Physics 112—General Physics II: Electricity, Magnetism, and Optics
Section 1, MFW 11:00 a.m. – 11:50 a.m.
Course Description, Spring 2017

Instructor:	Andrew Dougherty
Office:	HSC 028 610-330-5212
Lab:	HSC 025 610-330-5212
E-mail:	doughera@lafayette.edu
Web Page:	`http://workbench.lafayette.edu/~doughera/`

Office Hours: Please feel free to e-mail, call or stop by at any time and ask a question or set up an appointment. I will be available during my office hours and on most other days during the free times indicated on my schedule.

Classes on Snow Days and Other Emergencies: If I am unable to make it to class, I will send out an email via Moodle or leave a message on my voice mail (610-330-5212).

Web Pages: There are two main web sites for this course:

Course Documents: Most course documents will be posted at `http://workbench.lafayette.edu/~doughera/phys112/`. (This same site is also available through Moodle at `http://moodle.lafayette.edu`.)

Mastering Physics: We will use the on-line homework system `Mastering Physics` at `http://www.masteringphysics.com/`. Our course ID is `LafayettePhys112Spring2017`.

Description: Phys 112 is the second semester of a non-calculus-based introduction to the foundations of physics, designed primarily for students in science who do not require a calculus-based physics course. Topics include electric and magnetic forces and fields, DC circuits, induction, mechanical and electromagnetic waves, optics, and introductory atomic and nuclear physics.

Recognizing and applying physical ideas is stressed; there will also be emphasis on problem solving.

Prerequisites: Phys 111, 131, or 151; Math 125, 141, or 161. In addition, high school algebra and trigonometry are used extensively.

Texts: *College Physics: A Strategic Approach Technology Update*, third edition, by Randall D. Knight, Brian Jones, and Stuart Field, ISBN-13: `978-0-13-416783-1`, along with an online homework component *Mastering Physics*. You can purchase this as a single package at the bookstore. If you did not get *MasteringPhysics* with your text, then you may purchase it online at `http://www.masteringphysics.com/`. Our course ID is `LafayettePhys112Spring2017`. You will also need the *Physics 112 Laboratory Manual*, available in the bookstore, and a bound laboratory notebook.

Laboratory: The laboratory is an essential part of this class, and successful completion of the laboratory is required in order to pass the course. You are responsible for completing all of the assigned experiments at the scheduled times. If you can not make it to your scheduled lab, please contact your lab instructor as soon as possible. You can't count on the equipment being available outside of the scheduled lab times.

Supplemental Instruction: Phys 112 participates in the Supplemental Instruction program (SI) run through Lafayette's Academic Tutoring and Training Information Center (ATTIC). More information about SI will be posted on the course web site.

Student Learning Outcomes: The main goal of this course is to help you understand, identify, and apply fundamental principles of physics in a variety of situations. You should be able to use both qualitative reasoning and quantitative problem-solving skills in applying those principles. A second goal is to help introduce you to the *process* of doing physics, including skills such as developing and testing models, interpreting experimental data, solving problems, and communicating results.

Specifically, upon successful completion of this course, you should be able to

- Calculate the electric potential and field due to simple charge configurations,
- Calculate the magnetic field due to simple current configurations,
- Predict the motion of charges in electric and magnetic fields,
- Build and analyze simple DC electrical circuits,
- Describe phenomena related to electromagnetic induction,
- Describe the characteristics of mechanical, sound, and electromagnetic waves,
- Apply the conditions for constructive or destructive interference of waves,
- Apply simple geometric optics,
- Perform simple quantum energy level calculations, and
- Predict basic properties of some common nuclear decays.

In addition to the outcomes listed above, this course (particularly the lab component) will promote the following outcomes from the Natural Sciences section of the Common Course of Study:

- NS 1 Employ the fundamental elements of the scientific method in the physical and natural world.
  - NS 1a Identify and/or formulate a testable scientific hypothesis.
  - NS 1b Generate and evaluate evidence necessary to test and/or revise a hypothesis.
- NS 2 Create, interpret, and evaluate descriptions and representations of scientific data including graphs, tables, and/or models.
- NS 3 Understand how scientific uncertainty informs the evaluation of hypotheses.

