# stichting mathematisch centrum



AFDELING NUMERIEKE WISKUNDE

NW 8/74 APRIL

P.W. HEMKER (ed.) NUMAL, A LIBRARY OF NUMERICAL PROCEDURES IN ALGOL 60 INDEX AND KWIC INDEX

2nd edition

# 2e boerhaavestraat 49 amsterdam

SIGNIGIESES MATHEMATISCH AMSTERDAM

CENTRUM

Printed at the Mathematical Centre, 49, 2e Boerhaavestraat, Amsterdam.

The Mathematical Centre, founded the 11-th of February 1946, is a non-profit institution aiming at the promotion of pure mathematics and its applications. It is sponsored by the Netherlands Government through the Netherlands Organization for the Advancement of Pure Research (Z.W.O), by the Municipality of Amsterdam, by the University of Amsterdam, by the Free University at Amsterdam, and by industries.

AMS (MOS) subject classification scheme (1970): 65-00

1st edition: december 1973

# Acknowledgements

The numerical library NUMAL is being developed by the joint efforts of the members of the library group of the Numerical Mathematics Department of the Mathematical Centre.

But, in this place I specially want to acknowledge Mr. G.J.F. Vinkesteyn, who takes care of the library files, and Mr. A.C. IJsselstein, who adapted and ran the kwic-index program by which the kwic-index in this report was generated.

P.W.H.

## Introduction

On request of the Academic Computing Centre Amsterdam (SARA) the Mathematical Centre adapted its library of numerical procedures for use with the CD CYBER 70 system. The major part is now available for use and compatible with the CD ALGOL 60 compiler version 3. The resulting library is called NUMAL.

The aim of NUMAL is to provide a high level numerical library for ALGOL 60 programmers. The library contains a set of validated numerical procedures together with supporting documentation. Except for a small number of double length scalar product routines, all the source texts are written in ALGOL 60 and they are to a high degree independent of the computer/compiler used.

Unlike the former numerical library of the Mathematical Centre, the documentation of the library NUMAL is self-contained and does not refer to other MC-publications as far as the directions for use and the source texts of the procedures are concerned.

Of course, the library is in continuous development and any description will be an instantaneous one. In this report we give an index of the procedures available in april 1974 and a kwic-index of the procedures whose full descriptions were available at december 1<sup>st</sup> 1973.

The aim of the Mathematical Centre is to distribute an extended version of the index and kwic-index approximately twice a year.

# Organization of the library

The library NUMAL is stored as a number of permanent files in the CD CYBER 70 system of SARA.

These files are:

1. the file "numal 3 index"

This file contains an up to date index of the library. A listing of version 740321 (march 21<sup>st</sup> 1974) is printed below.

It gives a survey of the procedures and it describes the way one can obtain the documentation of each procedure.

2. the file "numal 3"

(Numerical procedures in ALGOL 60, version 3).

This is a library file which contains the object code of the procedures available. This library can be used when programs are loaded, compiled by the CD ALGOL 60 compiler, version 3.

3. the files "numal 3 document a"

"numal 3 document b"

etc.

These files contain the documentation.

Each of these documentation files is subdivided into a number of segments, each consisting of two successive records. The first record of a segment contains a description of a procedure (or set of procedures) and instructions for use; the second record contains the ALGOL 60 source text(s).

The files "numal 3 document a" and "numal 3 document b" only contain ALGOL 60 source texts. Full documentation is in preparation. Mostly, the user can find documentation in the LR-series of the Mathematical Centre.

The files "numal 3 document c" upto "numal 3 document f" contain full documentation of those procedures which also were available for the EL-X8 computer of the Mathematical Centre and which are now available in a revised form for the CD CYBER 70 system.

The files "numal document g" and "numal document h" contain full docomentation of the procedures, developed in 1973 for NUMAL.

The procedures described in "numal 3 document a" up to and including "numal 3 document f" are available for all users of the SARA CD CYBER 70 system. At the moment (april 1974) the procedures described in "numal 3 document g" upto and including "numal 3 document j" are only available for those who have the disposal of an MC-project number.

#### INDEX TO THE LIBRARY

#### NUMAL

#### OF ALGOL 60 PROCEDURES IN NUMERICAL MATHEMATICS

ON REQUEST OF THE ACADEMIC COMPUTING CENTRE AMSTERDAM ( SARA )
THE LIBRARY NUMAL IS DEVELOPED AND SUPPORTED BY THE NUMERICAL

MATHEMATICS DEPARTMENT OF THE MATHEMATICAL CENTRE (AMSTERDAM).
THE PRESENT DOCUMENT CONTAINS A SURVEY OF THE PROCEDURES AVAILABLE IN
OR PLANNED FOR NUMAL, MOREOVER, IT DESCRIBES THE WAY BY WHICH ONE
CAN OBTAIN FULL DOCUMENTATION OF THOSE PROCEDURES ALREADY AVAILABLE,

#### FILES,

1 1

THE LIBRARY NUMAL CONSISTS OF A NUMBER OF FILES:

1. FILE "NJMALBINDEX".

THIS FILE CONTAINS THIS PARTICULAR DOCUMENT, I.E. THE INDEX TO THE LIBRARY.

2, FILE "NUMAL3" A LIBRARY FILE WHICH CONTAINS THE OBJECT CODE OF THE PROCEDURES AVAILABLE, THIS LIBRARY CAN BE USED WHEN PROGRAMS, COMPILED UNDER ALGOL3, ARE LOADED, FOR THE USE OF A LIBRARY FILE SEE E.G.

SCOPE REF MANUAL, CHAPTER 6.

INTERCOM REF MANUAL, CHAPTER 3, XED COMMAND.

3. THE FILES "NUMAL 3DOCUMENTA"

"NUMAL 3DOCUMENTB"

"NUMAL3DOCUMENTO"

ETC.

FULL DOCUMENTATION.

THESE FILES CONTAIN THE DOCUMENTATION OF THE PROCEDURES, EACH OF THESE FILES IS SUBDIVIDED INTO A NUMBER OF SEGMENTS, EACH CONSISTING OF TWO SUCCESSIVE RECORDS, THE FIRST RECORD OF A SEGMENT CONTAINS A DESCRIPTION OF A PROCEDURE (OR SET OF PROCEDURES); THE SECOND RECORD CONTAINS THE ALGOL 60 SOURCE TEXT(S), THE SECOND RECORD CONTAINS THE ALGOL 60 SOURCE TEXTS, FULL DOCUMENTATION IS IN PREPARATION, MOSTLY THE USER CAN FIND DOCUMENTATION IN THE LRESERIES OF THE MATHEMATICAL CENTRE, WHICH CONTAINS DESCRIPTIONS OF THE ELEXB THE FILES "NUMBLISDOCUMENTO", "NUMBLISDOCUMENTO" ETC. CONTAIN

HOW TO GET ENTRANCE TO THE DOCUMENTATION.

CLASSIFIED ACCORDING TO SUBJECT, THE PRESENT INDEX CONTAINS THE NAMES OF THE PROCEDURES, THE CORRESPONDING CODE NUMBERS IN NUMALS AND A REFERENCE TO THE DOCUMENTATION, THIS REFERENCE GIVE& A FILENAME AND A NUMBER OF RECORDS TO BE SKIPPED ON THAT FILE (SKIPR), IN ORDER TO CONSULT A SPECIFIED RECORD OF DOCUMENTATION, ALL PRECEDING RECORDS HAVE TO BE SKIPPED,

#### EXAMPLE.

IN ORDER TO OBTAIN THE DESCRIPTION OF THE PROCEDURE "MULTISTEP" (SECTION 5.2.1.1.1.1., ON FILE "NUMAL3DOCUMENTC", SKIPR=30) THE NEXT CONTROL CARDS CAN BE USED

ATTACH, N3C, NUMAL3DOCUMENTC, SKIPF, N3C, 30, COPYBR, N3C, OUTPUT,

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#### SERVICE.

ADVICE ABOUT THE USE OF THE LIBRARY OR ABOUT THE USE OF THE INDIVIDUAL PROCEDURES CAN BE OBTAINED FROM THE PRUGRAM ADVISOR OF THE MATHEMATICAL CENTRE.

#### NOTE.

FOR FUTURE PUBLICATION THE DOCUMENTATION IS SCATTERED WITH LAYOUT SYMBOLS: S+ S< S> S: S= S; S. ETC.,

P.W.HEMKER (MATHEMATICAL CENTRE)

#### REMARK.

AT THE MOMENT ( 1974-3-20 ) THE PROCEDURES DESCRIBED IN NUMALDOCUMENTG, NUMALBOCCUMENTH AND NUMALDOCEMENTJ ARE ONLY AVAILABLE FOR THOSE WHO HAVE THE DISPOSAL OF AN MC-PROJECTNUMBER.

NO PART OF THE LIBRARY NUMAL MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED, IN ANY FORM OR BY ANY MEANS, ELECTRONIC, PHOTOCOPYING, RECORDING, OR OTHERWISE, WITHOUT THE PRIOR WRITTEN PERMISSION OF THE ACADEMIC COMPUTING CENTRE AMSTERDAM (SARA) OR THE MATHEMATICAL CENTRE (AMSTERDAM).

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VERSION: 740321

# Kwic index to the library NUMAL of ALGOL 60 procedures in numerical mathematics.

This key word in context (kwic) index is based upon only those procedures whose full documentation was available on 1 december 1973.

