Syllabus for **PHY 3170 Modern Physics Lab**

Fall, 2020

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Class hours and place: Tuesday, 8:00 -11:59 a.m., 68 MSC

Objective:

This intermediate level undergraduate lab course aims to train students on how to perform experiments as well as to analyze the data and write laboratory reports by selves based on the experiments in Modern Physics. This course is designed to be middle point between the introductory physics lab where most of the experiments are set-up and an instructor is always available to provide assistance to you and the real world where the researchers have to do design and assemble the equipment, record data in systematic way, analyze their data, and interpret the results.

PROTECTING STUDENTS, FACULTY AND CAMPUS: IMPORTANT INFORMATION

Students must comply with the University mandated health protocols. For face-to-face classes, students must wear face coverings in the class and keep 6 feet apart from each other and from the professor.

See the Return to Campus website for up-to-date information. (URL: https://www.oakland.edu/return-to-campus/)

Organization:

You will have three weeks to complete each experiment. You will be doing four experiments in this course. Each experiment has a folder containing adequate background information and all other necessary information to setup the experiment. But you will have to work out the details of how to perform the experiment. Be systematic and keep a logbook (i.e., a detailed record) of your work done in every class. You will find that most experiments are open-ended. You should finish certain basic requirements and then try to do further investigations or perhaps modify the

experiment/procedures for better use next time. We believe that the approach we follow in this laboratory, provides you with an opportunity to work in a team, think critically, plan the experiment, develop systematic working habits in a laboratory, and present your data and analysis in a clear, concise and scientific way, thus preparing you better for real-world jobs.

List of experiments:

1.Photoelectric effect—Determination of Planck's constant, h.

2. Franck-Hertz experiment—Computerized experimental measurement of excited states in Ne.

3.Scanning Tunneling Microscope—Piezoelectric of the motion of a sharp tip over the surface of a conducting materials; generation of a tunneling current and thus the image of the surface atomic structure of the material.

4. Pulsed Nuclear Magnetic Resonance (NMR)—Pulsed NMR to measure relaxation processes in suitable materials.

5. Blackbody Radiation—a furnace and computer interface allows you to display the radiation spectrum in the visible and IR ranges at various temperatures.

6. Resistivity of a semiconductor—Computerized measurement of the variation of the electrical resistivity with temperature for a given semiconductor sample.

7. Determination of the e/m ratio of electron—the radius of curvature of a beam of electrons in a magnetic field, produced by Helmholtz coils, is measured directly. Use Leybold apparatus.

8. Determination of the charge of the electron using Milikan oil drop experiment—the motion of electrically charged oil drops between two parallel electric plates is viewed. Use Welch of apparatus and video camera.

9.* Determination of the gravitational constant G using Cavendish Balance—Delicate torsion pendulum and optical lever. Use Leybold apparatus.

10.* Determination of the speed of light c similar to Michelson's experiment—measure the displacement of a laser beam chopped by a rotating mirror.

11. Determination of the speed of light c using the modulated laser method.

12. Determination of the speed of light c using the static method. Measure 0, the permeability of free space, with a current balance. Then, the permittivity 0, of free space, with a Coulomb balance (both use a delicate balance and optical lever). c=(00)-1/2

13. Determination the Rydberg constant R: Measurement of hydrogen spectral lines with a grating spectrometer. And hydrogen hyperfine structure (Doublet splitting). H2-D2 spectral lines separation measured with a Fabry-Perot interferometer OR Sodium fine structure. Na spectral line separation measured with either a Fabry-Perot or Michelson interferometer.

14. Interferometers—Michelson interferometer (index of refraction of air), Fabry-Perot, and Twyman-Green configurations. Use PASCO apparatus from the Optics Lab (Rm 62 SEB).

15. Microwaves—studies of interference, diffraction and polarization. Use Cenco or Welch or Thornton apparatus.

Labs labeled with * may be difficult to do or may require good effort to make them work properly. Extra effort during these labs will be acknowledged.

