

Physics 327 - Advanced Mechanics

Lafayette College, Spring 2019



Professor

Zoe Boekelheide

Hugel Science Center 026

boekelhz@lafayette.edu

Office hours: M 3-4pm

Tu 2-4pm

F 3-4pm

Class meeting times

Lecture: MWF 2:10-3:00pm in HSC 017

4th hour: W 3:10-4:00pm in HSC 017 (immediately after lecture)

About this course

Physics 327 is an advanced course in classical mechanics. Our starting point will be your strong base in introductory Newtonian mechanics, particularly in Cartesian coordinates. We will expand on this and add the Lagrangian and Hamiltonian formulations of Newtonian mechanics to our repertoire, as well as other coordinate systems. We will apply these tools to a range of interesting mechanics problems. Along the way, we will learn some mathematical machinery to help us solve complicated problems both analytically and computationally. As you know, classical mechanics has its limitations among the very small and the very fast, but it is nevertheless a very successful model and is still the most relevant model for much of the world as we experience it.

Prerequisites

Physics 218 and Math 264 are prerequisites for this course. Either may be waived with permission from the instructor.

Expectations and workload

The student work in this course is in full compliance with the federal definition of a four credit hour course. The federal course credit rule requires a total of 180 hours (12 hours/week) of student work over an approximately 15-week semester for a full unit (four credit hour) course. See the Registrar's Office web site for the full policy and practice statement (<http://registrar.lafayette.edu/additional-resources/cep-course-proposal/>)

You should therefore expect to spend about 12 hours/week on this course: 3 hours in lecture, 1 hour in our 4th hour section, and an additional 8 hours spread throughout the week on homework and studying.

Course materials

For this course, you are required to obtain the following textbook: John R. Taylor, Classical Mechanics.

Course Website

I will use moodle to post class handouts, homework assignments, and homework and exam solutions: <http://moodle.lafayette.edu>.

I will use moodle to send email to the class if necessary (e.g. weather delays, homework clarifications, etc.) so please check your Lafayette email regularly.

Learning Outcomes

By the end of this semester...

- Analyze physical situations using non-Cartesian coordinate systems.
- Understand and apply the principles of the calculus of variations.
- Understand the derivation of Lagranges equations.
- Use Lagranges 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 phenomena which arise in nonlinear mechanics.
- Understand and use generalized coordinates and the Hamiltonian formulation of mechanics.
- Use numerical tools to solve mechanics problems

Grades

Grades on various assignments serve multiple purposes:

- To provide feedback on your performance on given assessments (e.g. exams, assignments). Your performance on such assessments should reflect your understanding of the material, i.e. the degree to which you have met learning outcomes.
- To provide more immediate incentives for certain behaviors which are beneficial to your learning (e.g. studying or completing homework) or to the class as a whole (e.g. participating in class).

Thus, your final course grade should reflect a combination of how well you understand the material and how well you complete required tasks. Your final course grade does NOT indicate your value as a person, and also does not determine your future success in life.

Your final course grade will be determined as follows:

Homework:	40% total
Written component:	(20%)
Oral component:	(20%)
Exam #1	20%
Exam #2	20%
Exam #3	20%

Detailed description of course components

Homeworks

There will be weekly homework assignments. These homeworks are critical to your learning in this course. If this is your first 300-level physics course, the problems you will encounter may be different or more challenging than problems you have encountered in previous courses. This is a good thing! Because of the importance of the homework assignments to this course, the homework grade is given a large amount of the available points in this course - 40% - and I am scaffolding the homework to make sure that you have multiple opportunities to revise your work, correct any errors, and fill any gaps in understanding.

Homework groups: For each assignment, I will assign students to homework groups or pairs. These are students with whom you MUST meet and discuss your homework solutions with outside of class before they are due. The expectation is that each student begins the problem set on their own, and

comes to the meeting prepared to share their ideas. Some caveats: You are NOT expected to and you should NOT simply give your homework solutions to the other students in your group. You should meet in person and discuss them, with a focus on understanding. I expect every member of this class to be a willing, eager, and equal contributor to this process, but if for some reason that is not the case, please let me know so I can handle it accordingly. You will not be penalized if, despite your best efforts to reach out, one of your group members does not participate fully. These groups function as a sanity check, to help you check your work and talk through your understanding of your solution before your homework presentations.

Homework presentations: During our 4th hour, students will present their solutions to the homework problems at the board. You should come to the 4th hour prepared to present your solution to any of the problems due. Students and problems will be matched at random. You may use one “pass” during the semester in the case that you are truly unprepared to present your solution.

Written homework: After you have met with your homework group, and after the 4th hour, you will have a chance to revise your solutions. Then you will turn them in to me to be graded. You can imagine that, by now, you should have had ample opportunity to correct any errors and the homework you turn in should be of excellent quality.

