Physics 2426 Principles of Physics II

Instructor

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Office Hours: MW 9:00 – 10:30 am, TT 8:00 – 9:00 am, F 8:00 – 11:00 am
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Course Description

Content

Fundamental principles of physics, using calculus, for science, computer science, and engineering majors; the principles and applications of electricity and magnetism, including circuits, electromagnetism, waves, sound, light, and optics; experimental design, data collection and analysis, and preparation of laboratory reports; with emphasis on problem solving.

Prerequisites

Completion of PHYS 2425 – Principles of Physics I and MATH 2414 – Calculus II is required before taking Physics 2426.

Textbook

The textbook is *Matter & Interactions, 4th edition* by R. Chabay and B. Sherwood (John Wiley & Sons, 2015). Textbook Errata are at http://matterandinteractions.org/errata/.

Course Overview

This course deals with electric and magnetic interactions, which are central to the structure of matter, to chemical and biological phenomena, and to the design and operation of most modern technology. The ***main goal*** of the course is to have you engage in a process central to science: ***modeling a broad range of physical phenomena using a small set of powerful fundamental principles.***

Approach

The course will emphasize rigorous problem-solving in physics using a student-centered active learning environment. Class sessions will require students to be responsive, to think, and to perform hands-on tasks. Key concepts of new material will be discussed in short lectures. Lab time will be interspersed with classroom discussion. If you devote a sufficient amount of time each day to studying physics, you will be in a position to attack physics problems efficiently, based on a clear understanding of the fundamental physical principles that underlie all successful analyses.

Collaborative Work

This course encourages collaborative teamwork, a skill that is valued by most employers. As you study together, help your partners to get over confusions, ask each other questions, and critique each other's homework write-ups. Teach each other! You can learn a great deal by teaching. But remember that you are responsible for understanding all details of a problem solution.

Study requirements

In addition to your time in class each week, you are expected to spend about 10 hours studying outside of class. If you typically spend less than 8 hours in outside study, you are unlikely to be able to learn the material. Less well prepared students may find they need to spend even more time than this. If you typically spend more than 12 hours in outside study, it is extremely important that you consult with me about ways to study more efficiently.

It is important to keep up with the class. New concepts introduced in this course build on earlier ones, so mastering key concepts is critical. If you get behind, seek help right away!

Attendance policy

Attendance and effort are vital to success in this course. Class attendance keeps you well connected to the course, so that you know at all times what's going on, what are the most important points, etc., and gives you opportunities to ask questions and clear up confusions. Therefore, students are expected to be in attendance for every class session. However, everybody gets sick, has some emergency, needs to care for a friend or family member or similar stuff now and then. Therefore, all students will be allowed two excused absences, no documentation required. The third and fourth absences will be unexcused and after a fifth absence you will be dropped from the class. Missing only lecture, missing only lab, or missing both will all be considered an absence. Chronic tardiness or leaving lab early will also be considered an absence (arriving late or leaving early three times will be considered one absence). If you stop attending class and wish to avoid an "F" you must obtain an official drop form, have it signed, and take the completed form to the registrar's office before your fifth absence. See the current class schedule for the last day you can drop a class.

Assignments

WebAssign

Online homework and reading assignments will be delivered and graded on WebAssign, a web-based homework system. WebAssign provides immediate feedback on the correctness of your answers and allows you to make another attempt on problems you initially miss. WebAssign access codes come packaged with a new textbook if purchased from the SPC bookstore or can be purchased online.

Readings

A key component of the course is the textbook, in which you are asked to analyze phenomena, to work out small examples, to make some of the steps in derivations, etc. *Class discussion will not cover all of the assigned material; it is essential that you study the textbook carefully.* You should work all the checkpoint questions in each reading assignment and seek help on any that give you difficulty.

Class sessions will be devoted to *discussion* of ideas, clarifying points of confusion, and activities of various kinds that allow you to practice using the concepts you have read about in the text. The text thus provides the *background* for these activities. *Therefore, it is essential to read the appropriate sections in the textbook BEFORE coming to class.* Your time in class will be largely ineffective if you have not studied the appropriate text sections prior to coming to class.

A reading assignment quiz will be due in WebAssign before the start of each class session.