Your Responsibilities:

Read the text. Your text is a critical resource for this class—it is a source of definitions, facts, ideas, explanations, derivations, and worked examples. I do not intend to spend class time simply repeating the text. Instead, class time will be used to *discuss* those ideas, answer your questions, observe demonstrations, do examples, and practice applying those ideas to various physical situations.

Accordingly, you should read the text ahead of time. I have included a detailed daily syllabus so you know what the assigned readings for each day will be. Occasionally, we may have unannounced quizzes on the assigned reading material.

Ask questions. If you are confused, it is important that you stop me and try to sort it out rather than falling behind. *Please* interrupt and stop the class whenever anything isn't clear. Remember that if you are confused, there are almost certainly many others who are confused as well, and they would welcome your question.

Do all assigned work. A good rule of thumb is that you should anticipate spending approximately two hours outside of class for each hour in class for a college course.

This means you should anticipate spending an average of six hours per week outside of class for physics (not including the lab). Plan ahead. I am here to help. If you start on your homework ahead of time, I will be available to help you if you get stuck. Don't wait until the night before an assignment is due before starting it.

Participate in class. Class time will be used to go beyond merely reading the text. Your active engagement during class can play an important part in helping you to master the material. Class time will also be used to announce changes to the syllabus. It is *your* responsibility to keep up.

Tests: There will be three hour-long in-class tests on the dates indicated on the syllabus. There may also be additional quizzes, either announced or unannounced.

Equation Sheet: You will receive an equation sheet with each test. The idea is that you will use your study time to focus on the fundamental ideas and practice doing physics rather than to memorize formulae.

Homework Problems: Homework assignments will be due at the beginning of class on the dates indicated on the syllabus. Some assignments will be given and graded using *MasteringPhysics*, an on-line system with quick feedback, hints, and guided tutorials. Other assignments will be pencil-and-paper problems; these problems will typically focus as much on the *methods* of solving problems as on getting the right numerical answer. Some of these problems may be graded by student graders.

- Problems will be due at the *beginning* of class. **Late homework will normally not be accepted**.
- For written homework, please staple your pages together. This ensures your pages don't get lost.
- **Illegible papers will not be accepted**. If I have difficulty reading or understanding your work, I may return it to you ungraded for re-submission. You may resubmit a legible version (along with the original) by the next class meeting, but that version must not have any new content—it must simply be a legible version of the original.
- Please look at the homework problems ahead of time and ask questions about them either in or out of class. I am happy to give whatever help you need, but it is important that you eventually learn to do these problems on your own—after all, that's what you will have to do on the tests.

Academic Honesty: The fabric of science, and indeed any intellectual endeavor, is built on the integrity of all involved. Accordingly, I take academic honesty very seriously. I expect that you will abide by the "Principles of Intellectual Honesty" appearing in the Lafayette College Student Handbook.

Working with others is often a helpful way to learn physics. I encourage you to collaborate with each other on homework, but unless specifically directed otherwise, all work you turn in as your own should be your own.

Academic dishonesty can hurt you in many different ways. First, of course, it is wrong to turn in someone else's work as your own. If you get caught, the penalties can be severe. Second, it hurts your grade. Learning to do problems by yourself is the best preparation for the tests. Students who take the “easy” way out and get excessive or inappropriate help from others tend to get significantly lower grades on the tests.

There are a variety of resources available to help you in your study of physics. These include office hours, SI, tutoring through ATTIC, and working with classmates. Some students also find it useful to consult other texts, friends, and even a variety of on-line sources. In all cases, though the principles of academic honesty apply: All collaborators must be acknowledged (apart from your instructor), and all work you turn in must be your own.

Please read the department’s Academic Honesty policy for the rules regarding collaboration. Feel free to ask if you have any questions about this policy.

Final Exam: There will be a comprehensive final exam at a time to be arranged by the registrar. *Please do not make travel plans that conflict with the scheduled exam time.*

Grades: Your grade will be based on homework (20%), tests and quizzes (40% total), the final exam (20%), and the laboratory (20%). The lowest homework assignment will be dropped. Feel free to ask questions about how your grade is determined.

Federal Credit Hour Statement: The student work in this course is in full compliance with the federal definition of a four credit hour course. Please see the Registrar’s Office web site `http://registrar.lafayette.edu/additional-resources/cep-course-proposal/` for the full policy and practice statement.

