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J. KOK (EDITOR)

SYSTEMATIC INDEX OF NUMPAS,
A LIBRARY OF NUMERICAL PROCEDURES IN PASCAL

2e boerhaavestraat 49 amsterdam

BIBLIOTHEEK MATHEMATISCH CENTRUM
—AMSTERDAM—

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Systematic index of NUMPAS, a library of numerical procedures in PASCAL

edited by

J. Kok

ABSTRACT

The index contains information about available numerical mathematics procedures which can be used in PASCAL programs. In particular a list is given of PASCAL procedures from NUMPAS and of several useful FORTRAN subroutines from the well-known libraries IMSL (International Mathematical and Statistical Libraries) and NAG (Numerical Algorithms Group). In addition, directions are given for the use of these subroutines in PASCAL programs for the CYBER 73-28 computer of the Academic Computer Centre Amsterdam (SARA).

KEY WORDS & PHRASES: *Numerical mathematics, procedure libraries, PASCAL.*

PREFACE

The library of numerical procedures in PASCAL, NUMPAS, is being developed by the NUMPAS Project Group of the Numerical Mathematics Department of the Mathematical Centre. The project was initiated by a request of the Wiskundig Seminarium of the Free University at Amsterdam, who participated in the costs involved.

The aim is, to make available reliable PASCAL procedures and their documentation for solving numerical mathematics problems. PASCAL programs using these procedures can be run in the PASCAL 6000-3.4 system available on the Control Data CYBER 73-28 computer of the Academic Computer Centre Amsterdam (SARA).

The project group has two main activities:

1. to program and document PASCAL procedures, where the existing library of numerical mathematics procedures in ALGOL 60, NUMAL, is used as a guide line.
2. to make available FORTRAN subroutines which can be called in PASCAL programs.

The here presented systematic index contains sufficient information about the available PASCAL procedures and FORTRAN subroutines.

In view of the continuous development of the library of PASCAL procedures, we intend to update this index regularly.

The NUMPAS project group is formed by: J. Blom, F. Groen, J. Kok and M. Louter-Nool. Former members were: R.R. de Graaf and J.K. Petiet.

REFERENCES

- IMSL, *Library 3 Reference Manual*,
International Mathematical and Statistical Libraries, Inc (1975).
- NAG, *Library Manual*,
Numerical Algorithms Group, Nottingham (1975).
- NUMAL, *A library of numerical procedures in ALGOL 60*.
Mathematisch Centrum, Amsterdam (1976).

INTRODUCTION.

THE INDEX CONTAINS THE FOLLOWING INFORMATION:

- 1 A SUBDIVISION OF THE COMPLETE AREA OF NUMERICAL MATHEMATICS
- 2 SUB 'PROCEDURE':
- 3 THE NAME OF THE PROCEDURE OR FUNCTION
- 3 SUB 'DESCRIPTION FILENAME' (AND 'RECNR');
- 4 THE NAME OF THE PERMANENT FILE (AND THE NUMBER OF THE RECORD) WHERE THE DOCUMENTATION CAN BE FOUND
- 4 SUB 'USE':
- 4 IF 'USE' = PROLOG, THEN USE THE SO-CALLED PREPROCESSOR FOR CONSTRUCTING A FILE OF EXTERNAL PROCEDURES; ELSE USE AS LIBRARY THE FILE(S) MENTIONED (NMP = NUMPAS, PASCLIB CAN BE OMITTED)
- 5 SUB 'EXT REF':
- 5 THE WAY OF REFERENCING THE EXTERNAL PROCEDURE.

THE FOLLOWING SETS OF PROCEDURES ARE AVAILABLE :

A. PASCAL PROCEDURES.

PROCEDURES AND FUNCTIONS IN PASCAL, WHOSE DESCRIPTIONS ARE GIVEN IN THE NUMPAS MANUAL (TO APPEAR) AND ON FILES WITH PERMANENT FILE NAMES NUMPASDOCUMENT# (# = 1, 2, ..) AND IDENTIFICATION ID=NUMPAS. RECNR GIVES THE NUMBER OF THE RECORD OF SUCH A FILE CONTAINING THE DOCUMENTATION, THE NEXT RECORD CONTAINS THE SOURCE TEXT(S) OF THE PROCEDURE(S) DOCUMENTED.

IN USER PROGRAMS REFERENCES TO THESE PROCEDURES ARE MADE AS FOLLOWS;

< PROCEDURE / FUNCTION HEADING > ; EXTERN; .

THE NUMPAS PROCEDURES ARE DIVIDED IN TWO SETS, DEPENDING ON THE PROPERTY WHETHER THEY ARE PRECOMPILED OR NOT.

A.1. PRECOMPILED NUMPAS PROCEDURES.

PRECOMPILED PROCEDURES ARE AVAILABLE ON THE PERMANENT FILE NUMPAS, ID=NUMPAS. COMPILED PROGRAMS (ON LGO) CAN BE EXECUTED IN THE FOLLOWING WAYS;

LIBRARY, NUMPAS. OR : LDSET, LIB=NUMPAS.
LGO.

A.2. OTHER NUMPAS PROCEDURES.

