v4 – updates are shown in blue

Physics 273 / 273H
Introductory Physics: Waves
Spring 2020 — Professor Shawhan

The most up-to-date version of the syllabus can always be found in ELMS

Class meetings

Lectures: Tuesdays & Thursdays 9:30-10:45 as Zoom sessions
Friday lecture/interactive sessions: Fridays 10:00-10:50 as Zoom sessions
Note: the Friday sessions are just as required as the Tuesday/Thursday lectures.
New material will be presented, discussed and used in Friday sessions.
Students in 273H will have some additional meetings, to be scheduled, in connection with their independent project work and presentations.

Contact information

Prof. Peter S. Shawhan, pshawhan@umd.edu, phone 301-405-1580 (currently forwards to my cell)
Office: room 2120 in the Physical Sciences Complex (PSC) building
(if/when campus re-opens for faculty & staff…)
If you have a question or issue that can't be handled during office hours, please email, text or call

TA/grader: Adam Dirican, adirican@umd.edu

Office hours

We will normally have office hours using Zoom on a schedule similar to what we did in-person before Spring Break. See our ELMS course page for the day-by-day schedule.

Course overview and prerequisites

This is the third course in the "introductory" physics sequence for students majoring in physics or astronomy, as well as other students who want a rigorous preparation in the physical sciences. A thorough understanding of calculus (MATH 140, 141 and 241, or equivalent) is a prerequisite, and PHYS 274 (mathematical methods) is a corequisite because we will be using some linear algebra and vector analysis concepts. If you are unsure of whether you have sufficient preparation for this class, please meet with me as soon as possible to discuss it.

Course topics will include harmonic oscillations (simple and forced), coupled oscillators, waves on strings, sound, AC circuits and electrical filters, Maxwell's equations in differential form, electromagnetic waves and their interactions, and physical optics (interference, diffraction, etc.). We should also have some time to talk about topics such as lasers and gravitational waves. There is a lot of really interesting material within the scope of "waves"! On the one hand, we will generally be approaching it with mathematical rigor, using complex variables, Fourier series, differential equations and integrals to get at the behavior of oscillations and waves in various contexts. On the other hand, these physical phenomena underlie a lot of what makes our world an interesting place, and we'll make connections to familiar real-world devices and experiences, as well as applications in physics and astronomy research.

Course materials

There is no required textbook to be purchased for this course ☺. Instead, we will be making extensive use of expanded lecture notes – chapters of a possible future book – by David Morin, a lecturer at Harvard. These are freely available at https://scholar.harvard.edu/david-morin/waves. Additional topics and mathematical approaches will be covered in the lectures, with supplementary online readings in some cases.

I recommend having a good calculus-based introductory physics book to consult for background and another view of the course topics. For example, the book by Giancoli used in PHYS 171 and PHYS 272 (*Physics for Scientists & Engineers*) has chapters corresponding to most of the topics in the course, and they are a good introduction. We will be expanding on those physics principles with more mathematical depth in this course.

Course grade calculation (PHYS 273) – revised after changing to 2 quizzes

Your scores from the different parts of Physics 273 will be combined as follows:

- 28% Homework
- 20% Quizzes (10% each)
- 20% Midterm Exam
- 32% Final Exam

No homework or quiz scores will be dropped—all will be used to calculate your grade.
If your calculated total ends up on the border between two grades, I will take class participation into account.

Information specific to PHYS 273H – revised after changing to 2 quizzes

Students in PHYS 273H, the honors section, will each complete an independent project, present it to their classmates and submit a written report. I will provide a list of suggested projects that fit with the scope of the course, but students can also propose other topics. I will meet with each student to agree on their topic and scope, and will schedule additional meetings with me and among classmates to check on progress and to encourage peer input. Project presentations will be scheduled near the end of the semester, and project reports will be due no later than May 18.
The course grade calculation will be as follows:

- 26% Homework
- 16% Quizzes (8% each)
- 16% Midterm Exam
- 15% Project presentation and report
- 27% Final Exam

Course policies

Standard university policies:
All of the standard policies at http://www.ugst.umd.edu/courserelatedpolicies.html apply.
Please take a look to familiarize yourself with these policies, including Academic Integrity.
My policies specific to this course are below.

