

Physics 470/570 – Electricity and Magnetism II – Fall 2009

Class meetings: M, W, F at 9:00-9:50 in Faraday West 227

Prof. S. Martin Faraday West 214 (815) 753-6467 spmartin@niu.edu

Office hours: M,T,W 10:00-11:30 (or whenever you can find me)

Class home page: <http://zippy.physics.niu.edu/phys470.html>

Textbook: *Introduction to Electrodynamics*, D.J. Griffiths, Prentice-Hall Inc., 3rd edition 1999. A more advanced book, NOT REQUIRED, is *Classical Electrodynamics*, J.D. Jackson, Wiley.

Grading:

40% Homework (Late penalty policy: 10% off for each day after the due date, for up to 1 week; 100% off for > 1 week late.)

25% Midterm Exam: (tentatively) Friday October 23, 9:00-9:59 a.m.

35% Final Exam: Wednesday December 9, 8:00-9:59 a.m.

To pass this course, you MUST score at least 50% on the homework AND at least 40% overall.

Please feel free to ask questions in or out of class. You are encouraged to consult with each other on the homework. However, everything you turn in should be your own work. Do not turn in anything that you have copied, or anything that you do not truly understand. Exam questions will be similar to homework questions. Exams will be closed book, but you will be allowed to bring in two pages of notes in your own original handwriting. Also, a formula sheet with spherical and cylindrical coordinates and vector derivatives will be provided.

Topics to be covered:

- One-week review of Physics 370 (Griffiths, Chapters 1-6)
- Electromotive Force (EMF)
 - Ohm's Law, batteries and circuits
 - Motional EMF
- Electromagnetic Induction
 - Faraday's Law
 - Lenz's Law
 - Induced electric fields
 - Self inductance and mutual inductance
- Maxwell's Equations
 - Maxwell's displacement current correction to Ampere's Law
 - Maxwell's equations in matter
 - Boundary conditions for Maxwell's equations
- Conserved quantities in electrodynamics
 - Local conservation of charge
 - Poynting vector and relation to energy, momentum and angular momentum in electromagnetic fields

- Waves
 - Wave equation in one dimension
 - Wave length, wave number, period, frequency, angular frequency, amplitude
 - Complex notation for sinusoidal waves
 - Reflection and transmission
 - Polarization
- Electromagnetic waves in vacuum
 - Wave equations for $\vec{\mathbf{E}}$ and $\vec{\mathbf{B}}$
 - Monochromatic electromagnetic plane waves
 - Light as an electromagnetic wave
 - The electromagnetic wave spectrum
- Electromagnetic waves in matter
 - Propagation in linear media
 - Index of refraction
 - Reflection and transmission at boundaries; optics
 - Absorption and dispersion
 - Rainbows
- Guided waves
 - Propagation of electromagnetic waves in waveguides
 - Rectangular waveguides
 - Coaxial transmission lines
- Potentials for electrodynamics
 - V and $\vec{\mathbf{A}}$ for time-varying fields
 - Gauge transformations; Coulomb gauge and Lorentz gauge
 - Retarded potentials
 - Liénard-Wiechert potential and fields for a moving point charge
- Electromagnetic Radiation
 - Electric dipole radiation
 - Magnetic dipole radiation
 - Radiation by point charges
 - Radiation by arbitrary sources
 - Radiation reaction
 - Radiated power and the Larmor formula
- Special relativity and electrodynamics
 - The principle of relativity and universal speed of light
 - Time dilation, Lorentz contraction, Lorentz transformations
 - 4-vectors and four-dimensional formulation of electrodynamics