Spring 2018 Physics 152Q Syllabus

Lecture: Mon Wed Fri 12:00pm-1:05pm, Oxford Science Building 217
Lab: Thu 9:45am-12:45pm, Oxford Science Building 217
Instructor: Thomas Osburn (tosburn@emory.edu)
Office: Oxford Science Building 202
Office Hours: Mon 4:00-5:30 & Thurs 3:30-5:00
Student tutoring location: OSB Nucleus (second floor lobby)
Student tutoring hours: 7pm-9pm Tue & Thu (Olivia) and Wed (Tianshu)
Textbook: "Physics for Scientists and Engineers" 9th ed. by Serway and Jewett

The purpose of this course is to study electromagnetic interactions between matter and to quantify the influence those interactions have on how things move. Understanding these interactions will empower you to make accurate predictions about the world around you (e.g., hydraulic brakes, the mechanics of bridges, etc.). Accurate scientific predictions are the driving force behind technological developments that shape modern society. In particular, physics breakthroughs have been responsible for the industrial revolution, the age of electricity, computers, and more! This course will also help you appreciate how physics concepts are constantly being used in other sciences (i.e., chemistry, biology, geology, etc.). Finally, mastery of introductory physics will amplify your critical thinking and problem solving skills.

Goals of the Course

At the end of this course, we will be able to:

1. Explain the basic concepts, theorems, and principles of physics (and when they apply)
2. Recognize the limitations of these physical models (where the assumptions break down)
3. Apply these models to solve both simple and advanced (i.e., multiple-step or multiple-concept) physics problems by learning how to
    a. Deconstruct (i.e., break down) a big problem to its component "mini" problems
    b. Identify and analyze which scientific models apply to each "mini" problem
    c. Reconstruct the overall solution by combining results from the "mini" problems
    d. Think critically about whether your final answer is reasonable relative to the concepts you have learned
4. Develop an organized and systematic solution to a problem
5. Integrate multiple concepts/principles when analyzing a complex phenomenon
6. Recognize how physical models apply to our day-to-day experiences
7. Begin to develop the quantitative and modeling skills used by scientists and engineers
8. Understand the questions physicists ask and the tools they use in order to discover knowledge in this field. This is the Ways of Inquiry approach that is outlined in detail below.

Remember that **knowing how to use calculus and using calculus is NOT the same as understanding the underlying concept/principle/theorem. In this class you will be asked to do both!**

To achieve these goals, we will solve many problems, use laboratory exercises, and discuss real-world applications while employing the mathematical tools of algebra and calculus in the process. We will be learning a lot of important concepts/principles/theorems during this semester. For this reason, you will have daily and weekly assignments and frequent quizzes.

Student work submitted as part of this course may be reviewed by Oxford and Emory faculty/staff for the purposes of improving instruction and enhancing Emory education.

Ways of Inquiry

This course has been designated as an Inquiry course. Since you have taken Physics 151 or the equivalent, you have been exposed to the science of physics and have developed a basic understanding of some fundamental physics concepts. Therefore, in Physics 152 you will be able to explore at a deeper level what makes physics a unique and distinct science. Through this course and the homework assignments, you will be learning what questions physicists ask, what tools they use, and how they discover knowledge. By reflecting on and thinking critically about what and how you are learning, you will be able to become independent learners in this field. You will also appreciate the insight into nature that physics can give you and the connection between physics and other disciplines. For more details on how the "Ways of Inquiry" approach will be applied to this course, please see the last three pages of this syllabus.

