stichting
mathematisch
centrum

MC

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

2nd edition

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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 1st 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 21st 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,

THE LIBRARY NUMAL CONSISTS OF A NUMBER OF FILES:

1, FILE "NUMAL3INDEX",
   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, XEQ COMMAND,

3, THE FILES "NUMAL3DOCUMENTA"
      "NUMAL3DOCUMENTB"
      "NUMAL3DOCUMENTC"
      ETC, ,
   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 FILES "NUMAL3DOCUMENTA" AND "NUMAL3DOCUMENTB" 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, WHICH CONTAINS DESCRIPTIONS OF THE EL-X8 IMPLEMENTATION OF THE ALGORITHMS, THE FILES "NUMAL3DOCUMENTC" , "NUMAL3DOCUMENTD" ETC, CONTAIN FULL DOCUMENTATION,

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 NUMAL3 AND A REFERENCE TO THE DOCUMENTATION, THIS REFERENCE GIVES 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.
......
```

IN ORDER TO OBTAIN THE SOURCE TEXT, ONE MORE RECORD HAD TO BE SKIPPED.

SERVICE.

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

NOTE.

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

P.W.HEMKER
(MATHEMATICAL CENTRE)

REMARK.

AT THE MOMENT (1974-3-20) THE PROCEDURES DESCRIBED IN NUMALDOCUMENTG, NUMAL3DOCUMENTH AND NUMALDOCEMENTJ ARE ONLY AVAILABLE FOR THOSE WHO HAVE THE DISPOSAL OF AN MC-PROJECTNUMBER.

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	INIMATD	31012	NUMAL3DOCUMENTD	0
	INISYMD	31013	NUMAL3DOCUMENTD	0
	INISYMROW	31014	NUMAL3DOCUMENTD	0
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	DUPVECROW	31031	NUMAL3DOCUMENTD	2
	DUPROWVEC	31032	NUMAL3DOCUMENTD	2
	DUPVECCOL	31033	NUMAL3DOCUMENTD	2
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DETSOL	34052	730901	740401	DECSOL(3,1,1,1,1,1,3),DETERM,
DETINV	34054	730901	731201	DECINV(3,1,1,1,1,1,4),DETERM,
RNKELM	34060	730901	740401	GSSELM(3,1,1,1,1,1,1)
RNKSOLELM	34062	730901	740401	GSSSOL(3,1,1,1,1,1,3)
SOLHOM	34063	730901	740401	SINGULAR VALUE PROCEDURES (3,5)
INVELM	34064	730901	740401	GSSINV(3,1,1,1,1,1,4)
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DETSOLBND	34072	730901	740401	DECSOLBND(3,1,2,1,1,1,1,3),DETERMBND,
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SOLSYM2	34081	730901	740401	CHLSOL2(3,1,1,1,1,2,3)
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DETSYM1	34090	730901	740401	CHLDEC1(3,1,1,1,1,2,1),CHLDETERM1(3,1,1,1,1,2,2)
SOLSYM1	34091	730901	740401	CHLSOL1(3,1,1,1,1,2,3)
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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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       MCOMCOL ADDS A COMPLEX NUMBER  TIMES A COMPLEX COLUMN VECTOR TO ANOTHER COMPLEX COLUMN VECTOR.                                      34377 G  0
       MROWVEC ADDS A COMPLEX NUMBER  TIMES A COMPLEX VECTOR TO A COMPLEX ROW VECTOR.                                                      34378 G  0
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ROW ADDS A SCALAR TIMES A ROW   VECTOR TO A COLUMN VECTOR.                                                                           34029 D  8
 DUPROWVEC COPIES (PART OF) A   VECTOR TO A ROW VECTOR.                                                                              31032 D  2
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ROW ADDS A SCALAR TIMES A ROW   VECTOR TO A ROW VECTOR, AND RETURNS THE SUBSCRIPT VALUE OF THE NEW ROW ELEMENT OF MAXIMUM ABSOLUTE V 34025 D  8
