# PHYSICS 405 COURSE DESCRIPTION/SYLLABUS
# Fall, 2012

## Lecture Room 3112 Physics Building
## Laboratory 3210 Physics Building

Physics 405 is an advanced undergraduate laboratory course with experiments from many fields of modern physics for physics majors. Students have full access to the experimental equipment and establish their own work schedules and procedures with the guidance of faculty and staff. Emphasis is on independent experiment organization, data acquisition, data analysis, and scientific report preparation.

**PREREQUISITE:** Physics 375

**LECTURES:** Wednesday 12:00-1:00 PM, Lecture Room 3112 Physics Building

**COURSE WEB SITE:** http://elms.umd.edu then select the link for Physics 405.

**INSTRUCTORS:**

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**TEACHING ASSISTANT**

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## LABORATORY STAFF

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**Mr. Thomas Baldwin**
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## SCHEDULE:

Instructor and Teaching Assistant laboratory hours will be announced in class and posted in the laboratory and on the course web site.

The laboratories are open Monday through Thursday from 9:00 a.m. - 5:00 p.m. and on Friday from 9:00 a.m. to 4:00 p.m. The last person to leave a laboratory must close the door. When returning to a laboratory, Mr. Monroe or Mr. Baldwin will open the door again. Work is to be finished at the end of the laboratory period. If work is not complete at 5:00 p.m. and the experiment is reserved for the following day, a note should be left on the experiment to avoid its being disassembled.

## TEXT and REFERENCES:

*Physics 405 Laboratory Manual* – Department of Physics, Fall 2012 edition.

This will be available electronically on the Physics 405 web site. This version is not available in print.

*Data Reduction and Error Analysis for the Physical Science*s - Phillip R. Bevington and D. Keith Robinson (McGraw Hill, Inc., 2003, ISBN 0-07-247227-8)

*An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement* – John R. Taylor (University Science Books, 1997, ISBN 0-935702-75-X).

*Building Scientific Apparatus* – J. H. Moore, C. C. Davis, and M. A. Coplan (Cambridge University Press, Fourth Edition, 2009, ISBN 978-0-521-87858-6).

T**wo (2)** laboratory notebooks are required so that one is available for laboratory work while the other is being graded. Notebooks are to be 8.5" x 11" or larger, with bound, numbered, quad-ruled pages that are permanent and unperforated.

## LECTURES:

There are one-hour lectures from 12:00 – 12:50 p.m. in room, 1219 Physics Building every Wednesday during the semester. The lectures will cover radiation safety, statistics and error analysis, laboratory measurement techniques, vacuum technology, detectors, basic electronics, signal analysis and other topics germane to experimental physics. On October 3, there will be a tour of the campus nuclear reactor. Students are responsible for understanding the material presented in lecture and, when appropriate, including this material in notebook reports and in the final formal report. Students missing a lecture are responsible for obtaining the lecture material from classmates. There will be homework assignments based on the lecture material due one week after the lecture. During the last half of the course, the lecture period will be used for 12-minute student presentations. **Attendance at the Wednesday lectures and presentations is mandatory. Attendance will be taken. The lecture, homework, laboratory notebook, formal report, and**

**presentation schedule will be posted on the course website.**

## EXPERIMENTS:

To pass the course, six units of work must be completed. This will typically consist of four to six experiments. **Completion requires satisfactorily answering the pre-laboratory questions, performing the laboratory work and data analysis, and submitting a laboratory notebook for grading on time**. **Six units must be completed to pass the class.** Each student is required to work on the experiments independently. At the completion of each experiment the laboratory notebook must be submitted to the instructors for grading. It is necessary to have at least **two** laboratory notebooks so that one is available for laboratory work while the other is being graded. The notebooks will be graded promptly so that improvements can be made in subsequent experiments and reports. The notebook reports are meant to be the notes and documentation of the work in the laboratory, and *are not the formal write-up*. (Please refer to the laboratory manual for more information on the notebooks.)

