Physics & Astronomy 222 – Fundamentals of Physics – S
Spring Semester 2019 – 3 Credit Hours
Online Learning

Instructor

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University email is preferable to a phone call, and will provide you with a written response you can save. Video conferences in my "virtual office" are available too, through the Zoom conferencing system if you have a microphone and webcam, or an Android cellphone or Iphone. Please send an email first to set up an appointment and for connection instructions.

Objectives

Physics is the foundation of the sciences that enable us to understand the universe on the largest and smallest scales, from the beginning of time to its uncertain future. It is also the practical basis of contemporary technology, engineering, medicine, and biology.

In this second of a two-semester sequence on the fundamental concepts and methods of physics we will explore how physics works, learn the necessary math concepts to use it, and apply it to electromagnetism and electronics, light and optics, quantum mechanics, and relativity.

The objective of this course is to incorporate physics into your critical thinking skills, and to develop your ability to understand and solve problems using the fundamental concepts of physics and a reasoned approach that seeks simplification leading to quantitative understanding of how nature behaves. This is a pre-professional course and is one of two semesters that together cover much of "classical physics". We will not ignore the really interesting new developments though, and we will develop a foundation that will

- Help you understand (and cope with) physics encountered in everyday life: LED light bulbs, microwave ovens, and car parts.
- Provide a basis for understanding the latest developments about science you will hear in the news: colliding blackholes, global warming.
- Apply physics principles to astronomy, geology, biology, chemistry, medicine, engineering, music, and yes, to cats.
- Recognize that while physics does not explain everything, it does predict observable effects through sometimes intangible, invisible, and not fully understood processes.

- Present you with mysteries not yet solved, perhaps so that you may solve them in the future and win a Nobel Prize giving due credit to your physics class.
- Teach physics that you may apply to make life better for yourself and others now, and in the future.
- Open your mind to new discovery by knowing that the world should be understandable.

Cardinal Core Outcomes and Assessments

Natural Sciences are concerned with understanding the laws of nature and the physical world. Students who satisfy the Cardinal Core requirement for Natural Sciences will be able to do all of the following:

1. Demonstrate an understanding of the nature and methods of science inquiry.
2. Apply scientific principles: to interpret evidence, to make predictions, and/or to explain cross-cutting concepts in one or more of the sciences.
3. Explain how scientific principles relate to issues of personal and/or societal importance.
4. Communicate effectively an understanding of scientific concepts and experimental outcomes in speech or writing, using sound scientific terminology and citation appropriate to the discipline.

In this course these outcomes will be assessed through online weekly quizzes, and three longer tests. A monitored online forum for class discussion of topics posed both by students and by the instructor will encourage students to develop their knowledge, deeper understanding of the science, and the skills to communicate effectively with others.

Outcome 1

Demonstrate an understanding of the nature and methods of science inquiry.

The course covers how we have come to understand the entire universe through physics and emphasizes in this first semester the motion, energy, gravity, heat, thermodynamics and sound. This embodies many of the elements that begin even before written history but continue to this day especially in applications as a basis for atmospheric science, energy generation and Earth's energy balance, space exploration, mechanical and civil engineering, bio-mechanics, and bio-medical devices. A second semester continues with electricity, magnetism, optics, relativity and quantum phenomena. Understanding the roles of individual scientists and their contemporaries, the methods enabling their discoveries, how their knowledge was communicated, and the current process of scientific enterprise, is part of the course content and is tested in quizzes and exams. Additionally, thoughtful questions posed to others in the class are encouraged to engage one another in analysis of the topics at hand, and to develop communication skills.

Outcome 2

Apply scientific principles: to interpret evidence, to make predictions, and/or to explain cross-cutting concepts in one or more of the sciences.

While physics is based on observation and measurement, the analysis of the observations leads to a broader understanding of the fundamental natural laws that simplify the apparent complexity of the natural world. The emphasis in this course is on understanding what those facts tell us about the universe, how we come to those conclusions, and what the uncertainties are in that process. These fundamental ideas of physics unify our understanding of the current state of the universe, and allow us to predict or model its future. Examples span from our everyday experiences to those we can only imagine. They include musical instruments and their sounds, flying airplanes and crashing automobiles, subatomic particles and the one that gives mass to matter, radioactivity and nuclear power, Earth's energy balance and global temperature rise. This content is included on the weekly quizzes and exams as appropriate for the topics at hand.