It is recommended that you do at least two experiments from 1-7 and two out of the rest.

Course schedule:

Sept. 8 introduction, lab safety, groups, experiments.

Sept. 15, quiz for lab safety at the beginning of the class

Sept. 15, 22, 29	Expt. #1
Oct. 6, 13, 20	Expt. #2
Oct. 27, Nov. 3, 10	Expt. #3
Nov. 17, 24, Dec. 1	Expt. #4

Each of students should turn-in independently a written report on the experiment. The reports are due at the beginning of the class in which the next experiment will be started to conduct.

Report of experiment # 1 is due at 10:00 p.m. on Oct. 5, 2020

Report of experiment # 2 is due at 10:00 p.m. on Oct. 26, 2020

Report of experiment # 3 is due at 10:00 p.m. on Nov.16, 2020

Report of experiment # 4 is due at 10:00 p.m. on Dec. 4, 2020

Try to complete most of the experiment within two weeks; prepare for the report and the next experiment in the 3rd week.

Note:

1)Please submit your PDF formatted homework to my email address ywang235@oakland.edu. In order to prevent the Covid-19 from spreading, the hard copy will not be accepted.

Grading plan:

Quiz for safety: 10 pts

Expt. #1 100 pts

Expt. #2 100 pts

Expt. #3 100 pts

Expt. #4 100 pts

Attendance, participation, attitude, motivation, independence, etc 40 pts

20 of the grade will be deducted from each lab report for each day's delay.

Total 450 pts

480-500 pts, A

380-479 pts, B

300-379 pts, C

250-299 pts, D

Final grade	Total grade	Honor points
A	440-450	4
A-	430-439	3.7
B+	420-429	3.3
B	410-419	3
B-	400-409	2.7
C+	390-399	2.3
C	380-389	2.0
C-	370-379	1.7
D+	360-369	1.3
D	350-359	1.0
F	<350	0

Laboratory instructions:

Experiment Folders, Books, and Equipment

The experiment folders are kept in a filing cabinet in the lab. Also, there are some books on the shelves in the lab for you to read during your experiment. When taking an experiment folder or a book from its place, you should fill out the entries in the notebook kept on the top of the filing cabinet. Similarly, when you return the folder/book, please make the return entry in the notebook. This makes it easy to locate a folder/book at any time. Failure to follow this will result in a deduction of the grade for your experiment. The same procedure applies to equipment taken from or out of any laboratory in the building.

Planning before the lab

- Before each class, it is important that you read the material in the folder and come with a plan for doing the experiment.

- If any equipment malfunctions or breaks down during the class, report it immediately to Dr. Rao or the instructor. Failure to do so will result in deduction of points for the lab.

Laboratory Data records

- Laboratory data should be carefully recorded in a notebook neatly. Each student should have a lab notebook and record his or her data for the report. Pages should be numbered. There is a notebook in the lab for each experiment wherein the students should write a summary of what they did in each class (no data need be shown in this book). This book should be left at the respective experiment station for other groups to continue their lab record. Also, at the end of each class please leave a note at the experiment station regarding whether or not the instructor (and Dr. Rao) may disturb the equipment. Absence of a note implies that the equipment can be disturbed.

- All entries in data books should be in ink. Do not erase or overwrite any entry on your data sheets. If you made a mistake, strike out the erroneous entry and restart. Write a small note in the book as to why you had to restart. This procedure would help prevent making the same mistake again.

- All data pages must be signed by the laboratory instructor at the end of the laboratory period during which the data was taken. Unsigned data will not be accepted.

- In addition to experimental results, your lab notebook might contain: detailed procedures, rough computed results, derivations, circuit diagrams, equipment layout sketches, etc.

Report preparation:

• Separation written reports should be turned-in by each student on the dates shown in the syllabus.

• ***The reports must be typed on 8.5" X 11" paper by using computer.***

Title pages-title of experiment, Date(s) performed, Data of report, your name, and your partner's name

Objectives/Goals-an original, concise statement indicating the purpose of the experiment.

