222C Applied Electromagnetic Theory - Computational Methods for Electromagnetics

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Prerequisites: 222B or permission from Instructor

Suggested books:

1. Computational Methods in Electromagnetics, A. F. Peterson, S. Ray and R. Mittra, IEEE Press
2. Field Computation by Method of Moments, R. F. Harrington, IEEE Press
3. Finite Element Methods in Electromagnetics, J. Jin, Wiley
4. Computational Electrodynamics: Finite Difference Time Domain Method, A. Taflov, Artech House

Class Policies:

1. Homework: Approximately 4 (-6) homework assignments
2. Projects: 2 projects and 1 presentation (of the last project).
3. Grade Distribution
    - Homeworks: 25%
    - Projects: 70%
    - Presentation: 5%

Detailed outline:

1. Introduction
    - Review of Maxwell's Equations, importance of numerical methods
    - Classification of computational methods: differential vs. integral equations methods, frequency vs. time domain methods

2. Finite difference methods
    - Approximation of derivatives by finite differences
    - finite difference time domain (FDTD): FDTD method in 1D, FDTD method in 2D and 3D, Yee scheme, numerical stability, numerical dispersion, absorbing boundary conditions, source modeling
    - Finite difference statics and frequency domain: 1D equations, eigenvalue problems, Laplace and Poisson equations, Helmholtz equation
3. Integral equation (IE) methods
    - Green's function approach, 2D&3D Green's functions, uniqueness, reciprocity, equivalence principles
    - IE formulations: electric field IE (EFIE), magnetic field IE (MFIE), combined field IE (CFIE), volume integral equations
    - Method of Moments: 2D problems, wires, basis functions, construction of matrix equations and solutions, review of 3D problems
    - Discussion on fast methods and time domain integral equation methods
4. Finite element method (FEM)
    - Basis functions and construction of matrix equations
    - 2D scalar and vector FEM, discussion of 3D FEM
    - Closed vs. open problems, eigenvalue problems