

Syllabus for Physics Laboratory, PHYS 381(W, O), Fall 2021

CRN: 73594, F01

Laboratory: TR 2:30-5:30 PM, REIC 135
Lecture: W 3:30-4:30 PM, REIC 207

Course Type: In person classroom teaching and laboratory work

Instructor: Ataur R. Chowdhury

Office: REIC 118

Office Hours: T 10:00-12:00 Noon
R 10:30-11:30 AM

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Prerequisites: COMM 131X or COMM 141X
ENGL 111X, and either 211X or 213X
PHYS 213X or demonstrated equivalent
PHYS 421 (Quantum Mechanics) concurrent enrollment is strongly recommended.

Textbook: *Experiment in Modern Physics*, A. C. Melissinos and J. Napolitano, 2nd Edition, Academic Press, Inc., 2003. (Required)
An Introduction to Error Analysis, J. R. Taylor, 2nd Edition, University Science Books, Mill Valley, California. (Required)

Course Description: Laboratory experiments in classical and modern physics. (Catalog)

Course Objectives

1. To gain experience in the methods of experimental physics through laboratory work.
2. To sharpen ones skills of writing scientific reports.
3. To master the art of oral presentation of scientific reports

Student Learning Outcomes: At the completion of the course, students will gain understanding of

- (1) the concepts that are the foundation of classical physics,
- (2) the fundamental concepts of some experiments that form the basis of modern physics,
- (3) performing indepth laboratory work related to physics,
- (4) collecting experimental data and analyzing data using software tools,
- (5) scientific basis for determining meaningful experimental outcomes,
- (6) the skills of writing a scientific paper, and
- (7) the art of successful oral presentation.

Instructional methods: Interactive lecture based instruction and laboratory work

Credits: 3 credit: 1 hour of lecture and 6 hours of laboratory per week.

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Help Session: Help with the homework and laboratory is available through the instructor during his designated office hours.

Course Requirements and Policies

There will be an hour-long class every week on materials required for the course. It is highly recommended that every student attends the class. Homework will be assigned from time to time, and the students must turn them in by the date they are due. No late homework will be accepted. Collaboration with your fellow classmates on the assignment is highly encouraged, but you must work out your own solutions before you turn it in.

An integral part of this course is the laboratory work, and every student must attend two laboratory sessions every week. Credit is given for attending the laboratory, participating in meaningful discussion, and maintaining a clean and orderly work area. All laboratory work must be neatly recorded in a bound notebook, and have it signed before you leave the laboratory for the day. The notebook will be graded for clarity and completeness. As per requirement of this course, you must turn in four complete laboratory reports following the guidelines described below, and make an oral presentation on one of them at the end of the semester.

Details of Course Outline and Instructional Policy

This course satisfies the core curriculum communications requirement for a one-semester oral-intensive course (“O”) and is the first of two semesters (PHYS 381 and 382) that satisfies the writing-intensive (“W”) requirement. The normal procedure in the laboratory is for students, alone or in pairs, to perform **four** experiments in the semester and individually prepare written reports in a recognized scientific format. Pairing becomes increasingly necessary as enrollment exceeds 3-4 students. Each experiment involves five steps:

1. develop an understanding of the experiment to be performed, including literature searches in the library;
2. select and set-up the necessary equipment;
3. perform the experiment and collect all necessary data;
4. analyze the data and complete an error analysis; and
5. prepare a detailed written report.

In addition, each student is required to give two 20-minute oral presentations as per requirements of the UAF core curriculum. The oral-intensive portion of the course will be part of the weekly classroom sessions, with the final presentations being held during the final exam week before a larger audience of faculty and students within the department.

