PRELIMINARY EXAMINATION TOPICS LIST
FOR NUMERICAL ANALYSIS

1. Numerical Linear Algebra
   (a) Methods for solving linear systems
      i. Direct methods
         A. Gaussian elimination (LU and Cholesky factorization)
         B. Orthogonal decomposition
   (b) Iterative methods
      i. Jacobi, Gauss-Seidel, and SOR methods
      ii. Conjugate gradient method

2. Methods for solving for eigenvalues and eigenvectors
   (a) Power method
   (b) Inverse power method
   (c) QR method

3. Computer arithmetic
   (a) Floating point arithmetic
   (b) Rounding errors

4. Approximation Theory
   (a) Polynomial approximation
      i. Weierstrass approximation theorem
      ii. Lagrange interpolation
      iii. Hermite interpolation
      iv. Least squares (orthogonal polynomials)
      v. Best approximation in the uniform norm (minimax)
   (b) Piecewise polynomials
      i. Continuous piecewise linear interpolation
      ii. Cubic spline interpolation
   (c) Trigonometric approximation
   (d) Rational approximation (Pade approximations)

5. Numerical Differentiation and Integration
   (a) Numerical differentiation
(b) Numerical integration
   i. Newton-Cotes methods
   ii. Gaussian quadrature
   iii. Romberg integration (Richardson extrapolation)

6. Initial-Value Differential Equation Systems
   (a) Taylor-series methods
   (b) Runge-Kutta methods
   (c) Multistep methods
   (d) Predictor-Corrector methods
   (e) Extrapolation methods
   (f) Stiff systems

7. Numerical Solution of Nonlinear Equations
   (a) Equations in one variable
      i. Bisection method
      ii. Fixed point method
      iii. Newton’s method
      iv. Secant method, Muller’s method
      v. Acceleration of convergence (Aitken’s method, Steffensen’s method)
   (b) Systems of nonlinear equations
      i. Contraction mapping theorem
      ii. Newton’s method
      iii. Quasi-Newton methods
      iv. Minimization and the steepest descent method

8. Linear Two-point Boundary-Value Problems
   (a) Finite-difference methods
   (b) Linear shooting method
   (c) Galerkin method (finite element method)