Physics 142: PRINCIPLES OF CLASSICAL PHYSICS II

Winter, 2017

"It seems to me a superlative thing to know the explanation of everything, why it comes to be, why it perishes, why it is." — Plato

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Course Meeting times:
Section 1 MWF 10:40am-11:35am, Room: Kroehler 204
Section 2 MWF 1:20pm-2:15pm, Room: Kroehler 204

Laboratory Instructors: Prof. Horner, Prof. Bloom, Prof. Sinnott
Laboratory Times: Tues 9am-11:50am, Tues 2:00pm-4:50pm, Tues 6:30pm-9:20pm
Laboratory Room: Kroehler 102

Course Outline and Goals:
Physics 142 provides a calculus-based introduction to concepts in classical physics: dynamics; waves; optics; and interference. The goals of this course are:

- To develop an intuitive understanding of fundamental physical concepts.
- To use this conceptual understanding to quantitatively analyze and solve problems.
- To look beyond the textbook exercises and think about how these concepts apply outside the classroom.

Required Materials:
There is no required text for this class! However, we have 15 copies of "Physics for scientists and engineers, 3rd Ed." by Wolfson and Pasachoff on 2-hour reserve in the library. The topics we cover each day are listed in the schedule and I've indicated the chapters from the text that correspond. My goal is that if you don't want to purchase a textbook you don't need to-use the copies at the library. If you do want to purchase one, the text indicated above is old and relatively cheap, but not terribly different from other texts out there.

We will be using an online content management system called *Expert TA* to work homework problems with. Each week, you'll get a series of problems to do and through Expert TA you'll get some (hopefully) helpful hints and direction and will enter your solutions online. We use this system primarily so that you can be independent as you go about learning how to do physics. I'll be available, of course, to help you through these problems, but my goals is to make you independent and thoughtful scholars. We'll use Expert TA throughout the entire introductory

sequence and will cost a total of $55, or $55/3 per term. Use the following information to register for our course:

Registration Link:
https://www.theexpertta.com/registration/

Student Class Code:
USG15IL-643E72-1I2

A laboratory notebook is also required (ISBN 9781930882706).

Course Philosophy:
Substantial research-based evidence indicates Plato had a few ideas right – at least, when it comes to physics education: Physics knowledge cannot simply be put into your mind; *you* have to do work to learn physics concepts[1]. My role is to turn your mind's eye toward the sun; your role is to use your mind to perceive the sun.

Therefore, lectures in this course will be devoted to promoting *your* understanding of the concepts of classical physics, not repeating the text word-for-word. This requires commitments from you: you must read the assigned reading before coming to class, and you should be ready to participate in class. Be prepared for homework and exam problems based on material covered in the text but not in the lectures.

Much of the rationale for structuring the course is available in the syllabus for Physics 141, which I've made available on the Blackboard site. Physics 142 represents a departure from the traditional teaching pedagogy for the introductory physics sequence. When instructors and students in other majors are polled on what their expectations are from this course we consistently come away with three main goals, which are (not coincidentally) our goals for this course:

1.) Prepare critical thinking skills for future challenges.

2.) Frame physical phenomena in a way to stresses qualitative and conceptual understanding.

3.) Introduce students to interesting (and dare I say fun) physical phenomena.

Healthy Balance:
All members of the North Central community – students, staff, and faculty – have the responsibility to promote balance in their lives by making thoughtful choices. Balance results from two skills: avoiding imbalance through careful planning, and managing and containing imbalance when it occurs. This course will be demanding, but should not overwhelm your academic (let alone whole) life. If it threatens to, come talk to me, a tutor, friend, counselor, or advisor.

[1] See, for example, Hake, "Interactive-engagement versus traditional methods: A six-thousand-student survey", American Journal of Physics, 1998.

Physics 142 has the following key components:

Readings: Reading assignments for each day in the schedule are to be done BEFORE class starts. I expect you to read through the assigned reading. I reiterate- I WILL NOT lecture from the text and I will not cover each piece of material from the text during class time. Our time in class is focused on developing your conceptual understanding of the important physical principles. However, even if material isn't explicitly covered in class THAT MATERIAL IS STILL FAIR GAME FOR THE REST OF THE COURSE. I won't waste time on extensive definitions from the text. This implies that you can't read or think for yourself and you should be offended. Additionally, substantial research has shown (see Van Huevelen, 1991a[2] and 1991b[3] for instances) that devoting class time to re-presenting the material from the text doesn't enhance learning. You are an equal partner in your own education- If you don't do the assigned reading, you're not holding up your end.

