Numerical Analysis Ph.D. Qualifying Examination Syllabus

1. Solution of Nonlinear Equations, Chapter 3.1 to 3.4 of [KC]
    - Bisection, Newton's, secant, fixed points and functional iterations
2. Solving Systems of Linear Equations, Chapter 4 of [KC]
    - Direct methods: LU and Choleskey factorizations, pivoting, special matrices
    - Iterative methods: Neumann series, iterative refinement, Jacobi, Gauss-Seidal, SOR, steepest descent, conjugate gradient, preconditioning,
    - Norm, error analysis, condition number
3. Selected Topics in Numerical Linear Algebra, Chapter 5 of [KC]
    - power method, Schur's and Gershgorin's theorems, orthogonal factorization, least-squares problems, SVD.
4. Approximating Functions, Chapter 6 of [KC]
    - Interpolation: Polynomial (Divided differences), Hermite, and Splines interpolations.
    - Best approximation: Least squares theory.
5. Numerical Differentiation and Integration, Chapter 7 of [KC]
    - Numerical differentiation, Richardson extrapolation, numerical integration based on interpolation, Gaussian quadrature, Romberg integration
6. Numerical Solution of Ordinary Differential Equations, Chapter 8 of [KC].
    - Initial value problem: Taylor-series method, Runge-Kutta, multistep, stability, systems and higher-order ODEs, and stiff equations
    - Boundary value problems: finite-differences.
7. Numerical Solution of Partial Differential Equations, Chapter 9 of [KC]
    - Parabolic problems: explicit and implicit methods, elliptic problems: finite differences.

Reference:

[KC] D. Kincaid and W. Cheney, Numerical Analysis–Mathematics of Scientific Computing, 2nd Edition, Brooks/Cole Publishing Company, 2002