

Topics in Numerical Methods

Finite difference methods

- Difference equations and stencils

- Laplace eigenvalue problem

- FDTD

 - Stability

 - Dispersion error

 - Boundary conditions, Dirichlet, Neumann, absorbing

 - Hard and soft sources

 - Yee cell

 - Materials

 - Scattered field formulation

 - Post processing

 - Far field transformation

 - Radar cross section, scattering width

Numerical integration

- Classical polynomial rules

- Gaussian quadrature, weight functions

- Singular integrals

Method of moments

- Integral equations and integral operators

- Surface and volume integral equations

- Basis and testing functions

- Computational cost and solution error

Linear systems

- Linear spaces and norms

- Classes of matrices

- Direct solvers, LU factorization

- Stationary iterations

- Krylov subspace methods

- Convergence rate and condition number

- Preconditioners

- Fast methods

Finite element method

- Functionals and variational principles

- Rayleigh-Ritz method

- Elements and shape functions

- Assembly

- Boundary conditions

Optimization and inverse problems

- Cost or objective function

Local and global minimization

Simplex method

Ill-posed problems

Regularization

Born approximation, holographic backpropagation

Regularized sampling

General considerations

How long does it take to get a solution?

How do I know if a solution is accurate?

What are the advantages and disadvantages of different numerical methods?