Here are some guidelines for what your homework should look like when you turn it in:

- Each problem should start on a new page. This is more for you than for me - it will make it much easier for you if you need to go back and change something on a long problem solution.
- Write out the problem (or an abbreviated version containing all relevant information).
- Draw and use pictures/diagrams generously.
- Clearly work out the problem, commenting your work as you go. Problem sets should never contain just math; use words to describe what you are doing and to reference where in the text an equation came from and why it is relevant.
- Box your final solution. This makes it easier to grade and also tells me that you know what the problem was asking for. You may wish to underline, star, or otherwise highlight other major milestones as you do the problem.
- Comment on the significance of your answer. (Does it make sense? Is it what you expected? Why or why not?)
- You may use the problem sheet as a cover sheet, or not. Either way, you should put your name, the date, the course #, and the problem set # at the front and top of your problem set. You should also acknowledge everyone you have collaborated with on the assignment. This includes the students from your homework group, any other fellow students, faculty, etc. (anyone who you consulted or worked with). Staple your problem set and remove any ragged edges with scissors.

Exams

There will be two exams and a final:

- *Exam #1* will be on Monday, March 4. It will be a 110 minute exam beginning in class and extending until 4:00pm.
- *Exam #2* will be on Friday, April 12. It will be a 110 minute exam beginning in class and extending until 4:00pm.
- *Exam #3* will be a three hour exam during finals week at a time determined by the Registrar.

Exam problems will be similar to problems worked on homework and discussed in class. Exam problems will be designed to be completed within the time period provided, and will be designed to test understanding of concepts and competence in skills learned in the preceding weeks.

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>). Here are some guidelines specific to this course.

Homework - collaboration

Learning is a collaborative process. Discussion and collaboration on homework in this course is not only encouraged, but required. “Collaboration” does not mean “copying.” You must understand and individually write out your answer to each problem. For computational problems, start from the beginning and create your own computation/simulation file, do not use a classmate’s file. Acknowledge your collaborators on your homework paper.

Homework - resources You may use classmates, my office hours, and the textbook as resources. Do not seek out solutions to homework problems on the internet; this is considered a breach of intellectual honesty. Finding solutions to homework problems on sites such as (but not limited to) Chegg or Bartleby is not allowed.

Exams and quizzes

Exams and quizzes must be done on your own, using only materials specifically allowed (typically paper, pencil, the given equation sheet if any, and a calculator). Access to a smartphone or any electronic device besides your calculator is not allowed.

Accommodation

It is important to me that nothing impedes your ability to do well in this course. If you have any disabilities which you feel may interfere with your ability to succeed and prosper in this class, please contact me to discuss ways of accommodating them.

Mandatory statement for any Lafayette course with a disability policy. In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

Mandatory Moodle 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.

Approximate schedule for Lafayette Spring 2019 PHYS327 course

*subject to change

Wk	Lec #	Date	Topic	Relevant Chapter	HW due
1	1	28-Jan	Intro; Newton's Laws	1	
2	2	30-Jan	Projectiles and Drag	2	
3	3	1-Feb	Projectiles and Drag	2	HW 1
4	4	4-Feb	Projectiles and Drag	2	
5	5	6-Feb	Calculus of Variations	6	HW 2
6	6	8-Feb	Calculus of Variations	6	
7	7	11-Feb	Calculus of Variations	6	
8	8	13-Feb	Lagrangian Mechanics	7	HW 3
9	9	15-Feb	Lagrangian Mechanics	7	
10	10	18-Feb	Lagrangian Mechanics	7	
11	11	20-Feb	Lagrangian Mechanics	7	HW 4
12	12	22-Feb	Lagrangian Mechanics	7	
13	13	25-Feb	Lagrangian Mechanics	7	
14	14	27-Feb	Central force problems	8	HW 5
15	15	1-Mar	Central force problems	8	
16	16	4-Mar	Exam 1		
17	17	6-Mar	Central force problems	8	HW 6
18	18	8-Mar	Central force problems	8	
19	19	11-Mar	Central force problems	8	
20	20	13-Mar	Central force problems	8	HW 7
21	21	15-Mar	Central force problems	8	
		18-Mar	Spring break		
		20-Mar	Spring break		
		22-Mar	Spring break		
22	22	25-Mar	Non-inertial reference frames	9	
23	23	27-Mar	Non-inertial reference frames	9	HW 8
24	24	29-Mar	Non-inertial reference frames	9	
25	25	1-Apr	Non-inertial reference frames	9	
26	26	3-Apr	Rigid body rotation	10	HW 9
27	27	5-Apr	Rigid body rotation	10	
28	28	8-Apr	Rigid body rotation	10	
29	29	10-Apr	Rigid body rotation	10	HW 10
30	30	12-Apr	Exam 2		
31	31	15-Apr	Rigid body rotation	10	
32	32	17-Apr	Rigid body rotation	10	HW 11
33	33	19-Apr	Rigid body rotation	10	
34	34	22-Apr	Nonlinear mechanics	12	
35	35	24-Apr	Nonlinear mechanics	12	HW 12
36	36	26-Apr	Nonlinear mechanics	12	
37	37	29-Apr	Nonlinear mechanics	12	
38	38	1-May	Nonlinear mechanics	12	HW 13
39	39	3-May	Hamiltonian mechanics	13	
40	40	6-May	Hamiltonian mechanics	13	
41	41	8-May	Hamiltonian mechanics	13	
42	42	10-May	Hamiltonian mechanics	13	HW 14
		TBD	Final exam		Cumulative (Ch. 2,6-10, 12-13)