# Course Syllabus Summer 2022

PHYS 2126 PHYSICS LABORATORY II (All sections) Summer 2021
The first report for PHYS 2126 is due on **Thursday June 2nd**.

## Professor Contact Information

Instructor: Paul Mac Alevey
Office: SLC 3.306
Phone: extension 4634
E-mail: paulmac@utdallas.edu
Mailbox: In office PHY 1.506

I will send e-mail to UTD e-mail addresses **only**.

## Teaching Assistants:

A teaching assistant is assigned to each section of this course. The TA on your section will be directly in touch with you during the semester and available to answer your questions and address your concerns or personal issues. **TAs should be your first person to contact about PHYS 2126 questions, submissions or grades**. The following table gives the TAs for each section.

| Last Name | First Name | UTD Email address | Section Taught |
|---|---|---|---|
| Patra | Rittik | rxp200009@utdallas.edu | 1U1 |
| Dongre | Ninad | nxd200001@utdallas.edu | 1U2 |
| Gibbons | Stasio | smg200011@utdallas.edu | 1U3 |
| Shrestha | Samyak (Caesar) | sxs210058@utdallas.edu | 1U4 |
| Khan | Junaid | jxk210017@utdallas.edu | 1U5 |

Office hours with TAs are either online using MS Teams or in person (at the TAs discretion). Times for TAs office hours will be posted on eLearning as it becomes available.

| | days | times | location |
|---|---|---|---|
| 1u1 | Tuesday & Thursday | 13:00 - 15:45 | SCI 1.169 |
| 1u2 | Tuesday & Thursday | 13:00 - 15:45 | SCI 1.179 |
| 1u3 | Tuesday & Thursday | 16:00 - 18:45 | SCI 1.169 |
| 1u4 | Tuesday & Thursday | 10:00 - 12:45 | SCI 1.169 |
| 1u5 | Tuesday & Thursday | 16:00 - 18:45 | SCI 1.179 |

## Course Pre-requisites, Co-requisites, and/or Other Restrictions

Any student enrolling in this lab class should either have done or be doing PHYS 2326 (Electromagnetism & Waves), 1302 (College Physics II), PHYS 2422 or equivalent.

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## Course Description

The course includes experiments designed to explore Electromagnetism. As always in Physics, there is interplay between the theory that you see in a class and experimental work. One is not more important than the other but each informs the other: theoretical predictions are a natural focus of experiment and experimental results help to develop theory. That is why you need to study both.

Electrostatics I and Electrostatics II explore electrostatics. Coulomb's law is an application of electrostatics. Electricity I, Electricity II, Electricity III etc. develop the ideas behind DC circuits. Multimeters, Ohm's law and RC circuits finish an introduction to electricity. Helmholtz Coils involves magnetic fields caused by two coils of wire.

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The schedule is designed so that we meet for the same number of experiments in Summer as in either Spring or Fall. Meeting once-a-week doesn't give us enough meetings so we meet twice a week and finish in mid-July!

## Schedule

| Meeting | Experiment |
|---|---|
| May 24 | *No lab scheduled* |
| May 26 | *No lab scheduled* |
| May 31 | *No lab scheduled* |
| June 2 | Electrostatics I; Report due |
| June 7 | Electrostatics II; Pre-Lab & Report due |
| June 9 | Coulomb's law |
| June 14 | Electricity I; Report due |
| June 16 | Electricity II; Pre-Lab & Report due |
| June 21 | Electricity III; Pre-Lab & Report due |
| June 23 | Electricity IV; Pre-Lab & Report due<br>**Homework on 'Graphs & Trendlines' is *due*.** |
| June 28 | Electricity V; Pre-Lab & Report due |
| June 30 | Multimeters; Pre-Lab & Report due |
| July 5 | Ohm's law; Pre-Lab & Report due<br>**Homework on 'Analyzing a circuit' is *due*.** |
| July 7 | RC circuits |
| July 12 | Helmholtz Coils |
| July 14 | *No lab scheduled* |
| July 19 | *No lab scheduled* |
| July 21 | *No lab scheduled* |
| July 26 | *No lab scheduled* |
| July 28 | *No lab scheduled* |
| August 2 | *No lab scheduled* |
| August 4 | *No lab scheduled* |

## Student Learning Objectives/Outcomes

The aims of the course are to encourage students to:

- think critically & practice reasoning skills[1]

- construct knowledge[2] themselves (rather than getting it from some authoritative source). This requires conducting their own experiments and using their observations to reach conclusions. Fitting curves to data will help analysis of data.