Homework: All homework assignments and other announcements and handouts will be posted on Canvas. Therefore, **you are expected to check Canvas at least once a day**. Omission on your part to do so will not be regarded as a valid excuse for not completing an assignment. Homework assignments will be of three different kinds:

a) **Daily reading:** After each class, I will assign the reading that you are REQUIRED to do BEFORE coming to class the next time. The reading will consist of sections from the textbook that are already posted on Canvas. **I will be asking for your oral responses during class.** By doing the reading before coming to class, you will be better prepared to present the material and follow the discussion that will take place in class.
b) **Daily practice problems and review questions:** After every lecture you will be assigned a couple of problems and questions on Canvas from the handout "Electromagnetism Practice Problems." These problems will be much simpler than the Advanced Problems described in part (c) below (remember that these practice problems were written for the Physics 142 students). Thus, you should be able to do these problems before attempting the Advanced Problems described in (c) below. Use sheets of paper for the problems and keep them in a binder. I will be randomly collecting your solutions to the assigned practice problems (but not the answers to the review questions). Submission of the solutions to the assigned problems will count towards your Practice Problems grade (see section on Grading below).
c) **Advanced problems:** Each week I will also be assigning a set of five advanced problems. The due date of each set will be announced under the "Assignments" tab on Canvas. I will be collecting one or more of the problems in each set on the due date. Understanding how to do these problems will help you in preparation for the tests, as the tests will have problems of the same level of difficulty as these advanced problems. Submission of these problems will count towards your Advanced Problems grade (see section on Grading below).

Notice that there are many *daily* assignments. **The goal is to be looking at the material as often as possible so that you can actually learn it.**

Quizzes: There will be frequent quizzes on the material that was discussed in the lectures and homework assignments. Quizzes cannot be made up: If you miss class the day when a quiz is taken, then you will not receive a grade for that quiz. Just as with the homework assignments, my goal is to ensure that you

review the material frequently. You cannot possibly learn a concept/principle/theorem if you see it only once.

Tests and Exams: There will be three tests and one final exam (for dates, see below). The tests will be on the material discussed up until that point (the second test will cover the material after the first test and, similarly, the third test will be on the material after the second test). The final exam will be cumulative. There is no such thing as a make-up test/exam!

Re-grading Assignments: I am very careful when I grade assignments. However, I might make mistakes when I grade. If you would like me to re-grade a test/quiz/assignment, your request should be submitted to me **in writing within 24 hours** from the time I give back the graded assignment. Note that such a request will result in me re-grading the whole assignment/test/quiz (not just the specific problem you requested).

Attendance: I find attendance and class participation to be vital for your learning in this course. You will find the homework to be really easy to do, if you come to class and you actively participate by asking and answering questions. You are allowed **3 absences regardless of whether you have a valid reason for them or not.** Therefore, I recommend that you save those for when you really need them (e.g., you get sick) instead of skipping class. If you exceed the 3 absences, there will be a 5% deduction off of your final grade for every additional absence. **ATTENDANCE IS MANDATORY FOR LAB SESSIONS**.

Tardiness and Cell Phones: Being late for a class, or having your cell phone ring in the middle of one, is distracting not only for you but also for me and for your classmates. Students who are more than 5 minutes late will generally be considered absent. Food and drink is not allowed in class, with the exception of a bottle of water.

Grading: Grades are assigned on the plus-minus scale. The final grade will be determined based on the following weighting.

Practice problems and review questions: 5%
Advanced problem sets: 10%
Quizzes: 15%
Exam 1: 10%
Exam 2: 10%
Exam 3: 10%
Final Exam: 20%
Labs (lab questions, report, project): 20%

Grades to the assignments will be given based on correctness and, most importantly, on the methodology you use (see section on "How to solve a physics problem" below). So, especially for the homework, make sure that you start on it early, come to me for help, solve the problems correctly, and follow/show all the steps that a solution should have (draw a picture, draw a coordinate system, etc.)!

Course Content: Electricity, Magnetism, and Optics

Important dates: Make sure you include these important dates in your planner/calendar. The actual times for the tests will be determined but they will be out of class, on Friday afternoons.

