Physics 162

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This course is the second course in the introductory physics sequence PHY 161-162-263. Like PHY 161, the goal in this course is to understand and appreciate that all natural phenomena can, in theory, be explained using a small number of fundamental laws and ideas. We will also continue to learn how to improve logical reasoning and problem-solving skills. Whereas PHY 111 explored mechanical phenomena, PHY 162 will explore electricity and magnetism. We will use our knowledge of these phenomena, together with the knowledge of mechanics from PHY 161, to explain a wider array of physical phenomena than you encountered in PHY 161. Also, this course will help prepare you for many of the labs that you will encounter in PHY 263.

The purpose of this course is to understand E&M and be able to apply these principles to solve both specific and fairly broad classes of physics problems. This level of understanding is essential to a future career in physics at a graduate level and is extremely useful for understanding the physical basis of electriciy and magnetism. (Knowledge, Inquiry, Reasoning)

The texts for this course are Halliday, Resnick, Walker, *Fundamentals of Physics, Volume 2, 7th, 8th, 9th, or 10th Edition*

Date	Text Material	Topics
Day 1 - Mon	Ch 21	Charge and Coulomb's law, conductors and insulators, conservation of charge, quantization of charge, charge and current
Day 2 - Tue	Ch 22	Electric fields, electric field lines, electric fields and conductors, motion in a uniform electric field, field of a uniform spherical shell of charge, dielectric breakdown, dipoles
Day 3 - Wed	Ch 23	Electric flux, Gauss's law, using Gauss's law to find electric fields, spherical symmetry, cylindrical symmetry, planar symmetry, superposition, Earnshaw's theorem
Day 4 - Thur	Ch 24	Electrostatic potential energy, electron-volts, conservation of energy, uniform electric fields, parallel plates, potential, voltage, conductors and equipotentials
Day 5 - Fri	Ch 25	Capacitors, parallel plate capacitors, electrostatic energy, capacitance, energy in a capacitor, energy density, batteries and capacitors, circuits, capacitors in series and parallel

Date	Text Material	Topics
Day 6 - Mon	Exam 1 (Ch 21-24)	
Day 7 - Tue	Ch 26	Current, current density, carrier density, resistance, resistivity, ohm's law, power, resistance and temperature
Day 8 - Wed	Ch 27	Single loop circuitrs, resistors in series and parallel, multiloop circuits, RC circuits, real batteries, maximizing power, resistor networks, voltmeters, ammeters
Day 9 - Thur	Ch 28	magnetic forces, cross-product, right-hand rule, force on moving charge, force on current in wire, mass spectrometer, crossed electric and magnetic fields, Hall Effect, torque on a current loop
Day 10 - Fri	Ch 29	Magnetic fields, Biot-Savart law, Ampere's law, field due to current loop, field due to straight wire, field due to solenoid, field due to toroid, magnetic dipoles, forces between two wires
Day 11 - Mon	Ch 30.1–6	Faraday's law, motion in a magnetic field, magnetic flux, Lenz's law, eddy currents, inductors
Day 12 - Tue	Ch 30.7–12	Inductors, LR circuits, energy stored in an inductor, energy stored in magnetic fields, mutual inductance, transformers, impedance matching, LC circuits, RMS voltage, Maxwell's equations, EM waves, Poynting vector
Day 13 - Wed	Exam 2 (Ch 25-29)	
Day 14 - Thur	Ch 31	AC circuits, complex impedance, LRC circuits, resonance, transformers
Day 15 - Fri	Ch 33	Electromagnetic waves, polarization, Malus' Law, refracton, index of refraction, total internal reflection
Day 16 - Mon	Ch 35	Interference, Young's experiment, Thin-film interference, Michelson's Interferometer
Day 17 - Tue	Ch 36	Diffraction, Diffraction gratings, Single-slit diffraction, Optical resoluton
Day 18 - Wed	Exam 3 (Ch 30-36)	Chapters 32 and 34 are not covered

Class is held 9:00–11:00 AM and 1:00–3:00 PM in Norton Geology Room 208.

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When not teaching, I am usually in my office (or in Norton, either in the classroom or lab directly upstairs) unless I am in a meeting. Please feel free to stop by to ask for help or questions. I can always be reached by e-mail. As far as office hours go, I'm usually available much of the time class isn't in session (and I'm not in a meeting), but I will always be available during the lunch hours on Mondays and Wednesdays.

Grade: There are three exams: each exam is 25% of your grade. 25% of your grade consists of homework, quizzes, and home experiments.