The first experiment must be a one-unit experiment. (in order to total six units, it is therefore necessary to complete at least one other one-unit experiment).

## SCHEDULING EXPERIMENTS:

There is an online sign-up sheet that can be accessed from any computer with an internet connection or from the computer in room 3210. The url is http://www.physics.umd.edu/cgi-script/courses/p405.pl. Prior to carrying out an experiment, the pre-laboratory questions at the start of the experiment must be answered. The answers are to be written in the laboratory notebook. **The preparatory questions must be examined and initialed by either the instructor or the TA before experimental work can begin.** Time to perform the experiments must be formally scheduled. Time slots are available in half-day periods. To save an experimental setup, two consecutive periods must be reserved. **Because of the class size and limited**

**number of experiments, scheduled periods must be scrupulously honored. Failure to attend scheduled periods and last minute cancellations will result in report penalties.** When an experiment has been completed and data taking finished, the experiment must be dismantled.

## DUE DATES FOR THE NOTEBOOK REPORTS:

Notebook reports are due according to the schedule shown in the syllabus. **There is a 2-point penalty, out of a total of 20 points, per day for late reports.**

## FORMAL REPORT:

A formal report on the second experiment is required and is to be submitted according to the schedule in the syllabus. The format of the formal report is given in the laboratory manual and on Blackboard.

## ORAL PRESENTATION:

Each student is required to give a 12-minute presentation on an experiment. The talks will be followed by questions from students, the instructors and TA

## HOMEWORK:

During the semester homework problems will be assigned. The purpose of these problems is to review and strengthen understanding of error analysis that will be used in the interpretation of data, as well as provide experience with common experimental topics.

## GRADES:

| | |
|---|---|
| Notebooks (20 points per unit) | 60% |
| Homework | 10% |
| Formal Report | 15% |
| 12-Minute Presentation | 15% |
| | |
| Total | 100% |

## VALID EXCUSES:

If you have a valid excuse for failing to attend a scheduled experiment period, missing a due date for homework, a notebook report, a 12-minute presentation, or the formal report (e.g. a medical emergency), see one of the instructors to make alternate arrangements, in advance, if at all possible. *Ex post facto* (after the fact) excuses will require validation and may not be acceptable. You must speak to one of the instructors. The TA does not have the authority to make alternate arrangements.

## ACADEMIC DISHONESTY (CHEATING):

Academic dishonesty is a serious offense that can result in suspension or expulsion from the university. In addition to any other action taken, the normal sanction is a grade of "XF", denoting "failure due to academic dishonesty," and will normally be recorded on the transcript of the offending student. Students are required to perform all experiments, analysis, and write-ups independently. The experiments may be discussed with other students but ***each student must work independently.***.

## TIPS FOR DOING WELL:

Read the laboratory manual carefully before beginning an experiment. Answer the pre-laboratory questions in your notebook or submit them on the course website and have them checked by the professor or TA before beginning the experiment.

Keep a complete log for the experiment including equipment diagrams, measurement configurations, results, estimates of errors and limitations to the measurements, analysis used to obtain final results and a proper estimate of all errors including systematic as well as statistical errors. Record clearly the reasoning used to arrive at conclusions. If the experimental result does not agree with the known or accepted value, documented reasoning may be the only means for determining what went wrong. Additional information, a list of experiments, and more detailed help can be found at the course website. ***Good time management is essential for success in this class. Don't fall behind! Don't wait until the last day to do an experiment!***

