Physics 15C: Wave Phenomena — Fall 2024

Mon/Wed 10:30–11:45 AM, Science Center Hall C
https://canvas.harvard.edu/courses/136913

Physics 15C studies oscillations and waves as the third part of the introductory Physics sequence. The topics covered in the course include: harmonic oscillation; forced oscillation; coupled oscillators; mechanical waves; sound; sound in solid, gas; reflection and standing waves; two- and three-dimensional waves; Doppler effect; electromagnetic waves; radiation; interference and diffraction; and geometrical optics.

Lecturer Prof. Masahiro Morii (morii@g.harvard.edu)

Lab Instructors Prof. Markus Greiner (mgreiner@fas.harvard.edu)
Dr. Gregorio Ponti (gponti@g.harvard.edu)
Dr. Anna Wang-Holtzen (annawang1@g.harvard.edu)

Teaching Fellows Aidan Chambers (section) (aidanchambers@g.harvard.edu)
Aaron Coe (lab) (acoe@g.harvard.edu)

Course Assistants TBD

Prerequisites Physics 15A and 15B or Physical Science 12A and 12B or equivalent

Textbook There is no textbook for this course: the lecture notes and the lab notes contain sufficient material to study. A set of (very thorough) course notes prepared by Dr. David Morin is available on the Canvas website.

Lectures Prof. Morii will give the lectures on Mondays/Wednesday at 10:30–11:45 AM in Science Center Hall C. A tentative schedule is found at the end of this syllabus. Attendance is mandatory. In case you do miss a class, the lectures are videotaped, and you may contact Prof. Morii for access to the recording.

Your questions about the material are the most important thing for you to bring to the lectures, and you are encouraged to ask them as they occur to you.

Laboratory Prof. Greiner, Dr. Ponti, and Dr. Wang-Holtzen will teach the interactive laboratories that explore oscillations and waves, interference, and optics. You must register with your preferred lab section. The labs meet in Science Center 305, starting in the second week of the semester.

In the first half of the semester, you will meet 2 hours per week to perform experiments on thin film interference, diffraction, imaging, etc.

In the second half of the semester, you will meet 3 hours per week and take on a small independent project. You will explore a topic of your choice such as: how musical instruments work; water waves and tsunamis; telescopes and microscopes; radio waves; sound interference; and Fourier transforms. We will provide you with plenty of help, and additional material when necessary. The projects will be hands-on, but can also have computation/simulation aspects. You will present your project at the end of the semester. Final presentations will take place as a poster session during the reading period (date TBD). The lab grade will be based on participation, assignments, and the final presentation.

Sections

Sections meet once a week for 75 minutes, starting in the second week of the semester. The meeting times and locations will be decided after a student poll during the first week.

Problem Sets

There will be 12 problem sets. They are posted on Canvas normally on Thursday and are due the following Thursday at 12:00 noon. (The only exception is the 10th problem set that is due on the Tuesday before Thanksgiving.) See the Course Schedule below.

You will submit your homework report through Gradescope. Late problem sets will not be accepted. We will drop your lowest problem set from the grade.

You are encouraged to use LaTeX to typeset your report. If you prefer other methods, please make sure that your report is clearly legible. (We don't like grading cell-phone pictures of rumpled hand-written notes. There are nice document scanners in Science Center.)

Office Hours

Prof. Morii will hold office hours on Wednesdays 2:00–4:00 PM in Lyman 230. If you wish to meet with Prof. Morii outside the office hours, send him an email to arrange a time.

Office hours for the TFs will be posted on the Canvas during the first week of the semester. The CAs will also hold homework help room at time/place TBD.

Exams

There will be **two midterm exams**, on October 7 and November 11. Each midterm exam has two parts: The first part is a 75-minute exam during the regular lecture time (10:30–11:45 AM). After the first part is collected, you will work on the same problems in groups of three or four and submit the solutions through Gradescope by midnight. The two parts are weighted 80% (first) vs. 20% (second).

