PHY-202: ELECTRICITY AND MAGNETISM

Effective Term
Fall 2026

BOT Approval Date
12/11/2025

Discipline
PHY - Physics

Course Number
202

Course Title
Electricity and Magnetism

Short Title
Electricity & Magnetism

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
3.00

Lab Units
1.00

Total Units
4.00

Hours

Lecture Contact Hours
48-54

Out of Class Hours Lecture
96-108

Lab Contact Hours
48-54

Out of Class Hours Lab
0.00

Total Contact Hours
96 - 108

Total Out of Class Hours
96 - 108

Total Student Learning Hours
192 - 216

Is this an existing Extensive Lab?
Yes

Distance Education
Yes

Distance Education

Distance Education Type
Hybrid Only

What will be done in face-to-face meetings
Laboratory experiments will take place during face-to-face meetings. Exams and quizzes will be completed face-to-face. Other activities will be done as well, such as working example problems.

Are you using publisher content?
No

Regular Substantive Interaction
Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

C-ID (Admin Only)
C-ID PHYS 210

Catalog Description
This calculus-based course covers topics in thermodynamics, electricity and magnetism including electric fields and potential; Gauss' law, capacitance, magnetic fields, Ampere's law, Faraday's law and induction, electromagnetic oscillations and DC and AC circuits.

Requisites

Prerequisite(s)

Prerequisite(s) (must be taken before)
PHY-201 (with a grade of C or better)
and MATH-C2220 or higher (with a grade of C or better).

Codes

TOP Code (CB 03)
1902.00 - Physics, General

CIP Code
40.0801 - Physics, General.

Repeatability Code
No

Grading Option
Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Physics/Astronomy (Masters Required)	End

GE Information

Check GE Types Requested

AA/AS A - Natural and Physical Sciences

Cal-GETC Areas

Approved Cal-GETC Area

AREA-5A

Approved Second Cal-GETC Area

AREA-5C

Learning Objectives

Learning Objectives

Learning Objective
1. Evaluate the fundamental laws of electromagnetism and apply them in the analysis of the corresponding physical systems.
2. Analyze and solve a variety of problems in electromagnetism, often using calculus.
3. Demonstrate the ability to make precise measurements using simple laboratory instruments including but not limited to pressure gauges, VOM meters, electric power supplies and oscilloscopes.
4. Manipulate computer based data acquisition systems.
5. Analyze and appraise laboratory data using calculator and computer based analytic and graphing applications as needed.
6. Illustrate the ability to write clear and comprehensive laboratory reports.
7. Demonstrate the ability to determine the transient and AC response of circuits containing R, L and C electronic components.
8. Demonstrate the use of vector calculus to solve problems in electromagnetism.
9. Demonstrate an understanding of the contributions made to the physical sciences by members of underrepresented groups.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Students will compute the work done by various thermodynamic processes.
2. Students will apply Kirchoff's rules in order to determine the current, voltage and resistance in components of circuits.
3. Students will calculate the force on a charged particle due to a magnetic field using the Lorentz force law.
4. Students will utilize Ampere's law in order to determine the magnetic field at a point due to a conductor.

Content

Course Lecture Content

1. Temperature and the Kinetic Theory of Gases.
   a. Temperature and the Zeroth Law of Thermodynamics
   b. Thermometers and Temperature Scales
   c. Thermal Expansion of Solids and Liquids
   d. The Ideal Gas Law
   e. The Kinetic Theory of Gases
2. Energy in Thermal Processes: The First Law of Thermodynamics
   a. Heat and Internal Energy
   b. Specific Heat

   c. Latent Heat and Phase Changes
   d. Work in Thermodynamic Processes
   e. The First Law of Thermodynamics and Its Applications
   f. Molar Specific Heats and the Equipartition of Energy
3. Heat Engines, Entropy and the Second Law of Thermodynamics
   a. Heat Engines and the Second Law of Thermodynamics
   b. Reversible and Irreversible Processes
   c. The Carnot Engine
   d. Heat Pumps and Refrigerators
   e. Entropy and the Second Law of Thermodynamics
4. Electric Forces and Fields.
   a. Properties of Charges
   b. Coulomb's Law
   c. Electric Fields
   d. Motion of Charged Particles in a Uniform Electric Field
   e. Electric Flux and Gauss's Law
5. Electric Potential and Capacitance.
   a. Potential Difference and Electric Potential
   b. Electric Potential and Electric Potential Energy
   c. Capacitance
   d. Energy stored in a Charged Capacitor
   e. Capacitors with Dielectrics
6. Current and Direct Current Circuits.
   a. Electric Current
   b. Resistance and Ohm's Law
   c. Electric Energy and Power
   d. Sources of emf
   e. Kirchoff's Rules and Simple DC Circuits
   f. RC Circuits
7. Magnetic Forces and Fields.
   a. The Magnetic Field
   b. Motion of a Charged Particle in a Magnetic Field
   c. Magnetic Force on a Current Carrying Conductor
   d. Torque on a Current Loop in a Uniform Magnetic Field
   e. The Biot-Savart Law
   f. The Magnetic Force Between Two Parallel Conductors
   g. Ampere's Law
   h. The Magnetic Field of a Solenoid
   i. Magnetism in Matter
8. Faraday's Law and Inductance
   a. Faraday's Law of Induction
   b. Motional emf
   c. Lenz's Law
   d. Induced emfs and Electric Fields
   e. Self-Inductance
   f. RL Circuits
   g. Energy Stored in a Magnetic Field
9. Electromagnetic Waves
   a. Displacement Current and the generalized Ampere's Law
   b. Maxwell's Equations
   c. Electromagnetic Waves
   d. Energy Carried by Electromagnetic Waves
   e. Momentum and Radiation Pressure
   f. The Electromagnetic Spectrum
   g. Polarization.

