Instructor : Dr. W. Wallace McMillan

Classroom : Physics 107 (Tu/Th 1-1:50)

Laboratory : Physics 209 (Tu 2:30-6:20)

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Office Hours : Thursday 2-5 in the lab, or by appointment

Text: *Principles of Electronic Instrumentation*, Diefenderfer and Holton

Webpage: http://userpages.umbc.edu/∼mcmillan/PHYSICS320/index.html

T.A.: Josh Bowman, Phys 423, jbo2@umbc.edu

1 Academic Integrity

1.1 Official Paragraph

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. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory.

1.2 Electronics 320L Rules

If I catch you cheating on any quiz, homework, lab report, lab practical, or exam, you will be given a zero for that assignment, and I will refer the matter to the Physics Department and the University for further disciplinary action.

For this class, cheating includes preparing your labs or homeworks with assistance from *any* written or verbal materials acquired from *anyone* or *any* book, including students who previously have taken this course. I am aware

that students who have previously taken this course may offer their materials to you. **DO NOT ACCEPT THEM!** All materials and conversations utilized to complete labs and homeworks must be cited in endnotes to avoid charges of plagiarism.

Each student bears an individual responsibility for learning all material in this class. If you do not understand something, come to me or the T.A. with your questions. I assure you that failure to master the material will come back to haunt you during quizzes, lab practicals, and written examinations. To ensure that each student is performing their own work, you should expect frequent quizzes in both the classroom and lab.

2 Philosophy

This course serves to introduce you to the principles of electronics, primarily from the standpoint of a user. You will be introduced to a number of standard electronic instruments and techniques and gain enough background to design simple circuitry of your own. The overriding goals of this course are to make you comfortable working with electronic circuitry and familiar with various electrical measuring devices. You will learn the basic skills necessary to troubleshoot more complicated circuitry.

Electronics basically is problem solving. 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. It is best to be methodical in your approach. You can get shocked by some of the circuits we will build. But, thus far, no one has been severely damaged by any laboratory mishaps, and I plan to keep it that way. Some electrical components can get hot and overloaded integrated circuits (IC's) have been know to catastrophically fail. Be sure you know what you are doing before you turn on the power to your circuit or **ASK FOR HELP**.

Your are encouraged to experiment in this lab. The fun thing about electronics is you can go into the lab and test out any circuit you can dream up. Although there is an awful lot of microscopic theory behind the operation of each component, in the end, you can go into lab and use macroscopic devices to test any circuit's operation.

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'm always learning, too, and appreciate your comments.

I can bark pretty loud, but will bite when necessary. If you encounter any difficulty or do not understand something, please come see me. I cannot help you if you do not ask questions. I can be strict, but I always strive to be fair. I expect each of you to do your best and work your hardest.

3 Class Structure

One hour lectures are scheduled every Tuesday and Thursday. A four–hour laboratory will be held after the Tuesday lecture. On occasion, we may double up on class on Tuesday and you will finish lab on Thursday. These changes will be announced in class. You may work at other times by arrangement with the Professor and/or T.A. subject to the following safety rule: **NO STUDENT SHALL EVER WORK ALONE IN LAB!** If you are caught working in the laboratory by yourself your grade on the most recently graded lab will be changed to zero points. **NO EXCEPTIONS!** However, you do not have to work at other times with your lab partner or someone from the class, you just cannot be alone in the lab.

Regular problem sets will be assigned with due dates given in class. Quizzes can occur at any time and may include implementing assigned homework problems in the laboratory. 12 labs will be completed. Labs are due at the beginning of class one week after they are performed except for Lab 12 (see lab schedule). Both the mid-term and final exams will contain laboratory practical sections.

4 Grading

Your Physics 320 grade will be determined as follows:

Homework:	10%
Mid-Term:	15%
Class Participation (quizzes, etc):	10%
Final Exam:	15%
Lab Reports:	50%

5 Chapters Covered – Diefenderfer and Holton

- Chapter 1 and Chapter 6-1 through 6-8
- Chapter 2

- Chapter 3
- Chapter 4
- Chapter 5
- Chapter 8 (Mostly 8-1 through 8-9)
- Chapter 9
- Chapter 10
- Chapter 11
- Chapter 12

We will not always be able to keep the classwork in sync with the labs, but I will make every effort to do so. If not, you will have to read ahead to keep up. It is your responsibility to have read the relevant Chapters and Labs each week so you are prepared for Tuesday's lecture.

6 Introduction

The vast majority of laboratory measurements are based on electrical measurements. Somehow a physical variable is transformed into a current, voltage, resistance, etc. An example measurement that is not electrical would be the recording of a visible spectrum on photographic film. Most spectroscopy was originally done this way. But today, you can perform far more sensitive spectroscopic measurements with CCD's, photomultipliers, etc!

You will learn how to use basic instruments including:

- Voltmeter
- Ammeter
- Oscilloscope – analog and digital
- Function Generator
- Power Supplies

and how to understand the role of discrete components in circuits, such as

- resistors

- capacitors
- diodes
- transistors.

You will then "graduate" to more "black box" components such as

- Op Amps
- 555 Timers
- Multivibrators, etc.
- Digital gates (NAND, flip flops, counters ...)
- Medium level integrated circuits.

The ultimate "black box" component, the microprocessor, is beyond the scope of this course.