ALL NUMPAS PROCEDURES WHICH USE ARRAYS WITH USER-DEFINED BOUNDS CANNOT BE PRECOMPILED. THE PROCEDURES REQUESTED MUST BE COMPILED WITH THE SAME ENVIRONMENT OF TYPE DEFINITIONS FOR ARRAY PARAMETERS AS EXISTS IN THE USER PROGRAM. FOR SUCH USER PROGRAMS A PREPROCESSOR IS AVAILABLE, WHICH CONSTRUCTS A PASCAL PROGRAM CONTAINING ALL REQUESTED NUMPAS PROCEDURES AND THEIR AUXILIARY PROCEDURES IN THE DESIRED ENVIRONMENT OF TYPE DEFINITIONS.

THE PREPROCESSOR IS AVAILABLE ON THE PERMANENT FILE PROLOG, ID=NUMPAS, AND IS USED TOGETHER WITH TWO AUXILIARY FILES PASINFO, ID=NUMPAS AND SOURCETEXTS, ID=NUMPAS. FULL INFORMATION ABOUT THE USE OF PROLOG IS GIVEN ON THE PERMANENT FILE PROLOGDOC, ID=NUMPAS.

B. FORTRAN SUBROUTINES.

SUBROUTINES WRITTEN IN FORTRAN AND AVAILABLE IN FORTRAN SUBROUTINE LIBRARIES CAN BE CALLED IN PASCAL PROGRAMS WITH CERTAIN RESTRICTIONS (E.G. ONLY THOSE SUBROUTINES WHICH DO NOT EXPECT A PROCEDURE OR FUNCTION IN THE USER'S PROGRAM AS A PARAMETER).

REFERENCES ARE MADE IN THE FOLLOWING WAY:

< PROCEDURE / FUNCTION HEADING > ; FORTRAN;

FOR INFORMATION ABOUT THE USE OF FORTRAN SUBROUTINES, SEE; J. KOK & M. LOUWER - NOOL; THE USE OF FORTRAN SUBROUTINES IN PASCAL PROGRAMS (TO APPEAR).

ENTRIES TO FORTRAN SUBROUTINES ARE INCORPORATED IN THIS INDEX ONLY IF NO APPROPRIATE PASCAL PROCEDURE IS AVAILABLE. A LARGE SET OF SUBROUTINES CAN BE CALLED VIA AN INTERFACE SUBROUTINE (SEE B.3.), THUS AVOIDING CONFUSING RULES FOR PARAMETER SUBSTITUTION. FOR INFORMATION ABOUT THESE SUBROUTINES ONE IS REFERRED TO THE PERMANENT FILE NUMPASFTNDOC, ID=NUMPAS.

B.1. THE FORTRAN SYSTEM LIBRARY.

FORTRAN SYSTEM FUNCTIONS AND SUBROUTINES CAN BE CALLED WHEN THE SYSTEM LIBRARY IS GIVEN IN THE FOLLOWING WAY:

LIBRARY, FORTRAN. OR; LDSET, LIB=FORTRAN.

B.2. MATHEMATICAL LIBRARIES.

B.2.1. IMSL.

IMSL (INTERNATIONAL MATHEMATICAL AND STATISTICAL LIBRARIES) LIBRARY 3 IMPLEMENTATION FOR CDC CYBER 70 SERIES.

WAY OF USE :

LIBRARY, NUMPAS, IMSL. OR; LDSET, LIB=NUMPAS/IMSL.

IF NO INTERFACE SUBROUTINE WILL BE USED, THEN:

LIBRARY, IMSL. OR; LDSET, LIB=IMSL.

ONE IS WARNED, HOWEVER, THAT THE INTERFACE SHOULD BE USED IN THE CASE THAT AN IMSL SUBROUTINE CAN BE EXPECTED TO WRITE A MESSAGE ON THE FILE OUTPUT.

B.2.2. NAG.

NAG (NUMERICAL ALGORITHMS GROUP) CDC CYBER 70 SERIES IMPLEMENTATION, WAY OF USE :
 LIBRARY, NAGF. OR: LDSET, LIB=NAGF.
 OR (IN THE CASE OF AN INTERFACE SUBROUTINE):
 LIBRARY, NUMPAS, NAGF. OR: LDSET, LIB=NUMPAS/NAGF.
 ALL NAG SUBROUTINES SHOULD BE CALLED WITH THE SOFT FAILURE OPTION (IFAIL = 1).

B.3. THE FORTRAN PASCAL INTERFACE.

INTERFACE SUBROUTINES ARE WRITTEN FOR ALL USEFUL FORTRAN SUBROUTINES OPERATING WITH TWO-DIMENSIONAL ARRAYS, IN THIS CASE ARRAYS OUGHT TO BE TRANSPOSED DUE TO THE DIFFERENT STORING OF ARRAYS IN PASCAL AND FORTRAN, WITH THE INTERFACE SUBROUTINES, ONE CAN USE THE DIRECTIONS OF USE IN THE RESPECTIVE LIBRARY MANUALS DISREGARDING THIS PECULIARITY, ONE ONLY HAS TO REMEMBER THAT IF A PARAMETER IS REQUIRED CONTAINING THE LENGTH OF THE COLUMNS OF AN ARRAY ONE MUST GIVE THE LENGTH OF THE ROWS INSTEAD, THE PERFORMANCE OF AN INTERFACE SUBROUTINE CONSISTS OF THE APPROPRIATE TRANSFORMATIONS OF THE PARAMETERS AND OF A CALL OF THE INTENDED SUBROUTINE.

