Waves and Fields (PHYS 195) Course Syllabus

Spring 2021 v2.0

1. Introduction to Phys 195:

Welcome to 195! This semester we will explore physics related to oscillations, waves, and static fields while continuing to build your sophistication in model building of the world. Many of my choices in material are guided by what comes next - quantum! - in the form of Phys 290 next fall. I expect that you will be challenged in terms of both physics and mathematics and be supported. I will do my best to offer the support you need and offer a light hearted exploration. In part because of the pandemic, I ask you to take a patient, dedicated role in your learning. This will hopefully occur in many forms, working with fellow students, reading, puzzling over lab, trying out the extras, and in class.

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, we start 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 to design an experiment to measure "little g", the local acceleration of gravity, to one part in 10^3.

The study of oscillations - and how they can loose energy - naturally leads to the study of waves. We start with waves on a string and then sound. Thematically there is a bit of a break as the middle 'third' of the course opens 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.

If you have friends studying physics elsewhere you will be surprised when you compare notes: The standard second semester intro physics course is focused on electric and magnetic fields. At Hamilton, we save this for second semester sophomore year so we can teach the material in its "native language" of vector calculus.

2. Course Information

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

Lectures: MWF 9:40 - 10:30 AM in Science Center G041
Zoom link: https://hamilton.zoom.us/j/95624016488

Office Hours: My official hours are Friday afternoons 2 - 3, Monday afternoons 2 - 3:30 and Tuesday 2:30 - 4:30 PM (although some weeks I have to leave early for chairs and faculty meetings, both of which start at 4:15).
Zoom link: https://hamilton.zoom.us/j/3284057318
When spring weather arrives I'll likely shift outside.

Texts: We use the same text as in Phys 190 plus Taylor's introduction to error analysis (used heavily in the first weeks of the semester).

Required texts:

- Halliday, Resnick, Walker, **Fundamentals of Physics** Extended, 11th Edition (same as Phys 190) henceforth referred to as HRW. **Required**
  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.
  I strongly recommend that you read over the material before class and lab, even if it is a quick read. That way your mind will be ready to fill in the puzzling bits. Additionally the presentation in the texts is complementary to mine so, by reading, you will learn some required material which is not discussed in lecture.
- John Taylor, **An Introduction to Error Analysis** Our source for essential methods of working with uncertainties **Required**
- Kleppner and Kolenkow (or K & K) **An Introduction to Mechanics** required but available on BlackBoard. Please do not buy! It is also in our library - Burke (QA805 K62 1973)

In addition the following books are useful:

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

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.

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.

Written work: 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 Phys 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 answered the correct problems, your solutions are in order, 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 and Symbolic Reasoning (QSR) 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. If you owe key ideas, methods, or steps you find you find online then **cite them (or it)**. Informal citations next to problem solutions such as "Worked with Tetsua and Jane" are fine. Leaving them out is not. As always for citations, when in doubt - cite! The Hamilton Honor Code applies to all the written work you submit such as problems sets, lab notebooks, and exams.

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

Problem Solution Logistics: Please upload your solutions on Gradescope by 11:59 PM (eastern) on Tuesdays when they are due (Weeks we have midterms will not have solutions.) There will generally be no extensions. But you have 3 "Oops! passes" you can use for any reason. These allow you to submit the work up to 36 hours later. Email me to re-open the gradescope assignment for this extension. If you have a medical or other emergency, please write and we will work out a plan for submitting work that makes sense for your situation. Your solutions will be normally graded 1 point per problem. Solutions will generally be available by Thursday afternoon through the website (if all goes well).

Mid-term, Quizzes, and Final: There will be two mid-terms and a final. These are required. The mid-terms will be held during lab times. The final will be during the regularly scheduled time: **Saturday May 15, 7 - 10 PM**. The exams include material in the reading, lecture, and labs. Calculators are required. The midterm, quizzes, 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 your exam grade.

Labs: Physics is a science of quantitative observation and so we have labs. They start February 9 (in the second full week of classes). 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 some of 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.

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. If you miss the lab or do not submit work for that week, you will receive a 0 for that lab.

Lab Instructors:
Brad Moser - Tuesday Lab
Email: bmoser@hamilton.edu Phone: x4228

Kristen Burson - Wednesday Lab
Email: kburson@hamilton.edu Zoom Office: https://hamilton.zoom.us/j/7318778153

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. If you fully participate in classes and lan then you would have a 1. Extra participation such as attending office hours regularly, building the bonus motor, etc. 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%

The upcoming "Grade Calculator" 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-.

Help: "Sometimes asking for help is the bravest move you can make."

If you are feeling stressed, overwhelmed, anxious, or depressed or you are facing some other personal crisis, I am happy to work with you to make arrangements to help you out and accommodate you. There are also many resources available on campus to help and support you:

- Counseling Center (www.hamilton.edu/offices/counselingcenter, 315-859-4340) located at 100 College Hill Road offers individual and group therapy, peer counselors, psychiatric treatment, and a 24-hour hotline. If you need immediate assistance, phoning the Counseling Center and selecting option 2 will connect you with a counselor, 24 hours a day, 7 days a week.
- Associate Dean of Students for Student Support, Lorna Chase (315-859-4600; lchase@hamilton.edu)
- Associate Dean of Students for Academics, Tara McKee (315-859-4600; tmckee@hamilton.edu)
- Your faculty advisor
- Your RA and Area Director in your residence hall

Accommodations: Students with a documented disability needing academic adjustments or accommodations are encouraged speak with me during the first two weeks of classes. Hamilton College will make accommodations for students with properly documented disabilities. Allen Harrison in the Dean of Students Office (Elihu Root House; ext. 4021) coordinates services for students with disabilities.

3. Schedule

Except for break and the exams dates, 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 2021 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	*Making a Universe With Axions* Dr. Prescod-Weinstein Feb 4
Resonance	As a differential equation Damping & driving Q and phase Attaching oscillators	Taylor 2 KK eRes	2	Lab 1:Exploring Pendula Labs start February 9
Waves	Traveling waves Mathematical description	HRW 16	3	Lab 2: Measuring g
	Wave equation for string Energy and momentum Superposition & Reflection Standing waves	HRW 17 Taylor 3	4	Lab 3: Resonance *Wine Glass Wobble*
	Sound: Derivation Beats, 2D Superposition Doppler Effect Interference Phasors Fourier's insight Fourier series	HRW part of 14 HRW 17	5	Wellness Day
Fields	Charge Electric field and Force	HRW 21	6	Lab 4: Waves on a string *Tape Experiments* *Coulomb in a Box*
	Field lines Electric Potential	HRW 22 HRW 24	7	**Mid-term I** in Lab Starting March 16 *Kelvin Water Dropper* *Van de Graaff*
	Moving charges	HRW part of 26	8	Lab 5: Speed of Sound
	More electric potential Elctric dipoles Magnetic Field	HRW 28	9	*Motor Kits* Lab 6: Electroscopes
	$q\mathbf{v} \times \mathbf{B}$ Torque on a loop	HRW 33	10	Wellness Day
Light: Optics	Physical and Geometric E&M waves Snell's Law, mirrors and Lenses Ray tracing Optical instruments	HRW 34	11	Lab 7: **B** Field mapping
Interference	Young's double slit Phasors II LIGO and Michelson	HRW 35	12	*APS April Meeting* 17-20 April **Mid-term II** in Lab
Diffraction	Single slit diffraction Double slit Intensity	HRW 36	13	Lab 8 : Snell's Law
	Many slits Polarization Review	HRW 36	14	Lab 9: Interference and Diffraction
Final Saturday May 15, 7 - 10 PM				