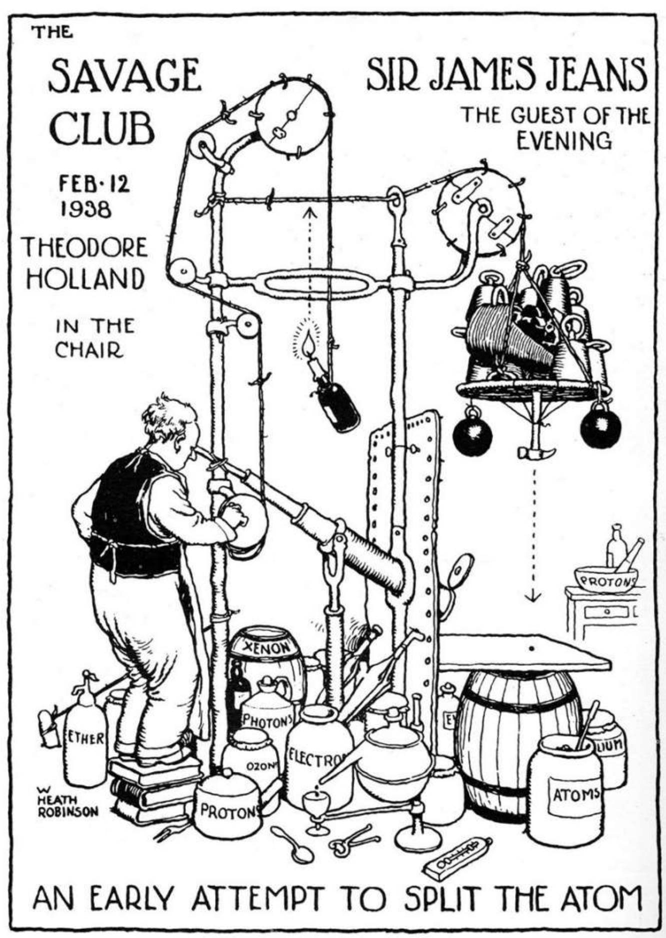
**University of Alaska Fairbanks** **Fall 2020**

# Physics 381

## Advanced Physics Laboratory – 3 Credits

Instructor – Dr. Mark Conde

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# Overview

## Description

The overarching purpose of this class is to prepare students to conduct and report on real-world experimental physics, as distinct from the much more sanitized lab experience provided in lower-division physics courses.

Do not underestimate the importance of verifying principles through your own personal measurements. The modern connected world exposes us all to a torrent of inexpert opinions, conspiracy theories, and fake news. Ideally, we would personally verify by absolute measurements any such postulates presented to us. This is of course not feasible in most cases, and we must instead try to weight information according to some assessment of the reliability of the source. But lab work is one small exception – in which we can, personally, make our own measurements to absolutely verify (or not) the reliability of some assertion. This absolute personal experience with the underlying behavior of a system is the foundation of genuine expertise.

In laboratory work there is a major distinction between studies designed to verify existing knowledge, versus those intended to create new knowledge. In particular, undergraduate teaching labs do not usually attempt to create new knowledge; that is the domain of research. Research (almost by definition) requires making measurements or performing studies that have never been done before.

While many universities do allow undergraduates to participate in true research, that is not the goal here. Rather, we will be repeating famous experiments of great historical importance that did, in their day, fundamentally change our understanding of physics. The goal is for you to recreate the experience of those pioneering researchers, by making your own measurements and determining for yourself whether their conclusions are indeed justified.

The key idea here is to "repeat the experience." Research requires us to push boundaries and, as such, it rarely goes smoothly. Measurement uncertainties are usually large compared to the accuracy required to reach a definitive conclusion. (If a quantity could be measured accurately enough to demonstrate some conclusion with "no brainer" confidence, then that conclusion would likely have been verified already.) Equipment underperforms or breaks, results are unclear, and mistakes are made. All this is normal. One goal of this class is to illustrate that robust conclusions can often still be made, even when our procedures and data are imperfect. This is how real science works.

