Course Syllabus

PHYS 2126 (both sections); PHYSICS LABORATORY II summer 2015
(PHYS 2126 begins meeting on Monday June 1.)

Professor Contact Information

Instructor: Paul Mac Alevey
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Each section meets on both Monday and Wednesday as follows:

Section	Day	Room	Begin
1U1	M&W	SLC 1.211	1:00
1U2	M&W	SLC 1.205	1:00

Your section will meet twice-per-week until June 24 and once-per-week after that.

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.

Office hours: TAs will be assigned to this course and their office hours have yet to be arranged. Office hours will be posted on the eLearning site for the course. Otherwise, office hours are by appointment at my office.

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.

The labs called Electricity I, Electricity II etc develop the ideas behind DC circuits. The others concern Oscilloscopes and RC circuits.

Student Learning Objectives/Outcomes

The aims of the course are to perform experiments in which:

- Students will use simple observations to deduce properties of DC circuits.

- Students will compute time constants given changing voltages in circuits that involve resistors and capacitors

- Students will become familiar with an oscilloscope

Required Textbooks and Materials

We use a manual that I have written. This summer **I will post the manual on eLearning. I will also post questions with answer-spaces on eLearning that are needed for pre-labs and for reports**. While you can write your report on any paper, using the sheets that I post will mean that you don't spend lab-time writing out questions, copying tables etc. If you want to print them then please do so before your lab-section.

Suggested Course Materials

You should have a calculator, pencil and pen at all meetings of your section. (The calculator need only be a 'scientific' one.)

Assignments & Academic Calendar

Begin by reading the 'preface' in the manual before labs meet. Expect to see some topics for the first time in this lab course. Lab time is limited so I require all students to read the introduction to each experiment in the week 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 lab reports consist of answers written to questions posed in the lab manual. You can write these answers on any paper that you have at the lab (or on the sheets of questions and answers that I post on eLearning provided that you print them before the lab begins.)

Schedule

Meeting	Experiment
May 27	*No Labs Scheduled*
June 1	Course information & Pretest
June 3	Electrostatics I; Report due
June 8	Electrostatics II; Pre-Lab & Report due
June 10	Electricity I; Report due
June 15	Electricity II; Pre-Lab & Report due
June 17	Electricity III; Pre-Lab & Report due
June 22	Electricity IV; Pre-Lab & Report due [exercise: ‘Drawing Graphs with Excel’ is *due.*]
June 24	Electricity V; Pre-Lab & Report due
June 29	*No Labs Scheduled*
July 1	Multimeters; Pre-Lab & Report due
July 6	*No Labs Scheduled*
July 8	Ohm’s law; Pre-Lab & Report due
July 13	*No Labs Scheduled*
July 15	Voltage across a (big) capacitor; Pre-Lab & Report due
July 20	*No Labs Scheduled*
July 22	Introduction to Oscilloscopes; Pre-Lab & Report due
July 27	*No Labs Scheduled*
July 29	RC circuits; Pre-Lab & Report due & Posttest
Aug 3	*No Labs Scheduled*
Aug 5	*No Labs Scheduled*

Course Policies

1. These course policies have been designed by the instructor for the course: Dr. P. Mac Alevey. Please contact me if a question arises about these policies. The syllabus and contact information for all TAs will be posted on eLearning.

   The manual is a description of some experiments. It *is not intended to be a comprehensive Physics textbook*. It is not a recipe book either and needs to be read carefully. Please don't think that you can get by skimming through the introduction and/or the instructions that are given in this manual. (See #3 below.) By far the most common difficulty encountered by students is their not knowing what they should do. Invariably, this results from not reading the manual properly.

   Some sections of introductory physics books might be useful. (These include "College Physics" by Hugh D. Young, "University Physics" by Young and Freedman, "Physics for Scientists and Engineers" by Serway & Jewett and "Fundamentals of Physics" by Halliday, Resnick & Walker etc.)

