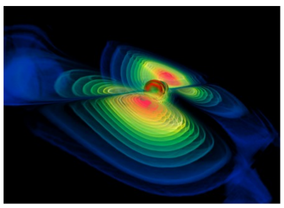
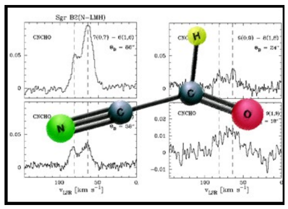
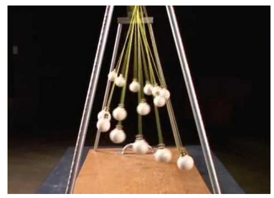
   

Physics 218
Oscillatory and Wave Phenomena

Spring Semester, 2018

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General Course Information

In this course, we will investigate the physics of periodic motion – i.e., motion that regularly repeats. Periodic motion plays an important role in nearly every branch of physics and is ubiquitous in everyday life. Sound waves, water waves, radio waves, visible light, the flow of charge in certain circuits, the vibration of atoms in a crystal, and even the behavior of certain fundamental particles in the early universe all manifest this behavior.

The common thread which unites all of these these phenomena is not *physical* — indeed, the physical principles which govern the corresponding systems are very different! Rather, it is *mathematical*: the equations which describe how the relevant physical quantities evolve or change in each system turn out to have a very similar mathematical form. We will therefore focus a great deal of attention in this course on the mathematical tools useful for describing and studying systems which exhibit periodic motion, including power series, complex variables, linear algebra, Fourier analysis, and a variety of strategies for solving differential equations. We will also examine why so many different physical systems exhibit these phenomena. Learning to recognize mathematical analogies between seemingly unrelated physical systems and exploit those analogies to solve problems lies at the core of what it means to "think like a physicist."

All of this makes this course a challenging one, but it makes it a rewarding one as well. Indeed, you can look forward to being able to do all of the following by the time this semester concludes.

- You'll be able to assess whether **oscillatory motion** is likely to arise in a given physical system and to describe that motion quantitatively.
- You'll be able to apply the techniques of **linear algebra** in order to analyze systems of coupled oscillators.
- You'll be able to apply the technique of **Fourier analysis** to oscillator systems.
- You'll learn a number of techniques for solving simple **ordinary differential equations** and be able to apply them in order to solve physics problems.
- You'll be able to **assess and report the uncertainty** in an experimental measurement.
- You'll be able to use **computational tools such as Python and Mathematica** in order to solve problems numerically that cannot be solved analytically.

The prerequisites for this course include Phys 133 or 152, as well as an understanding of multi-variable calculus at the level of Math 263. In addition, since understanding the natural phenomenal we will be studying in this course involves solving differential equations and applying the principles of linear algebra, Math 264 is also a co-requisite. However, rest assured that we will also be getting an introduction to these topics in this course as well.

Components of the Course

The course will consist of class meetings, reading assignments in the text, homework problems, labs, three mid-term exams, and a final exam. These are described more fully below.

Class Meetings:

Class meetings will be held **from 1:10 PM – 2:00 PM in Hugel 017** each Monday, Wednesday, and Friday during the semester. A schedule of topics to be covered each day is listed on the course web page. Much of the material covered in this course – and many of the homework problems that you'll be working through – are quite challenging. It is therefore important that you come to class prepared to ask questions and to engage in discussions. You should be aware that class meetings will involve not only my lecturing to you about the material covered in the readings (which is not necessarily the best way for me to help you learn the material), but a variety of other activities as well – the benefit you get out of which is directly proportional to the effort you put in.

Textbook:

The required textbooks for this course are

- Walter Fox Smith, *Waves and Oscillationss* (Oxford University Press, 2010).
- John R. Taylor, *An Introduction to Error Analysis*, 2nd Ed. (University Science Books, 1997).

I will also be posting on the course Moodle a set of my own lecture notes on oscillatory and wave phenomena, entitled *Slightly Disturbed: A Mathematical Approach to Oscillations and Waves*. These notes focus much more on mathematical methods than does Smith's book and are therefore intended primarily as a supplementary text.

In addition to these required texts, given the mathematical nature of the subject material and the variety of special functions we will encounter over the course of the semester, you may want to have a good reference volume on mathematical methods in physics on hand. For this, I recommend the following:

- Mary L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Ed. (Wiley, 2005).
- George B. Arfken, Hans J. Weber, and Frank E. Harris, *Mathematical Methods for Physicists*, 7th Ed. (Academic Press, 2012).

Finally, since we will be using both Python and Mathematica extensively in this course, you may find it useful to have a guide or tutorial for each that you can reference. A good introductory reference for Mathematica is:

- C-K. Cheung, Gerard E. Keough, Robert H. Gross, and Charles Landraitis, *Getting Started with Mathematica*, 3rd Ed. (Wiley, 2009).

A number of additional tutorials, programming guides, and other references for both Python and Mathematica are also available online. Links to some of the more useful ones for the applications we'll be dealing with in this course will be posted on the course web page.

Homework Assignments:

Working through problems is an essential part of this course. There's no way of truly understanding the physics we'll be dealing with in this course without delving in and *doing* quantum mechanics. For this reason, I will be assigning a number of homework problems each week which I feel provide practice with the most crucial aspects of the material we're covering in the course. A list of the problems included in each problem set will be posted on the course Moodle, and each problem set is due at the beginning of class on the day indicated on the schedule on the course web page. Some of these problems will require nothing more than pen, paper, and a lot of careful thought; others are designed to give you some practice solving problems using computational tools like Mathematica or Python.