Conclusions drawn from lab measurements can undoubtedly be satisfying and useful for the experimenters. But their value is vastly amplified if the experimenters can communicate the outcomes to a wider audience – by conveying not only the conclusions drawn, but also the methods used to reach them, and by justifying the level of confidence that the data provides for those conclusions. The rise of misinformation means that society will increasingly depend on professionals like you to disseminate clear, unambiguous, rigorous knowledge, whose veracity is justified. But such messages face intense and growing competition for audience attention. To be heard, they must be understandable and engaging.

## Course goals and student learning outcomes

Motivated by the discussion above, the goals and learning outcomes for this course are to:

- Allow students to recreate a number of key experiments that shaped our modern understanding of physics.
- Personally verify the results of those experiments, and the resulting theory derived from them. Students will test through their own personal measurements whether the conclusions drawn from these experiments are justified.
- Introduce the idea that all such experimental verification is subject to uncertainty – no measurement is perfectly accurate, so we need to establish the degree of confidence that we can have in experimental conclusions, based on the uncertainties in our observational data.
- Learn a number of key experimental techniques and procedures that are used to make physical measurements and to interpret the meaning of the results.
- Learn how communicate experimental conclusions in a clear rigorous manner, both orally and in writing.

My goal as an instructor is to provide every student with maximum possible opportunity for success. This means that I try to be as flexible as possible with the course requirements, to avoid creating needless hurdles. Nevertheless, some penalties for missed or late work are necessary; my policies in this regard are outline below.

## Instructor information


| | |
|---|---|
| Instructor: | Dr. Mark Conde<br>Email: mgconde@alaska.edu |
| Office locations: | Reichardt rooms 110 & 135 |
| Office Phone: | 474-7741 |
| Email: | mgconde@alaska.edu |


| | |
|---|---|
| Office hours: | I do not intend to establish fixed office hours for this small class. I will always be available during lab hours and immediately after lectures, or at other times by arrangement. If you need to see me, speak to me after class or send me an email, to setup a time. |

## Approximate schedule

| *Week* | *Dates* | *Class Topics* | *Labs* |
|---|---|---|---|
| 1 | Aug 24 - Aug 28 | Class intro; intro to lab & experiments | |
| 2 | Aug 31 - Sep 04 | Electronics for measurement | Lab 1 |
| 3 | Sep 07 - Sep 11 | Pulse Counting | Lab 1 |
| 4 | Sep 14 - Sep 18 | Radiation Detection | Lab 1 |
| 5 | Sep 21 - Sep 25 | Radiation Detection | Lab 1 & 2 |
| 6 | Sep 28 - Oct 02 | Radiation Detection | Lab 2 |
| 7 | Oct 05 - Oct 09 | Experimental Uncertainties | Lab 2 |
| 8 | Oct 12 - Oct 16 | Experimental Uncertainties | Lab 2 |
| 9 | Oct 19 - Oct 23 | Experimental Uncertainties | Lab 3 |
| 10 | Oct 26 - Oct 30 | Electronic Measurements | Lab 3 |
| 11 | Nov 02 - Nov 06 | Electronic Measurements | Lab 3 |
| 12 | Nov 09 - Nov 13 | High-Frequency Measurements | Lab 4 |
| 13 | Nov 16 - Nov 20 | Transmission Lines | Lab 4 |
| 14 | Nov 23 - Nov 27 | Thanksgiving Week | Lab 4 |
| 15 | Nov 30 - Dec 04 | Vacuum Techniques | Lab 4 |
| 16 | Dec 07 - Dec 11 | Finals Week | Oral presentations |
| 17 | Dec 14 - Dec 18 | Grades posted by noon Dec 18 | |

Lecture topics are a target only. I expect this will change depending on how long each topic actually takes.

