Eastern Kentucky University
Department of Physics and Astronomy
Physics 406W
TBD
Advanced Physics Laboratory Writing Intensive
CRN: TBD
3 Credit Hours

Course Time and Location: NSB3165

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Office Hours: MWF 10-11 AM or any other times in which I am in my office. Feel free to stop by!

Catalog Description: PHY 406W Advanced Physics Laboratory. (3) A. Prerequisites: ENG 102, 105(B), or HON 102; PHY 132, 202, or departmental approval. Experiments in mechanics, optics, electricity, and nuclear physics. Computer simulations of physical situations. Measurement and data analysis techniques, including error analysis. Credit will not be awarded to students who have credit for PHY 406. 5 Lec/Lab.

Experiments will be performed with the basic laboratory goals of
a) How measurements are made.
b) How data is analyzed, including how data is graphed, and
c) How to draw quantitative conclusions from data in tabular and graphical form.
d) Indicate the reliability and confidence in the data acquired through an appropriate error analysis.
e) Demonstrate a good grasp of a-d by communicating effectively in writing.

Last Date to withdraw from full semester classes: as per University policy.

Textbook: "An Introduction to Error Analysis" 2nd edition by John R. Taylor.
For the experiments we'll use handouts. You must have a 3-ring binder or folder to keep you handout neatly. You will need a flash drive to keep your results. You will need loose-leaf sheet for your 3-ring binder so your sketches, table and any information you jot down during an experiment can be recorded.

Student Learning Outcomes: Upon completion of this course, students will:

1) Employ the scientific method to gain insight into the physical world.
2) Apply general physical laws to specific problems.
3) Investigate physical phenomenon using appropriate laboratory skills.
4) Provide confidence range and error in any of the measurement performed.
5) Quantitatively predict, from physical laws, the outcome of situations.
6) Demonstrate the skill to write reports in the style, process and format required by the discipline. We will use the style and format adopted by The America Journal of Physics

7) Demonstrate a writing process that produces effective documents appropriate to the level of this course. PHY 406 is a senior level Physics Course and the students are expected to be able to convey physics at that level.

Evaluation: Your final grade will be based upon your performance as follow:

Homework and quizzes on the statistical methods (20%).

Written Laboratory reports on the experiments performed as well as your performance in the lab (60%).
Lab reports must be turned in within a week of completion of the data acquisition and analysis. These reports will be read, graded and feedback on how to improve them will be provided. Students are then to read critically the reports handed back, and, based on the feedback provided, prepare a new lab report incorporating the suggestions and correction. These new lab report will be then graded again and, if warranted, the new score will replace the old one
Clarity of exposition, thoroughness of discussion, rigorousness of the physical approach and good adherence to professional writing standards, coupled with the submit-feedback-revise-resubmit cycle will determine your grade on this section. During the lecture part of the course, feedback of general nature, do's and don'ts on professional writing will discussed as needed.

Oral Presentation (10%): This is a group activity, in which you analyze a physical phenomenon using spreadsheets. The presentation will be made to the whole class using PowerPoint. Here too clarity of exposition, thoroughness of discussion and rigorousness of the physical approach will determine the outcome.

Final exam (10%): 10 questions (a mix of essay and multiple choice) drawn from the statistical methods section and from the experiments performed.

Your final letter grade will be determined by the following:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

The instructor reserves the right to adjust this scale as necessary, but only to help the students.

Attendance: Lecture attendance is mandatory. Regarding labs, because of its nature, attendance is mandatory as well. Depending upon the circumstances, in general you will not be able to use your lab partners' data should you miss a lab. You will have to retake the data yourself outside of the normal lab hours. Thus, it is wise not to miss lab. In addition, the lab starts at 2:00 and ends at 4:45 pm. Be here on time and stay to the end even if you finish an experiment early. You can always analyze your data.

