Numerical Analysis – Questions for the Exam
Spring Semester 2021/2022

1. Integer numbers, their diadic representation. Real numbers, floating pont numbers, mantissa and characteristics. The smallest and the largest representable numbers.

2. Absolute and relative errors. The absolute and relative errors of the basic arithmetic operations, inner product, etc.

3. The Manhattan, the Euclidean and the maximum norm on finite dimensional spaces and their equivalence. The induced matrix norms and their computation.

4. Absolute and relative error for the solutions of systems of linear equations when the righta hand side and when the matix is perturbed. The condition number, and the spectral radius of a matrix.

5. The Gauss elimination method to solve systems of linear equations. Necessary and sufficient condition for solvability. The LU factorization and its uniqueness.

6. Linear regression, the method of least squares. Nonlinear regression, normal equations.

7. Eigenvalues and eigenvectors of matrices, the characteristic polynomial. Unitary and normal matrices. Localization of the eigenvalues, Gershgorin disks.

8. Iterative methods to find the largest eigenvalue and the corresponding eigenvector. The Rayleigh quotient.

9. Iterative methods to solve systems of linear equations. The Gauss and the Seidel iterations. Sufficient conditions for the convergence.

10. Finding zeroes and multple zeroes of polynomials. Error estimates for the roots of polynomials.

11. Solution methods for nonlinear equations. The Newton(–Raphson), the modified Newton, the chord (secant) and the midpoint methods. The convergence of the Newton method.

12. Solution methods for systems of nonlinear equations. The Newton and the modified Newton methods. The convergence of the Newton method.

13. The Lagrangian interpolation problem. Existence and uniqueness. The error of the Lagrangian interpolation.

14. Divided differences. The recursive property and determinantal representation of divided differences. The Newton formula for the Lagrangian interpolation polynomial. Mean value theorem for divided differences.

15. The Hermite interpolation problem. Existence and uniqueness. The error of the Hermite interpolation.

16. Numerical integration. The midpoint, the trapezoid and the Simpson rules and their order of exactness. The general quadrature formula.

17. Interpolational quadrature formulas. The Newton-Cotes formulas and their error term.