   Any of the co-requisite classes [PHYS 1302 (College Physics II), PHYS 2326 (Electromagnetism & Waves) or PHYS 2422 (Honors Physics II)] might be helpful in this lab. **However no section of these classes follows the same schedule as this separate course and you might see some topics for the first time in this lab.**

2. Your grade is weighted as follows;

   a. 94% of your grade will be the average of grades on Pre-Labs and Lab Reports (and the assignment on Graphs.). The averages on Pre-Labs and Lab Reports are weighted according to the maximum number of points achievable in the particular Pre-Lab or Lab Report.

   b. **The Report with the lowest percentage of possible points and the Pre-Lab with the lowest percentage of possible points will be dropped**. (The assignment on 'Drawing Graphs" is neither a Pre-Lab nor a Lab Report and will not be dropped.)

c. 4% of your grade depends on your **score in the post-test** for electricity

d. 2% of your grade depends on your **completion of the pre-test** for electricity. *Answer sheets that are filled out without a serious effort to answer the questions [as judged by the instructor] will be treated as incomplete.* This test must be done before electricity I and is unavailable after that.

3. Each description of an experiment in this manual includes an *Introduction* and *Instructions*. *Read the Introduction to the experiment well before your lab meeting*. **If questions are posed in bold type in the Introduction then all students are required to submit a Pre-lab with answers to those questions. Pre-labs will be graded.** You are welcome to go to the office hours that are conducted by any TA for these labs.

   Think of pre-Labs as homework exercises. I'll put the questions and space for the answers on the eLearning site if you want to print them. (I think that it will save you time if you print them.) You can write answers to the pre-lab question on any sheets of paper. Any **Pre-Lab that is submitted for grading must written in ink** and is **due at the very beginning of the lab meeting**. **Late Pre-Labs attract no credit. Please have your Pre-Lab stapled and give it to your TA as soon as you come in to the lab**. The possible number of points is in brackets beside each question. *Note that the Pre-Lab does not have to begun in ink on the same paper that you'll submit. You can write your answer at first on any paper that you like. Transferring answers gives you a chance to edit them! Your TA will appreciate your effort to be clear.*

4. **No student can copy or paraphrase work from any other source and turn it in for a grade.** (See policy #12 for more on scholastic dishonesty.) **All Pre-Labs submitted for grading must be the work of the student named at the top of the Pre-Lab. Any Pre-Lab must be written individually, using your own voice to answer any question that is asked**.

5. You will work through the section of the manual called *Instructions* during the lab meeting. Begin by checking that all the apparatus is there. Inform your TA if something is missing.
   All group members must contribute to the gathering and analysis of data etc. **All students** are required to turn in **their own Lab Report** (with answers **written in ink) at the end of the lab meeting in which the experiment is done.** Names & section numbers must appear on Lab Reports in order that credit can be attributed properly. Your TA is free to insist on this when assigning a grade to the report. *If you begin a lab in any section, then you must submit your lab Report at the end of that section*.

6. **The questions that are posed in the *Instructions* must be answered in your Report**. No other format for the report is necessary. As is the case for the Pre-

Labs, you can write the Report on any paper you like. Just remember to bring paper etc. to the lab because you'll be submitting it to your TA as you finish your lab. (I'll post questions and answer spaces on eLearning so you can print them if you prefer. If you choose to use these pages then print them before your lab begins.) **You might want to begin by writing data or drafting answers in pencil but the Report submitted for grading must be written in ink.** Please remember that your TA will be grading the answer that you write. Thus, clarity of your written work and effective communication are important. Reports will be given credit as indicated in brackets after each question. **Always write your name in pen on any graphs. Please staple your Reports for your TA. Late Lab Reports attract no credit. Any Report must be written individually, using your own voice to answer any question that is asked**. *See my italicized comments in #3 above. They are just as useful for reports too.*

7. You will need to use a **scientific calculator, a pen** and **a ruler at all lab meetings.** No student can bring food or drink into the lab.

8. **Leave the equipment in good working order** for the next lab class. All apparatus must be arranged on the lab bench as it was before your section. **Expect your TA to look at your work-area just before your group leaves**.

   In a lab class there are cases in which equipment doesn't perform as expected. We would like to minimize this. Tell your TA about any equipment that doesn't seem to work as you expect. Other simple things that help include turning off meters, computers etc. when not using them and doing the experiment as described rather than aimlessly 'playing' with apparatus.

