

Physics 105. Mechanics. Professor Dine

Fall, 2005. Syllabus

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Office hours: Monday 1:00-3:00 or by appointment.

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Course website: go to department website and click on Dine, or go to [http : //scipp.ucsc.edu/~dine](http://scipp.ucsc.edu/~dine)
Homework and solutions and handouts will be posted here.

Course Description: This is a pretty standard junior-level mechanics course. Like lot's of physics courses, there is lots of review of things you already know, at least sort of, but with a much higher level of sophistication. You will learn better ways of understanding and handling vectors, you will get a lot of practice solving differential equations, but you will also develop a deeper understanding of conservation laws and encounter a whole new way of formulating Newton's laws. **There will be a midterm and a final exam; there will be approximately one homework set per week.**

Note on the text: Marion and Thornton is an updated version of a text by Marion which has been around for a long time. It is quite thorough. While there are more advanced texts, this covers most of the material that the average physicist encounters in his/her professional life.

Books on Reserve: I have put a number of books on reserve, and strongly recommend you look at them. . These include

1. Feynman, Leighton, Sands, *The Feynman Lectures on Physics, Vol. 1*
2. Landau and Lifschitz, *Mechanics*.
3. Goldstein, *Classical Mechanics*.
4. Shu, *An Introduction to Astronomy*
5. Moulton. *An Introduction to Celestial Mechanics*.
6. Moon, *Chaotic and Fractal Dynamics*

I will put other books on reserve from time to time as seems appropriate.

Miscellany

We have a lot to cover in barely 10 weeks. It will be important to keep up in the reading (see the schedule below). I will indicate as we go what things you must read, which are less important (this should correspond closely to what I cover in class). It is important to be an active reader. You should always have a big pile of scratch paper with you, and do lots of little exercises as you read.

Tentative Schedule

- Sept. 22. **Introduction.** Why are we studying mechanics? Some of the basics of Newton's Laws. Review of vectors, vector operations, rotations. This will be quick. I will provide a handout with all you need to know. I won't talk About all of the material of chapter one, but you must read it and there will be some problems from the chapter. **Chapter 1.**
- Sept. 27, 29. **Mechanics of a Single particle.** Not by itself all that interesting, but important since most of the problems we (anyone) can solve exactly, even with more particles, reduce to this one. Our first exposure to the important conservation Laws. **Chapter 2.**
- Oct. 4, 6. **Oscillations** (Mainly linear). Oscillatory phenomena are ubiquitous in nature, and many systems are linear to a good approximation. The techniques - and intuition - we develop here have broad applications. **Chapter 3.**
- Oct. 11. **Nonlinear oscillations and chaos.** The world isn't really described by linear equations. Sometimes the effects of non-linearity are small and easy to account for. In others they are important and sometimes bizarre. **Chapter 4. Read Sections 4.1-4.4 carefully. Rest to the extent it holds your interest..**
- Oct. 13. **Gravitation.** Here we treat Newton's law of gravity. The gravitational potential is an extremely useful concept, which we will develop. **Chapter 5.**
- Oct. 18-Oct. 25. **Calculus of Variations, Hamilton's Principle; Lagrangians and Hamiltonians.** This is the really exciting (yes, you are supposed to be excited now!) part of this course. We will formulate Newton's laws, not in terms of vectors, but in terms of scalar quantities which describe the whole history of the system. This formulation is quite counterintuitive, but quite beautiful and very important. It is essential in the development of the quantum theory. It applies not only to mechanical systems like springs and pulleys (and planets) but to the electromagnetic field, Einstein's general relativity, and the Standard Model. **Chapters 6,7.**
- Oct. 27. **Mid Term Exam** (In class, closed Book). Will cover through chapter 6.
- Nov. 1. Conclude Lagrangian, Hamiltonian
- Nov. 3, 8. **Central-Force Motion.** Here we will encounter the problem which Newton solved, the motion of the planets. **Chapter 8**
- Nov. 10. **Systems of Particles.** The methods we have developed up to now, such as lagrangians and Hamiltonians, are very powerful in dealing with systems with many degrees of freedom (many particles; fields). In this framework, we can really understand the origin of conservation of energy, momentum and angular momentum. **Chapter 9.**
- Nov. 15,17. **Motion in a Non-Inertial Reference Frame.** Newton's laws refer to a frame of reference known as an inertial frame of reference. We won't worry too much about how one knows one is in such a frame (this is one of the problems that bothered Einstein and led to his General Theory of Relativity), but we often know when we aren't in one. The surface of the earth is a good example. **Chapter 10.**
- Nov. 22 **Dynamics of Rigid Bodies.** Moments of inertia, and all that, for objects which don't necessarily have lots of symmetry. **Chapter 11, sections 11.1-11.7; more if time.**
- Nov. 29, Dec. 1 **Coupled Oscillations.** 3/4 of physics is about coupled oscillations. **Chapter 12.**