UMBC does require all students to be technologically self-sufficient, which entails having a reliable personal computer (preferably a laptop with webcam) and Internet access. Since UMBC requires all students to have a computer and Internet access, financial aid may be used to meet this requirement. To learn more, students should contact their financial aid counselor at financialaid.umbc.edu/contact.

Statement of Values for Student Academic Integrity at UMBC

In February 2001, the Faculty Senate affirmed the importance of our values and practices by adopting the Statement of Values for Student Academic Integrity that is placed on most course syllabi:

Academic integrity is an important value at UMBC. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal.

The purposes of higher education are the learning students and faculty undertake, the knowledge and thinking skills developed, and the enhancement of personal qualities that enable students to be strong contributing members of society. In a competitive world, it is essential that all members of the UMBC community uphold a standard that places integrity of each student's honestly earned achievements above higher grades or easier work dishonestly sought.

All members of the UMBC community are expected to make a commitment to academic honesty in their own actions and with others. Academic misconduct can result in disciplinary action that may include suspension or dismissal. The following are examples of academic misconduct that are not tolerated at UMBC:

- **Cheating:** Using or attempting to use unauthorized material, information, study aids, or another person's work in any academic exercise.
- **Fabrication:** Falsification or invention of any information or citation in an academic exercise.
- **Facilitating academic misconduct:** Helping or attempting to help another student commit an act of academic misconduct.
- **Plagiarism:** Knowingly, or by carelessness or negligence, representing as one's own, in any academic exercise, the intellectual or creative work of someone else.
- **Dishonesty:** Lack of truthfulness or sincerity when interacting with the faculty member regarding an academic exercise

To this end, UMBC undergraduate students also adopted the following Undergraduate Honor Statement as it describes the high standards to which everyone in the community will be held: *I hereby assume the responsibilities of an engaged member in a scholarly and civic community in which academic work and behavior are held to the highest standards of honesty. It is my active participation that affirms these principles and gives them true meaning as well as value in my education. I realize that by committing acts of dishonesty I hurt myself and place an indelible mark on the reputation of UMBC. Therefore, I will not cheat, fabricate materials, plagiarize, or help another to undertake such acts of academic dishonesty, nor will I protect those who engage in acts of academic dishonesty.*

For more information on the topic of Academic Integrity, visit: <http://oue.umbc.edu/ai/>

Accessibility and Disability Accommodations, Guidance and Resources:

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that would create equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu, SDS phone: (410) 455-2459

If you will be using SDS approved accommodations in this class, please contact me (instructor) to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination:

UMBC's **Policy on Sexual Misconduct, Sexual Harassment and Gender Discrimination** and Federal Title IX law prohibit discrimination and harassment on the basis of sex in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy

discrimination, gender-based harassment or retaliation should contact the University's Title IX Coordinator to make a report and/or access support and resources:

Mikhel A. Kushner, Title IX Coordinator (she/her/hers)
410-455-1250 (direct line), kushner@umbc.edu

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in or thinking about making a report, please see the **Online Reporting Form**. Please note that, while University options to respond may be limited, there is an anonymous reporting option via the online form and every effort will be made to address concerns reported anonymously.

Notice that Faculty are Responsible Employees with Mandatory Reporting Obligations:

All faculty members are considered *Responsible Employees*, per **UMBC's Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination**. Faculty are therefore required to report possible violations of the **Policy** to the Title IX Coordinator, even if a student discloses something they experienced before attending UMBC.

While faculty members want you to be able to share information related to your life experiences through discussion and written work, students should understand that faculty are required to report Sexual Misconduct to the Title IX Coordinator so that the University can inform students of their **rights, resources and support**.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of **Confidential Resources** available to support you:

- The **Counseling Center**: 410-455-2472 / After-Hours 410-455-3230
- **University Health Services**: 410-455-2542
- Pastoral Counseling via **Interfaith Center**: 410-455-3657; interfaith@umbc.edu

Other Resources:

- **Women's Center** (for students of all genders): 410-455-2714; womenscenter@umbc.edu.
- **Shady Grove Student Resources, Maryland Resources, National Resources**.

Child Abuse and Neglect:

Please note that Maryland law and **UMBC policy** require that I report all disclosures or suspicions of child abuse or neglect to the Department of Social Services and/or the police.