- communicate their conclusions by means of written lab reports.

- build scientific models[3] (by actually constructing one)

### Required Textbooks and Materials

We use a manual that **is posted on eLearning. Questions can appear in both the 'Introduction' and 'Instructions' sections of the manual. Answers to questions from the Introduction will be your prelab. Answers to questions from the Instructions will be your report.** (There are no questions [in bold type] in the introductions for either electrostatics I or electricity I. This means that there are no prelabs due for those experiments.)

**Templates for your answers to prelab questions and for your answers to report questions are posted in the same folder as the manual. All questions asked have corresponding answer spaces in these templates. The templates have any empty tables and diagrams that you need. Credit for each question is indicated in brackets at the end of each answer-space.**

### Suggested Course Materials

*Suggested Readings/Texts:* All written materials that are necessary will be posted on eLearning.

*Suggested Materials:* Nothing special is needed: you need a pen. Every now and then, a calculator might be useful. (Only be a 'scientific' one is ever needed.)

[1] For those that anticipate doing the MCAT exam, "Reasoning" is regarded as particularly important among the "Scientific Inquiry and Reasoning" skills given in the AAMC document https://www.aamc.org/students/download/374012/data/mcat2015-cp.pdf

2 Those that have read the recommendations of the American Association of Physics Teachers will recognize that this goal "captures some of the overarching goals of the undergraduate lab curriculum". (From http://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf )

[3] This goal is mentioned in the AAPT document that is mentioned in footnote 1.

## Assignments & Academic Calendar

**Please read the 'preface' in the manual before labs meet. (The preface is included in this syllabus). Expect to see some topics for the first time in this lab course.** I require all students to read the introduction to each experiment before the experiment. If there is a Pre-Lab associated with any experiment then it must be done before the experiment itself. (If there are questions in bold type in the introduction to an experiment then these need to be answered in the pre-lab. No prior familiarity with physics labs is assumed. Ask questions during office hours before your lab meeting if needed. The hard-copy of your prelab (and any homework assignments) is due at the beginning of the associated lab meeting.

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# Course & Instructor Policies

1. Please contact the instructors if a question arises about these course policies. (TAs don't have permission to change these policies.) The syllabus and contact information for all TAs will be posted on eLearning.

2. Your grade is weighted as follows;

    a. The average of your grades on lab reports will contribute a maximum of 85% to your course grade. **eLearning will drop the report with the lowest percentage**.

    b. The average of your grades on pre-labs & any homework will contribute a maximum of 15% to your course grade. **eLearning will drop the pre-lab or homework with the lowest percentage.**

    When calculating your average results, **eLearning drops the lowest scores right from the beginning of the semester**. The grade on eLearning is not a predictor of your course grade if you don't submit work from the last lab.

**3.** Manuals are in the eLearning folder called "Manual" (on the homepage). The Manual will contain a folder corresponding to each experiment on the schedule. The folder for each experiment will contain a description of the experiment, photos of apparatus and templates for reports and pre-labs (if due).

**4.** **Any work submitted for a grade must be written by the individual student named at the top of the work submitted. You must use your own voice to answer any question that is asked. No student is allowed to copy or paraphrase work from any other source and turn it in for a grade.** (See policy #9 for more on scholastic dishonesty.) Names & section numbers must appear on any work that is submitted in order that credit can be attributed properly. Your TA is free to insist on this when assigning a grade.

