**Caltech – Ph106a – Fall 2001**

# Introductory handout

Welcome to Ph106a, where we will be learning classical mechanics, focusing particularly on lagrangian methods. The main text will be *Analytical Mechanics* by Hand and Finch. Ph106b will continue with classical mechanics and then turn to electromagnetism, which is also the subject of Ph106c.

## 1 Web and e-mail

General information regarding the course, as well as announcements of anything unexpected or out of the ordinary, can be found at this URL:[1]

`http://www.theory.caltech.edu/people/ssgubser/Ph106a01/main.html`

All problem sets will be posted on this web page, and unless there are howls of protest, this will be the *only* way that the problem sets and most other handouts are distributed.

I will sometimes send out e-mail to alert you to an urgent or time-sensitive issue. For this purpose I will maintain a list of your e-mail addresses as best I can. A list of people enrolled in the course is attached to this handout (but not the web version). Please check to see if your name is listed. If it isn't, or if you have a star by your name on the list, then I don't have your e-mail address. In this case, please send it to me at `ssgubser@theory.caltech.edu`.

If you want to get in touch with me outside of office hours, e-mail is the surest and usually the quickest way to do it.

## 2 Staff

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|---|---|---|---|
| Instructor: | Steve Gubser | 439 Lauritsen | 395-6688 |
| E-mail: | `ssgubser@theory.caltech.edu` | | |
| Office Hours: | Tuesday 4:00 - 5:00pm or by appointment | | |
| Teaching Assistants: | Federico Spedalieri | `federico@cco.caltech.edu` | |
| | Yuk-Tung Liu | `ytliu@cco.caltech.edu` | |
| | Yi Li | `lym@its.caltech.edu` | |
| Course Secretaries: | Helen Tuck | 452 Lauritsen | 395-6685 |
| | Charlene Cartier | 458 Lauritsen | 395-6651 |

[1] Note that there are a couple small changes to information in this handout in the Notices section of the course web page.

# 3 Schedule

The lectures will be on Tuesdays and Thursdays, from 10:30 AM to noon, in 107 Downs. There will be in addition a help session on Monday evenings from 8:00 to 10:00 PM. Problem sets typically will be assigned on Tuesday and be due in the TA's mailboxes by 5:00 PM on the Wednesday of the following week. As there could be exceptions to this, the due date of each problem set will be indicated on the set.

The midterm exam will fall somewhere between November 1 and 6. The final will be between December 12 and 15. The format of the exams has yet to be determined.

# 4 Course Content

Ph106a and the first half of Ph106b will roughly follow Hand and Finch, though with a few omissions near the end, and at least two additions (intro to scattering and to continuous media).

You may wish to look up other texts in search of greater understanding or in search of topics where you find the lectures and Hand and Finch a bit obscure. We have listed some of them in the reading list below. The first four are available in the Caltech bookstore. Altogether, the reading list covers a wide range of levels, from the intuitive treatments of the Feynman lectures and Baierlein to the arcane sophistication of Arnold.

- *Analytical Mechanics*, Hand and Finch (**required**)
- *Classical Dynamics of Particles and Systems*, Marion and Thornton
- *Mechanics*, Landau and Lifshitz
- *Classical Mechanics*, Goldstein
- *Dynamical Systems*, Arnold
- *Newtonian Dynamics*, Baierlein
- *Feynman Lectures on Physics, Volume 1*, Feynman, Leighton and Sands
- *Mathematical Methods for Physicists*, Arfken and Weber

The last one, Arfken, is a text that will help you with the mathematics that we will use: vector analysis, differential equations, calculus of variations, linear algebra and Fourier analysis. Sometimes I will discuss needed mathematical results in class, and depending on your background you may never need to crack a math text during this course. A summary of basic results can be found in the mathematical handout available on the course web page.