Outcome 3

Explain how scientific principles relate to issues of personal and/or societal importance.

The role of science in modern society is a topic that recurs throughout this class, especially in the context of technology that depends on physics. We look at how things work with their dependence on the principles of mechanics, electricity, magnetism, thermodynamics, quantum mechanics and relativity. We also explore topics of immediate pressing concern such how modern society generates the energy it needs, power from the Sun, the Earth's global temperature rise, and beyond Earth to consider space exploration. During the term we also look at the ways in which society supports scientific discovery, and the benefits and costs of that enterprise, often based on selections from current news or exciting developments in fundamental and applied physics. This content is included in the weekly quizzes and longer tests.

Outcome 4

Communicate effectively an understanding of scientific concepts and experimental outcomes in speech or writing, using sound scientific terminology and citation appropriate to the discipline.

There are required written responses to posed questions on the quizzes and exams. The topics for these questions are explored in a discussion forum for the class that invites participation by everyone, so that skills to communicate scientific concepts develop during the course when students explain those concepts to one another, and pose questions to their peers. The forum is mentored, and the written responses on quizzes and tests become part of the class grade.

Requirements

The class website will guide you through about 12 different weekly topics over the semester, and will pose specific ideas and questions to consider in that context. While you study, you are expected to use the discussion forum on the website with other students in the same way that you would work with one another for any class. This is a very important part of

the class and we monitor the forum to see where you are having difficulty. We encourage collaboration and peer instruction because our goal is to have you learn by whatever means you find most helpful, but of course you must do your own work. We will try to resolve questions you may have for the class as a whole through the discussion forum whenever we can, and to respond to email individually as needed.

Use the discussion forum, take your time to understand, ask questions when you need help, and remember the objective is to learn how to observe, reason, and use your growing knowledge and skill to understand our universe. Individual and group assistance through email, Google Hangouts, our Zoom video conferencing system, or telephone is available on request.

Each week the class website has new web-based content, suggested readings, and an interactive review. There is a graded quiz on Blackboard over the week's content that may be taken any time from Saturday morning through the end of day Monday midnight(US Eastern Time) at the end of each week. There will be three longer exams administered through Blackboard, one at midterm, one at the end of the course, and one during the final exam period. The midterm and second exam are also open from Saturday through Monday, while the final is offered in a three day window during the final exam period. Details are on the schedule at the end of this syllabus.

We will send email reminders weekly about the quizzes and exams. If you are at all confused about what you need to do, please post a question on the forum or send me an email.

Websites

The University's Blackboard system is its gateway to Distance Education programs:

http://blackboard.louisville.edu/

Use your University *User ID* and *Password* to log into Blackboard for the quizzes, exams, and announcements. For this Fundamentals of Physics class, however, all of the content will be managed on our program website at

http://prancer.physics.louisville.edu/moodle

This site is available only to registered students, and it requires a personal password that is different from your university computer password. Instructions on how to use this system will be posted on Blackboard and sent to registered students by email on or before the first day of classes. Please contact Professor Kielkopf if you have not received this by the second day of classes, or if you have difficulty logging into the website. The University's Help Desk can only respond to questions about Blackboard.

Textbook

The content will be provided online through the class website. For additional help, the recommended text for the course is

It is made available under the auspices of Rice University and other donors **for free** online at

https://openstax.org/details/college-physics

Click "Download a PDF" or links on the class website or Blackboard. It is also available in a high quality paper copy through Amazon. This is a comprehensive general college physics textbook that uses algebra. It covers two semesters in more detail than we will be able to cover this first semester, but has many worked problems and illustrations you will find helpful. Selected readings will be indicated in the on-line website for the class.

If you have a background in calculus, there is a similar Openstax book that is calculus-based but we do not use it explicitly in this course.

In many cases, simply by using Google and looking for an appropriate entry in the Wikipedia you can find an answer to basic astronomy and physics questions, and links to far more detail than most textbooks provide. If you follow this suggestion, be selective in accepting answers from Internet resources. Wikipedia has proven to be very reliable, as are the sites supported by NASA. There will be selected links to these resources on the class website.