<table>
<tr><th colspan="6">Andrew Dougherty Spring 2017
Office: Hugel Science Center 028
Lab: Hugel Science Center 025
610-330-5212 doughera@lafayette.edu</th></tr>
<tr><th>Time</th><th>Mon.</th><th>Tues.</th><th>Wed.</th><th>Thurs.</th><th>Fri.</th></tr>
<tr><td>8:00</td><td rowspan="2">prep</td><td rowspan="2"></td><td rowspan="2">prep</td><td rowspan="2"></td><td rowspan="2">prep</td></tr>
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<tr><td>1:00</td><td rowspan="2"></td><td rowspan="3">prep</td><td rowspan="2"></td><td rowspan="6">Phys 112
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HSC 119</td><td rowspan="2"></td></tr>
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<tr><td>2:00</td><td rowspan="2"></td><td rowspan="4">Office
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Phys 218
Lab</td></tr>
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ACADEMIC HONESTY GUIDELINES
Department of Physics

It is expected that each student taking courses in the Department of Physics is familiar with the statement "Principles of Intellectual Honesty" appearing in the Lafayette College Student Handbook. The following guidelines are intended to indicate how that statement pertains to your work in physics. Your instructor may have further guidelines for your specific course. We assume that students are honest; if you are not certain as to what is expected of you, consult your instructor before proceeding.

I. EXAMINATIONS:

1. Bring only those materials specifically authorized by your instructor. Frequently in the elementary courses, you will be permitted to bring in a formula sheet or you will be provided with one.

2. If you find that the seating arrangement is such that you can see someone else's paper, don't look! Better yet, ask if you can sit in another seat.

3. If you use a calculator, clear the answer before setting the calculator aside.

4. If you fail to hand in your paper at the end of the period you will be awarded a grade of zero for that test.

II. TAKE-HOME EXAMINATIONS: Take-home examinations are often assigned in some courses. Specific rules governing such tests will be announced by your instructor. The overriding principle, however, is that any work submitted be your own or be specifically credited to its source. There should be no discussion of the test questions with *anyone* other than the instructor.

III. HOMEWORK: You must acknowledge *all* collaborators. You are encouraged to learn from one another. You should first try to do homework problems on your own; after all you will have to do similar problems on your own in tests. However, discussion of difficult problems with others can help you to develop your own analytical skills and is encouraged, provided that, *after discussion* you write up solutions *on your own.* Do *not* borrow or lend homework papers. There is an important difference between discussing a problem with someone and copying his or her work. There have been students who have loaned papers to friends for a few minutes to "check answers", and been horrified to find themselves charged with academic dishonesty because their "friends" copied their solutions.

Please Note: The same ethical standards of academic integrity and honesty apply to the on-line homework as to the written homework, except that there is no place for you to specifically acknowledge collaboration. However, the same general rules apply.

IV. LABORATORY: Usually two or more students will work together in performing experiments and will submit reports of their work. In some courses, a single joint report may be submitted. Specific instructions will be announced by your instructor. If the words used to describe some part of the experiment are taken from some other source (such as the lab manual), then the source should be cited. (Reference to the lab manual can usually substitute for laborious copying.) If you consult with *anyone* about the experiment (e.g. students in your lab class other than your lab partner), that consultation should be acknowledged in your report. Do *not* borrow or lend a completed lab book or any portion of one.

