ELECTROMAGNETISM AND OPTICS

Phys 132 Fall 2018

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Office Hours: M 10 – 11am, M 2 – 3 pm, TW 1 – 2pm, F 9am – 10am

Class Meetings: MTWR 11:00-11:50am, WS 160

Course Website: http://www.coloradomesa.edu/~dacollin/teaching/2018Fall/Phys132/index.html

Required Text: R. D. Knight, *Physics for Scientist and Engineers,* Vol 2, 4ed, Pearson (2017).

Overview

The theory of electromagnetism was one of the great accomplishments of 19^{th} century physics and, built on the general framework of Newton's Laws of mechanics, unified and explained a large range of phenomena associated with charged objects, currents and magnets. By the end of the century the theory had evolved to a compact and aesthetically pleasing form, which is still widely used.

Electromagnetism is perhaps the most important way of probing and learning about the physical world. Almost all modern scientific laboratories and the experiments conducted in them would be impossible to imagine without extensive use of electronic equipment. Much of what is learned in these circumstances hinges on understanding the electromagnetic interaction between the equipment and the physical system that is being observed. Electromagnetism has made possible much of the technology that is characteristic of the industrialized world: electric appliances, electronics, electric motors, power generation, computers, wireless communication, etc,. . . .

One of the predictions of the theory of electromagnetism is the existence of electromagnetic waves, which offer a complete description of the classical properties of light. Optics is the study of the properties of light. Some, such as reflection, refraction and image production using lenses are readily apparent. However, optics has consistently yielded surprising phenomena, which often provide fundamental insights into the nature of the physical world.

Phys 132 aims to introduce you to the phenomena of electricity and magnetism and optics and the theories which describe them as well as some of their practical applications.

The course will cover:

1. Electric charge, fields, potentials and currents.
2. Electric circuits.
3. Magnetic fields, interaction with currents.
4. Maxwell's equations, electromagnetic waves.
5. Wave optics.
6. Geometric optics.

Course Structure

The Monday, Wednesday and Thursday class meetings will usually be in lecture format. You will be expected to study the relevant sections of the text before class meetings.

Most Tuesday meetings will consist of a discussion/problem session during which you will work in small groups (with the instructor's help) on pre-assigned problems. You will be expected to attempt these **before the Tuesday class meeting.** There will be a short quiz covering the material at the end of the discussion session.

Assignments, Quizzes and Exams

1. **Warm Up Exercises:** Warm up exercises, available on the course Desire 2 Learn (D2L) shell, are based on readings of the text and must be completed by 9:00am on the day on which they are due. Instructions and grading schemes for each exercise are provided on the D2L shell.

2. **Homework assignments:** Homework assignments will be due **by 5:00pm on the designated day**. You should work by yourself on the homework problems but collaboration with other students is acceptable. You can discuss the broad outlines of problem solutions with your colleagues but must write your final solutions independently. You may consult the instructor for help with homework problems. You are not allowed to use any services which provide complete solutions to the problems assigned from the text.

3. **Quizzes:** There will be a short quiz at the end of each discussion/problem session.

4. **Class Exams:** There will be three exams during class on the following days:

   Exam 1 Wednesday 19 September 2018
   Exam 2 Wednesday 10 October 2018
   Exam 3 Wednesday 7 November 2018

   Exams will be closed book and closed notes although you can use a formula sheet. Calculators will be allowed.

5. **Final Exam:** There will be a final exam at **10:00am on Wednesday 12 December 2018**. The final will last one hour and 50 minutes and be comprehensive and closed book although a formula sheet will be allowed. Calculators will be allowed.

An undergraduate student should expect to spend on 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.

Grades

Your course grade will be composed as follows:

Component	**Number in Semester**	**Points for Each**	**Total**
Warm Up Exercises	15	2	30
Quizzes	12	5	60
Homework Assignments	10 $(11-1)$	15	150
Class Exams	3	70	210
Final Exam	1	150	150
All components			**600**

To get full credit (100%) for any question or problem your solution must be correct with a complete explanation. Partial credit may 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.

