ELECTROMAGNETIC THEORY II

Phys 312 Spring 2021

Instructor:	Professor David Collins
Office:	WS 228B
Phone:	248-1787
email:	dacollin@coloradomesa.edu

Office Hours:	M 1 – 2pm, T 2 – 3pm, W 10 – 11am, Th 10 – 11am, F 1 – 2 pm
Class Meetings:	TTh 11:00am – 12:15pm, WS 113
Course Website:	http://www.coloradomesa.edu/~dacollin/teaching/2021Spring/Phys312/index.html
Required Text:	D. J. Griffiths, *Introduction to Electrodynamics,* 4th ed, Prentice Hall (2013).
Prerequisites:	Phys 311

Overview

The classical theory of electromagnetism is completely described by Maxwell's equations and the Lorentz force law. Maxwell's equations specify how charge distributions produce electric and magnetic fields and the Lorentz force law describes the forces that these exert on charges.

Physics 311 focused on methods for determining fields for stationary charge and current distributions. However, many charge and current distributions are not of this type. Yet Maxwell's equations are still valid here. Physics 312 will concentrate on applying Maxwell's equations to such situations. This will include some of the greatest triumphs of 19^{th} century physics: the existence and properties of electromagnetic waves and the production of electromagnetic waves by moving charges. Additionally Physics 312 will present methods for relating electromagnetic fields for different inertial observers and will connect this to special relativity. Various other topics from electromagnetism, that were omitted from Phys 311, will also be covered.

Physics 312 assumes a solid understanding of electromagnetism from Physics 311 as well as fluency with the associated mathematics.

The course covers:

1. Electric fields in matter, polarization, dielectrics.
2. Magnetic fields in matter, magnetization.
3. Maxwell's equations, boundary conditions, conservation laws.
4. Electromagnetic waves.

5. Potential formulation of electromagnetism.
6. Fields produced by a moving point charge.
7. Electromagnetic radiation.
8. Electromagnetism and relativity.

Assignments

An undergraduate student should expect to spend on this course a minimum of two hours outside the classroom for every hour in the classroom. The outside hours may vary depending on the number of credit hours or type of course. More details are available from the faculty member or department office and in CMU's Curriculum Policies and Procedures Manual.

1. **Homework:** There will typically be one homework assignment per class meeting. This will be due by 5pm on the date indicated on the assignment. Late homework will be subject to a penalty of at least a 2% reduction in maximum grade for each hour that the work is late. It is in your best interests to work by yourself on the homework problems but collaboration is acceptable. You can discuss the broad outlines of problem solutions with your colleagues but must write your final solutions independently. You are also encouraged to consult me for help with homework problems.

Exams and Quizzes

1. **Class Exams:** There will be two exams during class on the following days:

   Exam 1: 25 February 2021
   Exam 2: 8 April 2021

   Exams will be closed book and closed notes although you will be able to bring a formula sheet. Calculators will be allowed.

2. **Final Exam:** There will be a final exam at **10:00 am on Tuesday 18 May 2021**. The final will consist of a single exam done outside of class. Students will have two hours to complete the exam and submit it electronically.

Grades

Individual assignments and exams will be graded using suitable scales. In general, to get full credit (100%) for a problem your solution must be correct with complete explanations and calculations. Partial credit will be given for incomplete or partly correct solutions. No credit (0%) will be given for problems not attempted, assignments not turned in or quizzes and exams missed without good reason.

The numerical grades for each component will be totaled and a final numerical grade will be computed according to the following distribution.

Homework	40%
Class Exams	30%
Final Exam	30%

The following final numerical scores will guarantee letter grades:

90%	A
80%	B
70%	C
60%	D

Policies

1. **Helpful Resources:** The Tutorial Learning Center (TLC) is a *free* academic service for all CMU students. Tutors are available in Houston Hall 113 on a walk-in basis for many courses. More information is available at www.coloradomesa.edu/tutoring or 248-1392.

   In coordination with Educational Access Services, reasonable accommodations will be provided for qualified students with disabilities. Students should contact Educational Access Services (EAS) at 970-248-1856 or Houston Hall Room 108 as soon as possible. Please visit https://www.coloradomesa.edu/educational-access for additional information.