**5.** Each description of an experiment in the manual includes an *Introduction* and *Instructions*. **Questions that are asked (in bold unitalicized type) in the *Introduction* must be answered in your pre-lab. Questions that are asked (in bold unitalicized type) in the *Instructions* must be answered in your Report. Templates for pre-labs, reports and the homework assignments are posted on**

**eLearning. The template that is posted must be used.** The amount of credit for each question is indicated in brackets after each question in the corresponding template

**6.** Pre-labs & homework assignments (if any) are due at the beginning of your in-person lab meeting**.** You will work through the section of the manual called *Instructions* during the lab meeting. Use the computers in the labs that are provided by UTD. No student of PHYS 2126 is allowed to use a phone, laptop, tablet or any device capable of communication in any the physics labs. **Remember to print the template before an in-person lab**: the 2126 labs don't have printers for you to use**.** Hard-copy reports are due at the end of your lab meeting.

7. **Attend the lab section for which you registered.** Experiments are to be done in **groups of three.** Your TA may ask any student to work with a different group so that groups will be roughly the same size (or for any other reason that the TA thinks appropriate).

**8. Any late work can only be accepted (at the instructor's discretion) if you send us a doctor's note (with contact information) before the last scheduled lab meeting.**

**9.** It is of great importance that others perceive your degree as having value. That value is diminished if it is suspected that a grade can be obtained through dishonest means. Academic dishonesty also gives a false picture of the capabilities of the individual that is being dishonest. In a wider context, it gives a false picture of what can be reasonably expected of students.

In order to further the objective of eliminating scholastic dishonesty, the University has a student code of conduct at https://policy.utdallas.edu/pdf/utdsp5003. **Students enrolling in the course are bound by this policy**. **Any suspected cases of scholastic dishonesty will be passed along to the Office of Community Standards and Conduct.**

10. **In the event of closure due to inclement weather:** check the UTD Web page http://www.utdallas.edu/ for notice of any unexpected closure of the university (in which case, lab will not meet). The university expects to post information about closures by 6:00 am on any day that classes are suspended. **After UTD has announced reopening** of the campus, **look for an *announcement on eLearning*** that will tell you about the schedule for this lab.

11. There are two options if you miss a lab;

   i. Do nothing and get a grade of zero for any pre-lab, homework assignment or report due at the lab meeting.

   ii. Try to arrange a makeup lab provided that no more than TWO meetings of your lab section have passed since your absence. (Suppose that your section is scheduled to meet on the 1st, 8th, 15th, etc. If you miss a lab that was scheduled on the 1st then you have until the 15th to make up the lab that you missed).

   - Identify a scheduled section of PHYS 2126 that you can attend. Use coursebook to find a section with fewer than 30 students if you can.

   - Email the TA **in charge of the lab section that you enrolled in to tell the TA why you were absent.** If your TA accepts your reason for not attending then they will reply to your email saying so. ***You must wait for this written reply.***

- **Email the TA in charge of the section that you would like to attend and cc** (send a copy of the email to) **the TA in charge of the lab section that you enrolled in.** Ask if there is room for you to attend. If there is enough apparatus to accommodate you, then the **TA in charge that section will reply** saying that the change is possible. ***You must also wait for this written reply***.

- **Turn-in any pre-lab or homework exercise that was due at the lab meeting that you missed. Give these to the TA in whose section you make-up the lab**. Both the name of your usual TA for PHYS 2126 and your section number must be on anything that you turn in. This TA will pass along your report etc. to the TA in charge of the lab section that you enrolled in so that they can be graded.

**Make up any labs in the order in which they are presented in the manual.** Please don't abuse this system. The guidance given to TAs is that a student **can only go to another section three times before instructors require formal documentation** (doctor's notes with verifiable contact information etc).

If more than two meetings of your section have happened since an absence, make up labs will only be scheduled if formally documentation (doctor's notes with verifiable contact information etc.) has been sent to instructors before the last scheduled lab.

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## Preface

The most important goals of these labs are to;

- Give you a chance to construct knowledge[4] yourself (rather than getting it from some authoritative source)
  - Let you think critically & practice your reasoning skills[5]
- Learn to build scientific models[6] (by actually constructing one)

and of lesser importance;

- Use the model of electricity that was found to investigate RC circuits
- Learn to use multimeters

The starting-point is observations made in PHYS 2126 labs of things that actually happen. You will have to pay particular attention to your actual observations because the model of electricity that you construct will be based on them.