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31010 D  0  INIVEC INITIALIZES (PART OF) A VECTOR WITH A CONSTANT,
31011 D  0  INIMAT INITIALIZES (PART OF) A MATRIX WITH A CONSTANT,
31012 D  0  INIMATD INITIALIZES (PART OF) A DIAGONAL OR CODIAGONAL WITH A CONSTANT,
31013 D  0  INISYMD INITIALIZES A CODIAGONAL OF A SYMMETRIC MATRIX WITH A CONSTANT,
31014 D  0  INISYMROW INITIALIZES A ROW OF A SYMMETRIC MATRIX WITH A CONSTANT,
31020 D  4  MULVEC MULTIPLIES A VECTOR BY A SCALAR,
31021 D  4  MULROW MULTIPLIES A ROW VECTOR BY A SCALAR STORING THE RESULT IN ANOTHER VECTOR,
31022 D  4  MULCOL MULTIPLIES A COLUMN VECTOR BY A SCALAR,
31030 D  2  DUPVEC COPIES (PART OF) A VECTOR TO A VECTOR,
31031 D  2  DUPVECROW COPIES (PART OF) A ROW VECTOR TO A VECTOR,
31032 D  2  DUPROWVEC COPIES (PART OF) A VECTOR TO A ROW VECTOR,
31033 D  2  DUPVECCOL COPIES (PART OF) A COLUMN VECTOR TO A VECTOR,
31034 D  2  DUPCOLVEC COPIES (PART OF) A VECTOR TO A COLUMN VECTOR,
31035 D  2  DUPMAT COPIES (PART OF) A MATRIX TO (AN OTHER) MATRIX,
31040 C  0  POL EVALUATES A POLYNOMIAL GIVEN IN THE GRUNERT FORM BY THE HORNER SCHEME,
31041 C  2  NEWPOL EVALUATES A POLYNOMIAL GIVEN IN THE NEWTON FORM BY THE HORNER SCHEME,
31050 C  4  NEWGRN TRANSFORMS A POLYNOMIAL REPRESENTATION FROM NEWTON FORM INTO GRUNERT FORM,
31060 D 32  ABSMAXVEC COMPUTES THE INFINITY NORM OF A VECTOR AND DELIVERS THE INDEX FOR AN ELEMENT MAXIMAL IN MODULUS,
31131 D  4  COLCST MULTIPLIES A COLUMN VECTOR BY A SCALAR,
31132 D  4  ROWCST MULTIPLIES A ROW VECTOR BY A SCALAR
32010 D 28  EULER COMPUTES THE SUM OF AN ALTERNATING SERIES,
32020 E 16  SUMPOSSERIES COMPUTES THE SUM OF A CONVERGENT SERIES WITH POSITIVE TERMS, USING THE VAN WIJNGAARDEN TRANSFORMATION,
32051 C 48  INTEGRAL ( QUADRATURE ) COMPUTES THE DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE OR INFINITE INTERVAL OR OVER A NU
            MBER OF CONSECUTIVE INTERVALS,
32070 C  6  QADRAT ( QUADRATURE ) COMPUTES THE DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE INTERVAL,
33010 C  8  RK1 SOLVES A SINGLE FIRST ORDER DIFFERENTIAL EQUATION USING A 5-TH ORDER RUNGE KUTTA METHOD,
33011 C 10  RK1N SOLVES A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS USING A 5-TH ORDER RUNGE KUTTA METHOD.
33012 C 12  RK2 SOLVES A SECOND ORDER DIFFERENTIAL EQUATION USING A 5-TH ORDER RUNGE KUTTA METHOD,
33013 C 14  RK2N SOLVES A SYSTEM OF SECOND ORDER DIFFERENTIAL EQUATIONS USING A 5-TH ORDER RUNGE KUTTA METHOD,
33014 C 16  RK3 SOLVES 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 5-TH 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  RK4NA 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 ORDER 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 INTEGRATI
            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 EQUATIONS,
33130 D 38  LINIGER1 SOLVES INITIAL VALUE PROBLEMS, GIVEN AS AN AUTONOMOUS SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS, BY AN IMPLICIT, EXPONEN
            TIALLY FITTED, FIRST ORDER ONE-STEP 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
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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  SEQVEC COMPUTES THE SCALAR PRODUCT OF TWO VECTORS.
34017 D  6  SCAPRD1 COMPUTES THE SCALAR PRODUCT OF TWO VECTORS.
34018 D  6  SYMMATVEC COMPUTES 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 SCALAR 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.
34028 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  ICHSEQVEC 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  SOLBND SOLVES A SYSTEM OF LINEAR EQUATIONS WITH BAND MATRIX, WHICH IS DECOMPOSED BY DECBND.
34131 E 34  LSQSOL SOLVES A LINEAR LEAST SQUARES PROBLEM, PROVIDED THAT THE COEFFICIENT MATRIX HAS BEEN DECOMPOSED BY LSQORTDEC.
34132 E 32  LSQDGLINV COMPUTES THE DIAGONAL ELEMENTS OF THE INVERSE OF M'M (M COEFFICIENT MATRIX) OF A LINEAR LEAST SQUARES PROBLEM.
34134 E 32  LSQORTDEC PERFORMS THE HOUSEHOLDER TRIANGULARIZATION OF THE COEFFICIENT MATRIX OF A LINEAR LEAST SQUARES PROBLEM.
34135 E 34  LSQORTDECSOL SOLVES A LINEAR LEAST SQUARES PROBLEM AND COMPUTES THE DIAGONAL ELEMENTS OF THE INVERSE OF M'M (M COEFFICIENT MATRIX).
34140 D 34  TFMSYMTRI2 TRANSFORMS A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY HOUSEHOLDERS TRANSFORMATION.
34141 D 34  BAKSYMTRI2 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERFORMED BY TFMSYMTRI2.
34142 D 34  TFMPREVEC COMPUTES THE TRANSFORMING MATRIX IN COMBINATION WITH PROCEDURE TFMSYMTRI2.
34143 D 34  TFMSYMTRI1 TRANSFORMS A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY HOUSEHOLDERS TRANSFORMATION.
34144 D 34  BAKSYMTRI1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE HOUSEHOLDERS TRANSFORMATION AS PERFORMED BY TFMSYMTRI1.
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 SEQ
            UENCE.
34152 D 36  VECSYMTRI 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  EIGSYM2 COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX, WHICH IS STORED IN A TWO-DIMENSIONAL A
            RRAY.
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  EIGSYM1 COMPUTES ALL, OR SOME CONSECUTIVE EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX, WHICH IS STORED IN A ONE-DIMENSIONAL A
            RRAY.
34161 D 36  QRISYMTRI COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY QR-ITERATION.
34162 E 12  QRIVALSYM2 COMPUTES ALL EIGENVALUES OF A SYMMETRIC MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY, BY QR-ITERATION.
34163 E 12  QRISYM COMPUTES ALL EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX BY QR-ITERATION.
34164 E 12  QRIVALSYM1 COMPUTES ALL EIGENVALUES OF A SYMMETRIC MATRIX, STORED IN A ONE-DIMENSIONAL ARRAY, BY QR-ITERATION.
34165 D 36  VALQRISYMTRI COMPUTES ALL EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY QR-ITERATION.
34170 F 14  TFMREAHES TRANSFORMS A REAL MATRIX INTO A SIMILAR UPPER HESSENBERG MATRIX BY THE WILKINSON TRANSFORMATION.
34171 F 14  BAKREAHES1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORMED BY TFMREAHES, ON A VECTOR.
34172 F 14  BAKREAHES2 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE WILKINSON TRANSFORMATION AS PERFORMED BY TFMREAHES, ON THE COLUMNS
            OF A MATRIX.
34173 F 12  EQILBR 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  REAVALQRI 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
             ITERATION.
34183 F  8  REASCL NORMALIZES THE COLUMNS OF A TWO-DIMENSIONAL ARRAY.
34186 F 16  REAQRI CALCULATES THE EIGENVALUES AND EIGENVECTORS OF A REAL UPPER HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL, BY MEA
            NS OF SINGLE QR-ITERATION.
34190 F 16  COMVALQRI CALCULATES THE REAL AND COMPLEX EIGENVALUES OF A REAL UPPER HESSENBERG MATRIX BY MEANS OF DOUBLE QR-ITERATION,
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,
34211 D 30  RNK1UPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION,
34212 D 30  DAVUPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION.
34213 D 30  FLEUPD IS AN AUXILIARY PROCEDURE FOR OPTIMIZATION,
34214 D 30  RNK1MIN ( OPTIMIZATION ) MINIMIZES A GIVEN DIFFERENTIABLE FUNCTION OF SEVERAL VARIABLES BY A VARIABLE METRIC METHOD.
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  MAXMAT 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  ONENRMINV COMPUTES THE 1-NORM OF THE INVERSE OF A MATRIX, WHICH IS TRIANGULARLY DECOMPOSED.
34241 E 22  ERBELM 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,
34251 E 30  GSSITISOL COMPUTES AN ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS,
34252 E 22  GSSNRI IS AN AUXILIARY PROCEDURE FOR THE ITERATIVELY REFINED SOLUTION OF A SYSTEM OF LINEAR EQUATIONS,
34253 E 30  ITISOLERB 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 HSHREABID TO TRANSFORM A MATRIX INTO BIDIAGONAL FORM,
34262 H  8  PRETFMMAT CALCULATES THE PREMULTIPLYING MATRIX USED BY HSHREABID TO TRANSFORM A MATRIX INTO BIDIAGONAL FORM.
34270 H 10  QRISNGVALBID CALCULATES THE SINGULAR VALUES OF A REAL BIDIAGONAL MATRIX BY MEANS OF IMPLICIT QR-ITERATION.
34271 H 10  QRISNGVALDECBID CALCULATES THE SINGULAR VALUE DECOMPOSITION OF A REAL MATRIX OF WHICH A BIDIAGONAL DECOMPOSITION IS GIVEN, BY MEANS
            OF AN IMPLICIT QR-ITERATION.
34272 H 12  QRISNGVAL CALCULATES THE SINGULAR VALUES OF A REAL MATRIX BY MEANS OF AN IMPLICIT QR-ITERATION.
34273 H 12  QRISNGVALDEC CALCULATES THE SINGULAR VALUE DECOMPOSITION OF A REAL MATRIX BY MEANS OF AN IMPLICIT QR-ITERATION,
34280 H  0  SOLSVDOVR 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  0  SOLOVR CALCULATES THE LEAST SQUARES SOLUTION OF A OVERDETERMINED SYSTEM OF LINEAR EQUATIONS BY MEANS OF SINGULAR VALUE DECOMPOSITION
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34282 H  2  SOLSVDUND 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
            SITION.
34284 H  4  HOMSOLSVD SOLVES A HOMOGENECUS SYSTEM OF LINEAR EQUATIONS, PROVIDED THAT THE SINGULAR VALUE DECOMPOSITION OF THE CCEFFICIENT MATRIX
            IS GIVEN.
34285 H  4  HOMSOL SOLVES A HOMOGENEOUS 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  DECINV 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-DIMENSIONA
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			L ARRAY,
34311	F	0	CHLDEC1 (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	DECBND PERFORMS THE TRIANGULAR DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION,
34321	E	2	DETERMBND COMPUTES THE DETERMINANT OF A BAND MATRIX, WHICH HAS BEEN DECOMPOSED BY DECBND,
34322	E	4	DECSOLBND PERFORMS THE DECOMPOSITION OF A BAND MATRIX BY GAUSSIAN ELIMINATION AND SOLVES THE SYSTEM OF LINEAR EQUATIONS,
34330	E	6	CHLDECBND 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 CHLDECBND,
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 THE 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	COMSQRT 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	COMKWD COMPUTES THE ROOTS OF A QUADRATIC EQUATION WITH COMPLEX COEFFICIENTS,
34352	G	6	COMCOLCST MULTIPLIES A COMPLEX COLUMN VECTOR BY A COMPLEX NUMBER,
34353	G	6	COMROWCST 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	HSHCOMCOL TRANSFORMS A COMPLEX VECTOR INTO A VECTOR PROPORTIONAL TO A UNIT VECTOR,
34356	G	24	HSHCOMPRD PREMULTIPLIES A COMPLEX MATRIX WITH A COMPLEX HOUSEHOLDER MATRIX,
34357	G	2	ROTCOMCOL PERFORMS A ROTATION ON TWO COMPLEX COLUMN VECTORS,
34358	G	2	ROTCOMROW PERFORMS A ROTATION ON TWO COMPLEX ROW VECTORS,
34359	G	20	COMEUCNRM COMPUTES THE EUCLIDEAN NORM OF A COMPLEX MATRIX,
34360	G	22	SCLCOM NORMALIZES THE COLUMNS OF A COMPLEX MATRIX,
34361	G	16	EQILBRCOM TRANSFORMS A COMPLEX MATRIX INTO A SIMILAR EQUILIBRATED COMPLEX MATRIX,
34362	G	16	BAKLBRCOM PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO THE EQUILIBRATION AS PERFORMED BY EQILBRCOM,
34363	G	4	HSHHRMTRI TRANSFORMS A HERMITIAN MATRIX INTO A SIMILAR REAL SYMMETRIC TRIDIAGONAL MATRIX,
34364	G	4	HSHHRMTRIVAL DELIVERS THE MAIN DIAGONAL ELEMENTS AND SQUARES OF THE CODIAGONAL ELEMENTS OF A HERMITIAN TRIDIAGONAL MATRIX WHICH IS UNITARY SIMILAR TO A GIVEN HERMITIAN MATRIX,
34365	G	4	BAKHRMTRI PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HSHHRMTRI,
34366	G	14	HSHCOMHES TRANSFORMS A COMPLEX MATRIX INTO A SIMILAR UNITARY UPPER HESSENBERG MATRIX WITH A REAL NON-NEGATIVE SUBDIAGONAL,
34367	G	14	BAKCOMHES PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HSHCOMHES,
34368	G	8	EIGVALHRM COMPUTES ALL EIGENVALUES OF A HERMITIAN MATRIX,
34369	G	8	EIGHRM COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A HERMITIAN MATRIX,
34370	G	8	QRIVALHRM COMPUTES ALL EIGENVALUES OF A HERMITIAN MATRIX,
34371	G	8	QRIHRM COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A HERMITIAN MATRIX,
34372	G	12	VALQRICOM COMPUTES ALL EIGENVALUES OF A COMPLEX UPPER HESSENBERG MATRIX WITH A REAL SUBDIAGONAL,
34373	G	12	QRICOM COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A COMPLEX UPPER HESSENBERG MATRIX WITH A REAL SUBDIAGONAL,
34374	G	10	EIGVALCOM COMPUTES ALL EIGENVALUES OF A COMPLEX MATRIX,
34375	G	10	EIGCOM COMPUTES ALL EIGENVECTORS AND EIGENVALUES OF A COMPLEX MATRIX,
34376	G	0	ELMCOMVECCOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO A COMPLEX VECTOR,
34377	G	0	ELMCOMCOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO ANOTHER COMPLEX COLUMN VECTOR,
34378	G	0	ELMCOMROWVEC 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 CHLDEC1,
34392	F	4	CHLDECSOL2 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	CHLDECSOL1 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 CHLDEC2,
34401	F	6	CHLINV1 COMPUTES THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX WHICH HAS BEEN DECOMPOSED BY CHLDEC1,
34402	F	6	CHLDECINV2 COMPUTES, BY THE CHOLESKY METHOD, THE INVERSE OF A SYMMETRIC POSITIVE DEFINITE MATRIX, STORED IN A TWO-DIMENSIONAL ARRAY,
34403	F	6	CHLDECINV1 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  LNGMATVEC COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF A ROW VECTOR AND A VECTOR,
34412 H 14  LNGTAMVEC 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 COLUMN VECTORS,
34415 H 14  LNGMATTAM COMPUTES IN DOUBLE PRECISION THE SCALAR PRODUCT OF TWO ROW VECTORS,
34416 H 14  LNGSEQVEC 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  LNGSYMMATVEC 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 U'DU DECOMPOSITION IS
             GIVEN,
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  DECTRIPIV CALCULATES, WITH PARTIAL PIVOTING, THE LU DECOMPOSITION OF A TRIDIAGONAL 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  INCOMGAM 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,Q>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 FUNCTION,
35054 E 14  IXPFIX IS AN AUXILIARY PROCEDURE FOR THE INCOMPLETE 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
            D.
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  INI IS AN AUXILIARY PROCEDURE FOR MINIMAX APPROXIMATION,
36021 E 20  SNDREMEZ (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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