Course Outline:
Single measurement
1. Description of Error Analysis and How to report Uncertainties (Chapter 1 and 2)
2. Propagation of uncertainties (Chapter 3)

Multiple measurements as independent results
1. Mean and standard deviation (Chapter 4)
2. Normal distribution (first half of Chapter 5)
3. The Binomial distribution (Chapter 10)
4. The Poisson distribution (Chapter 11)
5. χ^2 test – how well does the data fit the distribution model? (Chapter 12)

Multiple measurements as one sample
1. Normal distribution (second half of Chapter 5)
2. Rejection of data (Chapter 6)
3. Curve fitting (Chapter 8)

Experiments: These are a series of experiments and you will cycle through most of the following experiments, working in groups of two-three students:

1. E/m ratio for the electron.
2. Millikan Oil drop Experiment.
3. Wavelength of HE-NE laser measured with a ruler.
4. Using a Telescope and a CCD camera to obtain an image.
5. Radioactive Decay.
6. Measurement of the Earth's magnetic Field.
7. Using the Ocean Optics Spectrometer.
8. Coefficient of restitution.
9. The Frank-Hertz experiment.
10. Measure Planck's constant.
11. Numerical simulation of a Physical Phenomenon using spreadsheet followed by an oral presentation to the class.

Note: each student will be required to have a minimum of 7 completed experiments and 7 drafts-revision-final version lab reports plus the oral presentation.

Each experiment will require about two weeks to complete, and you will prepare a written report for each of them. Each person must hand in a report on each exercise. If you work together, you can use the same data, but a written report from each of you is required.

Course Requirements:
1. Formal lab reports (a minimum of 7) will be collected and graded for content, technical correctness and writing quality throughout the semester (see the Laboratory Reports Format for what is expected). As mentioned previously, the lab reports will be read, graded and feedback provided. Students will then revise the lab reports based on the feedback received and will resubmit within a week after the initial lab report was handed back. Your grade will be then based on this revised version.

2. There will be homework and quizzes on data analysis.

3. There will be in-class group work done in the form of both lab activities and group problem solving.

4. There will a comprehensive final exam given at the end of the semester.

Student Progress:
Students will be able to gauge their progress by receiving back graded homework, graded quizzes and graded preliminary and eventually final lab reports.

Time and effort expected: The lab meets 5 hours each week (1 lecture, 4 lab), and counts for 3 credit hours. On average, you would then be expected to spend an additional 2 hours per week on this course outside each class meeting. Self discipline (i.e. do not goof off) will be required, especially during the set-up phase of the experiments, since you'll be working mostly on your own. Much of the lab time will be spent in my checking of your progress and you will be expected to inform me regularly of that progress.

Official E-mail: An official EKU e-mail is established for each registered student, each faculty member, and each staff member. All university communications sent via e-mail will be sent to this EKU e-mail address.

Academic accommodations
A student with a "disability" may be an individual with a physical or mental impairment that substantially limits one or more major life activities such as learning, seeing or hearing. Additionally, pregnancy or a related medical condition that causes a similar substantial limitation may also be considered a disability under the ADA.
If you are registered with the Office of Services for Individuals with Disabilities, please obtain your accommodation letters from the OSID and present them to the course instructor to discuss any academic accommodations you need. If you believe you need accommodation and are not registered with the OSID, please contact the office in the Whitlock Building Room 361 by email at disserv@eku.edu or by telephone at (859) 622-2933. Upon individual request, this syllabus can be made available in an alternative format.

Academic Integrity Policy: Students are advised that EKUs Academic Integrity policy will strictly be enforced in this course. The Academic Integrity policy is available at www.academicintegrity.eku.edu. Questions regarding the policy may be directed to the Office of Academic Integrity.

Useful Dates

TBD	Last day to drop/add
TBD	Labor Day, Holiday
TBD	Assurance of Learning Day, no classes
TBD	Midterm Grades due
TBD	Fall Break
TBD	Last day to withdraw from a full semester class with a "W"

TBD	Thanksgiving, Holiday
TBD 2013	Last day of classes
TBD	Final exam: 10:30-12:30 in NSB 3122

Laboratory Reports Format

Laboratory reports should be typed. Each lab report that you submit should contain the following information:

Title
Author, Course, Date

Abstract
A brief summary, 1 **short** paragraph, less than 8 sentences.
State: (1) what you did and (2) what you found.
Include final values with uncertainties and expected values

I. Introduction (1 or 2 paragraphs)

- Briefly state the physics underlying the experiment (what is being tested).

