PHYC 511: Electrodynamics
Spring 2018

This class is a 3 credit hour graduate course.

Instructor:
Rouzbeh Allahverdi, Physics and Astronomy Rm 172, rouzbeh@unm.edu
Office Hours: T R 10:00-11:00

Time and Location:
M W 09:00-10:15, Physics and Astronomy Rm 5

Course Webpage:
http://physics.unm.edu/Courses/Allahverdi/Phys511Sp18/

Teaching Assistant:
Karthik Chinni, kchinni@unm.edu
Office Hours: W R 14:00-15:00 (Physics and Astronomy Lobby)

Requisites:
The required background for the class is that provided by our undergraduate E&M and methods of theoretical physics courses. Although the course will have a distinct physics flavor, engineering based students should find the class equally stimulating.

Outline:
This course will cover a number of fundamental topics in classical electrodynamics, including a brief review of electrostatics and magnetostatics and detailed studies of the characterization, propagation, generation, and scattering of electromagnetic waves, and an introduction to covariant electrodynamics. The course assumes a prior exposure to electrostatics and magnetostatics at the undergraduate level.

A problems class (PHYC 551.073) is set up for Fridays 09:00-10:15 in Rm 5 to help you primarily with problem solving skills. To get maximum benefit from the lectures, you are strongly encouraged to consider registering in the problems class.

Here is the list of topics that we will discuss:

REVIEW OF ELECTROSTATICS AND MAGNETOSTATICS
Laplace and Poisson Equations, Green's Functions
Boundary Value Problems – Image Method, Separation of Variables
Multipole Expansion, Dielectrics
Vector Potential, Magnetic Dipole, Macroscopic Magnetic Media
Magnetic Scalar Potential
Boundary Value Problems – Image Method

TIME VARYING FIELDS, MAXWELL'S EQUATIONS
Maxwell's Equations
Vector and Scalar Potentials, Gauge Transformations
Poynting's Theorem, Other EM Conservation Laws

PLANE WAVES AND PROPAGATION IN HOMOGENEOUS MEDIA
Polarization
Reflection and Refraction
Dispersion in Dielectric, Conductive, and Dissipative Media
Group Velocity
Causality, Kramers-Kronig Relations

WAVE GUIDES AND RESONATORS
Electromagnetic Fields and Attenuation in Conductors
Cylindrical Waveguides, Monochromatic Modes, Energy Flow and Attenuation
Resonant Cavities, *Q*-Factor
Dielectric Waveguides – introduction to optical fibers

RADIATING SYSTEMS, SCATTERING, AND DIFFRACTION
Electric Dipoles and Quadrupoles, Magnetic Dipoles
General Multipole Expansion of the EM Field (optional)
Scattering at Long Wavelengths, Rayleigh Scattering
Scalar Diffraction Theory
Diffraction by a Circular Aperture
Scattering in the Short-Wavelength Limit
Optical Theorem

RADIATION BY RELATIVISTICALLY MOVING CHARGES
Review of Special Relativity
Covariant Formulation of Electrodynamics
Lienard-Wiechert Potentials for a Point Charge
Angular Distribution of Radiation from an Accelerated Charge

Book(s):

Main Text:

Classical Electrodynamics by J. D. Jackson, Wiley, 3rd Ed.

Supplementary Texts:

1. *Modern Electrodynamics* by A. Zangwill, Cambridge, 2013.
2. *Introduction to Electrodynamics* by D. Griffiths
3. *Classical Field Theory* by F. E. Low, Wiley, 1997
4. *Electrodynamics of Continuous Media* by L. Landau and E. Lifshitz

Grading Policy:

The final grade will consist of contributions from the following three things:

a) Homework assignments (9-10 problem sets) 30%
b) Midterm exams (two exams) 40%
c) Final exam 30%