Date	Description
Feb. 16, 2018	Test 1

Feb. 19, 2018	Draft for first full lab report due in class
March 9, 2018	Test 2 (be careful with travel plans for spring break!)
March 19, 2018	First full lab report due in class
April 13, 2018	Test 3
April 26, 2018	Second full lab report or final project presentation during lab session
Thursday, May 3, 2018, 2pm-5pm	Final exam: Cumulative

Working with the Honor Code: Completing college with academic integrity sets the foundation for a principled life. The Oxford College Honor Code (http://oxford.emory.edu/catalog/regulations/honor-code.html) is taken very seriously and applies to this course as follows:

Quizzes, tests, and final exam: The work presented in these assignments should be your own. No collaboration permitted. You are expected to follow the instructions given by me and abide by the Honor Code. Sharing calculators, pencils, etc., is not allowed.

Lab report, lab project: On these assignments you can only collaborate with your lab partner.

Advanced problems, practice problems, and review questions: You are encouraged to work on the assignments **by yourselves first, before consulting others (classmates, tutor, me, etc.) for help.**

Study groups: Even though you cannot work together on quizzes, tests, and exams, you are definitely encouraged to form study groups and study concepts together and explain to each other things about which you were not clear from class or from your reading assignments. However, as mentioned above, you are strongly encouraged to work on the homework assignments by yourself first, before consulting your classmates for help.

Accommodating Students with Disabilities: The Office of Accessibility Services (OAS) works with students who have disabilities to provide reasonable accommodations. In order to receive consideration for reasonable accommodations, please contact the OAS and complete the registration process. Faculty may not legally provide you with accommodations until an accommodation letter has been processed and discussed with them; accommodations do not start until this point and are not retroactive. Students registered with OAS who receive a letter outlining specific academic accommodations are thus strongly encouraged to immediately coordinate a meeting with their professors to discuss a protocol to implement accommodations that will (or may) be needed over the course of the semester. This meeting should occur as early in the term as possible. OAS can be contacted at (770) 784-4690 or oas_oxford@emory.edu.

Religious Holidays: Please make every effort to negotiate your religious holiday needs within the first two weeks of the semester; waiting longer may compromise your instructor's ability to extend satisfactory arrangements. If you need guidance negotiating your needs related to a religious holiday, the College Chaplain, Rev. Lyn Pace, ppace@emory.edu, Candler Hall 202, is willing and available to help. ***Please be aware that Rev. Pace is not tasked with excusing students from classes or writing excuses for students to take to their professors.* Emory's official list of religious holidays may be found at http://www.religiouslife.emory.edu/faith_traditions/holidays.html.

How to Solve a Physics Problem

Your homework assignments will consist of pre-lecture reading assignments, review questions and practice problems, and advanced problems. In your solutions to all problems (tests, practice problems, etc.), I expect to see that you solve the problems following several important steps. **This is the proper methodology for solving a physics problem and this methodology is the same for all problems!**

Following these steps will ensure that you are learning how to approach a problem and how to develop an organized and methodical solution to a problem (see section **Goals of the Course**).

1. **Read the problem** carefully so that you know what is given and what is asked.
2. **Draw a picture**. I cannot think of any physics problems that can be solved without drawing a good picture.
3. **Label all the quantities** in the diagram, those that are given and those that you need to find. Also, **show your coordinate system and show which direction you have defined as positive!**
4. **State the Physics Laws/Principles/Theorems** that apply to that problem and explain why. Here, I am not asking for an essay, a sentence is enough. For example: ``No external forces act on the system ➔ Conservation of Momentum applies."
5. **Write the law in equation(s) form**. To continue the example, at this point you will say: $\overrightarrow{P_{final}} = \overrightarrow{P_{initial}}$
6. **Solve** the equations and substitute the values. **Always include the units in your calculations!** Also, **show your work**! You cannot just write the initial equation and then the result. You have to show me the intermediate steps. This way, I can identify the wrong step and help you understand why what you did is not right.
7. **Check your answer**. Do the units match? Does the sign in front of your result make sense? Is the answer too big or too small compared to what you expected?