## Campus-wide Covid-19 Policies

Students should keep up-to-date on the university's policies, practices, and mandates related toCOVID-19 by regularly checking this website:
https://sites.google.com/alaska.edu/coronavirus/uaf/uaf-students?authuser=0
Please note that students are expected to adhere to these policies, practices, and mandates and are subject to disciplinary actions if they do not comply.
Be aware that the covid-19 situation in Alaska will evolve, in currently unknown ways, and on a weekly basis. Procedures and policies will change as needed. For this class, the most likely changes would apply to the actual lab work which, at least initially, will be conducted in a face-to-face manner. The lecture component of this class is already intended to be delivered 100% online, and so this component of the course is unlikely to change before the end of the semester.
Remember – ***it is required that you wear a mask and maintain social distancing in all indoor shared spaces on campus.*** This is the most important thing that each of us can do to ensure that our campus is a safe, healthy, and effective learning environment.

# Course components and instructional methods

## Course materials

Material for this course will be prepared electronically and will be available *over the web via the "Blackboard"*[1] *system* at https://classes.alaska.edu/. Material to be posted this way includes:

- Course syllabus (this document)
- Lecture notes (see comments below)
- Homework problem sets
- Lab notes
- Supplementary handouts
- Online student grades

Note that I will not be distributing homework solutions to the web. These will instead be posted in the glass cabinets in the physics departmental area of the Reichardt building.

## Laboratory work

*Overview, and accommodations for covid-19*

Laboratory work represents the main component of this course. There are two three-hour lab sessions each week, on Tuesdays and Thursdays from 2:30-5:30 pm in Reichardt room 135. However, in order to maximize class safety with respect to covid-19, the lab procedures will be slightly different this semester compared to what has been done in the past. Specifically:

- We will not be doing experiments in pairs or groups; **each student will work individually on their experiments**.
- We will divide into a Tuesday group and a Thursday group. Each group will physically attend the lab to work on experiments on their namesake days. The converse group will work remotely during their "off" lab days. This remote work will involve reading about the history and technique associated with their current experiment, working on data and analysis, and writing the lab report.
- I will attend the lab on both Tuesday and Thursday, to help students who are physically present. I will also run a zoom session during the lab class times, so that students working remotely can call in and discuss their experiment with me.
- The Tuesday/Thursday grouping for in-person versus remote attendance will be regarded as the "baseline" configuration. I encourage you to trade-off in-person between the two groups – for example if you know you can't be present at one of your designated in-person sessions, it may be helpful to try to swap that session with someone from the other group.
- I will setup six experiments on six different benches in the Advanced Lab. Students will work at or near their experiment's bench, and maintain at least 6 feet of social distance from other class members. Everyone will need to wear a mask while in the lab.

Over the course of the semester, each student is required to conduct four experiments, and to prepare a formal written report on each one in a format similar to that of a publishable

[1] All students should have access to Blackboard. Please let me know if you have difficulties with this.

scientific paper. In addition, each student must give two 20-minute oral presentations. The first of these will be presented solely to the 381 class. However the second must be presented to a wider audience of faculty and students from the Physics Department. The first presentations will be scheduled near the middle of the semester, whereas the second will occur during or close to the final exam week. Actual dates for the presentations will be determined by student progress and by mutual agreement among the class and instructor. **This semester, the oral presentations will be delivered over zoom**.

In conducting an experiment, each student will be required to:

- Develop an understanding of the experiment being performed – its purpose, method, historical context and outcome, and its impact on how physics was understood at the time.
- Identify and setup the necessary equipment.
- Perform an initial first-pass at the experimental procedure to become familiar with all required steps, identify difficulties, refine any steps that may be limiting the quality of the final results, and verify that the proposed procedure is likely to lead to definitive conclusions.
- Conduct an "implementation readiness review" with the instructor to verify that the student understands the experiment, has developed a viable and safe procedure, and is ready to conduct the "live" version of the experiment.
- Perform the experiment, recording all necessary background and setup information, calibration data, and observational results. All experimental setups should be photographed.
- Analyze the experimental data and all associated uncertainties.
- Develop conclusions and discuss anomalies.
- Prepare a formal written (and, in two cases, oral) report. Written reports will be prepared electronically and will undergo two levels of review before final submission (see below.)

