Numerical Analysis Preliminary Exam Syllabus

1. **Mathematical Review and Computer Arithmetic**
   a. Basic Calculus Concepts and Taylor's Theorem
   b. Orders of Convergence
   c. Floating point numbers and Round-off errors

2. **Numerical Solutions to Non-linear equations**
   a. Bisection Method
   b. Fixed-point Method
   c. Newton's Method
   d. Secant Method

3. **Numerical Linear Algebra**
   a. Basic results from Linear Algebra
   b. Direct Methods
      i. Gaussian Elimination
      ii. LU and Cholesky decomposition
      iii. QR decomposition
         1. Householder Transformation
         2. Givens Rotation
         3. Gram-Schmidt Procedure
         4. Least Squares
   c. Iterative Methods
      i. The Jacobi method
      ii. The Gauss-Seidel method
      iii. The SOR method
   d. Singular Value Decomposition
   e. Method for solving eigenvalues and eigenvectors
      i. Power method
      ii. Inverse Power method
      iii. QR method

   a. Polynomial approximation
      i. Taylor polynomial approximation
      ii. Lagrange interpolation
      iii. Hermite interpolation
      iv. Least squares approximation
   b. Piecewise polynomial approximation
      i. Continuous piecewise linear interpolation
      ii. Cubic Spline interpolation

5. **Numerical Differentiation and Integration**
   a. Numerical differentiation
   b. Numerical integration
      i. Newton Cotes
      ii. Gaussian Quadrature

6. **Numerical Solutions to Ordinary Differential Equations**
   a. Taylor-series methods
   b. Runge-Kutta methods
   c. Multi-step methods
   d. Predictor-Corrector Methods
   e. Stiff Systems

7. **Linear two-point boundary value problems**
   a. Finite-difference methods
   b. Linear shooting method

4. **Approximation Theory**