Late or missed work:
From now on you'll submit homework using ELMS, and the deadline is now Mondays at 10 p.m. Assignments normally must be completed and turned in when they are due unless you have a valid excuse according to university policy, *e.g.* illness or family emergency, in which case an extension will be granted. Please let me know your situation as soon as possible, and I will tell you if I need documentation for the reason. However, **I am also giving each student two free one-day (24-hour) extensions to use on homework assignments**, with no excuse needed (but you can only use one per assignment). For example, for an assignment due at 10 p.m. on a Monday, using one of your one-day extensions would allow you to turn it in by 10 p.m. on Tuesday. Be sure to submit it on ELMS by then (or email to me if ELMS doesn't accept it after deadline). In general, no credit will be given for work turned in late without either a free extension or a valid excuse, but contact me if there is some extenuating circumstance and I may make some allowance for that.

In the case of illness, we will follow the university policy posted at http://www.president.umd.edu/policies/v100g.html: The *first* time you miss a due date during the semester, I will accept a self-signed note from you (without a doctor's note) explaining the dates of your illness and stating that the information is true and correct. If illness causes you to miss more than one due date during the semester, or to miss a quiz or an exam, I will require a doctor's note. If you do miss a quiz or exam, I will schedule a make-up time with you as soon as possible—it starts to cause problems if it's more than a few days later. In any case, whatever the reason for your absence, it is important that you contact me as soon as you reasonably can.

Policy on collaborating:
Working together with other students is part of the course, e.g. in the lectures, discussions, and activities. Working together to study and figure out the homework is also encouraged, but you must do and turn in **your own work**! This simple rule applies: **Never look at someone else's written solution** (on paper, a blackboard/whiteboard, or a screen). That applies to your classmates as well as anything you might find on the web. Talking about how to work the problem is fine if it helps you to understand it better, and writing notes or sketches on a piece of paper or a whiteboard is fine – that is a natural thing to do when working together – but copying a solution is strictly forbidden (and will not enable you to succeed on the exams). Work that appears to have been copied will receive zero credit and may lead to an academic integrity referral (see standard university policies).

Religious observances:
If you need to miss class, discussion, a homework deadline, or an exam due to a religious observance, please notify me in advance—preferably at the beginning of the semester—so that we can make appropriate arrangements.

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

Weather or emergency closures:
I don't expect that there is any risk of weather canceling our class sessions during the rest of the semester. However, technical problems like an outage of my Internet connection could still occur. If I need to cancel class, I will try to keep the quiz and final exam schedule unchanged.

Since the University has switched entirely to online instruction for the rest of the semester, I am continuing the course by live-streaming lectures using Zoom at our regularly scheduled times on Tuesdays, Thursdays and Fridays. I will also record the lectures so that the recordings will be available shortly after each class. Homework will be due each week, to be uploaded in ELMS. I will provide course information through ELMS announcements. I strongly recommend that you adjust your notification settings (at https://umd.instructure.com/profile/communication) so that announcements are delivered to you right away, not as a daily summary.

Privacy:
You have a right to privacy of your educational records, including the fact that you are enrolled in this course, but I hope you won't mind if I call you by name in the presence of other students, and hand back graded papers in class. If that may be an issue or if you are ever uncomfortable with the class environment, please don't hesitate to let me know.

Communications

I prefer email or phone calls for one-on-one communications. If you do not use <DirectoryID>@terpmail.umd.edu for email, please let me know your preferred email address.

I am currently planning to use ELMS to send announcements to the class and to initiate and respond to discussions. (In the past I have used Piazza, in part because of its easy LaTeX math typesetting feature, but it looks like ELMS supports LaTeX math typesetting now.)

If you have a question that you'd like to ask outside of class, I encourage you to start a discussion on ELMS -- that way you can get a reply at any hour of the day or night. Naturally, if you see a question posted and have a good answer or comment to contribute, please do so! Just remember that the **Policy on collaborating** applies to online communications too, so don't give answers away, but discuss in a way that aids learning! Also, I might step in if there is something I think I can clarify.

Other help resources

If you are ever experiencing difficulties in keeping up with the academic demands of this course and/or your overall course load, I encourage you to make use of the Academic Resources offered by the Counseling Center (https://www.counseling.umd.edu/academic/). All of their services are free to UMD students. Some other support services, including SPS Tutoring for Physics Majors, are described at http://umdphysics.umd.edu/academics/academic-support.html .

Note: Although you may get help in many forms, remember the **Policy on collaborating** described above! Please remind the people you are working with that they should explain and help you learn, not simply show you the answer to a problem, since you are not allowed to copy anyone else's written answer (and you wouldn't really learn much from it). Also, it is ultimately your responsibility to understand and arrive at (your own) correct answers. There is not much I can do if someone else gives you an ambiguous or incorrect line of reasoning, and even professionals make mistakes from time to time. Therefore, receive help with a healthy skepticism and cross-check your understanding to make sure it really holds together.

