Physics 110A – Electromagnetism and Optics (1st part)

Website

The course website can be found on [Bcourses.Berkeley.Edu].

(Once there, look for course materials under [Assignments], [Files], and [Syllabus].)

Textbook

Griffiths, INTRODUCTION TO ELECTRODYNAMICS, 4th Ed., 2013, Prentice Hall.

Grade formula

Final grade = 10% Homework + 30% Midterm #1 + 30% Midterm #2 + 30% Final Exam,

or 10% Homework + 30% Max (Midterm 1, Midterm 2) + 60% Final Exam, whichever is bigger.

In-class midterms on Monday, October 7, 10:10-11am,

and Monday, November 4, 10:10-11am.

Final exam is on Monday, December 16, 9:10-11am.

(Please bring exam-books or other writing material to both exams)

Homework policy

Homework is due by **5pm** on the **Wednesday** of each week.

Please drop your solutions into the 110A slot in the pathway between Birge and LeConte.

There are 12 problem sets and you are required to turn in **at least 10**.

The first problem set is **due on September 11**. (See [Syllabus].)

The problem sets will be available on BCOURSES under [Assignments].

Office hours

Ori Ganor's office hours: Monday, 12:00-2:00, 403 LeConte Hall.

Hadar Lazar's office hour: To be announced in the discussion.

David Sun's office hour: To be announced in the discussion.

Contacting the instructors

Please feel free to contact us with any question, concern, or suggestion you may have.

Email: Ori Ganor [**ganor@berkeley.edu**] (please include "Physics 110A" in the subject)

Accommodation for disability

Please come and talk to me (Ori) in private to let me know how I can make the class and course materials more accessible.

Resources for prevention of harassment and discrimination

physics.berkeley.edu/about-us/equity-inclusion/resources-on-harassment

Physics 110A: Tentative Schedule

Date	Description	Ref.	HW
WEEK 0			
8/28	Introduction		
8/30	Vector Analysis	§1	
WEEK 1			
9/2	Labor Day		
9/4	Vector Analysis	§1	
9/6	Vector Analysis	§1	
WEEK 2			
9/9	Vector Analysis	§1	
9/11	Vector Analysis	§1	Set 1
9/13	Vector Analysis	§1	
WEEK 3			
9/16	Vector Analysis	§1	
9/18	Electrostatics	§2	Set 2
9/20	Electrostatics	§2	
WEEK 4			
9/23	Electrostatic Energy	§2	
9/25	Conductors and Capacitors	§2	Set 3
9/27	Electrostatic force	§3	
WEEK 5			
9/30	Dirichlet and Neumann boundary conditions	§3	
10/2	Method of images	§3	Set 4
10/4	Green's functions	*	
WEEK 6			
10/7	Midterm Exam 1		
10/9	Class canceled		
10/11	Class canceled		
WEEK 7			
10/14	Multipole Expansion	§4	
10/16	Multipole Expansion	§4	Set 5
10/18	Magnetostatics	§5	
WEEK 8			
10/21	Magnetostatics	§5	
10/23	Magnetic fields in matter	§6	Set 6
10/25	Magnetic fields in matter	§6	
WEEK 9			
10/28	Electrodynamics	§7	
10/30	Electrodynamics	§7	Set 7
11/1	Review		
WEEK 10			

Date	Description	Ref.	HW
11/4	Midterm Exam 2		
11/6	Conservation laws	§8	Set 8
11/8	Electromagnetic Waves	§9	
WEEK 11			
11/11	Veterans Day		
11/13	Electromagnetic Waves	§9	Set 9
11/15	Veterans Day Holiday	§9	
WEEK 12			
11/18	Potentials and Fields	§10	
11/20	Potentials and Fields	§10	Set 10
11/22	Potentials and Fields	§10	
WEEK 13			
11/25	Radiation	§11	
11/27	Radiation	§11	Set 11
11/29	Thanksgiving		
WEEK 14			
12/2	Electrodynamics and Relativity	§12	
12/4	Electrodynamics and Relativity	§12	
12/6	Review		Set 12
12/16	Final Exam		

Ref. - Reference in Griffiths.
* - Indicates advanced topics.
HW - Homework is due by 5pm on the Friday of this week.

