Questions for exam from Numerical methods

1. Source and types of errors
2. Definition of absolute and relative errors, their estimation. Error of basic arithmetic operations.
3. Rounding, significant digits, significant decimal places. Show 5 examples.
4. Propagation of errors (illustrate on one example).
5. Representation of numbers, the smallest and the largest positive number, machine epsilon, underflow, overflow.
6. Conditionality of numerical problems, condition number, numerical stability of algorithms.

7. Briefly describe an algorithms for solution of nonlinear equation $f(x) = 0$.
8. Iterative method, the rate of convergence.
9. Bisection method, rate of convergence, pros and cons.
10. Regula falsi method, rate of convergence, pros and cons, compare with bisection method.
11. Secant method, rate of convergence, pros and cons.
12. Newton's method, rate of convergence, condition for convergence.
13. Explain the principle of fixed-point iteration method.
14. Aitken-Steffensen method, principle.
15. Achievable accuracy of the root.

16. Main methods for solution of system of linear equations. Brief characteristics.
17. Explain, why we should use Gaussian elimination with pivoting.
18. LU decomposition and its application.
19. Explain: "Gaussian elimination with pivoting assures the small residua."
20. Conditionality of problem to find solution of system of equations.
21. Cholesky decomposition.
22. Methods for calculation of determinant of matrix. Which method is suitable for determinants of matrices of high order?
23. When we use iterative method for solution of system of equations and why?
24. Briefly describe Jacobi method and compare with Gauss-Seidel method.
25. Basic principle of Krylov subspace methods, example.
26. Meaning of preconditioning.
27. Singular value decomposition, principle, application.

28. Approximation of functions
29. Lagrange polynomial, pros and cons.
30. Newton polynomial, pros and cons.
31. The error of approximation for interpolating polynomial. Optimal distribution of interpolation nodes.

32. Hermite interpolation, principle.
33. Spline interpolation, principle.
34. Linear spline interpolation, properties.
35. Hermite cubic spline, principle and properties.
36. Cubic spline, principle, boundary conditions, properties.
37. Least-square method, principle. Weighted least squares.
38. Normal equations, Gramian matrix and its condition number, selection of basis functions.

Example will consist of written preparation for answer to 4 questions and from oral answer to them and to other supplementary questions.

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