Requirements for the Lab portion of this course

As noted above, the lab portion of the course constitutes 20% of your grade. For the lab portion of the course the requirements are as follows:

1. Bring your lab handout: You will be given the lab manual at the beginning of the semester. You are expected to have read the lab handout for each week's lab BEFORE coming to the lab. Don't be surprised if there is a pre-lab quiz!
2. Answer all the questions in the lab handout: Some of these questions will require that you spend time at home analyzing the data. If you are asked to make a plot during the experiment or analysis then you are required to print out the plot and attach it to the lab questions. ALWAYS bring the answers to those questions in next week's lab for me to check. This will count towards your lab grade.
3. Understand the lab: Experiments require repetition in order to ensure that your data is reproducible. Sometimes students regard this repetition as "busy work." However, remember that at all times you need to be thinking about what your data means, if this is what you expected and why (or why not) and, also, what the reproducibility (or lack of) means. Essentially you are expected to be thinking about what conclusions you can draw from your data. Again, don't be surprised if there is a post-lab quiz to ensure that you have understood the data and the purpose of the experiment.
4. A full lab report (for due date, see the table above). For one lab experiment (I will announce which one) you will have to do one full lab report. I will give more detailed handouts on what a proper scientific lab report should look like when the time comes. The lab report will be corrected and graded and detailed comments will be given. If you desire, you can resubmit the lab report (after addressing <u>all</u> the comments) and the lab report will be re-graded, erasing in this way the first grade. You can only resubmit the lab report once. The reports will be written in groups of two. The grade on your full report will count as two short reports.

5. Towards the end of the semester you will be doing a small final project. For the final project you will have to pick a topic and experimental setup. Using the setup, you will explore some pre-determined questions but you will also be asked to develop and explore your own questions. Descriptions of the projects will be given later in the semester. We will have the last lab section of the semester devoted to the project presentations. The final projects will be group projects and the grade will count as two short reports.

Lab Schedule

The experiments we will be conducting this semester are on the following topics. Additional experiments might be added if time permits.

Lab 1: Class

Lab 2: Equipotential lines and the electric field

Lab 3: Measurement of capacitance

Lab 4: Basic electricity

Lab 5: The oscilloscope – RC circuits

Lab 6: The earth's magnetic field

Lab 7: Faraday's law

Lab 8: Final project

Lab 9: Optics

Lab 10: Final project presentations

Acceptable and unacceptable class/lab behavior

For our class and lab you are expected to

a) have done the reading and homework problems (i.e., you are expected to come prepared),
b) have all the things you will need during class and lab (your notebook, binder with the solved homework problems, calculator, lab manual, office supplies, etc.),
c) pay attention and take notes.

There are certain things that I have observed students do during class and lab that I find unacceptable. In those cases I ask the students to leave the classroom or laboratory and I count them as absent.

You cannot:

a) come to class/lab without having done the reading and homework problems,
b) come to class/lab without your notebook, binder with solved problems, calculator, lab manual, office supplies, etc.,
c) eat during class/lab,
d) drink during class and lab (except for water),
e) not pay attention by sleeping or being distracted,
f) distract other students,
g) text during class/lab.
h) be late for class/lab more than 3 minutes,

i) be disrespectful.

If you need to leave the classroom or laboratory for any reason, you should avoid being disruptive and distracting. Try to leave the class/lab quickly and with as little noise as possible. You should not have to leave the class/lab more than once.

This syllabus is subject to change at the discretion of the instructor.

Ways of Inquiry

Physics 152Q: General Physics II

Physics 152 is the second semester of the calculus-based introductory physics series. It is a course that is required of all students interested in majoring in physics, engineering, and other sciences. This course explores fundamental concepts/principles/theorems in electricity, magnetism, and optics. These principles have many applications, especially with regards to technological innovations that define our modern way of life. For the laboratory portion of this course, you will conduct some fundamental experiments that intend to deepen your understanding of the concepts. At the end of the semester, you will also conduct an open-ended, month-long inquiry-based experimental investigation of a content-related physics topic where you will have the opportunity to experimentally answer your own questions.

Asking the "right" questions: What (fundamental) questions will you learn to ask when dealing with this discipline?