There will be no make up exams. If you miss one midterm exam for a valid reason, your final exam score will be used in place of the missed exam.

A regular 3-hour **final exam** will be given during the Examination Period. The date/time of the final exam will be announced by the FAS examination office.

Grading

Midterm Exam 1	15% (= 12% individual + 3% group)	
Midterm Exam 2	15% (= 12% individual + 3% group)	
Final Exam	20%	
Problem Sets	10%	Note: Lowest problem set score is dropped.
Labs	20%	
Class Participation	10%	

Class participation includes in-class activities, in-class quizzes, surveys, and other activities designed to help you learn. We will tell you the correct answers for every problem, so you can earn full credit for every activity. If you earn 90% of the participation points you will get full credit for participation; anything less will be prorated accordingly.

Collaboration Policy

Discussion and the exchange of ideas are essential to doing academic work. For assignments in this course, you are encouraged to consult with your classmates as you work on problem sets. However, after discussions with peers (or course instructional staff such as tutors, TF/CAs, course assistants), make sure that

you can work through the problem yourself and ensure that any answers you submit for evaluation are the result of your own efforts. In addition, you must cite any books, articles, websites, lectures, etc. that have helped you with your work using appropriate citation practices. Similarly, you must list the names of students with whom you have collaborated on problem sets.

Use of Software We ask that you use Mathematica only when explicitly instructed so in the problem. The material we study in this course is foundational for the upper-level physics courses (e.g., Physics 143A) and developing math facility here is crucial for your success.

We also discourage the use of ChatGPT and other AI tools. Your work will be judged based not on the persuasiveness but on the correctness, and that is not (yet) what today's large language models are good at.

Accessible Education Any student receiving accommodations through the Accessible Education Office should present their AEO letter to Prof. Morii by Friday, September 27. Failure to do so may prevent us from making appropriate arrangements for the first exam.

Course Schedule Here is the tentative course schedule for Fall 2024. Actual mileage may vary.

Week	Date	Lecture	Problem Set	Lab
1	9/4 (Wed)	1. Introduction	#1 due 9/12	
2	9/9 (Mon)	2. Harmonic Oscillators	#2 due 9/19	Lab #1
	9/11 (Wed)	3. Forced Oscillators		
3	9/16 (Mon)	4. Coupled Oscillators	#3 due 9/26	Lab #2
	9/18 (Wed)	5. Longitudinal Waves		
4	9/23 (Mon)	6. Energy and Momentum	#4 due 10/10	Lab #3
	9/25 (Wed)	7. Sound, Transverse Waves		
5	9/30 (Mon)	8. Transmission Lines	#5 due 10/17	Lab #4
	10/2 (Wed)	9. Reflection		
6	10/7 (Mon)	Midterm Exam 1		Lab #5
	10/9 (Wed)	10. Standing Waves	#6 due 10/24	
7	10/14 (Mon)	— Indigenous Peoples' Day —		Project
	10/16 (Wed)	11. Fourier Analysis		
8	10/21 (Mon)	12. Dispersion, Group Velocity	#7 due 10/31	
	10/23 (Wed)	13. Multi-dimensional Waves		
9	10/28 (Mon)	14. Spherical Waves, Doppler Effect	#8 due 11/7	
	10/30 (Wed)	15. Electromagnetic Waves		
10	11/4 (Mon)	16. Reflection, Refraction	#9 due 11/14	
	11/6 (Wed)	17. Radiation of E&M Waves		
11	11/11 (Mon)	Midterm Exam 2		
	11/13 (Wed)	18. E&M Waves in Matter	#10 due 11/26	
12	11/18 (Mon)	19. Interference		
	11/20 (Wed)	20. Diffraction	#11 due 12/5	
13	11/25 (Mon)	21. Geometrical Optics		
	11/27 (Wed)	— Thanksgiving Recess —		
14	12/2 (Mon)	22. Geometrical Optics	#12 due 12/12	
	12/4 (Wed)	23. Coherence		
15	12/9 (Mon)	Final Exam Review		
	TBD	Final Exam		Poster session