Waves and Fields (PHYS 195) Course Syllabus

Spring 2017 v6.2

1. Introduction to Phys 195:

This semesters 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 dynamics, the course starts with a study of oscillations, first simple mass-on-a-spring systems and then more complex systems. This leads into the study of the physics and mathematics of waves. The middle 'third' of the course focuses on static electric and magnetic fields. The course finishes with a study of the wave nature 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: The "official" hours are Thursday afternoons until about 5 PM and Monday 2 - 4 in the tutorial area outside my office (drop-in help sessions). But 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 chat 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. Note: a copy of any edition, or even any good intro text, will also work for most cases.
- 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 electronic reserve in our library

In addition the following books are useful:

- G. Simmons, **Calculus with Analytic Geometry** reading on eReserves
- Mary Boas **Mathematical Methods in the Physical Sciences** (QA37.2 .B59 1983) Several copies are around, e.g. in the Physics Common Room and the tutorial areas.
- Schaums outline on **Mathematical Handbook of Formulas and Tables**
- R. Reese **University Physics** (QC21.5 .R435 2000) – A calculus-based introduction.

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 clicker questions, labs, hands-on activities in the form of home experiments and there are problem sets that encourage thinking 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.

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 all 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 Friday. Your solutions will be due on the following Friday 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. Your solutions will be normally graded 1 point per problem. Solutions will generally be available by Friday afternoon through the website (if all goes well).

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 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. You absolutely must cite anything you find online, even if you only looked up a constant.

Finally, starting early in the week on your solutions will be of great help!

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

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

After the first mid-term I will post a Excel spreadsheet – the "Grade Calculator" – that will allow you to calculate your grade.

There will be opportunities to earn extra credit during the semester. These will be labeled with **Bonus**. The credit must be earned by the due date. There will be one extra credit extravaganza later in the semester that will call on your engineering, creative, building, and physics skills.

Mid-terms and Final: There will be two mid-term and a final. The final will be during the scheduled time: Friday, May 12 2-5 PM. The exams include material in the reading, lecture, and labs.

[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 22 (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.

The second text by John Taylor is a 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 will make a good reference for later courses.

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 you might have. Please see your lab instructor in advance to arrange a switch.

Lab Instructors:
Tuesday: Seth Major
Wed: Adam Lark
Thurs: Viva Horowitz

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!

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!

THE FINE PRINT: The maximum number of bonus points will be 2π.

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 2017 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	Simple Oscillations
	As a differential equation	Taylor 2	2	
Resonance	Damping & driving Q and phase Attaching oscillators	KK eRes		Exploring Pendula
Waves	Traveling waves Mathematical description	HRW 16	3	Pendula and g
	Wave equation for string Energy and momentum Superposition & Reflection Standing waves	HRW 17 Taylor 3	4	Resonance
	Sound: Derivation Beats, 2D Superposition Doppler Effect Interference Phasors 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	Waves on a string *Tape Experiments* *Coulomb in a Box*
	Field lines Electric Potential	HRW 22 HRW 24	7	*Kelvin Water Dropper* Speed of Sound *Van de Graaff*
	Moving charges	HRW part of 26	8	Electroscopes
Spring Break, March 13 - March 24				
	Magnetic Field $q\mathbf{v} \times \mathbf{B}$ Torque on a loop	HRW 28	9	*Motor Kits* **E** Field mapping
	E&M waves	HRW 33	10	**Mid-term II** in Lab
Light: Optics	Physical and Geometric Snell's Law Mirrors and Lenses Ray tracing Optical instruments	HRW 34	11	**B** Field mapping
Interference	Young's double slit Phasors LIGO and Michelson	HRW 35	12	Snell's Law
Diffraction	Single slit diffraction Double slit Intensity	HRW 36	13	Thin Lenses
	Many slits Polarization Review	HRW 36	14	Interference and Diffraction
Final Friday, May 12 2-5 PM				