Reading Quizzes: To further encourage you to read the text, there will be short Blackboard reading quizzes based on the reading due for most class periods. You must complete these quizzes by 10:00a.m. the day of class. Most of these quizzes will be short, multiple choice, and designed to make sure that you've done the reading and not that you've comprehended the deeper meaning of the material. You may use your book for these quizzes but you must do them on your own. The purpose of these assignments is to come to class prepared to hash out ideas. This approach, sometimes called "Just in Time Teaching" has been shown to be very effective (Novak *et al.*, 1999).

Class Time: Come to class. This is the time when we do the heavy lifting of the course together. Participation will account for a percentage of your final grade. While I won't be taking attendance in class I reserve the right to administer so-called "Lecture Tutorials." Lecture Tutorials are brief group exercises in which you and one or two partners will complete and extended example problem. The group will turn in the exercise DURING CLASS TIME and you will be assigned a grade: you will score a 2 for a good faith attempt at the tutorial; you will score a 1 for a poor attempt at completing the tutoring; you will receive a 0 if you don't turn in a tutorial or arrive late for the tutorial. Tutorials will be administered at my discretion without any advance warning. COME TO CLASS.

Because this course has a laboratory associated with it, you and I have 165 officially together each week. We'll meet Monday, Wednesday and Friday for 55 minutes. On most Mondays and Fridays, we'll engage the material with a combination of discussion, interactive conceptual quizzes, lecture tutorials, and other, yet to be determined work. On Wednesdays of most weeks, we'll either be engaged in a **Workshop Session** or a dedicated **Problem Solving Session**. In the former, you'll work in a small group to complete a guided worksheet that tackles a potentially

[2] A. Van Huevelen, "Learning to think like a physicist: A review of research-based instructional strategies," *Am. J. Phys.* **59**, 891-897 (1991a).

[3] A. Van Huevelen, "Overview, Case Study Physics," *Am. J. Phys.* **59**, 898-907 (1991b).

tricky topic from class. In the latter, we'll work through a series of problems together sometimes breaking out into groups and then presenting for the class.

Refer to the schedule for details on when we'll be in workshop and when we'll be solving problems. On all days where the class meets, we'll meet together for 55 minutes but I'll remain to answer questions for the 15 minutes rounding out the 70 minute time slot.

Peer Instruction: At the heart of my pedagogical philosophy is the importance of conceptual understanding. Each class period is broken up into a number topical discussions followed by a concepTest. The concepTest gives me feedback about how you have grasped a particular concept. CONCEPTESTS ARE NOT GRADED! ConcepTests by their very nature require peer-to-peer interaction and discussion. Research has shown (Mazur, 1997[4]) that it is very common that in a pair of students during peer instruction, one student has a better grasp on the concept than the other. RESEARCH ALSO SHOWS THAT THIS DIFFERENCE IN CONCEPTUAL UNDERSTANDING IS NOT A REFLECTION OF INHERENT ABILITY. THIS DIFFERENCE IS A REFLECTION OF DIFFERENT BACKGROUNDS.

Research also shows that during peer instruction, both people improve their understanding of the concept by attempting to explain their positions during the ConcepTest. This pedagogical approach relies on all students taking part in the peer instruction. I want to make it absolutely clear that your peers' grades in the course HAVE NO IMPACT ON YOUR GRADE. GRADES ARE DETERMIEND ON AN ABSOLUTE SCALE. Thus there is absolutely no incentive for you not to participate. Your grade will not be determined based on a curve and grades will not be scaled at the end of the course. While the average grade in this course has traditionally hovered around a B there is no reason why it can't be an A.

Homework: This course requires reading of the textbook prior to class and because of this I've attempted to reduce the amount to homework so as to not overwhelm you the student. There will be regular homework sets of (what I think of as) reasonable length. There will be a mix of conceptual and quantitative problems. While class time is heavily focused on conceptual understanding and qualitative problem solving, homework problems will require significant computation. Homework problems will discourage formula seeking. A focus on qualitative analysis over quantitative analysis, in an active-learning environment, somewhat counter-intuitively, results in students doing better with basic quantitative problem solving (Hake, 1998[5]). As such, while you will get less practice in class with quantitative problem solving, your skills will improve *faster* than in traditional lecture.