10. Diversity Equity and Inclusion
    a. Discuss developments in physics made by underrepresented minorities.
11. Quizzes and Exams
    a. Four exams should be given throughout the term.
    b. Low risk quizzes should be given regularly throughout the term. At least one quiz per exam so students and faculty can assess student progress and retention.

Course Lab Content

1. Measurements and uncertainty
    a. Significant figures
    b. Error analysis
2. Proper use of simple laboratory equipment
    a. Meter stick
    b. Scales
    c. Calipers
3. The computer based laboratory
    a. Opening data collection programs
    b. Setting up experimental equipment and sensors
    c. Calibrating sensors
    d. Taking data.
    e. Analyzing data
4. The laboratory report
    a. Importance of laboratory notebook
    b. Lab report structure
    c. Creating data tables
    d. Writing adequate conclusions
5. Labs Covering the Following Topics
    a. Capacitor networks
    b. Current balance
    c. Elementary electric circuits
    d. Electromagnetism
    e. Equipotentials and electric fields.
    f. RC circuits
    g. RLC circuits
    h. Solar cells
    i. Wheatstone Bridge
    j. Thermodynamics

Methods of Instruction

Method

Lab Activities

Integration

Experiments in labs examine some of the basic phenomena in electromagnetism. Students are to become proficient in the use of common, modern measuring instruments e.g. digital and analog voltmeters, ammeters, ohmmeters and the oscilloscope. The principles of data taking and analysis, and the writing of scientific reports are emphasized. (learning objectives 3, 4, and 5).

DE Adaptations for MOI

The lab activities will be a required face-to-face activity, and therefore will not need adaptations for DE.

Method

Lecture

Integration

Lecture is used to verbally, diagrammatically and mathematically demonstrate the fundamental laws of physics. In particular, we will explore the various physical theories outlined in the course content and demonstrate how they are applied to solve problems and make physical predictions. Care should be taken to encourage student engagement, such as utilizing the Socratic method. Visual aids should be encouraged and the mathematical techniques unique to physics should be emphasized.

DE Adaptations for MOI

Recorded accessible videos of lectures will be provided in the course management system. These recordings must be made accessible to all students. Furthermore, the discussion board should be utilized for interactive discussions. Live lectures can be utilized to facilitate interaction between students and faculty. Time should be set aside every two weeks in face-to-face meetings in order to interactively work examples; employing the Socratic method to encourage engagement, or having students work in groups to solve problems.

Method

Observation and Demonstration

Integration

Observation and demonstration are used to analyze problem solving strategies in physics. The student will successfully solve problems dealing with electrostatics, electric potential, capacitance, electrodynamics, direct and alternating current circuits, magnetic forces and fields, fields, electromagnetic induction, Maxwell's equations, and electromagnetic waves (learning objective 2).

DE Adaptations for MOI

The discussion board should be utilized for interactive discussions. Time should be set aside every two weeks in face-to-face meetings in order to interactively work examples; employing the Socratic method to encourage engagement, or having students work in groups to solve problems.
In our hybrid course, this can be achieved outside of the classroom by setting up group discussions in the CMS or small groups using video conferencing software through the CMS.

Method

Discussion

Integration

Discussions in the course management system can be utilized to create a space for students to interact with faculty and each other in order to discuss and ask questions about course material and homework. These discussions can be provided for the key topics covered in the course. For instance, different discussions can be provided for thermodynamics, electric charges and electric fields, circuits, magnetism, motors and generators and last, AC current and electromagnetic waves. The various discussion boards can remain active for the whole course, but we can pin the ones to the top of the discussion board in the CMS for the current topic as we progress through them. A discussion can also be posted on topics such as current research in physics, philosophy of physics or other tangential topics as a way to pique interest in physics.

