# Syllabus for PHY 305: Waves

## Waves

Physics 305

West Science Hall, Room 005 M-F 9-11,1-3

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Office hours: I'm available most non-teaching times outside of class, but 12-1 W-F (with the exception of the Physics and Engineering Pizza Lunch Presentations) will be kept open.

Preferred mode of contact: email.

### *Course Description*

Harmonic oscillations and wave phenomena are ubiquitous in physics. When any stable physical system is displaced from equilibrium, it exhibits simple harmonic motion. And, in turn, when harmonic motion is imposed on many different types of continuous physical media, waves will propagate. Examples of this include mechanical vibrations of a piano string, sound waves moving through air, electromagnetic waves produced by a resonant LC circuit, gravitational waves produces by two massive objects in orbit around a common center of mass, and even quantum waves of an electron moving through space.
The purpose of this course is to understand the general concepts of oscillations and wave phenomena (most notably mechanical oscillations and waves, although electromagnetic waves will also be covered) as well as the mathematical techniques used to analyze oscillations and waves, namely complex exponentials and Fourier transforms. In addition, you should understand the general physical phenomena of resonance, standing waves, traveling waves, reflection, refraction, dispersion, diffraction, and interference.

### *Course Goals*

Students who complete this course successfully will be able to:

- understand basic wave phenomena (Knowledge)
- solve a wide range of problems involving waves (Reasoning)
- analyze new experimental situations where waves play an important role (Inquiry)

### *Course Support of Educational Priorities and Outcomes of the College*

This course supports the following Educational Priorities and Outcomes of Cornell College:

- Knowledge – you will read about wave phenomena as well as viewing demos in lecture.

- Reasoning – you will solve many homework (and exam) problems involving basic wave phenomena .
- Inquiry – you will perform some home experiment as well as experimental exam problems to discover new features of wave phenomena.

***Required Texts, Materials, or Equipment***

- The main text for this course is French, *Vibrations and Waves* (1971). In addition, there is a handout consisting of four chapters from Frank Crawford's book *Waves* as well as my book *Real, Imaginary, Complex*, available in PDF format.
- French's book is available in the bookstore. The excerpt from Crawford's book, as well as my book, are available online on the PHY 305 Moodle page..

***Daily Work/Homework***

Homework is due the next afternoon in class. For example, the "Day 1" homework assignment is the one you will start work on during the first day of class, but will be due the second day. There may be a quiz on the homework in class. Solutions to the homework problems will be posted on Moodle. Unlike the tests, you are encouraged to work on the homework assignments with your classmates. However, regardless of your methods for solving the homework problems, you must gain sufficient proficiency with the material that you are able to do the homework problems on your own. During the first hour of class, we'll typically review homework. During the second hour, we'll discuss new material. During the third hour, we'll look at new problems. During the fourth hour, you may start homework in class, unless we are still reviewing problems.

***Major Assignments/Exams: Descriptions & Deadlines***

There are three exams in this course. The first two are traditional exams (a set of problems that you will have to solve on your own) and the third exam is an experimental group exam where you will work as a group to solve a series of experimental problems. The first exam covers the material presented during the first week of class (oscillations). The second exam covers the material presented during the second week of class (one dimensional waves). The third, experimental group exam covers the material presented during the last week of the course (two dimensional waves).

***Class Participation***

Class participation is not required, but it is very, very strongly recommended. It is possible for some students to learn this material on their own, but there are often subtleties that are best picked up in class.

I expect that all interactions in class will be civil, respectful, and supportive of an inclusive learning environment for all students.

***Course Grading***

Grading Process

Homework grading is based more on whether you made a good-faith effort to solve the problems and if you understood the basic concepts rather than whether you got the correct answer. You may work with other students on the homework, although you are ultimately responsible for knowing how to solve each problem.

Explanation of Grading System

- Exam 1: 30**% of total grade**
- Exam 2: 30**% of total grade**
- Exam 3: 15**% of total grade**
- Homework/quizzes: 25**% of total grade**

Sample Grade Cutoffs

85% A
70% B
55% C

***Course-Specific Support***

I am available for help outside class. You are encouraged to work on problems together with your classmates outside of class. You are welcome to seek help at the Center for Teaching and Learning, but your classmates will know more about waves than will other students on campus.

