NUMERICAL ANALYSIS PRELIMINARY EXAMINATION SYLLABUS

November 15, 2004

Topics:

1. Approximation and Interpolation: least squares approximation and data fitting; orthogonal polynomials; polynomial interpolation: Lagrange interpolation and Hemite interpolation, error and convergence; interpolation at Chebyshev points, Chebyshev polynomials; trigonometric polynomial approximation; interpolation by spline functions, interpolation error and convergence;

2. Numerical Integration and differentiation: finite difference approximation of derivatives; numerical integration by composite trapezoidal and Simpson rules; Newton-Cotes formulas; Gaussian quadrature formulate; extrapolation methods; Romberg integration.

3. Ordinary Differential Equations: one-step methods, local and global error; Runge-Kutta methods; stiff equations; multi-step methods, convergence of multi-step methods

4. Solving system of equations:

1. Direct methods and Iterative methods for solving linear systems:

   Gaussian elimination, roundoff-error analysis of Gaussian elimination, Factorization: LU factorization, Cholesky factorization, LDL^t factorization, Crout factorization, QR factorization. Iterative methods: Jacobi's method, Gauss-Seidel's method, SOR method, Steepest decent method, conjugate gradient method, convergence theorems of iterative methods A multigrid method (1-D problem, see Stoer and Bulirsch's book)

2. Systems of non-linear Equations:

Newton's method and its local convergence; Quasi-Newton methods and local convergence.

3. Eigenvalue problem: QR algorithms.

Senior level textbooks used in the past:

1. R.L. Burden and J.D. Faires, Numerical Analysis, 7th edition, Thomson, 2001.
2. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd edition, Wiley, 2004

Graduate level textbooks in the past:

1. J. Stoer and R. Bulirsch, Intro. to Numerical Analysis, 2nd edition, Springer-Verlag, 1993.
2. A.Quarteroni, R. Sacco and F. Saleri, Numerical Mathematics, 2nd edition, Springer, 2004