In introductory physics the main goal for us is to answer the question of "Why?": Why do things work the way they do? Through this course, you will realize that the answer to this question comes by learning about some fundamental physical concepts, theorems, and principles. Though the question of "Why?" is at the core of this course, there are other questions that are equally important. Some examples include: When and how can I apply this theorem/concept/principle? What are the limitations of this concept/theorem/principle and why? How is this principle similar and different to other principles that we have learned (both in Physics 151 and in Physics 152)? What does this equation mean? How was this equation derived and why was it necessary to derive this equation? What assumptions are being made every time one uses this equation? By asking and answering these questions, you will develop a deeper understanding of the physical concepts/principles/theorems discussed in this course and, in the process, you will also learn to think like a physicist.

Using the "right" tools: What methods of analysis and argument will you learn to help you investigate questions in this discipline?

In the lecture part of the course, you will be asked to solve physics problems as part of the homework assignments. The physics problems will be of two different levels of difficulty: intermediate (practice problems) and advanced. The intermediate problems will require that you use two different concepts/principles to develop a complete solution, while the advanced problems will require more than two principles and/or a more abstract thought process. By solving these problems you will learn how to break down (i.e., deconstruct) a problem into its component "mini" problems and correctly identify and apply the concept/principle/theorem associated with each "mini" problem. You will also be asked to combine (i.e., integrate) multiple concepts/principles/theorems in order to analyze a complex

phenomenon (as is the case for many complex technologies). In the laboratory portion of the course, you will be using the scientific method as you conduct the experiments that are outlined in the laboratory manual. You have already been exposed to the scientific method in Physics 151 or the equivalent. Therefore, in Physics 152 you will feel more comfortable in the laboratory and, thus, you will be expected to show a deeper level of understanding of your data, how the data should be analyzed, and how your data verifies or falsifies your hypothesis. At the end of the semester you will also have the opportunity to develop your own hypothesis and experimentally verify/falsify it (final project.)

Actively practicing inquiry: How will you "discover" knowledge in this course? How will you actively practice the process of inquiry?

You will be discovering knowledge in this course both in the lecture and the laboratory components. You can get new insights into learned concepts/principles/theorems when you solve physics problems. Each problem can provide you knowledge with regards to a new application of the concept and a new way of combining (i.e., integrating) concepts. In essence, by combining principles/theorems and de-constructing problems you will be discovering knowledge through the homework assignments. In the laboratory, you will have the opportunity to actively discover the concepts that you have learned about in class on your own by using the scientific method. For example, by measuring the currents through and the voltages across the elements of a complicated circuit, you will be able to verify Kirchhoff's rules. Though the experiments are outlined in the laboratory manual, you will be expected, as mentioned above, to think more deeply and critically about your data and "discover" on your own the knowledge that you can obtain from your data.

The last four weeks in the course will be dedicated to an open-ended final project. By that point in the semester you will be more comfortable, knowledgeable, and experienced in the way physicists think about the world. Therefore, you will be ready to tackle an independent project in groups of two. You will be given a list of projects from which to choose. After conducting some preliminary experiments in order to familiarize yourselves with the chosen equipment, you will be asked to come up with your own question of what you would like to study with your setup. You will then need to develop your own experimental procedure, conduct the experiment, collect and analyze data, and draw conclusions. During the last week of the semester each group will give a presentation/demonstration to the class of the project. Therefore, you will discover first-hand how to develop a hypothesis and how the scientific method will result in your obtaining new knowledge by using concepts/principles that you have already learned.

Meta-level reflection: How will you be asked to reflect upon, question, and appreciate the ways of inquiry used in this discipline?

In the lecture part of the course, you will be asked to discuss and think critically about each learned principle and its limitations. Solving problems provides you with ample opportunities for reflection. For example, you will often ask me why it is that you can use one concept rather than another closely related concept to solve a problem. These assignments also allow you to question the applicability of the concept, which in turn causes you to wonder if a new, more encompassing principle/theorem needs to be developed. The process of deconstructing problems and integrating concepts will also help you appreciate this way of inquiry.