Information on useful software and other materials will be provided online. While we are working to provide all content through advanced web-based technology, access to a desktop or laptop rather than a tablet or cellphone may be necessary for some of the required work. If you have problems with class content or on-line software, please use our website and post your question to the Discussion Forum. Often other students have seen the same issue and will know the answer, or if not, we can work together to a solution.

Evaluation and Grading

Online activity in the class is monitored and your participation is required. You should study the weekly content, take the self-assessment quizzes, and post and answer comments in the forum. Quizzes and exams will evaluate your progress toward meeting the course objectives. There will be a quiz at the end of each week. Weekly quizzes will be added and averaged to make 25% of your grade.

There will be 3 exams: the first is near mid-term provides an early assessment of your progress; another at the end covers the second half of the course; and a third one during the final exam period covers the entire course. Each exam counts 25%.

Credit for quizzes and exams is contingent on your participation in the online class content each week. An additional 5% will be added for students who make consistent thoughtful contributions to the forum discussions on the class website.

To complete the course and receive a grade, you must participate in the online class and take all the quizzes and exams. Given that, letter grades are based on the graded quizzes and exams, and scoring on quizzes and exams is based on a simple percentage of correct answers. Letter grades are approximately A (90 to 100); B (80 to 89); C (70 to 79); and D (60 to 69). Plus and minus grades may be used when a numerical score is within 2 points of a letter grade division.

Caveats

We reserve the right to make changes in the syllabus when necessary to meet learning objectives, when new physics related discoveries occur, or when there is a technical or software issue that requires a change in content or methodology. Any changes will be announced by email and posted in the current online syllabus and schedule.

Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other non-consensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain confidential support fromthe PEACC Program (502.852.2663), Counseling Center (502.852.6585), and Campus Health Services (502.852.6479). To report sexual misconduct or sex discrimination, contact the Dean of Students (502-852-5787) or University of Louisville Police (502.852.6111).

Disclosure to University faculty or instructors of sexual misconduct, domestic violence, dating violence, or sex discrimination occurring on campus, in a University-sponsored program, or involving a campus visitor or University student or employee (whether current or former) is not confidential under Title IX. Faculty and instructors must forward such reports, including names and circumstances, to the University's Title IX officer.

For more information, see the Sexual Misconduct Guide.

http://louisville.edu/hr/employeerelations/sexual-misconduct-brochure

Getting Started

- From the notice on Blackboard or our emails to you, locate your username and your password to our class website
- Connect to http://prancer.physics.louisville.edu/moodle
- Select your class and log in with your username and password (case sensitive)
- First time login you will be asked to change your password
- Update your profile if you want others to know more about you (optional)
- If you have a problem with this, send an email to `kielkopf@louisville.edu`

What to do Weekly

- Each Monday begins a new topic for that week.
- Study content on line, work through it at your own pace.
- Read the chapters or sections that are suggested in the textbook.
- Try the homework question for this week.
- Ask and answer questions on the discussion forum.
- Take the self-assessments on the class website to see how you are doing.
- Before end of day the following Monday, complete the weekly quiz on Blackboard for credit.

Longer Tests

- The first longer test on Blackboard covers the first half of the course at midterm. It is available from Saturday morning of that week through the end of day on the following Monday.
- The second longer test on Blackboard covers the second half of the course. It is available from Saturday morning of that week through the end of day on the following Monday.
- It is followed by a comprehensive final exam that will be available from Wednesday of finals week through the end of day Saturday.

Grades

The final course grade is based on the average of four equally weighted components: the average of all the quizzes, the midterm, the second test, and the final.

Schedule and Content

The primary content is on-line on the class website. Follow the "What to do weekly" guide above, and check there first for the new material. On-line content and the textbook go together, and it may be best to begin with the on-line material which is more succinct. The website also includes interactive components, the discussion forum, and self-assessment activities that may help you judge your progress and problem-solving skills. There is more in the textbook than we have time to cover in class, and reading through the complete chapters would be helpful. The syllabus schedule has suggested selections.

Remember that the required weekly quizzes for credit are on Blackboard from Saturday through Monday.

January 7 - 13 A light review of physics.
- Chapter 2.2: Vectors.
- Chapter 4.3: Newton's Second Law and conservation of momentum.
- Chapter 4.8: The four forces.
- Chapter 7.6: Conservation of energy.