DE Adaptations for MOI

Since the discussions are available online through the CMS, no adaptations are necessary for distance education.

Method

Film/video Viewing and Discussion

Integration

We will watch an accessible video with subject matter that elucidates the struggles faced by minorities or under-represented minorities in physics. The video can be a documentary about a particular physicist or group of physicists facing discrimination, a film about a true story or even a fictional film about the very real struggles faced by so many women and minorities struggling to succeed in the sciences.

DE Adaptations for MOI

Ideally the video will be watched in the weekly course meetings, but if that is not possible, it can be posted in the CMS for students to view on their own.

Methods of Evaluation

Method

Class Work

Integration

Laboratory reports. Students will be evaluated on their ability to make precise measurements, analyze the collected data, interpret the results and perform appropriate error analysis in a concise and clear manner.

DE Adaptations for MOE

Laboratory work will be completed in the weekly face-to-face meetings.

Method

Exams/Tests

Integration

A minimum of 4 examinations. Students will be evaluated on their ability to analyze various physical systems, derivation of a mathematical description of each, solution of the resultant equations and physical interpretation of the result.

DE Adaptations for MOE

Exams must be completed in person, in the weekly face-to-face meetings.

Method

Homework

Integration

Quizzes on homework assignments involving similar analysis as in the examinations. Students will be evaluated on their ability to identify the correct calculus formula, and explain how it applies to the particular problem.

DE Adaptations for MOE

Quizzes can be provided online through the course management system, or given during the face-to-face meetings. For instance, a face-to-face meeting can be split into a time to interactively work examples followed by a quiz.

Method

Class Participation

Integration

A discussion should be had either in class or in the CMS about the DEI media shown. Students can answer questions about how the field would be different without the contributions of underrepresented people.

DE Adaptations for MOE

The discussion can be assigned and graded in the CMS.

Assignments

Assignment Type

Writing

In-class and/or outside of class

Outside of class

Formative or Summative
Formative

Assignment
A bar of gold is in thermal contact with a bar of silver of the same length and area. One end of the compound bar is maintained at 80.0 ?, and the opposite end is at 30.0 ?. When the energy transfer reaches steady state, what is the temperature at the junction? A spherical conductor has a radius of 14.0 cm and charge of 26.0 mC. Calculate the electric field and the electric potential at (a) r = 1.0 cm, (b) r = 20.0 cm, and (c) r = 14.0 cm from the center. Additional assignments are given that require students to analyze a given physical system, such as determining the speed of sound using isothermal versus adiabatic compression of a gas, measure the acceleration of gravity using the electric force, determine electric current in a wire using the Hall effect, and design a laboratory experiment to measure and confirm the analysis.

How assignment will be adapted in online format
This would be assigned as a homework problem that does not necessarily need adaptation, but it is possible to structure the question to be assigned and graded in the CMS.

Assignment Type
Writing

In-class and/or outside of class
In-class
Outside of class

Formative or Summative
Summative

Assignment
With the data from the in-class experiment where you measured the pressure and temperature of the fixed volume of gas in the sphere, you will write a lab report where you determine if the data you compiled supports the hypothesis that the temperature and pressure of a fixed volume of an ideal gas are proportional. That is to say that there is a linear relationship between the pressure and temperature of the gas in the sphere.

Your report should include the following content:
A title page with the names of all the group members that worked on the experiment and lab report.
An abstract that contains a summary your hypothesis, what you measured and what the results were from the lab.
A purpose and theory section that explains the experiment and the needed equations to describe the relevant theory mathematically.
A procedure and apparatus section that describes the steps, equipment and set-up used.
A data section with the collected raw data and graphs that shows all the data from the lab in either table or graph form.
A calculations and error analysis section that shows how the final result was calculated with its corresponding error bar.
A conclusion that states what was learned and how to improve the results.

How assignment will be adapted in online format
Lab activities and reports will be exactly the same between our hybrid and face to face courses.

Assignment Type
Reading

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Read Chapter 20, sections 20.5 to 20.8. When you get to Section 20.8, think about how the entropy version of the second law of thermodynamics relates to the heat engine version given in section 20.5.

How assignment will be adapted in online format
No adaptations for course reading assignments are necessary for the hybrid format.

Assignment Type
Writing

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
What challenges did women initially face in studying and participating in physics research? If it were not for women such as Emmie Noether, Emilie du Chatelet and Lise Meitner, would physics as a field have advanced to the extent to which it is today?

How assignment will be adapted in online format
There is no need for adaptation as the course discussion questions are provided via the CMS.

