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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

NUMAL

OF ALGOL 60 PROCEDURES IN NUMERICAL MATHEMATICS

PROGRAM TEXTS AND DOCUMENTATION

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MATHEMATICAL CENTRE , AMSTERDAM
4-TH REVISION, 1980

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NUMAL

OF ALGOL 60 PROCEDURES IN NUMERICAL MATHEMATICS

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GENERAL INFORMATION AND INDICES

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" GOL 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 IIMAS (INSTITUTO DE INVESTIGACIONES EN MATEMATICAS APPLICADAS Y EN SYSTEMAS), 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. BJOERCK, 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 COMITTEE:
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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 SUCCESIVE 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=S8328I.

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=S8328I.
   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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OBSOLETE PROCEDURES

PROCEDURE	CODE	WITHDRAWAL	EXPIRATION	REPLACED BY
DET	34050	730901	750701	DEC(3.1.1.1.1.1.1),DETERM(3.1.1.1.1.1.2)
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	INFNRMVEC(1.1.8)
MAXMAT	34230	750101	760101	ABSMAXMAT(1.1.8)
BESSELJ	35100	750101	750701	BESS J (6.9.1)
BESSELY	35101	750101	750701	BESS Y (6.9.1)
BESSELI	35102	750101	750701	BESS I (6.9.2)
BESSELK	35103	750101	750701	BESS K (6.9.2)
K0	35040	750101	750701	BESS K01 (6.9.2)
NONEXPBESSELI	35104	750101	750701	NONEXP BESS I (6.9.2)
NONEXPBESSELK	35105	750101	750701	NONEXP BESS K (6.9.2)
NONEXPK0	35038	750101	750701	NONEXP BESS K01 (6.9.2)
YA	35075	750101	750701	BESS YA01 (6.10.1)
YAPLUSN	35076	750101	750701	BESS YAPLUSN (6.10.1)
BESSELPQ	35077	750101	750701	BESS PQA01 (6.10.1)
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)
SYMDEC2	34700	790701	791231	DECSYM2 (3.1.1.1.1.3.1)
SYMDEC1	34701	790701	791231	DECSYM2 (3.1.1.1.1.3.1)
SYMDETERM2	34702	790701	791231	DETERMSYM2 (3.1.1.1.1.3.2)
SYMDETERM1	34703	790701	791231	DETERMSYM2 (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)
SYMDECSOL2	34706	790701	791231	DECSOLSYM2 (3.1.1.1.1.3.3)
SYMDECSOL1	34707	790701	791231	DECSOLSYM2 (3.1.1.1.1.3.3)
SYMINV2	34708	790701	791231	
SYMINV1	34709	790701	791231	
SYMDECINV2	34710	790701	791231	
SYMDECINV1	34711	790701	791231	
POLZEROS	34500	790701	791231	ZERPOL (3.6.1)

OBSOLETE PROCEDURES

PROCEDURE	CODE	WITHDRAWAL	EXPIRATION	REPLACED BY
RNKSYM20	34100	730901	740401	
SOLSYM20	34101	730901	731201	
RNKSOLSYM20	34102	730901	731201	
INVSYM20	34103	730901	740401	
RNKINVSYM20	34104	730901	740401	
SOLSYMHOM20	34105	730901	740401	
RNKSYM10	34110	730901	740401	
SOLSYM10	34111	730901	740401	
RNKSOLSYM10	34112	730901	740401	
INVSYM10	34113	730901	740401	
RNKINVSYM10	34114	730901	740401	
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)
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)
SOLSYM2	34081	730901	740401	CHLSOL2(3.1.1.1.1.2.3)
DETSOLSYM2	34082	730901	740401	CHLDECSOL2(3.1.1.1.1.2.3),CHLDETERM2.
INVSYM2	34083	730901	740401	CHLINV2(3.1.1.1.1.2.4)
DETINVSYM2	34084	730901	740401	CHLDECINV2(3.1.1.1.1.2.4),CHLDETERM2.
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)
DETSOLSYM1	34092	730901	740401	CHLDECSOL1(3.1.1.1.1.2.3),CHLDETERM1.
INVSYM1	34093	730901	740401	CHLINV1(3.1.1.1.1.2.4)
DETINVSYM1	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.
LSQDECSOL	34133	730901	740401	LSQORTDECSOL(3.1.1.2.1.2)
MODIFIED RUNGE KUTTA	33060	740501	740601	ARK(5.2.1.1.1.1)

