

Syllabus for Physics 222, spring 2021

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prerequisites The prerequisites are Physics 221 and Math 152 with a grade of C or better.

office hours When you need help with the class, please feel free to get in touch 7 days a week between 7 am and 7 pm. You don't need to make an appointment. Just call my landline, 714 525 8466, and we'll set up a zoom session. If I'm not there, please either switch to email or wait 30 minutes before calling again. Don't leave voice mail, and don't call over and over at short intervals. I like to spend time in the mountains, so there will be times when I'm gone all day, but I will try to let you know in advance when those days will be.

web page www.lightandmatter.com/area3phys221.html

required materials The text is *Fields and Circuits*, which can be downloaded at lightandmatter.com/fac. Printed copies are available at lulu.com/spotlight/benjamin_crowell for \$14.60. I don't receive any royalties from sales of the printed book.

If you're a physics major with a strong mathematical background, I recommend that you also buy and read a copy of Purcell, *Electricity and Magnetism*, a beautiful, classic book. Old editions can be found for \$5-10 through aggregators like bookfinder.com. Although the old editions use a non-SI system of units, that only affects some of the numerical constants appearing in formulas, which is not a big issue in a book being used for this supplementary purpose.

getting started Here are the things you need to do by the second class meeting:

1. Read this syllabus.
2. Consult the schedule on page 6. Do the listed reading and the homework problems. Take notes on the reading.

recommended weekly routine The following is a typical way that you could allot your time for this course during a week in which there is one reading assignment and two homework assignments.

	hours
Read (first pass).	1
Read (second pass, typing notes).	0.5
Work alone on homework (first shot).	1.5 1.5
Tutoring/office hours.	0.5 0.5
Work alone on homework (second shot).	1 1
misc. (lab writeup, ...)	1
total	~ 8

grading Grades will be determined as follows:

homework	100 problems @ 0.1 point each	10
reading quizzes	24 questions @ 2 points each	48
labs	11 @ 20 points each	220
oral/written exams	14 @ ~40-50 points each	600
CPIE	4 evaluations @ 25 points each	100

points	grade
80%	A
69%	B
58%	C
47%	D

The reason for grading the homework is to give you feedback and track your progress. To avoid giving anyone an incentive to cheat by copying solutions from online or offline sources, I've made the weight assigned to the homework too low to have any significant direct effect on your grade. However, the way you learn the material in this type of course is by practicing. Therefore most students end up with about the same grades on the exams as on the homework. Turning in the homework will also affect your grade indirectly through your CPIE evaluations.

CPIE CPIE (“c-pie”) stands for continuous practice, improvement, and effort. I will grade you subjectively about every four weeks according to the following criteria.

1. Your homework and other written work is turned in, on time, not plagiarized from chegg *et al.*, and is substantially complete and correct.
2. Your most recent work shows that you’ve taken into account past feedback.
3. Your calculations don’t show the mistakes listed below in the section titled “basic literacy in calculations.”
4. Your work does not contain mistakes or omissions that could have been remedied. When necessary, you worked to fix such problems by methods such as using the answer checker; getting help from me when you were stuck on a homework problem; and seeking comments on drafts of lab writeups. You approached the process of doing such fixes in a timely manner, had realistic expectations about getting help, took responsibility for the outcome, and ultimately did your own work (a higher standard than just “I understood it”).
5. You attended all class meetings, were prepared for class, and participated actively. Your participation in class showed appropriate fluency with the material and organized access to the material at your fingertips. You made yourself socially present in class to the extent possible by doing things like turning on your video, and if there was a reason why you couldn’t do so, such as a technological or privacy issue, you made reasonable attempts to solve the issues.

A	20-25	substantially met all the criteria
B	17-19	minor glitches such as not making serious attempts on several homework problems
C	14-16	met most of the criteria but with substantial shortcomings such as missing one class or not turning in one homework assignment or turning in a significant amount of incomplete or incorrect work that could have been remedied with help
D	11-13	... similar but with more serious shortcomings such as not turning in one lab or several homework assignments
F	0-10	... still more serious shortcomings

basic literacy in calculations

The following are some common mistakes in carrying out a numerical calculation.

