

## Physics 420: Principles of Modern Physics, Fall 2019

(v. 1.00, Oct. 10, 2019)

Prof. Theodore L. Einstein

**What the course is about:** Physics 420 is a survey of atomic and nuclear phenomena and the main trends in modern physics. It is appropriate for students in engineering and other physical sciences. It meets on Mondays and Wednesdays at 3:30-4:45pm in Room 0405 of the Toll Physics Building.

**Prerequisites:** MATH246, and PHYS271 (formerly PHYS263) and PHYS270; or PHYS273.

**Credits:** 3

**Credit only granted for:** PHYS371 or PHYS420, not both.

**Required Textbook:** *Modern Physics*, R. A. Serway, C. J. Moses and C. A. Moyer, 3rd edition, Thomson, Brooks and Cole, 2005. ISBN-10:0-534-49339-4

### Contact Information for Instructors:

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**Office Hours:** Dr. Einstein: Monday 12:45-1:45 & Thursday 3:45-4:45 (with some exceptions to be announced) in 2100E IPST\* Bldg. You can also use e-mail to make an appointment at other times.



Teaching Assistant	Email	Room	Phone	Initial Office hours
Reza Ebadi	<a href="mailto:ebadi@umd.edu">ebadi@umd.edu</a>	0104 Toll Physics	(301-40)5-8577	W 11-11:45, F 12-12:45

\*The IPST Bldg. is the small building at northwest corner of Regents Dr. and Stadium Dr., just east of PSC; the staircase is in the back of the building (the side nearest PSC).

**Exams:** There are two midterm exams and one final exam. All exams are closed book, but a self-prepared paper crib sheet — **one side of an 8½" × 5½"** [half]-sheet for the midterm exams — will be allowed. (Keep your sheet for each midterm so that you can combine them for the final exam.) During exams calculators are allowed, but not any device with phone, photo, web, messaging or text display capabilities. You are expected to take all the exams. You must take the final exam to pass the course. The final exam is cumulative but emphasizes material after the second midterm exam.

**Excuses:** Missing an exam is not allowed without a valid documented (in writing) excuse as defined by the University (medical problem, religious holiday, participation in UMD activities at the request of university authorities, or serious family crisis). If you are going to miss an exam because of a religious holiday or other predictable event, you must inform the instructor of this fact at least one week in advance, so that suitable arrangements can be made (e.g., in exceptional cases, taking it slightly late); otherwise you will get 0. If you do miss a midterm for a valid reason (and have given prior notification if the excuse is predictable), your score on the missed midterm will be based on the results of the midterm that you did take and the final exam. (It will be a weighted average of the two unless there is a significant difference in means and/or standard deviations of class scores on the three exams. If that

happens, then a correction will be made, e.g. using as the score for the missed test the score of the average of the ranks of the two taken tests: If you ranked 80th and 60th in class on the two tests that you took, then you would get the score of the 70th –ranking student on the test that you [excusably] missed.)

**There will be no make-up midterms.**

Participation in lecture will be evaluated using web-based responses on short quizzes likely about every couple lectures. Most students have a web-enabled laptop, tablet, or smart-phone, which should be used in lecture for this purpose. If you lack such a device, please inform the instructor quickly. If the class size is not too large, quizzes may be on paper instead, depending on the TA's time constraints.

**Homework:** Homework, to be posted on ELMS, will typically be assigned every 2-3 lectures (27 lectures, 9 chapters of text, about 9 assignments). This will be due at the START of the lecture specified in the assignment; there will be a penalty for submitting at the end of the lecture. Note that the answers to odd-number problems are given at the end of Appendices of the text.

Homework will generally be due about a week after it is assigned. In principle the acceptable excuses for missing a homework deadline are the same as for missing an exam. Having an illness, or a religious holiday or official university event between the due date and Sunday night is not an acceptable excuse. (Note that it is UMD policy that for a medical absence from a single event/day, the student can attest to the illness by himself/herself, except for a "Major Scheduled Graded Event" (i.e., an exam). (See the undergraduate catalog <http://www.umd.edu/catalog/index.cfm/show/content.section/c/27/ss/1584/s/1540> for details.) However, 2-day extensions will be given fairly liberally **except for the last assignment before an exam.**

When you are working on the homework sets, feel free to discuss them among yourselves to try to better understand what is being asked. However, do not use these discussions as an excuse to copy someone else's solution to the homework, nor let someone else copy your solution. That is cheating and is strictly forbidden. It is also self-defeating since the major part of your grade will come from exams, which will tend to emphasize the thought processes used in working out the homework sets. The right way to discuss the homework is to first work through the problem on your own. Then try to arrive at a definite answer, even if you aren't sure it is correct. With this preparation you can then discuss intelligently with your colleagues and see if you have missed something essential. Of course, you can always ask your instructor or TA. After discussing problems with others, you must write up your homework answers by yourself.

**Why You Need to Do the Homework:** One of the main ways you can understand physics is by doing the homework. Do not wait until the night before it's due to start working on your homework. A sure way to do poorly in this course is skipping the homework or not giving yourself enough time to work on it. A key to success in physics courses is to do lots of problems. In addition to the assigned problems, you should work through some unassigned problems nightly, taking advantage of the provided answers to odd-numbered problems (mentioned above) and **ideally in tandem with a study group.**

While solutions to homework problems from standard texts can often be found online, using them is cheating and will deprive you of the vital experience of thinking through the problem. In recognition of this issue, the homework counts less than some years ago to decrease the incentive to cheat in this way. Furthermore, one of the roles of the quizzes is to gauge whether you have understood the gist of one of the homework problems.