9. Experiments are to be done in **groups of three**. Your TA may ask anyone 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).

10. **Attend the lab section for which you registered**. You may attend another section of the lab class only if the following procedure is followed;

    a. E-mail both the TA in charge of the section that you would like to attend and the TA in charge of your lab section. Tell them why you need to attend another lab section. **Contact information for the TAs is either on the bulletin board in the lab and/or posted on eLearning**.

    b. If there is enough apparatus to accommodate you at the other section, then the TA in charge of your chosen section will reply to your email, saying that the change is possible. ***You must wait for this written reply***.

11. You may be able to make-up a lab if you miss the meeting of your section. Deciding not to turn in a report will give you a zero and may reduce your grade.

a. Labs can be made up in other **scheduled** sections of the lab provided

i. The procedure outlined in policy #10 is followed
ii. Your lab section has met THREE times (or fewer) since your absence
iii. **check that the TA for the section in which you are registered actually records your score for the lab**.

I urge students to **make-up any missed lab early in the semester**. You should be particularly careful to avoid absences near the end of the lab schedule since fewer regularly scheduled lab sections are available near the end of the semester.

b. Circumstances may prevent you from making up a lab promptly. (These include an *illness certified by a medical doctor, jury duty* …). You'll need their doctor's note or formal document (on official letterhead with contact information), that lists the dates of your absence and the date when you can return to school. This formal documentation must be brought to Paul MacAlevey as soon as you return to school. If everything is in order, then we can organize a time for you to do the experiment. **If I have not received formal documentation about an absence before the last scheduled lab then the absence will not be excused.**

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

In order to further the objective of eliminating scholastic dishonesty, the University has a policy on scholastic dishonesty. This policy is clearly articulated in Subchapter F section 49.36 of the policy on student discipline & conduct adopted by the University and used in this course. The full chapter 49 is at http://www.utdallas.edu/deanofstudents/titlev/. **Students enrolling in the course are bound by this policy. Any suspected cases of scholastic dishonesty will be passed along to the Office of Judicial Affairs**.

13. I have used this scheme for generating (a first approximation to) grades in previous semesters. If x is a score then,

$x \geq 95$ A+	$70 > x \geq 65$ C+
$95 > x \geq 90$ A	$65 > x \geq 60$ C
$90 > x \geq 85$ A-	$60 > x \geq 55$ C-

$85 > x \geq 80$	B+	$55 > x \geq 50$	D+
$80 > x \geq 75$	B	$50 > x \geq 45$	D
$75 > x \geq 70$	B-	$45 > x \geq 40$	D-
		$40 > x$	F

No grade is official unless given by Dr. MacAlevey.

14. In the event of inclement weather etc, 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 will also announce its reopening after this kind of closure. After it does, look for an *announcement on* ***eLearning*** that will tell you about the schedule for this lab.

Course & Instructor Policies

The most important goals of these labs are to;

- Learn to build scientific models
- Let you think critically & practice your reasoning skills

What are scientific models?
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[1] 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.

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

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 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

