Physics 351 : Analytical Mechanics

University of Pennsylvania — Spring 2017

- Course web page: http://positron.hep.upenn.edu/p351
  This handout is basically a snapshot (2017-01-10) of the course web page.

Contact info

Instructor

- Bill Ashmanskas — ashmansk@hep.upenn.edu
  - telephone: 215-746-8210
  - mobile: (I'll write on chalkboard)
  - office: DRL 1W15
  - drop in any time you see my door open (but not MWF before class!)
  - I'm generally on campus 9:30am-6pm M-F

Teaching Assistant

- James Sheplock — shepj@sas.upenn.edu

Handouts / PDFs

- Homework PDFs, class notes, etc. can be found at
  http://positron.hep.upenn.edu/p351/files
  and will be linked from Canvas
  https://canvas.upenn.edu/courses/1350807

Course policies

Grading

- 40% — weekly problem sets (most Fridays)
- 10% — completing weekly reading assignments with online feedback (most Mondays)
- 10% — weekly quizzes (most Wednesdays): scaled to min(0.90,raw_score)/0.90
- 15% — midterm exam (Mar 20, in class): emphasize chapters 7,8,9
- 25% — final exam (May 8, 9am-11am): covers chapters 7,9,10,13
- in addition, extra-credit problems can boost your overall score by up to 5%

Homework

- There will be a homework assignment due once per week, at the start of Friday's class.
- The homework problems should take you about 5 to 7 hours to complete.
  - If the homework takes you less time than this, you should do the extra-credit problems for an added challenge.
  - If the homework takes you much longer than this, consider:
    - forming a study group with one or more of your classmates;
    - coming to the Wednesday/Thursday afternoon study sessions for help.
  - You should consider doing these two things in any case, because you are likely to gain more from the course by discussing the homework problems with me, James, and your classmates.
- Discussing the homework problems with your classmates is strongly encouraged, but all work that you turn in must be the result of your own thinking. **Copying solutions, whether from your classmates or from other sources, is unacceptable, and constitues academic dishonesty, which Penn takes very seriously.**
  - If you work through a problem together with a friend at a blackboard, that's great, but you should then both go and write up your own solutions separately (not just mindlessly copying line-by-line what you wrote on the board).
  - This works far better if you first try to work through each question on your own, then team up with a friend to trade ideas, then compare your solutions once you've both solved the problem.
  - In any case, two of the best ways to learn physics are by solving practice problems and by explaining physics to someone else. Working cooperatively on homework achieves both of these aims. Just make sure that what you turn in is honestly the result of your own reasoning.
- In lieu of a traditional discussion section or office hours, I have reserved classrooms at the following times so that you can work with me, with James, or with each other if you wish:
  - I (Bill) will be in **DRL 4N30 on Wednesdays from 4pm—7pm**, starting January 18.
  - James will be in **DRL 3W2 on Thursdays from 4:30pm—7pm**, starting January 19.
  - Even if you don't have questions, you can show up just to work with your classmates.
  - You're also welcome to contact me any time by email and to stop by my office any time the door is open. On MWF, any time after class is fine, but not before class. On Tu/Th, any time I'm around is fine. I am usually on campus approximately 9:30am to 6pm.

Late assignments

- It is important to me that you keep up with the course week-by-week.
  - Cramming is stressful. Reading, discussing, and gradually assimilating is much more fun.
- I want to hand back graded work promptly so that you can learn from your mistakes before you forget what you were thinking when you made them.
- Therefore, late work will be given reduced credit as follows:
  - By "day" I mean class meeting day — Monday, Wednesday, or Friday
  - 1 day late: 10% penalty
  - 2 days late: 25% penalty
  - a week or more late: 40% penalty
- I recognize that your life is busy, and does not revolve completely around this course. For that reason:

  - You can ask me once per term for an extension, as long as you contact me by email before the deadline. You can tell me the reason if you wish, but it is not necessary for you to do so.
  - To be fair to people who turn in the work on time, I will only waive the penalty on one assignment per term.

