

Physics & Astronomy 222 – Fundamentals of Physics – S

Fall Semester 2022 – 3 Credit Hours

Online Learning

Instructor

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Video Conference: by Zoom or Blackboard Collaborate on request

This class is entirely online. It uses content we provide from our own servers, a free textbook, and the University's Blackboard system for testing and grades. Your work will be at your own pace whenever you want to do it. There are no scheduled class times. However the course has weekly assignments which are required. See the section below about how to begin your class.

University email is preferable to a phone call, and will provide you with a written response you can save. Please identify the course you are taking in the subject line with "222-50" if the mail is about this class. Video conferences in my "virtual office" are available too, through the Zoom or Blackboard's Collaborate conferencing systems if you have a microphone and webcam on your desktop computer, an Android cellphone or an iPhone. Please send an email first to set up an appointment and for connection instructions. There is a discussion forum on class website where questions that others may have could be asked.

The physics class has a teaching assistant who helps me with grading and who will also will help you if you need assistance. When the contact information for your assistant is available it will be added to the Blackboard site as well.

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 two 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 emphasized in motion, energy, gravity, heat, thermodynamics and sound in the first semester. This embodied 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. This 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

Blackboard and the class website will guide you through weekly topics over the semester, and will pose specific ideas and questions to consider. While you study, you are expected to use the discussion forum 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 how physics helps us understand the universe. Individual and group assistance through email, video conferencing, or telephone is available on request.

Each week the class website accessed through Blackboard (see below) has new web-based interactive content, there are suggested readings from the textbook, and a graded quiz on Blackboard over the week's content to be taken any time from Saturday morning through Monday midnight (US Eastern Time) at the end of each week. There will be two longer tests, one at midterm, and one at the end of the course. We will send email reminders weekly about the quizzes and exams.

Blackboard

The University's Blackboard system is its gateway to support for all of its classes:

<https://blackboard.louisville.edu/>

Use your University *User ID* and *Password* to log into Blackboard. Select the course PHYS-222-50-4222 (Fundamentals of Physics - S-Spring) for the latest announcements, the weekly quizzes, and the two exams.

Start Here provides guidance the first time and will help if you are new to online classes.

Announcements are updated at least weekly with the topic and any new instructions. These are also sent to you by email.

Assignments will have your weekly quizzes and exams, available Saturday morning through Monday midnight.

Content has the link to our class web server. It is different from Blackboard and requires its own password (see below).

Tools is a link provided by the University to many different features of Blackboard and its commercial partners. If we need these (for example Collaborate Ultra) we will also link to them from Content. This tab is overflowing with options, most of which you do not need.

My Grades will be updated with recent work when it is evaluated. Your course grade is the average of 3 parts, of which the quizzes are 60% and each test is 20%. You must participate in the class content and discussions as well, so be sure to stay active in the class each week.

Help will take you to Blackboard support. Please note that this does not provide help with our class website which we run ourselves. If you need help with it, send an email and we will work with you individually.

Class website

Content for this course is provided through our server at

<https://prancer.physics.louisville.edu/moodle>

which you may bookmark for direct access during the week, or click on the link in Blackboard for the course under Content.

This resource requires a login with a user ID and password. We create these accounts for you using your U of L ID (something like “ablast01”) which you use for access to university online resources. The list we use is based on Blackboard enrollment and it may lag your enrollment in the class by a day after Friday, January 7. You may send an email to remind us if the following does not work.

When you go to the class site the first time you will be asked to enter a user name and password. For the name use your U of L ID (in the form “ablast01”) For the password use the one we will provide on the Announcements page, and also on the Content link, of your Blackboard class. Once you do this the first time, the server will request that you enter a new password. You may then select your own. You may also edit your personal information on the server if you want to share it with others in the class. The next time you connect you will need to use the password you created. We advise not to use the same password you have on other university accounts for your own protection. Should you forget or need to change your password we will provide another one for you if you request one by email. This server provides records for us of your participation in the class, and we use it for the discussion forum for the course too.

If you are also in another online Physics & Astronomy class this semester you will only need to create a new password once. Once you log in, our site will offer the classes to you that we know you are taking.

Textbook

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

College Physics, Openstax College, 2022

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

<https://openstax.org/details/books/college-physics-2e>

Click “Download a PDF” or links on the class website or Blackboard. A print version is available through the Openstax site links. This is a comprehensive general college physics textbook that uses algebra. It covers two semesters and 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. No matter what kind of computer you use, there will be tools available for you. Because the class is entirely online, you will need Internet access and would benefit from a laptop or desktop computer for working with the content and taking quizzes and exams.

Evaluation and Grading

Required quizzes and exams are administered online through Blackboard. They will evaluate your progress toward meeting the course and Cardinal Core objectives with a variety of question formats, and will include written responses to assess outcomes.

