Waves and Fields (PHYS 195) Course Syllabus

Spring 2019 v8.0

1. Introduction to Phys 195:

This semester's 195 material is divided into three (unequal) parts:

(1) Oscillations, Resonance and Waves
(2) Static Electric and Magnetic Fields ("electro- and magneto-statics")
(3) Light as a wave: Optics, Interference, and Diffraction

Building on your work last semester on Newtonian mechanics, the course starts with a study of oscillations, first simple mass-on-a-spring systems and then more complex systems. Simultaneously in lab you work with these systems and develop uncertainty techniques. This leads to you designing an experiment to measure the local acceleration of gravity 'little" g.

The study of oscillations - and how they can loose energy - naturally leads into the study of waves. We start with waves on a string and sound. The middle 'third' of the course focuses on static electric and magnetic fields. The course finishes by returning to waves, in the form of light.

Behind the physics is a set of mathematical methods including Taylor series, differential equations, partial differential equations, complex numbers, and Fourier series. Although we won't study each of these in depth, they will be introduced and used.

2. Course Information

Instructor: Seth Major – please call me "Seth."
email : smajor@hamilton.edu
web : academics.hamilton.edu/physics/smajor/
phone : x4919
office : Sci G052

Lectures: MWF 10:00-10:50 AM in Science Center G041

Office Hours: My official hours are Monday afternoons 2 - 4 and Tuesday 2 - 5 PM (although some weeks I have to leave early for chairs and faculty meetings, which start at 4). However feel free to stop by, call or send an email about a homework problem, questions on the text, or any other physics-flavored issue you'd like to talk about.

Texts: I strongly recommend that you read over the material before class and lab. The presentation in the texts is complementary to mine so, by reading, you will learn some of the required material not discussed in lecture.

- Halliday, Resnick, Walker, **Fundamentals of Physics** Extended, 10th Edition (same as Phys 190) henceforth referred to as HRW. Notes: A copy of any edition, or even any good intro text, will also work. If you have an older edition it is handy to have a listing of the problems from the 10th edition. Almost all of these sections are posted on BlackBoard.
- John Taylor, **An Introduction to Error Analysis**
- Kleppner and Kolenkow (or K & K) **An Introduction to Mechanics** An introductory text at a high level, on BlackBoard. It is also in our library - Burke (QA805 K62 1973)

In addition the following books are useful:

- G. Simmons, **Calculus with Analytic Geometry** or other favorite calc+ text
- Schaum's outline on **Mathematical Handbook of Formulas and Tables**

On learning physics: Learning occurs, and the seed of understanding is planted, when we think about a subject. Typically this happens when we actively confront a situation or a problem in a new way. Unfortunately, full understanding normally occurs only after iterating this process several times! Such active engagement with the material is especially beneficial to learning physics. This course is structured to foster active and productive learning: there are class discussions, clicker questions, labs, hands-on activities in the form of home experiments and problem sets that encourage you to think about the material. Please regard all these as opportunities to seeing the world, and its physics, in a new way. Hopefully through these you will understand more of the complexity, beauty, and fun of the world. It is also often more fun to work with others as you discover new methods, solutions, and concepts. I encourage you to do this as you work your way through problems, for instance in office hours. When you write up your work, however, it must be your own words and equations. If you owe a key idea or two to someone else (or another source) then **cite them (or it)**

Web page: Phys 195 has a web page:
http://academics.hamilton.edu/physics/smajor/Courses/195.html
Or Google "195 good waves" This will be the source for news about the course and as a repository for course information. Please refer to it often.

Weekly Guides: Every week I will distribute (via the webpage) a weekly Guide that includes information on the reading, other aspects of the course including special events, and the problems. Guides normally will be posted on the 195 site on Wednesday. Starting early in the 'week' on your solutions will be of great help!

As you know from 190 the logic and methods employed in your solutions are **more important** than achieving the correct numerical or algebraic answer. Write your work in a logical, easy-to-read manner. The student graders deduct points for solutions that are not clearly written up, even if you have the correct answer. Take the preparation of your work seriously; I strongly recommend that you copy over your solutions and hand in a readable final copy. Always check that you have included units and have stated numerical results to the correct number of significant figures.

I encourage you to discuss the questions on the problem sets, and methods of solution, with your fellow students, clinicians at the Quantitative Literacy Center, and professors. However, the written work you hand in for a grade must be your own, must reflect your own understanding, and you must cite classmates or anyone else who contributes significant ideas. The Honor Code applies. Cite important ideas, methods, or steps you find you find online.

Again and finally, start early in the week on your solutions.

Problem Solution Logistics: Your solutions will be due on Wednesdays at the **beginning** of class. No late[1] problem sets will be accepted. However, if you know **in advance** that you have an emergency of some kind then I will normally grant an extension. To ensure that this happens, please email me in advance of the deadline. Your solutions will be normally graded 1 point per problem. Solutions will generally be available by Wednesday afternoon through the website (if all goes well). Unless you direct me otherwise, I will not include your lowest problem set score in the semester average.

Mid-terms and Final: There will be two mid-term and a final. The mid-terms will be held during lab times. The final will be during the scheduled time: **Saturday, May 12 9-12 PM**. The exams include material in the reading, lecture, and labs. When grading these I normaally provide a raw score and a re-scaled score. Calculators are required. The midterms and the final will contain lab questions where you will be asked to answer questions using your lab notebook and/or use lab equipment. These questions are part of you exam grade.

