Course Contents

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- Computer representation of numbers
  - Binary numbers, floating point format
  - Finite precision, round-off, machine epsilon
  - Error propagation and catastrophic cancellation
- Basic numerical analysis.
  - Taylor series as asymptotic expansions.
  - Asymptotic error expansions, error analysis and order of accuracy.
  - Extrapolation and interpolation techniques
  - Methods for integration on a uniform mesh: rectangle rule, trapezoid rule, midpoint rule, Simpson's rule.
  - Convergence study as a correctness check.
- Numerical Linear Algebra.
  - Review of linear algebra, vector and matrix norms.
  - Condition number of a system of linear equations, condition number of a matrix.
  - Improving condition number: scaling and balancing
  - The LU factorization and its use for systems of linear equations.
  - Computing the factors by Gauss elimination.
  - Pivoting.
  - The Choleski factorization.
  - Band matrices.
- Time stepping methods for dynamical systems (ODE's).
- Partial differential equation
  - Elliptic equation
  - Parabolic equation
  - Hyperbolic equation
- Nonlinear equations and optimization, Newton's method.
- Principles of numerical software, performance and reliability
  - Software tools: debuggers, memory leaks, performance tools.
  - Understanding the hardware: prefetch, pipelining, cache.
  - Coding for performance.
  - Using open-source modeling software.