*Typical Schedule*

The semester timetable allows students to spend roughly 3 weeks on each of the four experiments. Notionally, I am expecting the resulting ~6 lab sessions per experiment to be used approximately as:

1. Become familiar with the equipment and experiment goals. Begin work on background sections of the written report.
2. Prepare and test a draft experimental procedure. Begin written description of the proposed procedure.
3. Implementation Review, then begin performing the live measurements. Complete written descriptions of the experimental background and procedure.
4. Complete live measurements.
5. Analyze data and prepare preliminary results; correct or repeat any steps that appear to have produced anomalous outcomes. Submit first draft of the report.
6. Complete second draft of the report. The final draft will be due at the end of the following week – which will either be week one of your work on the next experiment or, at the end of the semester, it will be during finals week.

This is of course only a target schedule; substantial departures from it are to be expected, especially due to social distancing limitations. Nevertheless, **it is vital that you start each new experiment on time**. This is not merely to avoid getting behind. It is essential, since another student will want to start working with the equipment after the designated changeover day. Because access to in-person time in the lab is limited, I will try to establish some mechanism to allow students to "trade-off" lab time as described above.

In general, you should not disassemble your apparatus before the changeover day unless you are certain that your results are finalized. You may discover that you need to repeat some measurements, either due to an anomaly in the results, or because you failed to record some necessary measurement. **Under no circumstances should you interfere with the setup of any other student's experiment.** If you need to borrow some item that they are using, ask first. Do not assume that anything can be touched without impacting another group's work. Once your work is finalized on an experiment, it is your responsibility to pack equipment away carefully and safely. The department and students following behind you are depending on you to do this.

We will generally begin each lab session with each student giving a brief verbal summary to the whole class describing their progress on the experiment they're working on, a description of any issues encountered, and a brief statement of plans for the coming lab session.

*Laboratory Notebook*

An important requirement for this work will be to maintain a **detailed, bound laboratory notebook.** This notebook must accompany you at all times in the lab and be available for inspection by the instructor. A portion of your grade for each experiment will be based on the completeness and appropriateness of your lab notebook.

Your lab notebook is intended to be readily at hand and used to easily maintain a permanent record of all relevant information, including (but not limited to): clear and labeled diagrams of all equipment setups, identification of all equipment and materials (including serial numbers when available), all measurements made, along with their associated uncertainties, notes on all intermediate calculations used to tune or validate the procedure, rationale for rejecting any measurements, and notes of any anomalous factors that may impact the results.

Each entry in your notebook should begin with a HH:MM time stamp, identifying when it was written. Generally each new lab session should begin on a new page, with the date of the session specified at the start. If you ended up working past midnight for some reason, then the change of date should of course be prominently noted in the appropriate place in your log. These notes will form the source material for you lab report. All entries should be sufficiently neat, clear, and complete that you could pick up the notebook in five years' time and still understand what you did. (This is a surprisingly difficult goal – do not skimp on descriptions or detail when recording your activities!)

Many students may prefer to use a laptop or tablet for their log and, indeed, there is now a plethora of software options and strategies available for both general-purpose note taking and specifically for electronic lab notebooks. Nevertheless, **for this class, we will use paper notebooks**. Once you have gained experience with traditional lab note-taking, you will be better positioned to decide what form of electronic laboratory notebook, if any, would work best for you.

*Nature of the Lab Work*

These labs are intended to include a substantial element of self-discovery. As you begin each experiment I will provide a brief verbal overview and demonstration of its purpose, the major equipment required, and a general discussion of the recommended procedure. But it will be up to you to flesh out the procedure, identify how to obtain the most accurate results, and how to deal with practical limitations of the equipment and the working environment. You may have to improvise or design strategies for conducting parts of your chosen procedure. I will be available to offer help and advice.

You will be able to choose freely from equipment available in Reichardt room 135. You may also request use of other departmental apparatus that is not usually available in our lab. Any such requests need to be approved by the PHYS381 instructor and by the departmental Lab Supervisor. By design, this is not a highly structured class. The instructor is there to guide and advise, but most of the practical problem solving is your responsibility.