Each homework set will be graded out of 15 points. Two problems which will be selected at random and graded for correctness and completeness, each out of 3 points. The remaining problems will be checked for completeness and assigned 9 points. Your single lowest homework score will be dropped at the end of the semester.

Every question on all other components will be graded for completeness and correctness.

Your total score out of 600 points will be converted into a percentage. The minimum percentages for which letter grades will be *guaranteed* are as follows:

90%	A
79%	B
67%	C
50%	D

It is possible that letter grades will be attained at lower numerical scores than those above. This depends on the difficulty of exams and assignments during the semester. The only exception is that an F will be given if your numerical score is less than 50%.

Policies

1. 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 must register with the EAS office to receive assistance. Please meet with the instructor the first week of class for information and/or contact Dana VandeBurgt, the Coordinator of Educational Access Services, directly by phone at 248-1801, or in person in Houston Hall, Suite 108.

   Helpful advice on student success can be found at:

   http://www.coloradomesa.edu/academics/documents/StudentSuccessatCMU_WCCC.pdf

2. **Attendance:** Attendance policies are described in the CMU catalog. You are expected to attend all the class meetings and attendance will be recorded. 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.

   You will not be allowed to take a class quiz unless you attended the entire discussion session. If you have a valid reason for missing a discussion session, then you will be allowed to make up the quiz but must do so by the time that you return to class.

   The dates of the class exams and final exam are set at the beginning of the semester and it will be assumed that these have priority over any other events (consult me about conflicts known at the start of the semester). If you miss an exam for illness, an emergency or any other reason, you must provide documentation that justifies your absence. If the reason for your absence is satisfactory to the the instructor, he will make an accommodation for the exam that you missed; times for any make-up exams will be decided by the instructor.

3. **Withdrawals:** There are several ways to drop this course. The deadline for dropping without penalty is **4 September 2018.** Please consult the CMU academic calendar and catalog for more details about adding and dropping courses.

4. **Electronic Equipment Use:** The only electronic equipment that can be used during exams are calculators. During exams you will not be allowed to use any type of electronic equipment that allows you to communicate with other people or to store information which may be useful during the exam. Examples of such equipment include cellphones, smart phones, iPads, iPods and other similar devices that can record information or connect to the internet. The only exceptions are for students who have

a documented disability and need a particular device as part of their disability accommodation.

5. **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.

Student Learning Outcomes

The learning outcomes for this course are as follows. A student who has taken this course will demonstrate the ability to:

1. Translate between verbal and mathematical descriptions of physical situations. Apply mathematical reasoning, using algebra, trigonometry and calculus, to analyze these situations.
2. Articulate the arguments, verbal and mathematical, used to analyze physical situations.
3. Represent physical processes graphically and describe given graphical representations in physical terms.
4. Use calculus to describe and analyze physical situations.
5. Use the mathematics of vectors, vector algebra, products of vectors and vector components to analyze physical situations.
6. Distinguish between and relate electric charge, forces, fields, potentials and currents.
7. Distinguish between and relate magnetic forces and fields.
8. Determine and use electric fields, electric potentials, electric forces, electrostatic energy, magnetic fields and magnetic forces in various physical situations.
9. Describe and use basic concepts associated with waves and superpositions of waves.
10. Use the geometrical picture of light to describe the properties of and propagation of light in various physical situations.
11. Use the wave picture of light to describe the properties of and propagation of light in various physical situations, including interference and diffraction phenomena.

This course is part of CMU's essential learning curriculum and satisfies the following essential learning outcomes:

1. Demonstrate investigative and analytical thinking skills to solve problems.
2. Select and use appropriate information in an academic project.

This course contributes to the fulfillment of the following program learning outcomes 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.