Homework

Homework will consist of two components, online homework and written homework. Online homework will consist of a WebAssign assignment due each week. For most problems in these assignments, you are allowed two free submissions per question part and a third submission that, if used, will incur a 25% penalty to your score on that part. It is therefore extremely important that you work each problem carefully on paper, in great detail, before submitting your answers. This practice is vital to learning the material and will also help you when reviewing the assignments before a test. Written homework will consist of two problems each week requiring detailed written solutions. Writing good solutions provides practice in communicating your thinking process in a clear and precise way. Engineers (as well as professionals in other technical areas) actually spend a significant amount of time communicating their ideas in a way that is comprehensible to others. Being able to write clearly is an important skill for an engineer. You will also find that writing good explanations of your thinking process will improve your understanding of the physics concepts you are studying. Communicating your thinking process on paper will require writing sentences and paragraphs in addition to equations and formulas. A well written solution will include verbal explanation stating what physics principles are used, appropriate well-labeled diagrams, symbolic solution before numerical values are substituted, and correct numerical result with correct number of significant figures and correct units. Students whose work is excessively messy or poorly explained will be asked to rewrite the assignment.

Course Portfolio

You will maintain all your course work in a three-ring binder. The binder must have separate sections for your checkpoint solutions, online homework solutions, written homework solutions, and lab work. You may also include sections for your reading notes and class notes if you want. These materials may be collected for inspection at any time. Please make certain that you keep your portfolio up-to-date and bring it with you to every class meeting and when seeking help during office hours. Maintaining a well-organized, up-to-date portfolio will provide you an extremely useful tool for reviewing before exams.

Getting help with assignments

You should ask lots of questions in class to clear up any initial confusion you might have about a topic. I also encourage you to avail yourself of my help during office hours. You do not have to wait for my official office hours to get help; anytime I am in my office you are always welcome to come get help. If you fall behind for any reason, please let me know as soon as possible. The sooner I know about these situations, the better I can help you make up work. I will do what I can to help you complete the course satisfactorily.

Laboratory

During lab you will typically work in groups of three students on the following three kinds of activities:

- Experiments, involving measurement and analysis of data according to fundamental principles.
- Computer modeling, involving constructing 3-D models of electric and magnetic fields and their effects on charged objects. This will involve the VPython programming language. No previous programming experience is needed – I will teach you the basic concepts needed. Some computer modeling activities may need to be finished outside of class.
- Group problem solving, involving work on large, complex problems. In lab you may begin work on a large problem to be completed outside class or the entire problem may be solved during class.

You must attend class during the day the lab is done in order to receive credit. If you have an excused absence, you will be excused from the lab you missed, and your lab average will be taken from your remaining labs. If you miss a lab, you should work with your classmates to be sure you understand the missed lab activities since these will be covered on tests.

Semester Project

Semester projects will be chosen in consultation with the instructor. Possibilities include numerical simulations that expand beyond what we do in lab, an experimental project carried out and reported by the student, extended analysis of a challenging, more realistic problem to demonstrate application of fundamental physics principles, or some other creative project you get approved as long as it demonstrates mastery of the basic physics principles studied. You must decide on your project and have it approved by the instructor before the midterm exam. Final project reports will be due the week before the final exam.

Exams

Midterm exam

A single midterm exam will be given approximately half way through the semester. The date of the exam is shown on the course calendar. The exam will be closed-book, but some relevant formulas and constants will be provided. If you have an excused absence, you will need to contact me to make up the missed exam.

Final exam

A comprehensive final exam will cover all of the course material. The final exam will be closed-book, but some relevant formulas and constants will be provided. It will be given during the scheduled final exam time as shown in the schedule of classes and on the course calendar.

Grade calculation

Your final grade will be assigned based on your overall, weighted class average using the weighting scheme shown below:

Weighting Scheme		
Task	Code	Weight
Reading	R	10%
Online Homework	OH	15%
Written Homework	WH	15%
Lab	L	10%
Semester Project	P	10%
Midterm	M	20%
Final	F	20%

The letter grades will be based on a fixed scale as follows:

A: 89.5 – 100 B: 79.5 – 89.5 C: 69.5 – 79.5 D: 59.5 – 69.5 F: below 59.5

If everyone in the class does well, grades are not curved downward. Everyone can get an A. There usually is a "gray area" between two letter grades for borderline cases (grades within 0.5 points of the break point). Earning the higher grade in these cases depends on your interactions in class and whether your test and homework performance shows improvement during the course of the semester.

Miscellaneous information

In this class, the teacher will establish and support an environment that values and nurtures individual and group differences and encourages engagement and interaction. Understanding and respecting multiple experiences and perspectives will serve to challenge and stimulate all of us to learn about others, about the larger world and about ourselves. By promoting diversity and intellectual exchange, we will not only mirror society as it is, but also model society as it should and can be.

