Physics & Astronomy 222 – Fundamentals of Physics – S
Spring Semester 2025 – 3 Credit Hours
Online Learning

Instructors

Faculty

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Quick read

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.

The class has teaching assistants who help me with grading and who will also will help you if you need assistance. When their contact information is available it will be added to the Blackboard site as well. There is a discussion forum on our class website where questions should be asked and answered. When you need individual assistance try University email rather than a phone call, and always put the course name "222-50" on the subject line. While phone calls and video conferences are other options, email is the best one for us if it works for you.

Go to Blackboard and check out "Start Here" to have access to class content online. The class is all about contemporary physics and is meant to be conceptual, engaging, and applicable to science-related career preparation using math at the level of college algebra. There is work due each week based on this content, and you will receive email reminders when it is due. Use the class website discussion group. We watch that, can offer advice or answer questions, and you get credit for participation too. For the rest, skip to the **Requirements** below, or read on for the details.

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 first 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 mechanics, heat, and sound.

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, as we build 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 emphasizes in this first semester 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 tests. 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. testples 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 in the weekly homework, quizzes and tests 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 homework, 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, homework, and tests. 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 other written components of the assignments 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 Blackboard 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 comprehend the universe. Individual and group assistance through email, video conferencing, or telephone is available on request.

Every week access the class website through Blackboard (see below) for new web-based interactive content, suggested readings from the textbook, and homework problem. Use Blackboard Assignments to submit the homework as a single PDF file, and take the weekly quiz any time from Saturday through the usual due date Monday midnight (US Eastern Time). There will be two longer tests instead of quizzes, one at midterm, and one at the end of the course. We will send email reminders weekly about these assignments.

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 (Fundamentals of Physics) for the latest announcements, to link to weekly content on the class website, and to submit the weekly work for assessment.

Start Here under Course Content provides guidance the first time and will help if you are new to online classes. It includes the syllabus, information about the faculty, and a guide on what to do weekly.

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

Assignments under Course Content is where you submit your work for the week by answering the questions asked there. Each assignment is due before Monday midnight of the week following the topic.

Week One to ... entries are for each week of the semester with the topic and content for that week. Usually they will take you to our class web server.

Gradebook will be updated by Blackboard with assessments of recent work when it is evaluated. Your course grade is the *weighted* average of quizzes, homework and tests. Be sure to stay active in the class by participating in the class website and submitting your work on time for assessment weekly.

Discussions is the Blackboard forum for this class.

Messages provides an online message service with an email copy to the instructors. We may reply directly by email.

Class website

Content for this course is provided through our server that is independent of Blackboard. You should access the server through the weekly links for content on Blackboard. You may notice that you are a guest user, and that for your convenience no login is required. However, Blackboard tracks your access so that we will be alerted if you do not use the content. To avoid issues with your activity in the class, be sure to use your own Blackboard account when working on the course and its assignments.

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 links on the class website or Blackboard for the interactive version which also supports note-taking, or "Download a PDF" if you prefer a static version on your device or computer. 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.

Help and discussions

When you have questions or need help, please use our Discussion forum on Blackboard. Often other students have seen the same issue and will know the answer. If not, we can work together to find one. Of course you may also send us questions or comments by email. If you participate in a forum or group outside of Blackboard, then we will not be aware of issues or be able to respond to them.

Our Department of Physics & Astronomy operates a "Physics Learning Center" with daily hours for those on campus who need help in-person. See the Announcements on Blackboard for the most recent updates.

In many cases, simply by using Google and looking for an appropriate entry in Wikipedia you can find an answer to basic 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 is the Khan Academy and sites supported by NASA. There will be selected links to these resources and others on the class website. Artificial intelligence services (e.g. ChatGPT or Google Gemini) may also be useful, but be wary because their responses may be too creative. When in doubt, seek out and compare the most authoritative sources.

Information on useful software and other materials will be provided online. Some of the work may be best done on a computer with a screen, whether it is desktop, laptop, or Chromebook.

Policy on the use of artificial intelligence (AI)

We encourage you to use those tools that help you learn, and these include artificial intelligence provided through Internet services such as Google Gemini and ChatGPT. Over the last months of 2024, some of them were capable of competent tutorial help when prompted with precision. The obvious cautions are to

- use judgment on the accuracy and verify references
- cite the use of the AI tool if it is included in a response to a homework
- do not submit AI responses as your own work
- be aware that AI use policy varies with the class and the instructor

We are all learning what AI can do for education and for research, so when you find something especially noteworthy, a post to the discussion would be appreciated.

Evaluation and grading

Required submissions to Blackboard 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.

Each week look for a homework assignment on the class website. Give that some thought, discuss the topic with others as needed, and respond with your work using a single PDF file on Blackboard whenever you are ready before its due date, usually the Monday of the following week. Our teaching assistants will assess your response and provide individual feedback. The average score on this part is 10% of your grade.