## Directions for use:

The kwic index is based upon program abstracts such as:

32070 C 6 \$qadrat ( \$quadrature ) computes the \$definite \$integral of a

\$function of one variable over a finite interval.

The first ten characters ("32070 C 6") of each abstract are a code to locate the procedure, while the remaining characters until a period comprise a short description of the program (its name, what it does, and how it does it), only "important" words (preceded by a \$ in the above example) are used as key words in the kwic index.

The first appearance of our above example abstract in the kwic index is:

t ( quadrature ) computes the definite integral of a function of one variable over a finite interval. 32070 C 6

If this program (qadrat) is of interest, you can locate it as follows: the first five digits give the number of the object code procedure in the library file "NUMAL3". The next letter is to locate the documentation file: "A" corresponds to file "NUMAL3DOCUMENTA", "B" to file "NUMAL3DOCU MENTB" etc.. The final number specifies the number of records to be skipped on the documentation file in order to locate the documentation of the particular program.

In case an entry in the kwic index is not completely readable (i.e., truncated at an end of the line), you can find a complete listing (by code number) of all the abstracts following the kwic index.

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                                BAKREAHES1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORM
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                                BAKREAHES2 PERFORMS THE BACK TRANSFORMATION COPRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORM
                                                                                                                                      34172 F 14
                                BAKSYMTRI1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERF
                                                                                                                                      34144 D 34
                                BAKSYMTRI2 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERF
                                                                                                                                      34141 D 34
                                SAND MATRIX, WHICH HAS BEEN DECOMPOSED BY DECEND.
                                                                                                                                       34321 E 2
COMPUTES THE DETERMINANT OF A
                                BAND MATRIX, WHICH IS DECOMPOSED BY DECBND.
                                                                                                                                       34071 E 4
STEM OF LINEAR EQUATIONS WITH
                                                                                                                                       34332 E 10
H SYMMETRIC POSITIVE DEFINITE
                                BAND MATRIX, WHICH HAS BEEN DECOMPOSED BY CHIDECIND.
                                BAND MATRIX AND SOLVES THE SYSTEM OF LINEAR EQUATIONS BY THE CHOLESKY METHOD.
                                                                                                                                       34333 E 10
A SYMMETRIC POSITIVE DEFINITE
```

TRIANGULAR DECOMPOSITION OF A RFORMS THE DECOMPOSITION OF A , ADAMS - MOULTON, OR ADAMS -SOLSYDUND CALCULATES THE SOLUND CALCULATES THE CBETA COMPUTES THE INCOMPLETE PLUSH COMPUTES THE INCOMPLETE PLUSH COMPUTES THE INCOMPLETE N OF A REAL MATRIX OF WHICH A TRANSFORMS A REAL MATRIX INTO ID TO TRANSFORM A MATRIX INTO ID TO TRANSFORM A MATRIX INTO THE SINGULAR VALUES OF A REAL ED TAYLOR SOLVES AN INITIAL ( NGE KUTTA SOLVES AN INITIAL ( UATIONS AND COMPUTES AN UPPER ERSE OF A MATRIX AND AN UPPER REFINED SOLUTION AND AN UPPER ERBELM COMPUTES AN UPPER

RMS A COMPLEX NUMBER GIVEN IN

NEAR EQUATIONS ) COMPUTES THE NEAR EQUATIONS ) COMPUTES THE SITIVE DEFINITE DATRIX BY THE EM OF LINEAR EQUATIONS BY THE EM OF LINEAR EQUATIONS BY THE EM OF LINEAR EQUATIONS BY THE CHLDECINV2 COMPUTES, BY THE CHLDECINV1 COMPUTES, BY THE LELEMENTS AND SQUARES OF THE LINEAR AND SOURCES OF THE LINEAR AND STANDARD OF THE LINEAR AND STANDARD OF THE COMPLEX (PART OF) A DIAGONAL OR ADRATIC EQUATION WITH COMPLEX NEWTON DETERMINES THE MINMAXPOL DETERMINES THE

TES THE SCALAR PRODUCT OF TWO INTERCHANGES ELEPENTS OF TWO ARY ROTATION OPERATION ON TWO R PRODUCT OF A ROW VECTOR AND ELEMENTS OF A ROW VECTOR AND PUTES THE SCALAR PRODUCT OF A MULCOL DULTIPLIES A COLCST MULTIPLIES A

34320 E 0 BAND MATRIX BY GAUSSIAN ELIMINATION. BAND MATRIX BY GAUSSIAN ELIMINATION AND SOLVES THE SYSTEM OF LINEAR EQUATIONS. 34322 E 4 BASHFORTH METHOD; WITH AUTOMATIC STEP AND ORDER CONTROL AND SUITABLE FOR THE INTEGRATION OF STIFF DI BEST LEAST SQUARES SULUTION OF A UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS, PROVIDED THAT THE SINGU 34282 H 2 BEST LEAST SQUARES SOLUTION OF A UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS BY MEANS OF SINGULAR VAL 34283 H 2 BETA FUNCTION I(X,P,Q),9<=X<=1,P>0,Q>0. 35050 E 14 BETA FUNCTION  $I(X,P+N,Q),0 \le x \le 1,P>0,Q>0,$  FOR N=0(1)NMAX. 35051 E 14 BETA FUNCTION  $\{(X,P,Q+N),0<=X<\pm1,P>0,Q>0,$  FOR N=U(1)NMAX. 35052 E 14 BIDIAGONAL DECOMPOSITION IS GIVEN, BY MEANS OF AH IMPLICIT GREITERATION. 34271 H 10 BIDIAGONAL FORM BY MEANS OF HOUSEHOLDER TRANSFORMATION. 34260 H B 34261 H 8 BIDIAGONAL FORM. BIDIAGONAL FORM. 34262 H B BIDIAGONAL MATRIX BY MEANS OF IMPLICIT GRAITERATION, 34270 H 10 BOUNDARY ) VALUE PROBLEM, GIVEN AS A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY A ONE-STEP TAY 33040 C 26 BOUNDARY ) VALUE PROBLE 1, GIVEN AS A SYSTEM OF FIRST ORDER ( NON-LINEAR ) DIFFERENTIAL EQUATIONS, BY 33060 C 28 BOUND FOR ITS ERROR. 34243 E 26 BOUND FOR ITS ERROR. 34244 E 28 BOUND FOR ITS ERROR, OF A SYSTEM OF LINEAR EQUATIONS, OF WHICH THE TRIANGULARLY DECOMPOSED FORM OF T 34253 E 30 BOUND FOR THE ERROR IN THE SOLUTION OF A SYSTEM OF LINEAR EQUATIONS. 34241 E 22 CARPOL TRANSFORMS A COMPLEX NUMBER GIVEN IN CARTESIAN COORDINATES INTO POLAR COORDINATES. 34344 D 18 34344 D 18 CARTESIAN COORDINATES INTO POLAR COORDINATES. CHLDEC1 ( LINEAR EQUATIONS ) COMPUTES THE CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MA 34311 F 0 CHLDEC2 ( LINEAR EQUATIONS ) COMPUTES THE CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MA 34310 F CHIDECOND PERFORMS THE TRIANGULAR DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX BY THE CHOLE 34330 E 6 CHLDECINV1 COMPUTES, BY THE CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, ST 34403 F CHLDECINV2 COMPUTES, BY THE CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, ST 34402 F CHIDECSCL1 SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS BY THE CHOLESKY METHOD, T CHIDECOCL2 SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS BY THE CHOLESKY METHOD, T CHIDECSCLAND PERFORMS THE DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE BAND MATRIX AND SOLVES THE CHIDETERM1 COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOS 34313 F CHIDETERM2 COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOS CHEDETERMBND COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMP 34331 E CHLINVI COMPUTES THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX WHICH HAS BEEN DECOMPOSED BY CH CHLINV2 COMPUTES THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX WHICH HAS BEEN DECOMPOSED BY CH 344U0 F CHESOLI SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS, THE MATRIX BEING DECOMPOSED 34391 F CHESOLS SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS, THE MATRIX BEING DECOMPOSED CHESOLIND SOLVES A SYSTEM OF LINEAR EQUATIONS WITH SYMMETRIC POSITIVE DEFINITE BAND MATRIX, WHICH HA CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY, CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED COLUMNWISE IN A ONE-DIMENSION. 34311 F. O. CHOLESKY METHOD. 34330 E 6 CHOLESKY METHOD. 34333 E 10 CHOLESKY METHOD, THE MATRIX BEING STORED IN A TWO-DIMENSIONAL ARRAY. 34392 F 4 CHOLESKY METHOD, THE MATRIX BEING STORED IN A ONE-DIMENSIONAL ARRAY. 34393 F CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL AR 34402 F CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A ONE-DIMENSIONAL AR CODIAGONAL ELEMENTS OF A HERMITIAN TRIDIAGONAL MATRIX WHICH IS UNITARY SIMILAR TO A GIVEN HERMITIAN 34364 G CODIAGONAL OF A SYMMETRIC MATRIX WITH A CONSTANT. 31013 D 0 CODIAGONAL WITH A CONSTANT. 31012 D 0 COEFFICIENTS. 34345 D 24 COEFFICIENTS OF THE NEWTON INTERPOLATION POLYNOMIAL FOR GIVEN ARGUMENTS AND FUNCTION VALUES. 36010 C 44 COEFFICIENTS OF THE POLYNOMIAL (IN GRUNERT FORM) THAT APPROXIMATES A FUNCTION GIVEN FOR DISCRETE ARG 36022 C 46 COLCST MULTIPLIES A COLUMN VECTOR BY A SCALAR, 31131 D 4 COLUMN VECTORS. 34014 D 6 COLUMN VECTORS. 34031 D 10 COLUMN VECTORS. 34040 D 12 COLUMN VECTOR. 34013 D 6 COLUMN VECTOR. 34033 D 10 COLUMN VECTOR AND VECTOR. 34012 D 6 COLUMN VECTOR BY A SCALAR. 31022 D 4 COLUMN VECTOR BY A SCALAR. 31131 D 4