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4 Those that have read the recommendations of the American Association of Physics Teachers will recognize that this goal "captures some of the overarching goals of the undergraduate lab curriculum". (From http://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf )

5 For those of you that anticipate doing the MCAT exam, "Reasoning" is regarded as particularly important among the "Scientific Inquiry and Reasoning" skills given in the AAMC document https://www.aamc.org/students/download/374012/data/mcat2015-cp.pdf

6 This goal is mentioned in the AAPT document that is mentioned in footnote 1.

*What are scientific models?*
Scientific models are arrangements of fundamental ideas that explain physical phenomena. The fundamental ideas in the model must be suggested by physical observation. The model must have some predictive power.

I want you to do more than use a model that someone else made. I want you have a hand in coming up with a model. You will do this by making observations and thinking about their significance in relation to other observations that you have made.

An example of a model that you have encountered in physics I is Newtonian mechanics. It probably wasn't presented as a model in your class but is a model nonetheless. It contains three laws that are suggested by observations. (Newton's three laws are the 'fundamental[7] ideas' that are part of any scientific model.) It is an extremely successful model in that Newton's model explains the motion of objects in many circumstances.

Models are built by asking ourselves questions & suggesting tentative answers (often called hypotheses). The hypothesis is scientific if it is subject to comparison with physical reality. (While it may be interesting, any non-testable hypothesis is outside the realm of natural science.) There must at least be approximate agreement between physical reality and predictions made using the hypothesis if we are to accept it as not being false.

*Why/How do we practice reasoning and critical thinking skills?*

Even if you don't usually think about scientific models, you will still need to think critically about the information that you encounter. You practice critical thinking when you put things together for yourself rather than just going along with conclusions made by other people. (Even though you might set out to reach your own conclusions, you might end up agreeing with the conclusions of other people.)

Critical thinking is easier if you ***make observations yourself*** because you'll know exactly what happened etc. (I try to avoid indirect 'observation' where you have to take my word for it that a certain result/observation is what happens. In this manual, 'observation' always means 'direct observation'.) ***I hope that you don't think that I am underestimating your abilities when observations are simple***. I'm not. I just want you to be thorough and to be sure of the fundamental observations before your use them to make conclusions. Even though the observations might be simple, it is not easy to use them to make conclusions that help us construct a model.

**Implications:**

The goals chosen have certain implications.

- *Lab Apparatus must be simple*. This reduces the time needed to figure how any particular measuring device works. Needlessly complicated equipment just puts you in the position of taking the word of someone else that the equipment operates as you are told. Needless complexity makes it very hard to think critically

[7] Remember that 'fundamental' doesn't mean 'easy'!

- *Lab reports have a simple structure*: *in this lab, reports involve writing answers to questions*. Questions on lab reports often involve 'pulling together' several observations so that a useful idea is seen more clearly. The simple structure is intended *to give you time to think critically* and think about the significance of your observations

- We'll concentrate on *systems* (electrostatics & DC circuits) *in which a small number of fundamental ideas is enough to make a model* that can explain your observations. These systems also have the advantage that it is possible for us to make all the necessary observations with the simple apparatus that we'll use

- *'Covering' new material is not a very important goal in these labs*. Actually, the involvement of lots of unfamiliar material makes it difficult to think critically and to build models

If we restrict ourselves to observations that we have made then **some familiar terminology will be out of our reach**. Good examples are the terms; **'electrons', 'protons' and 'neutrons'**. Since we don't observe them directly in these labs, we won't use this information to explain anything. Observations come before any terminology that explains the observations. Since we won't be directly observing these fundamental particles in this lab, you won't need to use these terms. ***Put these terms aside when you need to explain an observation in this course***. From another perspective, not using these terms won't hinder your explanation of anything that you'll see in these labs. (Of course, all your conclusions will be consistent with electrons, protons and neutrons when you want to explain these 'microscopic' observations later.)

Another difficulty with terminology occurs when we observe electric circuits. All of us have heard of voltage, current and resistance though the meaning of these terms may not be totally clear. The root of this difficulty is probably that you haven't observed circuits directly yourself. Part of the solution involves not using ***the terms voltage, current and resistance to explain anything in these labs***. As above, it will be difficult for most of us to avoid using familiar terminology when trying to describe DC circuits.