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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.	INISYMROW		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.	DUPVECROW	*	APR/74
31032	1. 1. 2.	DUPROWVEC	*	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.	INFNRMROW	*	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.	ONENRMROW	*	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.	COSSER	OCT/74
31092	2. 2. 3. 1.	FOUSER	OCT/74
31093	2. 2. 3. 1.	FOUSER1	OCT/74
31094	2. 2. 3. 1.	FOUSER2	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.	LNGREATODECI	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 MUL	* 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.	RECCOF	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

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34112	OBSOLETE PROCEDURE	RNKSOLSYM10	
34113	OBSOLETE PROCEDURE	INVSYM10	
34114	OBSOLETE PROCEDURE	RNKINVSYM10	
34120	OBSOLETE PROCEDURE	DETSYMBND	
34121	OBSOLETE PROCEDURE	SOLSYMBND	
34122	OBSOLETE PROCEDURE	DETSOLSYMBND	
34130	OBSOLETE PROCEDURE	LSQDEC	
34131	3. 1. 1. 2. 1. 2.	LSQSOL	MAY/74
34132	3. 1. 1. 2. 1. 1.	LSQDGLINV	MAY/74
34133	OBSOLETE PROCEDURE	LSQDECSOL	
34134	3. 1. 1. 2. 1. 1.	LSQORTDEC	MAY/74
34135	3. 1. 1. 2. 1. 2.	LSQORTDECSOL	MAY/74
34136	3. 1. 1. 2. 1. 3.	LSQINV	OCT/74
34137	3. 1. 1. 2. 1. 4.	LSQDECOMP	DEC/78
34138	3. 1. 1. 2. 1. 4.	LSQREFSOL	DEC/78
34140	3. 2. 1. 2. 1. 1.	TFMSYMTRI2	JUN/74
34141	3. 2. 1. 2. 1. 1.	BAKSYMTRI2	JUN/74
34142	3. 2. 1. 2. 1. 1.	TFMPREVEC	JUN/74
34143	3. 2. 1. 2. 1. 1.	TFMSYMTRI1	JUN/74
34144	3. 2. 1. 2. 1. 1.	BAKSYMTRI1	JUN/74
34150	5. 1. 1. 1. 1.	ZEROIN	OCT/75
34151	3. 3. 1. 1. 1.	VALSYMTRI	JUL/74
34152	3. 3. 1. 1. 1.	VECSYMTRI	JUL/74
34153	3. 3. 1. 1. 2.	EIGVALSYM2	JUL/74
34154	3. 3. 1. 1. 2.	EIGSYM2	JUL/74
34155	3. 3. 1. 1. 2.	EIGVALSYM1	JUL/74
34156	3. 3. 1. 1. 2.	EIGSYM1	JUL/74
34160	3. 3. 1. 1. 1.	QRIVALSYMTRI	JUL/74
34161	3. 3. 1. 1. 1.	QRISYMTRI	JUL/74
34162	3. 3. 1. 1. 2.	QRIVALSYM2	JUL/74
34163	3. 3. 1. 1. 2.	QRISYM	JUL/74
34164	3. 3. 1. 1. 2.	QRIVALSYM1	JUL/74
34170	3. 2. 1. 2. 1. 2.	TFMREAHES	JUN/74
34171	3. 2. 1. 2. 1. 2.	BAKREAHES1	JUN/74
34172	3. 2. 1. 2. 1. 2.	BAKREAHES2	JUN/74
34173	3. 2. 1. 1. 1.	EQILBR	JUN/74
34174	3. 2. 1. 1. 1.	BAKLBR	JUN/74
34180	3. 3. 1. 2. 1.	REAVALQRI	JUL/74
34181	3. 3. 1. 2. 1.	REAVECHES	JUL/74
34182	3. 3. 1. 2. 2.	REAEIGVAL	JUL/74
34183	1. 1. 9.	REASCL	APR/74
34184	3. 3. 1. 2. 2.	REAEIG1	JUL/74
34186	3. 3. 1. 2. 1.	REAQRI	JUL/74
34187	3. 3. 1. 2. 2.	REAEIG3	JUL/74
34190	3. 3. 1. 2. 1.	COMVALQRI	JUL/74
34191	3. 3. 1. 2. 1.	COMVECHES	JUL/74
34192	3. 3. 1. 2. 2.	COMEIGVAL	JUL/74
34193	1. 2. 9.	COMSCL	DEC/75
34194	3. 3. 1. 2. 2.	COMEIG1	JUL/74
34200	5. 1. 1. 2. 3.	DAMPED NEWTON	
34202	5. 1. 1. 2. 3.	NEWRAP	