wrong	right	
$\frac{2(1.36)}{(0.53)^2} = 9.7$	$\frac{2(1.36 \text{ m})}{(0.53 \text{ s})^2} = 9.7 \text{ m/s}^2$	Never write numbers without units. When plugging in, check that the units work out to be what you expected.
$1.37 \text{ m} = \frac{1}{2}a(0.53 \text{ s})^2$ $1.37 \text{ m} = (0.140 \text{ s}^2)a$ $a = 9.7 \text{ m/s}^2$	$x = \frac{1}{2}at^2$ $a = \frac{2x}{t^2}$ $a = \frac{2(1.37 \text{ m})}{(0.53 \text{ s})^2}$ $a = 9.7 \text{ m/s}^2$	Finish the algebra before plugging in the numbers.
Volume of one ton of helium: $V = \frac{m}{\rho}$ $V = \frac{1000000 \text{ g}}{172 \text{ g/m}^3}$ $V = 5813.95 \text{ m}^3$	Volume of one ton of helium: $V = \frac{m}{\rho}$ $V = \frac{10^6 \text{ g}}{172 \text{ g/m}^3}$ $V = 5.81 \times 10^3 \text{ m}^3$	Use scientific notation. Put your calculator in scientific notation mode. Don’t waste time writing down lots of insignificant figures.

reading-based class, flipped classroom

The organization of this class is based on a belief in the primacy of written language.

This class will use what’s known as a flipped classroom technique. That means that you’ll encounter all the material first by reading the book. Class time will not be used to present the material from scratch, but instead for activities designed to deepen your understanding and help you clarify points that you had a hard time understanding just by reading. These activities will include student questions,

demonstration, examples, small-group discussion, and whole-class discussion. For a fairly recent meta-analysis of educational studies supporting the use of this technique, see Von Korff et al., “Secondary Analysis of Teaching Methods in Introductory Physics: a 50k-Student Study,” *Am. J. Phys.* 84, 969 (2016), arxiv.org/abs/1603.00516.

As soon as you’re done with a reading assignment, you should go back through and type up notes on what you’ve just read. You should do the notes on a computer (for ease of revision), and do them after you read, not while reading (so that you know what ended up being the main points).

There will be a short multiple-choice reading quiz on every reading assignment. I’ll distribute all of these as a PDF file at the beginning of the semester. The quizzes are due at the beginning of class. Because the quizzes can be done at home and are open-notes, I expect that very few people will get any of the questions wrong, and normally you will just be able to confirm this because the points will show up on your online grade report. If you get a question wrong, I’ll let you know by email.

When writing your notes, shorter is better. The laws of physics are fundamentally simple. I would suggest limiting yourself to no more than quarter of a page per chapter. By the end of the semester, the simple underlying structure of the material will have become more and more obvious to you, and I think you should be able to go back over your notes and edit them down to no more than about a page *total*. It’s not against the rules for your notes to be too long, but it’s not smart, either; long notes usually indicate that you’re not distinguishing fundamental principles from trivia, or that you’re making futile efforts to write a cookbook of problem-solving techniques, which is a self-defeating way to approach problem solving.

Any time you feel like showing me your notes, I would be happy to give you feedback on them.

Google Docs for
note-taking

For note-taking, I recommend that you use Google Docs, docs.google.com, which makes it easy to do equations. It works in any web browser, and you don’t have to install any software. To do an equation, go to the Insert menu and choose Equation. You can then type in your math. A toolbar also comes up, just above the top of the page, with symbols in it like square roots. I found the toolbar confusing when it came to doing exponents; the easiest way to do it is to enter, e.g., x^2 for x squared. Printing works, but is a little awkward and ugly. A PDF file pops up, with your equations rendered at low resolution. You then have to print the PDF file (i.e., you have to do two print commands in order to get the output to actually go to the printer).

Spotter

Spotter is computer software I’ve written to help you check your answers to homework problems. It can check both numerical answers and symbolic ones. Having Spotter helps you more than having answers in the back of the book, because it is programmed to give you helpful pointers. If you put in an wrong answer that I’ve anticipated, it will explain why it’s wrong. If your answer doesn’t make sense in terms of units, it will tell you that. If you get a wrong answer, you can redo the problem and put in the right answer later for full credit.

Problems labeled as online on the homework page of the syllabus have purely mathematical answers, and are in Spotter. To get credit for an online homework problem, you need to enter a correct answer in Spotter, and also turn in your written calculations and explanations along with the rest of the homework. What I’m really trying to do here is get you to come to my office hours and get help if you can’t get the right answer — Spotter helps you by letting you know whether you have the problem right *before* you turn it in.

You don’t need to install the software; you just use it through a web browser. Start from the class’s web page, then click on the “homework” link to the class’s Spotter page. Once you’re in Spotter, make sure to log in, or else you won’t get credit for your work! Once you’re logged in, all your answers will be recorded.

