Physics 505 **Graduate Classical Electrodynamics** Prof. Paul M. Goldbart
Handout 2 `https://mycourses.stonybrook.edu/d2l/home` Physics & Astronomy
27 January 2025 Course Syllabus Stony Brook University

Here are the syllabus and grading policy for Physics 505: *Classical Electrodynamics*. At this stage, the details of the course content and order are probable rather than certain, as we may find ourselves wishing to adjust the focus as we proceed. Here, too, is the suite of Official Stony Brook University *Syllabus Statements*.

1. **Maxwell's equations**
   - Potentials and field strengths; charges and currents
   - Action principle and Maxwell's equations
   - Gauge invariance
   - Energies and forces
   - Electromagnetic stress tensor
2. **Electrostatics in vacuum**
   - Field energy; interactions
   - Coulomb's law
   - Electric dipoles and dipole layers
   - Multipole moments
3. **Laplace's and Poisson's equations**
   - Potential theory; linearity and superposition
   - Boundary conditions: Dirichlet, Neumann, Robin
   - Green functions
   - Method of images
   - Separation of variables; spherical harmonic functions
   - Complex variables techniques
   - Variational strategies
4. **Electrostatics with conducting media**
   - Screening
   - Capacitance
   - Systems of conductors
   - Forces on conductors

5. **Electrostatics with dielectric media**
    - Electric dipoles and polarization
    - Coarse-graining
    - Maxwell's equations for dielectric media
    - Forces and energies
    - Models of dielectric matter
    - Variational strategies
6. **Magnetostatics in vacuum and with magnetic media**
    - Amperès law; the law of Biot & Savart
    - Magnetic scalar potential; vector potential
    - Magnetic dipoles and dipole layers; multipoles
    - Forces and energies
    - Coarse-graining
    - Maxwell's equations for magnetic media
    - Models of magnetic matter
    - Variational strategies
7. **Dynamics and quasistatic fields**
    - General features of electrodynamics
    - Energy, linear momentum, angular momentum
    - Slowly time-varying charges and currents
    - Quasistatic fields in media
8. **Electromagnetic wave propagation in vacuum and in matter**
    - Plane waves; wave packets
    - Polarization
    - Beams and spherical waves
    - Waves in simple matter: reflection, refraction, pressure
    - Waves in dispersive matter
    - Guided and confined waves
9. **Radiation, scattering, interference, and diffraction**
    - Radiation and antennas
    - Thomson scattering; Rayleigh scattering
    - Exact solutions and approximation schemes

- Diffraction by a planar aperture

10. **Special relativity**
    - Einsteinian relativity
    - Minkowski space-time
    - Bondi's K-calculus
    - Hyperbolic geometry
    - The Lorentz transformation
    - Covariant mechanics and electrodynamics
    - Four-vector presentation
    - Radiation by relativistic charges
11. **Additional topics as time permits**

Grading Policy for the Course: In determining final grades, the weights given to the components of a student's work will approximately be: 65% for homework and 35% for the two examinations (taken together). Please note that these figures are liable to adjustment.

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