Computational physics

Level: General

Prerequisites: Linear algebra

- Numerical methods
  - Interpolation of a function
  - Least-squares interpolation
  - Spline approximation
  - Numerical differentiation
  - Numerical integration;
  - Root finding methods
  - Ordinary differential equation (Euler method, Runge-Kutta method)
  - Systems of inhomogeneous linear equations (Gaussian eliminations, QR decomposition, iterative solutions of inhomogeneous linear equation)
  - Fast Fourier transform
  - Random numbers and Monte Carlo methods
  - Eigenvalues and eigenvectors of large matrices
- Applications
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  - Numerical solution of the Schroedinger equation
    - Shooting method
    - Variational method
    - Spectral methods (Rayleigh-Ritz method)
    - Pseudospectral methods (collocation)
    - Mode matching
    - Problems in one, two and three dimensions
  - Numerical solution of the Helmholtz equation
    - Method of multiple solutions;
    - Spectral and pseudospectral methods;
    - Numerical verification of Weyl's law;
  - Random walks and brownian motion

Bibliography

- R. Landau, Computational physics, Wiley
- P.O.J. Scheer, Computational physics, Springer
- J.M. Thijssen, Computatioal physics, Cambridge University press