When using Spotter, you have to be careful about the notation you use for inputting mathematical expressions. Spotter is designed to allow you to use something resembling normal human mathematical notation, as opposed to the notation used in computer programs. However, human math notation is designed

for humans, not computers, and you need to learn a few things about how to type your expressions in a form that Spotter will interpret correctly.

First, everything you type will be smashed down to one line of text, eliminating the superscripts and subscripts. For example, a variable name with a subscript, like x_1 , is entered as `x1`. Since there are no superscripts, you have to enter exponents using the `^` symbol (shift-6), e.g., x^2 becomes `x^2`. You can enter a square root as either `sqrt(x)` or `x^.5`. There is no way to enter the times symbol, \times , without confusing the computer and making it think you meant the variable x , so in scientific notation you should simply leave a space where you would normally put the times symbol, e.g., 5×10^6 becomes `5 10^6`. Don't try to enter this as `5e+6`; that's what a lot of computer software would want, but Spotter is trying to interpret everything as normal human notation, so it will think you meant $5e + 6$, where e is a variable.

Human languages, including human math notation, are ambiguous. Use parentheses liberally to make your meaning clear. There are two main situations where you need to watch out. First, arguments to functions: `sin 2x` will be interpreted as $(\sin 2)(x)$; if you intended $\sin(2x)$, you should have entered `sin(2x)`. Second, the bottom of fractions: `1/3c` will be interpreted as $(1/3)c$, so if you want $\frac{1}{3c}$, you need to enter `1/(3c)`.

As you type your answer, the computer will display a rendering of it into "real" human math notation so that you can see how your input is being interpreted. If you're using this feature in a browser such as Internet Explorer that has poor math support, it will be slow, especially the first time you use it on a particular computer.

**academic honesty
policy**

In cases of serious academic dishonesty, I will assign a zero on the work, and I will also pursue action at the college level, which may result in penalties such as suspension or expulsion.

Serious academic dishonesty includes cheating on an exam, or turning in homework that is plagiarized from my solutions or from a source such as Chegg.

I will also assign a zero in cases where two students turn in homework or lab reports that contain identical or nearly identical work. A good rule of thumb is that if A is helping B, only B's paper should be out, and the pen should be in B's hand.

drops

I will drop you if you don't turn in two of the weekly exams in a row.

**communication
and turning in work**

Quizzes and homework will be turned in through email. To help me keep things organized, please send these emails with a subject line that looks like this:

p222q13, Jane Smith

"P" is for physics, the first number is the course number, "q" means it's a quiz, and 13 means it was the quiz on chapter 13. For homework, use a code like p222h28, meaning Physics 222, homework 28. Use "l" for labs and "e" for exams. Using these codes will cause my server to sort your email into the appropriate in-box for graded work.

Don't use these codes if you want to ask a question, set up a Zoom, etc., because I won't look at these emails until after the assignment is due when I'm grading it.

When you're sending an email to ask a question or for some other purpose, but not to turn in work, just use a detailed, descriptive subject line, e.g., "question about the right-hand rule for the Poynting vector." It's fine to send me a draft of some work, e.g., your partially complete work on a homework problem that you need help on. If doing this, use a descriptive title such as "FAC 9-13, power in series, is this right?"

You can send me your work as a plain text email, cell phone photo of a handwritten page, a PDF file, or some mixture of those things. When people in STEM email each other about stuff involving math, sometimes they use a plain-text version of the math, e.g., $\Delta x = x_1 - x_2$.

attachments and their size

When submitting work as a camera image or pdf file, please send it as an attachment, not a link to some external repository such as a dropbox account.

It will cause problems if you send photos that are large and high resolution. This can lead to results like your mail bouncing back with an error about its size, or your mail being delayed because my in-box reaches its maximum size. For a photo of a single page of your writing, the file size should be something like 0.1 to 0.5 Mb. If you have a fancy smartphone that takes high-resolution photos, then you should reduce the resolution when you send the images.

If you're using an ipad or iphone, I believe the following instructions will work for reducing the sizes of images. When you mail a photo using this user interface, there is a step where you tap "Share." At this point, it should give you a menu of choices for the compressed size, with sizes of small, medium, large, and actual. Choose one of the smaller sizes. You may wish to check by sending yourself an email what size is the smallest that leaves your writing legible.

If you're using software that creates pdf files, a quick and easy way to reduce the pdf's size before emailing it is to use a service such as <https://smallpdf.com/compress-pdf>.

