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 in room 1410 of the Toll Physics Lecture Halls
Interactive Sessions: Fridays 10:00-10:50 in room 1202 of the Edward St. John Building
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, 301-405-1580
Office: room 2120 in the Physical Sciences Complex (PSC) building
If you have a question or issue that can't be handled during office hours, please email or call

TA/grader: Adam Dirican, adirican@umd.edu
Office for office hours: room 1303 in the Toll Physics Building

Office hours

One or both of us will normally have office hours three or four days per week. See ELMS for the schedule, including changes which may be necessary in some weeks.

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 (*Physicists 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)

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

25% Homework
27% Quizzes (9% each)
18% Midterm Exam
30% 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

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:

24% Homework
21% Quizzes (7% each)
15% Midterm Exam
15% Project presentation and report
25% 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 in class on a Tuesday, using one of your one-day extensions would allow you to turn it in by 9:30 a.m. on Wednesday morning. The 9:30 deadline will be strictly enforced. Please plan to deliver your paper work to my office by then (and if I am not there, slip it under my door). However, if you are unable to come to my office for some reason, you can scan or photograph the pages and email me the file(s). 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:
If the University is closed due to bad weather or some emergency situation on a day when homework is due, then that homework must be turned in at the beginning of the next class when

the University is open. If the University is closed on the scheduled date of a quiz or exam, then the quiz/exam will be given during the next class period when the University is open. If the University is closed on any other day, including just before a quiz or exam, then the quiz/exam will still be given according to the original schedule.

If some calamity causes the University to be closed for an extended period, I will continue the course by recording video lectures and posting them on ELMS, and will ask you to watch them, read, and do homework assignments on your own. In these or other exceptional circumstances, I will provide information through ELMS and/or by email.

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 **(preliminary)**
Spring 2020 — Professor Shawhan

Date	HW/Test	Topic
Tue Jan 28		Course intro; Recall basic physics principles
Thu Jan 30		Oscillations / Simple harmonic motion [mass on spring, initial values]
Fri Jan 31		Various harmonic oscillators [restoring force, pendula, torsion, nonlin]
Tue Feb 4	HW 1	Complex exponentials and their usefulness
Thu Feb 6		Damped and forced harmonic oscillations [incl Q]
Fri Feb 7		Transfer functions [amplitude and phase]
Tue Feb 11	HW 2	Fourier series, Fourier transforms and their usefulness
Thu Feb 13		"Noise"
Fri Feb 14		Applications of Fourier analysis, e.g. mechanical filters
Tue Feb 18	HW 3	Mechanics of gravitational wave detectors [incl thermal noise]
Thu Feb 20	Quiz	Quiz 1. Afterward: Coupled oscillators and normal modes
Fri Feb 21		Working with *N* coupled oscillators
Tue Feb 25	HW 4	Mathematical representation of waves [wave equation, traveling wave]
Thu Feb 26		Waves on strings [i.e., transverse waves]; boundary values
Fri Feb 28		Reflection and transmission of waves at an interface
Tue Mar 3	HW 5	Impedance and energy
Thu Mar 5		Sound waves
Fri Mar 6		Standing waves and musical instruments [beats, harmonics, …]
Tue Mar 10	HW 6	Review and discussion
Thu Mar 12	Exam	Midterm Exam
Fri Mar 13		Sound propagation around obstacles; the physics of hearing
Spring Break		
Tue Mar 24		Attenuation and dispersion
Thu Mar 26		Phase velocity and group velocity
Fri Mar 27		Water waves and plasma waves
Tue Mar 31	HW 7	Electronic components
Thu Apr 2		AC circuits
Fri Apr 3		Applications of AC circuits, e.g. electrical filters
Tue Apr 7	HW 8+Quiz	Quiz 2 (or may be on Thu Apr 9). Afterward: Maxwell's equations
Thu Apr 9	*	Maxwell's equations and electromagnetic waves
Fri Apr 10		Working with electromagnetic waves

Tue Apr 14	HW 9	Polarization of EM waves [and how to transform]
Thu Apr 16		Reflection at normal interface; Optical cavities
Fri Apr 17		Ways to emit and detect EM waves [antennas, atoms]
Tue Apr 21	HW 10	Two-slit interference [and phasor approach]
Thu Apr 23		Michelson's interferometer, and other designs
Fri Apr 24		Thin-film interference and applications
Tue Apr 28	HW 11	Single-slit diffraction; Diffraction from a circular aperture
Thu Apr 30	Quiz	Quiz 3. Afterward: Lasers [principle, design, properties, applications]
Fri May 1		The Fourier transform connection of interference & diffraction
Tue May 5	HW 12	Gravitational waves [theory, polarizations, sources]
Thu May 7		LIGO optics [mirrors, coatings, diffraction, cavities]
Fri May 8		Waves in cosmology [Hubble expansion, grav redshift, CMB, BAO]
Tue May 12	HW 13	Review and discussion
Fri May 15	Exam	Final Exam, 8:00-10:00 a.m., room TBD