You are expected to maintain a neat work area at all times. This is for reasons of both safety and experimental reliability. Messy cables are confusing and can lead to erroneous connections that could damage equipment or cause injury. Cables draped loosely over equipment and running across the floor are a tripping hazard. All equipment should be positioned stably, so it will not readily topple. Any hazardous apparatus should be prominently labeled, to alert other lab users of the danger.

While the equipment that have is capable of producing good data when used properly, please understand that "getting the right answer" is only a (very) small component of the learning objectives for this class. It much more about the process of setting up and attempting the measurements than it about the final answer. That said, of course a well-executed lab that produces good results will earn somewhat more points than a sloppy one that produces meaningless data. But do not be distressed if your best results don't fully match expectations. I am expecting that will occur and, in such cases, you can still get a very good grade if you discuss adequately what you think the remaining issues might be.

*List of Experiments*

Our advanced lab has a pool of ten experiments to draw from. In approximate order of increasing complexity, these are:

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

That said, not all of these experiments are currently operational. For this semester, we will focus on experiments 2, 3, 4, 5, 6, and 7.

**Several of these experiments involve potentially hazardous apparatus**, including high voltages, radioactive sources, lasers, and x-rays. Safety procedures will be explained, and unsupervised access to the lab will not normally be permitted.

*Written Reports*

A major portion of your grade will be based on your written lab reports. It is expected that your writing skills will improve during the semester, which means your first two written reports will contribute less weight (i.e. 10% each) to your overall grade; the latter two reports will each contribute 15% to your grade.

While your lab notebook will be paper-based, your written reports must be submitted electronically. There are several reasons for this, including:

- You will be required to submit two drafts for review before your final submission. Review and revision is far easier when the source material is in electronic form – especially when we trying to do as much as possible remotely due to pandemic concerns.
- Electronically formatted reports are neater and easier to read.
- Professional written communication in science is invariably electronic nowadays, and many journals provide templates for ensuring that submitted articles are consistent with the journal's style.

Reports may be submitted using either Microsoft Word, LaTeX, or in PDF format.[2] While LaTeX is by far the best environment for authors, it is less convenient for review. MS Word has by far the best review and markup tools, which means it is my preferred format for submitting your draft and final reports. But I will work with LaTeX/PDF if necessary. I will discuss this further in class.

Written reports must be subject to two levels of instructor review and student revision before the final report is submitted – see the "typical schedule" listed above for a description of when these drafts should be submitted.

*Grading of Written Reports*

The format of the reports should follow (at least approximately) that of papers published in typical refereed physics journals. Useful templates for AGU style journal articles can be found here:

https://publications.agu.org/author-resource-center/checklists-and-templates/

Reports will be graded out of 100 points. Factors that will determine the grade include:

- *Quality, clarity and rigor of the writing*: Does the report make sense? Could it be understood by class peers who have not yet done that experiment? Is it free of errors in spelling and grammar? Are the ideas expressed using precise and unambiguous language?
- *Understanding*: Does the report clearly and correctly state the purpose and historical significance of the experiment, the physical principles behind the measurements, the results obtained in this instance, and conclusions that can be drawn?
- *Quality of the data and analysis*: Were good results obtained? Were the data analyzed appropriately, and was this analysis clearly explained? Were the uncertainties clearly derived and presented? Were the conclusions justified, given the uncertainties? Were any anomalous outcomes identified and appropriately discussed?
- *Quality of presentation*: Was the paper well organized? Were tables and figures clear, adequately labelled, and unambiguous? Were figure captions appropriate and complete? Were all references provided in an accepted publication-quality format?

A typical report will contain the following sections, weighted for grading as indicated:

- *Abstract*: A brief summary (10-30 lines) stating the purpose of the experiment, how it was conducted, and what the major conclusions were. Abstracts are used by

[2] Talk to me if you want use Google Docs. I generally find Google Docs horrible to use. But possibly newer tweaks have improved the review and markup environment.

researchers to quickly determine whether it is worth their time obtaining a complete copy of the paper (which may be expensive) and reading it in full. [10%]