II. Apparatus

- Diagrams or sketches of important apparatus (label items and describe in the text).
- List equipment components (brief specifications and if it clarifies possible uncertainties, the model number. This is usually not necessary however)

III. Procedures, Results, and Conclusions

Because there are several parts of each experiment, it is often better to discuss the procedures, results and conclusions of each part before going on to the next part. For each part of the experiment include the following.

- Describe the experimental procedures (in your own words).
- Discuss calibrations, etc., if required.
- Plots showing relevant results (label each figure, e.g. *Fig. 3*, with caption)
- Curve fit the data to theory whenever possible.
- Include only one example of many repeated measurements unless noteworthy.
- Put error bars on all data points; if there are 5 or more points use one typical error bar**.**
- Report final **values**, **uncertainties**, and **units** in a table.
- Discuss the comparison of theory and experiment (are they within the uncertainties)**.**
- what could be done better if you had more time or equipment

All statements should be complete sentences. All graphs should be properly labeled and should be sufficiently large so as to be easily read for computational purposes. Significant figures should be observed and errors (in standard deviations) should be reported.

Reports are generally due one week after experiment completion. A completed experiment means that you are now starting a different one.

There are definite rules and procedures that are followed when one writes a scientific paper. Even if you never have to submit a paper to a scientific journal, you will still probably be required sometime in your life to make a written report to a superior about what you have done. We will follow the guidelines of a scientific Journal, The America Journal of Physics. The format clues can be found at http://ajp.dickinson.edu/Contributors/manFormat.html
Further style clues are contained in the American Institute of Physics Style guide. This guide is out of print but an electronic version is available and will be provided.
Some guidelines that all scientific papers must invariably follow are given below.

1. When first listing or quoting any equation anywhere, identify each variable and constant used.

2. If you use or quote standard values, identify where they came from. If you make a comparison between experimental and standard accepted values, compute % variance. Never make vague statements like "our measured value was close to the standard value" unless you back it up with numbers. For most of the experiments in this lab, there are standard values that you can use for comparison. Also, there is a difference between the error you obtain from your experiment and a percent v. Make sure you are specific about which you are quoting.

3. **Label axes on graphs and do not connect dots**; rather draw the best curve through the points. Label your graph as Fig. I, or II etc. Tables used should be labeled separately but in a similar manner (Table I etc.).

4. Give a brief description of the equipment used. If you wish, you can specify the type and model, but it is not absolutely necessary unless to avoid confusion with similar equipment.

5. Always assume that the reader did not do the experiment and is learning about it for the first time. Can he or she understand what you did and how you did it? Of course, you may assume that he or she is familiar with physics.

6. When you refer to a graph or figure in your text, be specific (e.g. "Figure I shows" or "as shown in Table II"). You should refer to all graphs and figures in the text somewhere. Do not just attach a graph or figure to your report and hope that the reader will automatically figure out what it means.

7. If you make a conclusion, back it up with numbers. Do not make vague statements such as "I learned a lot in this experiment", or "The experiment was a success", etc.

8. You must give the uncertainty of your results and their range of validity, and you must do so for each measured result. If a formal error discussion is not possible, you must estimate its uncertainty and offer a justification of why it is so.

9. Write primarily in the past tense. You are describing what you did. If you write in the present tense, it implies you are doing the experiment as the reader looks at your paper. Exceptions to the above would be for statements like "Figure 2 shows that ....".

10. Don't use acronyms and expect a first time reader to figure out what it means. If you must use one, then define it. For example: "We performed an experiment at the Jet Propulsion Laboratory (JPL) last April. Any future experiments at JPL are subject to funding constraints."

11. If you use outside references for constants, values, etc. give the source, author and page #.

12. You will be using various programs to accumulate data. In your reports don't say things like "The computer software did this or that". Just state what procedure was done (plot, average, etc.)

13. Each person submits his own data and reports, even on short reports.

Laboratory Rules

1. When finished with an experiment, return equipment to where you found it when you started the experiment.

2. If you are in the middle of an experiment when time for lab is over, put up a sign telling people not to touch your setup.

3. Turn off all power supplies when you are finished.

4. Be careful around all equipment.

5. When using computers, store your data on your flash drive.