# Physics 351 : Analytical Mechanics

### University of Pennsylvania — Spring 2018

- Course web page: http://positron.hep.upenn.edu/p351
  This handout is basically a snapshot (2018-01-08) of the course web page.

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## 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 usually on campus 9:30am-6pm M-F. If you don't see me there, feel free to text or email.

### Teaching Assistant

- Grace O'Neil — goneil@sas.upenn.edu

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## Handouts / PDFs

- Homework PDFs, class notes/slides, etc. can be found at http://positron.hep.upenn.edu/p351/files and will be linked from Canvas https://canvas.upenn.edu/courses/1387344

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## Course policies

### Grading

- 45% — weekly problem sets (most Fridays)
- 10% — completing weekly reading assignments with online feedback (most Mondays)
- 5% — problems worked on cooperatively in class (about one per week): scaled to min(0.90,raw_score)/0.90
- 15% — midterm exam (Mar 26, in class): emphasize chapters 7,8,9
- 25% — final exam (May 3, 9am-11am): covers chapters 7,9,10,13
- in addition, extra-credit problems can boost your overall score by up to 5%

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**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, Grace, 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 Grace, with me, or with each other if you wish:
  - I will be in **DRL 3N6 on Wednesdays from 4pm—7pm.**
  - Grace will be in **DRL 2C2 on Thursdays from 5:30pm—8:30pm.**
  - 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. If you don't see me, feel free to text or email.

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**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.

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**Textbook**

- The textbook for Physics 351 is *Classical Mechanics* by John R. Taylor.
  - https://www.amazon.com/Classical-Mechanics-John-R-Taylor/dp/189138922X
  - But before you buy a copy, decide whether you'd rather read the book online via Perusall, which will earn you extra-credit points for annotating each chapter with comments, questions, and answers to your classmates' questions.
  - To access Perusall, log into this course's Canvas page, https://canvas.upenn.edu/courses/1387344, and click the Perusall button. In case you need a course access code, use "COURSE-9443". When you purchase John Taylor's textbook via Perusall, you have up to 14 days from the purchase date to request a refund, so there is minimal risk to giving Perusall a try to see if you like it.
- 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.
- 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.

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**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 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 12, 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.
  - When Penn physics majors summarize key physics ideas clearly and in complete sentences, the result is a joy for me to read. If you later ask me for a recommendation letter, your reading responses help me to demonstrate how articulate you are and how clearly you reason about physics.

- 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.
  - 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.

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**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.

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**Exams**

- The final exam (25% weight) will be on Thursday, May 3, from 9am–11am.
- The midterm exam (15% weight) will be in class on Monday, March 26.
- Unlike past years, there will be no quizzes this year. Instead, I will aim to have you solve problems cooperatively in class about once a week.
- All exams will be closed-book, but you can bring one $3\times5$ index card.
  - Writing up a crib sheet is a good opportunity for review.
- The overall goal of the exams is to motivate you to take the weekly homework assignments seriously. Most exam problems will 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.

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**Academic integrity and honesty**

- The University of Pennsylvania takes academic integrity very seriously.
  - *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.
- If you are ever unclear on whether your level of cooperation is acceptable, the most prudent course of action is to state honestly in what way your submitted work depends upon the work or the reasoning of another person, and of course to name that person or source. Proper attribution is a key part of academic work.

## Schedule

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

| **Monday** | **Wednesday** | **Friday** |
|---|---|---|
| | **Jan 10**<br>*first day of class* | **Jan 12**<br>read ch 1+2 (newton's laws, 30pp; projectiles & charged particles, 28pp) |
| **Jan 15** (holiday)<br>read ch3 (momentum & angular momentum, 15pp)<br>recommended: download Mathematica & watch/do screencast (35 min) | **Jan 17**<br>read ch4 (energy, 43pp) | **Jan 19**<br>read ch5 (oscillations, 44pp) |
| **Jan 22**<br>read ch6 (calculus of variations, 15pp) | **Jan 24**<br>reading/exercises from *Hands-on start to Mathematica*: | **Jan 26**<br>hw01 due |
| **Jan 29**<br>read (start) ch7 (Lagrange's equations, first 30pp) | **Jan 31** | **Feb 02**<br>hw02 due |
| **Feb 05**<br>read (finish) ch7 (Lagrange's equations, last 13pp) | **Feb 07** | **Feb 09**<br>hw03 due |
| **Feb 12**<br>read ch8 (two-body central-force problems, 26pp) | **Feb 14** | **Feb 16**<br>hw04 due |
| **Feb 19**<br>read ch9 (mechanics in non-inertial frames, 32pp) | **Feb 21** | **Feb 23**<br>hw05 due |
| **Feb 26**<br>read (start) ch10 (rotational motion of rigid bodies, first 30pp, sections 10.1 through 10.7) | **Feb 28** | **Mar 02**<br>hw06 due |
| — | *spring break* | — |
| **Mar 12**<br>read (finish) ch10 (last 14pp of chapter, starting by re-reading section 10.7) | **Mar 14** | **Mar 16**<br>hw07 due |
| **Mar 19** | **Mar 21** | **Mar 23**<br>hw08 due |
| **Mar 26**<br>midterm exam<br>(you can bring one hand-written 3x5 card) | **Mar 28** | **Mar 30**<br>hw09 due |
| **Apr 02**<br>read ch11 (coupled oscillators and normal modes, 30pp) | **Apr 04** | **Apr 06**<br>hw10 due |
| **Apr 09**<br>read ch13 (Hamiltonian mechanics, 29pp) | **Apr 11**<br>read David Morin's chapter 15 (the Hamiltonian method, 32pp) | **Apr 13**<br>hw11 due |

| Monday | Wednesday | Friday |
|---|---|---|
| **Apr 16**<br>read ch12 (nonlinear mechanics and chaos, 55pp) | **Apr 18**<br>optional/xc read ch14 (collision theory, 29pp) | **Apr 20**<br>hw12 due |
| **Apr 23**<br>read Feynman/Hibbs supplement (skim ch1, read 2.1—2.3) | **Apr 25**<br>read/skim fluids chapters from Feynman lectures v2ch40 and v2ch41<br>**May 03 (Thu)**<br>final exam 9am<br>(you can bring one hand-written 3x5 card of notes) | **Apr 27**<br>optional/xc read ch16 (continuum mechanics) |
| **May 08 (Tue)**<br>*spring term ends* | | |