January 14 - 20 Classical experiments and concepts of electricity and magnetism.
- Chapter 18.1: Charge and static electricity.
- Chapter 18.3: Coulomb's law.
- Chapter 22.1: Magnets.
- Chapter 22.2: Electromagnets.
- Chapter 22.10: Force between parallel currents.

January 21 - 27 Electrical charge, forces, fields, and potential energy.
- Chapter 18.4: Electrical fields.
- Chapter 18.7: Electrostatics.
- Chapter 19.1: Electrical potential energy.
- Chapter 19.2: Electrical potential in a uniform field.
- Chapter 19.3: Point charge.
- Chapter 19.4: Equipotentials.

January 28 - February 3 Moving charge, electrical current, and magnetic fields.
- Chapter 20.1: Charge and electrical current.
- Chapter 20.2: Ohm's Law.
- Chapter 20.3: Resistance.
- Chapter 20.4: Power.
- Chapter 22.3: Magnetic fields.
- Chapter 22.4: Force on a moving charge.
- Chapter 22.9: Magnetic fields from currents.

February 4 - 10 Electrical circuits, motors, and generators.
- Chapter 21.1: Resistors in circuits.
- Chapter 21.2: Voltage.
- Chapter 21.6: Capacitors.
- Chapter 22.8: Torque on a current loop.
- Chapter 23.1: Induced EMF.
- Chapter 23.2: Faraday's Law of Induction.
- Chapter 23.5: Generators.

February 11 - 17 AC circuits and electronic devices.
Chapter 23.7-11: AC circuits and transformers.
Supplement: Diodes and transistors.
Supplement: Logic with electronics.
Supplement: Amplifiers.

February 18 - 24 Review and study for first test.

Saturday, February 23, through Monday, February 25 First test.

February 25 - March 3 Electromagnetic waves from radio to x-rays. Reflection, refraction, dispersion and absorption.
Chapter 24.1: Maxwell's equations.
Chapter 24.2: Electromagnetic waves.
Chapter 24.3: The electromagnetic spectrum.
Chapter 25.2: Reflection.
Chapter 25.3: Refraction.
Chapter 25.4: Total internal reflection.
Chapter 25.5: Dispersion.

March 4 - 10 Interference and diffraction. Polarization and scattering.
Chapter 27.1 Wave optics.
Chapter 27.3: Double slit interference.
Supplement: Michelson interferometer.
Chapter 27.7: Thin films.
Chapter 27.4: Diffraction grating.
Chapter 27.2: Huygen's principle.
Chapter 27.5: Diffraction at a slit.
Chapter 27.8: Polarization. Supplement: Rayleigh scattering.

March 11 - 17 Spring break.

March 18 - 24 Light as a quantum phenomenon: generation and detection.
Chapter 29.1: Photon.
Chapter 29.2: Photoelectric effect.
Chapter 29.3: Photon energy.
Chapter 29.4: Photon momentum.
Chapter 29.6-7: Uncertainty.

March 25 - 31 Optical devices.
Chapter 25.6-7: Lenses and mirrors.
Chapter 26.1: The eye .
Chapter 26.5: Telescopes.
Chapter 26.4: Microscopes.

April 1 - 7 Quantum phenomena in atoms and materials. Radioactivity.
Chapter 30.3: The emission and absorption of a hydrogen atom.
Chapter 30.4: X-ray emission.
Chapter 31.1: The emission of particles by an atomic nucleus - radioactivity.

Chapter 31.2: Radiation detection .
Chapter 31.4: Nuclear decay.
Chapter 31.5: Half-life.
Chapter 32.2: Biological effects of radiation.
Chapter 33.3: Particle accelerators.

April 8 - 14 Relativity and the Universe at large.
Chapter 28.1: Postulates of Special Relativity.
Chapter 28.2: Time dilation.
Chapter 28.3: Length contraction.
Chapter 28.6: Energy and relativity.
Supplement: Space-time and geodesics.
Chapter 34.2: General relativity and gravity.

April 15 - 21 Top 10 new physics concepts since midterm.
Review and study for the second test.

Saturday, April 20, through Monday, April 22 Second test.

April 22 - 28 Top 10 physics ideas from this semester
Review and study for the final exam.

Wednesday, April 24, through Saturday, April 27 Final exam.

Class schedule version of January 1, 2019