- *Introduction*: A statement of the underlying physical problem, what is known about it already, and why further study of this topic is needed. In our case the introduction should also describe the historical context and significance of the experiment. [25%]
- *Experimental Method*: A general description of the physical principles behind the measurements, any relevant equations or mathematical derivations, the apparatus and procedures used, and any special techniques that may not be widely understood by the expected readers. [25%]
- *Results, Analysis, and Discussion*: This section contains narrative and tabular presentations of the original measurements, a description of the analysis techniques used (with equations as necessary) to derive final results, tabular presentation of intermediate and final results, and a description of the procedures used and outcomes obtained when deriving estimates of experimental uncertainties. This section should also discuss the meaning of the results, and the conclusions that can be drawn from them, including any anomalous results obtained. [25%]
- *Summary and Conclusions*: The main body of a paper can contain many lengthy discussions. All papers should end with a brief summary that restates what has been learned, in a compact and straightforward manner. [15%]

A well-written lab report should be concise – but do not confuse "concise" with "sparse". Your report must be complete, and must include sufficient detail to allow other workers at different institutions to replicate your work using their own equipment, based solely on what you have written.

*Oral Reports*

You will also be required to give two 20-minute oral presentations – one mid-semester to the rest of the class, and one during finals week to the wider physics department. The topics for each of these presentations will be to report on one of the experiments that you have completed. You are free to choose which, provided you choose two different experiments. As with written reports, these presentations should cover the science problem addressed by the experiment, its historical background, the physical principles behind it, the apparatus and method that you used, the results and uncertainties you obtained, and the conclusions derived.

Your oral presentation should be accompanied by computer-based visual aids (powerpoint, LaTeX Beamer, etc.) You should practice your talk multiple times, to ensure that you can make your points clearly and within the time allocated. Experience shows that a very good speaker with a well-practiced presentation can cover at most one slide per minute.[3] You should expect to achieve at most half this rate. Your 20 minutes includes 2-3 minutes for questions, so 9 slides would be a good target for planning purposes.

Your oral presentation will be graded according to the following criteria:

- Were the objectives and conclusions of the work stated clearly at the outset?
- Did the speaker clearly explain the motivation, historical context, experimental principles and method, measured results, derived results, uncertainties, and conclusions?
- Was this done in a clear, engaging, and easily-followed manner?

[3] At the other end of the spectrum, I once saw a presenter in Japan speak for two hours while showing just 4-5 slides. I have no idea how she did it – it was all in Japanese and I didn't understand a word. But the audience was fully engaged throughout!

- Were the graphics clear, unambiguous, and easily followed?
- Did the speaker engage the audience with clear speech, eye contact, body language, and enthusiasm?
- Were the responses to audience questions clear and reasonable?

Oral presentations expose the speaker to very direct judgement by the audience. Many beginning speakers find this intimidating, and you should not feel unusual if that is your experience as well. Fear of public speaking is something that all professionals must face and overcome. There are two simple secrets to becoming comfortable with public speaking:

- Believe that your material is important and interesting to your audience.
- Understand your material, and practice your talk!

A previous instructor for this course included this superb quote in their syllabus: "Outstanding presentations are not given casually – they only look like it."

## Lectures

Lectures material will be taken from a number of sources, so there is no single textbook assigned for this course. It is recommended that you read the lecture notes beforehand, and take notes during the lecture. The emphasis in the lectures will be on clarification of the key concepts, rather than lengthy mathematical derivations.

Lectures will be held online via live streaming, on Wednesday from 3:30 pm to 4:30 pm. Lectures will be live-streamed via zoom, and also recorded for later review. Here is the relevant zoom meeting information:

- When: Wednesday from 3:30 pm to 4:30 pm, beginning Aug 26, 2020.
- You can find a link to the zoom meeting on the left side of the blackboard home page for this class.
- Alternatively, you can use this link: https://alaska.zoom.us/j/93622768470?pwd=Tit6NjRIcVhIR3c5akdyTEtyYThnQT09. The meeting ID is Meeting ID: 936 2276 8470, and the passcode is 8y173s
- You can also join by telephone, using one of the numbers listed here: https://alaska.zoom.us/zoomconference?m=rX1xjgCGvA_teNc5rV-5lXSEv-9P94kJ

I will be presenting lectures using a combination of computer slides and additional notes, diagrams etc. drawn by hand on a whiteboard. I will post printable versions of the electronic lecture notes online ahead of time. You should read the lecture notes and the relevant chapter from *Universe* beforehand. Many students may find it helpful to annotate these notes with your own supplemental notes during the lecture.