Examinations: There will be one midterm and a final in this course. Many of the exam questions will be based on homework, reading quizzes, ConcepTests, and Lecture Tutorial questions; the rest will be based on your readings and the lab exercises. The final examination will be cumulative, while emphasizing material covered since the midterm. Exams will be

[4] E. Mazur, *Peer Instruction: A User's Manual*, Prentice-Hall, Upper Saddle River, NJ, 1997.

[5] R. R. Hake, "Interactive-engagement vs. traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses," *Am. J. Phys.* 66, 64-74 (1998).

closed book and closed notes. Quite frankly, if you spend all your study time memorizing equations and formulae, you will not do well on the exams. I care so very little about the final numerical answer that it will be a shockingly small fraction of the point total for any given exam question. I want to test your ability to break down a problem into its most basic elements, qualitatively understand the problem and potential solutions, and check to see that your solution makes sense. Because I wish to discourage equation seeking and memorization of equations, I will provide you with an equation sheet containing all the equations you'll need. I'll make copies of this equation sheet available for you well in advance of the exam; however, you won't be allowed to bring any notes to the exam itself and fresh equation sheets will be provided at the exam. You may use a calculator for any necessary computation, but you will not be allowed to store information in it that may be potentially useful on the exam. You may not use a cell phone, PDA, smart phone, or any other device that could connect to the internet as your calculator. If you don't have a calculator, I'm more than happy to provide one to you.

The use of Calculus:

"To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature... If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in."

—Richard Feynman (The Character of Physical Law (1965) Ch. 2)

*C*alculus it is requisite for this course and but quite frankly the mechanics of calculus isn't our focus. Rather, we'll use practical calculus to help us to understand physical phenomena and hopefully we'll begin to "think with calculus." This applies to other mathematical topics that will appear in this course, such as vectors.

Weighting: All exams are closed book and closed notes. Unless I say something along the lines of "you won't need to remember this," assume that you will, in fact, need to remember it. You may use a calculator on exams, but ONLY FOR COMPUTATION. You are NOT allowed to store information or connect to the internet with devices such as PDA's.

LABORATORY EXERCISES: Eight times during the term you will meet in one of four separate laboratory sections (see schedule). We will discuss the labs in more detail when we have our first meeting.

Course Grade:

Participation/Quizzes	**5%**
Reading Quizzes	**5%**
Homework	**30%**
Laboratory	**20%**
Midterm Exam	**20%**
Final Exam	**20%**

Grades are determined on an absolute scale and the grade breakdown follows the college. This is done to encourage peer instruction and interaction and to discourage an ultra-competitive atmosphere in class. A = 100-90%, B = 89-80%, C = 79-70%, D = 69-60%, F = 59% and lower. I set no quota for the number of grades I hand out; I would be ecstatic and pleased beyond all reasonable measure to give all A's to a class that earned it.

COMMUNICATION: An important asset in any field is the ability to communicate your ideas clearly. With this in mind, I expect all homework, quiz and exams to be written legibly and presented neatly. Plots and figures MUST be labeled accurately and captioned if necessary. Finally, your answer to any question MUST include the appropriate units, if applicable. This is crucial not only to conveying an answer intelligibly, but also to checking the validity of your answer; after all, if you find that an electron has a speed of 25 kg/m, you know something must be wrong!

ATTENDANCE & MAKE-UP POLICY: Attendance is extremely important in this and all classes, given the 10 week pace of the term, and the extensive ground we will cover in that time. Attendance will be measured informally as well as through such activities as the Lecture Tutorials. All assignments are due on the day given in the class schedule. Make-up midterms will be possible ONLY if I am notified prior to the exam AND I approve the excuse. Any make-up exams are to be taken before the date listed on the syllabus.

ACADEMIC DISHONESTY: Academic dishonesty of any sort will not be tolerated. Academic dishonesty includes, but is not limited to, plagiarism, cheating on exams, falsifying experimental data, and providing unauthorized aid to another student. When working with others, or receiving help from CTL tutors, you must include an acknowledgement of those with whom you worked. That includes me. Plagarism, cheating and academic dishonesty will treated seriously and the college's policies will be enforced.

ADA AND ANTI-DISCRIMINATION STATEMENT: In compliance with the Americans With Disabilities Act (ADA), all qualified students enrolled in this course are entitled to reasonable accommodations. It is your responsibility to contact student academic services to work out accommodations. Please note, this must be done on a course by course basis, i.e., you must discuss specific accommodations for this course. I'm happy to discuss any of these issues with you at any time, BUT, do not come to me the day before the exam and request accommodations. I am strongly committed to ensuring that the antidiscrimination policy established at NCC will be honored in my class.

Let's do this!