Students with disabilities, including but not limited to physical, psychiatric, or learning disabilities, who wish to request accommodations in this class should notify the Disability Services Office early in the semester so that the appropriate arrangements may be made. In accordance with federal law, a student requesting accommodations must provide acceptable documentation of his/her disability to the Disability Services Office. For more information, call or visit the Disability Services Office at Levelland (Student Health & Wellness Office) 806-716-2577, Reese Center (Building 8) 806-716-4675, or Plainview Center (Main Office) 806-716-4302 or 806-296-9611.

South Plains College does not discriminate on the basis of race, color, national origin, sex, disability or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Vice President for Student Affairs, South Plains College, 1401 College Avenue, Box 5, Levelland, TX 79336. Phone number 806-716-2360.

If you are pregnant, or have given birth within six months, Under Title IX you have a right to reasonable accommodations to help continue your education. To activate accommodations you must submit a Title IX pregnancy accommodations request, along with specific medical documentation, to the Director of Health and Wellness. Once approved, notification will be sent to the student and instructors. It is the student's responsibility to work with the instructor to arrange accommodations. Contact Crystal Gilster, Director of Health and Wellness at 806-716-2362 or email at cgilster@southplainscollege.edu.

Core Objectives Addressed in this course:

As a part of the Texas Core Curriculum established by the Texas Higher Education Coordinating Board (THECB), the following core objectives will be addressed in this class:

Communication Skills – effective development, interpretation and expression of ideas through written, oral, and visual communication

Critical Thinking Skills - creative thinking, innovation, inquiry, analysis, evaluation and synthesis of information

Empirical and Quantitative Skills - manipulation and analysis of numerical data or observable facts resulting in informed conclusions

Teamwork - ability to consider different points of view and to work effectively with others to support a shared purpose or goal

Course Objectives

Learning objectives students should achieve to successfully complete this course:

1. Describe how the field concept is employed to explain the interaction between charged objects.
2. Calculate electric and magnetic fields due to collections of individual source charges and/or continuous distributions of source charges. Sketch a diagram using arrows to show the electric or magnetic field.
3. Calculate forces exerted by electric and magnetic fields on charges. Use these forces in analyzing the motion of charges in the fields.
4. Produce computational models displaying the electric or magnetic field of various charge arrangements and predicting the motion of a charged particle in the field.
5. Describe the effects of electric and magnetic fields on matter, using appropriate sketches of charge arrangements in and on the material and mathematically relating polarization, drift speed, current density, and Hall voltage to the fields.
6. Use conservation of charge to reason both qualitatively and quantitatively about processes involving the rearrangement of charge in and/or on both insulators and conductors and about the steady state current in a circuit.
7. Mathematically relate electric field, electric potential, and electric potential energy and apply conservation of energy to the motion of charged particles in electric fields.
8. Use superposition to find the electric potential of a collection of point charges or a continuous charge distribution and calculate differences in electric potential in and around conductors and insulators.
9. Describe current flows in terms of surface charge distributions, discussing both steady state and transient behavior. Apply conservation of energy to circuits with steady state current flows.
10. Relate the macroscopic and microscopic descriptions of circuits and analyze simple circuits in terms of the macroscopic properties of resistance, capacitance, current, and potential difference.
11. Use Gauss's law and Ampere's law to relate charge and current to the patterns of electric and magnetic fields in space and use this to calculate electric and magnetic fields from sufficiently symmetric charge and current arrangements.
12. Use Faraday's law to relate time-varying magnetic fields to electric fields, calculating the emf and induced current produced around closed circuits.
13. Use inductance to relate the changing magnetic field flux in a coil to the induced emf along the coil. Analyze simple circuits including inductors.
14. Explain the necessity of the term Maxwell added to Ampere's law. Demonstrate the consistency of a simple traveling pulse of electromagnetic field with Maxwell's equations and enumerate the conditions needed for this consistency.
15. Calculate the radiative electric and magnetic fields produced by an accelerating source charge.
16. Calculate the energy density in electric and magnetic fields and use the Poynting vector to relate the energy flux and momentum flux to the electromagnetic field.
17. Use re-radiation to explain various effects of radiation on matter such as scattering, why some materials are opaque, polarization, resonance, absorption, reflection, and refraction.

