PHYSICS 541-01

Electromagnetic Fields

Autumn 2021
NS 130
MW 12:00 - 1:15 pm

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WWW:	http://www.physics.louisville.edu/cldavis/phys541/fall21/index.html
Text:	Electromagnetic Fields by Roald K. Wangsness
	2nd edition. Published by Wiley

INTRODUCTION

This course is the first of two senior level electricity and magnetism courses. Only this course is required for the Physics BS with the Astronomy and Astrophysics and Applied Physics Tracks. Both courses (541 and 542) are required for the Physics BS Professional Track. The material to be covered in these courses does not lend itself well to a 50/50 split. According to the UofL catalogue, this course (541) should cover "Electrostatic and magneto-static fields in free space and material media, solutions of Poisson's equation, time dependent fields, Maxwell's equations". Whereas the second semester (542) should include the development of electromagnetic waves from Maxwell's equations followed by a description of certain properties of this radiation. In my opinion, attempting to cover all E&M up to and including Maxwell's equations, to a level appropriate for a final year undergraduate course, in a single 14 week semester is foolhardy. There is just too much material, much of which, while conceptually relatively easy, is practically quite difficult. Therefore, in developing this course I have treated the two semester sequence as a single unit. If all goes according to plan, by the end of this first semester we will be three quarters the way to the formulation of Maxwell's equations (Chapters 1-10, 12-19 of the text). The second semester (542) will start with the completion of the formulation of Maxwell's equations and continue with properties of electromagnetic waves and radiation. For the Physics BS students choosing the Professional Track this causes no difficulties, you will receive the "full treatment" over two semesters. On the other hand, the remaining BS students and any others taking this course as an elective, will not receive exposure to everything described in the catalogue during this semester (541). This is unfortunate but, I believe, preferable to attempting to force the coverage described in the catalogue for this single semester course.

A detailed description of the intended coverage for this course may be found at the end of this syllabus. You are strongly urged to **read** the chapter or sections slated for coverage **before** each class. Ideally, you should

treat the lectures as a review of what you have already read. You will gain most from the lectures if you can concentrate on what I am **saying** not on what I am writing and this can only be achieved if you have some idea of what I am talking about in the first place.

Most of the lectures will be spent in a formal development of the topic of discussion. Only on limited occasions will there be time to completely solve any of the assigned homework problems. You are encouraged to make use of worked examples in the text, discussion with fellow class members and the instructor's office hours to solve assigned problems.

A copy of this syllabus, together with important course announcements will be posted on this course's home page, accessed via the address given above. Grades will be posted on the Blackboard page for the course.

GRADING

Grades will be determined from the overall percentage obtained by the following weighting, where the numbers in brackets represent the distribution of the weight between the "in-class" and "take-home" sections of the tests.

	Undergraduate	Graduate
Test 1 (Oct 6)	40% (27, 13)	25% (17,8)
Test 2 (Dec 6 or 10)	40% (27, 13)	25% (17,8)
Final (Dec 6 or 10)	-	25% (17,8)
Homework	20%	25%

The dates given above are tentative. **There will be no make-ups.**

It is expected that letter grades will be assigned according to the scale indicated below. These grade boundaries will not be raised. However, the instructor reserves the right to lower the grade boundaries if deemed necessary.

		A	$\geq$	73%
73%	>	A-	$\geq$	68%
68%	>	B+	$\geq$	63%
63%	>	B	$\geq$	58%
58%	>	B-	$\geq$	53%
53%	>	C+	$\geq$	48%
48%	>	C	$\geq$	43%
43%	>	C-	$\geq$	38%
38%	>	D+	$\geq$	34%
34%	>	D	$\geq$	30%
30%	>	F		

In addition, **whatever your overall class score, if your average score for the in-class portion of the tests is less than 25% you will be assigned an "F".**

TESTS

Each test will have an "in-class" and a "take-home" section. The tests will include only material covered during the regular class meetings unless otherwise specified. The "in-class" test problems will, by necessity, require less time to solve than the typical homework problems. But this does not mean that they will be easy, in order to solve the problems you will need to be completely familiar with the material. In other words, time will be a factor. You will be provided a sheet containing all the important basic formulas and any other critical information. The

"take-home" problems will typically be more difficult than the "in-class" problems, but will not be more difficult than the most difficult homework problems. There will, of course, be more time available to solve the "take-home" problems, but probably not more than three days. The exact limitation will be announced prior to each test.

