Physics 273 / 273H
Introductory Physics: Waves
Spring 2021 — Professor Shawhan

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

Class meetings

Lectures: Synchronous Zoom sessions, Tuesdays & Thursdays 9:30-10:45, Fridays 10:00-10:50
The Zoom link will be posted on our course page in ELMS and will be the same for all sessions.

Students in 273H will have a few additional meetings, to be scheduled, in connection with their independent project work and presentations.

Contact information

Prof. Peter S. Shawhan (he or they), pshawhan@umd.edu
Phone: 301-405-1580 (currently forwards to my cell, which is 240-606-2898)
Office: room 2120 in the Physical Sciences Complex (PSC) building
(I will typically be on campus 1-2 days per week)

TA/grader: Matt Bravo, mbravo@terpmail.umd.edu

Office hours

We will generally have office hours for a couple of hours every weekday. The day-by-day schedule with exact hours will be maintained on our ELMS course page. If you have a question or issue that can't be handled during office hours, please email or call.

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

Readings for this course will be mainly from two sources. The required textbook for you to buy or rent is "Vibrations and Waves" by A. P. French, ISBN 9788123909141. This is a very old book but is generally good and takes an approach compatible with how I will be teaching the course. Because it is so old, it is pretty inexpensive in physical book or Kindle formats. I see that the Kindle edition has rather poor-quality scanned images of the figures, but I think they are readable enough. In addition to the book by French, we will be making frequent 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 mathematics approaches will be covered in the lectures, with supplementary online readings in some cases.

We will be using an online peer evaluation system called Kritik for some of the homework questions in the course. You will need to register for this by responding to an invitation email that will be sent to you when I import the course roster into Kritik. The cost of the service is $24. If that cost represents a hardship, let me know and we can inquire about a waiver.

I recommend having a good calculus-based introductory physics book to consult for background and another view of the course topics. The books typically used in PHYS 171 and PHYS 272, such as Giancoli's *Physics for Scientists & Engineers*, have chapters corresponding to many 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)

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

26%	Homework (including Kritik)
4%	Participation in class
40%	Quizzes (10% each)
30%	Final Exam

No homework or quiz scores will be dropped; all will be used to calculate your grade.

Information specific to PHYS 273H

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:

25%	Homework (including Kritik)
4%	Participation in class
32%	Quizzes (8% each)
15%	Project presentation and report
24%	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:
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 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 tests). 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, a homework deadline, or a quiz/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.

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 address.**

I will 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 ELMS supports LaTeX math typesetting now.) **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.**

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 (planned)
Spring 2021 — Professor Shawhan

Date	HW/Test	Topic	Reading
Tue Jan 26		Course intro; Recall basic physics principles	
Thu Jan 28		Descriptions of periodic motion	French Ch 1; Morin 1.1.5-1.1.7 (pp 8-11)
Fri Jan 29		Physical oscillations / simple harmonic motion	Morin Ch1-1.1.4 (pp 1-7); French pp 41-45
Mon Feb 1	*HW 1 due by 10 p.m.*		
Tue Feb 2		More harmonic oscillators: pendulum, torsional oscillator	French pp 45-57; Morin 1.1.9 (pp 12-13)
Thu Feb 4		Damped harmonic oscillations	Morin 1.2 (pp 14-20); French pp 62-70
Fri Feb 5		Driven harmonic oscillators	French pp 77-92; Morin 1.3.1 (pp 20-27)
Mon Feb 8	*HW 2 due by 10 p.m.*		
Tue Feb 9		Transients, resonance and power	French pp 92-101; Morin 1.3.2-1.3.3 (pp 27-35)
Thu Feb 11		Electronic components and AC circuits	https://ter.ps/p273r200409 pp 4-11
Fri Feb 12		Linearity and its consequences	French Ch 2
Mon Feb 15	*HW 3 due by 10 p.m.*		
Tue Feb 16		Transfer functions and mechanical filters	
Thu Feb 18	**Quiz 1**		
Fri Feb 19		Mechanics of gravitational wave detectors	
Mon Feb 22	*HW 4 due by 10 p.m.*		
Tue Feb 23		Fourier series	Morin Ch 3 pp 1-10
Thu Feb 25		The Fourier transform	Morin Ch 3 pp 10-19
Fri Feb 26		Step function and delta function; impulse response	Morin Ch 3 pp 23-25
Mon Mar 1	*HW 5 due by 10 p.m.*		
Tue Mar 2		Applications of AC circuits, e.g. filters	https://youtu.be/lagfhNjMuQM
Thu Mar 4		Intro to coupled oscillators	Morin Ch 2 pp 1-7
Fri Mar 5		Working with coupled oscillators	French pp 119-135
Mon Mar 8	*HW 6 due by 10 p.m.*		
Tue Mar 9		Chains of many coupled oscillators	Morin Ch 2 pp 7-17; French pp 135-151
Thu Mar 11	**Quiz 2**		
Fri Mar 12		Mathematical representation of waves; wave equation	Morin Ch 2 pp 17-26

