PHYS 6610, Electromagnetic Fields II, Winter 2015

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1 Learning Outcomes

As part of the work associated with this course, the student will be expected to (in no particular order):

1) Be able to compute the resistance of complicated electromagnetic assemblies. Understand Faraday's law and apply it to compute the back E.M.F. in a variety of circuit arrangements. Be able to calculate inductance of various arrangements, understand the implications of the displacement current and the full form of Maxwell's equations in vacuum.

2) Be able to quantitatively understand the concepts of energy and momentum in electromagnetic fields, and be able to compute and apply the stress tensor to a variety of problems.

3) Develop an intuition about electromagnetic waves in both vacuum and matter. Understand the origin of various laws of optics from the fundamentals of Maxwell's equations in vacuum and matter. Have a working knowledge of EM waves in waveguides and cavities.

4) Be able to recast Maxwell's equations in terms of vector and scalar potentials and posses a basic understanding of gauge choice and its consequences. Understand the origin of retarded and advanced potentials and be able to compute these for simplified current distributions.

5) Be able to compute the radiation from simplified assemblies such as the electric and magnetic dipoles. Be able to compute the energy and power carried away by radiation.

6) Develop a deeper understanding of the special theory of relativity. Become versed in the use of relativistic kinematics and dynamics. Be able to formulate Maxwell's equations in relativistic form and be able to relate electromagnetic phenomena in different reference frames via Lorentz transformations.

2 Hours and location:

Mon-Wed-Fri, 11:45am - 12:40pm, 0177 Physics.

Office Hours: Friday 12:50-1:45 or by appointment.

3 Textbooks:

Introduction to Electrodynamics, By D. J. Griffiths.

Other books of interest:

Electromagnetism, by G. Pollack and D. Stump,

Foundations of Electromagnetic Theory, by Reitz, Milford and Christy,

Classical Electrodynamics, J. D. Jackson.

4 Grading (total 500)

Homework: Assigned Bi-weekly, and due every 2 weeks: 40 points each.
(total 6 assignments=240 points)

Midterm: 2 during class (end of February and end of March), **"closed"** book, 50 points.
(total on midterms=100 points)

Final Exam: 2 and 1/2 hours, closed book. 160 points.

5 Course Outline:

Electromotive force: Ohms Law, conductivity, Faraday's law, inductance,

Maxwell's equations: Maxwell's displacement current, Maxwell's equations, Poynting's theorem, stress tensor, Poynting vector,

Electromagnetic waves: Solutions of Maxwell's equations in free space, radiation pressure, EM waves in matter, EM waves in conductors,

Waves in Media: reflection, transmission and dispersion in media, phase velocity and group velocity, wave guides,

Radiation: Lienard-Weichert potentials, Jefimenko's equations, electric dipole radiation, magnetic dipole radiation, radiation from a point charge,

Relativity: relativistic kinematics, relativistic dynamics, electromagnetism in relativistic notation.

6 Homework

About 6 assignments will be handed out during the semester. Each assignment will consist of about 4 to 6 problems. Some of these will be quite difficult. You will have 2 weeks for each homework. Please do not leave these for the last minute. No solutions will be provided. You will be expected to complete as much of the homework as possible. **While consultation with your fellow students and with the instructor is encouraged, copying another student's work is not acceptable. More than one student with similar solutions will be penalized.**

7 Midterm 1, Feb 23th (Monday)

The midterm will be **closed** book in class.

8 Midterm 2, March 30th (Monday)

The midterm will be **closed** book in class.

9 Endterm, Apr 30th (Thursday)

The end term will be a 2 and 1/2 hour exam. This will be a closed book exam. Beyond a conceptual understanding of the subject, the ability to carry out straightforward though difficult and long calculations will be expected. The ability to reproduce fundamental derivations will also be expected.

10 Intended Audience (grading for graduate students)

This course is meant for advanced undergraduates. Any graduate students taking this class will be required to solve one extra problem with higher difficulty level on each assignment. Also graduate students will be required to solve one extra problem of similar difficulty in the final exam. Note that the final score for both graduate and undergraduate students will be out of 100%, i.e., graduate students will not receive any extra credit for the extra load.