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# *Modern Physics Laboratory*

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**Instructor:** Dr. Theodosia Gougousi

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**Office Hours:** Monday, Friday 8:30-9:30 am, or just stop by. If I am busy or otherwise unavailable we can arrange for a mutually convenient time to meet.

## **Course description (from the registrar)**

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Laboratory course intended for physics majors. Purpose is to acquaint the student with some of the phenomena and experimental techniques of atomic and modern physics. Error analysis and advanced data fitting technique are included.

## **Prerequisites:**

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You must have completed PHYS 324 & PHYS 330L with a grade of C or higher.

## **Course Objectives**

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Since this lab is the last experimental course in the curriculum the main objective of this course is to provide an experience closer to a real-life work place or graduate school.

Unlike the previous laboratory courses you took, in this class we will challenge you by asking you to design and carry out the experiments independently. All the required equipment will be at your disposal in good working order. You will be given a brief outline of the subject as well as supporting material but it will be your own responsibility to design and assemble the experimental set up and decide on the correct data acquisition procedure. Some of the supporting material provided will be write-ups from other universities for similar experiments. There is also a plethora of information available at your fingertips. Therefore it will be of the utmost importance that you come to the lab prepared. The instructor will be there to answer your questions and make sure that you are capable of performing the experiment in a safe and proper manner.

As in any lab course, we will place a lot of emphasis on the correct recording and handling of the experimental errors. You will have to include uncertainties for all the measured quantities, and use standard error propagation techniques to find the error associated with the measurements reported in your lab report.

## **Textbook**

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You will not need to purchase a textbook for this class.

## **Course requirements**

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- 9 prelabs
- 9 lab reports
- Final presentation on an experiment of your choice.

## **Course grade**

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- ☐ Lab report: 80 points each
- ☐ Prelabs: 25 points each
  - ☐ General prelab (up to 4 pages): 15 points
  - ☐ Exercises: 10 points
- ☐ Final presentation: 55 points

- ☐ *A = 900 and up*
- ☐ *B = 800 and up*

- ☐ *C = 700 and up*
- ☐ *D = 500 and up*

In principle, everyone can get an A. Total score above 900 guarantees an A. Total score below 500 is an F. I will not grade the class on a curve. This is the absolute grading scale I will use.

## Special rule on final grade:

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**At the end of the semester you must have turned in all the reports. If you miss any report (even a single one), you will automatically get a C or F, regardless of the grades you got for the other reports.**

## Course management

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I will use **blackboard** to post course announcements and grades, and to disseminate information, handouts and supporting materials for the class. Please do not use the digital dropbox. Send me an email instead. It is your responsibility to check the keep up to date with the course requirements.

## Lab time

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Some experiments will take longer to complete so be prepared to spend Thursday afternoons in the lab in addition to the Tuesday session. I also plan to use the Thursday lab time for demonstrations of the equipment for the upcoming lab work and for going over the theory.

## List of experiments

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1<sup>st</sup> group: Franck-Hertz effect (FH), Black body radiation (BB), Photoelectric effect (PE), Pulsed NMR (NMR),

2<sup>nd</sup> group: Muon lifetime (ML), Atomic spectra of hydrogen isotopes (HS), Millikan oil drop (MOD), Hall effect (HE), Atomic force microscope (AFM)

## Course policies

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### Laboratory reports

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You are encouraged to work with your partner(s), helping each other to understand the subjects, but you must perform your own analysis and write your own report alone.

***Copying someone else's work is cheating.***

***Lab reports are due a week after the experiment was completed.*** There is no special format for lab reports, but the report should include the following information:

1. Title page (must follow the template shown at the end of this syllabus).
2. Introduction (theory, purpose of the experiment)
3. Data and analysis (use graphs and tables whenever possible)
4. Results (again, try to use graphs and tables whenever possible)
5. Conclusions and discussion

### Blackboard and SafeAssign

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In addition to the written lab report, all reports must be electronically submitted to the course blackboard site where SafeAssign will be used to check for plagiarism. Reports must be uploaded to Blackboard before turning in the hardcopy. If you submit a late lab report, the report must be uploaded to Blackboard on the same day the report is turned in. Failure to upload your lab report to Blackboard will result in a score of 0 for that lab.

### Computer code

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You can use MatLab, Mathematica, Excel or any other software you want to process and graph data. Your graphs should be **publication quality** (thick lines, legible titles, legend, markers, axis titles, etc). For most software you will have to do a bit more work rather than use the default graph type. Do not forget the **error bars** and to calculate **uncertainties** for any quantity revived. You do not have to include a copy of your calculation but make sure that your report is comprehensive enough so that I can follow your data analysis.