***Course Policies and Information for Students***

1. ABSENCE FROM CLASS AND LATE ASSIGNMENTS

   You may be absent from class due to a few reasons. Your absence is excused if either 1) you obtain permission from your instructor in advance of the absence or 2) the absence is of an emergency or medical nature. If your absence is excused, you will need to make up the material that you missed, but there will be no other penalty. If your absence is not excused then you will not be allowed to make up the work. If you turn in an assignment late, then you will not receive full credit.

2. DISABILITIES AND ACCOMODATIONS POLICY: Cornell College makes reasonable accommodations for persons with disabilities. Students should notify the Office of Academic Support and Advising and their course instructor of any disability related accommodations within the first three days of the term for which the accommodations are required, due to the fast pace of the block format. For more information on the documentation required to establish the need for accommodations and the process of requesting the accommodations, see http://www.cornellcollege.edu/academic-support-and-advising/disabilities/index.shtml.

3. ACADEMIC HONESTY POLICY: Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless

generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgment of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Catalogue, under the heading "Academic Honesty."

***Preliminary Schedule of Topics, Readings, and Assignments***

| **Date** | **Text Material** | **Problems (**problems marked with an asterisk are optional**)** | **Topics** |
|---|---|---|---|
| Day 1 - M | French p.3-38<br><br>Sherman 1.1-1.3, 3.1-3.3 | F **Ch 1**: 1, 3, 4, 8, 10, 12<br><br>F **Ch 2**: 1, 6*<br><br>S **Ch 1**: 1, 6* | Simple Harmonic Motion<br><br>Complex Numbers |
| Day 2 - T | French p. 40-53 | F **Ch 2**: 3, F **Ch 3**: 1, 2, 12, 13, 15 | Oscillators, Beats |
| Day 3 - W | French p. 53-70 | F **Ch 3**: 4, 6, 11, 16, 19a-d, 18* | Physical pendulums, Energy |
| Day 4 - Th | French p. 77-96 | F **Ch 4**: 1, 3, 5, 6*, 8a-b<br><br>S **Ch 4**: 2, 3, 4 | Resonance, AC circuits |
| Day 5 - F | French p. 96-112 | F **Ch 4**: 10, 13, 16 | Resonance and power |
| Day 6 - M | Exam I | | Oscillations (0-D waves) |
| Day 7 - T | French p. 161-181 | F **Ch 6**: 1, 3*, 5, 6, 10 | Wave equation, standing waves |
| Day 8 - W | French p. 181-196 | F **Ch 6**: 11a, 12, 14* | Fourier transforms |

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| Day 9 - Th | French p. 201-237 | F **Ch 7**: 1, 2, 4, 6, 12, 14 | Traveling waves |
| Day 10 - F | French p. 228-246 | F **Ch 7**: 18, 20, 23*, 24, 25<br>F **Ch 6**: 13*, S **Ch 6**: 8 | Dispersion |
| Day 11 - M | French p. 253-280 | F **Ch 8**: 1, 2*, 6*, 8, 9, 10, 11 | Reflection, thin films |
| Day 12 - T | Crawford p.498-518 | C 9.42, 9.54 | Refraction |
| Day 13 - W | Exam II | | One dimensional waves |
| Day 14 - Th | Crawford p.342-366 | C 7.14, S **Ch 6**: 6, 7 | Maxwell's Equations |
| Day 15 - F | Crawford p.453-477 | C 9.2, 9.5, 9.6, 9.9 (use laser), 9.11, 9.24 | Interference |
| Day 16 - M | Crawford p.478-498 | S **Ch 8**: 1, 2* | Diffraction |
| Day 17 - T | Crawford p.394-427 | C 8.5, 8.6, 8.11-13, 8.23, S **Ch 7:** 1, 2 | Polarization |
| Day 18 - W | Exam III | | Two dimensional waves |