Course Materials

Textbooks
William Moebs, Samuel J. Ling, Jeff Sanny (2025). University Physics, Volume 2. OpenStax.
ISBN-13: 978-1-947172-21-0

Young, Hugh D., Freedman, Roger A. (2020). University Physics with Modern Physics 15th ed.
ISBN-13: 978-0-1351-5955-2

Other Resources
Pasco Scientific. Physics Labs with Computers V2. PASCO Scientific , 01-01-1999.

Open Educational Resources
William Moebs, Samuel J. Ling, Jeff Sanny (2025). University Physics, Volume 2. OpenStax.
ISBN-13: 978-1-947172-21-0

Class Size Information

Class Size
32

Class Size Category
G - Large lab 32

Diversity and Inclusion

Course Design and Materials: Course will incorporate diverse perspectives, authors, and examples that reflect a variety of cultures, identities, and lived experiences. Instructional materials will be reviewed regularly to ensure representation, inclusivity, and alignment with equity-minded practices across disciplines.

Inclusive Learning Environment: Instructors will establish classroom norms and policies that promote respect, civil discourse, and belonging in both online and face-to-face classes. Clear expectations for communication and engagement will support a learning space where all students feel valued and heard.

Accessible Instruction: Course content will be delivered using accessible design. Materials will follow accessibility guidelines within the CMS, including captioned media, readable document formats, and multiple means of engagement to support diverse learning.

Equitable Teaching Practices: Instructors will use transparent and grading criteria, varied assessment methods, and timely feedback to promote fairness and student success. Opportunities for revision, reflection, and multiple demonstrations of learning may be incorporated when appropriate to the discipline.

Culturally Responsive Pedagogies: Instructional strategies will encourage critical thinking about diverse perspectives and systems of power relevant to the course content. Faculty will foster opportunities for students to connect course material to real-world contexts.

Ongoing Reflection and Improvement: Faculty will engage in continuous professional development related to IDEAA principles and reflect on course practices using metacognition to identify opportunities for increased equity, inclusion, and accessibility.

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

The content references and discusses the contribution that members from underrepresented groups in STEM have made to our knowledge of classical mechanics. Some assignments, such as readings, research papers and discussions will center on how people of color and women have used their knowledge of classical mechanics to make impactful contributions to their communities or society at large. Examples and assigned problems will apply concepts of classical mechanics to every day situations which can reflect the experiences of students from different backgrounds.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

The content presented to the students, either through the CMS or in class, will follow Universal Design for Learning (UDL) guidelines. These guidelines ensure that, among other things, the course content provides different ways of engagement that can appeal to students from a variety backgrounds and that content is presented in different formats so that it can be accessed by students with different abilities. The course promotes an equitable learning environment by adopting the use of Open Educational Resources (OER), like an EOR textbook and an open homework platform, so that the course is accessible to students from different socioeconomic backgrounds. The course also includes a variety of formative and summative assessments so that the methods of evaluation provide students with multiple ways to demonstrate the knowledge of classical mechanics.

Interactions

Explain how the course will incorporate student-to-student interaction.

This course will incorporate student-to-student interaction by having students interact with each during in class discussions, such as comparing their thought process to determine the amount of mechanical work achieved by a cyclic thermodynamic process or finding the potential at a point due to a particular charge distribution. Students will also work on groups to solve some of the problems presented as examples during class or review sessions. During laboratory experiments students will work together to set up the experimental device, perform measurements as well as collect and analyze data. Students may use discussion boards in the CMS to coordinate how to work on their laboratory reports and have all of their collected data in a single place.

Explain how the course will incorporate instructor-to-student interaction.

This course will incorporate instructor-to-student interaction by having the instructor present the material in lectures. The instructor may also join the discussion boards if questions arise about the requirements for assignments. Weekly announcements can be used to summarize the content seen in class, remind students of due dates and upcoming assignments. The instructor will provide feedback on students' performance through grading rubrics and comments in the CMS. During lab experiments the instructor will interact with students by providing guidance and clarification on how to perform the laboratory experiments.

Explain how the course will incorporate student-to-content interaction.

This course will incorporate student-to-content interaction by having the students engage with the course content from the lectures and content provided in different formats, such as accessible video and audio, posted on the CMS. Students will also interact with the course content by working on solving problems, like calculating the equivalent capacitance of different combinations of capacitors.

Explain how the course will incorporate student-to-self interaction (metacognitive).

This course will incorporate student-to-self interaction by providing multiple opportunities for self-reflection on the process that each student follows to solve a particular problem. A student can for example compare the description of an electric field both by directly integrating the charge distribution and by utilizing Gauss's law. By working on solving a variety of problems on their own students will also strengthen their critical thinking skills by distinguishing the necessary and redundant variables among all the information provided in a particular word problem.

Key: 2637