2. **Withdrawals:** There are several ways to drop this course. The deadline for dropping without penalty is **9 February 2021.** Please consult the CMU academic calendar and catalog for more details about adding and dropping courses.

3. **Attendance:** Attendance policies are described in the CMU catalog. You are expected to attend all the class meetings. In case of illness or other emergencies you must be able to produce the appropriate documentation. There are other circumstances under which you can be excused but you must discuss these with me in advance. If you miss a class or lab for a valid reason, turn in any assignments due before the start of the next class. Assignments turned in beyond your return to class will not be accepted.

   If there is an unavoidable conflict with one of the class exams or the final exam, please discuss it with me as soon as possible. In general I will assume that the final exam will have priority, since you know the dates of the exam.

4. **Academic integrity:** You are expected to present your own work in assignments, exams and quizzes. Fabrication of data, plagiarism, and copying from anyone else, particularly in closed book exams, are serious violation of academic norms. CMU has extensive policies on these matters and penalties for infringement can be severe. For more details, consult the academic integrity policies in the CMU catalog.

You are prohibited from using sources which provide solutions to homework assignment or exam problems. Websites which allow students to solicit solutions for homework problems will be monitored regularly for solutions to problems that have been written and produced by the course instructor or any other CMU faculty. Students who are discovered to have submitted any assignment or exam problem to any such service or have used any such service to obtain or view solutions to any assignment or exam problem will receive zero credit for that entire assignment and the instructor will submit a Report of Academic Dishonesty with the Office of Academic Affairs. Additional penalties may be levied in such cases.

Student Learning Outcomes

Upon completion of this course, a student should be able to:

1. Translate between verbal and mathematical descriptions of physical situations. Apply mathematical reasoning, using algebra, trigonometry and calculus, to analyze these situations.
2. Apply electrostatics and magnetostatics to situations where charges and currents are present in matter.
3. Apply energy and momentum conservation in electromagnetism to physical situations.
4. Apply Maxwell's equations to demonstrate the existence of electromagnetic waves and their reflection and transmission properties.
5. Apply Maxwell's equations and the potential formulation to determine fields produced by moving charge distributions.
6. Relate Maxwell's equations in different frames of reference.

This course contributes to the fulfillment the following program learning objectives for the BS in Physics degree. A student will have demonstrated the ability to:

1. Show fluency with the major fields of physics (classical mechanics, electromagnetism, statistical physics and quantum theory).
2. Use mathematical representations to analyze physical scenarios. This requires translating back and forth between physical and mathematical problems and using appropriate mathematics to aid in the analysis of the scenario.

Schedule

The following schedule is tentative, except for the dates of the class exams.

Week	Dates	Topic
1	1/26 – 1/28	Review of electrostatics, polarization, electric displacement (Ch. 4.1 – 4.3).
2	2/2 – 2/4	Electric displacement, dielectrics, magnetic dipoles (Ch. 4.3 – 4.4).
3	2/9 – 2/11	Magnetization, magnetic fields in matter (Ch. 6.1 – 6.4).
4	2/16 – 2/18	Maxwell's equations in matter, boundary conditions, energy in electromagnetism (Ch. 7.3, 8.1).
5	2/23	Momentum in electromagnetism, waves in one dimension (Ch. 8.2, 9.1).
5	2/25	**Exam I**.
6	3/2 – 3/4	Electromagnetic waves (Ch. 9.1 – 9.2).
7	3/9 – 3/11	Electromagnetic waves (Ch. 9.2 – 9.3).
8	3/16 – 3/18	Reflection and transmission of waves (Ch. 9.3).
9	3/23 – 3/25	Absorption and dispersion, potential formulation of electromagnetism (Ch. 9.4 – 10.1).
10	3/30 – 4/1	Potentials produced by point charges (Ch 10.2 – 10.3).
11	4/6	Moving point charges (Ch 10.3).
11	4/8	**Exam II**.
12	4/13 – 4/15	Moving point charges (Ch 10.3).
13	4/20 – 4/22	Dipole radiation, radiation (Ch 11.1 – 11.2).
14	4/27 – 4/29	Special relativity (Ch 12.1 – 12.2).
–	5/3 – 5/5	Break (no classes).
15	5/10 – 5/12	Relativistic electromagnetism (Ch 12.2 – 12.3).