Theory-Brief and precise summary of the background theory and equations needed to explain the experiment and its goals. Provide the source *i.e*., cite the references properly.

Experimental details—a complete block and/or schematic diagram of the experimental setup used should be given in every report. Identify all major equipment used in the experiment with their brand name and model number. Give also a brief step-by-step description form which a person reasonably familiar with the theory (for example the next group to perform the experiment) would be able to understand your work.

Data—present the recorded data (reproduced from your logbook) in well-organized tables along the proper units for the measured quantities. Your original data pages with the instructor's signature should be stapled to the end of your report. Give a reasonable estimate of error/uncertainty in each of the measured quantities.

Analysis—wherever possible, present appropriate data as graphs. Analyze the data using the theory outlined earlier in the report. Compute results using your data. If the same quantity is calculated from a set of several measurements, tabulate the results. Write down the formula used and show one sample calculation. Indicate all units. Give a reasonable error estimate for the calculated values.

Student should read "an introduction to Error Analysis," Physics 158 Lab Manual available in the lab room

Results and discussion—Discuss the results of your experiment, outlining the trends observed with reference to the data, graph, and analysis presented above. State if your results agree with those expected from theory. If appropriate, give reasons why your results differ from the expected values. This is an important part of your report, which reflects the quality of your experiment. Discuss also the sources of errors in your measurements. How might one improvement procedures, equipment etc. ?

Summary—Finally give a brief summary of the experiment.

CLASSROOM BEHAVIOR

1. ***ACADEMIC CONDUCT POLICY.*** All members of the academic community at Oakland University are expected to practice and uphold standards of academic integrity and honesty. Academic integrity means representing oneself and one's work honestly. Misrepresentation is cheating since it means students are claiming credit for ideas or work not actually theirs and are thereby seeking a grade that is not actually earned. Following are some examples of academic dishonesty:

a. **Cheating.** This includes using materials such as books and/or notes when not authorized by the instructor, copying from someone else's paper, helping someone else copy work, substituting another's work as one's own, theft of exam copies, falsifying data or submitting data not based on the student's own work on assignments or lab reports, or other forms of misconduct on exams.

Plagiarizing the work of others. Plagiarism is using someone else's work or ideas without giving that person credit; by doing this, students are, in effect, claiming credit for someone else's thinking. Both direct quotations and paraphrases must be documented. Even if students rephrase, condense or select from another person's work, the ideas are still the other person's, and failure to give credit constitutes misrepresentation of the student's actual work and plagiarism of another's ideas. Buying a paper or using information from the World Wide Web or Internet without attribution and handing it in as one's own work is plagiarism.

Emergency and safety information:

Copies of emergency procedures and safety in physics education (physics, electrical, ionizing and non-ionizing radiation hazards) are available in the laboratory.

It is IMPORTANT that you are aware of the emergency and safety procedure pertaining to this lab when you work here.

• If there is an ***emergency*** situation, call police by dialing 911. For non-life threatening emergency assistance, call **campus police at 3331**

• When calling the police, describe the emergency situation or nature of help need and the room where help should arrive. PHY 317 Laboratory classes are held in the room 68 Science and Engineering Building (**68 SEB**)

• Closest accessible telephone would be a cellular phone with someone in the class. There is a telephone in the hallway outside the classroom.

Fire: if the fire alarm is activated, **exit** the building. Closest exit way is through the stairway in the middle of the building.

Take a minute to note the location of the ***Fire extinguishers*** in the room.

A first aid kit is available in rm 101 HHS

Personal safety and care of equipment:

Student ***safety and equipment care*** are important. Safety precautions are described in the folders for each of the experiments. Please pay attention to those instructions.

Never work alone in a room without the permission of an instructor.

Read instruction manuals carefully before starting any experiment.

If there is **an accident or breakage/malfunction of equipment**, please contact Dr. Rao or the instructor.

- You must sign out every thing that you take out of this room or may borrow from the physics stockroom (rm 110 hhs) or any other laboratory.