- *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

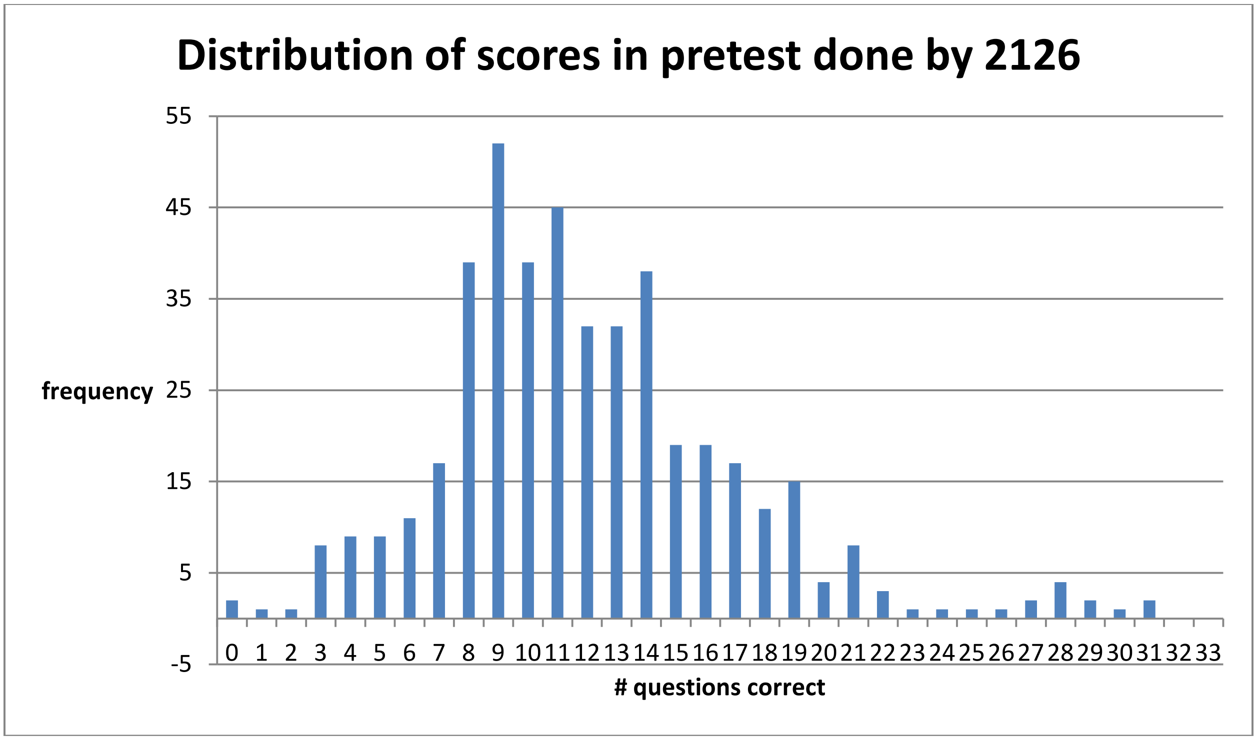
- We'll concentrate on *systems* (electrostatics & DC circuits) *in which a small number of fundamental ideas is enough to make a model* that can explain your observations. These systems also have the advantage that it is possible for us to make all the necessary observations with the simple apparatus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

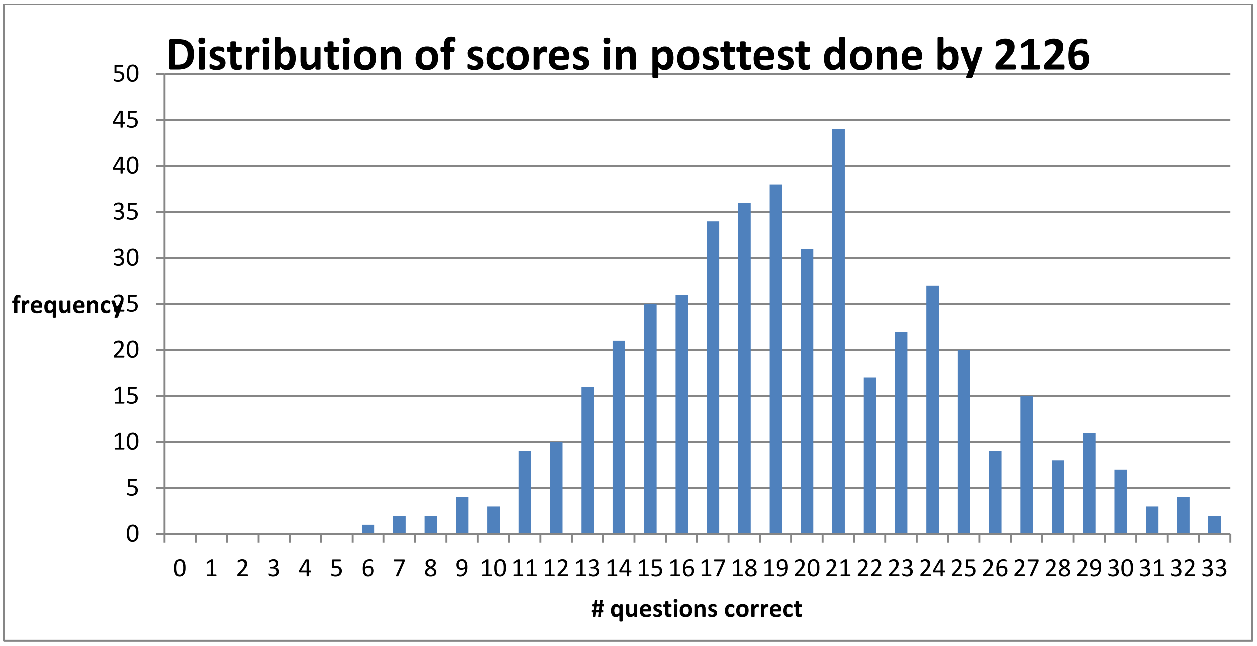
Another difficulty with terminology occurs when we observe electric circuits. All of us have heard of voltage, current and resistance though the meaning of these terms may not be totally clear. The root of this difficulty is probably that you haven’t observed circuits directly yourself. Part of the solution 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: they are familiar with the terminology but probably don’t know much about the underlying concept**. Few students have asked me to justify this claim but (true to the spirit of the course) I use an observation that I have made myself. Here is a graph of the number of students (the frequency on the y-axis) that get a given number of questions correct in the pretest.



