Physics 105A Syllabus

Fall Quarter 2012

1 Welcome to Physics 105A: Analytical Mechanics

This course will introduce the basics of Analytical Mechanics. This is the first part of a two-quarter course. In this part, we will review the Newtonian methods of solving problems using force vectors, introduce the Lagrangian approach to mechanics, and apply it to illustrate the dynamics of many systems. We will focus on systems with several degrees of freedom, in cartesian, polar, spherical or cylindrical coordinates, and include constraints and conserved quantities. These will include for example coupled oscillators, Atwood's machines, and motion of various objects under gravity and normal forces.

This is an upper level course, and you will therefore be expected to take it to the next level with regards to your problem solving and analytical skills. This class is the basis for a solid grounding in quantitative analysis of natural phenomena, in particular of Mechanics: motion, energy, momentum, and forces. We will discuss one of the most profound findings in all of Physics, that the laws of nature as best as we know them can be obtained from a variational approach: Hamilton's principle of least (or rather, stationary) action, which leads to the Euler-Lagrange equations. We will spend much of our time familiarizing ourselves with Lagrange's approach to mechanics, and the consequences of this world view, since it is important for many other branches of Physics.

2 Course Information and Contact

- Instructor: Prof. Manuel Calderón de la Barca Sánchez
- E-mail:`calderon at physics.ucdavis.edu`

[redacted]

When using e-mail to contact me, please include "PHY 105" in the subject line. My inbox gets about 100 emails a day and sometimes I can't get to it all, so this allows me to sort through my class email more easily and make sure I get to it. If you are browsing from a public computer terminal, make sure to include your return email address (and your full name) in the body of your message, as it often does not show up in the email header. We would prefer replying to your official `ucdavis.edu` email (to make sure it goes through the campus spam filters). Using the smartsite Mailtool to email me will automatically add "PHY 105A" to the subject line and go through the spam filters, so that is a good option.

2.1 Website

Go to
`http://smartsite.ucdavis.edu/`
and Login using your kerberos username and password, you should see a tab for Phy 105A, or you can get it from the dropdown menu under "My Active Sites". Please make sure you check the website frequently as course announcements, reminders, homework assignments, and all grades will be posted there. The course schedule including all homework due dates, midterm, and final exam dates will be posted on the smartsite schedule. You can find the pdf of the syllabus (this document) on the site.

Since the SmartSite system is a work in progress, in case you need help, the quickest way is to call IT Express at 754-HELP (Monday through Friday from 7 AM to 9 PM). You can also send email at `smarstite-help@ucdavis.edu` or directly in person at Shields Library 182.

2.2 Text

Textbook: **David Morin, "Introduction to Classical Mechanics", Cambridge, 2008.**

Additional resources:

- Landau & Lifshitz, Mechanics, Butterworth-Heinemann, 3d Edition, 1982.
- Goldstein, Classical Mechanics, 3d Ed. Addison Wesley, 2002. (Graduate Level Text)

2.3 Lecture Hours

Lectures are **Tuesday and Thursday, 9:00-10:20 am** in room **55 Roessler**.

3 105A Topics

We will follow the text throughout the fall quarter, covering the following:

- Problem solving strategies
  We'll begin by discussing general strategies for solving problems which will be useful throughout the course. These will include dimensional analysis, limiting cases and approximations.
- Statics
  We will then find applied forces for static conditions, i.e. when there are no translations nor rotations.
- Newton's laws
  Problems involving the presence of forces, and use of the second law to write a differential equation of motion that we will then solve.
- Oscillations
  We will find and solve the equations of motion for a simple harmonic oscillator, treat the case of damping and driving forces, and coupled oscillators.
- Energy and momentum conservation
  Using energy and momentum conservation can be very useful alternate to attacking problems. We will see how in cases involving gravity and collisions.
- The Lagrange approach
  Joseph Louis Lagrange developed a way to treat mechanics problems using only scalar quantities (no force vectors) to directly find the equations of motion by taking appropriate derivatives of the relevant scalars. He called his method "analytical mechanics" as opposed to vectorial mechanics, and was proud of the fact that in his text there were no free-body diagrams, as he reduced mechanics to applying "analysis", which was the name that was given to what we currently call differential and integral calculus. We will develop his method, deriving the Euler-Lagrange equations from Hamilton's Principle of Stationary Action.

4 Grading

All grading will be on a 100 point scale. The components of the grade are as follows.

4.1 Homework

We will have homework problem sets every week from the end-of-chapter problems. Collaboration with your classmates for homework sets is greatly encouraged. Try to write the solutions as an explanation to one of your colleagues. It is when we try to explain what we are doing that we best are able to understand the problems ourselves. All the homeworks will be averaged and will count for 40% of the final grade. **The homework is an integral part of the course, it is where you will really learn mechanics.** We will discuss the general ideas in lecture and do examples, but only by working through many problems on your own can you truly master the subject matter.

4.2 Midterm

There will be one mid-term held on Nov 1. This will be closed-book and closed-notes, but you can bring one formula sheet. The Midterm will count 30% of the final grade.

4.3 Final Exam

The **final exam** is **Friday December 12, 3:30 pm - 5:30 pm**. Again, the final will be closed-book and closed-notes, but one formula sheet is allowed. You **must** take the final exam at the appointed time and day. **If you cannot take the final at the appointed time, please bring this up immediately**. If you qualify for extra time you must make this known well in advance of any exam for which you want this to apply. The final exam will count for 30% of the final grade.

4.4 Calculation of Final Grade

Your course grade is based on your performance on the homework, midterm and on the final exam. Your Final Grade grade is determined by the following grading scheme:
40% Homework + 30% Midterm + 30% Final exam
The default course grade limits are:

A's	$\geq 97 \rightarrow$ A+	$\geq 93 \rightarrow$ A	$\geq 90 \rightarrow$ A-
B's	$\geq 87 \rightarrow$ B+	$\geq 83 \rightarrow$ B	$\geq 80 \rightarrow$ B-
C's	$\geq 77 \rightarrow$ C+	$\geq 73 \rightarrow$ C	$\geq 70 \rightarrow$ C-
D's	$\geq 67 \rightarrow$ D+	$\geq 63 \rightarrow$ D	$\geq 60 \rightarrow$ D-
F's		$< 60 \rightarrow$ F	

5 Additional Notes

In lecture, it will be assumed that you have done and understood the homework. On occasion, a topic will be discussed only after you have done a homework problem on it. There are at least two good reasons for it. The first is that this is an upper division college class, and we are training you to solve problems on your own. The aim is to help you develop and sharpen your problem solving skills, which is not the same as giving away answers. The homeworks will focus on problems that do not have worked out solutions. Part of the goal is for you to develop enough confidence in your skills that you don't need to know an answer beforehand, but you can get to an answer by yourself. This is, after all, what you will be hired to do when you graduate. No one will pay for you to solve problems that already have answers. The second reason is that learning is best achieved when you have already thought hard about a problem, struggled with it, come up with your own questions about it, and tried your best to tackle it before coming to lecture. At that point, you will be ready to absorb the material covered with much more ease, and furthermore appreciate the subtleties that would have escaped you had you not asked yourself all the questions when you tried to solve a problem on your own. If you come to lecture after thinking hard about a topic, the discussion in lecture will be much more straightforward, enlightening even.

If you get stuck on a point, please come to office hours, and if you can't make it during the scheduled times, you can set up appointments with the course instructor or the TA. If you get stuck and you think you are not alone, though, let me know – it may mean that this topic should be covered in more detail in lecture.