- Before you start any measurement or switch on any equipment, have a clear idea of the procedure, order of magnitude and approximate values of the quantities to be measured.

- When using electrical or electronic gadgets, calculate approximately all currents and voltages before connecting the power source. Note the wattage rating of all decade resistors. Do not exceed the ratings. If you do, you will destroy the equipment.

- Leave all of multimeters OFF or on the highest voltage/current setting of the selector switch. In this position the movement is highly damped and best protected from damage.

- Do not touch or attempt to clean optical components, e.g. front surface mirrors in interferometers.

- Do not overheat interference filters. Do not bring light to a focus on one filter. Light passing through the filter should be distributed over approximately one square inch of the filter surface. Interference filters are very expensive and easily damaged.

Laboratory safety information:

Note: there will be a safety test over this material. You must take and pass this test before you can proceed with any experiment!

- Never work alone in a room without the permission of an instructor.

- Read instruction manuals carefully before starting any experiment.

- Electrical hazards:

- All voltages above 30 V must be considered dangerous.

- High charge devices such as large capacitors are dangerous when voltages are greater than 30 V. such capacitors are found in some electronic power supplies. High voltage power supplies can be very dangerous too.

- Test all contacts with a ground wire before touching. Short out all large capacitors. Touch all contacts with the BACK of one finger before grasping contacts in a grip, which may be enhanced by nervous convulsion. Put one hand behind your back and test all contacts before starting to work on a circuit.

- Disconnect all power lines at the source or wall outlet before working on a circuit.

- Do not leave one end of wires loose when the other end is connected in the circuit, particularly to a voltage source.

- Disconnecting a large inductor (>>5 Hy) carrying substantial current can be a very shocking experience.

- Light source:

- Do not look directly at a strong mercury vapor light source. It emits ultraviolet light, which can burn the retina of the eye.

- Do not look directly into a beam along the line of the beam. Again this will damage the retina of your eye. None of our laser beams, however, will heat the skin of your hand. No long-term cumulative effects, such as those caused by X-rays and nuclear radiation, are expected from laser radiation. The principal danger of laser is to the eye.

Class II lasers have maximum power output of one milliwatt or less. These must be marked Caution. They are judged to be eye-safe.

Class IIIA lasers have a maximum power output of 5 miliwatts.

Class IIIB lasers have a maximum power output of 20 miliwatts.

Class III lasers will have a key lock, and several second delay after turning on the power before there is an output beam. These must be marked *Danger*. Recent data indicate that at about 20 mW, the human eye has 50% probability of damage.

- Chemicals:

- There is a laboratory safety information holder, distributed by OU risk management and Contracting environment Health and Safety, available in this laboratory.

• Consult “Laboratory chemical hygiene plan: procedures manual and safety guide” before using chemicals.

• Liquid mercury-mercury vapor is dangerous only if breathed over a period of months. The only concern with liquid mercury is to keep it from contaminating the laboratory. Any apparatus containing should be set in a large pan so that the mercury will be contained if spilled.

Please not the locations of **Eye-wash and emergency shower stations** nearest to this lab.

PREFERRED NAME AND PRONOUN

If you do not identify with the name that is listed with the registrar's office, please notify me so that I may appropriately amend my records. In addition, if you prefer to go by a different pronoun, please inform me. For more information including a preferred first name on university records please review OU’s Preferred Name Policy (Link to Preferred Name Policy: oakland.edu/uts/common-good-core-resources/name-services/)

ADD/DROPS

As a student, university policy officially gives you the responsibility to add and drop courses. Put in your calendar deadline dates for dropping courses (even if you think it won’t be necessary), and consult the Drop or Not Guide to make a well-informed decision before dropping a course. (Link to Drop or Not Guide: oakland.edu/registrar/registration/dropornot/)

Violence/Active Shooter: If an active shooter is in the vicinity, call the OUPD at (248) 370-3331 or 911 when it is safe to do so and provide information, including the location and number of shooter(s), description of shooter(s), weapons used and number of potential victims. Consider your options: Run, Hide, or Fight.