The first thing that you should notice is that the average number of questions answered correctly is about 12 out of 33. (The average is $36.7\% \pm 0.7\%$ if you want to work it out.) If someone really is familiar with the concepts behind DC circuits then it is quite possible to get all of the questions right. However, only 15 students out of the 447 got more than 22 questions right. The fact that only 15/447 = 3.35% got more than 66% does not suggest mastery of the underlying concepts. (In case you are worried that this data sample is a statistical fluke then I invite you to look at pretest data from other semesters [posted on the bulletin board outside SLC 1.211] and see how similar the grade distribution is in these other cases.) ***Be careful; familiarity with terminology is not the same as familiarity with the underlying concepts***.

I don't like pointing out a problem unless I know of a solution. This course can address the problem. A graph of the results in the posttest done by the same 447 students is;



The average is much higher: $60.0\% \pm 0.7\%$ (almost 20 questions correct) with almost half getting 20 or more questions right. (Nobody got fewer than 6 questions right.)

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 the familiar terms and your understanding in order for your understanding to develop unhindered. After we are sure of our understanding, it will be easy to exchange our terms for the more usual ones. 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 on 'multimeters'.

Practicalities

You will do a quiz about DC circuits at your first lab meeting. This quiz contributes to your course grade. (See course policy #2 for details.) The quiz gives you the opportunity to tell us about your initial understanding of DC circuits and will involve the usual terms of voltage, current & resistance. The test is about batteries and the brightness of one bulb in a circuit compared with the brightness of other bulbs.

A feature this ***multiple-choice quiz*** is an ***option that allows you not to choose an answe****r* but shows that you thought about the question and took the quiz seriously. The idea is not to force you to choose when you haven't seen the topic of the question or are genuinely unsure of the answer. Of course you can use anything that you know and any convictions about how circuits actually work. ***If you can't reason your way to an answer after considering the question for a minute or so, then choose option (k) instead of making a random guess*** at the answer. ***Don't spend time trying to eliminate answers that you think 'must be wrong' and guessing*** among the ones you find most plausible.

Even though these topics have technically been 'covered' in your previous courses, the reality is that the average student doesn't do particularly well with this pretest. I choose to take this result seriously and use a large fraction of the course to give you the opportunity to do something about this. Please take the opportunity.

In the past, 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 much 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***.

Does this approach work?

Yes. You will do another quiz towards the end of the course. (As with the first one, this quiz also contributes to your course grade. See course policy #2 for details.) Comparison of the two results has indicated significant improvement in every semester. As above, I invite you to compare the pre- and posttest results (posted outside SLC 1.211) so that you can see that there is quite a change. While most students gain significantly from the course, the amount that you gain is totally in your hands and is highly dependent on the thinking that you do to develop your understanding.

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."

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.