According to my projected timetable the first test will include all of the material described below in Chapters 1-7 of the text. As far as possible the second test will include **only** material covered **since** the first test. Hopefully, this will mean Chapters 10, 12-19 of the text. However, the nature of the subject means that you will need to be comfortable with the material from the first nine chapters in order to understand chapters 10, 12-19. If you are a classified as a graduate student you will be required to take an additional comprehensive test (Chapters 1-10, 12-19, inclusive), having equal weight to tests 1 and 2.

HOMEWORK

Homework will be assigned at the completion of each chapter of the text. Unless specified otherwise it must be completed one week from the date of assignment. All homework will be collected, graded and returned as soon as possible, hopefully within one week. At the end of the semester your total homework score will be converted to a percentage and included as part of your overall grade in the manner described above.

I will almost exclusively assign odd numbered problems, since the answers to these problems may be found in the text. In many cases knowing the answer can be of assistance in developing a solution. But remember, since the answer is given, merely stating it will gain no credit, you must show how the answer is obtained. If a chapter takes one class to complete there will likely be 4 or 5 problems assigned from that chapter and this will constitute one homework assignment. If a chapter takes two classes to complete you can expect 7-8 problems in that chapter's home work assignment. Each assigned **problem** will be worth ten points, therefore, all homework assignments will not carry equal weight. Partial credit will be awarded. This means that you should always submit your attempt at a solution even if you were unable to arrive at the final answer. Also, look out for questions that have several parts; the ten points will be divided between the parts. If you make no attempt at one part you will automatically lose the points assigned to that part. In a similar vein, if the second part of a problem requires the answer to the first part of the problem (which you were unable to evaluate) you should make an attempt at the second part using the answer to the first part given in the text. Since problem solving time in class will be limited, when your graded homework is returned, attached to it will be worked solution of every **attempted** problem that seemed to cause you undue difficulty. Together with your correct solutions the homework problems will form a valuable study aid for the tests.

In addition to the "required" homework, for most assignments there will be several "extra credit" problems. Extra credit problems will be graded in the same way as required problems. A maximum of 5 additional percentage points towards your final grade will be available through extra credit. For example, if the semester includes a total of 20 extra credit problems and you earn 50 points from these problems, your extra credit score would be 50/200 = 25% so that 0.25 x 5 = 1.25% will be added to your final percentage score. Extra credit is only available for undergraduate students. The ***extra credit problems are part of the required homework for graduate students***.

Late homework will not be accepted. As you can see homework constitutes a significant part of the grading scheme. My recommendation is to make a first pass attempt at each homework assignment as soon as is practically possible after receiving the assignment. If you identify potential difficulties you will then have plenty of time to work on them before the due date. I will be very sympathetic to requests for guidance several days before an assignment is due. My sympathy will decrease rapidly as the due date approaches. By all means discuss the problems with fellow class members, this can be beneficial to all involved. However, I expect individual solutions. The same solution submitted by several individuals is usually obvious and will be considered a **single** solution. That is, each individual will receive a fraction of the total points awarded for the solution equal to the reciprocal of the number of individuals submitting the solution.

Finally, please take pride in your work. I will not grade your "scratch-pad". Each step in a solution should follow logically. If necessary, explain your variables, include sketches and always show all your working.

CLASS PARTICIPATION

When a course follows a text closely, as is the case for this course, there is a tendency to think that lectures are unnecessary. It is true that certain individuals are able to learn physics solely from a textbook. However, for

most of us, more explanation is needed than that which appears in a typical textbook. When learning new material, lectures provide the opportunity to ask questions as well as clarifying explanations. In order to ensure that you avail yourself of this opportunity class participation will be monitored throughout the semester. Participation does not mean that you are required to ask questions or be otherwise vocal in class; attendance in and of itself is a type of participation.

The following criteria will be followed; your final grade will be reduced by one ± letter grade for every complete multiple of 5 (unexcused) class absences. If you arrive more than 15 minutes late for class you are deemed to be absent. For example, if at the end of the semester you earn a B+ from tests and homework, but missed a total of 12 class meetings, your grade will be reduced by 2 ± letter grades. Your final grade will be a B-.

SYLLABUS

The material covered will closely follow the chosen text. The proposed schedule is described below.