V. PAPERS: Refer to the statement "Principles of Intellectual Honesty" in the Student Handbook.

Syllabus		Physics 112	Spring 2017
Jan.	23	Introduction; Oscillation Review	Ch. 14
	25	Traveling Waves	Ch. 15:1–3
	27	Sound & Light Waves; Energy; HW #1	Ch. 15:4–5
	30	Doppler Effect; Superposition	Ch. 15:7, 16:1–2
Feb.	1	Standing Waves	Ch. 16:3–4
	3	Interference; Beats; HW #2	Ch. 16:6–7
	6	Electromagnetic Waves; Interference	Ch. 17:1–3
	8	Single Slit Diffraction	Ch. 17:5
	10	Thin Films; HW #3	Ch. 17:4
	13	Reflection and Refraction	Ch. 18:1–4
	15	Lenses	Ch. 18:5,7
	17	Optical Instruments; HW #4	Ch. 19:1–7
	20	Electric Charge	Ch. 20:1–2
	22	**Hour Exam I**	Chs. 15–19
	24	Coulomb's Law	Ch. 20:3–4
	27	Electric Field	Ch. 20:5–6
Mar.	1	Forces and Torques;	Ch. 20:7
	3	Electric Potential Energy; HW #5	Ch. 21:1–2
	6	Electrical Potential and Field	Ch. 21:3–5
	8	Capacitors and Dielectrics	Ch. 21:6–8
	10	Electric Current; Batteries; HW #6	Ch. 22:1–3
	13–17	*Spring Break*	
	20	Resistance; Power	Ch. 22:4–6
	22	Circuits; Series and Parallel	Ch. 23:1–3
	24	DC Circuits; HW #7	Ch. 23:4–5
	27	Capacitors; RC Circuits	Ch. 23:6–8
	29	Magnetic Force and Field	Ch. 24:1–3
	31	**Hour Exam II**	Chs. 20–23
Apr.	3	Sources of Magnetic Field	Ch. 24:4
	5	Forces on Charged Particles and Currents	Ch. 24:5–6
	7	Torques; Magnetic Materials; HW #8	Ch. 24:7–8
	10	Magnetic Flux	Ch. 25:1–3
	12	Faraday's Law	Ch. 25:4–5
	14	Electromagnetic Waves; HW #9	Ch. 25:6–7
	17	Photons; Particles	Ch. 28:1–4
	19	Quantization; Uncertainty	Ch. 28:5–8
	21	The Hydrogen Spectrum; HW #10	Ch. 29:1–3
	24	The Bohr Model; Quantum Mechanics	Ch. 29:4–7
	26	Nuclear Physics	Ch. 30:1–3
	28	**Hour Exam III**	Chs. 24, 25, 28, and-29
May	1	Radioactivity and Half Life	Ch. 30:4–5
	3	Applications	Ch. 30:6–7
	5	*Final Review*; HW #11	
		Final Exam (cumulative)	

Kinematics: $v_x = \frac{dx}{dt}$ $a_x = \frac{dv_x}{dt}$ $v_{x_f} = v_{x_i} + a_x\Delta t$ $x_f = x_i + v_{x_i}\Delta t + \frac{1}{2}a_x\Delta t^2$
$v_{x_f}^2 = v_{x_i}^2 + 2a_x(x_f - x_i)$ $a_{rad} = \frac{v^2}{r}$ $T = \frac{2\pi r}{v}$ $f = 1/T$

Oscillations: $F = -kx$ $x = A\cos(2\pi ft + \phi)$ $\omega = 2\pi f = \frac{2\pi}{T}$ $f = \frac{1}{2\pi}\sqrt{k/m}$
$E = \frac{1}{2}kA^2$ $v_{\max} = 2\pi fA$ $a_{\max} = (2\pi f)^2 A$

Waves: $y(x,t) = A\cos\left(\frac{2\pi}{\lambda}x - \frac{2\pi}{T}t\right)$ $k = 2\pi/\lambda$ $v = \lambda f$ $v = \sqrt{\frac{F_T}{\mu}}$ $\mu = \frac{M}{L}$
$v = \sqrt{\frac{\gamma RT}{M}}$ $f_n = n\frac{v}{2L}$ $f_L = \left(\frac{v + v_L}{v + v_S}\right)f_S$ $f_{beat} = |f_2 - f_1|$ $I = \frac{P}{A}$

Interference: $\Delta r = m\lambda$ $d\sin\theta = m\lambda$ $d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$ $a\sin\theta = n\lambda$
$n = \frac{c}{v}$ $\lambda_n = \frac{\lambda}{n}$ $2nt = m\lambda$ $2nt = \left(m + \frac{1}{2}\right)\lambda$

Optics: $n_1\sin\theta_1 = n_2\sin\theta_2$ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$

Electric Forces and Fields: $\vec{E} = k\sum_i \frac{q_i}{r_i^2}\hat{r}_i$ $k = \frac{1}{4\pi\epsilon_0}$ $\vec{F_0} = q_0\vec{E}$