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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.	CONJ GRAD	JUN/74
34230	OBSOLETE PROCEDURE	MAXMAT	
34231	3. 1. 1. 1. 1. 1. 1.	GSSELM	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
34261	3. 2. 2. 1. 1.	PSTTFMMAT	JUN/74
34262	3. 2. 2. 1. 1.	PRETFMMAT	JUN/74
34270	3. 5. 1. 1.	QRISNGVALBID	JUL/74
34271	3. 5. 1. 1.	QRISNGVALDECBID	JUL/74
34272	3. 5. 1. 2.	QRISNGVAL	JUL/74
34273	3. 5. 1. 2.	QRISNGVALDEC	JUL/74
34280	3. 1. 1. 3. 1. 1.	SOLSVDOVR	MAY/74
34281	3. 1. 1. 3. 1. 1.	SOLOVR	MAY/74
34282	3. 1. 1. 3. 1. 2.	SOLSVDUND	MAY/74
34283	3. 1. 1. 3. 1. 2.	SOLUND	MAY/74
34284	3. 1. 1. 3. 1. 3.	HOMSOLSVD	MAY/74
34285	3. 1. 1. 3. 1. 3.	HOMSOL	MAY/74
34286	3. 1. 1. 3. 1. 4.	PSDINVSVD	MAY/74
34287	3. 1. 1. 3. 1. 4.	PSDINV	MAY/74
34291	3. 1. 1. 1. 1. 3. 1.	DECSYM2	DEC/78
34292	3. 1. 1. 1. 1. 3. 3.	SOLSYM2	DEC/78
34293	3. 1. 1. 1. 1. 3. 3.	DECSOLSYM2	DEC/78
34294	3. 1. 1. 1. 1. 3. 2.	DETERMSYM2	DEC/78
34300	3. 1. 1. 1. 1. 1. 1.	DEC	MAY/74
34301	3. 1. 1. 1. 1. 1. 3.	DECSOL	MAY/74
34302	3. 1. 1. 1. 1. 1. 4.	DECINV	MAY/74
34303	3. 1. 1. 1. 1. 1. 2.	DETERM	MAY/74
34310	3. 1. 1. 1. 1. 2. 1.	CHLDEC2	MAY/74
34311	3. 1. 1. 1. 1. 2. 1.	CHLDEC1	MAY/74
34312	3. 1. 1. 1. 1. 2. 2.	CHLDETERM2	MAY/74
34313	3. 1. 1. 1. 1. 2. 2.	CHLDETERM1	MAY/74
34320	3. 1. 2. 1. 1. 1. 1. 1.	DECBND	JUN/74