I have setup a dedicated video studio in the Reichardt building, and will be live-streaming from there. I am hoping this setup will make for high-quality and engaging live class sessions.

## Homework

There will be four homework sets assigned during the semester. The homework is designed to reinforce concepts presented in the lectures, as well as to motivate you to read up on a few important topics that I do not expect to have time to cover in class.

Problems assigned in this class can often be solved in several ways, with each solution involving a number of steps. So please be aware that even if you submit a correct solution to a problem, I may not recognize it as correct if it's poorly presented. While I will accept almost any work that you turn in, it is unlikely that I'll award many points for a homework or exam solution unless it:

- Is neatly laid out
- Is largely free from crossing out and over-writing
- Is accompanied by **descriptions in words of what you are doing at each step**

Plain-text explanations are **required** for any major mathematical steps. This is an upper-division class, which means students should be preparing either to enter the professional workforce or to begin graduate school. The point of submitting homework solutions is not to tell me the final answer. (I already know that.) The point is to demonstrate that you can explain clearly and professionally *how that answer is obtained*.

***All homework will be assigned, submitted, and graded using UAF's "Gradescope" tool.*** This means your completed work must be either scanned or photographed, and uploaded to Gradescope. Here is a link to a short video explaining the homework submission process in Gradescope:

- https://youtu.be/KMPoby5g_nE

## Exams

There will be no exams or quizzes for this class.

## Pandemic Contingency Plans

The 2020 Fall semester will begin with UAF operating in a partially re-opened mode. This means that, depending on how the covid-19 pandemic progresses, UAF's restrictions on face-to-face classes could be either tightened or loosened as the semester progresses.

**Plan for increased restrictions:** Experience at other schools across the country has been that increased covid-19 cases are likely once the semester begins. I expect the same to occur at UAF and, as a result, I am assuming there is a not-too-small chance that we may be required to convert all in-person instruction over to a purely online mode, possibly within only a few weeks of the semester start. If that happens, the only course component that would change is that associated with you physically performing the experiments. Unfortunately, however, this is also by far the most prominent aspect of your student experience in this class. I am hoping all students would be able to complete at least one experiment before any such changes occur. In any case, if we are required to cease in-person lab work, I plan to instead do all the experiments for you, and to video each small step of the procedure and data collection in minute detail. I will post these videos to Blackboard, and require you to use them as the basis for writing your reports and preparing your talks. I did this for the second half of the lab sessions for my Optics class in 2020 spring semester. While not ideal, it actually worked better than I expected, and the student feedback was quite positive.

**Plan for relaxed restrictions:** Should the pandemic fade substantially enough for UAF to relax restrictions, the most immediate change would be to allow more students in the lab at the same time – perhaps including the whole class. We may even consider performing subsequent experiments in pairs rather than individually. (Many experiments are easier in pairs, and learning to perform experimental work as a collaborative team is normally another goal for this course.) Finally, if the pandemic is sufficiently contained, I will consider re-starting in-person lectures, if the class as a whole expresses a desire for me to do so.

## Course policies

### Grading

The course grade will consist of the following components

- Homework — 16% (4% for each of four sets.)
- First two written lab reports — 24% (12% for each of two.)
- Second two written lab reports — 28% (14% for each of two.)
- Oral presentations — 16% (8% for each of two)
- In-lab performance and notebook — 16% (4% for each of four labs)

I will post all grades online, using the UAF's "Blackboard" system (https://classes.alaska.edu/). All registered students have access to this system for checking their grades.

Final grades will be returned as letter grades with plus/minus modifiers. These will be derived from your overall percentage grade. The approximate conversions for each letter grade will be as follows. A: ≥90%; B: 75% to 90%; C: 60% to 75%; D: 50% to 60%; F: <50%. Plus/minus modifiers will subdivide each main grade into three equally spaced sub-levels.