All laboratory work must be recorded in a bound laboratory notebook that is available for inspection throughout the semester. The notebook is used to create a detailed record of all aspects of your activities in the laboratory, including, but not limited to, clear diagrams of all experimental configurations, identification of all equipment and materials, records of all quantities measured in setting up an experiment, all data, with clear records of discarded data and the rationale for their deletion from the final data set, and the methods of error analysis. The contents of this notebook form the basis for each written report. Data collection can be a very lengthy process for some experiments, so it is then acceptable for the two individuals performing the experiment to share a single data set. Discuss this with the instructor. In general, it is a good idea to collect your own data. Any data originally entered into a computer must be printed and attached to the notebook.

In order to make the laboratory experience as similar as possible to that of an actual physics laboratory, you will not find this to be a highly structured class. You may encounter more than one way of carrying out an experiment, and may encounter dead ends requiring a re-evaluation of the chosen procedure and the selection of a new procedure. You may have to improvise and design parts of the experiments. **BEFORE YOU START A**

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LAB, PLEASE SUBMIT A SHORT OUTLINE AS TO HOW YOU PLAN TO CARRY OUT THE PROPOSED LAB, HOW YOU ARE GOING TO ANALYZE DATA, AND WHAT RESULTS YOU ARE LOOKING FOR TO ACCOMPLISH THE LAB SATISFACTORILY.

You should not expect the instructor to provide answers to your every problem, as the laboratory is a place of self-discovery. This can include outside reading if your course work has not adequately covered the necessary material. In this case, however, you should inform the instructor of the deficiency in the department's curriculum. In the end, however, the instructor is there to keep you moving forward and to guide you in reasonable laboratory practices. You will also be expected to aid in maintaining a clean and well-organized working environment. You are not to disturb in any way a laboratory setup in use by anyone else.

You are to perform a preliminary data analysis after each laboratory session to verify that the experiment is proceeding satisfactorily. Hence, it is perfectly reasonable for the instructor to ask for a brief summary of the experiment's progress at the beginning of a lab session, or you may be invited to give a brief synopsis of the experiment's progress at one of the weekly class sessions. Failure to be able to do so will be noted. You are expected to be in attendance throughout the full meeting time in each class and lab session and to participate in the class.

The experiments available in our student laboratory are listed below, in approximate order of increasing complexity. The first six experiments are available in the first semester.

- | | |
|---|-------------------------------------|
| 1. Rutherford scattering of alpha particles | 6. Gravitational constant |
| 2. Frank-Hertz experiment | 7. Compton scattering of gamma rays |
| 3. Bragg scattering of x-rays | 8. Electron spin resonance |
| 4. Millikan oil-drop experiment | 9. Zeeman effect |
| 5. Speed of light | 10. Mössbauer Effect |

Nearly all the experiments require the use of high voltage (100s of volts) and/or radioactive sources, and one makes use of a small X-ray machine. Radiation badges will be organized.

The Written Report, Writing Skills

You will begin the semester by providing a writing sample to assist me in assessing your general competence in writing. This will be organized during the first classroom session. The sample will be graded, and feedback will be provided. However, this will not count towards the final grade.

You are required to produce four lab reports for this course, and a detailed outline for writing the reports will be provided in class. You are expected to submit a first draft of the report for each laboratory experiment by the third laboratory session after completion of data collection. The draft will be critically reviewed for scientific content and writing skill within one week and recommendations made for improvements that can include additional laboratory work to correct deficiencies in the experimental method, data collection, and/or results. This means firstly that you do not start writing your report after you have collected the data – you start writing when you start the experiment – and secondly you do not break down the experimental setup as soon as you think you have completed data collection. You should expect to meet privately with me after submission of each first draft.

Issues raised in this first review are to be resolved within one week of the report's return to you through the submission of a second draft. History teaches that in this first semester the second draft is generally deficient in important details, so be prepared to make further corrections once this second draft has been reviewed and returned to you. At this point you are to prepare a final report for grading. You have one more week to prepare the final report. A more compressed schedule is required with approach to the end of the semester, as the final

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versions of the first three reports must be submitted on or before the last day of classes in the semester. The fourth report acts as a final exam paper for the course and will not be returned for review. It is due on or before the day assigned for a final exam in this course. PLEASE NOTE THAT YOU WILL NOT BE ALLOWED TO START THE NEXT LAB BEFORE YOU HAVE SUBMITTED THE LAB REPORT FOR THE CURRENT ONE.