Infinite sheet: $E = \frac{\sigma}{2\epsilon_0}$

Electric Potential: $V = k\sum \frac{q_i}{r_i}$ $\Delta U = q_0\Delta V$ $\Delta V = -E\Delta x$ $E_x = -\frac{dV}{dx}$

Capacitance: $Q = C(\Delta V)$ $C = \frac{\epsilon_0 A}{d}$ $\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$
$C_{parallel} = C_1 + C_2 + C_3 + \cdots$ $U = \frac{1}{2}Q(\Delta V)$ $u_e = \frac{1}{2}\epsilon_0 E^2$

Circuits: $I = \frac{dq}{dt}$ $\Delta V = IR$ $R = \frac{\rho L}{A}$ $P = I(\Delta V)$ $R_{series} = R_1 + R_2 + R_3 + \cdots$
$\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$ $\tau = RC$ $q = Q_0 e^{-t/\tau}$ $q = Q_0(1 - e^{-t/\tau})$

Magnetic Forces and Fields: $\vec{F} = q\vec{v}\times\vec{B}$ $\vec{F} = I\vec{L}\times\vec{B}$ $\vec{\mu} = NIA\hat{n}$ $\vec{\tau} = \vec{\mu}\times\vec{B}$
$\mu_0 I_{encl} = \oint \vec{B}\cdot d\vec{s}$ **Long solenoid:** $B = \mu_0 nI$ $n = N/L$

Long straight wire: $B = \frac{\mu_0 I}{2\pi r}$ **Center of current loop:** $B = \frac{\mu_0 I}{2r}$

Induction: $\Phi_B = NBA\cos\theta$ $\varepsilon = -\frac{d\Phi_B}{dt}$ $\varepsilon = vBL$ $\varepsilon = -L\frac{di}{dt}$ $U = \frac{1}{2}LI^2$
$u_m = \frac{B^2}{2\mu_0}$

Electromagnetic Waves: $\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$ $v_{em} = c = 1/\sqrt{\epsilon_0\mu_0}$ $c = \lambda f$ $E_0 = cB_0$
$\vec{S} = \frac{1}{\mu_0}(\vec{E}\times\vec{B})$ $I = S_{ave} = \frac{1}{2}c\epsilon_0 E^2$

Modern Physics: $E = hf = \frac{hc}{\lambda}$ $\quad p = \frac{h}{\lambda}$ $\quad \Delta E = hf$

$r_n = n^2 a_0$ $\quad E_n = -\left(\frac{me^4}{8\epsilon_0^2 h^2}\right)\frac{1}{n^2} = -\frac{13.6\text{eV}}{n^2}$ $\quad (\Delta x)(\Delta p_x) \geq h/2\pi$ $\quad E = (\Delta m)c^2$

$N = N_0 e^{-t/\tau}$ $\quad T_{1/2} = \tau \ln 2$

Vectors: $A_x = A\cos\theta$ $\quad A_y = A\sin\theta$ $\quad A = \sqrt{A_x^2 + A_y^2}$ $\quad \vec{A}\cdot\vec{B} = AB\cos\phi_{AB}$

$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$ $\quad \vec{A}\times\vec{B} = \hat{n}AB\sin\phi_{AB}$

Math: $ax^2 + bx + c = 0$ $\quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $\quad (1+x)^n \approx 1 + nx$ for $x \ll 1$

$A = 4\pi r^2$ $\quad V = \frac{4}{3}\pi r^3$

Constants: $e = 1.602 \times 10^{-19}\,\text{C}$ $\quad \epsilon_0 = 8.854 \times 10^{-12}\,\text{C}^2/\text{Nm}^2$

$k = 1/4\pi\epsilon_0 = 8.988 \times 10^9\,\text{Nm}^2/\text{C}^2$ $\quad \mu_0 = 4\pi \times 10^{-7}\,\text{N/A}^2$ $\quad m_e = 9.109 \times 10^{-31}\,\text{kg}$

$c = 2.998 \times 10^8\,\text{m/s}$ $\quad h = 6.626 \times 10^{-34}\,\text{J}\cdot\text{s}$ $\quad hc = 1239.8\,\text{eV}\cdot\text{nm}$

$a_0 = 0.0529\,\text{nm}$ $\quad 1\text{u} = 931.5\,\text{MeV}/c^2 = 1.661 \times 10^{-27}\,\text{kg}$