[1] "Late" means after the beginning of class, i.e.10:00 AM.

Labs: Physics is a science of quantitative observation and so we have labs. They start January 24 (in the first week). The labs are available on the course web page. You should also bring a bound composition book to use as your lab notebook. If you still have space, you are welcome to reuse your 190 lab notebooks.

The second text by John Taylor, familiar from 190, is devoted to a careful treatment of uncertainties. Although you have already encountered these in Phys 190 (or other physics courses) this book is a great source for introductory through advanced material such as you might use in research. It is an essential reference for later courses.

You lab grade will be determined by pre-labs questions (10%), post-lab questions (60%), and lab notebooks (30%). The pre- and post-lab questions are similar to last semester. Your lab notebooks will be collected and graded two or more times during the semester. The post-labs will be posted Friday evening.

The lab sessions are mandatory. It will generally not be possible to make-up labs. You may be able, however, to switch labs to help with conflicts. Please see or email your lab instructor in advance to see whether a switch is possible.

Lab Instructors:
Thursday: Viva Hororwitz
Friday: Adam Lark

Participation: This is a catch all 5 percentage points that includes attending and participating in class. Attending extra events such as the colloquia, office hours, and motor testing later in the semester are pluses. At the start of the semester I assume that everyone has a 3. Extra participation adds to a max of 5. Absences in class lower this portion of the grade.

Grades: Your semester grade will be determined by the following scheme:

Problem Sets	25%
Labs	20%
Mid-terms (2)	20%
Final (cumulative)	30%
Participation	5%

A note on 'curving': In my days as a student I understood this to mean that there was a roughly equal chance of my grade being lowered or raised in a course taught by a professor who graded on a 'curve'. I now doubt that this was this case but when I started teaching I certainly didn't want to grade within a scheme that was competitive. This remains true today. I do not fit the class grades of the class to a gaussian (or even other type of) distribution. If you all accomplish A-level work then we all celebrate!

You can get a good idea of your current grade using the "grade calculator". After the first mid-term I will post an Excel spreadsheet – aka the "Grade Calculator" – that will allow you to calculate your expected grade. To get some idea which letter grade corresponds to which numerical interval, here is the translation: Each decade is divided into three intervals for instance, 90-88 B+, 87-84 B, 83-81 B-.

Colloquia: On Thursday afternoons, several times during the semester, there will be talks by physicists and astronomers from other institutions. These talks are a wonderful way to see what physics is done in "the real world.' These events begin with **free food** at about 4 PM. The talks are often at 4:10 PM and end at about 5:15. Please join us!

Here is the list for this spring:

- 4/18/2019 Mike Brown (Swarthmore) - plasma experiment
- 4/25/2019 Chris Collison (RIT) - condensed matter experiment
- 5/2/2019 Greg Fuchs (Cornell)

In addition we expect to have a couple of talks from applicants for visitings positions during the first half of the semester.

Accommodations: Hamilton College will make reasonable accommodations for students with properly documented disabilities. If you are eligible to receive an accommodation(s) and would like to make a formal request for this course, please discuss it with me during the first two weeks of class. You will need to provide Allen Harrison, Associate Dean of Students (Elihu Root House; ext. 4021) with appropriate documentation of your disability.

Enjoy!

3. Syllabus

What follows on the next page is preliminary. HRW is for Halliday, Resnick, and Walker. KK is for Kleppner and Kolenkow - reading on eReserves. Details will be given in the weekly Guides.

Phys 195: Waves and Fields Spring 2019 Syllabus				
Part	Topics	Reading	Week	Labs and *Events*
Oscillations	As Newtonian Dynamics Energy and examples As universal motion	HRW 15 Taylor 1 KK eRes	1	L1:Simple Oscillations
	As a differential equation	Taylor 2	2	
Resonance	Damping & driving Q and phase Attaching oscillators	KK eRes		L2: Exploring Pendula
Waves	Traveling waves Mathematical description	HRW 16	3	L3: Measuring g
	Wave equation for string Energy and momentum Superposition & Reflection Standing waves	HRW 17 Taylor 3	4	L4: Resonance
	Sound: Derivation Beats, 2D Superposition Doppler Effect Interference Fourier's insight Fourier series	HRW part of 14 HRW 17	5	**Mid-term I** in Lab
Fields	Charge Electric field and Force	HRW 21	6	L5: Waves on a string *Tape Experiments* *Coulomb in a Box*
	Field lines Electric Potential	HRW 22 HRW 24	7	*Kelvin Water Dropper* L6: Speed of Sound *Van de Graaff*
	Moving charges	HRW part of 26	8	L7: Coulomb's Law
Spring Break, March 18 - April 1				
	More electric potential Elctric dipoles Magnetic Field	HRW 28	9	*Motor Kits* L8: Electroscopes
	$q\mathbf{v} \times \mathbf{B}$ Torque on a loop	HRW 33	10	**Mid-term II** in Lab
Light: Optics	Physical and Geometric E&M waves Snell's Law, mirrors and Lenses Ray tracing Optical instruments	HRW 34	11	L9: **B** Field mapping
Interference	Young's double slit Phasors LIGO and Michelson	HRW 35	12	L10: $q\mathbf{v} \times \mathbf{B}$ Force
Diffraction	Single slit diffraction Double slit Intensity	HRW 36	13	L11: Snell's Law
	Many slits Polarization Review	HRW 36	14	L12: Interference and Diffraction
Final Saturday, May 12 9-12				