Textbook

- The textbook for Physics 351 is *Classical Mechanics* by John R. Taylor.
  - https://www.amazon.com/Classical-Mechanics-John-R-Taylor/dp/189138922X
  - To give you time to buy a copy of the book, PDFs of the first few chapters are on Canvas.
- My plan is for us to cover Chapters 1–13.
  - Chapters 1–5, which review material that you have seen before in Physics 150/170, will be covered only briefly. Even though these review chapters are not the focus of Physics 351, I include them to take advantage of the very nice coherence of Taylor's book. These chapters also provide a helpful review of some math that you have seen in earlier physics courses.
  - If you took Phys 230 before 2016, then Chapter 11 (coupled oscillators) will also be mostly a review for you. As of 2016, Phys 230 no longer covers this topic.
- **Textbook reading will be mandatory.** Usually you will read each chapter just before we begin the corresponding topic in class.
  - Your reading in advance allows us to spend a larger fraction of the classroom time on solving problems (in place of detailed derivations), since I can assume that you have already seen the material before coming to class.
  - I think problem-solving is more fun and interesting than lengthy derivations — especially when you have just recently seen the derivations in the textbook. We'll repeat derivations in class only when they seem worth your while to go through more than once.
  - So my plan for much of the classroom time is that after introducing each topic, I will first solve a problem or two for you; then we will work through some problems together, such that you and your neighbors have time to think about the problems on your own before seeing my solutions.
  - My aim is that this format will allow you to spend more of the classroom time actively solving problems, asking questions, and probing your own understanding of the material, rather than passively watching me write equations on the blackboard.

Online feedback

- Focusing the classroom time on problem-solving only works if you really read the textbook.
  - You will have a reading assignment due each Monday. (More often for the first and last couple of weeks of the term.)
  - Most weeks, you will read one chapter. Some chapters will take us two weeks to read. And for this Friday, Jan 13, you have two short chapters to read.
  - As an incentive for you to keep up with the reading, the assigned reading has deadlines, is graded, and counts for 10% of your course grade.
  - To receive credit for doing each reading assignment, you will fill out an online response at http://positron.hep.upenn.edu/q351/ that involves answering some questions whose answers should be straightforward once you read the chapter.

  - Your giving thoughtful answers is helpful in two ways:
    * First, it makes it clear to me that you took the reading seriously.
    * Second, reading your thoughtful answers helps me to focus the classroom time on the topics that you find most interesting or most challenging.
    * Therefore, correct but perfunctory answers will receive 9/10 points.
  - By the end of the term, I have, in my email, nearly 20 samples of your thoughtful reasoning about the physics that you are learning from each reading assignment. These archived responses are **extremely helpful to me if you later ask me for a letter of recommendation!**
  - My main reason for creating the special "q351" web page is to format your answers into emails (sent to me, cc back to you) with a special subject line that makes your answers easy for me to reply to, grade, file, and keep track of.
- In addition to the reading responses, each weekly problem set will have a corresponding feedback form at the same site — http://positron.hep.upenn.edu/q351/
  - The "feedback" for a problem set is worth only 20% as much as the feedback for the reading assignments (i.e. 2 points instead of 10 points).
  - The main goal of the problem-set feedback is to help me to gauge whether the length, difficulty, and content of the homework is appropriate, so that I can make adjustments as needed. I really do adapt future homework assignments in response to your feedback!
  - Solving homework problems is the most important part of this course. I count on your input to make sure that the assignments are challenging, yet manageable, and are (I hope) fun and interesting.

Work load

- You should expect to spend a total of 10–12 hours/week on this course.
  - 3 hours/week in class.
  - 2 hours/week (about) on the required textbook reading.
  - 5–7 hours on each week's problem set.
- I do my best to keep the workload steady and predictable. I want to maximize your learning while minimizing stress and uncertainty for you.

Exams

- The final exam (25% weight) will be on Monday, May 8, from 9am–11am.
- The midterm exam (15% weight) will be in class on Monday, March 20.
- Instead of an additional midterm exam, we'll have weekly quizzes (10% total weight) at the end of class most Wednesdays, starting Feb 1.
  - The plan is to have a total of 7 or 8 quizzes, each one about 15 minutes.
  - To allow for the possibility that you miss one quiz, your combined quiz score will be scaled up to min(raw_score,0.90)/0.90. So a 90% semester quiz total counts as a perfect score.
  - Unlike the quizzes for Physics 150, etc., the quiz for a given homework assignment will be 1.5 weeks after you've turned in that homework.
    * Homework #1 will be due on Friday, Jan 20.
    * You'll get back your graded HW #1 (with solutions) on or before Friday, Jan 27.
    * Quiz #1 (a minor modification of a problem from HW #1) will be on Wednesday, Feb 1.