Quizzes at the end of each week will help you to stay current in the course and to understand and retain the new material. These quizzes are focused on the core material for the week and are not timed, so once they are open you may work on them until you submit your work. However, quizzes are usually due before Monday midnight, and you must keep up with the work every week. Although most quiz answers are automatically scored by Blackboard which limits the feedback we can provide, you are welcome to use the discussion forum or to send an email when you need help. The average of quizzes for the course, counting the missed ones as zero, is 50% of your grade.

After 7 weeks, in time for a midterm progress assessment, there is a longer test over the first half of the course. At the end of the term before the last day of classes another longer test 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 engagement in this online class is a course requirement. Our expectation is that you will study the online content every week before submitting work, and we monitor your activity. You should log in through Blackboard during the week, 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 outside our site. While you study, contribute to the discussion forum when you have a question or can offer an answer or comment for the benefit of your peers. The homework and 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 new material and work that is due. Always expect a homework problem and a quiz each week, with a longer test rather than a quiz at midterm and at the end of the course. These will appear on Blackboard under assignments during that time. You may check your submitted work by looking at your Grades on Blackboard where weekly scores will be posted after your work has been assessed. A common error on Blackboard is to forget to submit your work after you have

answered the questions we posted. We cannot read work unless it is submitted, but we will try to provide reminders when we see issues.

This is very important – you must fully participate in this course, that is, read and study the material, contribute to the discussion forum, answer the homework questions, take every weekly quiz, and take both longer tests. 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 homework, 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 submitting homework and taking quizzes and tests when they are scheduled. The assignment of a letter grade based on averages of homework, quizzes and tests 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 test 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/sexualharassment/procedures/

Syllabus version of August 1, 2024

What to do Weekly

- Each Monday begins a new topic for that week.
- Study content for the week online, 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 the due date, usually the end of day the following Monday, complete the weekly quiz on Blackboard and upload your homework for assessment and 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 last day of classes.

Grades

You must participate in the online course content every week, ask and answer questions on the discussion group, submit your homework, take all the quizzes when they are available, and take the two longer tests. If you do, then the final course grade is based on the quizzes (50%), the homework (10%), and the two tests (20%) each.

Reminders

The class is organized to cover new material each week, so plan your study time with the online material and participate weekly. Weekly quizzes open on Saturday morning and remain available through the due date, usually 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. There is more in the textbook than we have time to cover in class, yet reading through the complete chapters would be helpful. The class website will have core content for these topics, 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.

Submit the homework on Blackboard and take the required weekly quizzes when they are available Saturday through Monday unless otherwise noted. You will receive weekly reminders about the homework, quizzes and tests for credit. Your weekly participation in the online material on the class website is also a requirement of the class.

6 January - 12 January 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

13 January - 19 January 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.

20 January - 26 January 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

27 January - 2 February 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

3 February - 9 February 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

10 February - 16 February Electronic devices
- Chapter 23.7-11: AC circuits and transformers
- Supplement: Diodes and transistors
- Supplement: Logic with electronics
- Supplement: Amplifiers

17 February - 23 February Review for first test
- First longer exam from Saturday through Monday

24 February - 2 March Electromagnetic waves from radio to x-rays
- Chapter 24.1: Maxwell's equations
- Chapter 24.2: Electromagnetic waves
- Chapter 24.3: The electromagnetic spectrum
- Chapter 24.4: Energy in electromagnetic waves

3 March -9 March Optics
- Chapter 25.1: Ray aspect of light
- Chapter 25.2: Reflection
- Chapter 25.3: Refraction
- Chapter 25.4: Total internal reflection
- Chapter 25.5: Dispersion Chapter 25.6: Lenses
- Chapter 25.7: Mirrors

10 March - 16 March Spring Break

17 March - 23 March Optical devices
- Chapter 26.1: The eye
- Chapter 26.2: Vision
- Chapter 26.3: Color
- Chapter 26.4: Microscopes
- Chapter 26.5: Telescopes

24 March - 30 March Interference, diffraction, polarization and scattering

Chapter 27.1 Wave optics
Chapter 27.7: Thin films
Chapter 27.2: Huygen's principle
Chapter 27.3: Double slit interference
Chapter 27.4: Diffraction grating
Chapter 27.5: Diffraction at a slit
Chapter 27.8: Polarization
Supplement: Michelson interferometer and LIGO
Supplement: Rayleigh scattering

31 March - 6 April Light quanta: generation and detection of photons

Chapter 29.1: Photon
Chapter 29.2: Photoelectric effect
Chapter 29.3: Photon energy
Chapter 29.4: Photon momentum
Chapter 29.6: Wave nature of matter
Chapter 29.7: Probability and uncertainty

7 April - 13 April Quantum phenomena in matter and radioactivity

Chapter 30.3: The emission and absorption of light by 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 April - 20 April 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
Chapter 34.2: General relativity and gravity
Supplement: Spacetime and geodesics

21 April - 27 April Last week of classes

Review for the second exam
All course work including the second exam is due Wednesday
The course does not have a comprehensive final