Experimental Physics, 2021 Spring

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1 *Basic information*

Course title	Experimental Physics, Physics 470.
Instructor	Palash Banerjee.
Contact	B201 Science, palash.banerjee@uwsp.edu
Pre-requisite	PHYS 300 *is* required
Textbook	*Experiments in Modern Physics*, Melissinos and Napolitano,
Required	Research laboratory notebook

2 *Laboratory notebook*

The bookstore should have a proper cloth bound research grade notebook with numbered pages. The page size should be $11\frac{3}{4} \times 9\frac{1}{4}$ inches. Your notebook should look like this: `http://amzn.to/XRk7hD`. Please *do not* buy a cheap notebook.

Figure 1: Your research laboratory notebook available at the UWSP bookstore.

3 *Course description and objectives*

A capstone course is designed to be one of the final experiences of your undergraduate education. In this course, you will apply your previous knowledge of physics and mathematics in a laboratory setting. You will design and set up experiments and learn how to make them work. You will collect data and construct mathematical models for their analysis. And you will document your work and write reports and manuscripts so your discoveries reach a wider audience. This is a typical scientific workflow and the purpose of this course is to introduce you to this way of working.

4 *Course assignments*

1. **Laboratory notebook:** You must maintain a laboratory notebook that documents your work, ideas clearly. You will turn in your notebook for evaluation after each experiment. Please be conscientious in maintaining a detailed notebook as you work. Your notebook **must** be up to date at all times — do not finish your experiment and then "work on" your notebook. Such a practice is considered unacceptable in a graduate setting or an industrial laboratory.

2. **Reports and manuscripts:** You will write short reports for each junior exercise and a longer manuscript for each senior project. The manuscript must be written according to the style of an "American Journal of Physics" article.
3. **Homeworks:** I will assign homeworks based on the content of the experiments and the lectures. Your written solutions must be turned in by the due date. Please respect the deadlines — late solutions will not be accepted.
4. **Exams:** The midterm exam will be based on your homeworks and the junior exercises. The final exam will be based on your homeworks and senior projects.

5 Grading and evaluation

I will calculate your grade based on a weighted percentage of your scores as shown in the table to the left below. Your final letter grades will be determined as shown in the table to the right below.

Assignment	Value
Junior lab reports	15%
Laboratory notebook evaluations	25%
Homeworks	10%
Senior project manuscripts	30%
Midterm exam	10%
Final examination	10%

Total score	Grade
90% and above	A
87–89%	A-
83–86%	B+
80–82%	B
77-79%	B-
73–76%	C+
70–72%	C
67–69%	C-
60–66%	D+
50–59%	D
below 50%	F

I do *not* grade on a curve. Scores will be rounded up according to the following example: 86.6 – 86.9% will be rounded up to 87% and become a A-, but 86.0 – 86.5% will remain at 86% and will earn a B+.

6 *List of experiments*

The following experiments are available. Each experiment introduces you to some clever instrumentation, some interesting physics, and some nice mathematics.

1. Junior labs (you must do all of these)
   (a) To measure the resistance of a wire using a four-probe technique.
   (b) Torsional oscillator.

2. Senior projects (choose any three)
   (a) Quantum mechanics of a 2-level spin system — electron spin resonance.
   (b) Interaction of polarized electromagnetic waves with a transparent material — the optical Faraday effect.
   (c) The relativistic collision between high energy photons and electrons — gamma ray spectroscopy.
   (d) An ultrasensitive optical interferometer to study the picometer scale displacements of a large mirror — recreating the LIGO experiment at UWSP.
   (e) Electrical transport in semiconductors — the Hall effect in germanium.
   (f) Quantum mechanics with photons — a single photon interfering with itself.
   (g) A scanning Fabry-Perot cavity to measure the wavelength of microwaves.
   (h) Building a high resolution spectrometer with a photomultiplier tube, a stepper motor and a diffraction grating.

7 *Course schedule*

Week	Topic
(1) Jan 24	Introduction and Junior lab 1.
(2) Jan 31	Junior lab 1 (continued).
(3) Feb 7	Begin: Junior lab 2.
(4) Feb 14	Junior lab 2 (continued).
(5) Feb 21	Begin: Senior project 1.
(6) Feb 28	Senior project 1 (continued)
(7) Mar 7	Senior project 1 ends.
(8) Mar 14	Mid term exam 1.
(–) Mar 21	Spring break
(9) Mar 28	Begin: Senior project 2.
(10) Apr 4	Senior project 2 (continued).
(11) Apr 11	Senior project 2 ends.
(12) Apr 18	Begin: Senior project 3.
(13) Apr 25	Senior project 3 (continued).
(14) May 2	Senior project 3 ends.
(15) May 9	Final analysis and manuscript due.
(16) May 16	Final exam, Tue May 18,

8 *Academic misconduct*

Please *do not* copy each others homeworks, class assignments, laboratory reports, and examinations and pass them off as your own. Any confirmed incidence of academic misconduct, including plagiarism and other forms of cheating will be treated seriously and in accordance with University policy.