Electromagnetic Theory I, PHY6346

SYLLABUS

0. Introduction
    1. Electromagnetic fields as dynamical variables
    2. Maxwell's equations as the equations of motion for fields
    3. Boundary conditions at media interfaces

I. Electrostatics I
    1. Gauss's law from one of Maxwell's equations
    2. Electric and potential of a point charge
    3. Laplace equation
    4. Boundary conditions and uniqueness theorems.
    5. Green's theorem and Green functions.
    6. Energy, energy density, and Capacitance

II. Electrostatics II: Boundary value problems
    1. Method of images
    2. Special geometries: spherical conductors, popint charges.
    3. Green function for a sphere
    4. Orthogonal functions and expansions
    5. Separation of variables
    6. Spherical coordinates, Legendre Polynomials
    7. Problems with azimuthal symmetry
    8. Sperical Harmonics
    9. Cylindrical coordinates, Bessel functions
    10. Green functions in spherical and cylindrical coordinates

III. Multipoles and dielectrics
    1. Multipole Expansion
    2. Electrostatics in media
    3. Boundary value problems with dielectrics
    4. Polarizability and electric susceptibility
    5. Energy in dielectric media

IV. Magnetostatics

1. Biot-Savart law
2. Magnetostatics and Ampere's law
3. Vector potential
4. Magnetic field due to a current loop
5. Magnetic fields of localized currents, magnetic moments
6. Boundary value problems in magnetostatics
7. Magnetized sphere, Permanent magnets
8. Magnetic shielding

V. Faraday's Law

1. Faraday's law of induction
2. Energy in the magnetic field
3. Self and Mutual Inductance
4. Quasi-static magnetic fields in conductors

VI. Maxwell's Equations and Conservation Laws

1. Displacement current and Maxwell's equations
2. Gauge Invariance, choosinig gauges
3. Green Functions for the wave equation
4. Retarded solutions for the fields
5. Equations of macroscopic electromagnetism
6. Conservation of energy and momentum: Poynting's theorem
7. Dissipative media and losses
8. Impedance and Admittance
9. Rotations, spatial reflection, and time reversal
10. Magnetic monopoles: the Dirac quantization condition

VII. Plane Electromagnetic waves and their propagation

1. Plane waves
2. Linear and circular polarization
3. Reflection and refraction at a plane interface

University Policies:

• Students are expected to know and comply with the University's policies regarding academic honesty and use of copyrighted materials. Cheating, plagiarism, or other violations of the Academic Honesty Guidelines will not be tolerated and will be pursued through the University's adjudication procedures.

• Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at

https://gatorevals.aa.ufl.edu/public-results/

• Students requesting classroom accommodations must first register with the Disabilities Resources Program, located in the Dean of Students Office, P202 Peabody Hall. The Disabilities Resources Program will provide documentation to the student, who must then deliver this documentation to the instructor when requesting accommodations.

COVID Statements:

• Our class sessions may be audio-visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate verbally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

• We may have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

• You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements

are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.

• This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.

• Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class. Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.

• If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus (Links to an external site.)), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms (Links to an external site.).

• Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies (Links to an external site.).

Electromagnetic Theory II, PHY6347

VIII. Lorentz Covariance of Maxwell Equations and Special Relativity

1. Spacetime symmetries of the wave equation
2. Lorentz transformations on space-time coordinates
3. Tensors and Tensor Fields
4. The electromagnetic field strength tensor and current density
5. Lorentz covariance of Maxwell equations
6. Lorentz invariant particle mechanics
   (a) Momentum and energy
   (b) Addition of velocities.
7. Thomas precession and Spin

IX Dynamics of Relativistic particles and electromagnetic fields

1. Lorentz covariant Lagrangians for particles and fields.
2. Motion in uniform fields
3. Adiabatic invariance
4. Relativistic corrections
5. Effective photon mass, penetrtion depth in superconductivity
6. Covariant stress tensor and conservation laws
7. Invariant Green functions

X. Plane Electromagnetic waves, continued

1. Frequency dispersion, waves in conductors
2. The ionosphere and magnetosphere
3. Spreading of a wave packet in dispersive media
4. Causality and dispersion relations

XI. Wave guides and Cavities

1. Fields in conductors
2. Waveguides
3. Resonant cavities
4. Normal mode expansion

XI Radiating Systems and Multipole fields

1. Localized oscillating source

2. Electric and magnetic dipole fields, Electric quadrupole fields
3. Linear Antenna
4. Multipole expansion
   (a) Energy and angular momentum
   (b) Angular distribution
   (c) Sources of multipole radiation

XII. Scattering of electromagnetic waves and diffraction

1. Long wavelength scattering
2. Sperical wave expansion
3. Scattering by a sphere
4. Scalar and vector diffractin theory
5. Short wavelength limit
6. Optical theorem

XIII. Radiation by moving charges

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