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34352 G 6
OMCOLOST MULTIPLIES A COMPLEX COLUMN VECTOR BY A COMPLEX NUMBER,
                                                                                                                                      31033 D 2
DUPVECCOL COPIES (PART OF) A
                               COLUMN VECTOR TO A VECTOR.
                               COLUMN VECTOR TO ANOTHER COLUMN VECTOR.
                                                                                                                                      34023 D B
 ELMCOL ADDS A SCALAR TIMES A
                                COLUMN VECTOR TO A VECTOR.
                                                                                                                                      34021 D 8
MVECCOL ADDS A SCALAR TIMES A
                                                                                                                                      34028 D 8
MROWCOL ADDS A SCALAR TIMES A
                                COLUMN VECTOR TO A ROW VECTOR.
                                COMADS COMPUTES THE GODULUS OF A COMPLEX NUMBER.
                                                                                                                                      34340 D 14
                                CONCOLOST MULTIPLIES A COMPLEX COLUMN VECTOR BY A COMPLEX MUMBER.
                                                                                                                                      34352 G 6
                                CONDIV COMPUTES THE QUOTIENT OF TWO COMPLEX NUMBERS.
                                                                                                                                      34342 D 22
                                                                                                                                      34359 G 20
                                COMPUCNEM COMPUTES THE EUCLIDEAN NORM OF A COMPLEX MATRIX.
                                CONKID COMPUTES THE ROOTS OF A QUADRATIC EQUATION WITH COMPLEX COEFFICIENTS.
                                                                                                                                      34345 D 24
                                COMMATVEC COMPUTES THE SCALAR PRODUCT OF A COMPLEX ROW VECTOR AND A COMPLEX VECTOR.
                                                                                                                                      34354 G 18
                                                                                                                                      34341 D 20
                                CONMUL MULTIPLIES TWO COMPLEX NUMBERS,
                                COMPLEMENTARY ERROR FUNCTION FOR A REAL ARGUMENT; THESE FUNCTIONS ARE RELATED TO THE NORMAL OR GAUSS 35020 C 38
MPUTES THE ERROR FUNCTION AND
                                                                                                                                      34231 E 22
ION WITH COMBINED PARTIAL AND
                                COMPLETE PIVOTING.
                                                                                                                                      34232 E 26
ION WITH COMBINED PARTIAL AND
                                COMPLETE PIVOTING.
                                                                                                                                      34345 D 24
 OF A QUADRATIC EQUATION WITH
                                COMPLEX COEFFICIENTS.
                                                                                                                                     34376 G 0
ADDS A COMPLEX NUMBER TIMES A
                                COMPLEX COLUMN VECTOR TO A COMPLEX VECTOR,
                                                                                                                                     34377 G 0
                                COMPLEX COLUMN VECTOR TO ANOTHER COMPLEX COLUMN VECTOR.
ADDS A COMPLEX NUMBER TIMES A
                                                                                                                                      34357 G 2
                                COMPLEX COLUMN VECTORS.
OL PERFORMS A ROTATION ON TWO
                                                                                                                                     34352 G 6
      COMCOLOST FULTIPLIES A
                                COMPLEX COLUMN VECTOR BY A COMPLEX NUMBER.
                                                                                                                                     34356 G 24
PLIES A COMPLEX MATRIX WITH A
                                COMPLEX HOUSEHOLDER MATRIX.
                                                                                                                                     34374 G 10
COMPUTES ALL EIGENVALUES OF A
                                COMPLEX MATRIX.
                                                                                                                                     34375 G 10
NVECTORS AND EIGENVALUES OF A
                                COMPLEX MATRIX.
                                                                                                                                     34359 G 20
PUTES THE EUCLIDEAN NORTH OF A
                                COMPLEX MATRIX.
                                                                                                                                      34360 G 22
M NORMALIZES THE COLUMNS OF A
                               COMPLEX MATRIX.
                               COMPLEX MATRIX INTO A SIMILAR UNITARY UPPER HESSENBERG MATRIX WITH A REAL HON-HEGATIVE SUBDIAGONAL.
                                                                                                                                     34366 G 14
       HSHCOMHES TRANSFORMS A
                                                                                                                                      34361 G 16
                               COMPLEX MATRIX INTO A SIMILAR EQUILIBRATED COMPLEX MATRIX.
       EQILBPOOM TRANSFORMS A
                                                                                                                                     34341 D 20
        COMMUL MULTIPLIES TWO
                                COMPLEX NUMBERS.
                                                                                                                                     34342 D 22
 COMPUTES THE QUOTIENT OF TVO
                                COMPLEX NUMBERS.
                               COMPLEX NUMBER.
                                                                                                                                     34340 D 14
ABS COMPUTES THE MODULUS OF A
                                                                                                                                     34343 D 16
COMPUTES THE SQUARE ROOT OF A
                               COMPLEX NUMBER.
                                COMPLEX NUMBER GIVEN IN CARTESIAN COORDINATES INTO POLAR COORDINATES.
                                                                                                                                     34344 D 18
          CARPOL TRANSFORMS A
                                CONPLEX NUMBER TIMES & COMPLEX COLUMN VECTOR TO A COMPLEX VECTOR.
                                                                                                                                     34376 G 0
          ELHCOMVECCOL ADDS A
