Math 571 Comprehensive exam

Numerical analysis of Ordinary Differential Equations

Course description

Theory and implementation of numerical methods for initial and boundary value problems in ordinary differential equations. One-step, linear multi-step, Runge-Kutta, and extrapolation methods; convergence, stability, error estimates, and practical implementation, Study and analysis of shooting, finite difference and projection methods for boundary value problems for ordinary differential equations.

Topics

One-step methods

Scalar problems and systems, implicit and explicit methods, consistency and convergence, error estimates.

Runge-Kutta methods

General formula, implicit and explicit methods, Butcher tableaux, truncation error.

Linear multi-step methods

Implicit and explicit methods, construction, initiation, consistency, stability, convergence, absolute stability, predictor-corrector methods, A-stability for stiff problems.

Boundary value problems

Difference and shooting methods for linear and nonlinear BVPs.

References

- Numerical Methods for Ordinary Differential Equations, Butcher, 2016.
- Numerical solution of ODEs, Suli, 2022.
- Numerical methods for ODEs, Griffiths & Higham, 2010.
- Numerical solution of ODEs, Atkinson, 2009.
- Numerical Analysis: Mathematics of Scientific Computing, Kincai and Cheney, 2002.