Guaranteed Transfer

The Colorado Commission on Higher Education has approved PHYS 131 for inclusion in the Guaranteed Transfer (GT) Pathways program in the GTSC1 category. For transferring students, successful completion with a minimum C- grade guarantees transfer and application of credit in this GT Pathways category. For more information on the GT Pathways program, go to http://highered.colorado.gov/Academics/Transfers/gtPathways/curriculum.html.

Content Criteria

This course should provide students with the opportunity to/Students should be able to:

a) Develop foundational knowledge in specific field(s) of science.
b) Develop an understanding of the nature and process of science.
c) Demonstrate the ability to use scientific methodologies.
d) Examine quantitative approaches to study natural phenomena.

Student Learning Outcomes

Inquiry and Analysis Competency

Inquiry is a systematic process of exploring issues/objects/works through the collection and analysis of evidence that results in informed conclusions.

Student Learning Outcomes (SLOs): Students should be able to:

1. Select or Develop a Design Process
    a) Select or develop elements of the methodology or theoretical framework to solve problems in a given discipline.
2. Analyze or Interpret Evidence
    a) Examine evidence to identify patterns, differences, similarities, limitations, and/or implications related to the focus.
    b) Utilize multiple representations to interpret the data.
3. Draw Conclusions
    a) State a conclusion based on findings.

Quantitative Literacy Competency

Competency in quantitative literacy represents a student's ability to use quantifiable information and mathematical analysis to make connections and draw conclusions. Students with strong quantitative literacy skills understand and can create sophisticated arguments supported by quantitative evidence and can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc.).

Student Learning Outcomes (SLOs): Students should be able to:

1. Interpret Information

    a) Explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words).

2. Represent information

    a) Convert information into and between various mathematical forms (e.g., equations, graphs, diagrams, tables, words).

Schedule

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

Week	Dates	Topic
1	8/20 – 8/23	Electric charge, Coulomb's law (Ch 22.1 – 22.5).
2	8/27 – 8/30	Electric fields (Ch 22.5, 23.1 – 23.5).
3	9/3 – 9/6	Charged particle in a field, conductors, electric potential energy (Ch 23.6, 24.6, 25.1 – 25.4).
4	9/10 – 9/13	Electric potential, field and potential (Ch 25.5 – 25.7, 26.1 – 26.3).
5	9/17	Capacitors (Ch 26.5 – 26.6).
5	9/18 – 9/19	Exam review, **Class Exam I**.
5	9/20	Capacitors, currents (Ch 26.6 – 26.7, 27.1 –27.3)
6	9/24 – 9/27	Ohm's law, circuits (Ch 27.5, 28.1 – 28.3).
7	10/1 – 10/4	Circuits (Ch 28.4, 28.6 – 28.9).
8	10/8	Magnetic fields (Ch 29.1 –29.4).
8	10/9 – 10/10	Exam review, **Class Exam II**.
8	10/11	Magnetic fields, dipoles (Ch 29.4 –29.5).
9	10/15 – 10/18	Solenoids, Magnetic forces (Ch 29.6 – 29.9).
10	10/22 – 10/25	Induction, Faraday's law (Ch 30.1 - 30.7).
11	10/29 – 11/1	Applications of Faraday's law, waves overview, electromagnetic waves (Ch 30.7, 31.6 – 31.7).
12	11/5	Interference overview.
12	11/6 – 11/7	Exam review, **Class Exam III**.
12	11/8	Wave optics, interference of light (Ch 33.1 – 33.3).
13	11/12 – 11/15	Interference of light, reflection, refraction (Ch 33.4 – 33,8, 34.1 – 34.3).
–	11/19 – 11/22	Thanksgiving break (no classes).
14	11/26 – 11/29	Image formation, lenses (Ch 34.4 – 34.5).
15	12/3 – 12/6	Lenses, final review. (Ch 34.5 – 34.6).