# 5 Prerequisites

I will not indicate any fixed prerequisites for this course. It is part of the standard undergraduate sequence, with quantum mechanics taken either before or concurrently. Thus I will feel at liberty to introduce aspects of quantum mechanics at appropriate moments and assume reasonable familiarity on your part. If you're concerned about your level of preparation, have a look at Problem Set 0 and the mathematical handout. If everything there looks familiar and feasible, you should be OK.

# 6 Evaluation

Your grade for the course will be based 40% on the final, 25% on the midterm, and 35% on the weekly problem sets. For the problem sets, I encourage a "no holds barred" approach: you can work together, look up any reference, use any computer program, and attempt to wheedle information out of me or the TA's. Only be sure that the final writeup of your solution is self-contained (and no Xeroxing other people's writeups). For the exams, you can't work together. Please staple your solutions to the problem sets before you hand them in: this is to your benefit since it helps prevent lost pages.

Late problem sets will be penalized by a factor $(2/3)^{(\text{number of days late})}$. A problem set due on Wednesday at 5pm is counted one day late if it arrives in the TA's mailbox after 5pm on Wednesday but before 5pm on Thursday. It's two days late if it arrives before 5pm on Friday, etc. Note that what this means is, you should turn in what you have on time for partial credit rather than polishing things up and being penalized. Exceptions to the late homework policy will be granted for medical reasons (please supply documentation from the Health Center or equivalent), or for a death in the family.[2] If at all possible, please apply to me *in advance of the due date* for any extensions.

The administration warns me to expect a somewhat heterogeneous audience in Ph106a. In order to stimulate the better prepared students while not overburdening the others, I will put one or two "challenge problems" on each weekly problem set. These problems will be optional, in that you can, without ever trying any of them, stand first in the class. I do however wish to provide some incentive beyond the "do it for the good of your soul" argument. Here's the incentive. Over the course of the term, if you do the challenge problems and score 90% or higher on them, you will be guaranteed a score at the 70th percentile on the midterm. For scores between 0% and 90%, a prorated benefit will apply: thus for instance, a score of 45% will entitle you to a minimum grade of the 35th percentile. Partial credit on the challenge problems

[2]Exceptions may also be granted once or twice during the term to allow students to observe recognized religious holidays. I would prefer that such extensions be limited to one day.

is possible, but only if substantial progress on the problem is made. All matters of interpretation will be resolved by me.

Note that what this means is, if you do a bunch of challenge problems, you can really bomb the midterm and not suffer much grade-wise.

A final note: **KEEP YOUR OLD PROBLEM SETS.** For one thing, this may help you study for the exams. But the real reason is, if I make a mistake in recording a grade for a problem set, or if you belatedly realize that one of your problems was graded wrongly, then your best and only recourse is to bring the relevant problem set to me so that I can make an adjustment.

# 7 Generalities

Classical mechanics worth learning merely for its great beauty and elegance. But it's useful too: it has a large range of applicability, from cells to rockets to earthquakes to the solar system. Also, understanding the formal structure of mechanics is the easiest path to finding the true quantum mechanical laws that govern even microscopic systems—which is why physicists speak of "quantizing" a system.

The main purpose of this course is to reformulate classical mechanics (that is, $\vec{F} = m\vec{a}$) from something closer to the vantage point of the practicing physicist and to familiarize you with some of the tools and perspectives that a physicist brings to the solution of problems in its domain. Foremost among these tools is the lagrangian. Hamiltonians will also figure prominently.

Problem solving is an absolutely essential aspect of doing physics, and the field of classical mechanics is second to none other as a wellspring of real mind-benders which can nevertheless be solved elegantly and concisely. Please don't underestimate the time commitment of this course. The weekly problem sets do keep on coming, and generally will be due eight days after they are assigned.

In the course of working on problems, most of you will want to talk things over with the instructors and TAs. To this end, please come to the Monday night sessions and to our office hours. At the same time, I can't emphasize enough the importance of getting a good start on the problems *before* the help session.