# ME/CE96: Mechanical Engineering Laboratory

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**Teaching Assistants**

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**Location**

The labs are in the sub-basement of Thomas, Rooms 0018 and 0021, though with the creation of some new labs, you may be carrying out some work in Watson, Steele or Broad - this will be announced when appropriate. Everyone needs to contact Chris Silva in order to get keys to the lab.

**Course Overview**

ME/CE96 is a laboratory course with experiments in mechanics, dynamics, control and the thermal sciences. As in previous years, the course is built around two tracks:

Track 1: This track involves four experiments chosen from all of the experiments that are up and running. You will work on each experiment for two weeks. For most of them, the actual data taking in the lab can probably be completed in two sessions of 3-4 hours each. The remainder of the time will be spent preparing for the lab, analyzing the results once the data has been taken and preparing your presentation of the lab.

Track 2: This track involves two experiments chosen from all of the experiments that are up and running. The procedure for these experiments is identical to that for track 1. However, in addition to these two experiments, you will also be responsible for the creation of a new experiment from a list of several that are available. These experiments have been designed in concept and partially implemented, but there is much that remains to be done. This track is by instructor's permission only and will require the creation of a proposal for how you will make the experiment work. Your original experiment will be judged on the basis of your success in implementation and on the basis of your lab notebook and will count for the equivalent of two of the conventional experiments.

Generally speaking, the philosophy of this course is that I will be especially receptive to those who go above and beyond the call of duty. If you have an idea for ways to improve the labs or suggestions for some new lab that you would like to try, this will be welcomed.

**Lab Notebooks**

You will need two bound laboratory notebooks. The bookstore sells several suitable styles. All of your written work will be done in these notebooks and you will alternate from one to the next so that while one is being graded the other can be used for doing experiments. However, unlike in previous years, the lab notebook will only serve as your actual "report" once during the term. For the other labs, this year I am going to try something new and ask you to: a) present your lab by giving a talk, b) present your lab by writing a Scientific American style article and c) present your lab by writing a mock scientific paper in the mold of Physical Review Letters or Applied Physics Letters.

### Prelab

Each lab handout has a set of questions, estimates to make and problems that must be solved before beginning the experiment. These are designed to insure that you come to lab well prepared. Write the answers to the prelab questions directly into your notebook. There is no need to copy the problem statements. When you meet the TA to go over the experiment, he or she will check that you and your lab partner have done the prelab appropriately.

### The Lab Report

The lab report is the sole means for you to communicate your success and understanding. There will be no other homeworks (the prelab assignments are part of your lab report), midterms or finals. Again, note that starting in 2005, the lab reports are going to be done a bit more creatively, though you will still be expected to turn in your notebooks with every lab.

For the first lab, the lab report will follow the prelab in the notebook. The report format this year is less formal than in years past. You do not need to write an abstract, introduction and theory section, nor do you need to use a computer to write your report (though illegible reports will not be graded). However, if you find it easier, you may certainly produce typed documents and staple or tape them into your notebooks. Plots should be prepared graphically using the computer for faithful reproduction of quantitative results.

The report should contain a brief statement of the objective of the experiment, a description of the apparatus (with a sketch) and procedures followed, a record of all measurements made and a discussion and analysis section at the end, where the results are compared to theory or other measurements, as appropriate, and conclusions are drawn. Your report should also contain an error analysis, in which the uncertainties in the measured values and in any functions derived from them are estimated. Any comparison of measured data to theory should always include error bars on the data points. (Note from RP: Please prepare clear and thoughtful reports - we will likely use the best of your reports to help the TAs for next years course).

The analysis and discussion portions should be thorough with attention to detail. If you are asked to compare your measurements to theoretical or numerical predictions, and you find discrepancies larger than experimental

uncertainties, discuss why this is so. If you can, attempt to resolve the problem - don't be satisfied with unexplained discrepancies. If you conclude that an instrument was malfunctioning, or the measurements were done incorrectly, you may want to go back into the lab to make more measurements or check the first ones (so don't leave the report writing until the last minute). Or it may be that the theoretical results are missing some important effects; can you account for them with better theory? It is easy to claim the problem is with the theory and not with the measurements. How do you know? What evidence supports your claim? Whatever you conclude, always back up your statements with evidence.

As noted above, remember that a lab notebook is a lasting record of your experiment - in a research laboratory, they are often retained for years or decades, so that later researchers can refer to the original data. (Millikan's famed oil-drop experiments were recorded in notebooks that are in the Caltech Archives). It is just good policy to get into the habit of making top quality lab notebooks right from the start and in addition, the best of your lab reports will be used to train next year's TAs.

Note that specific instructions will be given for the other presentations that you will do over the term, but the same basic ideas pervade all of your presentations. Be clear, explain your logic, tell a story, demonstrate that you have learned something that your audience should care about.

**Grading Policy**

Grading will be done primarily by the TAs and reviewed by Prof. Phillips. The grade for each experiment will be based on a 100 point scale with the prelab counting for 20 points, the presentation counting for 40 points and lab performance counting for 40 points. The lab performance will be based on a number of factors that may include resourcefulness in finding needed information, preparation before coming to the lab, safety practices, experimental technique and the quality of the resulting data. This portion of the grade attempts to assess the quality of what you do in the lab and how you do it. In most cases, it will be determined from your written lab report, although it may be based in part on observations by the TA.

The lab report points will be based on the quality of the presentation, analysis and discussion in your report. The emphasis is not on superficial appearance - it is on the content.

In addition, as noted earlier, some labs have an open-ended component and extra points may be awarded for well executed measurements and analysis beyond the stated requirements.

Finally, for those who elect to follow track 2, your grade on the first two labs will be done in an identical fashion to those in track 1. However, the second half of your grade will be determined by your ability to design, test and use the new experiments being developed. The ultimate metric for success will be: did you successfully measure the desired quantity?

**Lab Partners**

You will all work in teams of two. In most cases, you should arrange to have the same partner over the whole term. You and your partner should both be present when taking data. All lab reports must be written individually.

**Collaboration Policy**

You may freely discuss the experiment and your interpretation of the results with your partner or other students. On the other hand, you are expected to do your own numerical solutions, derivations, error analysis, etc.

**Sign-Up Sheets**

Sign up sheets for the experiments may be found in Thomas 0021. Each lab group (of 2) should sign up for four experiments - one for each two week period. For each period, there are three blank lines since we estimate most experiments can accomodate three groups at once (working in the lab at different times during the week). Consult the TA before signing up for an experiment in a time period when there are already three groups signed up.

**Starting an Experiment**

At the beginning of each two-week period you should make an appointment with the TA to meet in the lab at a mutually convenient time to have the TA go over the experiment. You must do the prelab before starting the experiment. Grades will be reduced for those who are unprepared or for

those who miss their appointments with the TAs (remember, the TAs are busy students just like you).

### Scheduling Time

Each experiment will have a sign-up sheet where your group can reserve the experiment. Each group can reserve one block of time (up to four hours in duration) in advance. Once you have finished the lab time, you can sign up for an additional block of time. It is best to space lab sessions by a day or two so that you can look over your results and check that things are looking reasonable before going back into the lab.

### Malfunctioning Equipment

If something is broken, please report it immediately by email to Phillips and Ursell.

### Due Dates

Lab presentations are due every two weeks, beginning Monday, April 18. Late presentations will be penalized beginning with a 10 point reduction per day. For those of you on track 2, the first two labs will follow the usual procedure. The final experiment will be turned in at the same time as the rest of the class has its deadline for its final experiment.