

MATH77 and *mathc90*

Mathematical Subprogram Libraries for Fortran 77 and ANSI C

Table of Contents

1. Introduction

- 1.0 Release 6.0 of MATH77
- 1.1 Purpose and Scope
- 1.2 Access to the MATH77 and *mathc90* Libraries
- 1.3 Conventions Followed in the Code and Documentation

2. Mathematical Functions

- 2.1 Inverse Hyperbolic Functions
- 2.2 Error Function
- 2.3 Gamma and Log-Gamma Functions
- 2.4 Bessel Functions J_0 , J_1 , Y_0 and Y_1
- 2.5 Bessel Functions of General Orders J_ν and Y_ν
- 2.6 Bessel Functions I_0 , I_1 , K_0 and K_1
- 2.7 { Empty }
- 2.8 Complete Elliptic Integrals K and E
- 2.9 Incomplete Elliptic Integrals
- 2.10 Exponential Integrals Ei and E_1
- 2.11 Finite Legendre Series
- 2.12 Finite Laguerre Series
- 2.13 Inverse Error Function and Inverse Complementary Error Function
- 2.14 Sine and Cosine Integrals
- 2.15 Procedures to Avoid Loss of Precision: $\ln(1+x)$, etc
- 2.16 Complex Error Function $w(z)$
- 2.17 Fresnel Integrals
- 2.18 Digamma or ψ Function
- 2.19 Incomplete Gamma Function Ratio
- 2.20 Binomial Coefficients

3. Pseudorandom Number Generation

- 3.1 Uniform Random Numbers
- 3.2 Gaussian (Normal) Random Numbers and Vectors
- 3.3 Random Numbers: Exponential, Rayleigh, and Poisson

4. Linear Systems of Equations and Linear Least-Squares

- 4.1 Square Nonsingular Systems of Linear Equations
- 4.2 Linear Least-Squares and Covariance Matrix
- 4.3 Singular Value Decomposition and Analysis
- 4.4 Sequential Preprocessing of Linear Least-Squares Data
- 4.5 Sequential Solution of a Banded Least-Squares Problem
- 4.6 Solution of a Positive-Definite System with Cholesky Factorization

5. Matrix Eigenvalues and Eigenvectors

- 5.1 Eigenvalues and Eigenvectors of a Symmetric Matrix
- 5.2 Eigenvalues and Eigenvectors of a Hermitian Complex Matrix
- 5.3 Eigenvalues of an Unsymmetric Matrix
- 5.4 Eigenvalues and Eigenvectors of an Unsymmetric Matrix

6. Matrix-Vector Utility Subprograms

- 6.1 Vector and Matrix Output
- 6.2 Extended Vector and Matrix Output
- 6.3 Basic Linear Algebra Subprograms (BLAS1)
- 6.4 One Householder Transformation

7. Polynomial Root Finding

- 7.1 Roots of a Polynomial
- 7.2 Roots of a Quadratic Polynomial
- 7.3 Compute Polynomial Coefficients from Roots

8. Nonlinear Equation Solving

- 8.1 Zero of a Univariate Function
- 8.2 Solve System of Nonlinear Equations
- 8.3 Check Code for Computing Derivatives

9. Minimization

- 9.1 Local Minimum of a Univariate Function
- 9.2 Local Minimum of a Multivariate Function, with Linear Constraints
- 9.3 Nonlinear Least-Squares

10. Finite Fourier Transforms

- 10.0 Overview of Fourier Transforms and Spectral Analysis
- 10.1 One-Dimensional Real Fourier Transforms
- 10.2 Trigonometric, Cosine, and Sine Fourier Transforms
- 10.3 Complex Fourier Transform
- 10.4 Multi-dimensional Real Fourier Transform
- 10.5 Primitive Fast Fourier Transform

11. Curve Fitting

- 11.1 Polynomial Least-Squares Curve Fit
- 11.2 Evaluation, Integration, and Differentiation of Polynomials
- 11.3 Conversion between Chebyshev and Monomial Representations of a Polynomial
- 11.4 Least-Squares Cubic Spline Fit
- 11.5 Least-Squares Data Fitting Using K^{th} Order Splines with Constraints
- 11.6 Low-level Subprograms for Operations on Splines

12. Table Look-Up and Interpolation

- 12.1 One-Dimensional Table Look Up, Interpolation, and Differentiation
- 12.2 Multi-Dimensional Table Look Up, Interpolation, and Differentiation
- 12.3 Table Look-up With Hermite Cubic Interpolation
- 12.4 C^0 and C^1 Surface Interpolation to Scattered Data

13. Definite Integrals (Quadrature)

- 13.0 Effective Use of the Quadrature Software
- 13.1 Numerical Evaluation of Integrals Over One Dimension
- 13.2 Numerical Evaluation of Integrals Over More Than One Dimension

14. Ordinary Differential Equations

- 14.1 Variable Order Adams Method for Ordinary Differential Equations
- 14.2 Explicit Runge-Kutta Method for Ordinary Differential Equations

15. Statistics

- 15.1 Basic Statistics and Histogram
- 15.2 Cumulative Distribution Function and Percentage Points for Normal Probability Distribution
- 15.3 Cumulative Distribution Function for Chi-Square Probability Distribution
- 15.4 Cumulative Distribution Function for Poisson Probability Distribution

16. Graphics

- 16.1 Character-based Graphics — One or More XY Graphs
- 16.2 Character-based Graphics — Single Print Line
- 16.3 Plotting Using T_EX

17. Special Arithmetic

- 17.1 Computation Using Derivative Arrays or Univariate Taylor Series
- 17.2 Computation Using Partial Derivative Arrays or Multivariate Taylor Series
- 17.3 Double Precision Complex Computation

18. Sorting

- 18.1 Sorting One-dimensional Arrays in Memory
- 18.2 Sorting Data of Arbitrary Structure in Memory
- 18.3 Sorting Partially Ordered Data of Arbitrary Structure in Memory
- 18.4 Sorting Data Sets Too Large to Fit in Memory

19. Library Utilities

- 19.1 System Parameters
- 19.2 Error Message Processor
- 19.3 Extended Error Message Processor
- 19.4 Converting Codes to Different Versions
- 19.5 Checking the Installed Library
- 19.7 Checking and Output of Program Unit Interfaces

Appendix A. Files Required by Each Entry

Appendix B. Entry Names and Common Block Names

Appendix C. Usage of the *mathc90* Library

Appendix D. Function Prototypes for the *mathc90* Library

Index