Videos

The following videos are assigned along with the reading assignment for a particular chapter. For example, if the schedule page of the syllabus says 13†for the assigned reading, the †footnote directs you to this page, which tells you where to find the relevant video that supplements ch. 13. (The acronym 3b1b stands for 3Blue1Brown, a series of excellent videos that introduce mathematical concepts by starting with a visualization.)

supplement to ch.	URL	
1	youtu.be/nRetD5x8rPg	magnetic fields (first 9 minutes of the video)
2.1-4	youtu.be/nRetD5x8rPg	magnetic flux (the rest of the video)
2.5-8	youtu.be/rB83DpBJQsE	3b1b, divergence (first 4:30)
4	youtu.be/rB83DpBJQsE	3b1b, curl (4:30 to 6:00)
5	youtu.be/5VhEzDjb-SI	magnetic force on a charged particle
6	youtu.be/R5A83aXw5-I	magnetic induction
12.1-2	youtu.be/y0YEaeIC1KY	3b1b, complex exponentials
12.3-5	youtu.be/-pToyx00SUs	mechanical resonance
13	tinyurl.com/ycp9x9s4	3b1b, Fourier transform (first 12 min.)

Schedule for Physics 222, section , spring 2021

		read ch.	hw	topics		lab‡
Jan.25	M			Electric and magnetic fields		
	W	1*†	1**	practice exam		
Feb. 1	M	2.1-4†	2	Gauss's law	exam 1	c2.1 field of a permanent magnet
	W	2.5-8†	3	Coulomb's law, charge, divergence		
8	M	3	4	Models of matter		
	W	4†	5	The electric potential	exam 2	On your own time, solder cables for lab 2.4.
15	M			<i>Labor Day</i>		<i>Labor Day</i>
	W		6		exam 3	c2.4 electric potential
22	M		7			
	W	5	8	Electromagnetism	exam 4	
Mar. 1	M		9			c2.5 the dipole and superposition
	W	6†	10	Radiation	exam 5	
8	M		11			c2.6 polarization
	W	8	12	Resistance	exam 6	
15	M		13			c2.9 electrical measurements
	W	9	14	DC circuits	exam 7	
22	M		15			c2.10 the loop and junction rules
	W		16		exam 8	
Apr. 5	M		17			c2.7 the oscilloscope
	W	11	18	Sources of magnetism	exam 9	On your own time, wind coil(s) for lab 2.8, 2.15.
12	M		19			c2.8 electromagnetism
	W	12.1-2†	20	Complex numbers	exam 10	
19	M	12.3-5†	21	Resonance		
	W	13†	22	AC circuits	exam 11	c2.13a RC circuits
26	M		23			
	W	14	24	Impedance	exam 12	c2.13b the LR circuit
May 3	M		25			
	W		26		exam 13	c2.14 AC circuits
10	M	15	27	Stokes's theorem		
	W		28		exam 14	c2.15 Faraday's law
17	M		29			
	W				exam 15	

* Before each class that has assigned reading, do the reading, take notes, and turn in the reading quiz. See pp. 2-3 for details.

** Turn in your papers showing all the work you did on the homework, including the online problems. The list of problems for each homework is on p. 7.

†Also watch the video listed on p. 5.

‡Most or all of the lab work will be done on your own time, not during class time. Each lab is listed on a certain date. You are responsible for reading the lab by that date, which is also a good time to ask questions in class if there are things you didn't understand. For labs that have a "preparation" section, try to do the prep by the date when the lab is listed, and we may discuss it in class. Each lab is due 7 days after the date when it was listed.

exams Exams will be at the beginning of the classes shown above. They will be 20-40 minutes long. I will be online in zoom in case you have a question about the exam. I will appreciate it if you are also online with your video on during this time. Turn in your exam using the method described on p. 4. To allow for possible technical issues or getting stuck in traffic, I will not count your lowest test grade.

Exams will be cumulative but will concentrate on more recent material. The topics and difficulty of the exams will be coordinated with the homework, and as much as possible will be arranged so that you have had feedback on homework problems that are on the same topic and at a similar level.

Homework assignments

A notation like 2-5 means chapter 2, problem 5.

Problems labeled “online” are in Spotter, which is explained in the syllabus. The full statement of each problem is in the book, not in Spotter. For these problems, you have to do *both* of the following things to get credit: (1) check the answer in Spotter and get it right, and (2) show your work on the paper that you turn in. If you’re getting the wrong answer in Spotter and don’t know how to get it right, please come to my office hours for help! My office hours are listed on the front page of the syllabus.

I’d appreciate it if you would leave about an inch of empty space at the top of the front page of your homework, so I can write your scores on the problems there.

Solutions for some problems, marked with an “s” below, are given in the back of the book. Try to solve these without peeking at the solution, then use the solution to check yourself. These problems are not for credit, and you don’t need to turn in your work.