Calendar

Phys 2426.001 Fall 2019

Week	Tuesday		Thursday	
	Readings	Topics	Readings	Topics
1	08/27	Course Introduction; WebAssign Registration	08/29 **13.1 – 13.5**	Electric Charge; Electric Force; Electric Field of a Point Charge; Superposition Lab – Glowscript/VPython Review/Intro
2	09/03 **13.6 – 13.9**	Electric Field of a Dipole; Retardation Lab – VPEM01: Electric Field of a Point Charge	09/05 **14.1 – 14.4**	Charged Particles in Matter; Conservation of Charge; Polarization Lab – VPEM02: Electric Field of a Dipole
3	09/10 **14.5 – 14.8**	Polarization of Conductors; Properties of Metals in Equilibrium; Charging and Discharging; Feedback Lab – VPEM03: Motion in a Dipole Field	09/12 **15.1 – 15.2**	Calculating Electric Field of a Distributed Charge: Uniformly Charged Thin Rod Lab – Problem Solving
4	09/17 **15.3 – 15.4**	Calculating Electric Field of a Distributed Charge: Uniformly Charged Ring, Uniformly Charged Disk Lab – Problem Solving	09/19 **15.5 – 15.9**	Calculating Electric Field of a Distributed Charge: Capacitor, Spherical Shell, Solid Sphere Lab – VPEM04: E-Field of a Charged Rod
5	09/24 **16.1 – 16.5**	Electric Potential Energy; Electric Potential; Relating Potential and Field Lab – VPEM05: E-Field of a Charged Ring	09/26 **16.6 – 16.11**	Calculating Potential using Superposition; Field and Potential in Insulators; Electric Field Energy Density Lab – Problem Solving
6	10/01 **17.1 – 17.6**	Magnetic Field; Biot-Savart Law; Electron Current and Conventional Current; Biot-Savart Law for Currents Lab – Experiment: Measuring Potential Differences	10/03 **17.7 – 17.10**	Magnetic Field of Current Distributions: Long Straight Wire, Loop; Magnetic Dipole Moment Lab – VPEM06: B-Field of a Moving Charge
7	10/08 **17.11 – 17.14**	Bar Magnets; Atomic Structure of Magnets; Solenoid Lab – Experiment: Measuring B-Field of a Wire	10/10 **18.1 – 18.3**	Current in Different Parts of a Circuit; Electric Field and Current Lab – Experiment: Magnetic Dipoles
8	10/15 **18.4 – 18.8**	Surface Charge Model of Electric Circuits Lab – Experiment: Measuring Current	10/17	**Midterm Exam**
9	10/22 **18.9 – 18.11**	Energy in Circuits; Using Conservation of Charge and Energy to Analyze Circuits Lab – Experiment: Investigating Simple Circuits	10/24 **19.1 – 19.4**	Capacitors; Non-Steady State Conditions in a Circuit; Resistors; Power in Circuits Lab – Experiment: Capacitors
10	10/29 **19.5 – 19.8, 19.11**	Batteries; Meters; Quantitative Analysis of RC Circuits; More Complex DC Circuits Lab – Experiment: Real Batteries	10/31 **20.1 – 20.4**	Forces Produced by Magnetic Fields; Hall Effect Lab – Experiment: DC and RC circuits
11	11/05 **20.5 – 20.7**	Motional emf; Magnetic Torque Lab – Problem Solving	11/07 **20.8 – 20.9**	Potential Energy of a Magnetic Dipole; Motors and Generators Lab – Constructing a Simple Motor
12	11/12 **21.1 – 21.5**	Patterns of Electric Field: Gauss's Law; Gauss's Law for Magnetism Lab – VPEM07: Moving Charge in B-Field	11/14 **21.6 – 21.10**	Patterns of Magnetic Field: Ampere's Law; Maxwell's Equations; Differential Form of Gauss's and Ampere's Laws Lab – Problem Solving
13	11/19 **22.1 – 22.4**	Changing Magnetic Fields and Curly Electric Fields: Faraday's Law; Maxwell's Equations Updated Lab – Experiment: Faraday's Law	11/21 **22.5 – 22.10**	Superconductors; Inductance; RL and LC circuits; Peculiar Circuit Examples; Differential Form of Faraday's Law Lab – Problem Solving
14	11/26 **23.1 – 23.4**	Maxwell's Equations in Final Form; Electromagnetic Waves; Accelerated Charges Produce Radiation Lab – Problem Solving	11/28	Thanksgiving – No Class
15	12/03 **23.5 – 23.7**	Energy and Momentum in Radiation; Effects of Radiation on Matter; Light Propagation through Matter Lab – Problem Solving	12/05 **23.8 – 23.10**	Refraction and Snell's Law; Thin Lenses; Image Formation Lab – Experiment: Thin Lenses
16	12/10		12/12	**Final Exam – 8:00 to 10:00 am**