                                COMPLEX NUMBER TIMES / COMPLEX COLUMN VECTOR TO ANOTHER COMPLEX COLUMN VECTOR.
                                                                                                                                     34377 G 0
             ELMCOMCOL ADDS A
                               COMPLEX NUMBER TIMES / COMPLEX VECTOR TO A COMPLEX ROW VECTOR.
                                                                                                                                      34378 G 0
          ELMCOMROWVEC ADDS A
                                                                                                                                     34358 G 2
                               COMPLEX POS VECTORS.
OW PERFORMS A ROTATION ON TWO
                                                                                                                                      34353 G 6
       COMPONEST FULTIPLIES A COMPLEX ROW VECTOR BY A COMPLEX NUMBER.
PUTES THE SCALAR PRODUCT OF A
                               COMPLEX ROW VECTOR AND A COMPLEX VECTOR.
                                                                                                                                      34354 G 18
                               COMPLEX UPPER HESSENBERG MATRIX WITH A REAL SUBDIAGONAL,
                                                                                                                                      34372 G 12
COMPUTES ALL EIGENVALUES OF A
                                                                                                                                     34373 G 12
                                COMPLEX UPPER HESSEHBERG MATRIX WITH A REAL SUBDIAGONAL.
NVECTORS AND EIGENVALUES OF A
                                                                                                                                     34378 G n
ADDS A COMPLEX NUMBER TIMES A
                                COMPLEX VECTOR TO A COMPLEX ROW VECTOR,
                                                                                                                                     34355 G 24
       HSHCOMCOL TRANSFORMS A
                                COMPLEX VECTOR INTO A VECTOR PROPORTIONAL TO A UNIT VECTOR.
                                COMROWEST MULTIPLIES 4 COMPLEX ROW VECTOR BY A COMPLEX NUMBER.
                                                                                                                                      34353 G 6
                                COMSCL IS AN AUXILIARY PROCEDURE FOR THE COMPUTATION OF COMPLEX EIGENVECTORS OF A REAL MATRIX,
                                                                                                                                     34193 F 10
                                                                                                                                      34343 D 16
                                COMSORT COMPUTES THE SQUARE ROOT OF A COMPLEX NUMBER,
                                CONVALOR! CALCULATES THE REAL AND COMPLEX EIGENVALUES OF A REAL UPPER HESSENBERG MATRIX BY MEANS OF
                                                                                                                                     34190 F 16
                                CONVECHES CALCULATES THE EIGENVECTOR CORRESPONDING TO A GIVEN COMPLEX EIGENVALUE OF A REAL UPPER HES
                                                                                                                                     34191 F 16
                                                                                                                                      34220 C 36
AR EQUATIONS BY THE METHOD CF
                                CONJUGATE GRADIENTS.
                                CONJ GRAD SOLVES A SYMMETRIC AND POSITIVE DEFINITE, SYSTEM OF LINEAR EQUATIONS BY THE METHOD OF CONJ
                                                                                                                                     34220 C 36
                                CONTROL; SUITABLE FOR INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS.
                                                                                                                                      33120 C 32
IAN MATRIX AND AUTOMATIC STEP
                                CONTROL AND SUITABLE FOR THE INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS.
                                                                                                                                      33080 C 30
WITH AUTOMATIC STEP AND ORDER
                                                                                                                                     34344 D 18
TESIAN COORDINATES INTO POLAR
                                COORDINATES.
                                                                                                                                      34344 D 11
LEX NUMBER GIVEN IN CARTESIAN
                               COORDINATES INTO POLAR COORDINATES.
                                                                                                                                      31030 D ;
                       DUPVEC COPIES (PART OF) A VECTOR TO A VECTOR.
                                                                                                                                      31031 D 2
                               COPIES (PART OF) A ROW VECTOR TO A VECTOR.
                    DUPVECROV
                                                                                                                                      31032 D 2
                    DUPROWVEC COPIES (PART OF) A VECTOR TO A ROW VECTOR,
                                                                                                                                      31033 D 2
                               COPIES (PART OF) A CULUMN VECTOR TO A VECTOR.
                    DUPVECCCL
                    DUPCOLVEC COPIES (PART OF) A VECTOR TO A COLUMN VECTOR.
                                                                                                                                      31034 D 2
                              COPIES (PART OF) A MATRIX TO (AN OTHER) MATRIX.
                                                                                                                                      31035 D 2
                      DUPMAT
 DECOMPOSITION OF A MATRIX BY CROUT FACTOR!ZATION WITH PARTIAL PIVOTING,
                                                                                                                                      34300 E 22
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CROUT FACTORIZATION WITH PARTIAL PIVOTING. 343U1 E 26 SYSTEM OF LINEAR EQUATIONS BY DAVUPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION, 34212 D 30 DECEND PERFORMS THE TRIANGULAR DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION. 34320 E 0 34302 E 28 DECINY COMPUTES THE INVERSE OF A MATRIX. 34421 H 22 ATRIX, PROVIDED THAT THE UIDU DECOMPOSITION IS GIVEN. ECBND PERFORMS THE TRIANGULAR 34320 E 0 DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION. DECCMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION AND SOLVES THE SYSTEM OF LINEAR EQUATIONS. 34322 E 4 DECSOLBND PERFORMS THE DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX BY THE CHOLESKY METHOD. 34330 E 6 ECBND PERFORMS THE TRIANGULAR DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE BAND MATRIX AND SOLVES THE SYSTEM OF LINEAR EQUATIONS 34333 E 10 CHLDECSOLBND PERFORMS THE DEC PERFORMS THE TRIANGULAR DECOMPOSITION OF A MATRIX BY CROUT FACTORIZATION WITH PARTIAL PIVOTING. 34300 E 22 DECOMPOSITION OF A MATRIX BY GAUSSIAN ELIMINATION WITH COMBINED PARTIAL AND COMPLETE PIVOTING. SSELM PERFORMS THE TRIANGULAR 34231 E 22 34310 F 0 DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY. TIONS ) COMPUTES THE CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STOPED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY. 34311 F 0 TIONS ) COMPUTES THE CHOLESKY 34423 H 16 TES, WITHOUT PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL MATRIX. WITH PARTIAL PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL MATRIX. 