In the laboratory, the application of the scientific method provides opportunities for that kind of reflection, questioning, and appreciation. In your lab reports, you will be asked to think about your experiment and your data. For example, when you describe the error associated with your data, you will

have to discuss the limitations of your experimental setup and how you would improve it. You will also need to think about how your data verifies or falsifies your hypothesis. By consistently using the scientific method, you will be able to reflect on and appreciate its advantages and its general acceptance as *the* method of inquiry.

Finally, reflection is a major part of the open-ended final project because you must consider how concepts you have studied throughout the semester can be combined to explain a new laboratory scenario. In summary, this module provides the challenge, self-reliance, and the constant evaluation and revision of your own work.

Increasingly independent investigation: How, specifically, will your investigations become more independent over the course of the semester?

Since you enrolled in Physics 152, you have already taken Physics 151 or the equivalent. Therefore, at this point you have developed some basic understanding of the way physical concepts/principles are discovered and learned. In Physics 152 you will have the basic skills needed in order to be more independent investigators of the physical concepts/principles. The assignments in Physics 152 will consist of problems that will require a higher level (when compared to the assignments in Physics 151) of deconstruction and integration of the concepts. For example, principles/theorems that were learned in Physics 151 will be used for solving problems in Physics 152. In the case where you do not remember how to use a concept/principle/theorem learned in Physics 151, you will be asked to go back and remind yourselves. In other words, you will be encouraged and asked to answer your own questions in that regard, since you have had enough exposure to physics to be independent learners.

As explained above, in the laboratory you will be conducting experiments that are outlined in detail in the laboratory manual. However, as the semester progresses, you will be asked to address questions that arise from your acquired data but are not posed in the manual. Furthermore, as mentioned, at the end of the semester you will conduct a final project where you will develop your own hypothesis and study it. With regards to these final projects, you will be working independently, using me only as a reference source.

Connections to something bigger: What specific "real-world" questions, interdisciplinary connections, or ethical issues will you explore in an attempt to deepen your understanding and appreciation of the class content?

One cannot really talk about physics without discussing "real-world" applications. Physics 152, since it deals with electricity, magnetism, and optics, involves many applications that you can readily experience in the "real-world." One example that will be brought up in class has to do with the equipment in the Williams gym and you will be asked to think why the treadmills, for example, need to be plugged into electrical outlets while some of the ellipticals do not. These "real-world" questions address the core question in physics of "why does this work the way it does." In addition, the concepts learned in this course readily allow for interdisciplinary applications. For example electrostatic forces between charges, one of the main concepts we will learn in Physics 152, are fundamental in biology and chemistry. Optics becomes relevant when one discusses how light affects an artist's painting, for example. In this course we will not explore any ethical issues.

Appropriate assessment for inquiry-based learning: What specific assignments will you be asked to do, to demonstrate your increased abilities in reading critically, writing, analyzing, or speaking with clarity?

As mentioned, you will be asked to solve physics problems throughout the semester. In your solutions you are expected to demonstrate your ability to deconstruct problems and integrate concepts. This is a fundamental part of demonstrating your ability to analyze a physics problem. You are expected to follow the solution format, which is described in the syllabus in detail, and guide the reader through your thought process as you develop the solution. In the laboratory portion of the course, you will be asked to write multiple (approximately 8) short lab reports, and one full lab report (which can be submitted in drafts), in addition to the final project (which, as explained above, will be an independent project). All of these assignments will require that you analyze your work (experiment, data, hypothesis, etc.) critically. The full lab reports will contain all the parts of a published research paper (title, abstract, introduction, materials and methods, results, discussion, conclusion, and references.) Via the short lab reports and the drafts of the full report you can receive feedback not only on the quality of your writing but, also, on the depth of your critical analysis of your experiment and the acquired data. The final project will be a culmination of these efforts, since it will require you to independently work with a setup, study it, and leave you room for asking and answering your own questions.