But should we? **Students often ask me why they can't use concepts (such as voltage, current and resistance) that they are already familiar with. The answer is simple: it is frequently the case that the student is familiar with the terminology but doesn't really know much about the underlying concept**. The only way around this is to build the concept yourself from 'scratch'.

This won't be enough. You'll be refining ideas that underlie these terms as you develop a model of electricity. Unfortunately, half-understood ideas about voltage, current and resistance delay your understanding. Using them puts you in the awkward position of not knowing if what you suspect is actually true or if the problem is with partly understood terminology. It is very easy to confuse a fundamental idea with a piece of technical terminology that is often used to describe the fundamental idea. ***A practical solution is to leave those terms aside and temporarily develop a set of 'home-made' terms ourselves***. (I'll help through suggestions and instructions in the manual.) This will put enough 'distance' between the familiar terms and your understanding in order for a better understanding to develop. After we are sure of our understanding, it will be easy to exchange our terms for the more usual ones. (The converse is true too: if you have difficulty translating from our home-made terms to more recognizable ones, then perhaps your understanding wasn't as good as you thought.) Since you'll have been involved in defining our 'home-made' terms from the beginning, you'll know exactly what they mean. We'll use these 'home-made' terms until we do the lab called Multimeters.

**Practicalities**

I have found it to be useful to return right to the beginning of DC circuits and to take as little as possible for granted. Rather than tell you (again) how DC circuits work, I invite you to put things together for yourself. ***Please have patience with yourself: it is not easy to put ideas together if you haven't had to do this before.*** (This is just as true if the subject matter is dismissed as being 'simple'). I hope that learning the skill in this context will help you to put ideas together in other contexts later.

Make good use of ***office hours***. A quick ***question asked early*** is often all that is needed to make progress on a Pre-Lab. By all means, tell me or your TA if you don't understand something. However, ***complete answers to questions are not helpful unless you have grappled with the questions yourself***. Expect any of us to ask you what you think (and why) before saying much more.

Expect something similar during the labs: ***expect TAs to ask you questions about what you are thinking or doing***. Their questions are intended to *encourage you to think about things* in useful ways while leaving the implications and conclusion to you! During the lab, the TA may also ask any person to explain something or repeat any part of the procedure if they feel it might be helpful.

***My TAs do almost all of the face-to-face instruction in these labs.*** Several of the lab sections will meet during my other classes and office hours for those other classes. Lab sections also meet during my other activities for the department; faculty meetings etc. I may pop-in for a few minutes when I can but that is all I expect to have time to do.

***Beware of blindly following instructions in the manual. You are not being asked to follow a recipe so don't expect my instructions to be a detailed list of directions. Expect to have to read ahead and think about my instructions before doing anything.***

***If a question asks you to explain something then an answer of "yes/no" or "I can't explain" is not sufficient.*** Don't move on until you find explanations for things. Please write neat answers for your TA. This should be easy for questions that involve simple observations or data items. ***For more complicated questions, consider writing your first answer on another piece of paper. Only write your answer on the Report that you'll give the TA after you have thought about your 'draft' answer and are sure that it answers the question that was asked***.

*Format of Questions for Lab Reports.*

I mentioned earlier that the format for reports is simple in PHYS 2126: you just write *answers to questions*. These questions are designed to lead you through the thought process that I'd lead you through if we were talking to each other. Some questions are about observations that you have made and are not difficult. However, the function of these questions is to remind you of something helpful just before I ask a more difficult question. This is the reason that marks offered for different questions vary so much.

I don't want to put words in your mouth while leading you through a thought process. In many instances I could be more specific in the way a question is asked but only at the cost of telling you the answer to a later question. This puts some limitations of the specificity of my questions.

The requirement that you learn actively means that I have to phrase my questions in terms I know that you are familiar with. Of course, it is easier to ask question when we have access to a set of well-defined &

physically useful terms. Those terms will often be unavailable since we will be in the process of approaching an understanding of those useful terms!

At the same time, if you find a better way of asking a particular question then please email it to me.

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**Comet Creed**

*This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:*

"As a Comet, I pledge honesty, integrity, and service in all that I do."

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## UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus.

Please go to http://go.utdallas.edu/syllabus-policies for these policies.

***The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.***