34426 H 16 34420 H 20 DECSYMTRI CALCULATES THE UIDU DECOMPOSITION OF A SYMMETRIC TRIDIAGONAL MATRIX. DECSOLBND PERFORMS THE DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION AND SOLVES THE SYSTEM 34322 E 4 34422 H 22 DECSOLSYMTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH SYMMETRIC TRIDIAGONAL COEFFICIENT MATRIX. DECSOLTRIPIN SOLVES WITH PARTIAL PINOTING A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT 34428 H 18 DECSOLTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT MATRIX, 34425 H 18 DECSOL SOLVES A SYSTEM OF LINEAR EQUATIONS BY CROUT FACTORIZATION WITH PARTIAL PIVOTING. 34301 E 26 DECSYMTRI CALCULATES THE UIDU DECOMPOSITION OF A SYMMETRIC TRIDIAGONAL MATRIX. 34420 H 20 DECTRIPIV CALCULATES, WITH PARTIAL PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL MATRIX. 34426 H 16 34427 H 18 ECOMPOSITION AS CALCULATED BY DECTRIPIV IS GIVEN. DECTRI CALCULATES, WITHOUT PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL MATRIX. 34423 H 16 DEC PERFORMS THE TRIANGULAR DECOMPOSITION OF A MATRIX BY CROUT FACTORIZATION WITH PARTIAL PIVOTING. 343U0 E 22 DEFINITE, SYSTEM OF LINEAR EQUATIONS BY THE METHOD OF CONJUGATE GRADIENTS, 34220 C 36 LVES A SYMMETRIC AND POSITIVE DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE INTERVAL. T ( QUADRATURE ) COMPUTES THE 32070 C 6 DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE OR INFINITE INTERVAL OR OVER A NUMBER 32051 C 48 L ( QUADRATURE ) COMPUTES THE DETERMIND COMPUTES THE DETERMINANT OF A BAND MATRIX, WHICH HAS BEEN DECOMPOSED BY DECBND. 34321 E 2 34321 E 2 DETERMINANT OF A BAND MATRIX, WHICH HAS BEEN DECOMPOSED BY DECEND, DETERMBND COMPUTES THE CHLDETERMBND COMPUTES THE DETERMINANT OF A SYMPETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDECBND. 34331 E 8 DETERMINANT OF A MATRIX PROVIDED THAT THE MATRIX HAS BEEN DECOMPOSED BY DEC OR GSSELM. 34303 E 24 DETERM COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDEC2. 34312 F 2 CHLDETERM2 COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDEC1. 34313 F 2 CHLDETERM1 COMPUTES THE DETERM COMPUTES THE DETERMINANT OF A MATRIX PROVIDED THAT THE MATRIX HAS BEEN DECOMPOSED BY DEC OR G 34303 E 24 DIAGONAL ELEMENTS OF THE INVERSE OF MIM (M COEFFICIENT MATRIX) OF A LIMEAR LEAST SQUARES PROBLEM. 34132 E 32 LSQDGLINV COMPUTES THE DIAGONAL ELEMENTS OF THE INVERSE OF MIM (M COEFFICIENT MATRIX). 34135 E 34 ARES PROBLEM AND COMPUTES THE DIAGONAL ELEMENTS AND SOURCES OF THE CODIAGONAL ELEMENTS OF A HERMITIAN TRIDIAGONAL MATRIX WHICH IS 34364 G 4 SHHRMTRIVAL DELIVERS THE MAIN IMATO INITIALIZES (PART OF) A DIAGONAL OF CODIAGONAL WITH A CONSTANT. 31012 D 0 DIFFERENTIABLE FUNCTION OF SEVERAL VARIABLES BY A VARIABLE METRIC METHOD. 34214 D 30 IMIZATION ) MINIMIZES A GIVEN DIFFERENTIABLE FUNCTION OF SEVERAL VARIABLES BY A VARIABLE METRIC METHOD. 34215 D 30 IMIZATION ) MINIMIZES A GIVEN 1 SOLVES A SINGLE FIRST ORDER DIFFERENTIAL EQUATION USING A 5-TH ORDER RUNGE KUTTA METHOD. 33010 C 8 DIFFERENTIAL EQUATIONS USING A 5-TH ORDER RUNGE KUTTA METHOD. 33011 C 10 OLVES A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATION USING A 5-TH ORDER RUNGE KUTTA METHOD. 33012 C 12 RK2 SOLVES A SECOND ORDER DIFFERENTIAL EQUATIONS ISING A 5-TH ORDER RUNGE KUTTA METHOD. LVES A SYSTEM OF SECOND OFDER 33013 C 14 DIFFERENTIAL EQUATION USING A 5-TH ORDER RUNGE KUTTA METHOD; NO DERIVATIVES ALLOWED ON RIGHT HAND SI 33014 C 16 RK3 SOLVES A SECOND ORDER LVES A SYSTEM OF SECOND ORDER DIFFERENTIAL EQUATIONS USING A 5-TH ORDER RUNGE KUTTA METHOD; NO DERIVATIVES ALLOWED ON RIGHT HAND S 33015 C 18 DIFFERENTIAL EQUATION BY SOMETIMES USING A DEPENDENT VARIABLE AS INTEGRATION VARIABLE. RK4A SOLVES A SINGLE 33016 C 20 DIFFERENTIAL EQUATIONS BY SOMETIMES USING THE DEPENDENT VARIABLE AS INTEGRATION VARIABLE. 33017 C 22 RKANA SOLVES A SYSTEM CF DIFFERENTIAL EQUATIONS USING THE ARC LENGTH AS INTEGRATION VARIABLE. 33018 C 24 OLVES A SYSTEM OF FIRST ORDER EN AS A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY A ONE-STEP TAYLOR METHOD; THIS METHOD IS PARTICULARLY SUITABLE FOR THE IN 33040 C 26 DIFFERENTIAL EQUATIONS, PROVIDED HIGHER ORDER DERIVATIVES CAN BE EASILY OBTAINED. 33040 C 26 SYSTEMS ARISING FROM PARTIAL DIFFERENTIAL EQUATIONS, BY A STABILIZED RUNGE KUTTA METHOD WITH LIMITED STORAGE REQUIREMENTS. OF FIRST ORDER ( NON-LINEAR ) 33060 C 28 EN AS A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY ONE OF THE FOLLOWING MULTISTEP METHODS: GEARS, ADAMS - MOULTON, OR ADAMS 33080 C 30 FOR THE INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS. 33080 C 30 DIFFERENTIAL EQUATIONS, BY AN EXPONENTIALLY FITTED, EXPLICIT RUNGE KUTTA METHOD WHICH USES THE JACOB ONOMOUS SYSTEM OF FIRST ORDER 33120 C 32 ABLE FOR INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS. 33120 C 32

ONOMOUS SYSTEM OF FIRST ORDER

ABLE FOR INTEGRATION OF STIFF

DIFFERENTIAL EQUATIONS.

DIFFERENTIAL EQUATIONS, BY AN EXPONENTIALLY FITTED, SEMI - IMPLICIT RUNGE KUTTA METHOD; SUITABLE FOR

33160 C 34

33160 C 34

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DIFFERENTIAL EQUATIONS, BY AN IMPLICIT, EXPONENTIALLY FITTED, FIRST ORDER ONE-STEP METHOD WITH NO AU 33130 D 38
ONOMOUS SYSTEM OF FIRST ORDER
                                                                                                                                      33130 D 38
ABLE FOR INTEGRATION OF STIFF
                                DIFFERENTIAL EQUATIONS.
                                DIFFERENTIAL EQUATIONS, BY AN IMPLICIT, EXPONENTIALLY FITTED, SECOND ORDER ONE-STEP METHOD WITH NO A 33131 D 38
ONOMOUS SYSTEM OF FIRST ORDER
                                                                                                                                      33131 D 38
ABLE FOR INTEGRATION OF STIFF
                                DIFFERENTIAL EQUATIONS.
                                DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS,
        LNGVECVEC COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF A ROW VECTOR AND A VECTOR.
                                                                                                                                      34411 H 14
        LINGHATVEC COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF A COLUMN VECTOR AND A VECTOR
                                                                                                                                      34412 H 14
        LNGTAMVEC COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF A ROW VECTOR AND A COLUMN VECTOR.
                                                                                                                                      34413 H 14
        LINGMATMAT COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF TWO COLUMN VECTORS.
                                                                                                                                      34414 H 14
        LNGTAMMAT COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF TWO ROW VECTORS.
                                                                                                                                      34415 H 14
        LNGMATTAM COMPUTES IN
                                                                                                                                      34416 H 14
                                DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS.
        LNGSEQUEC COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS.
                                                                                                                                      34417 H 14
       LNGSCAPRD1 COMPUTES IN
                                DOUBLE PRECISION THE SCALAR PRODUCT OF A VECTOR AND A ROW IN A SYMMETRIC MATRIX,
                                                                                                                                      34418 H 14
     LNGSYMMATVEC COMPUTES IN
                                                                                                                                      31034 D 2
                                DUPCOLVEC COPIES (PART OF) A VECTOR TO A COLUMN VECTOR.
                                DUPMAT COPIES (PART OF) A MATRIX TO (AN OTHER) MATRIX.
                                                                                                                                      31,035 D
                                DUPROWVEC COPIES (PART OF) A VECTOR TO A ROW VECTOR.
                                                                                                                                      31032 D