This is **NOT** a course in electrical engineering or circuit design. We will mainly cover areas that any ordinary scientist should know for everyday work. Some overall themes in this course will be:

- How to connect one instrument to another.
- Troubleshooting.
- Basics of the most important electronic instruments.
- Pitfalls in measuring certain types of signals.
- Simple digital circuits.

7 Homework

All problems are from Diefenderfer and Holton, *Principles of Electronic Instrumentation*, unless otherwise noted. The tentative due date for each assignment is listed. I might shift the dates later, but I will not move them earlier! **Homework assignments are due at 5PM on the respective day.**

Homework 1 1/29/09 Chapter 6, Problems 2, 3, 4, 5, 7

Homework 2 2/5/09 Chapter 1, Problems 3, 12, 16, 18 (but remove V_1 not V_2), 19, 20, 21, 26, 27 (but work all parts for 5Ω not 10Ω resistor, 29.

Homework 3 2/12/09 Chapter 2, Problems 2, 3, 4, 7, 8.

Homework 4 2/19/09 Chapter 3, Problems 2, 3, 4; For 6, 7, 8, 9 use f=120Hz, R=5kΩ, and C=0.3μF; For 16, 17, 18, 19 use C=0.2μF, R=12kΩ; 20, 21, 25 (note answer to 24 incorrect, but not needed for 25).

Homework 5 Chapter 4, Problems 1, 2, 3, 5, 13

Homework 6 2/26/09 Chapter 5, Problems 2 (not well worded, but give it a try), 3, 7 (100 mA through R_L, not 100 mV), 12, 13.

Homework 7 3/5/09 Handout with problems. Page 252 of Simpson-Chapter 5, problems 6, 11, and 12 and page 285 of Simpson-Chapter 6, problems 4, 11.

Homework 8 4/2/09 Chapter 9, Problems 3, 4, 5, 10 (hint: use one normal R, second R is a voltage-controlled R - FET can do that, and a standard inverting amplifier), 14 (hint: look at Lab 7), 15

Homework 9 4/16/09 Chapter 10, Problems 2, 11.

Homework 10 4/23/09 Chapter 11, Problems 5, 6, 7, 8, 11, 13 (1 trick), 14. See page 301 of text for help with problems 13, 14.

Homework 11 4/30/09 Chapter 12, Problems 1, 7, 8, 9

8 Rules and Guidelines

1. Be timely to lecture and lab! I make every effort to be on time and I expect you to be punctual as well. (penalty = you miss something important).

2. You are expected to perform labs on the assigned days. If have a problem, you must discuss it in advance with the Prof or TA. (penalty = 0 to 100%).

3. **READ THE LAB BEFORE STARTING and BE CAREFUL!**

4. When in doubt about how to use a piece of equipment, ask the TA/Prof for help and **read the manual!** There should be a manual in the bottom drawer at your workstation for each piece of equipment. If not, ask the TA/Prof!

5. ALWAYS probe a circuit with one hand behind your back! Connect your ground lead first, then make measurements with the other probe. There's no need to have us test our CPR skills on you. (penalty = your own risk)

6. **YOU MUST TURN OFF YOUR POWER WHEN YOU LEAVE!** (penalty 100%)
   You will work in pairs at an assigned workstation. You are responsible for the well being of **all** devices at your station. Your workstation must be left in good order at the end of lab but you may leave circuits assembled.

7. **No student shall ever work alone in the laboratory!** (100% penalty)
   A friend, classmate, or Prof/TA must be present.

8. ALWAYS use a pen in lab to record your data. (50% penalty)

9. All final lab reports must be typed for submission. (50% penalty)
   All results in you lab copy must be written in pen. (50% penalty)
   The Prof will provide one hardcopy to be filled out during the lab. An electronic template will be available for the student to enter their results in italics or a different typeface, or the student can choose to type up their results on separate pages.

10. Both copies of the lab must be turned in, **final copy on top**. (penalty 25%)

11. Staple or use binder clips to attach all lab copies. (5% penalty)
    Use the heavy-duty stapler in Phys 205. The graders will not be responsible if part of a lab report is lost due to poor attachment.

12. Plots and graphs: Dr. McMillan can/will help you with MATLAB if you choose to use it for plotting. You may use any other graphics package but you will be on your own. Penalties for not following the following rules will depend on the situation.

    (a) Clearly label all plots and graphs including a title, axes labels with appropriate units, and a legend where appropriate.

    (b) Show data points on your plots unless you have too many (don't show all 10,000 from your scope data-files).

    (c) Unless a curve fit to your data tells you something about how well your data compares to theory, do NOT do more than connect the data points with straight lines. Caution Excel and Kaliedagraph often draw a smooth curve through data points – DO NOT DO THIS!!!

    (d) If you use a curve fit, explain why you did it, how you did it, and what it means.

13. Data tables: ALWAYS use a well labeled table to present numerical results and calculations. In your final lab copy, you should present your lab data and any calculations you perform in a table. DON'T FORGET YOUR UNITS! It is sufficient to give units in the column/row headings. You do not have to specify units in every entry in your data table.

14. Staple all homework assignments. (5% penalty).

15. All homework and labs are due **BEFORE** the start of class on the specified day. (25%-100% penalty)

    (a) Class starts when I walk into the classroom or 1 PM on my watch, whichever is later.

    (b) If you know you will miss class, make arrangements with me to hand the assignment in early.

    (c) There will be a box outside my office (Phys 418) the morning assignments are due. I will bring this box to class. After the lid goes on the box any submissions are late.