**Reading:** To get the most from lectures, you should preview the relevant sections in the text. I will try to skip the details of long derivations while emphasizing the key ideas involved. If you find the details in the text unclear, please do ask. You will help not only yourself but others perhaps too shy to ask.

## Grading:

- 24% First midterm exam
- 24% Second midterm exam
- 10% Homework
- 33% Final exam
- 9% Quizzes, etc.

Final letter grades for the course will be based on the composite score obtained using the above percentages, which will be curved to replicate the historic distribution for this course: somewhat fewer A's than B's, and considerably fewer C's than A's. To the extent possible, borders between letter grades will be placed in large gaps in the distribution of cumulative scores (so that a few more points will not make a difference. Hard as it may be, please ignore the totals and percentages on ELMS. They tend to cause much uncertainty and dismay. Unfortunately, I have not yet found a way to suppress them. Means and standard deviations of exam scores will be provided to let students know their position in class. Note that requests to have one problem on an exam regraded will entail the possibility of other problems being reevaluated.

**Honor Code:** The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council: [www.studenthonorcouncil.umd.edu/whatis.html](http://www.studenthonorcouncil.umd.edu/whatis.html) .

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all exams: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination."

**Students with disabilities:** Accommodations will be provided to enable students with disabilities to participate fully in the course. Please discuss any needs with your instructor at the beginning of the semester so that appropriate arrangements can be made.

**Weather and emergency closures:** If the University is closed due to weather or some emergency situation on a day when homework is due, then that homework will be due by 3:30 pm on the next day when the University is open. If the University is closed on the *scheduled date of an exam*, then the exam will be given during your next regularly scheduled class period when the University is open. If the University is closed on your regular class day in any other (non-exam) week, *including any "review" session before each exam*, then the exam will still be given according to the original schedule. In these or other exceptional circumstances, we will attempt to communicate with students by email.

**Use of laptops, phones or tablet devices are NOT permitted during class, except when needed for quizzes or Quantum Tools activities** (or for DSS accommodations). Researchers have found that these distractions do interfere with learning and active participation. (See <http://youtu.be/WwPaw3Fx5Hk> , for example.) If a computer is needed to accomplish a class objective for the day, you will get advanced notice. It should go without saying that if you have some critical phone communication to make or receive, please excuse yourself from class and return when done.

## PHYS 420 – Planned Schedule of Lectures, subject to minor changes — Fall 2019

Date	Section	Topics
8/26	1.2-1.3	Overview of modern physics; Galilean relativity; Michelson-Morley
8/28	1.3-1.5	Postulates of sp. rel.; simultaneity; time dilation; length contraction
9/2		<b>Labor Day Holiday</b>
9/4	1.5	Relativistic Doppler shift; events
9/9	1.6-1.7	Lorentz transformation; invariants in space-time
9/11	2.1-2.2	Relativistic momentum & energy
9/16→13	2.3	Mass-energy conversion
9/18→16	2.4-2.5	Energy/momentum conservation; ideas of general relativity
9/23	3.1-3.2	Blackbody radiation; infrared divergence paradox
9/25	3.3-3.6	Planck law; photoelectric effect; Compton scattering
9/30→26	4.2	Faraday on electrolysis; Millikan oil drop; Rutherford scattering
10/2	4.3-4.5	Bohr atom; correspondence; Franck-Hertz
10/7	5.1-5.2	De Broglie waves; Davisson-Germer
10/9→11	5.3-5.5	Review of waves; Heisenberg uncertainty principle
10/14	5.6-5.7	Wave-particle duality; Review
10/16		<b>Midterm 1 (Chaps. 1-4)</b>
10/21	6.1-6.3	Wave function & Born interpretation; Schrödinger eqn
10/23	6.4-6.5	Particle in a 1D box
10/28	6.6-	Quantum 1D harmonic oscillators
10/30	6.7-6.8	Expectations & observables
11/4	7.1	Tunneling; square barrier
11/6	7.2	Barrier penetration; field emission, $\alpha$ decay, STM, etc.
11/11	8.1	Particle in a 3D box
11/13	8.2-8.4	Quantization & orbital angular momentum
11/18	8.5	Hydrogen atom
11/20		<b>Midterm 2 (Chaps. 5-7)</b>
11/25	9.1	Orbital angular momentum & Zeeman effect
11/27		<b>Day-Before-Thanksgiving Holiday</b>
12/2	9.2-9.3	Electron spin and consequences
12/4	9.4-9.5	Exchange symmetry & exclusion principle; screening
12/9	9.6	Periodic table; review; perhaps quantum bits of chap. 10
12/13 Friday		<b>FINAL EXAM, 1:30-3:30pm, room to be determined</b>

The questionnaire poll did not adequately support substituting Chap. 10 for Chap. 9. If time permits, I will mention a few highlights from Chap. 10. There is no class on 9/16, 9/30, & 10/9. Instead, there are 3 make-up lectures (starting mid or late afternoon) on Fridays 9/13 & 10/11 and Thursday 9/26, to be videotaped via Panopto and posted on ELMS. Sorry for the inconvenience.