                                DUPVECCEL COPIES (PART OF) A COLUMN VECTOR TO A VECTOR,
                                                                                                                                      31033 D 2
                                DUPVECTOR COPIES (PART OF) A ROW VECTOR TO A VECTOR.
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                                EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY QR-ITERATION.
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> PCI NEWPOL

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RK1 SOLVES A SINGLE RKIN SOLVES A SYSTEM OF RK5NA SOLVES A SYSTEM OF PROBLEM, GIVEN AS A SYSTEM CF PROBLEM, GIVEN AS A SYSTEM CF EN AS AN AUTONOMOUS SYSTEM OF PROBLEM, GIVEN AS A SYSTEM CF QUATIONS, BY AN EXPONENTIALLY BY AN IMPLICIT, EXPONENTIALLY BY AN IMPLICIT, EXPONENTIALLY QUATIONS, BY AN EXPONENTIALLY

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FUNCTION !(X,P+N,Q),U <= X <= 1,P > 0,Q > 0, FOR  $N=U(1)N^{M}AX$ .

FUNCTION I(X,P,Q+N), U<=X<=1,P>0,Q>0, FOR N=U(1)NMAX.

FUNCTION !(X,P,Q),0<=X<=1,P>0,Q>0.

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35050 E 14

35052 E 14

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32070 C 6
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                              FUNCTION OF ONE VARIABLE OVER A FINITE OR INFINITE INTERVAL OR OVER A NUMBER OF CONSECUTIVE INTERVAL 32051 C 48
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                               GAMMA COMPUTES THE GAMMA FUNCTION FOR A REAL ARGUMENT.
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                               GAMMA FUNCTION FOR PUSITIVE ARGUMENTS.
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33013 C 14 RK2N SOLVES A SYSTEM OF SECOND ORDER DIFFERENTIAL EQUATIONS USING A DETH ORDER RUNGE KUTTA METHOD.
33014 C 16 RK3 SCLVES A SECOND ORDER DIFFERENTIAL EQUATION USING A 5.TH ORDER RUNGE KUTTA METHOD; NO DERIVATIVES ALLOWED ON RIGHT HAND SIDE.
33015 C 18 RK3N SOLVES A SYSTEM OF SECOND ORDER DIFFERENTIAL EQUATIONS USING A DETH ORDER RUNGE KUTTA METHOD; NO DERIVATIVES ALLOWED ON RIGHT H
            AND SIDE.
33016 C 20 RK4A SOLVES A SINGLE DIFFERENTIAL EQUATION BY SOMETIMES USING A DEPENDENT VARIABLE AS INTEGRATION VARIABLE.
33017 C 22 RKANA SOLVES A SYSTEM OF DIFFERENTIAL EQUATIONS BY SOMETIMES USING THE DEPENDENT VARIABLE AS INTEGRATION VARIABLE,
33018 C 24 RK5NA SOLVES A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS USING THE ARC LENGTH AS INTEGRATION VARIABLE,
33040 C 26 MODIFIED TAYLOR SOLVES AN INITIAL ( BOUNDARY ) VALUE PROBLEM, GIVEN AS A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY A ONE-STEP
            TAYLOR METHOD; THIS METHOD IS PARTICULARLY SUITABLE FOR THE INTEGRATION OF LARGE SYSTEMS ARISING FROM PARTIAL DIFFERENTIAL EQUATION
            S, PROVIDED HIGHER CROER DERIVATIVES CAN BE EASILY OBTAINED.
33060 C 28 MODIFIED RUNGE KUTTA SOLVES AN INITIAL ( BOUNDARY ) VALUE PROBLEM, GIVEN AS A SYSTEM OF FIRST ORDER ( NON-LINEAR ) DIFFERENTIAL EQUA
            TIONS, BY A STABILIZED RUNGE KUTTA METHOD WITH LIMITED STORAGE REQUIREMENTS.
33080 C 30 MULTISTEP SOLVES AN INITIAL VALUE PROBLEM, GIVEN AS A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY ONE OF THE FOLLOWING MULTISTE
           P METHODS; GEARS, ADAMS - MOULTON, OR ADAMS - BASHFORTH METHOD; WITH AUTOMATIC STEP AND ORDER CONTROL AND SUITABLE FOR THE INTEGRAT!
            ON OF STIFF DIFFERENTIAL EQUATIONS.
33120 C 32 EFERK SOLVES INITIAL VALUE PROBLEMS, GIVEN AS AN AUTONOMOUS SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY AN EXPONENTIALLY FITTED
            , EXPLICIT RUNGE KUTTA METHOD WHICH USES THE JACOBIAN MATRIX AND AUTOMATIC STEP CONTROL; SUITABLE FOR INTEGRATION OF STIFF DIFFERENT
            IAL FOUATIONS.
33130 D 38 LINIGER SOLVES INITIAL VALUE PROBLEMS, GIVEN AS AN AUTONOMOUS SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY AN IMPLICIT, EXPONEN
           THALLY FITTED, FIRST OFFICE CHERSTEP METHOD WITH NO AUTOMATIC STEP CONTROL, SUITABLE FOR INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS.
33131 D 38 LINIGER2 SOLVES INITIAL VALUE PROBLEMS, GIVEN AS AN AUTONOMOUS SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY AN IMPLICIT, EXPONEN
            TIALLY FITTED, SECOND ORDER ONE-STEP METHOD WITH NO AUTOMATIC STEP CONTROL; SUITABLE FOR INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS
33160 C 34 EFSIRK SOLVES INITIAL VALUE PROBLEMS, GIVEN AS AN AUTONOMOUS SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY AN EXPONENTIALLY FITTE
            D, SEMI - IMPLICIT RUNGE KUTTA METHOD; SUITABLE FOR INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS.
34010 D 6 VECVEC COMPUTES THE SCALAR PRODUCT OF TWO VECTORS.
34011 D 6 MATVEC COMPUTES THE SCALAR PRODUCT OF A ROW VECTOR AND VECTOR.
34012 D 6 TAMVEC COMPUTES THE SCALAR PRODUCT OF A COLUMN VECTOR AND VECTOR.
34013 D 6 MATMAT COMPUTES THE SCALAR PRODUCT OF A ROW VECTOR AND COLUMN VECTOR.
34014 D 6 TAMMAT COMPUTES THE SCALAR PRODUCT OF TWO COLUMN VECTORS.
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34015 D 6 MATTAM COMPUTES THE SCALAR PRODUCT OF TWO ROW VECTORS,
34016 D 6 SEQUEC COMPUTES THE SCALAR PRODUCT OF TWO VECTORS.
34017 D 6 SCAPRD1 COMPUTES THE SCALAR PRODUCT OF TWO VECTORS,
34018 D 6 SYMMATVEC CUMPUTES THE SCALAR PRODUCT OF A VECTOR AND A ROW OF A SYMMETRIC MATRIX,
34020 D 8 ELMVEC ADDS A SCALAR TIMES A VECTOR TO ANOTHER VECTOR.
34021 D 8 ELMVECCOL ADDS A SCALAR TIMES A COLUMN VECTOR TO A VECTOR,
34022 D 8 ELMCOLVEC ADDS A SCALAP TIMES A VECTOR TO A COLUMN VECTOR.
34023 D 8 ELMCOL ADDS A SCALAR TIMES A COLUMN VECTOR TO ANOTHER COLUMN VECTOR,
34024 D 8 ELMROW ADDS A SCALAR TIMES A ROW VECTOR TO ANOTHER ROW VECTOR.
34025 D 8 MAXELMROW ADDS A SCALAR TIMES A ROW VECTOR TO A ROW VECTOR, AND RETURNS THE SUBSCRIPT VALUE OF THE NEW ROW ELEMENT OF MAXIMUM ABSOLU
            TE VALUE.
34026 D 8 ELMVECROW ADDS A SCALAR TIMES A ROW VECTOR TO A VECTOR.
34027 D 8 ELMROWVEC ADDS A SCALAR TIMES A VECTOR TO A ROW VECTOR.
34026 D. 8. ELMROWCOL ADDS A SCALAR TIMES A COLUMN VECTOR TO A ROW VECTOR.
34029 D. 8. ELMCOLROW ADDS A SCALAR TIMES A ROW VECTOR TO A COLUMN VECTOR.
34030 D 10 ICHVEC INTERCHANGES ELEMENTS OF TWO VECTORS.
34031 D 10 ICHCOL INTERCHANGES ELEMENTS OF TWO COLUMN VECTORS.
34032 D 10 ICHROW INTERCHANGES ELEMENTS OF TWO ROW VECTORS.
34033 D 10 ICHROWCOL INTERCHANGES ELEMENTS OF A ROW VECTOR AND COLUMN VECTOR.
34034 D 10 ICHSEGVEC INTERCHANGES ELEMENTS OF TWO VECTORS.
34035 D 10 ICHSEQ INTERCHANGES ELEMENTS OF TWO VECTORS.
34040 D 12 ROTCOL PERFORMS AN ELEMENTARY ROTATION OPERATION ON TWO COLUMN VECTORS.
34041 D 12 ROTROW PERFORMS AN ELEMENTARY ROTATION OPERATION ON TWO ROW VECTORS.
34051 E 26 SOL SOLVES A SYSTEM OF LINEAR EQUATIONS, OF WHICH THE TRIANGULARLY DECOMPOSED FORM OF THE MATRIX IS GIVEN.
34053 E 28 INV COMPUTES THE INVERSE OF A MATRIX OF WHICH THE TRIANGULARLY DECOMPOSED FORM IS GIVEN.
34061 E 26 SOLELM SOLVES A SYSTEM OF LINEAR EQUATIONS, OF WHICH THE TRIANGULARLY DECOMPOSED FORM OF THE MATRIX IS GIVEN.
34071 E 4 SOLBNO SOLVES A SYSTEM OF LINEAR EQUATIONS MITH BAND MATRIX, WHICH IS DECOMPOSED BY DECEND.
34131 E 34 LSOSOL SOLVES A LINEAR LEAST SQUARES PROBLET, PROVIDED THAT THE COEFFICIENT MATRIX HAS BEEN DECOMPOSED BY LSOORTDEC.
34132 E 32 LSODGLINY COMPUTES THE DIAGONAL ELEMENTS OF THE INVERSE OF MIM (M COEFFICIENT MATRIX) OF A LINEAR LEAST SQUARES PROBLEM.
34134 E 32 LSBORTDEC PERFORMS THE HOUSEHOLDER TRIANGULARIZATION OF THE COEFFICIENT MATRIX OF A LINEAR LEAST SQUARES PROBLEM.
34135 E 34 LEGORTHECSOL SOLVES A LINEAR LEAST SQUARES PROBLEM AND COMPUTES THE DIAGONAL ELEMENTS OF THE INVERSE OF MIM (M COEFFICIENT MATRIX).
34140 D 34 TEMSYFTRI2 TRANSFORES A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY HOUSEHOLDERS TRANSFORMATION.
34141 D 34 BAKSYMTRIZ PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERFORMED BY TEMSYMTRIZ.
34142 D 34 TEMPREVEC COMPUTES THE TRANSFORMING MATRIX IN COMBINATION WITH PROCEDURE TEMSYMTRI2.
34143 D 34 TEMSYMITEL TRANSFORMS A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY HOUSEHOLDERS TRANSFORMATION.
34144 D 34 BAKSYNTRI1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERFORMED BY TEMSYNTRI1.
34150 F 18 ZEROIN SEARCHES FOR A ZERO OF A FUNCTION OF ONE VARIABLE IN A GIVEN INTERVAL.