## IMPORTANT DATES:

First Meeting: Wednesday, August 29; Introduction to the laboratory

Labor Day: Monday, September 3

First Class Lecture: Wednesday, September 5

Last Day for Schedule Adjustment: Monday, September 10

Last Day to Drop with a "W": Monday, November 5

Thanksgiving Recess: Thursday, November 22 and Friday, November 23

Last day of Classes: Tuesday, December 11

## TENTATIVE SCHEDULE (subject to revision)

| Dates | Lecture Period Topic | Reading | Due Date |
|---|---|---|---|
| 8/29 | Introduction to Experiments | Laboratory Manual | |
| 9/5 | Lecture 1, Radiation Safety | | **Experiment Prelab(*)** |
| 9/12 | Lecture 2, Statistics: Random/Systematic Errors | Bevington Ch. 1-2, Taylor Ch. 3, 4, 5, 10, 11 | **Radiation Sa HW** |

| | | | |
|---|---|---|---|
| 9/19 | Lecture 3, Electronics | Building Scientific Apparatus, Ch. 6 | **Statistics HV** |
| 9/26 | Lecture 4, Detectors | Building Scientific Apparatus, Ch. 7 | **Experiment Notebook Electronics** |
| 10/3 | Lecture 5, Vacuum technology | Building Scientific Apparatus, Ch. 3 | **Detectors HV** |
| 10/10 | Tour of campus reactor | | **Experiment Notebook Vacuum HW** |
| 10/17 | 12 Min. Presentations | | **Reactor HW** |
| 10/24 | 12 Min. Presentations | | **Experiment Notebook** |
| 10/31 | 12 Min. Presentations | | |
| 11/07 | 12 Min. Presentations | | **Experiment Notebook** |
| 11/14 | 12 Min. Presentations | | |
| 11/21 | 12 Min. Presentations | | **Experiment Notebook** |
| 11/28 | 12 Min. Presentations | | **Formal Repo** |
| 12/05 | 12 Min. Presentations | | **Experiment Notebook** |

*All pre-laboratory questions after the second week must be completed and checked (initialed) by the TA or an instructor before laboratory work can start. The laboratory notebook due dates correspond to two-week one-unit experiments. Two-unit experiments take four weeks. Reports are due at 12:00 noon on Wednesdays.

## NOTEBOOKS:

Laboratory notebooks must include a complete description of how the experiment was performed and the way the data were analyzed. Another person should be able to take the notebook and duplicate the experiment. Below is a list of the essential elements of the notebook report:

- Notebook reports written in ink in a laboratory notebook with quad-ruled, numbered pages. Mistakes are not to be erased, scratched over or covered with White-Out. A single line is to be drawn through mistakes.

- All graphs stapled, pasted or taped in the notebook. Graph axes labeled with units. Formulas, derivations, and discussions necessary to understand the graphs included.

- A brief description of theory of the experiment followed by a clear description of the procedure used to take data. Schematic diagrams of the experimental arrangement along with circuit diagrams of electronics. Raw data in tabular form with units and proper significant figures.

- Units for all numbers with appropriate significant figures.

- Estimates of random and systematic errors and the justification for the estimates.

- Analysis of the data using proper error analysis and a description of the analysis methods. If *Mathematica* is used, include the analysis steps in addition to the *Mathematica* notebook included in the laboratory notebook.

- Comparison of statistical error with random error (reduced $\chi^2$).

- Final results with total error (including systematic errors), comparison of the final results with expected values and a discussion of discrepancies.

- Answers to all questions in the Laboratory Manual including discussion questions.

- All parts of the experiments completed.

## NOTEBOOK REPORT FORMAT AND GRADING:

Procedure (including preparatory questions) **3 points**

Raw data (including tables, plots) **5 points**

Analysis (including errors and final results) **8 points**

Remaining topics listed above **4 points**

**Two points will be subtracted from any report grade for each day late. All reports must be submitted to pass the course.**

## CourseEvalUM Fall 2012

Participation in the evaluation of courses through CourseEvalUM is a student responsibility held as a member of our academic community. Feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process. CourseEvalUM will be open for students to complete evaluations for fall semester courses between Tuesday, November 30 and Sunday, December 12. Go directly to the website (www.courseevalum.umd.edu) to complete the evaluations starting November 30. Completing all evaluations each semester gives online access at Testudo to the reports of the thousands of courses for which 70% or more students submitted their evaluations.