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34321	3. 1. 2. 1. 1. 1. 1. 2.	DETERMBND	JUN/74
34322	3. 1. 2. 1. 1. 1. 1. 3.	DECSOLBND	JUN/74
34330	3. 1. 2. 1. 1. 2. 1. 1.	CHLDECBND	JUN/74
34331	3. 1. 2. 1. 1. 2. 1. 2.	CHLDETERMBND	JUN/74
34332	3. 1. 2. 1. 1. 2. 1. 3.	CHLSOLBND	JUN/74
34333	3. 1. 2. 1. 1. 2. 1. 3.	CHLDECSOLBND	JUN/74
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34341	1. 3. 2.	COMMUL	MAY/74
34342	1. 3. 2.	COMDIV	MAY/74
34343	1. 3. 1.	COMSQRT	MAY/74
34344	1. 3. 1.	CARPOL	MAY/74
34345	3. 6. 3.	COMKWD	JUL/74
34352	1. 2. 3.	COMCOLCST	MAY/74
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34355	1. 2. 4.	HSHCOMCOL	MAY/74
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34357	1. 2. 7.	ROTCOMCOL	JAN/76
34358	1. 2. 7.	ROTCOMROW	JAN/76
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34360	1. 2. 9.	SCLCOM	DEC/75
34361	3. 2. 1. 1. 2.	EQILBRCOM	JUN/74
34362	3. 2. 1. 1. 2.	BAKLBRCOM	JUN/74
34363	3. 2. 1. 2. 2. 1.	HSHHRMTRI	JUN/74
34364	3. 2. 1. 2. 2. 1.	HSHHRMTRIVAL	JUN/74
34365	3. 2. 1. 2. 2. 1.	BAKHRMTRI	JUN/74
34366	3. 2. 1. 2. 2. 2.	HSHCOMHES	JUN/74
34367	3. 2. 1. 2. 2. 2.	BAKCOMHES	JUN/74
34368	3. 3. 2. 1.	EIGVALHRM	JUL/74
34369	3. 3. 2. 1.	EIGHRM	JUL/74
34370	3. 3. 2. 1.	QRIVALHRM	JUL/74
34371	3. 3. 2. 1.	QRIHRM	JUL/74
34372	3. 3. 2. 2. 1.	VALQRICOM	JUL/74
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34391	3. 1. 1. 1. 1. 2. 3.	CHLSOL1	MAY/74
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34393	3. 1. 1. 1. 1. 2. 3.	CHLDECSOL1	MAY/74
34400	3. 1. 1. 1. 1. 2. 4.	CHLINV2	MAY/74
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34402	3. 1. 1. 1. 1. 2. 4.	CHLDECINV2	MAY/74
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34412	1. 5. 2.	LNGTAMVEC	* JAN/76
34413	1. 5. 2.	LNGMATMAT	* JAN/76