Assigned problems: Rather than use problems from the book, I will post each day's homework problems on Moodle. You can access Moodle at `http://moodle.cornellcollege.edu/` Homework is due the next afternoon in class. For example, the "Day 1" homework assignment is the one you will start work on during the first day of class, but will be due the second day. There may be a quiz on the homework in class. Unlike the tests, you are encouraged to work with your classmates on the homework assignments. However, regardless of your methods for solving the homework problems, you must gain sufficient proficiency with the material that you are able to do the homework problems on your own.

Course objectives: This course supports Cornell College's Educational Priorities and Outcomes with emphases on *knowledge, inquiry, reasoning.*

Knowledge: you will learn about Maxwell's theory of electricity and magnetism and discover how these theories explain a multitude of phenomena including circuits and the behavior of light.

Reasoning: you will use logical and mathematical skills to solve a variety of physics problems.

Inquiry: you will conduct some basic experiments to discover the nature of electromagnetic interactions and circuits.

Purpose of assignments:

Reading material is assigned each day in class. The purpose of the reading is to acquire basic *knowledge* of the material before the class lecture. This will better help you understand the material presented during the lecture.

Homework problems serve to both reinforce *knowledge* as well as developing mathematical and problem-solving *reasoning*. Each night's homework problems will cover the topics for that day, although they may also reinforce topics from previous days. The first few homework problems tend to emphasize *knowledge* while later problems will emphasize *reasoning* although both objectives are covered by most problems.

Home experiments provide you with the means to *inquire* about the nature of electricity and magnetism. You will be able to explore the validity of the theories we learn about in class.

A few homework problems are marked as **Try it** problems. These are problems that you can build using materials in your home experiment kit. You can make a theoretical prediction and then experimentally test how well the prediction holds.

Absence from class and late assignments: You may be absent from class due to a few reasons. Your absence is excused if either 1) you obtain permission from your instructor in advance of the absence or 2) the absence is of an emergency or medical nature. If your absence is excused, you will need to make up the material that you missed, but there will be no other penalty. If your absence is not excused then you will not be allowed to make up the work. If you turn in an assignment late, then you will not receive full credit.

Academic Integrity: Unless otherwise stated, assignments are for you to complete on your own. In some cases, they will be based on group work done in class. In these cases, please provide proper attribution to other's ideas. Failure to properly reference other people's ideas may result in a failing grade. Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgement of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Compass, our student handbook, under the heading "Academic Policies — Honesty in Academic Work."

Any student found cheating on a test will receive a zero on the test. The Registrar will also be notified.

Students with disabilities: Students who need accommodations for learning disabilities must provide documentation from a professional qualified to diagnose learning disabilities. For more information see `http://cornellcollege.edu/disabilities/documentation/index.shtml`

Home experiments: At various times throughout the course, you will be assigned some home experiments. The goal of each home experiment is primarily to show you a specific physics concept (or set of concepts) but it is also an opportunity to apply your knowledge in a more practical form. For each home experiment, you should provide a short explanation, typically a paragraph or two, together with supporting numerical data. For example, you might show a graph of voltage plotted as a function of current and use this graph to determine the value of a resistor. Please feel free to explore beyond the limits of the lab description: you can often use your equipment to conduct your own experiments to further your own understanding and learn new concepts.

- *Electric Field, Voltage and Distance* In this experiment, you will measure the relationship between electric field, voltage and distance. You should turn in your write-up for the home experiment on Day 5.
- *Capacitors, Voltage and Charge* This experiment will allow you to determine the relationship between voltage and charge on a capacitor, as well as giving you the opportunity to measure the conservation of charge. This experiment is due on Day 7.
- *Resistance* In this experiment, you will measure the internal resistance of a battery. Actually, you'll build a "high internal resistance" battery using a regular (low internal resistance) battery and a medium-sized resistor. You'll then measure the relationship between the current and voltage of this "high internal resistance" battery from which you'll be able to determine both the ideal voltage and internal resistance. This experiment is due on Day 8.
- *RC circuits — part 1* You'll construct a simple RC circuit and measure how the voltage decays with a characteristic time constant. Using this decay, we can create a simple electronic oscillator. This experiment is due on Day 9.
- *RC circuits — part 2* You'll build a simple electronic clock and use it to measure the time constant of your circuit. This experiment is due on Day 10.
- *Faraday's Law* You'll see how changing the magnetic flux in a loop can create voltage, and how this can be used to make generators and microphones. This experiment is due on Day 14.