Physics 7180 Modern Physics Laboratory

Instructor: Randy Ellingson; Spring 2010 (2 or 3 credit hours)
Lecture: Monday* 1:00-1:50 p.m., MH 4012
Lab Schedule: Session #1: Monday, 5:30 – 9:30 pm. Session #2: Wednesday, 8:00 am – 12:00 pm.
Session #3, Wednesday, 5:00 – 9:00 pm.
*The lecture for Monday, Jan. 18, will be included at the start of each lab session for that week.
Labs: MH 2026, 3010, 3006, 3002

GENERAL INFORMATION

This class meets weekly for a one-hour lecture and one 4-hour laboratory period; data analysis and write-up are to be done both inside and outside the laboratory. Some of the weekly labs require a short synopsis with graphs of data and brief explanations of the important features of the data. Three labs will require full lab reports (see below). January 18 is the Martin Luther King holiday – the weekly lab sessions will proceed as initially planned, and the lecture introducing the lab will be worked into the beginning of each lab session. There will be no class or labs the week of Mar. 8-12 due to Spring Break.

SAFETY FIRST!!

You will be working around **x-ray and radioactive sources, high voltages, and laser sources.** Familiarize yourself with proper operation of each instrument, and use appropriate caution when working with potentially dangerous equipment.

BACKGROUND: This is a course designed to give graduate students advanced laboratory experience in conducting experiments and analyzing the resulting data with appropriate error analysis. The schedule of 10 experiments listed may very well be modified over the semester due to time and/or equipment constraints.

COURSE CREDIT:

The normal course is for three credit hours and students will be expected to complete ten experiments. Graduate students in the medical physics program may register for the 2-credit-hours version of the course (if desired), completing six experiments (over the course of 9 weeks, since some experiments take two separate weeks). Medical physics students will conduct their final lab the week of Mar. 22, 2010 (final lab synopsis due Monday, March 29, 2010).

REPORTS: Each lab report will be worth 10 points per week (so a 2-week lab results in a 20 point report). Each lab report should be complete and self-sufficient, written in a style typical of a journal publication. The expected length of each report is 6-12 pages (depending in part on how many weeks the lab spanned), including graphs, data tables and drawings. Please use font size 12, with margins of 1" all around. A typical report could be as follows:

I. **Introduction** (of the experiment, including context and brief physics background) – 1 page
II. **Experimental Method** (apparatus, schematics, etc.) – 1 page
III. **Data and Results** (data summary) – 3+ pages
IV. **Error Analysis** 1/2 page
V. **Discussion** of results – 1/2+ page as needed

Synopsis/Full lab report grading:

Experimental data:	50%
Explanation/interpretation and error analysis:	50%

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Lab Schedule (tentative)

Experiment	Date (week of)	Subject
I	Jan 11	Introduction: Instrument control, data acquisition, error analysis
B5	Jan. 18	Alpha particle spectroscopy with surface barrier detectors
B5 cont.	Jan. 25	Alpha particle spectroscopy with surface barrier detectors
N2	Feb. 1	Gamma ray spectroscopy
N2 cont.	Feb. 8	Gamma ray attenuation
CM4	Feb. 15	Current-voltage curves in semiconductor diodes and solar cells
CM5	Feb. 22	X-ray diffraction and crystal structures
AM1	Mar. 1	Atomic spectra with diffraction grating spectrometers
Spring break	Mar 8	
AM3	Mar 15	Raman scattering gases – linear molecules
AM3 cont.	Mar. 22	Raman scattering gases (transparent liquids and solids)
(TBD)	Mar. 29	TBD
AM4	Apr. 5	Diode lasers
CM3	Apr. 12	Electrical transport and the Hall effect
CM6	Apr. 19	Scanning tunneling microscopies and surface morphologies
Review	Apr. 26	Review and follow-up as needed.

SCIENTIFIC and ACADEMIC HONESTY:
It is understood that scientific honesty requires that the author of a scientific paper (in this case, your Lab Report) presents and analyzes his or her own data. In this regard, each lab report must have sufficient "raw" data so that the reader (in this case, the instructor) can independently analyze the data to verify that the analysis was done correctly.

TEXT: The University of Toledo Graduate Physics Laboratory notes (originally compiled by A.D. Compaan)

REFERENCES: Any good intermediate level modern physics textbook, for example:

- Eisberg & Resnick, *Quantum Physics of Atoms, ...*
- Morrison, Estle, & Lane, *Quantum States of Atoms, ...*
- Price, *Nuclear Radiation Detection*
- Moore, Davis, & Coplan, *Building Scientific Apparatus*

OTHER MATERIALS: You will need to bring a lab notebook (NOT looseleaf), and (if you can find one), a 3½" IBM or Mac-compatible formatted disk.

EXPERIMENTS: The experiments each designed to be completed in the laboratory sessions. However, in order to be able to successfully do this, it will be necessary for you to enter the laboratory ***very well prepared***. Remember that you will be working with **radioactive sources** and high (often **lethal!**) voltages. Four hours goes by very quickly when you do not know what you are doing. Therefore, it will be necessary for you to have studied reference material before coming to the lab.

Lab Experiment Reports:

1. Develop good laboratory practices. Record all observations as they are made. DO NOT record them on scrap paper and copy them into the lab manual. Be sure to record ***everything*** which seems relevant (as well as some things which don't…). You will often find when you get home that you forgot to record a crucial piece of information anyway, but if everyone follows this suggestion, maybe at least someone may have recorded it! When you discover that you made an incomplete or inaccurate measurement, DO NOT tear the sheet out--merely note the error and record the new data. The old "wrong" data many times turns out to be useful to you later on.

2. Outside of the laboratory, do all reading, library research and computation necessary to understand the experiment. Record all calculations in the lab manual--explain clearly what you are doing. Be sure to answer all questions asked. The computer is an integral part of this laboratory. You will use it to graph the data and to perform statistical analysis on the data when needed. Sometimes you will be acquiring roughly 10,000 - 20,000 data points in a lab period!! You really don't want to analyze each point by hand! You should be using Excel or some other spreadsheet for data analysis. However, if you do some fitting with the spreadsheet please check for the appropriate number of significant digits in the fit! Since you will be on the computer extensively, it is also encouraged that you compose your laboratory write-ups on the computer using a word processor. The computers in the fourth floor micro-cluster are available for your use in this class.

3. It is especially important that the data of the prior week of a multi-week experiment be analyzed before returning to the lab for the following week.

All instrument manuals must stay in the lab.
Please do not take them out of the room.