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34421	3. 1. 2. 1. 1. 2. 2. 3.	SOLSYMTRI	JUN/74
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34423	3. 1. 2. 1. 1. 1. 2. 1.	DECTRI	JUN/74
34424	3. 1. 2. 1. 1. 1. 2. 3.	SOLTRI	JUN/74
34425	3. 1. 2. 1. 1. 1. 2. 3.	DECSOLTRI	JUN/74
34426	3. 1. 2. 1. 1. 1. 2. 1.	DECTRIPIV	JUN/74
34427	3. 1. 2. 1. 1. 1. 2. 3.	SOLTRIPIV	JUN/74
34428	3. 1. 2. 1. 1. 1. 2. 3.	DECSOLTRIPIV	JUN/74
34430	5. 1. 1. 2. 2.	QUANEWBND	OCT/74
34431	5. 1. 1. 2. 2.	QUANEWBND1	OCT/74
34432	5. 1. 2. 2. 2.	PRAXIS	OCT/75
34433	5. 1. 2. 1. 1.	MININ	DEC/78
34435	5. 1. 2. 1. 2.	MININDER	OCT/75
34436	5. 1. 1. 1. 1.	ZEROINRAT	OCT/75
34437	4. 3. 2. 1.	JACOBNNF	OCT/74
34438	4. 3. 2. 1.	JACOBNMF	OCT/74
34439	4. 3. 2. 1.	JACOBNBNDF	OCT/74
34440	5. 1. 3. 1. 3.	MARQUARDT	DEC/75
34441	5. 1. 3. 1. 3.	GSSNEWTON	DEC/75
34444	5. 2. 1. 3. 1.	PEIDE	OCT/75
34453	5. 1. 1. 1. 2.	ZEROINDER	OCT/75
34500	OBSOLETE PROCEDURE	POLZEROS	
34501	3. 6. 1.	ZERPOL	DEC/78
34502	3. 6. 1.	BOUNDS	DEC/78
34600	3. 4. 1. 2.	QZIVAL	JAN/76
34601	3. 4. 1. 2.	QZI	JAN/76
34602	3. 4. 1. 2.	HSHDECMUL	JAN/76
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34604	3. 4. 1. 2.	HESTGL2	JAN/76
34605	3. 4. 1. 2.	HSH2COL	JAN/76
34606	3. 4. 1. 2.	HSH3COL	JAN/76
34607	3. 4. 1. 2.	HSH2ROW3	JAN/76
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34609	3. 4. 1. 2.	HSH3ROW3	JAN/76
34610	3. 4. 1. 2.	HSH3ROW2	JAN/76
34611	1. 2. 7.	CHSH2	JAN/76
34700	OBSOLETE PROCEDURE	SYMDEC2	
34701	OBSOLETE PROCEDURE	SYMDEC1	
34702	OBSOLETE PROCEDURE	SYMDETERM2	
34703	OBSOLETE PROCEDURE	SYMDETERM1	
34704	OBSOLETE PROCEDURE	SYMSOL2	
34705	OBSOLETE PROCEDURE	SYMSOL1	
34706	OBSOLETE PROCEDURE	SYMDECSOL2	
34707	OBSOLETE PROCEDURE	SYMDECSOL1	
34708	OBSOLETE PROCEDURE	SYMINV2	

CODE	SECTION	PROCEDURE	MNT/YR
34709	OBSOLETE PROCEDURE	SYMINV1	
34710	OBSOLETE PROCEDURE	SYMDECINV2	
34711	OBSOLETE PROCEDURE	SYMDECINV1	
35020	OBSOLETE PROCEDURE	ERF	
35021	6. 7.	ERRORFUNCTION	OCT/74
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.	INCOMGAM	SEP/74
35038	OBSOLETE PROCEDURE	NONEXPKO	
35040	OBSOLETE PROCEDURE	KO	
35050	6. 6.	INCBETA	SEP/74
35051	6. 6.	IBPPLUSN	SEP/74
35052	6. 6.	IBQPLUSN	SEP/74
35053	6. 6.	IXQFIX	SEP/74
35054	6. 6.	IXPFIX	SEP/74
35055	6. 6.	FORWARD	SEP/74
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
35071	OBSOLETE PROCEDURE	KA	
35072	OBSOLETE PROCEDURE	KAPLUSN	
35073	OBSOLETE PROCEDURE	NONEXPKA	
35074	OBSOLETE PROCEDURE	NONEXPKAPLUSN	
35075	OBSOLETE PROCEDURE	YA	
35076	OBSOLETE PROCEDURE	YAPLUSN	
35077	OBSOLETE PROCEDURE	BESSELPQ	
35080	6. 5. 1.	EI	SEP/74
35081	6. 5. 1.	EI ALPHA	SEP/74
35083	2. 3.	JFRAC	MAY/74
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
35100	OBSOLETE PROCEDURE	BESSELJ	
35101	OBSOLETE PROCEDURE	BESSELY	
35102	OBSOLETE PROCEDURE	BESSELI	
35103	OBSOLETE PROCEDURE	BESSELK	
35104	OBSOLETE PROCEDURE	NONEXPBESSELI	
35105	OBSOLETE PROCEDURE	NONEXPBESSELK	
35111	6. 4. 2.	SINH	SEP/74
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
35121	6. 4. 1.	ARCSIN	SEP/74
35122	6. 4. 1.	ARCCOS	SEP/74

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.