  - The quizzes should not be a source of stress. They are an incentive for you to make sure that you have carefully thought through your own solutions to each week's homework, and for you to look over your graded homework to understand whatever you have missed.
  - The weekly quiz is also one more chance for you to spend some classroom time on problem-solving.
  - The quizzes are also an incentive for you to go back to review earlier weeks' topics, which will keep the earlier material more fresh in your mind when you need to prepare for exams.
- All exams and quizzes will be closed-book. For each quiz, you can bring one sheet of your own **hand-written** notes. For each exam, you can bring one 3×5 index card.
  - Writing up a sheet (or index card) of notes is a good opportunity for review.
- The overall goal of the exams and quizzes is to motivate you to take the weekly homework assignments seriously. All exam and quiz problems will closely resemble problems that you will have already solved on the homework.
- My approach to teaching strives to reward diligence above brilliance. Doing the homework diligently is the best way for you to gain something from this course.

Academic integrity and honesty

- The University of Pennsylvania takes academic integrity very seriously.
  - http://provost.upenn.edu/policies/pennbook/2013/02/13/code-of-academic-integrity
  - *Every member of the University community is responsible for upholding the highest standards of honesty at all times.*
  - Both gaining and helping someone else to gain unfair advantage constitute academic dishonesty: *Facilitating academic dishonesty: knowingly helping or attempting to help another violate any provision of the Code*
- As a bright and creative person, you too should take seriously the honest representation of what is and what is not your own work.
- What honesty implies for this course is that I don't want you simply to copy down other people's answers (or my answers). But I do want you to learn from your classmates, to discuss physics together, and to work cooperatively on solving problems.
- So I encourage you to learn cooperatively, but what you turn in must be the product of your own mind's reasoning.
- As an added incentive for you to be honest with yourself as you work through the homework, all quiz problems and most exam problems will closely resemble problems you have already solved on the homework.

Schedule

(subject to small adjustments — watch Canvas and course web page)

Monday	Wednesday	Friday
	Jan 11 *first day of class*	**Jan 13** read ch 1+2 (newton's laws, 30pp; projectiles & charged particles, 28pp): questions
Jan 16 (holiday) read ch3 (momentum & angular momentum, 15pp): questions recommended: download Mathematica & watch/do screencast	**Jan 18** read ch4 (energy, 43pp): questions	**Jan 20** hw01 due: feedback
Jan 23 read ch5 (oscillations, 44pp): questions	**Jan 25** optional/xc reading from *Hands-on start to Mathematica*: questions	**Jan 27** hw02 due: feedback
Jan 30 read ch6 (calculus of variations, 15pp): questions	**Feb 01** quiz #1 (on hw01)	**Feb 03** hw03 due: feedback
Feb 06 read (start) ch7 (Lagrange's equations, first 30pp): questions	**Feb 08** quiz #2 (on hw02)	**Feb 10** hw04 due: feedback
Feb 13 read (finish) ch7 (Lagrange's equations, last 13pp) questions	**Feb 15** quiz #3 (on hw03)	**Feb 17** hw05 due: feedback
Feb 20 read ch8 (two-body central-force problems, 26pp): questions	**Feb 22** quiz #4 (on hw04)	**Feb 24** hw06 due: feedback
Feb 27 read ch9 (mechanics in non-inertial frames, 32pp): questions	**Mar 01** quiz #5 (on hw05)	**Mar 03** hw07 due: feedback
—	*spring break*	—
Mar 13 read (start) ch10 (rotational motion of rigid bodies, first 30pp, sections 10.1 through 10.7): questions	**Mar 15** quiz #6 (on hw06)	**Mar 17** hw08 due: feedback
Mar 20 midterm exam (you can bring one hand-written 3x5 card)	**Mar 22** (no quiz)	**Mar 24** hw09 due: feedback

Monday	Wednesday	Friday
Mar 27 read (finish) ch10 (last 14pp of chapter, starting by re-reading section 10.7): questions	**Mar 29** quiz #8 (on hw08)	**Mar 31** hw10 due: feedback
Apr 03 read ch11 (coupled oscillators and normal modes, 30pp): questions	**Apr 05** quiz #9 (on hw09) *last quiz of semester*	**Apr 07** hw11 due: feedback
Apr 10 read ch13 (Hamiltonian mechanics, 29pp): questions	**Apr 12** read David Morin's chapter 15 (the Hamiltonian method, 32pp): questions	**Apr 14** hw12 due: feedback
Apr 17 read ch12 (nonlinear mechanics and chaos, 55pp): questions	**Apr 19** optional/xc read ch14 (collision theory, 29pp): questions	**Apr 21** hw13 due: feedback
Apr 24 read Feynman/Hibbs supplement (skim ch1, read 2.1—2.3): questions	**Apr 26** read/skim fluids chapters from Feynman lectures v2ch40 and v2ch41: questions	
May 08 final exam 9am (you can bring one hand-written 3x5 card of notes)	**May 09 (Tue)** *spring term ends*	