## Prelabs

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To ensure that you will not waste your time by coming to the lab unprepared to do the assigned experiment, you are required to hand in a pre-lab report of no more than 4 pages. In this document you should explain: i) the purpose of this experiment ii) give a brief overview of the theories/principles underlying the experiment iii) give an outline of your experimental approach. Make sure that you ***provide solutions/answers to the exercises included in the lab write up for all of the experiments. These answers do not count as part of your 4 page limit.*** More specifically you are expected to explain how you will use the equipment available in the lab, what kind of measurements you will make and what the purpose of these measurements is. Doing a good job on the prelab is important as it will assure that you will be able to use the lab time effectively and it will also provide the basis for your lab report. Before performing the experiment the instructor will discuss your prelab with you to make sure that there are no issues that will compromise your safety and prevent you from completing the work. You are welcome to see your instructor anytime about the experiment, especially the availability of the equipment you may need.

For safety reasons, you will be turned away if your instructor believes that you are not prepared to perform the assigned experiment. When this happens, your grade on this experiment will be reduced by 50% automatically (your partner's grade is not affected). You (and possibly your partner) will be allowed to continue on this experiment later during the make-up weeks.

***You do not need to include a cover page for your prelab.***

## Late assignments

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The assignments must be handed in prior to the beginning of the lab session they are due. Late assignments should be turned in to the physics office (PHYS 220), should be marked with the submission date and time by the person receiving them and their value will be reduced according to the formula:

$$\text{Value}(t) = \text{Original Value} * \exp(-0.05t),$$

where  $t$  is the number of calendar days the assignment is late, rounded up to an integer.

## Oral presentations

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Each of you will have to give a 15 min presentation on an experiment you performed during the semester. To avoid repetitive presentations I will assign you a topic based on a preference list you will fill later in the semester. Your presentation will follow the format of a typical research talk given by a scientist in a national conference. I will provide you with an outline later in the semester. The goal of this assignment is to make you comfortable presenting and answering questions about your work in front of other people. No matter what your job will be in the future you will benefit from being able to present a topic in a clear and concise form.

## Exams

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This course does not have any exams.

## Make-up lab policy

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Make-up labs will be given only in the event of a documented issue or problem and the instructor must be notified as soon as it is possible. Having to go out of town on a recreational trip does not constitute a valid reason for requesting a make-up.

## Incompletes

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Please read carefully the catalog statement on acceptable grounds for an incomplete. The only grounds for obtaining an incomplete in this course is failure to complete all of the last three experiments due to illness. Since, according to the catalog, you must be doing "qualitatively satisfactory" work in order to qualify for an incomplete, you must have at least completed the first six laboratory reports, with a grade of C or better up to the time you took sick. If you are given an "Incomplete", it can be removed by completing the missed assignments (labs and presentation) in the following semester's PHYS 431L course.

Note: Do not register for PHYS431L again; just make arrangements with the instructor to attend the appropriate sessions.

## Cell phone policy

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You must turn off your cell phone during the laboratory time.

## Academic Integrity

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You are encouraged to talk to your classmates about assignments. However, each should submit his own original work. The submission of a laboratory report written by someone else or the submission of a laboratory report written by you during a previous semester constitutes cheating. Cheating includes: copying someone else's homework, copying someone else's lab data, altering the lab data in any way.

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 Director.

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## Lab report cover page

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*[This is the title of your experiment]*

**by**

*[your name]*

**with partner**

*[your partner's name]*

**Experiment performed on:**

*[the date and/or dates you perform the experiment]*

**Report presented on:**

*[the date you hand in the report]*



## Lab schedule

DATES	PE	FH	BB	NMR	ML	HS	MOD	HE	AFM
<b>Jan 27-29</b>	Organization meeting, theoretical background								
<b>Feb 3-5</b>	AB	CD							
<b>Feb 10-12</b>			EF	GHI					
<b>Feb 17-19</b>	GH	IE	ADC	BF					
<b>Feb 24-26</b>	CIF	AH	GB	DE					
<b>Mar 3-5</b>	DE	BFG	HI	AC					
<b>Mar 10-12</b>	theoretical background								
<b>Mar 17-19</b>	No labs, Spring Break								
<b>Mar 24-26</b>						FG	CH		
<b>Mar 31-Apr 2</b>					ABE			DI	
<b>Apr 7-9</b>						DHI	AF	BE	CG
<b>Apr 14-16</b>					DH	AE		CFG	BI
<b>Apr 21-23</b>					FG	CB	EDI		AH
<b>Apr 28-30</b>					CI		BG	AH	DEF
<b>May 5-7</b>	Presentations and make ups								