LNGDIV	DIVIDES TWO DOUBLE PRECISION NUMBERS.	31108	2
DPDIV	DIVIDES TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION QUOTIENT.	31104	2
VECTOR CHANGE LINEARLY, BY	DOUBLE LENGTH ARIT	34416	2
R PRODUCT OF TWO VECTORS BY	DOUBLE LENTGH ARITHMETIC.	34410	2
VECTOR AND A ROW VECTOR BY	DOUBLE PRECISION ARITHMETIC.	34411	2
CTOR AND A COLUMN VECTOR BY	DOUBLE PRECISION ARITHMETIC.	34412	2
CTOR AND A COLUMN VECTOR BY	DOUBLE PRECISION ARITHMETIC.	34413	2
CT OF TWO COLUMN VECTORS BY	DOUBLE PRECISION ARITHMETIC.	34414	2
ODUCT OF TWO ROW VECTORS BY	DOUBLE PRECISION ARITHMETIC.	34415	2
TH VECTORS ARE CONSTANT, BY	DOUBLE PRECISION ARITHMETIC.	34417	2
LNGFULMATVEC CALCULATES BY	DOUBLE PRECISION ARITHMETIC THE PRODUCT A * B, WHERE A IS A GIVEN MATRIX AND B IS A VECTOR..	31505	2
GFULSYMMATVEC CALCULATES BY	DOUBLE PRECISION ARITHMETIC THE PRODUCT A * B, WHERE A IS A SYMMETRIC MATRIX, WHOSE UPPERTR..	31507	2
LNGFULTAMVEC CALCULATES BY	DOUBLE PRECISION ARITHMETIC THE PRODUCT A' * B, WHERE A' IS THE TRANSPOSED OF THE MATRIX A ..	31506	2
LNGRESVEC CALCULATES BY	DOUBLE PRECISION ARITHMETIC THE RESIDUAL VECTOR A * B + X * C, WHERE A IS A GIVEN MATRIX, B..	31508	2
LNGSYMRESVEC CALCULATES BY	DOUBLE PRECISION ARITHMETIC THE RESIDUAL VECTOR A * B + X * C, WHERE A IS A SYMMETRIC MATRI..	31509	2
NGLE PRECISION NUMBERS TO A	DOUBLE PRECISION DIFFERENCE.	31102	2
DOUBLE PRECISION POWER OF A	DOUBLE PRECISION NUMBER.	31110	2
LNGADD ADDS TWO	DOUBLE PRECISION NUMBERS.	31105	2
LNGSUB SUBTRACTS TWO	DOUBLE PRECISION NUMBERS.	31106	2
LNGMUL MULTIPLIES TWO	DOUBLE PRECISION NUMBERS.	31107	2
LNGDIV DIVIDES TWO	DOUBLE PRECISION NUMBERS.	31108	2
LNGREATODECI CONVERTS A	DOUBLE PRECISION NUMBER TO ITS DECIMAL REPRESENTATION.	31100	2
LNGPOW COMPUTES THE	DOUBLE PRECISION POWER OF A DOUBLE PRECISION NUMBER.	31110	2
DPPOW COMPUTES THE	DOUBLE PRECISION POWER OF A SINGLE PRECISION NUMBER.	31109	2
NGLE PRECISION NUMBERS TO A	DOUBLE PRECISION PRODUCT.	31103	2
NGLE PRECISION NUMBERS TO A	DOUBLE PRECISION QUOTIENT.	31104	2
NGLE PRECISION NUMBERS TO A	DOUBLE PRECISION SUM.	31101	2
	DPADD ADDS TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION SUM.	31101	2
	DPDIV DIVIDES TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION QUOTIENT.	31104	2
	DPMUL MULTIPLIES TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION PRODUCT.	31103	2