34151 D 36 VALSYMTRI COMPUTES ALL, OR SOME CONSECUTIVE, EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY LINEAR INTERPOLATION USING A STURM SED
34152 D 36 VECSYETRI COMPUTES EIGENVECTORS OF A SYMMETRIC TRIDIAGONAL MATRIX BY INVERSE ITERATION.
34153 E 12 EIGVALSYM2 COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES OF A SYMMETRIC MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY, BY LINEAR INTERPO
           LATION USING A STURM SEQUENCE.
34154 E 12 EIGSYNZ COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX, WHICH IS STORED IN A TWO-DIMENSIONAL A
34155 E 12 EIGVALSYM1 COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES OF A SYMMETRIC MATRIX, STORED IN A ONE-DIMENSIONAL ARRAY, BY LINEAR INTERPO
           LATION USING A STURM SEQUENCE.
34156 E 12 EIGSYNI COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX, WHICH IS STORED IN A ONE-DIMENSIONAL A
34161 D 36 GRISYITRI COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY QR-ITERATION.
34162 E 12 GRIVALSYM? COMPUTES ALL EIGENVALUES OF A SYMMETRIC MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY, BY QR-ITERATION.
34163 E 12 GRISYI COMPUTES ALL EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX BY GRAITERATION.
34164 E 12 ORIVALSYM1 COMPUTES ALL EIGENVALUES OF A LYMMETRIC MATRIX, STORED IN A ONE-DIMENSIONAL ARRAY, BY GR-ITERATION.
34165 D 36 - VALORISYMTRI COMPUTES ALL EIGENVALUES OF / SYMMETRIC TRIDIAGONAL MATRIX BY OR-ITERATION.
34170 F 14 TEMPERMES TRANSFORMS A REAL MATRIX INTO A SIMILAR UPPER HESSENBERG MATRIX BY THE WILKINSON TRANSFORMATION.
34171 F 14 BAKREAMES1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORMED BY TEMREAMES, ON A VECTOR
34172 F 14 BAKREAHESZ PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORMED BY TEMPEAHES. ON THE COLUMNS
34173 F 12 EQILBE TRANSFORMS A MATRIX INTO A SIMILAR EQUILIBRATED MATRIX.
34174 F 12 BAKLBR PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE EQUILIBRATION AS PERFORMED BY EQILBR.
34180 F 16 REAVALORI CALCULATES THE EIGENVALUES OF A REAL UPPER HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL. BY MEANS OF SINGLE Q
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R-ITERATION. 34181 F 16 REAVECHES CALCULATES THE EIGENVECTOR CORRESPONDING TO A GIVEN REAL EIGENVALUE OF A REAL UPPER HESSENBERG MATRIX, BY MEANS OF INVERSE 34183 F 8 REASCL NORMALIZES THE COLUMNS OF A TWO-DIMENSIONAL ARRAY. 34186 F 16 REAGRI CALCULATES THE FIGENVALUES AND EIGENVECTORS OF A REAL UPPER HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL, BY MEA NS OF SINGLE QR-ITERATION. 34190 F 16 COMVALORI CALCULATES THE REAL AND COMPLEX EIGENVALUES OF A REAL UPPER HESSENBERG MATRIX BY MEANS OF DOUBLE GRATERATION. 34191 F 16 COMVECHES CALCULATES THE EIGENVECTOR CORRESPONDING TO A GIVEN COMPLEX EIGENVALUE OF A REAL UPPER HESSENBERG MATRIX BY MEANS OF INVER SE ITERATION. 34193 F 10 COMSCL IS AN AUXILIARY PROCEDURE FOR THE COMPUTATION OF COMPLEX EIGENVECTORS OF A REAL MATRIX. 34210 D 30 LINEMIN IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION, RNK1UPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION. 34211 D 30 34212 D 30 DAVUPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION. FLEUPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION. RNK1MIN ( OPTIMIZATION ) MINIMIZES A GIVEN DIFFERENTIABLE FUNCTION OF SEVERAL VARIABLES BY A VARIABLE METRIC METHOD. 34214 D 30 34215 D 30 FLEMIN ( OPTIMIZATION ) MINIMIZES A GIVEN DIFFERENTIABLE FUNCTION OF SEVERAL VARIABLES BY A VARIABLE METRIC METHOD. 34220 C 36 CONJ GRAD SOLVES A SYMMETRIC AND POSITIVE DEFINITE, SYSTEM OF LINEAR EQUATIONS BY THE METHOD OF CONJUGATE GRADIENTS. 34230 D 26 HAXMAT FINDS THE INDICES AND MODULUS OF THAT MATRIX ELEMENT OF MAXIMUM ABSOLUTE VALUE, 34231 E 22 GSSELM PERFORMS THE TRIANGULAR DECOMPOSITION OF A MATRIX BY GAUSSIAN ELIMINATION WITH COMBINED PARTIAL AND COMPLETE PIVOTING 34232 E 26 GSSSOL SOLVES A SYSTEM OF LINEAR EQUATIONS BY GAUSSIAN ELIMINATION WITH COMBINED PARTIAL AND COMPLETE PIVOTING. 34235 E 28 INV1 COMPUTES THE INVERSE OF A MATRIX OF WHICH THE TRIANGULARLY DECOMPOSED FORM IS GIVEN. 34236 E 28 GSSINV COMPUTES THE INVERSE OF A MATRIX, 34240 E 22 ONENRMINY COMPUTES THE 1-NORM OF THE INVERSE OF A MATRIX, WHICH IS TRIANGULARLY DECOMPOSED. 34241 E 22 ERBELY COMPUTES AN UPPER BOUND FOR THE ERROR IN THE SOLUTION OF A SYSTEM OF LINEAR EQUATIONS. 34242 E 22 GSSERB IS AN AUXILIARY PROCEDURE FOR THE SOLUTION OF LINEAR EQUATION WITH AN UPPER BOUND FOR THE ERROR. 34243 E 26 GSSSOLERB SOLVES A SYSTEM OF LINEAR EQUATIONS AND COMPUTES AN UPPER BOUND FOR ITS ERROR. 34244 E 28 GSSINVERB COMPUTES THE INVERSE OF A MATRIX AND AN UPPER BOUND FOR ITS ERROR. 34250 E 30 ITISOL COMPUTES AN ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS, THE MATRIX OF WHICH IS GIVEN IN ITS TRIANGULARLY DE COMPOSED FORM. GSSITISOL COMPUTES AN ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS. 34251 E 30 34252 E 22 GSSNRI IS AN AUXILIARY PROCEDURE FOR THE ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS. 34253 E 30 ITISOLERS COMPUTES AN ITERATIVELY REFINED SOLUTION AND AN UPPER BOUND FOR ITS ERROR, OF A SYSTEM OF LINEAR EQUATIONS, OF WHICH THE T RIANGULARLY DECOMPOSED FORM OF THE MATRIX IS GIVEN. 34254 E 30 GSSITISOLERB COMPUTES AN ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS, 34260 H 8 HSHREABID TRANSFORMS A REAL MATRIX INTO BIDIAGONAL FORM BY MEANS OF HOUSEHOLDER TRANSFORMATION, 34261 H 8 PSTTFMMAT CALCULATES THE POSTMULTIPLYING MATRIX USED BY HSHREADID TO TRANSFORM A MATRIX INTO BIDIAGONAL FORM, 34262 H 8 PRETFEMAT CALCULATES THE PREMULTIPLYING MATRIX USED BY HISHREABID TO TRANSFORM A MATRIX INTO BIDIAGONAL FORM. 34270 H 10 GRISNGVALBID CALCULATES THE SINGULAR VALUES OF A REAL BIDIAGONAL MATRIX BY MEANS OF IMPLICIT QR-ITERATION. 34271 H 10 PRISNGVALDECTIO CALCULATES THE SINGULAR VALUE DECOMPOSITION OF A REAL MATRIX OF WHICH A BIDIAGONAL DECOMPOSITION IS GIVEN, BY MEANS OF AN IMPLICIT GRAJTERATION. 34272 H 12 GRISNGVAL CALCULATES THE SINGULAR VALUES OF A REAL MATRIX BY MEANS OF AN IMPLICIT GRATTERATION. 34273 H 12 GRISNGVALDEC CALCULATES THE SINGULAR VALUE DECOMPOSITION OF A REAL MATRIX BY MEANS OF AN IMPLICIT OR-ITERATION, 34280 H 0 SOLSVOOR CALCULATES THE LEAST SQUARES SOLUTION OF A OVERDETERMINED SYSTEM OF LINEAR EQUATIONS, PROVIDED THAT THE SINGULAR VALUE DEC OMPOSITION OF THE COEFFICIENT MATRIX IS GIVEN. 34281 H U SOLOVE CALCULATES THE LEAST SQUARES SOLUTION OF A OVERDETERMINED SYSTEM OF LINEAR EQUATIONS BY MEANS OF SINGULAR VALUE DECOMPOSITION 34282 H 2 SOLSVOUND CALCULATES THE BEST LEAST SQUARES SOLUTION OF A UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS, PROVIDED THAT THE SINGULAR VAL UE DECOMPOSITION OF THE COEFFICIENT MATRIX IS GIVEN. 34283 H 2 SOLUND CALCULATES THE BEST LEAST SQUARES SOLUTION OF A UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS BY MEANS OF SINGULAR VALUE DECOMPO 34284 H 4 HOMSOLSVO SOLVES A HOMOGENEOUS SYSTEM OF LINEAR EQUATIONS, PROVIDED THAT THE SINGULAR VALUE DECOMPOSITION OF THE COEFFICIENT MATRIX 34285 H 4 HOMSOL SOLVES A HOMCGENEOUS SYSTEM OF LINEAR EQUATIONS BY MEANS OF SINGULAR VALUE DECOMPOSITION, 34286 H 6 PSDINVSVD CALCULATES THE PSEUDO INVERSE OF A MATRIX, PROVIDED THAT THE SINGULAR VALUE DECOMPOSITION IS GIVEN. 34287 H 6 PSDINV CALCULATES THE PSEUDC INVERSE OF A MATRIX BY MEANS OF THE SINGULAR VALUE DECOMPOSITION. 34300 E 22 DEC PERFORMS THE TRIANGULAR DECOMPOSITION OF A MATRIX BY CROUT FACTORIZATION WITH PARTIAL PIVOTING. 34301 E 26 DECSOL SOLVES A SYSTEM OF LINEAR EQUATIONS BY CROUT FACTORIZATION WITH PARTIAL PIVOTING. 34302 E 28 DECINY COMPUTES THE INVERSE OF A MATRIX. 34303 E 24 DETERM COMPUTES THE DETERMINANT OF A MATRIX PROVIDED THAT THE MATRIX HAS BEEN DECOMPOSED BY DEC OR GSSELM. 34310 F 0 CHLDEC2 ( LINEAR EQUATIONS ) COMPUTES THE CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL

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34311 F 0 CHLDECT ( LINEAR EQUATIONS ) COMPUTES THE CHOLESKY DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED COLUMNWISE IN A ONE
            -DIMENSIONAL ARRAY.
34312 F 2 CHLDETERM2 COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDEC2.
34313 F 2 CHLDETERM1 COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDEC1.
34320 E 0 DECEND PERFORMS THE TRIANGULAR DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION,
34321 E 2 DETERMBND COMPUTES THE DETERMINANT OF A HAND MATRIX, WHICH HAS BEEN DECOMPOSED BY DECBNO.
