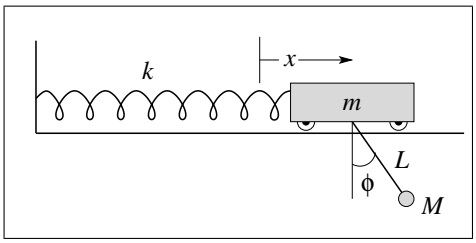
Physics 327:
Advanced Classical Mechanics
Lafayette College
Spring 2011



Instructor

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Course Website

We will use moodle, http://moodle.lafayette.edu.

Course Locations and Times

Hugel Science Center 017. Monday, Wednesday, Friday; 2:10-3:00.

Office hours

I will have regular weekly office hours. I will set my office hour schedule by the end of the week, once start-of-the-semester activities have settled down. My office hours will always be posted on moodle, on my own website, and on my office door. Feel free to drop by at other times and try your luck, or E-mail me if you wish to set an appointment time but have conflicts with my scheduled office hours.

Texts

The following text is required and is available at the college bookstore:

John Taylor. *Classical Mechanics.* University Science Books. ISBN 1-891389-22-X.

Prerequisites

The prerequisites for this course are Physics 218 and Math 264. By the transitive property of prerequisites, this implies that Physics 131-132/133 or 151-152, Math 161, Math 162, and Math 263 are also prerequisites.

Course goals and topic coverage

The goal of Physics 327 is to teach the fundamental ideas of classical mechanics. This includes Newton's laws, reformulations of those laws by Lagrange and Hamilton, and the application of these laws to a variety of classical physical situations.

The list below shows the topics which we will cover, along with the corresponding sections of the text and a very rough estimate of the amount of class time which will be spent on each topic. The schedule will evolve as the semester progresses. Specific topic and text coverage will be given on a weekly basis on the homework assignments.

We skip over several early chapters in the text. This material is largely covered in introductory courses and in Physics 218 (Oscillatory and Wave Phenomena). We cover some material in chapter 2 as warm-up for the semester, but then we skip forward. The heart of Physics 327 is contained in chapters 6 through 11 of the text: our goal is to give you a through understanding of this material. We will finish off with some applications of classical physics, covered in chapters 12 thorough 14 of the text.

Classical mechanics courses traditionally emphasize on analytic work (solving equations using algebra and calculus) as opposed to numerical work (solving equations using computers). Indeed, one of the goals of a classical mechanics course is to hone your analytic skills. While Physics 327 will continue the traditional emphasis on analytic analysis, we will not hesitate to use numerical calculations when warranted, usually by using *Mathematica*. Under such circumstances, the particular numeric techniques (and their implementation in *Mathematica*) will be discussed and demonstrated in class.

Topic	Text Chapter	Approximate number of classes
Newtonian mechanics review: projectiles and drag	2	3
Calculus of variations	6	3
Lagrangian mechanics	7	5
Central force problems	8	5
Non-inertial reference frames	9	4
Rigid body rotation	10	6
Coupled oscillations and normal modes	11	2
Nonlinear mechanics	12	5
Hamiltonian mechanics	13	4
Collision theory	14	3

Outcomes

After completing this course, you will be able to....

- Analyze physical situations using non-Cartesian coordinate systems.
- Understand the principles of the calculus of variations.
- Understand the derivation of Lagrange's equations.
- Use Lagrange's equations to solve mechanics problems.
- Evaluate two-body problems using the one dimensional central force formalism.
- Analyze phenomena in rotating reference frames.
- Calculate the rotational motion of three-dimensional bodies.
- Understand the basics of nonlinear mechanics and chaos.
- Understand and use generalized coordinates and the Hamiltonian formulation of mechanics.
- Analyze collision experiments using classical cross-section theory.

Homework

There will be weekly homework assignments. Homework papers will be due on Thursdays at 5 p.m. in a bin in the hallway near my office door. Late homework papers will be accepted for 50% credit through the following Monday at 5 p.m.

If you cannot complete a homework due to illness, family emergency, or similarly compelling reason, please contact me. (Also see the section on "Dean's excuse policy" in the Student Handbook.)

You are *strongly* encouraged to work with other students on the homework. Try the problems yourself. When you get stuck, talk to someone else about them. Physics is hard. You won't get all the problems on your own. Working with others is absolutely essential in advanced physics classes.

I will have extensive office hours. They are purposely scheduled on days before homework is due. Please come and visit if you are having difficulty on homework. I am happy to help.

Exams

There will be two midterm exams. They are scheduled for Friday, March 4, and Friday, April 22, from 2:10 to 4:00 each day, i.e., starting during the usual Physics 327 meeting time but extending one hour later. We will discuss the exam time at the start of the semester and, if there are significant conflicts with these times, we will come up with an alternate plan.

There will be a three hour final exam.

Details of exams (e.g., whether they are open or closed book) have not yet been determined, but they will be provided well in advance of each exam.

Exam questions will resemble homework problems. Each midterm exam will be on the material covered in the preceding weeks of class (i.e., since the previous midterm exam). The final exam will cover all course material, with a slight bias towards material covered after midterm #2.

Grading

There must be grades. Your grade will be based on:

Homework	30%
Midterm Exam #1	20%
Midterm Exam #2	20%
Final Exam	30%

Class participation, effort level, etc., may be factored into your final grade after your score is calculated using the above percentages. This will be most important if you are on the borderline between two grades.

Intellectual honesty

You are expected to abide by the principles of intellectual honesty outlined in the Lafayette Student Handbook (available from http://studentlife.lafayette.edu).

Learning is a collaborative process. Discussion and collaboration on homework in this course is very strongly encouraged. "Collaboration" does not mean "copying." You must understand and individually write out your answer to each problem.

Exams must be done on your own, using only materials specifically allowed. Exam procedures will be discussed in detail before each exam.

Accommodation

Following Lafayette College policy and equal access laws, I am available to discuss academic accommodations that you may require as a student with a disability. Requests for academic accommodations should be made during the first two weeks of the semester, except for unusual circumstances. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

Registrar's mandatory privacy statement

Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

What to call me

Please, let's all use first names. Call me David.

The real reason you are here

At this point in your studies, you know that quantum mechanics, relativity, and fundamental forces (electromagnetism, weak force, strong force) are all essential to understanding of how the world works. Most present day research work focuses on phenomena which arise because of these "modern" topics. You can't make a living as a physicist today if you spend your time studying the precession of tops, or the oscillation of pendula hanging from moving trains, or the motion of pucks sliding on rotating turntables.

So why spend a semester studying these things? What good is classical mechanics? And why do all professional physicists consider such a course to be an essential part of a physics education? The answer is simple. The methodologies you will learn in Physics 327—both the physical formulations and the underlying mathematics—are the foundation on which the problem solving and analysis techniques of all areas of physics are built. The formulations of classical mechanics were largely complete by the middle of the nineteenth century, but they remain essential components of advanced study in any field of twenty-first century physics.