Grading the Laboratory Reports

Format of the report is to follow that of papers in current scientific literature. Several examples of typical articles will be provided. Each report is graded on a scale from 0 to 100 points. Draft and final reports will be marked down by one point for each day they are late. Exceptions will be made only for serious illness or family emergencies. Grading is based on the following general criteria:

1. Clarity of writing, scientific thought, diagrams, tables, and figures
2. A simple test – Could the report be understood by a peer not in the course?
3. Spelling errors and poor grammar should be expunged in the draft version(s), and are not acceptable in the version submitted for grading
4. Quality of data; fixed parameters and independent and dependent variables
5. Error analysis; quantitative and interpretation
6. Comparison with the known result
7. Organization of the paper; abstract, introduction, body of report, results, discussion, references, tables, figures and their captions, etc.

The following specific areas are addressed when assigning a final grade to a laboratory report. Clarity of thought is always of great importance.

1. Overall quality as a written document (writing intensive component)		
-skill in writing	7	
-use of reference materials	7	
-general appearance	<u>6</u>	
		20 points
2. Presentation of physics		
-historical information	10	
-definition of problem	10	
-development of theory	<u>10</u>	
		30 points
3. Implementation of the experiment		
-description of the instrumentation	7	
-description of the necessary procedures	7	
-attention to seemingly minor details	6	
-presentation of observations, including figures and tables	<u>10</u>	
		30 points
4. Results		
-precision and accuracy of the results	5	
-error analysis	5	
-clarity of conclusions	5	
-abstract	<u>5</u>	
		<u>20 points</u>
		100 points

One-Hour Classroom Activity

In addition to the six hours per week of laboratory work, there is a single one-hour meeting per week in the classroom format to discuss writing issues, background material on experimental techniques, data and error

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analysis, planned and unplanned oral presentations, and other topics that are appropriate for this course. There will be homework.

The Oral Presentations

As part of the UAF core requirement for this oral-intensive course, you are required to give two 20-minute oral presentations during the semester. A detailed outline for the oral presentation will be provided in class. **In keeping with new university guidelines for communication courses, you must allow, at the beginning, enough time to communicate scientific and societal relevance of your experiment to the audience, who may or may not have required background in physics.** Each report will be accompanied by a question-and-answer period of about 5 minutes duration. It is the practice of this course that you are to select the topics of discussion from two of your laboratory investigations. You are free to select which ones you will use. Colored chalk and a projector for transparencies will be provided without need of a request, but you must provide the transparencies. Any special needs must be identified during the class period BEFORE the scheduled oral presentation, and you are free to provide any such materials yourself. You cannot use a portable PC for displaying graphics unless projected onto a screen. However, the department has such a projector, which you can borrow for your presentation.² The 100-point score will be based on 10 individual items (see below), with a maximum of 10 and a minimum of 0 points per item.

Do not view 20 minutes as something approaching infinity. My experience, and that of many of my colleagues, is that it requires an average of ~2-3 minutes per visual aid of any kind, where that can be, for example, a transparency, a nice diagram on the blackboard, or even the seemingly brief development of a mathematical derivation. At that rate, after the presentation of six or seven items you are behind schedule and searching for a conclusion.

Practice your presentation carefully and thoroughly as many times as it takes to feel comfortable with the material. Writing it out in outline form can be a great help, but I do not recommend writing it out in explicit detail and trying to read it. The reading of papers as a method of presentation is seldom seen today. A worthy objective of the first presentation is to put all the elements of a scientific talk together for the first time and to demonstrate to yourself just how long it takes to cover the material in a well-prepared talk. The second presentation at the end of the semester then builds on this experience. Speaking from my experience, it can take years to reach the point that you are not overly concerned about what you are about to do, while becoming too unconcerned can lead to a public demonstration that you are not working hard at it. I do not recommend the experience, though it is a great teacher. Outstanding presentations are not given casually—they only look like it.