### Attendance

Your laboratory work can only be performed if you are actually present in the labs. Safety concerns with these experiments mean that there will be limited opportunity to use the lab outside of scheduled times. Also, this class requires significant interaction with the instructor during the lab sessions – including your brief oral "progress reports" at the start of each session. Thus, by Physics Department policy, significant attendance is an absolute requirement for the laboratory portion of this class. That said, each student will only be allowed in the lab on one day per week. While you cannot attend physically on your "off" lab day, I will expect all students to report in to each lab session for at least the initial class discussion over zoom.

### Class participation

16% of your grade will be derived from an assessment of your in-lab performance and of your lab notebook. I will be working with each student in the lab, and will allocate these points based on my assessment of the degree of participation and quality of work done in the lab.

### Missed or late work

This class requires students to keep up a steady pace of experimental work and written & oral presentations. These are very time consuming activities – which means it will be very difficult to recover if you get behind. (And, due to covid and safety concerns, there will be little if any opportunity to use the lab equipment outside our scheduled sessions, or after the experiment changeover dates) For this reason I will discourage late submission of work, by penalizing each item by 2% of its value for each day that it's late.

Students having documented illnesses, family crises, or clashes with other UAF commitments may arrange alternate submission deadlines with me. All decisions regarding late work or alternate deadlines will be at the discretion of the instructor.

### Student conduct and academic honesty

It is the responsibility of each student to be informed about the policies for student conduct and safety at the University of Alaska. You are encouraged to read these policies at https://uaf.edu/csrr/student-conduct/ and links therein. It should go without saying that students are expected to do their own original work for all assignments. Copying from other students or indeed from any source that is not your own work constitutes plagiarism. Failure to comply with UAF policies may be considered academic misconduct and may result in a failing grade (either for individual portions of work, or for the entire course, depending on severity.) Serious cases will be referred to university authorities for possible further disciplinary action

## Course requirements and materials

### Prerequisites

Prerequisites: COJO F131X or COJO F141X; WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; PHYS.

### Required text

I will be drawing material from multiple sources, so that there is no single text book assigned for this class. All required learning material will be provided via notes uploaded to Blackboard.

### Technology Requirements

Course materials will be delivered via Blackboard, which means students will require easy web-browser access to the internet. Most material will be delivered in PDF format, so that students will need access to Adobe Acrobat Reader or other third-party equivalent software.

A simple digital camera or cellphone camera may be useful (but not absolutely required) for recording setups and results during lab sessions.

## Support Services

### Complaints and concerns

You are always welcome to discuss your concerns with me. However, if you have a concern that you feel cannot be resolved by discussion with me, you may wish to contact the Physics Department chair, Dr. Truffer. The University also has an Academic Advising Center on the 5th floor of the Gruening building, open Monday to Friday, 8 am to 5 pm and contactable via phone at 907-474-6396. The advising center can help with all student matters, from study tips to help with understanding the University's formal mechanisms for academic appeals. (See also http://www.uaf.edu/advising/)

## Student Health and Counseling Center

The University provides health and counseling services through its Student Health and Counseling Center, which is located at 612 N. Chandalar Drive, on the 2nd floor of the Whitaker Building (the same building as Fire and Police, across from the bus turn around.) Their web site is at http://www.uaf.edu/chc/. The center will see students on an appointment basis. The number to call for an appointment is 474-7043. It is best to do so at 8:00 AM in the morning, because they are scheduled daily on a first come first serve basis.

## Disabilities and/or Special Needs

Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc. to find reasonable accommodations. Disability services are provided free of charge, and are available to any student who qualifies as a person with a disability. Student seeking special accommodations for a disability must first discuss their needs with Disability Services. Call 474-5655 to schedule an appointment.

UAF Disability Services is located in the Whitaker Building, room 208. Extensive support is available, as described at http://www.uaf.edu/disability/

**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 Street, 907-455- 2860).

## Sexual Harassment and Discrimination

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/handbook/.

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