Aug	23	1.1 – 1.7	Vector calculus
	25	1.7 – 1.18	Vector calculus
	30	1.19, 2.1, 2.2	Vector calculus, Coulomb's Law
			HW: Ch.1 #5,13,21,23 **EC:** Ch. 1 #9
Sep	1	2.3, 2.4, 3.1, 3.2	Coulomb's Law, Electric Field
			HW: Ch.2 #3,7,9,11
	6	**Labor Day**	
	8	3.3,3.4, 4.1	Electric Field, Gauss's Law
			HW: Ch.3 #9,11 **EC:** Ch.3 #13
	13	4.2, 5.1, 5.2	Gauss's Law, Scalar Potential
			HW: Ch. 4 #1,5,7,9 **EC:** Ch. 4 #11
	15	5.3, 5.4	Scalar Potential
			HW: Ch.5 #7,9,15,17,23 **EC:** Ch. 5 #21
	20	6.1 - 6.3	Conductors in electrostatics
			HW: Ch.6 #1,3,15 **EC:** Ch. 6 #7,11
	22	7.1 – 7.3	Energy in electrostatics
	27	7.4, 8.1	Energy in electrostatics and electric multipoles
			HW: Ch.7 #1,11,15,17 **EC:** Ch. 7 #5,7
	29	8.2, 8.3	Electric multipoles
Oct	4	**Mid-semester break**	
	6	**Test 1**: Chapters 1-7	
	11	8.4, 9.1 – 9.5	Electric multipoles and Boundary conditions
			HW: Ch.8 #3,7,13,17; Ch.9 #3 **EC:** Ch. 8 #19; Ch.9 #5
	13	10.1 - 10.3	Electrostatics and matter
	18	10.4, 10.6	Electrostatics and matter
	20	10.6 – 10.8	Electrostatics and matter
			HW: Ch.10 #3,7,15,23,29,35 **EC:** Ch. 10 #21,33,37
	25	12.1 – 12.4	Electric currents
			HW: Ch.12 #1,3,13 **EC:** Ch. 12 #7
	27	13.1 – 13.3	Ampere's Law
Nov	1	13.3, 14.1 -14.3	Ampere's Law, Magnetic Induction
			HW: Ch.13 #1,3,9 **EC:** Ch. 13 #7

	3	14.4, 14.5, 15.1	Magnetic Induction, **B** field, Ampere's Law
			HW: Ch.14 #3,9,15 **EC:** Ch. 14 #11
	8	15.2, 16.1, 16.2	Divergence of B, Vector Potential
			HW: Ch.15 #3,7,9 **EC:** Ch. 15 #1,11
	10	16.3 – 16.5	Vector Potential
	15	17.1, 17.2	Vector Potential
			HW: Ch.16 #3,9,11,15 **EC:** Ch. 16 #7,17
	17	17.4, 18.1	Faraday's law of induction , Magnetic Energy
			HW: Ch.17 #3,5,7,17,21 **EC:** Ch.17 #15,23,25
	22	18.2, 18.3, 19.1	Magnetic Energy, Magnetic multipoles
			HW: Ch. 18 #5,7,9,19 **EC:** Ch. 18 #15,17
	24	**Thanksgiving**	
	29	19.2	Magnetic multipoles
Dec	1	19.3	Magnetic multipoles
			HW: Ch. 19 #1,3,7,13 **EC:** Ch.19 #15
	6	**Test 2:** Chapters 10, 12-19	
	10	**Or Test 2:** Chapters 10, 12-19	

Title IX/Clery Act Notification

Sexual misconduct (sexual harassment, sexual assault, and sexual/dating/domestic violence) and sex discrimination are violations of University policies. Anyone experiencing sexual misconduct and/or sex discrimination has the right to obtain confidential support from the PEACC Program 852-2663, Counseling Center 852-6585 and Campus Health Services 852-6479.

Reporting your experience or incident to any other University employee (including, but not limited to, professors and instructors) is an official, non-confidential report to the University. To file an official report, please contact the Dean of Student's Office 852- 5787 and/or the University of Louisville Police Department 852-6111. For more information regarding your rights as a victim of sexual misconduct, see the Sexual Misconduct Resource Guide (http://louisville.edu/hr/employeerelations/sexual- misconduct-brochure).

DISABILITY RESOURCE CENTER

Individuals with disabilities who need reasonable modifications to complete assignments and course criteria successfully are encouraged to meet with the instructor as early in the course as possible to identify and plan specific accommodations. Students requesting an accommodation will be asked to supply a letter from the Disability Resource Center (DRC) or other documentation that will assist in planning modifications. The instructor will not recognize requested accommodations without DRC approval/endorsement. The DRC is located in Stevenson Hall. Its staff can be reached by telephone at (502) 852-6938 or online at http://louisville.edu/disability/