

Syllabus for Algebra-Based Physics II: Electricity, Magnetism, and Modern Physics (PHYS135B-01)

Dr. Jordan Hanson - Whittier College Dept. of Physics and Astronomy

October 24, 2023

Abstract

The concepts of algebra-based electromagnetism, optics, and modern physics will be presented within the context of interactive problem-solving. The course will begin with the concepts of electric charge, electrostatics, electric potential, and capacitance. Next, current and DC circuits will be covered. Magnetostatics and magnetic induction follow DC circuits, concluding with AC circuits. Finally, selected topics in electromagnetic waves, optics, and modern medicine will be presented. The course work will include interactive computational exercises, analytic textbook problems, group-designed projects, and lab-based activities.

Pre-requisites: PHYS135A

Course credits, Liberal Arts Categorization: 4 Credits, None

Regular course hours and location: Monday and Wednesday, 8:50 - 10:50, SLC 232.

Instructor contact information: Discord: 918particle, Email: jhanson2@whittier.edu, Office: SLC 212, YouTube Channel: www.youtube.com/918particle, Book online appointments: <https://fgucmvjkyllumqfsco.10to8.com>.

Office hours: Booking service to schedule meeting: [10to8.com](https://fgucmvjkyllumqfsco.10to8.com) as above, and indicate in-person or online.

Attendance/Absence: Students needing to reschedule midterms must notify the professor a few days in advance.

Late work policy: Late work is generally not accepted, but is left to the discretion of the instructor.

Text: College Physics, 2nd Ed. <https://openstax.org/details/books/college-physics-2e>. Open-access.

Homework: Problem sets will be assigned on Fridays, and due after one week.

Grading: The course grade will be a weighted average of assignment scores, and the weights are listed in Tab. 1.

Grade Settings: $\geq 60\%$, $< 70\%$ = D, $\geq 70\%$, $< 80\%$ = C, $\geq 80\%$, $< 90\%$ = B, $\geq 90\%$, $< 100\%$ = A. Pluses and minuses: 0-3% minus, 3%-6% straight, 6%-10% plus (e.g. 79% = C+, 91% = A-).

ADA Statement on Disability Services: Whittier College is committed to make learning experiences as accessible as possible. If you experience physical or academic barriers due to a disability, you are encouraged to contact Student Disability Services (SDS) to discuss options. To learn more about academic accommodations, email disabilityservices@whittier.edu, call (562) 907-4825, or go to SDS which is located on the ground floor of Wardman Library.

Academic Honesty: <https://www.whittier.edu/policies/academic/honesty>

Course Objectives:

- To solve word problems in the subjects of physics and mathematics
- To construct mathematical models of physical systems
- To match mathematical models of physical systems to experimental results
- To apply logical thinking to conceptually-posed physics problems
- To practice scientific experimentation, data analysis, and reporting of results
- To practice written and oral expression of scientifically technical ideas
- To understand how to use measurement devices and electronics tools

Assignment	Weight	Date
Daily exercises	10 %	Completed during class
Homework sets and labs	30 %	Weekly on Fridays
First Midterm	20 %	March 8th, 2024 (take-home style on Units 0-3)
Second Midterm	20 %	April 26th, 2024 (take-home style on Units 4-5)
Final Project Presentation	20%	April 22nd and 24th, 2024 (in class)

Table 1: These are the grade weights for each assignment. The final project presentation can take two forms. **Option A:** A 10-15 minute traditional presentation with several minutes for questions. **Option B:** A video in digital storytelling format using WeVideo, also 10-15 minutes long.

Course Outline:

1. **Unit 0:** Review of pre-requisite courses, and electrostatics.
 - (a) Unit analysis, kinematics, and Newton's Laws
 - (b) Work and energy, momentum
 - (c) Electrostatics, I - **Chapters - 18.1 - 18.5**
 - i. The Coulomb Force, and Newton's Second Law for electric charges
 - ii. The concept of an electric field
 - (d) Electrostatics, II, electric potential - **Chapters 19.1 - 19.3**
 - i. Potential energy and charge, voltage
 - ii. Potential energy and fields, point charges
 - iii. Electrostatics in biology
2. **Unit 1:** Capacitors, current and DC circuits
 - (a) Capacitors and capacitance - **Chapters 19.4 - 19.7**
 - i. Equipotential lines, capacitance, and capacitors
 - ii. Capacitors in series and in parallel, energy considerations
 - (b) Current and DC circuits - **Chapters 20.1 - 20.5, 20.7**
 - i. DC current and resistance, Ohm's law
 - ii. Energy and power in DC current
 - iii. AC current and waveforms
 - iv. Biological example: human nerve conduction
3. **Unit 2:** DC Circuits with resistors in series and parallel, RC circuits
 - (a) DC circuit basics - **Chapters 21.1 - 21.4, 21.6**
 - i. Resistors in series and parallel, electromotive force (EMF)
 - ii. Kirchhoff's rules
 - iii. Voltmeters and ammeters
 - iv. RC circuits
4. **Unit 3:** Magnetism I
 - (a) Magnetostatics I - **Chapters 22.1 - 22.4**
 - i. Magnets, ferromagnetic and electromagnetic
 - ii. Magnetic fields and field lines, force on moving charge
 - iii. Magnetic applications I: fusion reactors
 - (b) Magnetostatics II - **Chapters 22.7 - 22.9**
 - i. Force on current carrying conductor, torque on current loop
 - ii. Ampère's Law: magnetic fields created by current
 - iii. Magnetic applications II: mass spectrometry
5. **First Midterm - March 8th, 2024.**
 - (a) Take-home style, covers Units 0-3
6. **Unit 4:** Magnetism II
 - (a) Magnetic induction - **Chapters 23.1 - 23.5, 23.7, 23.9**
 - i. Induced EMF, magnetic flux
 - ii. Faraday's Law
 - iii. Motional EMF and generators, transformers
 - (b) AC circuits - **Chapters 23.10 - 23.12**
 - i. RL circuits
 - ii. RLC circuits
7. **Unit 5:** Waves, Optics, Medical Physics
 - (a) Electromagnetic waves - **Chapters 24.1 - 24.4**
 - i. Maxwell's Equations
 - ii. Electromagnetic wave production
 - iii. Electromagnetic spectrum and energy
 - (b) Geometric optics - **Chapters 25.1 - 25.3, 25.6**
 - i. Ray-tracing
 - ii. Reflection
 - iii. Refraction
 - iv. Lens optics
 - (c) Wave optics - **Chapters 27.1 - 27.3**
 - i. Wave interference
 - ii. Wave diffraction
 - iii. Double slit experiments
 - (d) Nuclear physics in medicine - **32.1 - 32.4**
 - i. Diagnostics and medical imaging
 - ii. Biological effects of ionizing radiation
 - iii. Therapeutic uses of ionizing radiation
 - iv. Food irradiation
8. **Unit 6:** Second midterm, final project presentations
 - (a) **Second midterm on April 25th, 2024.**
 - i. Take-home style, covers Units 4 and 5
 - (b) Final project presentations
 - i. Presented via option A or B (see Tab. 1).
 - ii. Given on April 22nd and 24th in class