Problems labeled * are more difficult problems that are not required and are meant for students at the top of the bell curve who don’t find the regular homework challenging. These are not for points, but if you do one and would like feedback, please write me an eye-catching note on your homework paper so I’ll know to look at it.

Note that in many of the homework problems, you need to look up data in the back of the book.

If a problem doesn’t exist in your printed copy of the book, you can get it in the latest online version of the book at lightandmatter.com.

Homework 1

paper only
1-3 1-5 1-6_s

online and paper
1-1 1-2 1-4 1-7 1-8

FAQs about Spotter: (1) The full statement of the question is in the book, not in Spotter. (2) Spotter has every problem, not just the ones assigned to you.

Homework 2

paper only
1-12 1-17_s 1-18_s

online and paper
1-9 1-10 1-11 1-13

Homework 3

paper only

online and paper
1-15 2-5 2-6 2-7

Homework 4

paper only
2-1_s 2-3 2-9 2-10_s 2-17 2-18

online and paper
2-2 2-8 2-12 2-14* 3-5

Homework 5

paper only
3-4 4-1_s 4-25

online and paper
2-11 2-13 3-2 3-3 3-6 3-7* 4-2

Homework 6

paper only
4-3_s 4-4 4-5_s 4-9_s 4-10

online and paper
4-6 4-7 4-8 4-11 4-12 4-14 4-19_s

Homework 7

paper only
4-17 4-23*

online and paper
4-18 4-20 4-21

Homework 8

paper only
4-16 4-22* 4-24* 4-26 4-27 5-22_s 5-23

online and paper
4-15

Problem 5-22 may not be in your printed book, so you may need to download the latest online version.

Homework 9

paper only
5-1 5-2_s 5-21

online and paper
5-4

Homework 10 <i>paper only</i> 5-3 5-13 5-14 6-1	<i>online and paper</i> 5-12
Homework 11 <i>paper only</i> 5-5 5-15 _s 6-3 _s 6-5 _s	<i>online and paper</i> 5-16 5-17 5-20 6-2 6-4
Homework 12 <i>paper only</i> 6-6 _s 6-7* 8-1 _s	<i>online and paper</i>
Homework 13 <i>paper only</i> 8-6 _s 8-9	<i>online and paper</i> 8-2 8-3 8-4 8-5 8-7 8-8
Homework 14 <i>paper only</i> 8-11	<i>online and paper</i> 9-3
Homework 15 <i>paper only</i> 9-2 9-10 _s	<i>online and paper</i> 9-8
Homework 16 <i>paper only</i> 9-6 9-11	<i>online and paper</i> 9-9 9-12 9-13
Homework 17 <i>paper only</i> 9-14 9-15 _s	<i>online and paper</i> 9-16
Homework 18 <i>paper only</i> 9-18	<i>online and paper</i> 11-1
Homework 19 <i>paper only</i> 11-4 11-14 11-15	<i>online and paper</i> 11-2 11-3 11-6
Homework 20 <i>paper only</i> 11-5 11-13* 12-2 _s Problem 11-13 may not be in your printed book, so you may need to download the latest online version.	<i>online and paper</i> 11-7 11-8
Homework 21 <i>paper only</i> 11-9 11-11* 12-3 _s 12-5 _s 12-12 Before doing problem 11-11 You may want to warm up with the preceding problem in the book.	<i>online and paper</i> 12-1 12-4 12-11
Homework 22 <i>paper only</i> 12-6 12-8* 12-9	<i>online and paper</i> 12-10 13-1
Homework 23 <i>paper only</i> 13-2 _s 13-9 _s 13-10	<i>online and paper</i> 13-3 13-4 13-7 13-8
Homework 24 <i>paper only</i> 13-5	<i>online and paper</i> 13-6
Homework 25 <i>paper only</i>	<i>online and paper</i> 14-1
Homework 26 <i>paper only</i> 14-4	<i>online and paper</i> 14-2 14-3 14-5
Homework 27 <i>paper only</i> 14-7	<i>online and paper</i> 14-6

Homework 28

paper only
15-9 15-10 15-11 15-12

online and paper
15-3 15-4

Homework 29

paper only
15-1 15-2 15-7

online and paper

DRAFT

students with disabilities

Fullerton College is committed to providing educational accommodations for students with disabilities upon the timely request by the student to the instructor. Verification of the disability must also be provided. The Disability Support Services office functions as a resource for students and faculty in the determination and provision of educational accommodations. (Faculty Resource Guide at <http://staffdev.fullcoll.edu/>)

DRAFT