Physics 273 / 273H Class Schedule **(March 26 update)**
Spring 2020 — Professor Shawhan

Date	HW/Test	Topic	Pre-reading
Tue Jan 28		Course intro; Recall basic physics principles	
Thu Jan 30		Oscillations / Simple harmonic motion [mass on spring, initial values]	(Ch 1) 1-7
Fri Jan 31		Various harmonic oscillators [restoring force, pendula]	(Ch 1) 12-13
Tue Feb 4	HW 1	Torsional oscillator; complex exponentials	(Ch 1) 8-11
Thu Feb 6		Damped harmonic oscillations	(Ch 1) 14-20
Fri Feb 7		Driven harmonic oscillators	(Ch 1) 20-27
Tue Feb 11	HW 2	More about harmonic oscillators; Fourier series intro	(Ch 3) 1-10
Thu Feb 13		Fourier series and the Fourier transform	(Ch 3) 10-19
Fri Feb 14		Delta function; transfer functions and mechanical filters	(Ch 3) 23-25
Tue Feb 18	HW 3	Mechanics of gravitational wave detectors	None
Thu Feb 20	Quiz	Quiz 1. Afterward: Intro to coupled oscillators	(Ch 2) 1-7
Fri Feb 21		Working with coupled oscillators	(Ch 2) 1-7
Tue Feb 25	HW 4	Quiz (and homework) return and discussion	
Thu Feb 26	QuizCorr	Chains of many coupled oscillators	(Ch 2) 7-17
Fri Feb 28		Mathematical representation of waves; wave equation	(Ch 2) 17-26
Tue Mar 3	HW 5	Waves on strings, and boundary conditions	(Ch 4) 1-8
Thu Mar 5		Reflection, transmission and impedance	(Ch 4) 8-14 + sec 4.3.2
Fri Mar 6		Standing waves and musical objects/instruments	(Ch 4) 21-25 plus Wikipedia article
Tue Mar 10	HW 6	More about standing waves; Review for the midterm	
Thu Mar 12	Exam	Midterm Exam	
Fri Mar 13		*Class cancelled*	

Spring Break (Extended)

Tue Mar 31		Sound waves	(Ch 5) 5.1 to 5.2.3 + sec 5.2.6
Thu Apr 2		More on sound waves; Doppler effect and shock waves	(Ch 7) 5-11
Fri Apr 3		Dispersion, phase velocity and group velocity	(Ch 6) 1-5, 13-17
Mon Apr 6	HW 7 due by 10 p.m.		
Tue Apr 7		Various physical waves	(Ch 6) 9-11, 17-22
Thu Apr 9		Attenuation; Electronic components and AC circuits	(Ch 6) sec 4.6
Fri Apr 10		Applications of AC circuits, e.g. electrical filters	

Mon Apr 13	HW 8 due by 10 p.m.		
Tue Apr 14		From Maxwell's equations to the EM wave equation	(Ch 8) 3-7
Thu Apr 16		Solutions to Maxwell's equations; Polarization	(Ch 8) 7-13, 18-20, 23
Fri Apr 17		Reflection and transmission; Coaxial cables	(Ch 8) 2-3, 30-33
Mon Apr 20	HW 9 due by 10 p.m.		
Tue Apr 21		Energy in EM waves	(Ch 8) 13-17
Thu Apr 23	Quiz	Quiz 2; Plane mirrors and images	
Fri Apr 24		Geometric optics with curved mirrors	
Mon Apr 27	HW 10 due by 10 p.m.		
Tue Apr 28		Geometric optics with lenses	
Thu Apr 30		Two-slit interference; Gratings; Interferometers	(Ch 9) 1-6, 12-14
Fri May 1		Thin-film interference and applications	
Mon May 4	HW 11 due by 10 p.m.		
Tue May 5		Diffraction (single-slit, double-slit, circular)	(Ch 9) 15-20
Thu May 7		Gravitational waves	
Fri May 8		LIGO optical design	
Mon May 11	HW 12 due by 10 p.m.		
Tue May 12		Review and discussion	
Fri May 15	Exam	Final Exam (open book, but with no collaboration or communication) Distributed at 8:00 a.m. EDT on Friday, May 15 Must be submitted by 11:59 p.m. EDT on Friday, May 15	