34322 E 4 DECSOLBND PERFORMS THE DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION AND SOLVES THE SYSTEM OF LINEAR EGUATIONS,
34330 E 6 CHLDECHNO PERFORMS THE TRIANGULAR DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE MATRIX BY THE CHOLESKY METHOD.
34331 E 8 CHLDETERMBND COMPUTES THE DETERMINANT OF A SYMMETRIC POSITIVE DEFINITE MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDECEND,
34332 E 10 CHLSOLBND SOLVES A SYSTEM OF LINEAR EQUATIONS WITH SYMMETRIC POSITIVE DEFINITE BAND MATRIX, WHICH HAS BEEN DECOMPOSED BY CHLDECBND,
34333 E 10 CHLDECSOLBND PERFORMS THE DECOMPOSITION OF A SYMMETRIC POSITIVE DEFINITE BAND MATRIX AND SOLVES THE SYSTEM OF LINEAR EQUATIONS BY TH
           E CHOLESKY METHOD.
34340 D 14 COMABS COMPUTES THE MODULUS OF A COMPLEX NUMBER,
34341 D 20 COMMUL MULTIPLIES TWO COMPLEX NUMBERS.
34342 D 22 COMDIV COMPUTES THE QUOTIENT OF TWO COMPLEX NUMBERS,
34343 D 16 COMSORT COMPUTES THE SQUARE ROOT OF A COMPLEX NUMBER.
34344 D 18 CARPOL TRANSFORMS A COMPLEX NUMBER GIVEN IN CARTESIAN COORDINATES INTO POLAR COORDINATES.
34345 D 24 COMEWO COMPUTES THE ROOTS OF A QUADRATIC EQUATION WITH COMPLEX COEFFICIENTS.
34352 G 6 COMCOLOST MULTIPLIES A COMPLEX COLUMN VECTOR BY A COMPLEX NUMBER.
34353 G 6 COMPOWEST MULTIPLIES A COMPLEX ROW VECTOR BY A COMPLEX NUMBER.
34354 G 18 COMMATVEC COMPUTES THE SCALAR PRODUCT OF A COMPLEX ROW VECTOR AND A COMPLEX VECTOR.
34355 G 24 HISHCOMCOL TRANSFORMS A COMPLEX VECTOR HUTO A VECTOR PROPORTIONAL TO A UNIT VECTOR.
34356 G 24 HSHCOLPRO PREMULTIPLIES A COMPLEX MATRIX WITH A COMPLEX HOUSEHOLDER MATRIX.
34357 6 2 ROTCOMOL PERFORMS A ROTATION ON TWO COMPLEX COLUMN VECTORS.
34358 G 2 ROTCOPROM PERFORMS A ROTATION ON TWO COMPLEX ROW VECTORS.
34359 G 20 COMEUCNEN COMPUTES THE EUCLIDEAN NORM OF A COMPLEX MATRIX.
34360 G 22 SCLCOM NORMALIZES THE COLUMNS OF A COMPLEX MATRIX.
34361 G 16 EQILBROOM TRANSFORMS A COMPLEX MATRIX INTO A SIMILAR EQUILIBRATED COMPLEX MATRIX.
34362 G 16 BAKLBROOM PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE EQUILIBRATION AS PERFORMED BY EQILBROOM,
34363 G 4 HISHHRETRI TRANSFORMS A HERMITIAN MATRIX INTO A SIMILAR REAL SYMMETRIC TRIDIAGONAL MATRIX.
34364 G 4 HISHHRETRIVAL DELIVERS THE MAIN DIAGONAL ELEMENTS AND SQUARES OF THE CODIAGONAL ELEMENTS OF A HERMITIAN TRIDIAGONAL MATRIX WHICH IS U
           NITARY SIMILAR TO A GIVEN HERMITIAN MATRIX.
34365 G 4 BAKHRMTRI PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HISHHRMTRI.
34366 G 14 HISHCOPHES TRANSFORMS A COMPLEX MATRIX 19TO A SIMILAR UNITARY UPPER HESSENBERG MATRIX WITH A REAL NON-NEGATIVE SUBDIAGONAL.
34367 G 14 BAKCOLHES PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HISHCOMHES.
34368 G B EIGVALHRA COMPUTES ALL EIGENVALUES OF A HER HIT!AN MATRIX.
34369 G - 8 - EIGHRM COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A HERMITIAN MATRIX.
34370 G - 9 ORIVALHARM COMPUTES ALL EIGENVALUES OF A HER HITIAN MATRIX.
34371 G 8 ORIHRE COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A HERMITIAN MATRIX.
34372 G 12 VALORICOM COMPUTES ALL EIGENVALUES OF A COMPLEX UPPER HESSENBERG MATRIX WITH A REAL SUBDIAGONAL.
34373 G 12 GRICON COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A COMPLEX UPPER MESSENBERG MATRIX WITH A REAL SUBDIAGONAL.
34374 G 10 EIGVALCOM COMPUTES ALL EIGENVALUES OF A COMPLEX MATRIX.
34375 G 10 EIGCON COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A COMPLEX MATRIX.
34376 G. O. ELMCONVECCOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO A COMPLEX VECTOR.
34377 G 0 ELMCOMOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO ANOTHER COMPLEX COLUMN VECTOR.
34378 G 0 ELMCOPROWVEC ADDS A COMPLEX NUMBER TIMES A COMPLEX VECTOR TO A COMPLEX ROW VECTOR.
34390 F 4 CHLSOL2 SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS, THE MATRIX BEING DECOMPOSED BY CHLDEC2.
34391 F 4 CHLSOL1 SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS, THE MATRIX BEING DECOMPOSED BY CHIDEC1.
34392 F 4 CHIDECSOL SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS BY THE CHOLESKY METHOD, THE MATRIX BEING STORED IN A TWO-
           DIMENSIONAL ARRAY.
34393 F 4 CHIDECSOL1 SOLVES A SYMMETRIC POSITIVE DEFINITE SYSTEM OF LINEAR EQUATIONS BY THE CHOLESKY METHOD, THE MATRIX BEING STORED IN A ONE-
           DIMENSIONAL ARRAY.
34400 F 6 CHLINV2 COMPUTES THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX WHICH HAS BEEN DECOMPOSED BY CHIDEC2.
34401 F 6 CHLINVI COMPUTES THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX WHICH HAS BEEN DECOMPOSED BY CHIDECI,
34402 F 6 CHLDECTIVE COMPUTES, BY THE CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY.
34403 F 6 CHLDECINVA COMPUTES, BY THE CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A ONE-DIMENSIONAL ARRAY.
34410 H 14 LNGVECVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS,
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34411 H 14 LINGMATVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF A ROW VECTOR AND A VECTOR
34412 H 14 LINGTAMVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF A COLUMN VECTOR AND A VECTOR
34413 H 14 LNGMATMAT COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF A ROW VECTOR AND A COLUMN VECTOR.
34414 H 14 LNGTAMMAT COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO COLJMN VECTORS.
34415 H 14 LINGMATTAN COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO ROW VECTORS.
34416 H 14 LNGSERVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS.
34417 H 14 LNGSCAPRD1 COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO VECTORS.
34418 H 14 UNGSYMMATVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF A VECTOR AND A ROW IN A SYMMETRIC MATRIX.
34420 H 20 DECSYMTRI CALCULATES THE U.DU DECOMPOSITION OF A SYMMETRIC TRIDIAGONAL MATRIX.
34421 H 22 SOLSYMTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH SYMMETRIC TRIDIAGONAL COEFFICIENT MATRIX, PROVIDED THAT THE UIDU DECOMPOSITION IS
34422 H 22 DECSOLSYMTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH SYMMETRIC TRIDIAGONAL COEFFICIENT MATRIX.
34423 H 16 DECTRI CALCULATES, WITHOUT PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL MATRIX
34424 H 18 SOLTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT MATRIX, PROVIDED THAT THE LU DECOMPOSITION IS GIVEN.
34425 H 18 DECSOLTRI SOLVES A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT MATRIX.
34426 H 16 DECTRIPIN CALCULATES, WITH PARTIAL PINOTING, THE LU DECOMPOSITION OF A TRIBIAGONAL MATRIX.
34427 H 18 SOLTRIPIV SOLVES A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT MATRIX, PROVIDED THAT THE LU DECOMPOSITION AS CALCULATED
            BY DECTRIPIV IS GIVEN.
34428 H 18 DECSOLTRIPIV SOLVES WITH PARTIAL PIVOTING A SYSTEM OF LINEAR EQUATIONS WITH TRIDIAGONAL COEFFICIENT MATRIX.
35020 C 38 ERF COMPUTES THE ERROR FUNCTION AND COMPLEMENTARY ERROR FUNCTION FOR A REAL ARGUMENT; THESE FUNCTIONS ARE RELATED TO THE NORMAL OR G
           AUSSIAN PROBABILITY FUNCTION.
35030 C 40 INCOMBAM COMPUTES THE INCOMPLETE GAMMA FUNCTION BY PADE APPROXIMATIONS.
35050 E 14 INCBETA COMPUTES THE INCOMPLETE BETA FUNCTION I(x,P,Q),0<=x<=1,P>0,Q>0,
35051 E 14 IBPPLUSN COMPUTES THE INCOMPLETE BETA FUNCTION I(X,P+N,Q),0<=X<=1,P>0,0>0, FOR N=0(1)NMAX.
35052 E 14 IBQPLUSN COMPUTES THE INCOMPLETE BETA FUNCTION I(X,P,Q+N),0<=X<=1,P>0,Q>0, FOR N=0(1)NMAX.
35053 E 14 IXQFIX IS AN AUXILIARY PROCEDURE FOR THE INCOMPLETE BETA PUNCTION.
35054 E 14 EXPERX IS AN AUXILIARY PROCEDURE FOR THE ENCOMPLETE BETA FUNCTION.
35055 E 14 FORWARD IS AN AUXILIARY PROCEDURE FOR THE INCOMPLETE BETA FUNCTION.
35056 E 14 BACKWARD IS AN AUXILIARY PROCEDURE FOR THE INCOMPLETE BETA FUNCTION.
35060 C 42 RECIP GAMMA COMPUTES THE RECIPROCAL OF THE GAMMA FUNCTION FOR ARGUMENTS IN THE RANGE (1/2,3/2); ODD AND EVEN PARTS ARE ALSO DELIVERE
35061 C 42 GAMMA COMPUTES THE GAMMA FUNCTION FOR A REAL ARGUMENT.
35062 C 42 LOG GAMMA COMPUTES THE NATURAL LOGARITHM OF THE GAMMA FUNCTION FOR POSITIVE ARGUMENTS.
36010 C 44 NEWTON DETERMINES THE COEFFICIENTS OF THE NEWTON INTERPOLATION POLYNOMIAL FOR GIVEN ARGUMENTS AND FUNCTION VALUES.
36020 E 18 INT IS AN AUXILIARY PROCEDURE FOR MINIMAX APPROXIMATION.
36021 E 20 SNORELEZ (SECOND REMEZ ALGORITHM) EXCHANGES NUMBERS WITH NUMBERS OUT OF A REFERENCE SET.
36022 C 46 MINMAXPOL DETERMINES THE COEFFICIENTS OF THE POLYNOMIAL (IN GRUNERT FORM) THAT APPROXIMATES A FUNCTION GIVEN FOR DISCRETE ARGUMENTS;
             THE SECOND REMEZ EXCHANGE ALGORITHM IS USED FOR THIS MINIMAX POLYNOMIAL APPROXIMATION.
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