The specific items upon which your oral presentation will be graded are as follows:

1. Statement of your objectives, clarity;
2. Presentation of an introduction that may include historical information and the importance of the particular experiment;
3. Presentation of the experimental method – mathematical development;
4. Presentation of the experimental method – instrumentation and other important materials;
5. Presentation of the observations, including the error analysis;
6. Description of difficulties in carrying out the experiment;
7. Clear statement of your results;
8. Responses to questions posed by the audience;
9. Use of visual aids; transparencies, chalk board, etc.;
10. Personal presentation, including speech (clarity and efficiency;) body language (facing audience vs. chalk board), eye contact (direct vs. looking anywhere else), animation vs. rigidity, interest in the problem (positive presentation vs. indifference, or worst, an apparent dislike of the whole affair).

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Rules for Using the Lab's Computers:

1. The only people authorized to use the laboratory computers are faculty and staff of the physics department and students registered for PHYS 381.
2. No software is to be transported into or out of the computers.
3. Other student data files are also kept on the hard drive. It is recommended that you maintain personal backup copies, as the files are not password protected. Also, disks have been known to fail.
4. The software on the computers is highly specialized and except for EXCEL and KALIDAGRAPH, is probably useless outside the laboratory. You may wish to use the computers in the department's computer laboratory for routine data analysis.

Academic Honesty:

UAF expects and requires academic honesty from all members of the University community, and takes any act of plagiarism and cheating seriously. It is expected that all assignments, including homework and reports, that are turned in for this course must be the original work of the individual student. Failure to comply with this policy will result in penalty as stipulated under UAF regulations

Course Evaluation:

The final grade for this course will be based on student's performance on homework and final, and will be weighted as follows.

Homework	10%
Lab. notebook	10
Oral report	20
Lab. Participation	10
Lab. reports	<u>50</u>
	100%

The final grading for this course will be based on a curve. Allowed grades are limited to letter grades A,B,C,D,F,I,BN, and no plus-minus grades will be given for this course.

Incomplete Grade Policy: "The letter "I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) the majority of work in a course but for personal reasons beyond the student's control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an "I" grade."

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Student Protections and Services:

COVID-19 Essentials: Because of COVID-19, University has put in place some mandatory procedures to adhere to. All student are encouraged to observe these rules to ensure a safe environment for all of us for a successful fall semester. I request all of you to do the following:

- 1) Wear mask during class,
- 2) Maintain social distancing in class,
- 3) Use designated doors for entering and exiting,
- 4) Try to sit at the same place in class (for tracing),
- 5) Check updates about COVID-19 on the website listed below on a regular basis.

<https://sites.google.com/alaska.edu/coronavirus/uaf/uaf-students?authuser=0>

Further, students are expected to adhere to the university's policies, practices, and mandates and are subject to disciplinary actions if they do not comply.

Protection: Every qualified student is welcome in my classroom. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. As required, if I notice or am informed of certain types of misconduct, then I am required to report it to the appropriate authorities. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handboo

UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: alaska.edu/nondiscrimination.

Services: As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc to find reasonable accommodations.

Effective communication: Students who have difficulties with oral presentations and/or writing are strongly encouraged to get help from the UAF Department of Communication's Speaking Center (907-474-5470, speak@uaf.edu) and the UAF English's Department's Writing Center (907-474-5314, Gruening 8th floor), and/or CTC's Learning Center (604 Barnette st, 907-455-2860).

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Initial Questionnaire

NAME: _____ Student # _____

Age (NRC requirement for use of radioactive sources) _____

Academic Major(s) _____

Physics courses completed:

Physics courses this semester:

Laboratory experience:

Experience with radioactive materials? ☐ YES ☐ NO Any training? ☐ YES ☐ NO If so, please explain: