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NUMAL
NUMERICAL PROCEDURES IN ALGOL 60

GENERAL INFORMATION AND INDICES

P.W. HEMKER (ed.)

MATHEMATISCH CENTRUM AMSTERDAM 1981

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THE LIBRARY
ANNUAL
OF ALGOL 60 PROCEDURES IN NUMERICAL MATHEMATICS
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MATHEMATICAL CENTRE , AMSTERDAM
4-TH REVISION, 1980

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GENERAL INFORMATION AND INDICES

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INTRODUCTION.

AT REQUEST OF THE ACADEMIC COMPUTING CENTRE OF AMSTERDAM (SARA) THE MATHEMATICAL CENTRE STARTED IN 1973 THE ADAPTATION OF ITS COLLECTION OF NUMERICAL PROCEDURES FOR USE WITH THE CD CYBER 70 SYSTEM. THE RESULTING NUMERICAL LIBRARY IS CALLED "NUMAL" ("NUM" ERICAL PROCEDURES IN "AL" GDL 60).

THE DOCUMENTATION APPEARED IN 1974 IN A LOOSE LEAF MANUAL. IT WAS REVISED AND UPDATED IN 1975, 1977 AND 1979. IN THIS PERIOD THE LIBRARY GREW TO A COLLECTION OF ABOUT 430 ROUTINES IN ALL DIFFERENT FIELDS OF NUMERICAL MATHEMATICS. ALTHOUGH NO ATTEMPTS HAVE BEEN MADE TO CREATE A COLLECTION THAT GIVES A COMPLETE OVERVIEW OF ALL NUMERICAL PROCEDURES AVAILABLE, MOST AREAS OF NUMERICAL MATHEMATICS ARE COVERED AND MOST PROGRAMS FOR WHICH A NEED WAS FELT HAVE BEEN IMPLEMENTED.

THE AIM OF NUMAL WAS TO PROVIDE ALGOL 60 PROGRAMMERS WITH A HIGH LEVEL NUMERICAL LIBRARY WHICH CONTAINS A SET OF VALIDATED NUMERICAL PROCEDURES TOGETHER WITH SUPPORTING DOCUMENTATION.

THE LIBRARY HAS BEEN CONSTRUCTED IN A MODULAR WAY: MOST ROUTINES REFER TO AND RELY ON OTHER ROUTINES THAT PERFORM A WELL-DEFINED SUB-TASK. THE MORE EXPERIENCED USER CAN AVAIL HIMSELF OF THESE MORE ELEMENTARY ROUTINES IN THE SAME WAY AS THE AUTHORS OF THE LIBRARY DO. THE NOVICE, IT IS BETTER TO USE THE MORE COMPREHENSIVE PROCEDURES WHICH PERFORM COMPLETE MATHEMATICAL COMPUTATIONS.

IN 1976 AND 1977 THE NUMERICAL MATHEMATICS DEPARTMENT ORGANIZED A SEMINAR ON NUMERICAL SOFTWARE. IN THIS SEMINAR THE USE OF SOME ALGOL PROCEDURES IN THE NUMAL LIBRARY WAS EXPLAINED IN DETAIL AND THEIR ALGORITHMIC BACKGROUND WAS CLARIFIED. ALSO, THE NUMERICAL LIBRARIES IMSL (FORTRAN), NAG (ALGOL 60 AND FORTRAN) AND NUMAL (ALGOL 60) WERE COMPARED. THE PROCEEDINGS OF THIS SEMINAR APPEARED (IN DUTCH) IN THE MC-SYLLABUS SERIES OF THE MATHEMATICAL CENTRE AS:

COLLOQUIUM NUMERIEKE PROGRAMMATUUR, DEEL 1
J.C.P.BUS ED., MCS 29.1,
MATHEMATISCH CENTRUM, AMSTERDAM, 1976,

AND

COLLOQUIUM NUMERIEKE PROGRAMMATUUR, DEEL 2
H.J.J. TE RIELE ED., MCS 29.2,
MATHEMATISCH CENTRUM, AMSTERDAM, 1977.

THE LANGUAGE ALGOL 60 AND THE MODULAR STRUCTURE

TWO IMPORTANT CHARACTERISTICS OF NUMAL ARE : ITS MODULAR STRUCTURE AND THE CONSISTENT USE OF STANDARD ALGOL 60 (IN THE SENSE OF THE REVISED REPORT ON ALGOL 60, REF.)

INPUT AND OUTPUT ROUTINES, NOT BEING DEFINED IN STANDARD ALGOL 60, HAVE NOT BEEN USED IN THE LIBRARY SOURCE TEXTS. THEY ONLY APPEAR IN THE DOCUMENTATION WHERE EXAMPLES OF USE OF THE LIBRARY ROUTINES ARE GIVEN.

SINCE DOUBLE PRECISION IS ALSO NOT DEFINED IN ALGOL 60, A SMALL NUMBER OF DOUBLE PRECISION ARITHMETIC ROUTINES COULD NOT BE CODED IN ALGOL 60 AND, HENCE, A FEW (8) DOUBLE PRECISION MODULES WERE CODED IN ASSEMBLY LANGUAGE.

EXCEPT FOR THIS SMALL NUMBER OF DOUBLE PRECISION ARITHMETIC ROUTINES ALL THE SOURCE TEXTS ARE WRITTEN IN ALGOL 60 AND, HENCE, THEY ARE IN PRINCIPLE INDEPENDENT OF THE COMPUTER/COMPILER USED (REF.).

IN ITS PRACTICAL IMPLEMENTATION ON THE CDC-CYBER SYSTEM MOST ELEMENTARY ROUTINES IN THE MODULAR STRUCTURE OF THE LIBRARY (I.E. THE MATRIX AND VECTOR OPERATIONS) WERE RE-CODED BY HAND IN ASSEMBLY LANGUAGE. THIS HAS ACCELERATED THE OPERATION OF MOST LINEAR ALGEBRA ROUTINES BY A FACTOR 2.5. THUS, ONE OF THE MAJOR DISADVANTAGES OF THE USE OF ALGOL 60, THE RELATIVELY LONG EXECUTION TIMES (WHICH FIRST WERE APPROXIMATELY 4 TIMES LONGER THAN FOR AN EQUIVALENT FORTRAN PROGRAM) WAS CIRCUMVENTED TO A LARGE EXTENT. THIS REFINEMENT WAS POSSIBLE BECAUSE OF THE CONSISTENT APPLICATION OF THE MODULARITY PRINCIPLE.

REFS. P.NAUR (ED.)
REVISED REPORT ON THE ALGORITHMIC LANGUAGE ALGOL 60
A/S REGNECENTRALEN, COPENHAGEN, 1964.

P.W.HEMKER
CRITERIA FOR TRANSPORTABLE ALGOL LIBRARIES.
IN: PORTABILITY OF NUMERICAL SOFTWARE (W.COWELL ED.)
LECTURE NOTES IN COMP.SC. 57, SPRINGER VERLAG, 1977.

ORGANIZATION OF THE LIBRARY.

EACH ROUTINE IN THE LIBRARY IS IDENTIFIED BY A NAME AND A CODE NUMBER. THE CODE NUMBER CAN BE USED IN AN ALGOL 60 PROGRAM WHEN REFERENCE IS MADE TO A PRE-COMPILED PROCEDURE IN THE OBJECT CODE LIBRARY. ALL PROCEDURES IN NUMAL ARE CLASSIFIED ACCORDING TO SUBJECT. THE SUBJECTS ARE IDENTIFIED BY A SECTION NUMBER. THE MANUAL IS ORDERED BY THESE SECTION NUMBERS.

IN ORDER TO FIND A PARTICULAR PROCEDURE, THERE IS A SYSTEMATIC INDEX IN WHICH ALL PROCEDURES (THEIR NAMES AND THEIR CODE NUMBERS) ARE RECORDED AND CLASSIFIED BY THEIR SECTION NUMBER (I.E. BY SUBJECT).

FOR CROSS REFERENCING THERE IS AN INDEX BY CODE NUMBER, WHICH HAS REFERENCES TO PROCEDURE NAME AND SECTION NUMBER, AND THERE IS ALSO A KWIC INDEX IN WHICH KEYWORDS AND PROCEDURE NAMES HAVE BEEN ORDERED ALPHABETICALLY.

THE STATUS OF NUMAL

IN 1979 THE INTEREST AT THE MATHEMATICAL CENTRE IN THE CREATION OF GENERAL NUMERICAL SOFTWARE IN ALGOL 60 DECREASED AND THE DRAFTING-COMMITTEE DECIDED TO CONCLUDE THE NUMAL-PROJECT WITH THE PUBLICATION OF A FINAL REVISION OF THE LIBRARY IN BOOK FORM. IN ITS PRESENT FORM THE LIBRARY NUMAL CAN BE SEEN AS A DESCRIPTION OF THE STATE-OF-THE-ART OF NUMERICAL ALGOL 60 PROGRAMMING AT THE MATHEMATICAL CENTRE AT THE END OF THE 1970-S.

WE THINK THAT IT CONTAINS A VALUABLE COLLECTION OF ROUTINES IN A LANGUAGE THAT STILL CAN DESCRIBE NUMERICAL PROCEDURES BETTER THAN MANY OTHER PROGRAMMING LANGUAGES CURRENTLY IN USE.

IMPERFECTIONS AND RESPONSIBILITY.

ALTHOUGH THE NUMERICAL MATHEMATICS DEPARTMENT OF THE MATHEMATICAL CENTRE ASSUMES THE RESPONSIBILITY FOR IMPERFECTIONS BOTH IN PROGRAMS AND IN DOCUMENTATION, NEITHER THE MATHEMATICAL CENTRE NOR THE AUTHORS/CONTRIBUTORS ACCEPT RESPONSIBILITY FOR THE CONSEQUENCES OF SUCH IMPERFECTIONS.

ALTHOUGH MUCH EFFORT HAS BEEN SPENT TO KEEP THE NUMBER OF ERRORS TO A MINIMUM, IT IS POSSIBLE THAT SOME MINOR ERRORS STILL REMAIN. THEREFORE THE NUMERICAL MATHEMATICS DEPARTMENT WILL KEEP A LIST OF ALL ERRORS IN THE DOCUMENTATION AND/OR THE PROGRAMS THAT BECOME KNOWN AFTER PUBLICATION AND THIS LIST WILL BE MADE AVAILABLE UPON REQUEST.

NUMAL IN FORTRAN.

A TRANSLATION OF NUMAL INTO A FORTRAN VERSION SUITABLE FOR USE ON A MINI-COMPUTOR IS CARRIED OUT UNDER THE SUPERVISION OF P.WYNN BY H.T.LAU IN THE SCHOOL OF COMPUTER SCIENCE, MC-GILL UNIVERSITY, MONTREAL, CANADA.

FURTHER RESEARCH ON THE FORTRAN VERSION IS ALSO BEING CARRIED OUT AT LIMAS (INSTITUTO DE INVESTIGACIONES EN MATEMATICAS APPLICADAS Y EN SISTEMAS), UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO.

ORIGIN OF THE PROGRAMS.

THE MAJOR PART OF THE LIBRARY CONSISTS OF PROCEDURES THAT HAVE BEEN DEVELOPED AT THE MATHEMATICAL CENTRE. HOWEVER, SOME PROCEDURES ARE ADAPTED VERSIONS OF PROCEDURES PUBLISHED IN THE OPEN LITERATURE. IN PARTICULAR A NUMBER OF PROGRAMS ARE DERIVED FROM PROCEDURES PUBLISHED BY A. BJÖRCK, R. BULIRSCH, J.R. BUNCH, G.H. GOLUB, L. KAUFMAN, B. LINDBERG, B.N. PARLETT, C. REINSCH AND J. STOER.

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ACKNOWLEDGEMENTS.

THE LIBRARY NUMAL HAS BEEN DEVELOPED BY THE JOINT EFFORTS OF THE MEMBERS OF THE LIBRARY GROUP OF THE NUMERICAL MATHEMATICS DEPARTMENT OF THE MATHEMATICAL CENTRE. IN PARTICULAR, HOWEVER, WE WANT TO ACKNOWLEDGE THE MEMBERS F. GROEN, K. VAN 'T HOFF, R. PISCAER, B.P. SOMMEIJER, G.J.F. VINKESTEYN, WHO TOOK CARE OF FILE MANIPULATION, EDITING OF THE DOCUMENTATION FILES AND ADAPTION AND RUNNING OF THE KWIC INDEX PROGRAM.

FURTHER WE WANT TO ACKNOWLEDGE THE MEMBERS OF THE DRAFTING COMMITTEE: C.DEN HEYER, P.J.VAN DER HOUWEN, J.KOK, N.M.TEMME AND D.T.WINTER, AND THE EXTERNAL ADVISORS: TH.J.DEKKER, W.HOFFMANN (UNIVERSITY OF AMSTERDAM) AND C.G. VAN DER LAAN (UNIVERSITY OF GRONINGEN).

P.W. HEMKER
GENERAL EDITOR

CLASSIFIED ACCORDING TO SUBJECT, THIS INDEX CONTAINS THE NAMES OF THE PROCEDURES AND THE CORRESPONDING CODE NUMBERS. THE DOCUMENTATION OF THE PROCEDURES IS PRESENTED IN VOLUMES 1 THROUGH 7 AND IS ARRANGED ACCORDING TO SECTION NUMBERS. HENCE REFERENCE IS IMMEDIATE.

IN ADDITION TO THE CODE NUMBER AND THE NAME OF EACH PROCEDURE THE MONTH OF FIRST APPEARANCE OF THE FINAL DOCUMENTATION IS LISTED.

DIRECTIONS TO OBTAIN A PIECE OF DOCUMENTATION
IN MACHINE READABLE FORM
(ONLY FOR USE WITH THE CDC CYBER 70 SYSTEM).

IN ORDER TO OBTAIN A PIECE OF DOCUMENTATION IN MACHINE READABLE FORM ONE SHOULD AVAIL OF THE NUMAL DOCUMENTATION FILE. THIS FILE MIGHT BE AVAILABLE AT YOUR COMPUTER CENTER EITHER ON A MAGNETIC TAPE OR AS A PERMANENT FILE.

THE DOCUMENTATION FILE CONSISTS OF AN EVEN NUMBER OF RECORDS (LEVEL 0) EACH SECTION OF THE NUMAL DOCUMENTATION CAN BE FOUND IN TWO SUCCESSIVE RECORDS ON THIS FILE. THE FIRST RECORD CONSISTS OF THE DESCRIPTION OF THE PROCEDURE(S) IN THAT SECTION, THE SECOND RECORD CONTAINS THE SOURCE TEXT(S).

FOR EACH SECTION OF THE NUMAL DOCUMENTATION THE RECORD NUMBER OF THE FIRST OF THE TWO RECORDS CAN BE FOUND IN THE LAST COLUMN OF THE SYSTEMATICAL INDEX.

EXAMPLE :

AT THE SARA COMPUTER CENTER (AMSTERDAM), THE DOCUMENTATION FILE IS AVAILABLE AS THE SECOND FILE ON TAPE VSN=S83281.

TO OBTAIN THE DESCRIPTION AND THE SOURCE TEXT OF THE PROCEDURE "MULTISTEP" (SECTION 5.2.1.1.1.1 , RECORD NUMBER 151) FROM THE DOCUMENTATION FILE, THE FOLLOWING CONTROL CARDS CAN BE USED

LABEL,TAPE,R,L=NUMAL,ID=MC,D=PE,VSN=S83281.	
SKIPF,TAPE,1,17.	SKIP THE FIRST FILE ON TAPE
SKIPF,TAPE,150.	SKIP 150 RECORDS
COPYBR,TAPE,OUTPUT,2.	COPY TWO RECORDS

FOR USE WITH THE CD CYBER SYSTEM, THE OBJECT CODE OF THE PROCEDURES IS AVAILABLE AND IS CONTAINED IN THE LIBRARY FILE "NUMAL3". THIS LIBRARY FILE CAN BE USED WHEN PROGRAMS COMPILED UNDER ALGOL3 ARE LOADED.

FOR USE OF A LIBRARY FILE SEE E.G. CDC SCOPE REF. MANUAL, CHAPTER 6, OR THE CDC INTERCOM REF. MANUAL, CHAPTER 3, XEQ COMMAND.

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	MATMAT	* 34013	DEC/75	7
	TANMAT	* 34014	DEC/75	7
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	ELMCOLVEC	* 34022	APR/74	9
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LSQDEC	34130	730901	750701	LSQORTDEC(3.1.1.2.1.1)
ERF	35020	740501	750701	ERRORFUNCTION(6.7)
RK1N	33011	740501	750701	RKE(5.2.1.1.1.1)
LINIGER1	33130	740915	750701	LINIGER1VS(5.2.1.1.1.2)
ABSMAXVEC	31060	750101	760101	INFNRWVEC(1.1.8)
MAXMAT	34230	750101	760101	ABSMAXMAT(1.1.8)
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KA	35071	750101	750701	BESS KA01 (6.10.2)
KAPLUSN	35072	750101	750701	BESS KAPLUSN (6.10.2)
NONEXPKA	35073	750101	750701	NONEXP BESS KA01(6.10.2)
NONEXPKAPLUSN	35074	750101	750701	NONEXP BESS KAPLUSN (6.10.2)
SYNDEC2	34700	790701	791231	DECSYM2 (3.1.1.1.1.3.1)
SYNDEC1	34701	790701	791231	DECSYM2 (3.1.1.1.1.3.1)
SYNDETERM2	34702	790701	791231	DETERM2SYM2 (3.1.1.1.1.3.2)
SYNDETERM1	34703	790701	791231	DETERM2SYM2 (3.1.1.1.1.3.2)
SYMSOL2	34704	790701	791231	SOLSYM2 (3.1.1.1.1.3.3)
SYMSOL1	34705	790701	791231	SOLSYM2 (3.1.1.1.1.3.3)
SYNDECSOL2	34706	790701	791231	DECSOLSYM2 (3.1.1.1.1.3.3)
SYNDECSOL1	34707	790701	791231	DECSOLSYM2 (3.1.1.1.1.3.3)
SYMINV2	34708	790701	791231	
SYMINV1	34709	790701	791231	
SYNDECINV2	34710	790701	791231	
SYNDECINV1	34711	790701	791231	
POLZEROS	34500	790701	791231	ZERPOL (3.6.1)

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OBSOLETE PROCEDURES

PROCEDURE	CODE	WITHDRAWAL	EXPIRATION	REPLACED BY
RNKSVM20	34100	730901	740401	
SOLSYM20	34101	730901	731201	
RNKSOLSVM20	34102	730901	731201	
INVSVM20	34103	730901	740401	
RNKINVSVM20	34104	730901	740401	
SOLSVMHM20	34105	730901	740401	
RNKSVM10	34110	730901	740401	
SOLSYM10	34111	730901	740401	
RNKSOLSVM10	34112	730901	740401	
INVSVM10	34113	730901	740401	
RNKINVSVM10	34114	730901	740401	
DETSOL	34052	730901	740401	DECSOL(3.1.1.1.1.3),DETERM,
DETINV	34054	730901	731201	DECINV(3.1.1.1.1.4),DETERM.
RNKELM	34060	730901	740401	GSELM(3.1.1.1.1.1)
RNKSOLELM	34062	730901	740401	GSSOL(3.1.1.1.1.3)
SOLHM	34063	730901	740401	SINGULAR VALUE PROCEDURES (3.5)
INVELM	34064	730901	740401	GSSINV(3.1.1.1.1.4)
DETBND	34070	730901	740401	DECBND(3.1.2.1.1.1.1),DETERMBND(3.1.2.1.1.1.2)
DETSOLBND	34072	730901	740401	DECSOLBND(3.1.2.1.1.1.3),DETERMBND,
DETSYM2	34080	730901	740401	CHLDEC2(3.1.1.1.1.2.1),CHLDETERM2(3.1.1.1.1.2.2)
SOLSVM2	34081	730901	740401	CHLSOL2(3.1.1.1.1.2.3)
DETSOLSYM2	34082	730901	740401	CHLDECSOL2(3.1.1.1.1.2.3),CHLDETERM2,
INVSVM2	34083	730901	740401	CHLINV2(3.1.1.1.1.2.4)
DETINVSVM2	34084	730901	740401	CHLDECINV2(3.1.1.1.1.2.4),CHLDETERM2,
DETSVM1	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)
DETSOLSYM1	34092	730901	740401	CHLDECSOL1(3.1.1.1.1.2.3),CHLDETERM1,
INVSVM1	34093	730901	740401	CHLINV1(3.1.1.1.1.2.4)
DETINVSVM1	34094	730901	740401	CHLDECINV1(3.1.1.1.1.2.4),CHLDETERM1,
DETSYMBND	34120	730901	740401	CHLDECBND(3.1.2.1.1.2.1.1),CHLDETERMBND,
SOLSymbnd	34121	730901	740401	CHLSOLBND(3.1.2.1.1.2.1.3)
DETSOLSymbnd	34122	730901	740401	CHLDECSOLBND(3.1.2.1.1.2.1.3),CHLDETERMBND,
LSQRDECSOL	34133	730901	740401	LSQRDECSOL(3.1.1.2.1.2)
MODIFIED RUNGE KUTTA	33060	740501	740601	ARK(5.2.1.1.1.1)

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CODE	SECTION	PROCEDURE	MNT/YR
30001	6. 2.	MBASE	* JAN/76
30002	6. 2.	ARREB	* JAN/76
30003	6. 2.	DWARF	* JAN/76
30004	6. 2.	GIANT	* JAN/76
30005	6. 2.	INTCAP	* JAN/76
30006	6. 1.	PI	* JAN/76
30007	6. 1.	E	* JAN/76
30008	6. 2.	UNDERFLOW	* JAN/76
30009	6. 2.	OVERFLOW	* JAN/76
30010	6. 3.	RANDOM	
30011	6. 3.	SETRANDOM	
31010	1. 1. 1.	INIVEC	* APR/74
31011	1. 1. 1.	INIMAT	* APR/74
31012	1. 1. 1.	INIMATD	* APR/74
31013	1. 1. 1.	INISYMD	APR/74
31014	1. 1. 1.	INISYMR0W	APR/74
31020	1. 1. 3.	MULVEC	* APR/74
31021	1. 1. 3.	MULROW	* APR/74
31022	1. 1. 3.	MULCOL	* APR/74
31030	1. 1. 2.	DUPVEC	* APR/74
31031	1. 1. 2.	DUPVECR0W	* APR/74
31032	1. 1. 2.	DUPROWEC	* APR/74
31033	1. 1. 2.	DUPVECCOL	* APR/74
31034	1. 1. 2.	DUPCOLVEC	* APR/74
31035	1. 1. 2.	DUPMAT	* APR/74
31040	2. 2. 1. 1.	POL	OCT/75
31042	2. 2. 2. 2.	CHEPOL	DEC/78
31043	2. 2. 2. 2.	ALLCHEPOL	DEC/78
31044	2. 2. 2. 1.	ORTPOL	NOV/78
31045	2. 2. 2. 1.	ALLORTPOL	NOV/78
31046	2. 2. 2. 2.	CHEPOLSUM	DEC/78
31047	2. 2. 2. 1.	SUMORTPOL	NOV/78
31048	2. 2. 2. 1.	ORTPOLSYM	NOV/78
31049	2. 2. 2. 1.	ALLORTPOLSYM	NOV/78
31050	2. 4. 1.	NEWGRN	DEC/78
31051	2. 4. 1.	POLCHS	DEC/78
31052	2. 4. 1.	CHSPOL	DEC/78
31053	2. 4. 1.	POLSHTCHS	DEC/78
31054	2. 4. 1.	SHTCHSPOL	DEC/78
31055	2. 4. 1.	GRNNEW	DEC/78
31058	2. 2. 2. 1.	SUMORTPOLSYM	NOV/78
31059	2. 2. 2. 2.	ODDCHEPOLSUM	DEC/78
31060	OBSOLETE PROCEDURE	ABSMAXVEC	
31061	1. 1. 8.	INFNRMVEC	* OCT/75
31062	1. 1. 8.	INFNRMR0W	* OCT/75
31063	1. 1. 8.	INFNRMCOL	* OCT/75
31064	1. 1. 8.	INFNRMMAT	* OCT/75
31065	1. 1. 8.	ONENRMVEC	* OCT/75
31066	1. 1. 8.	ONENRMR0W	* OCT/75
31067	1. 1. 8.	ONENRMCOL	* OCT/75
31068	1. 1. 8.	ONENRMMAT	* OCT/75

CODE	SECTION	PROCEDURE	MNT/YR
31069	1. 1. 8.	ABSMAXMAT	* OCT/75
31070	1. 1. 4. 3.	HSHVECMAT	* JAN/76
31071	1. 1. 4. 3.	HSHCOLMAT	* JAN/76
31072	1. 1. 4. 3.	HSHROWMAT	* JAN/76
31073	1. 1. 4. 3.	HSHVECTAM	* JAN/76
31074	1. 1. 4. 3.	HSHCOLTAM	* JAN/76
31075	1. 1. 4. 3.	HSHROWTAM	* JAN/76
31090	2. 2. 3. 1.	SINSER	OCT/74
31091	2. 2. 3. 1.	COSSE	OCT/74
31092	2. 2. 3. 1.	FOUSER	OCT/74
31093	2. 2. 3. 1.	FOUSER1	OCT/74
31094	2. 2. 3. 1.	FJUSER2	OCT/74
31095	2. 2. 3. 1.	COMFOUSER	OCT/74
31096	2. 2. 3. 1.	COMFOUSER1	OCT/74
31097	2. 2. 3. 1.	COMFOUSER2	OCT/74
31100	1. 5. 3.	LNGREATDECI	MAR/77
31101	1. 5. 1.	DP ADD	* MAR/77
31102	1. 5. 1.	DP SUB	* MAR/77
31103	1. 5. 1.	DP MUL	* MAR/77
31104	1. 5. 1.	DP DIV	* MAR/77
31105	1. 5. 1.	LNG ADD	* MAR/77
31106	1. 5. 1.	LNG SUB	* MAR/77
31107	1. 5. 1.	LNG MJL	* MAR/77
31108	1. 5. 1.	LNG DIV	* MAR/77
31109	1. 5. 1.	DP POW	MAR/77
31110	1. 5. 1.	LNG POW	MAR/77
31131	1. 1. 3.	COLCST	* APR/74
31132	1. 1. 3.	ROWCST	* APR/74
31200	1. 4.	LNGINTADD	OCT/74
31201	1. 4.	LNGINTSUBTRACT	OCT/74
31202	1. 4.	LNGINTMULT	OCT/74
31203	1. 4.	LNGINTDIVIDE	OCT/74
31204	1. 4.	LNGINTPOWER	OCT/74
31241	2. 2. 1. 1.	TAYPOL	OCT/75
31242	2. 2. 1. 1.	NORDERPOL	OCT/75
31243	2. 2. 1. 1.	DERPOL	OCT/75
31248	2. 4. 3.	INTCHS	OCT/74
31250	2. 4. 1.	LINTFMPOL	DEC/78
31252	4. 2. 3. 1.	GSSWTSSYM	NOV/78
31253	4. 2. 3. 1.	GSSWTS	NOV/78
31254	4. 2. 3. 1.	RECCDF	NOV/78
31362	3. 6. 2.	ALLZERORTPOL	DEC/78
31363	3. 6. 2.	LUPZERORTPOL	DEC/78
31364	3. 6. 2.	SELZERORTPOL	DEC/78
31370	3. 6. 2.	ALLJACZER	DEC/78
31371	3. 6. 1.	ALLLAGZER	DEC/78
31425	4. 2. 3. 2.	GSSJACWGHTS	NOV/76
31427	4. 2. 3. 2.	GSSLAGWGHTS	NOV/76
31500	1. 1. 4. 2.	FULMATVEC	* DEC/75
31501	1. 1. 4. 2.	FULTAMVEC	* DEC/75
31502	1. 1. 4. 2.	FULSYMMATVEC	DEC/75

CODE	SECTION	PROCEDURE	MNT/YR
31503	1. 1. 4. 2.	RESVEC	* DEC/75
31504	1. 1. 4. 2.	SYMRESVEC	DEC/75
31505	1. 5. 2.	LNGFULMATVEC	* JAN/76
31506	1. 5. 2.	LNGFULTAMVEC	* JAN/76
31507	1. 5. 2.	LNGFULSYMMATVEC	JAN/76
31508	1. 5. 2.	LNGRESVEC	* JAN/76
31509	2. 5. 2.	LNGSYMRESVEC	JAN/76
32010	4. 1.	EULER	JUL/74
32020	4. 1.	SUMPOSSERIES	JUL/74
32051	4. 2. 1.	INTEGRAL	JUL/74
32070	4. 2. 1.	QADRAT	JUL/74
32075	4. 2. 2.	TRICUB	OCT/75
33010	5. 2. 1. 1. 1. 1.	RK1	AUG/74
33011	OBsolete PROCEDURE	RK1N	
33012	5. 2. 1. 1. 2. 1.	RK2	AUG/74
33013	5. 2. 1. 1. 2. 1.	RK2N	AUG/74
33014	5. 2. 1. 1. 2. 1.	RK3	AUG/74
33015	5. 2. 1. 1. 2. 1.	RK3N	AUG/74
33016	5. 2. 1. 1. 1. 1.	RK4A	AUG/74
33017	5. 2. 1. 1. 1. 1.	RK4NA	AUG/74
33018	5. 2. 1. 1. 1. 1.	RK5NA	AUG/74
33033	5. 2. 1. 1. 1. 1.	RKE	DEC/75
33040	5. 2. 1. 1. 1. 3.	MODIFIED TAYLOR	AUG/74
33050	5. 2. 1. 1. 1. 3.	EXPONENTIALLY FITTED TAYLOR	AUG/74
33060	OBsolete PROCEDURE	MODIFIED RUNGE KUTTA	
33061	5. 2. 1. 1. 1. 1.	ARK	DEC/75
33066	5. 2. 1. 1. 1. 3.	ARKMAT	NOV/76
33070	5. 2. 1. 1. 1. 1.	EFRK	AUG/74
33080	5. 2. 1. 1. 1. 1.	MULTISTEP	AUG/74
33120	5. 2. 1. 1. 1. 2.	EFERK	AUG/74
33130	OBsolete PROCEDURE	LINIGER1	
33131	5. 2. 1. 1. 1. 2.	LINIGER2	AUG/74
33132	5. 2. 1. 1. 1. 2.	LINIGER1VS	OCT/74
33135	5. 2. 1. 1. 1. 2.	IMPEX	OCT/75
33160	5. 2. 1. 1. 1. 2.	EFSIRK	AUG/74
33170	5. 2. 1. 2. 2. 1. 2.	RICHARDSON	OCT/74
33171	5. 2. 1. 2. 2. 1. 2.	ELIMINATION	OCT/74
33180	5. 2. 1. 1. 1. 1.	DIFFSYS	AUG/74
33191	5. 2. 1. 1. 1. 2.	GMS	OCT/74
33300	5. 2. 1. 2. 1. 2. 1. 1.	FEM LAG SYM	JAN/76
33301	5. 2. 1. 2. 1. 2. 1. 1.	FEM LAG	JAN/76
33302	5. 2. 1. 2. 1. 2. 1. 2.	FEM LAG SKEW	JAN/76
33303	5. 2. 1. 2. 1. 2. 2. 1.	FEM HERM SYM	JAN/76
33308	5. 2. 1. 2. 1. 2. 1. 1.	FEM LAG SPHER	DEC/79
33314	5. 2. 1. 2. 1. 3.	NON LIN FEM LAG SKEW	DEC/79
34010	1. 1. 4. 1.	VECVEC	* DEC/75
34011	1. 1. 4. 1.	MATVEC	* DEC/75
34012	1. 1. 4. 1.	TAMVEC	* DEC/75
34013	1. 1. 4. 1.	MATMAT	* DEC/75
34014	1. 1. 4. 1.	TAMMAT	* DEC/75
34015	1. 1. 4. 1.	MATTAM	* DEC/75
34016	1. 1. 4. 1.	SEQVEC	* DEC/75

CODE	SECTION	PROCEDURE	MNT/YR
34017	1. 1. 4. 1.	SCAPRD1	* DEC/75
34018	1. 1. 4. 1.	SYMMATVEC	DEC/75
34020	1. 1. 5.	ELMVEC	* APR/74
34021	1. 1. 5.	ELMVECCOL	* APR/74
34022	1. 1. 5.	ELMCOLVEC	* APR/74
34023	1. 1. 5.	ELMCOL	* APR/74
34024	1. 1. 5.	ELMR0W	* APR/74
34025	1. 1. 5.	MAXELMR0W	* APR/74
34026	1. 1. 5.	ELMVECROW	* APR/74
34027	1. 1. 5.	ELMR0WVEC	* APR/74
34028	1. 1. 5.	ELMR0WC0L	* APR/74
34029	1. 1. 5.	ELM0LROW	* APR/74
34030	1. 1. 6.	ICHVEC	* APR/74
34031	1. 1. 6.	ICH0L	* APR/74
34032	1. 1. 6.	ICHROW	* APR/74
34033	1. 1. 6.	ICHROWC0L	* APR/74
34034	1. 1. 6.	ICHSEQVEC	* APR/74
34035	1. 1. 6.	ICHSEQ	* APR/74
34040	1. 1. 7.	ROT0L	* APR/74
34041	1. 1. 7.	ROTROW	* APR/74
34050	OBSOLETE PROCEDURE	DET	
34051	3. 1. 1. 1. 1. 1. 3.	S0L	MAY/74
34052	OBSOLETE PROCEDURE	DETS0L	
34053	3. 1. 1. 1. 1. 1. 4.	INV	MAY/74
34054	OBSOLETE PROCEDURE	DETINV	
34060	OBSOLETE PROCEDURE	RNKELM	
34061	3. 1. 1. 1. 1. 1. 3.	S0LELM	MAY/74
34062	OBSOLETE PROCEDURE	RNKS0LELM	
34063	OBSOLETE PROCEDURE	S0LH0M	
34064	OBSOLETE PROCEDURE	INVELM	
34070	OBSOLETE PROCEDURE	DETBND	
34071	3. 1. 2. 1. 1. 1. 1. 3.	S0LBND	JUN/74
34072	OBSOLETE PROCEDURE	DETS0LBND	
34080	OBSOLETE PROCEDURE	DETSYM2	
34081	OBSOLETE PROCEDURE	S0LSYM2	
34082	OBSOLETE PROCEDURE	DETS0LSYM2	
34083	OBSOLETE PROCEDURE	INVSYM2	
34084	OBSOLETE PROCEDURE	DETINVSYM2	
34090	OBSOLETE PROCEDURE	DETSYM1	
34091	OBSOLETE PROCEDURE	S0LSYM1	
34092	OBSOLETE PROCEDURE	DETS0LSYM1	
34093	OBSOLETE PROCEDURE	INVSYM1	
34094	OBSOLETE PROCEDURE	DETINVSYM1	
34100	OBSOLETE PROCEDURE	RNKSYM20	
34101	OBSOLETE PROCEDURE	S0LSYM20	
34102	OBSOLETE PROCEDURE	RNKS0LSYM20	
34103	OBSOLETE PROCEDURE	INVSYM20	
34104	OBSOLETE PROCEDURE	RNKINVSYM20	
34105	OBSOLETE PROCEDURE	S0LSYMH0M20	
34110	OBSOLETE PROCEDURE	RNKSYM10	
34111	OBSOLETE PROCEDURE	S0LSYM10	

CODE	SECTION	PROCEDURE	MNT/YR
34112	OBSOLETE	PROCEDURE	
34113	OBSOLETE	PROCEDURE	
34114	OBSOLETE	PROCEDURE	
34120	OBSOLETE	PROCEDURE	
34121	OBSOLETE	PROCEDURE	
34122	OBSOLETE	PROCEDURE	
34130	OBSOLETE	PROCEDURE	
34131	3. 1. 1. 2. 1. 2.	LSQSOL	MAY/74
34132	3. 1. 1. 2. 1. 1.	LSQDGLINV	MAY/74
34133	OBSOLETE	PROCEDURE	
34134	3. 1. 1. 2. 1. 1.	LSQDEC SOL	
34135	3. 1. 1. 2. 1. 2.	LSQORTDEC	MAY/74
34136	3. 1. 1. 2. 1. 3.	LSQORTDECSOL	MAY/74
34137	3. 1. 1. 2. 1. 4.	LSQINV	OCT/74
34138	3. 1. 1. 2. 1. 4.	LSQDECOMP	DEC/78
34140	3. 2. 1. 2. 1. 1.	LSQREFSOL	DEC/78
34141	3. 2. 1. 2. 1. 1.	TFMSYMTRI2	JUN/74
34142	3. 2. 1. 2. 1. 1.	BAKSYMTRI2	JUN/74
34143	3. 2. 1. 2. 1. 1.	TFMPREVEC	JUN/74
34144	3. 2. 1. 2. 1. 1.	TFMSYMTRI1	JUN/74
34150	5. 1. 1. 1. 1.	BAKSYMTRI1	JUN/74
34151	3. 3. 1. 1. 1.	ZEROIN	OCT/75
34152	3. 3. 1. 1. 1.	VALSYMTRI	JUL/74
34153	3. 3. 1. 1. 2.	VECSYMTRI	JUL/74
34154	3. 3. 1. 1. 2.	EIGVALSYM2	JUL/74
34155	3. 3. 1. 1. 2.	EIGSYM2	JUL/74
34156	3. 3. 1. 1. 2.	EIGVALSYM1	JUL/74
34160	3. 3. 1. 1. 1.	EIGSYM1	JUL/74
34161	3. 3. 1. 1. 1.	QRIVALSYMTRI	JUL/74
34162	3. 3. 1. 1. 2.	QRISYMTRI	JUL/74
34163	3. 3. 1. 1. 2.	QRIVALSYM2	JUL/74
34164	3. 3. 1. 1. 2.	QRISYM	JUL/74
34170	3. 2. 1. 2. 1. 2.	QRIVALSYM1	JUL/74
34171	3. 2. 1. 2. 1. 2.	TFMREAHES	JUN/74
34172	3. 2. 1. 2. 1. 2.	BAKREAHES1	JUN/74
34173	3. 2. 1. 1. 1.	BAKPEAHES2	JUN/74
34174	3. 2. 1. 1. 1.	EQILBR	JUN/74
34180	3. 3. 1. 2. 1.	BAKLBR	JUN/74
34181	3. 3. 1. 2. 1.	REAVLQRI	JUL/74
34182	3. 3. 1. 2. 2.	REAVECHES	JUL/74
34183	1. 1. 9.	REAEIGVAL	JUL/74
34184	3. 3. 1. 2. 2.	REASCL	APR/74
34186	3. 3. 1. 2. 1.	REAEIG1	JUL/74
34187	3. 3. 1. 2. 2.	REAQRI	JUL/74
34190	3. 3. 1. 2. 1.	REAEIG3	JUL/74
34191	3. 3. 1. 2. 1.	COMVALQRI	JUL/74
34192	3. 3. 1. 2. 2.	COMVECHES	JUL/74
34193	1. 2. 9.	COMEIGVAL	JUL/74
34194	3. 3. 1. 2. 2.	COMSCL	DEC/75
34200	5. 1. 1. 2. 3.	COMEIG1	JUL/74
34202	5. 1. 1. 2. 3.	DAMPED NEWTON	
		NEWRAP	

CODE	SECTION	PROCEDURE	MNT/YR
34203	5. 1. 2. 2. 4.	NEWTONMIN	
34210	5. 1. 2. 2. 1.	LINEMIN	DEC/75
34211	5. 1. 2. 2. 1.	RNK1UPD	DEC/75
34212	5. 1. 2. 2. 1.	DAVUPD	DEC/75
34213	5. 1. 2. 2. 1.	FLEUPD	DEC/75
34214	5. 1. 2. 2. 3.	RNK1MIN	DEC/75
34215	5. 1. 2. 2. 3.	FLEMIN	DEC/75
34220	3. 1. 2. 2. 1.	COHJ GRAD	JUN/74
34230	OBSJLETE PROCEDURE	MAXMAT	
34231	3. 1. 1. 1. 1. 1. 1.	GSSSEL	MAY/74
34232	3. 1. 1. 1. 1. 1. 3.	GSSSOL	MAY/74
34235	3. 1. 1. 1. 1. 1. 4.	INV1	MAY/74
34236	3. 1. 1. 1. 1. 1. 4.	GSSINV	MAY/74
34240	3. 1. 1. 1. 1. 1. 1.	ONENRMINV	MAY/74
34241	3. 1. 1. 1. 1. 1. 1.	ERBELM	MAY/74
34242	3. 1. 1. 1. 1. 1. 1.	GSSERB	MAY/74
34243	3. 1. 1. 1. 1. 1. 3.	GSSSOLERB	MAY/74
34244	3. 1. 1. 1. 1. 1. 4.	GSSINVERB	MAY/74
34250	3. 1. 1. 1. 1. 1. 5.	ITISOL	MAY/74
34251	3. 1. 1. 1. 1. 1. 5.	GSSITISOL	MAY/74
34252	3. 1. 1. 1. 1. 1. 1.	GSSNRI	MAY/74
34253	3. 1. 1. 1. 1. 1. 5.	ITISOLERB	MAY/74
34254	3. 1. 1. 1. 1. 1. 5.	GSSITISOLERB	MAY/74
34260	3. 2. 2. 1. 1.	HSHREABID	JUN/74
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34422	3. 1. 2. 1. 1. 2. 2. 3.	DECSOLSYMTRI	JUN/74
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34424	3. 1. 2. 1. 1. 1. 2. 3.	SOLTRI	JUN/74
34425	3. 1. 2. 1. 1. 1. 2. 3.	DECSOLTRI	JUN/74
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34427	3. 1. 2. 1. 1. 1. 2. 3.	SOLTRIPIV	JUN/74
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34433	5. 1. 2. 1. 1.	MININ	DEC/78
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34609	3. 4. 1. 2.	HSH3ROW3	JAN/76
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34703	OBSOLETE PROCEDURE	SYMDETERM1	
34704	OBSOLETE PROCEDURE	SYMSOL2	
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35022	6. 7.	NONEXPERFC	OCT/74
35023	6. 7.	INVERSE ERROR FUNCTION	OCT/74
35027	6. 7.	FRESNEL	OCT/74
35028	6. 7.	FG	OCT/74
35030	6. 6.	INC DM GAM	SEP/74
35038	OBSOLETE PROCEDURE	NONEXP KO	
35040	OBSOLETE PROCEDURE	KO	
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35051	6. 6.	IBPPLUSN	SEP/74
35052	6. 6.	IBQPLUSN	SEP/74
35053	6. 6.	IXQFIX	SEP/74
35054	6. 6.	IXPFIX	SEP/74
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35056	6. 6.	BACKWARD	SEP/74
35060	6. 6.	RECIP GAMMA	SEP/74
35061	6. 6.	GAMMA	SEP/74
35062	6. 6.	LOG GAMMA	SEP/74
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35072	OBSOLETE PROCEDURE	KAPLUSN	
35073	OBSOLETE PROCEDURE	NONEXP KA	
35074	OBSOLETE PROCEDURE	NONEXP KAPLUSN	
35075	OBSOLETE PROCEDURE	YA	
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35077	OBSOLETE PROCEDURE	BESSEL PQ	
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35081	6. 5. 1.	EI ALPHA	SEP/74
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35084	6. 5. 2.	SINCOSINT	SEP/74
35085	6. 5. 2.	SINCOSFG	SEP/74
35086	6. 5. 1.	ENX	SEP/74
35087	6. 5. 1.	NONEXP ENX	SEP/74
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35102	OBSOLETE PROCEDURE	BESSEL I	
35103	OBSOLETE PROCEDURE	BESSEL K	
35104	OBSOLETE PROCEDURE	NONEXP BESSEL I	
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35112	6. 4. 2.	COSH	SEP/74
35113	6. 4. 2.	TANH	SEP/74
35114	6. 4. 2.	ARCSINH	SEP/74
35115	6. 4. 2.	ARCCOSH	SEP/74
35116	6. 4. 2.	ARCTANH	SEP/74
35120	6. 4. 1.	TAN	SEP/74
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35152	6.10. 3.	SPHER BESS I	DEC/78
35153	6.10. 3.	SPHER BESS K	DEC/78
35154	6.10. 3.	NONEXP SPHER BESS I	DEC/78
35155	6.10. 3.	NONEXP SPHER BESS K	DEC/78
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35161	6. 9. 1.	BESS JI	DEC/78
35162	6. 9. 1.	BESS J	DEC/78
35163	6. 9. 1.	BESS YO1	DEC/78
35164	6. 9. 1.	BESS Y	DEC/78
35165	6. 9. 1.	BESS PQO	DEC/78
35166	6. 9. 1.	BESS PQI	DEC/78
35170	6. 9. 2.	BESS IO	DEC/78
35171	6. 9. 2.	BESS I1	DEC/78
35172	6. 9. 2.	BESS I	DEC/78
35173	6. 9. 2.	BESS KO1	DEC/78
35174	6. 9. 2.	BESS K	DEC/78
35175	6. 9. 2.	NONEXP BESS IO	DEC/78
35176	6. 9. 2.	NONEXP BESS I1	DEC/78
35177	6. 9. 2.	NONEXP BESS I	DEC/78
35178	6. 9. 2.	NONEXP BESS KO1	DEC/78
35179	6. 9. 2.	NONEXP BESS K	DEC/78
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35181	6.10. 1.	BESS YA01	DEC/78
35182	6.10. 1.	BESS YAPLUSN	DEC/78
35183	6.10. 1.	BESS PQA01	DEC/78
35184	6.10. 1.	BESS ZEROS	DEC/78
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35190	6.10. 2.	BESS IAPLUSN	DEC/78
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36404	3. 3. 1. 1. 3. 1.	VECPERM	NOV/76
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IN THIS KEY WORD IN CONTEXT (KWIC) INDEX PROCEDURE NAMES AND KEY WORDS HAVE BEEN ORDERED ALPHABETICALLY.

THE KWIC INDEX IS BASED UPON PROGRAM ABSTRACTS SUCH AS:

32070 #QADRAT (#QUADRATURE) COMPUTES THE #DEFINITE #INTEGRAL OF A
#FUNCTION OF ONE VARIABLE OVER A FINITE INTERVAL.

THE ABSTRACT COMPRISES THE CODE NUMBER AND A SHORT DESCRIPTION OF THE PROGRAM (ITS NAME, WHAT IT DOES, AND HOW IT DOES IT). THE "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:

QADRAT COMPUTES THE .DEFINITE INTEGRAL OF A FUNCTION OF ONE
VARIABLE OVER A FINITE INTERVAL. 32070 133

IF THIS PROGRAM (QADRAT) IS OF INTEREST, YOU CAN LOCATE IT BY MEANS OF ITS CODE NUMBER (32070).

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.

SINCE ALL PROCEDURE NAMES HAVE BEEN INSERTED AS KEYWORDS, THE KWIC INDEX CAN ALSO BE USED TO TRACE A PROCEDURE BY ITS NAME.

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30002 275 ARREB DELIVERS THE ARITHMETIC ERROR BOUND OF THE COMPUTER.
30003 275 DWARF DELIVERS THE SMALLEST (IN ABSOLUTE VALUE) REPRESENTABLE REAL NUMBER.
30004 275 GIANT DELIVERS THE LARGEST REPRESENTABLE REAL NUMBER.
30005 275 INTCAP DELIVERS THE INTEGER CAPACITY.
30006 273 PI DELIVERS A FULL PRECISION APPROXIMATION TO $\pi = 3.14\dots$
30007 273 E DELIVERS A FULL PRECISION APPROXIMATION TO $e = 2.718\dots$
30008 275 OVERFLOW TESTS WHETHER A VALUE IS AN OVERFLOW VALUE.
30009 275 UNDERFLOW TESTS WHETHER A VALUE IS AN UNDERFLOW VALUE.
31010 1 INIVEC INITIALIZES A VECTOR WITH A CONSTANT.
31011 1 INIMAT INITIALIZES A MATRIX WITH A CONSTANT.
31012 1 INIMATD INITIALIZES A (CO)DIAGONAL OF A MATRIX.
31013 1 INISYMD INITIALIZES A (CO)DIAGONAL OF A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
31014 1 INISYMRW INITIALIZES A ROW OF A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
31020 5 MULVEC STORES A CONSTANT MULTIPLIED BY A VECTOR INTO A VECTOR.
31021 5 MULROW STORES A CONSTANT MULTIPLIED BY A ROW VECTOR INTO A ROW VECTOR.
31022 5 MULCOL STORES A CONSTANT MULTIPLIED BY A COLUMN VECTOR INTO A COLUMN VECTOR.
31030 3 DUPVEC COPIES A VECTOR INTO ANOTHER VECTOR.
31031 3 DUPVECROW COPIES A ROW VECTOR INTO A VECTOR.
31032 3 DUPROWVEC COPIES A VECTOR INTO A ROW VECTOR.
31033 3 DUPVECCOL COPIES A COLUMN VECTOR INTO A VECTOR.
31034 3 DUPCOLVEC COPIES A VECTOR INTO A COLUMN VECTOR.
31035 3 DUPMAT COPIES A MATRIX INTO ANOTHER MATRIX.
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31043 229 ALLCHEPOL EVALUATES ALL CHEBYSHEV POLYNOMIALS UP TO A CERTAIN DEGREE.
31044 293 ORTPOL EVALUATES THE VALUE OF AN N-DEGREE ORTHOGONAL POLYNOMIAL, GIVEN BY A SET OF RECURRENCE COEFFICIENTS.
31045 293 ALLORTPOL EVALUATES THE VALUE OF ALL ORTHOGONAL POLYNOMIALS UP TO A GIVEN DEGREE, GIVEN A SET OF RECURRENCE COEFFICIENTS.
31046 229 CHEPOLSER EVALUATES A CHEBYSHEV SERIES.
31046 229 CHEPOLSUM EVALUATES A FINITE SUM OF CHEBYSHEV POLYNOMIALS.
31047 293 SUMORTPOL EVALUATES A FINITE SERIES EXPRESSED IN ORTHOGONAL POLYNOMIALS, GIVEN BY A SET OF RECURRENCE COEFFICIENTS.
31048 293 ORTPOLSYM EVALUATES THE VALUE OF AN N-DEGREE ORTHOGONAL POLYNOMIAL, GIVEN BY A SET OF RECURRENCE COEFFICIENTS.
31049 293 ALLORTPOLSYM EVALUATES THE VALUE OF ALL ORTHOGONAL POLYNOMIALS UP TO A GIVEN DEGREE, GIVEN A SET OF RECURRENCE COEFFICIENTS.
31050 43 NEWGRN TRANSFORMS A POLYNOMIAL FROM NEWTON SUM INTO POWER SUM FORM.
31051 43 POLCHS TRANSFORMS A POLYNOMIAL FROM POWER SUM INTO CHEBYSHEV SUM FORM.
31052 43 CHSPOL TRANSFORMS A POLYNOMIAL FROM CHEBYSHEV SUM INTO POWER SUM FORM.
31053 43 POLSHTCHS TRANSFORMS A POLYNOMIAL FROM POWER SUM INTO SHIFTED CHEBYSHEV SUM FORM.
31054 43 SHTCHSPOL TRANSFORMS A POLYNOMIAL FROM SHIFTED CHEBYSHEV SUM FORM INTO POWER SUM FORM.
31055 43 GRNNEW TRANSFORMS A POLYNOMIAL FROM POWER SUM INTO NEWTON SUM FORM.
31058 293 SUMORTPOLSYM EVALUATES A FINITE SERIES EXPRESSED IN ORTHOGONAL POLYNOMIALS, GIVEN BY A SET OF RECURRENCE COEFFICIENTS.
31059 229 ODDCHEPOLSUM EVALUATES A FINITE SUM OF CHEBYSHEV POLYNOMIALS OF ODD DEGREE.
31061 241 INFNRNVEC CALCULATES THE INFINITY- NORM OF A VECTOR.
31062 241 INFNRMRW CALCULATES THE INFINITY- NORM OF A ROW VECTOR.
31063 241 INFNRMCOL CALCULATES THE INFINITY- NORM OF A COLUMN VECTOR.
31064 241 INFNRMMAT CALCULATES THE INFINITY- NORM OF A MATRIX.
31065 241 ONENRMVEC CALCULATES THE 1- NORM OF A VECTOR.

- 31066 241 ONENRMROW CALCULATES THE 1- NORM OF A ROW VECTOR.
 31067 241 ONENRMCOL CALCULATES THE 1- NORM OF A COLUMN VECTOR.
 31068 241 ONENRMMAT CALCULATES THE 1- NORM OF A MATRIX.
 31069 241 ABSMAXMAT CALCULATES THE MODULUS OF THE LARGEST ELEMENT OF A MATRIX AND DELIVERS THE INDICES OF THE MAXIMAL ELEMENT.
 31070 269 HSHVECMAT PREMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN IN A ONE-DIMENSIONAL ARRAY.
 31071 269 HSHCOLMAT PREMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN AS A COLUMN IN A TWO-DIMENSIONAL ARRAY.
 31072 269 HSHROWMAT PREMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN AS A ROW IN A TWO-DIMENSIONAL ARRAY.
 31073 269 HSHVECTAM POSTMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN IN A ONE-DIMENSIONAL ARRAY.
 31074 269 HSHCOLTAM POSTMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN AS A COLUMN IN A TWO-DIMENSIONAL ARRAY.
 31075 269 HSHROWTAM POSTMULTIPLIES A MATRIX BY A HOUSEHOLDER MATRIX, THE VECTOR DEFINING THIS HSH MATRIX BEING GIVEN AS A ROW IN A TWO-DIMENSIONAL ARRAY.
 31090 203 SINGER EVALUATES A SINE SERIES.
 31091 203 COSSER EVALUATES A COSINE SERIES.
 31092 203 FOU SER EVALUATES A FOURIER SERIES WITH EQUAL SINE AND COSINE COEFFICIENTS.
 31093 203 FOU SER1 EVALUATES A FOURIER SERIES.
 31094 203 FOU SER2 EVALUATES A FOURIER SERIES.
 31095 203 COMFOUSER EVALUATES A COMPLEX FOURIER SERIES WITH REAL COEFFICIENTS.
 31096 203 COMFOUSER1 EVALUATES A COMPLEX FOURIER SERIES.
 31097 203 COMFOUSER2 EVALUATES A COMPLEX FOURIER SERIES.
 31100 289 LNGREATODECI CONVERTS A DOUBLE PRECISION NUMBER TO ITS DECIMAL REPRESENTATION.
 31101 271 DPADD ADDS TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION SUM.
 31102 271 DPSUB SUBTRACTS TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION DIFFERENCE.
 31103 271 DPMUL MULTIPLIES TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION PRODUCT.
 31104 271 DPDIV DIVIDES TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION QUOTIENT.
 31105 271 LNGADD ADDS TWO DOUBLE PRECISION NUMBERS.
 31106 271 LNGSUB SUBTRACTS TWO DOUBLE PRECISION NUMBERS.
 31107 271 LNGMUL MULTIPLIES TWO DOUBLE PRECISION NUMBERS.
 31108 271 LNGDIV DIVIDES TWO DOUBLE PRECISION NUMBERS.
 31109 271 DPPOW COMPUTES THE DOUBLE PRECISION POWER OF A SINGLE PRECISION NUMBER.
 31110 271 LNGPOW COMPUTES THE DOUBLE PRECISION POWER OF A DOUBLE PRECISION NUMBER.
 31131 5 COLCST MULTIPLIES A COLUMN VECTOR BY A CONSTANT.
 31132 5 ROWCST MULTIPLIES A ROW VECTOR BY A CONSTANT.
 31200 201 LNGINTADD COMPUTES THE SUM OF LONG NONNEGATIVE INTEGERS.
 31201 201 LNGINTSUBTRACT COMPUTES THE DIFFERENCE OF LONG NONNEGATIVE INTEGERS.
 31202 201 LNGINTMULT COMPUTES THE PRODUCT OF LONG NONNEGATIVE INTEGERS.
 31203 201 LNGINTDIVIDE COMPUTES THE QUOTIENT WITH REMAINDER OF LONG NONNEGATIVE INTEGERS.
 31204 201 LNGINTPOWER COMPUTES $U^{**POWER}$, WHERE U IS A LONG NONNEGATIVE INTEGER AND POWER IS THE POSITIVE (SINGLE-LENGTH) EXPONENT.
 31241 245 TAYPOL EVALUATES THE FIRST K TERMS OF A TAYLOR SERIES.
 31242 245 NORDERPOL EVALUATES THE FIRST K NORMALIZED DERIVATIVES OF A POLYNOMIAL (I.E. J-TH DERIVATIVE/(J FACTORIAL)), $J=0,1,\dots,K \leq \text{DEGREE}$.
 31243 245 DERPOL EVALUATES THE FIRST K DERIVATIVES OF A POLYNOMIAL.
 31248 205 INTCHS COMPUTES THE INDEFINITE INTEGRAL OF A GIVEN CHEBYSHEV SERIES.
 31250 43 LINTFMPOL TRANSFORMS A POLYNOMIAL IN X INTO A POLYNOMIAL IN Y ($Y = AX + B$).
 31252 313 GSSWTSSYM CALCULATES THE GAUSSIAN WEIGHTS OF A WEIGHT FUNCTION, THE RECURRENCE COEFFICIENTS BEING GIVEN.
 31253 313 GSSWTS CALCULATES THE GAUSSIAN WEIGHTS OF A WEIGHT FUNCTION, THE RECURRENCE

- COEFFICIENTS BEING GIVEN.
- 31254 313 RECCDF CALCULATES RECURRENCE COEFFICIENTS OF AN ORTHOGONAL POLYNOMIAL, A WEIGHT FUNCTION BEING GIVEN.
- 31362 211 ALLZERORTPOL CALCULATES ALL ZEROS OF AN ORTHOGONAL POLYNOMIAL.
- 31363 211 LUPZERORTPOL CALCULATES A NUMBER OF ADJACENT UPPER OR LOWER ZEROS OF AN ORTHOGONAL POLYNOMIAL.
- 31364 211 SELZERORTPOL CALCULATES A NUMBER OF ADJACENT ZEROS OF AN ORTHOGONAL POLYNOMIAL.
- 31370 211 ALLJACZER CALCULATES THE ZEROS OF A JACOBIAN POLYNOMIAL.
- 31371 211 ALLLAGZER CALCULATES THE ZEROS OF A LAGUERRE POLYNOMIAL.
- 31425 291 GSSJACWGHTS COMPUTES THE ABSCISSAE AND WEIGHTS FOR GAUSS- JACOBI QUADRATURE.
- 31427 291 GSSLAGWGHTS COMPUTES THE ABSCISSAE AND WEIGHTS FOR GAUSS- LAGRANGE QUADRATURE.
- 31500 15 FULMATVEC CALCULATES THE PRODUCT $A * B$, WHERE A IS A GIVEN MATRIX AND B IS A VECTOR.
- 31501 15 FULTAMVEC CALCULATES THE PRODUCT $A' * B$, WHERE A' IS THE TRANSPOSED OF THE MATRIX A AND B IS A VECTOR.
- 31502 15 FULSYMMATVEC CALCULATES THE PRODUCT $A * B$, WHERE A IS A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY AND B IS A VECTOR.
- 31503 15 RESVEC CALCULATES THE RESIDUAL VECTOR $A * B + X * C$, WHERE A IS A GIVEN MATRIX, B AND C ARE VECTORS AND X IS A SCALAR.
- 31504 15 SYMRESVEC CALCULATES THE RESIDUAL VECTOR $A * B + X * C$, WHERE A IS A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY, B AND C ARE VECTORS AND X IS A SCALAR.
- 31505 285 LNGFULMATVEC CALCULATES BY DOUBLE PRECISION ARITHMETIC THE PRODUCT $A * B$, WHERE A IS A GIVEN MATRIX AND B IS A VECTOR.
- 31506 285 LNGFULTAMVEC CALCULATES BY DOUBLE PRECISION ARITHMETIC THE PRODUCT $A' * B$, WHERE A' IS THE TRANSPOSED OF THE MATRIX A AND B IS A VECTOR.
- 31507 285 LNGFULSYMMATVEC CALCULATES BY DOUBLE PRECISION ARITHMETIC THE PRODUCT $A * B$, WHERE A IS A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY AND B IS A VECTOR.
- 31508 285 LNGRESVEC CALCULATES BY DOUBLE PRECISION ARITHMETIC THE RESIDUAL VECTOR $A * B + X * C$, WHERE A IS A GIVEN MATRIX, B AND C ARE VECTORS AND X IS A SCALAR.
- 31509 285 LNGSYMRESVEC CALCULATES BY DOUBLE PRECISION ARITHMETIC THE RESIDUAL VECTOR $A * B + X * C$, WHERE A IS A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY, B AND C ARE VECTORS AND X IS A SCALAR.
- 32010 131 EULER PERFORMS THE SUMMATION OF AN ALTERNATING INFINITE SERIES.
- 32020 131 SUMPOSSERIES PERFORMS THE SUMMATION OF A INFINITE SERIES WITH POSITIVE MONOTONICALLY DECREASING TERMS USING THE VAN WIJNGAARDEN TRANSFORMATION.
- 32051 135 INTEGRAL CALCULATES THE DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE OR INFINITE INTERVAL OR OVER A NUMBER OF CONSECUTIVE INTERVALS.
- 32070 133 QADRAT COMPUTES THE DEFINITE INTEGRAL OF A FUNCTION OF ONE VARIABLE OVER A FINITE INTERVAL.
- 32075 257 TRICUB COMPUTES THE DEFINITE INTEGRAL OF A FUNCTION OF TWO VARIABLES OVER A TRIANGULAR DOMAIN.
- 33010 141 RK1 SOLVES A SINGLE 1ST ORDER DIFFERENTIAL EQUATION BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD.
- 33012 171 RK2 INTEGRATES A SINGLE 2ND ORDER DIFFERENTIAL EQUATION (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD.
- 33013 173 RK2N SOLVES A SYSTEM OF 2ND ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD.
- 33014 175 RK3 SOLVES A SINGLE 2ND ORDER DIFFERENTIAL EQUATION (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD; THIS METHOD CAN ONLY BE USED IF THE RIGHT HAND SIDE OF THE DIFFERENTIAL EQUATION DOES NOT DEPEND ON Y'.
- 33015 177 RK3N SOLVES A SYSTEM OF 2ND ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE

- PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD; THIS METHOD CAN ONLY BE USED IF THE RIGHT HAND SIDE OF THE DIFFERENTIAL EQUATIONS DOES NOT DEPEND ON Y' .
- 33016 145 RK4A SOLVES A SINGLE 1ST ORDER DIFFERENTIAL EQUATION BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD; THE INTEGRATION IS TERMINATED AS SOON AS A CONDITION ON X AND Y, WHICH IS SUPPLIED BY THE USER, IS SATISFIED.
- 33017 147 RK4NA SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD; THE INTEGRATION IS TERMINATED AS SOON AS A CONDITION ON $X(0), \dots, X(N)$, SUPPLIED BY THE USER, IS SATISFIED.
- 33018 149 RK5NA SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD; THE ARC LENGTH IS INTRODUCED AS AN INTEGRATION VARIABLE; THE INTEGRATION IS TERMINATED AS SOON AS A CONDITION ON $X(0), \dots, X(N)$, SUPPLIED BY THE USER, IS SATISFIED.
- 33033 143 RKE SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 5TH ORDER RUNGE-KUTTA METHOD.
- 33040 167 MODIFIED TAYLOR SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 1ST, 2ND OR 3RD ORDER ONE-STEP TAYLOR METHOD; THIS METHOD CAN BE USED TO SOLVE LARGE AND SPARSE SYSTEMS, PROVIDED HIGHER ORDER DERIVATIVES CAN EASILY BE OBTAINED.
- 33050 169 EXPONENTIALLY FITTED TAYLOR SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A VARIABLE ORDER TAYLOR METHOD; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS, WITH KNOWN EIGEN VALUE SPECTRUM, PROVIDED HIGHER ORDER DERIVATIVES CAN EASILY BE OBTAINED.
- 33061 155 ARK SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A STABILIZED RUNGE-KUTTA METHOD WITH LIMITED STORAGE REQUIREMENTS.
- 33066 295 ARKMAT SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL BOUNDARY-VALUE PROBLEM) BY MEANS OF A STABILIZED RUNGE-KUTTA METHOD, IN PARTICULAR SUITABLE FOR SYSTEMS ARISING FROM TWO-DIMENSIONAL TIME-DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS.
- 33070 157 EFRK SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 1ST, 2ND OR 3RD ORDER, EXPONENTIALLY FITTED RUNGE-KUTTA METHOD; AUTOMATIC STEPSIZE CONTROL IS NOT PROVIDED; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS WITH KNOWN EIGENVALUE SPECTRUM.
- 33080 151 MULTISTEP SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A VARIABLE ORDER MULTISTEP METHOD ADAMS-MOULTON, ADAMS-BASHFORTH OR GEAR'S METHOD; THE ORDER OF ACCURACY IS AUTOMATIC, UP TO 5TH ORDER; THIS METHOD IS SUITABLE FOR STIFF SYSTEMS.
- 33120 161 EFERK SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF AN EXPONENTIALLY FITTED, 3RD ORDER RUNGE-KUTTA METHOD; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS WITH KNOWN EIGENVALUE SPECTRUM.
- 33131 165 LINIGER2 SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF AN IMPLICIT, EXPONENTIALLY FITTED 1ST ORDER ONE-STEP METHOD; AUTOMATIC STEP-SIZE CONTROL IS NOT PROVIDED; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS.
- 33132 221 LINIGER1VS SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF AN IMPLICIT, EXPONENTIALLY FITTED 1ST ORDER ONE-STEP METHOD; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS.
- 33135 231 IMPEX SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF THE IMPLICIT MIDPOINT RULE WITH SMOOTHING AND EXTRAPOLATION; THIS METHOD IS SUITABLE FOR THE INTEGRATION OF STIFF DIFFERENTIAL EQUATIONS.
- 33160 159 EFSIRK SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 3RD ORDER, EXPONENTIALLY FITTED,

- SEMI-IMPLICIT RUNGE-KUTTA METHOD; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS.
- 33170 225 RICHARDSON SOLVES A SYSTEM OF LINEAR EQUATIONS WITH POSITIVE REAL EIGENVALUES (ELLIPTIC BOUNDARY VALUE PROBLEM) BY MEANS OF A NON-STATIONARY 2ND ORDER ITERATIVE METHOD.
- 33171 225 ELIMINATION SOLVES A SYSTEM OF LINEAR EQUATIONS WITH POSITIVE REAL EIGENVALUES (ELLIPTIC BOUNDARY VALUE PROBLEM) BY MEANS OF A NON-STATIONARY 2ND ORDER ITERATIVE METHOD, WHICH IS AN ACCELERATION OF RICHARDSON'S METHOD.
- 33180 153 DIFFSYS SOLVES A SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM); BY EXTRAPOLATION, APPLIED TO LOW ORDER RESULTS, A HIGH ORDER OF ACCURACY IS OBTAINED; THIS METHOD IS SUITABLE FOR SMOOTH PROBLEMS WHEN HIGH ACCURACY IS REQUIRED.
- 33191 223 GMS SOLVES AN AUTONOMOUS SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS (INITIAL VALUE PROBLEM) BY MEANS OF A 3RD ORDER MULTISTEP METHOD; THIS METHOD CAN BE USED TO SOLVE STIFF SYSTEMS.
- 33300 261 FEMLAGSYM SOLVES A LINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A SECOND ORDER SELF-ADJOINT DIFFERENTIAL EQUATION BY A RITZ- GALERKIN METHOD.
- 33301 261 FEMLAG SOLVES A LINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A SECOND ORDER SELF-ADJOINT DIFFERENTIAL EQUATION BY A RITZ- GALERKIN METHOD; THE COEFFICIENT OF Y' IS SUPPOSED TO BE UNITY.
- 33302 263 FEMLAGSKEW SOLVES A LINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A SECOND ORDER DIFFERENTIAL EQUATION BY A RITZ- GALERKIN METHOD.
- 33303 265 FEMHERMSYM SOLVES A LINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A FOURTH ORDER SELF-ADJOINT DIFFERENTIAL EQUATION WITH DIRICHLET BOUNDARY CONDITIONS BY A RITZ- GALERKIN METHOD.
- 33308 261 FEMLAGSPHER SOLVES A LINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A SECOND ORDER SELF-ADJOINT DIFFERENTIAL EQUATION WITH SPHERICAL COORDINATES BY A RITZ-GALERKIN METHOD.
- 33314 317 NONLINFEMLAGSKEW SOLVES A NONLINEAR TWO-POINT BOUNDARY-VALUE PROBLEM FOR A SECOND ORDER DIFFERENTIAL EQUATION WITH SPHERICAL COORDINATES BY A RITZ-GALERKIN METHOD AND NEWTON ITERATION.
- 34010 7 VECVEC := SCALAR PRODUCT OF A VECTOR AND A VECTOR.
- 34011 7 MATVEC := SCALAR PRODUCT OF A ROW VECTOR AND A VECTOR.
- 34012 7 TAMVEC := SCALAR PRODUCT OF A COLUMN VECTOR AND A VECTOR.
- 34013 7 MATMAT := SCALAR PRODUCT OF A ROW VECTOR AND A COLUMN VECTOR.
- 34014 7 TAMMAT := SCALAR PRODUCT OF A COLUMN VECTOR AND A COLUMN VECTOR.
- 34015 7 MATTAM := SCALAR PRODUCT OF A ROW VECTOR AND A ROW VECTOR.
- 34016 7 SEQVEC := SCALAR PRODUCT OF TWO VECTORS GIVEN IN ONE-DIMENSIONAL ARRAYS, WHERE THE MUTUAL SPACINGS BETWEEN THE INDICES OF THE 1ST VECTOR CHANGE LINEARLY.
- 34017 7 SCAPRD1 := SCALAR PRODUCT OF TWO VECTORS GIVEN IN ONE-DIMENSIONAL ARRAYS, WHERE THE SPACINGS OF BOTH VECTORS ARE CONSTANT.
- 34018 7 SYMMATVEC := SCALAR PRODUCT OF A VECTOR AND A ROW OF A SYMMETRIC MATRIX, WHOSE UPPERTRIANGLE IS GIVEN COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
- 34020 9 ELMVEC ADDS A CONSTANT TIMES A VECTOR TO A VECTOR.
- 34021 9 ELMVECCOL ADDS A CONSTANT TIMES A COLUMN VECTOR TO A VECTOR.
- 34022 9 ELMCOLVEC ADDS A CONSTANT TIMES A VECTOR TO A COLUMN VECTOR.
- 34023 9 ELMCOL ADDS A CONSTANT TIMES A COLUMN VECTOR TO A COLUMN VECTOR.
- 34024 9 ELMROW ADDS A CONSTANT TIMES A ROW VECTOR TO A ROW VECTOR.
- 34025 9 MAXELMROW ADDS A CONSTANT TIMES A ROW VECTOR TO A ROW VECTOR, MAXELMROW:=THE SUBSCRIPT OF AN ELEMENT OF THE NEW ROW VECTOR WHICH IS OF MAXIMUM ABSOLUTE VALUE.
- 34026 9 ELMVECROW ADDS A CONSTANT TIMES A ROW VECTOR TO A VECTOR.
- 34027 9 ELMROWVEC ADDS A CONSTANT TIMES A VECTOR TO A ROW VECTOR.
- 34028 9 ELMROWCOL ADDS A CONSTANT TIMES A COLUMN VECTOR TO A ROW VECTOR.
- 34029 9 ELMCOLROW ADDS A CONSTANT TIMES A ROW VECTOR TO A COLUMN VECTOR.
- 34030 11 ICHVEC INTERCHANGES TWO VECTORS GIVEN IN ARRAY A(L:U) AND ARRAY A(LSHIFT + L :

- SHIFT + UJ.
- 34031 11 ICHCOL INTERCHANGES TWO COLUMNS OF A MATRIX.
 - 34032 11 ICHROW INTERCHANGES TWO ROWS OF MATRIX.
 - 34033 11 ICHROWCOL INTERCHANGES A ROW AND A COLUMN OF A MATRIX.
 - 34034 11 ICHSEQVEC INTERCHANGES A ROW AND A COLUMN OF AN UPPERTRIANGULAR MATRIX, WHICH IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
 - 34035 11 ICHSEQ INTERCHANGES TWO COLUMNS OF AN UPPERTRIANGULAR MATRIX, WHICH IS STORED COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
 - 34040 13 ROTCOL REPLACES TWO COLUMN VECTORS X AND Y BY TWO VECTORS $CX + SY$ AND $CY - SX$.
 - 34041 13 ROTROW REPLACES TWO ROW VECTORS X AND Y BY TWO VECTORS $CX + SY$ AND $CY - SX$.
 - 34051 49 SOL SOLVES THE SYSTEM OF LINEAR EQUATIONS WHOSE MATRIX HAS BEEN TRIANGULARLY DECOMPOSED BY DEC.
 - 34053 51 INV CALCULATES THE INVERSE OF A MATRIX THAT HAS BEEN TRIANGULARLY DECOMPOSED BY DEC.
 - 34061 49 SOLELM SOLVES A SYSTEM OF LINEAR EQUATIONS WHOSE MATRIX HAS BEEN TRIANGULARLY DECOMPOSED BY GSSELM OR GSSERB.
 - 34071 79 SOLBND SOLVES A SYSTEM OF LINEAR EQUATIONS, THE MATRIX BEING DECOMPOSED BY DECBND.
 - 34131 65 LSQSOL SOLVES A LINEAR LEAST SQUARES PROBLEM IF THE COEFFICIENT MATRIX HAS BEEN DECOMPOSED BY LSQORTDEC.
 - 34132 63 LSQDGLINV CALCULATES THE DIAGONAL ELEMENTS OF THE INVERSE OF $M'M$, WHERE M IS THE COEFFICIENT MATRIX OF A LINEAR LEAST SQUARES PROBLEM.
 - 34134 63 LSQORTDEC DELIVERS THE HOUSEHOLDER TRIANGULARIZATION WITH COLUMN INTERCHANGES OF THE MATRIX OF A LINEAR LEAST SQUARES PROBLEM.
 - 34135 65 LSQORTDECSOL SOLVES A LINEAR LEAST SQUARES PROBLEM BY HOUSEHOLDER TRIANGULARIZATION WITH COLUMN INTERCHANGES AND CALCULATES THE DIAGONAL OF THE INVERSE OF $M'M$, WHERE M IS THE COEFFICIENT MATRIX.
 - 34136 207 LSQINV CALCULATES THE INVERSE OF THE MATRIX S'S, WHERE S IS THE COEFFICIENT MATRIX OF A LINEAR LEAST SQUARES PROBLEM.
 - 34137 309 LSQDECOMP COMPUTES THE QR- DECOMPOSITION OF A LINEAR LEAST SQUARES PROBLEM WITH LINEAR CONSTRAINTS.
 - 34138 309 LSQREFSOL SOLVES A LINEAR LEAST SQUARES PROBLEM WITH LINEAR CONSTRAINTS, IF THE MATRIX HAS BEEN DECOMPOSED BY LSQDECOMP.
 - 34140 101 TFMSYMTRI2 TRANSFORMS A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY MEANS OF HOUSEHOLDER'S TRANSFORMATION.
 - 34141 101 BAKSYMTRI2 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO TFMSYMTRI2.
 - 34142 101 TFMPREVEC IN COMBINATION WITH TFMSYMTRI2 CALCULATES THE TRANSFORMING MATRIX.
 - 34143 101 TFMSYMTRI1 TRANSFORMS A REAL SYMMETRIC MATRIX INTO A SIMILAR TRIDIAGONAL ONE BY MEANS OF HOUSEHOLDER'S TRANSFORMATION.
 - 34144 101 BAKSYMTRI1 PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO TFMSYMTRI1.
 - 34150 215 ZEROIN FINDS (IN A GIVEN INTERVAL) A ZERO OF A FUNCTION OF ONE VARIABLE.
 - 34151 111 VALSYMTRI CALCULATES ALL, OR SOME CONSECUTIVE, EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF LINEAR INTERPOLATION USING A STURM SEQUENCE.
 - 34152 111 VECSYMTRI CALCULATES EIGENVECTORS OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF INVERSE ITERATION.
 - 34153 113 EIGVALSYM2 CALCULATES ALL (OR SOME) EIGENVALUES OF A SYMMETRIC MATRIX USING LINEAR INTERPOLATION OF A FUNCTION DERIVED FROM A STURM SEQUENCE.
 - 34154 113 EIGSYM2 CALCULATES EIGENVALUES AND EIGENVECTORS BY MEANS OF INVERSE ITERATION.
 - 34155 113 EIGVALSYM1 CALCULATES ALL (OR SOME) EIGENVALUES OF A SYMMETRIC MATRIX USING LINEAR INTERPOLATION OF A FUNCTION DERIVED FROM A STURM SEQUENCE.
 - 34156 113 EIGSYM1 CALCULATES EIGENVALUES AND EIGENVECTORS BY MEANS OF INVERSE ITERATION.
 - 34160 111 QRIVALSYMTRI CALCULATES THE EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF QR ITERATION.

34161 111 QRISYMTRI CALCULATES THE EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF QR ITERATION.

34162 113 QRIVALSYM2 CALCULATES THE EIGENVALUES OF A SYMMETRIC MATRIX BY MEANS OF QR ITERATION.

34163 113 QRISYM CALCULATES ALL EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX BY MEANS OF QR ITERATION.

34164 113 QRIVALSYM1 CALCULATES THE EIGENVALUES OF A SYMMETRIC MATRIX BY MEANS OF QR ITERATION.

34170 103 TFMREAHES TRANSFORMS A MATRIX INTO A SIMILAR UPPER- HESSENBERG MATRIX BY MEANS OF WILKINSON'S TRANSFORMATION.

34171 103 BAKREAHES1 PERFORMS THE BACK TRANSFORMATION (ON A VECTOR) CORRESPONDING TO TFMREAHES.

34172 103 BAKREAHES2 PERFORMS THE BACK TRANSFORMATION (ON COLUMNS) CORRESPONDING TO TFMREAHES.

34173 97 EQILBR EQUILIBRATES A MATRIX BY MEANS OF A DIAGONAL SIMILARITY TRANSFORMATION.

34174 97 BAKLBR PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO EQILBR.

34180 115 REAVALQRI CALCULATES THE EIGENVALUES OF A REAL UPPER- HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL, BY MEANS OF SINGLE QR ITERATION.

34181 115 REAVECHES CALCULATES AN EIGENVECTOR CORRESPONDING TO A GIVEN REAL EIGENVALUE OF A REAL UPPER- HESSENBERG MATRIX BY MEANS OF INVERSE ITERATION.

34182 117 REAEIGVAL CALCULATES THE EIGENVALUES OF A MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL.

34183 117 REASCL NORMALIZES THE COLUMNS OF A TWO-DIMENSIONAL ARRAY.

34184 117 REAEIG1 CALCULATES THE EIGENVECTORS AND EIGENVALUES OF A MATRIX, PROVIDED THAT THEY ARE ALL REAL.

34186 115 REAQRI CALCULATES ALL EIGENVALUES AND EIGENVECTORS OF A REAL UPPER- HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL, BY MEANS OF SINGLE QR ITERATION.

34187 117 REAEIG3 CALCULATES THE EIGENVECTORS AND EIGENVALUES OF A MATRIX, PROVIDED THAT THEY ARE ALL REAL.

34190 115 COMVALQRI CALCULATES THE REAL AND COMPLEX EIGENVALUES OF A REAL UPPER- HESSENBERG MATRIX BY MEANS OF DOUBLE QR ITERATION.

34191 115 COMVECHES CALCULATES THE EIGENVECTOR CORRESPONDING TO A GIVEN COMPLEX EIGENVALUE OF A REAL UPPER- HESSENBERG MATRIX BY MEANS OF INVERSE ITERATION.

34192 117 COMEIGVAL CALCULATES THE EIGENVALUES OF A MATRIX.

34193 29 COMSCL NORMALIZES REAL AND COMPLEX EIGENVECTORS.

34194 117 COMEIG1 CALCULATES THE EIGENVALUES AND EIGENVECTORS OF A MATRIX.

34210 139 LINEMIN MINIMIZES A FUNCTION OF SEVERAL VARIABLES IN A GIVEN DIRECTION.

34211 139 RNKIUPD ADDS A RANK-1 MATRIX TO A SYMMETRIC MATRIX.

34212 139 DAVUPD ADDS A RANK-2 MATRIX TO A SYMMETRIC MATRIX.

34213 139 FLEUPD ADDS A RANK-2 MATRIX TO A SYMMETRIC MATRIX.

34214 19 RNK1MIN MINIMIZES A FUNCTION OF SEVERAL VARIABLES.

34215 19 FLEMIN MINIMIZES A FUNCTION OF SEVERAL VARIABLES.

34220 95 CONJ GRAD SOLVES A POSITIVE DEFINITE SYMMETRIC SYSTEM OF LINEAR EQUATIONS BY THE METHOD OF CONJUGATE GRADIENTS.

34231 45 GSSELM PERFORMS A TRIANGULAR DECOMPOSITION WITH A COMBINATION OF PARTIAL AND COMPLETE PIVOTING.

34232 49 GSSSQL SOLVES A SYSTEM OF LINEAR EQUATIONS.

34235 51 INV1 CALCULATES THE INVERSE OF A MATRIX THAT HAS BEEN TRIANGULARLY DECOMPOSED BY GSSELM OR GSSERB. THE 1-NORM OF THE INVERSE MATRIX MIGHT ALSO BE CALCULATED.

34236 51 GSSINV CALCULATES THE INVERSE OF A MATRIX.

34240 45 ONENRMINV CALCULATES THE 1- NORM OF THE INVERSE OF A MATRIX WHOSE TRIANGULARLY DECOMPOSED FORM IS DELIVERED BY GSSELM.

34241 45 ERBELM CALCULATES A ROUGH UPPERBOUND FOR THE ERROR IN THE SOLUTION OF A SYSTEM

- OF LINEAR EQUATIONS WHOSE MATRIX IS TRIANGULARLY DECOMPOSED BY GSSELM.
- 34242 45 GSSSERB PERFORMS A TRIANGULAR DECOMPOSITION OF THE MATRIX OF A SYSTEM OF LINEAR EQUATIONS AND CALCULATES AN UPPERBOUND FOR THE RELATIVE ERROR IN THE SOLUTION OF THAT SYSTEM.
- 34243 49 GSSSOLERB SOLVES A SYSTEM OF LINEAR EQUATIONS AND CALCULATES A ROUGH UPPERBOUND FOR THE RELATIVE ERROR IN THE CALCULATED SOLUTION.
- 34244 51 GSSINVERB CALCULATES THE INVERSE OF A MATRIX AND 1- NORM, AN UPPERBOUND FOR THE ERROR IN THE INVERSE MATRIX IS ALSO GIVEN.
- 34250 53 ITISOL SOLVES A SYSTEM OF LINEAR EQUATIONS WHOSE MATRIX HAS BEEN TRIANGULARLY DECOMPOSED BY GSSELM OR GSSSERB. THIS SOLUTION IS IMPROVED ITERATIVELY.
- 34251 53 GSSITISOL SOLVES A SYSTEM OF LINEAR EQUATIONS AND THE SOLUTION IS IMPROVED ITERATIVELY.
- 34252 45 GSSNRI PERFORMS A TRIANGULAR DECOMPOSITION AND CALCULATES THE 1- NORM OF THE INVERSE MATRIX.
- 34253 53 ITISOLERB SOLVES A SYSTEM OF LINEAR EQUATIONS WHOSE MATRIX HAS TRIANGULARLY DECOMPOSED BY GSSNRI; THIS SOLUTION IS IMPROVED ITERATIVELY AN UPPERBOUND FOR THE ERROR IN THE SOLUTION IS CALCULATED.
- 34254 53 GSSITISOLERB SOLVES A SYSTEM OF LINEAR EQUATIONS; THIS SOLUTION IS IMPROVED ITERATIVELY AND AN UPPERBOUND FOR THE ERROR IN THE SOLUTION IS CALCULATED.
- 34260 109 HSHREABID TRANSFORMS A MATRIX TO BIDIAGONAL FORM, BY PREMULTIPLYING AND POSTMULTIPLYING WITH ORTHOGONAL MATRICES.
- 34261 109 PSTTFMAT CALCULATES THE POSTMULTIPLYING MATRIX FROM THE DATA GENERATED BY HSHREABID.
- 34262 109 PRETFMAT CALCULATES THE PREMULTIPLYING MATRIX FROM THE DATA GENERATED BY HSHREABID.
- 34270 125 QRISNGVALBID CALCULATES THE SINGULAR VALUES OF A BIDIAGONAL MATRIX.
- 34271 125 QRISNGVALDECBID CALCULATES THE SINGULAR VALUES DECOMPOSITION OF A MATRIX OF WHICH THE BIDIAGONAL AND THE PRE- AND POSTMULTIPLYING MATRICES ARE GIVEN.
- 34272 127 QRISNGVAL CALCULATES THE SINGULAR VALUES OF A GIVEN MATRIX.
- 34273 127 QRISNGVALDEC CALCULATES THE SINGULAR VALUES DECOMPOSITION $U * S * V'$, WITH U AND V ORTHOGONAL AND S POSITIVE DIAGONAL.
- 34280 67 SOLSVDVR SOLVES AN OVERDETERMINED SYSTEM OF LINEAR EQUATIONS, MULTIPLYING THE RIGHT-HAND SIDE BY THE PSEUDO-INVERSE OF THE GIVEN MATRIX.
- 34281 67 SOLOVR CALCULATES THE SINGULAR VALUES DECOMPOSITION AND SOLVES AN OVERDETERMINED SYSTEM OF LINEAR EQUATIONS.
- 34282 69 SOLSVDUND SOLVES AN UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS, MULTIPLYING THE RIGHT-HAND SIDE BY THE PSEUDO-INVERSE OF THE GIVEN MATRIX.
- 34283 69 SOLUND CALCULATES THE SINGULAR VALUES DECOMPOSITION AND SOLVES AN UNDERDETERMINED SYSTEM OF LINEAR EQUATIONS.
- 34284 71 HOMSOLSVD SOLVES THE HOMOGENEOUS SYSTEM OF LINEAR EQUATIONS $A * X = 0$ AND $X' * A = 0$, WHERE "A" DENOTES A MATRIX AND "X" A VECTOR; (THE SINGULAR VALUE DECOMPOSITION BEING GIVEN).
- 34285 71 HOMSOL SOLVES THE HOMOGENEOUS SYSTEM OF LINEAR EQUATIONS OF EQUATIONS $A * X = 0$ AND $X' * A = 0$, WHERE "A" DENOTES A MATRIX AND "X" A VECTOR.
- 34286 73 PSDINVSVD CALCULATES THE PSEUDO-INVERSE OF A MATRIX; (THE SINGULAR VALUE DECOMPOSITION BEING GIVEN).
- 34287 73 PSDINV CALCULATES THE PSEUDO-INVERSE OF A MATRIX.
- 34291 303 DECSYM2 CALCULATES THE SYMMETRIC DECOMPOSITION OF A SYMMETRIC MATRIX.
- 34292 307 SOLSYM2 SOLVES A SYMMETRIC SYSTEM OF LINEAR EQUATIONS IF THE COEFFICIENT MATRIX HAS BEEN DECOMPOSED BY DECSYM2 OR DECSOLSYM2.
- 34293 307 DECSOLSYM2 SOLVES A SYMMETRIC SYSTEM OF LINEAR EQUATIONS BY SYMMETRIC DECOMPOSITION.
- 34294 305 DETERMSYM2 CALCULATES THE DETERMINANT OF A SYMMETRIC MATRIX, THE SYMMETRIC DECOMPOSITION BEING GIVEN.
- 34300 45 DEC PERFORMS A TRIANGULAR DECOMPOSITION WITH PARTIAL PIVOTING.
- 34301 49 DECSOL SOLVES A SYSTEM OF LINEAR EQUATIONS WHOSE ORDER IS SMALL RELATIVE TO THE

- NUMBER OF BINARY DIGITS IN THE NUMBER REPRESENTATION.
- 34302 51 DECINV CALCULATES THE INVERSE OF A MATRIX WHOSE ORDER IS SMALL RELATIVE TO THE NUMBER OF BINARY DIGITS IN THE NUMBER REPRESENTATION.
- 34303 47 DETERM CALCULATES THE DETERMINANT OF A TRIANGULARLY DECOMPOSED MATRIX.
- 34310 55 CHLDEC2 CALCULATES THE CHOLESKY DECOMPOSITION OF A POSITIVE DEFINITE SYMMETRIC MATRIX WHOSE UPPER TRIANGLE IS GIVEN IN A TWO-DIMENSIONAL ARRAY.
- 34311 55 CHLDEC1 CALCULATES THE CHOLESKY DECOMPOSITION OF A POSITIVE DEFINITE SYMMETRIC MATRIX WHOSE UPPER TRIANGLE IS GIVEN COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
- 34312 57 CHLDETERM2 CALCULATES OF THE DETERMINANT OF A POSITIVE DEFINITE SYMMETRIC MATRIX, THE CHOLESKY DECOMPOSITION BEING GIVEN IN A TWO-DIMENSIONAL ARRAY.
- 34313 57 CHLDETERM1 CALCULATES THE DETERMINANT OF A POSITIVE DEFINITE SYMMETRIC MATRIX, THE CHOLESKY DECOMPOSITION BEING GIVEN COLUMNWISE IN A ONE-DIMENSIONAL ARRAY.
- 34320 75 DECBND PERFORMS A TRIANGULAR DECOMPOSITION OF A BAND MATRIX, USING PARTIAL PIVOTING.
- 34321 77 DETERMBND CALCULATES THE DETERMINANT OF A BAND MATRIX.
- 34322 79 DECSOLBND SOLVES A SYSTEM OF LINEAR EQUATIONS BY GAUSSIAN ELIMINATION WITH PARTIAL PIVOTING IF THE COEFFICIENT MATRIX IS IN BAND FORM AND IS STORED ROWWISE IN A ONE-DIMENSIONAL ARRAY.
- 34330 85 CHLDECBND PERFORMS THE CHOLESKY DECOMPOSITION OF A POSITIVE DEFINITE SYMMETRIC BAND MATRIX.
- 34331 87 CHLDETERMBND CALCULATES THE DETERMINANT OF A POSITIVE DEFINITE SYMMETRIC BAND MATRIX.
- 34332 89 CHLSOLBND SOLVES A POSITIVE DEFINITE SYMMETRIC LINEAR SYSTEM, THE TRIANGULAR DECOMPOSITION BEING GIVEN.
- 34333 89 CHLDECSOLBND SOLVES A POSITIVE DEFINITE SYMMETRIC LINEAR SYSTEM AND PERFORMS THE TRIANGULAR DECOMPOSITION BY CHOLESKY'S METHOD.
- 34340 35 COMABS CALCULATES THE MODULUS OF A COMPLEX NUMBER.
- 34341 37 COMMUL CALCULATES THE PRODUCT OF TWO COMPLEX NUMBERS.
- 34342 37 COMDIV CALCULATES THE QUOTIENT OF TWO COMPLEX NUMBERS.
- 34343 35 COMSQRT CALCULATES THE SQUARE ROOT OF A COMPLEX NUMBER.
- 34344 35 CARPOL TRANSFORMS THE CARTESIAN COORDINATES OF A COMPLEX NUMBER INTO POLAR COORDINATES.
- 34345 129 COMKWD CALCULATES THE ROOTS OF A QUADRATIC EQUATION WITH COMPLEX COEFFICIENTS.
- 34352 21 COMCOLCST MULTIPLIES A COMPLEX COLUMN VECTOR BY A COMPLEX NUMBER.
- 34353 21 COMROWCST MULTIPLIES A COMPLEX ROW VECTOR BY A COMPLEX NUMBER.
- 34354 23 COMMATVEC CALCULATES THE SCALAR PRODUCT OF A COMPLEX ROW VECTOR AND A COMPLEX VECTOR.
- 34355 23 HSHCOMCOL TRANSFORMS A COMPLEX VECTOR INTO A VECTOR PROPORTIONAL TO A UNIT VECTOR.
- 34356 23 HSHCOMPRD PREMULTIPLIES A COMPLEX MATRIX WITH A COMPLEX HOUSEHOLDER MATRIX.
- 34357 287 ROTCOMCOL REPLACES TWO COMPLEX COLUMN VECTORS X AND Y BY TWO COMPLEX VECTORS CX + SY AND CY - SX.
- 34358 287 ROTCOMROW REPLACES TWO COMPLEX ROW VECTORS X AND Y BY TWO COMPLEX VECTORS CX + SY AND CY - SX.
- 34359 31 COMEUCNRM CALCULATES THE EUCLIDEAN NORM OF A COMPLEX MATRIX WITH LW LOWER CODIAGONALS.
- 34360 29 SCLCOM NORMALIZES THE COLUMNS OF A COMPLEX MATRIX.
- 34361 99 EQUILBRCOM EQUILIBRATES A COMPLEX MATRIX.
- 34362 99 BAKLBRCOM TRANSFORMS THE EIGENVECTORS OF A COMPLEX EQUILIBRATED (BY EQUILBRCOM) MATRIX INTO THE EIGENVECTORS OF THE ORIGINAL MATRIX.
- 34363 105 HSHHRMTRI TRANSFORMS A HERMITIAN MATRIX INTO A SIMILAR REAL SYMMETRIC TRIDIAGONAL MATRIX.
- 34364 105 HSHHRMTRIVAL DELIVERS THE MAIN DIAGONAL ELEMENTS AND THE SQUARES OF THE CODIAGONAL ELEMENTS OF A HERMITIAN TRIDIAGONAL MATRIX WHICH IS UNITARY SIMILAR WITH A GIVEN HERMITIAN MATRIX.

- 34365 105 BAKHRMTRI PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HSHRMTRI.
34366 107 HSHCOMHES TRANSFORMS A COMPLEX MATRIX BY MEANS OF HOUSEHOLDER'S TRANSFORMATION FOLLOWED BY A COMPLEX DIAGONAL TRANSFORMATION INTO A SIMILAR UNITARY UPPER- HESSENBERG MATRIX WITH A REAL NONNEGATIVE SUBDIAGONAL.
34367 107 BAKCOMHES PERFORMS THE BACK TRANSFORMATION CORRESPONDING TO HSHCOMHES.
34368 119 EIGVALHRM CALCULATES THE EIGENVALUES OF A COMPLEX HERMITIAN MATRIX.
34369 119 EIGHRM CALCULATES THE EIGENVALUES AND EIGENVECTORS OF A COMPLEX HERMITIAN MATRIX.
34370 119 QRIVALHRM CALCULATES THE EIGENVALUES OF A COMPLEX HERMITIAN MATRIX.
34371 119 QRIRHM CALCULATES THE EIGENVALUES AND EIGENVECTORS OF A COMPLEX HERMITIAN MATRIX.
34372 121 VALQRICOM CALCULATES THE EIGENVALUES OF A COMPLEX UPPER- HESSENBERG MATRIX WITH A REAL SUBDIAGONAL.
34373 121 QRICOM CALCULATES THE EIGENVECTORS AND THE EIGENVALUES OF A COMPLEX UPPER- HESSENBERG MATRIX.
34374 123 EIGVALCOM CALCULATES THE EIGENVALUES OF A COMPLEX MATRIX.
34375 123 EIGCOM CALCULATES THE EIGENVECTORS AND EIGENVALUES OF A COMPLEX MATRIX.
34376 25 ELMCOMVECCOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO A COMPLEX VECTOR.
34377 25 ELMCOMCOL ADDS A COMPLEX NUMBER TIMES A COMPLEX COLUMN VECTOR TO A COMPLEX COLUMN VECTOR.
34378 25 ELMCOMROWVEC ADDS A COMPLEX NUMBER TIMES A COMPLEX VECTOR TO A COMPLEX ROW VECTOR.
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