At the end of each week, quizzes will help you to stay current in the course and understand and retain the new material. These quizzes are focused on the material for the week, yet they may also include questions from previous weeks that were often incorrectly answered. The average of quizzes for the course, counting the missed ones as zero, is 60% of your grade.

After 7 weeks, in time for a midterm progress assessment, there is a longer exam over the first half of the course. At the end of the term before the last day of classes another longer exam covers the second half of the course while also reviewing content from the semester. Each of these two longer tests is 20% of your grade. There is no comprehensive final.

Consistent participation in this online class is a course requirement. We monitor your activity on the website that provides course content. You should log in and study the material there during the week before you take the quiz, much as you would attend weekly classes in a traditional course. The content is self-paced, and may lead you to explore on your own. While you study it, contribute to the discussion when you have a question or can offer an answer or comment for the benefit of your peers. The course is not passive, and we expect that you will actively engage in it. The quizzes are based on the content we provide which is intended to focus on key ideas for you to understand and retain. The textbook and other online sources have supplementary detail to explore too.

You will receive weekly reminders by email about the quizzes and exams. Always expect one to be available from Saturday through Monday every week. These will appear on Blackboard under assignments during that time. You may check your submitted work by

looking at your Grades on Blackboard where a weekly score will be posted after our teaching assistant reviews your work. A common error on Blackboard is to forget to submit your work after you have answered the questions we posed. We cannot read work unless it is submitted.

This is very important – you must fully participate in this course, that is, read and study the material, contribute to the discussion forum, take every weekly quiz, and take both longer exams. Given that, final course letter grades are approximately A (90 to 100); B (80 to 89); C (70 to 79); and D (60 to 69). We use +/- grades within 2 points of these cuts. For example, 85 would be “B”, while 82 would be “B-” and 88 would be “B+”. If you follow your grades on Blackboard, please remember how quizzes and tests are weighted differently. We will provide a midterm grade assessment for you after the first test, and we may reach out to ask if you need help or to offer advice if we see an issue developing. To do well, read and study the content, participate in the discussions at least occasionally, and do not miss taking quizzes and tests when they are scheduled. The assignment of a letter grade based on averages of quizzes and exams is contingent on participation in the class. While we will try to advise you if we see an issue with non-participation develop, it is your responsibility to study and engage in the course during the week and to be aware of the quiz and exam schedule.

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 from the 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.

<https://louisville.edu/hr/employeerelations/sexual-misconduct-brochure>

Getting Started

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.
- 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.

Grades

You must participate in the online course content every week, ask and answer questions on the discussion group, take all the quizzes when they are available, and take the two longer exams. If you do, then the final course grade is based on the quizzes (60%) and the two exams (20%) each.

Reminders

The class is organized to cover new material each week, so plan your study time with the online material and participate in the forums weekly. Weekly quizzes open on Saturday morning and remain available through Monday at midnight. These are intended to help you review and understand the material and to keep up with the pace of the class. If you go through the online material and read the textbook selections before taking the quizzes you should do well on them, and then you will be prepared for the longer tests and retain the key ideas of the class.

Schedule and Content

The primary content will be through links on Blackboard under **Content** that will take you to our resources. 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 content includes interactive components, the discussion forum, and 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 class website will have suggested selections linked to the online version of the text each week, as well as other web-based selections that supplement the primary content on our site.

The required weekly quizzes for credit are on Blackboard and are available from Saturday through Monday unless otherwise noted. You will receive weekly reminders to take the quizzes and the tests but your participation in the online material on the class website is also a requirement of the class.

22 August - 28 August 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

29 August - 4 September 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.

5 September - 11 September 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

12 September - 18 September 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

19 September - 25 September Electrical circuits, motors, and dynamos

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

26 September - 2 October Electronic devices

Chapter 23.7-11: AC circuits and transformers
Supplement: Diodes and transistors
Supplement: Logic with electronics
Supplement: Amplifiers

3 October - 9 October Review

The first exam in this course is from Saturday through Monday

10 October - 16 October Electromagnetic waves from radio to x-rays. Reflection, refraction, dispersion and absorption

Midterm exam from last week is due Monday
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

17 October - 23 October Interference, 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

24 October - 30 October Optical devices

Chapter 25.6-7: Lenses and mirrors
Chapter 26.1: The eye
Chapter 26.5: Telescopes
Chapter 26.4: Microscopes

31 October - 6 November 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

7 November - 13 November 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

14 November - 20 November 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

21 November - 27 November Thanksgiving week

There is no new content this week

28 November - 4 December Review

Second exam in this course is from Saturday through Monday

Top ten ideas to review for the second test

5 December Last day of classes

All course work is due today

The course does not have a comprehensive final