All homework problems are **due at 4:00 PM on the day indicated on the course schedule**, which is typically a Friday. I will accept late homework for half credit until the beginning of the following class meeting (typically the following Monday at 1:10 PM). However, because we will frequently discuss homework problems in class, late homework will not be accepted beyond that point.

I wholeheartedly encourage you to work together on homework problems with other students in the class. This can be a very productive way of expanding your own knowledge, and working with other people to solve problems is a big part of how science is really done. However, the written work that you turn in to me must be your own work: it should reflect your own understanding and should be written up independently after all discussion between you and your peers is complete.

Mid-block Tests and Final Exam**:**

There will be three mid-term exams given during the course. **The first exam will be held on Feb. 16th, the second on Mar. 23rd and the third on Apr. 20th**. These tests are designed give you the opportunity to demonstrate how well you understand the material. In addition, there will also be a final exam at a date and time to be determined by the Registrar.

Laboratory:

The laboratory section of this course, which meets **every Tuesday this semester from 2:45 – 4:00 PM**, is an integral part of this course. In some labs, you'll be conducting hands-on experiments in order to explore the phenomena we'll be examining in course meetings; in others, you'll be honing your computational skills by performing numerical simulations of these phenomena. Further information about the laboratory portion of this course will be provided by your laboratory instructor during your first lab meeting.

Grading and the Honor Code

Course Grade:

Your grade in the course will be determined by the following criteria:

Homework	15%
Laboratory	25%
Mid-Term Exam I	13%
Mid-Term Exam II	13%
Mid-Term Exam III	13%
Final Exam	21%

Office Hours:

You are encouraged to stop by my office at any time if you have questions about any aspect of the course. You may not always find me, however, if you drop by unannounced. My official office hours, during which you can count on my being in my office (except under extraordinary circumstances), will be held **Monday and Wednesday from 2:00 – 4:00 PM and Friday from 9:00 – 10:00 AM** unless otherwise noted on the course web page. If you are unable to drop by during these official office hours, you may also call or email me to make an appointment for some other time.

Intellectual Honesty:

All exams in this class are closed-book. Calculators are permitted, and you will also be provided with a sheet of useful equations and fundamental constants at the start of each exam. However, the use of any other resources is not permitted. When studying, working in the laboratory, or working on homework problems, I encourage you to work with other students. However, you may not consult a solutions manual or any other source for answers to the problems, and the write-up that you submit to me for each problem should be your own work.

As always, you are expected to abide by the principles of intellectual honesty and academic integrity outlined in the Lafayette Student Handbook, which can be found at

- https://conduct.lafayette.edu/

Other Useful Information

Accessibility Services:

In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. If you are requesting accommodations, you must register with the Disability Services Office (administered by ATTIC) for disability verification and for the determination of reasonable academic accommodations. It is **your responsibility** to provide me with an official letter from Disability Services which clearly outlines what those accommodations are. I cannot provide accommodations until you provide me with such a letter. Requests for academic accommodations must be made within the first two weeks of the semester, except in unusual circumstances, so that suitable arrangements can be made in a timely manner.

Informal Surveys:

Over the course of the semester, I want to hear from you how you feel the course is going, what you like, what you don't like, what your concerns are, and how you think the course could be improved. Therefore, at regular intervals throughout the semester, you'll have the opportunity to fill out a short, informal course evaluation so that we can get feedback from you.

Course Communication:

This syllabus, a list of assigned readings and problem sets, and other course materials will be posted on the course web page, which can be found at

- http://workbench.lafayette.edu/~thomasbd/Phys218-OscillationsWaves-Spring-2018/Phys218-OscillationsWaves-Spring-2018.html

In addition to the course web page, there is also a Moodle page for this course which I will frequently use in distributing course materials, communicating with the class, etc. The Moodle page can be found at

- https://moodle.lafayette.edu/course/view.php?id=12994

Occasionally, it may be necessary for me to communicate additional information (scheduling changes, clarifications about homework problems, etc.) to the class as a whole. When I do so, I will use your official Lafayette email addresses for all course-related correspondence, so make sure to **check your Lafayette email regularly**.

Moodle Privacy Statement:

Please note that Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Mandatory Credit-Hour Statement:

The student work in this course is in full compliance with the federal definition of a four-credit-hour course. The full policy and practice statement can be found on the Registrar's Office website at

- https://registrar.lafayette.edu/wp-content/uploads/sites/193/2013/04/Federal-Credit-Hour-Policy-Web-Statement.doc

Winter-Weather Emergencies:

You should assume that class meetings will occur as usual, despite any weather-related issues (including power outages), even if campus offices open late or close early. In the rare event that class must be canceled, I will notify the class by email, and by leaving a voicemail message on my office phone, the number for which is (610) 330-5207.

In Closing

If you have any questions about this syllabus, or about any aspect of the course, please don't hesitate to contact me. True, the material we will be covering is challenging and quite abstract; however, it is also immensely rewarding. Systems which manifest oscillatory or wave phenomena appear seemingly everywhere in nature, and understanding them better will vastly enrich your understanding of the world around us, while the mathematical and computational skills you'll be practicing and honing in the process will serve you well in any field of physics – and in many fields outside of physics as well.