	DPPOW COMPUTES THE DOUBLE PRECISION POWER OF A SINGLE PRECISION NUMBER.	31109	2
	DPSUB SUBTRACTS TWO SINGLE PRECISION NUMBERS TO A DOUBLE PRECISION DIFFERENCE.	31102	2
	DUPCOLVEC COPIES A VECTOR INTO A COLUMN VECTOR.	31034	
	DUPMAT COPIES A MATRIX INTO ANOTHER MATRIX.	31035	
	DUPROWVEC COPIES A VECTOR INTO A ROW VECTOR.	31032	
	DUPVECCOL COPIES A COLUMN VECTOR INTO A VECTOR.	31033	
	DUPVEC COPIES A VECTOR INTO ANOTHER VECTOR.	31030	
EIGVALCOM CALCULATES THE	EIGENVALUES OF A COMPLEX MATRIX.	34374	1
ULATES THE EIGENVECTORS AND	EIGENVALUES OF A COMPLEX MATRIX.	34375	1
ES THE EIGENVECTORS AND THE	EIGENVALUES OF A COMPLEX UPPER- HESSENBERG MATRIX.	34373	1
VALQRICOM CALCULATES THE	EIGENVALUES OF A COMPLEX UPPER- HESSENBERG MATRIX WITH A REAL SUBDIAGONAL.	34372	1
COMEIGVAL CALCULATES THE	EIGENVALUES OF A MATRIX.	34192	1
REAEIGVAL CALCULATES THE	EIGENVALUES OF A MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL.	34182	1
ULATES THE EIGENVECTORS AND	EIGENVALUES OF A MATRIX, PROVIDED THAT THEY ARE ALL REAL.	34184	1
ULATES THE EIGENVECTORS AND	EIGENVALUES OF A MATRIX, PROVIDED THAT THEY ARE ALL REAL.	34187	1
ULATES THE REAL AND COMPLEX	EIGENVALUES OF A REAL UPPER- HESSENBERG MATRIX BY MEANS OF DOUBLE QR ITERATION.	34190	1
REAVALQRI CALCULATES THE	EIGENVALUES OF A REAL UPPER- HESSENBERG MATRIX, PROVIDED THAT ALL EIGENVALUES ARE REAL, BY ..	34180	1
QRIVALSYM2 CALCULATES THE	EIGENVALUES OF A SYMMETRIC MATRIX BY MEANS OF QR ITERATION.	34162	1
QRIVALSYM1 CALCULATES THE	EIGENVALUES OF A SYMMETRIC MATRIX BY MEANS OF QR ITERATION.	34164	1
CALCULATES ALL (OR SOME)	EIGENVALUES OF A SYMMETRIC MATRIX USING LINEAR INTERPOLATION OF A FUNCTION DERIVED FROM A S..	34153	1
CALCULATES ALL (OR SOME)	EIGENVALUES OF A SYMMETRIC MATRIX USING LINEAR INTERPOLATION OF A FUNCTION DERIVED FROM A S..	34155	1
S ALL, OR SOME CONSECUTIVE,	EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF LINEAR INTERPOLATION USING A STUR..	34151	1
QRIVALSYMTRI CALCULATES THE	EIGENVALUES OF A SYMMETRIC TRIDIAGONAL MATRIX BY MEANS OF QR ITERATION.	34160	1
COMVECHES CALCULATES THE	EIGENVECTOR CORRESPONDING TO A GIVEN COMPLEX EIGENVALUE OF A REAL UPPER- HESSENBERG MATRIX ..	34191	1
REAVECHES CALCULATES AN	EIGENVECTOR CORRESPONDING TO A GIVEN REAL EIGENVALUE OF A REAL UPPER- HESSENBERG MATRIX BY ..	34181	1
NORMALIZES REAL AND COMPLEX	EIGENVECTORS.	34193	

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