More details

Introduction

Grade = 10% HW + 30% Midterm Exam #1 + 30% Midterm Exam #2 + 30% Final Exam, or 10% HW + 30% Max(Midterm #1, Midterm #2) + 60% Final Exam, whichever is bigger.

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Vector Analysis

dot and cross products;

Vector Analysis

Current density; Grad; Div; Curl;

Vector Analysis

Div as the infinitesimal limit of a surface integral; Curl as the infinitesimal limit of a closed loop integral;

Vector Analysis

Line integrals; Surface integrals; Volume integrals; Line integral of a gradient; Gauss's theorem (Divergence theorem); Stokes' theorem (Curl theorem); Determining a vector field given its Div and Curl (Helmholtz theorem); Decomposition of a vector field into its irrotational and divergenceless (solenoidal) components;

Vector Analysis

Helmholtz theorem; Scalar potential; Vector potential;

Vector Analysis

Field lines; Laplace's equation for the potential; Harmonic functions; Grad, Div, and Laplacian in cylindrical coordinates;

Vector Analysis

Unit basis vectors in spherical coordinates; Grad, Div, and Laplacian in spherical coordinates; Volumue, surface, and line charge densities; Example 2.2 of Griffiths (electrostatic field produced by a segment with line charge);

Electrostatics

Curl and Div of electrostatic field; Maxwell's first equation; Application of Gauss's law; Symmetric charge configurations; Application of spherical symmetry; Spherical, Cylindrical, and Planar symmetries; Electric field of infinite uniformly charged line; Electric field of uniformly charged sphere; Electric field of infinite uniformly charged plane;

Electrostatics

Electrostatic potential; Electrostatic potential produced by a uniformly charged spherical shell calculated by an explicit integral (Example 2.8 of Griffiths); Electric field of an infinite uniformly charged plane;

Electrostatic Energy

Electrostatic energy of a collection of point charges; Electrostatic energy of a continuous charge distribution; Expression for the electrostatic energy in terms of the electric field;

Conductors and Capacitors

Electrostatic energy of a uniformly charged sphere; The electrostatic potential is constant inside a conductor; Grounded conductors; Induced charge; Screening of charge in a cavity inside a conductor; Capacitance; Parallel plate capacitors; Expressions for the electrostatic energy stored in a capacitor;

Electrostatic force

Calculating the electrostatic force on surface charge density from the average of the electric fields on both sides; Calculating the force on a plate of a parallel-plate capacitor from the derivative of the electrostatic energy; Puzzle: how to calculate the force on a capacitor plate when the potential is kept constant; Laplace and Poisson's equations with boundary conditions; Uniqueness of solutions to electrostatic problems with boundary conditions

for the potential; Earnshaw's Theorem (a charged particle cannot be heald in a stable equilibrium by electrostatic forces alone);

Dirichlet and Neumann boundary conditions

Dirichlet, Neumann, and mixed boundary conditions for Laplace's equation; Uniqueness theorem for solution to Poisson's equation among conductors with total charge on each conductor given;

Method of images

Method of images; Total force on a point charge near a conducting plane; Induced surface charge; Electrostatic energy of a point charge near a conducting plane; Introduction to Green's functions;

Green's functions

Definition of Green's function; Using Green's function to solve Poisson's equation with general Dirichlet boundary conditions; Application: an infinite grounded plane with a cut-out disk kept at a higher voltage;

Midterm 1

Class canceled

Class canceled

Multipole Expansion

Multipole Expansion

Magnetostatics

Magnetostatics

Magnetic fields in matter

Magnetic fields in matter

Electrodynamics

Electrodynamics

Review

Midterm 2

Conservation laws

Electromagnetic Waves

Electromagnetic Waves

Veterans Day Holiday

Potentials and Fields

Potentials and Fields

Potentials and Fields

Radiation

Radiation

Electrodynamics and Relativity

Electrodynamics and Relativity

Review