Spring Break

Tue Mar 23	Waves on strings, and boundary conditions	Morin Ch 4 pp 1-8; French Ch 7 parts
Thu Mar 25	Reflection, transmission and impedance	Morin Ch 4 pp 8-14 + sec 4.3.2
Fri Mar 26	Standing waves and musical objects/instruments	French Ch 6; Morin Ch 4 pp 21-25 plus Wikipedia article
Mon Mar 29	*HW 7 due by 10 p.m.*	
Tue Mar 30	Sound waves	Morin 5.1 to 5.2.3 + sec 5.2.6
Thu Apr 1	More on sound waves; Doppler effect and shock waves	Morin Ch 7 pp 5-11
Fri Apr 2	Dispersion, phase velocity and group velocity	Morin Ch 6 pp 1-5, 13-17; French Ch 7 parts
Mon Apr 5	*HW 8 due by 10 p.m.*	
Tue Apr 6	Various physical waves	Morin Ch 6 pp 9-11, 17-22
Thu Apr 8	Attenuation	Morin section 4.6
Fri Apr 9	**Quiz 3**	
Mon Apr 12	*HW 9 due by 10 p.m.*	
Tue Apr 13	From Maxwell's equations to the EM wave equation	Morin Ch 8 pp 1, 3-9
Thu Apr 15	Electromagnetic waves and their properties	Morin Ch 8 pp 9-13, 18-20, 23
Fri Apr 16	Energy in EM waves	Morin Ch 8 pp 13-17
Mon Apr 19	*HW 10 due by 10 p.m.*	
Tue Apr 20	Reflection and transmission; Plane mirrors and images	Morin Ch 8 pp 30-33
Thu Apr 22	Geometric optics with curved mirrors	
Fri Apr 23	Geometric optics with lenses	http://ter.ps/p273r200424
Mon Apr 26	*HW 11 due by 10 p.m.*	
Tue Apr 27	Two-slit interference; Gratings; Interferometers	Morin Ch 9 pp 1-6, 12-14; French pp 280-288
Thu Apr 29	Thin-film interference and applications	Morin Ch 9 pp 6-12
Fri Apr 30	Diffraction (single-slit, double-slit, circular)	Morin Ch 9 pp 15-22; French pp 288-298
Mon May 3	*HW 12 due by 10 p.m.*	
Tue May 4	**Quiz 4**	
Thu May 6	Gravitational waves	
Fri May 7	LIGO optical design	
Mon May 10	*HW 13 due by 10 p.m.*	
Tue May 11	Review and discussion	

Fri May 14 Final Exam
(open book, but with no collaboration or communication)
Distributed at 8:00 a.m. on Friday, May 14
Must be submitted by 11:59 p.m. on Friday, May 14

Tue May 18 Honors project written reports due for students in PHYS 273H