FOR ALL INTERFACE SUBROUTINES THE LETTER P IS PRECEDING THE NAME OF THE ORIGINAL SUBROUTINE, IN A FEW CASES, HOWEVER, AN EXTRA PARAMETER IS NECESSARY, INDICATING THE LENGTH OF THE ROWS OF A SECOND ARRAY TO BE TRANSPOSED, THIS CONCERNS THE SUBROUTINES:

PICSFKU (SECTION 7.1.2.3.2.1.),
 PZX1LP, PZX2LP (SECTION 5.1.4.1.).

THE INTERFACE ALSO CONTAINS THE SUBROUTINES FOR TRANSPOSING REAL OR COMPLEX ARRAYS, AND A SUBROUTINE THAT AVOIDS THE PRINTING OF MESSAGES BY IMSL SUBROUTINES ON UNASSIGNED FILES.

ALL INTERFACE SUBROUTINES ARE CONTAINED IN THE PERMANENT FILE NUMPAS, ID=NUMPAS (SEE A.1.).

C. OTHER PROCEDURES.

IN THE PASCAL SYSTEM LIBRARY SOME NUMERICAL PROCEDURES ARE AVAILABLE WHICH CAN BE USED IN PASCAL PROGRAMS, THIS CONCERNS THE PROCEDURES PI, RANDOM AND RANDSET, REFERENCES ARE MADE BY:

FUNCTION PI : REAL; EXTERN;
 FUNCTION RANDOM : REAL; EXTERN;
 PROCEDURE RANDSET(X : REAL); EXTERN; .

SUPERVISION.

ALL COMMENTS, COMPLAINTS, AND REQUESTS FOR FURTHER
INFORMATION SHOULD BE ADDRESSED TO :

NUNPAS PROJECT GROUP
MATHEMATISCH CENTRUM
TWEEDE BOERHAAVESTRAAT 49
AMSTERDAM - 1005.

DATE : 760901.

1. ELEMENTARY PROCEDURES

1. REAL VECT AND MAT OPERATIONS

1. INITIALIZATION

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
INIVEC	NUMPASDOCUMENT1	1	PROLOG	EXTERN
INIMAT	NUMPASDOCUMENT1	1	PROLOG	EXTERN
INIMATD	NUMPASDOCUMENT1	1	PROLOG	EXTERN
INISYMD	NUMPASDOCUMENT1	1	PROLOG	EXTERN
INISYMR0W	NUMPASDOCUMENT1	1	PROLOG	EXTERN

2. DUPLICATION

DUPVEC	NUMPASDOCUMENT1	3	PROLOG	EXTERN
DUPVECROW	NUMPASDOCUMENT1	3	PROLOG	EXTERN
DUPROWVEC	NUMPASDOCUMENT1	3	PROLOG	EXTERN
DUPVECCOL	NUMPASDOCUMENT1	3	PROLOG	EXTERN
DUPCOLVEC	NUMPASDOCUMENT1	3	PROLOG	EXTERN
DUPMAT	NUMPASDOCUMENT1	3	PROLOG	EXTERN

3. MULTIPLICATION

MULVEC	NUMPASDOCUMENT1	5	PROLOG	EXTERN
MULROW	NUMPASDOCUMENT1	5	PROLOG	EXTERN
MULCOL	NUMPASDOCUMENT1	5	PROLOG	EXTERN
COLCST	NUMPASDOCUMENT1	5	PROLOG	EXTERN
ROWCST	NUMPASDOCUMENT1	5	PROLOG	EXTERN

4. SCALAR PRODUCTS

1. VECTOR VECTOR PRODUCTS

VECVEC	NUMPASDOCUMENT1	7	PROLOG	EXTERN
MATVEC	NUMPASDOCUMENT1	7	PROLOG	EXTERN
TAMVEC	NUMPASDOCUMENT1	7	PROLOG	EXTERN
MATMAT	NUMPASDOCUMENT1	7	PROLOG	EXTERN
TAMMAT	NUMPASDOCUMENT1	7	PROLOG	EXTERN
MATTAM	NUMPASDOCUMENT1	7	PROLOG	EXTERN
SEQVEC	NUMPASDOCUMENT1	7	PROLOG	EXTERN
SCAPRO1	NUMPASDOCUMENT1	7	PROLOG	EXTERN
SYMMATVEC	NUMPASDOCUMENT1	7	PROLOG	EXTERN

2. MATRIX VECTOR PRODUCTS

FULMATVEC	NUMPASDOCUMENT1	9	PROLOG	EXTERN
FULTAMVEC	NUMPASDOCUMENT1	9	PROLOG	EXTERN
FULSYMMATVEC	NUMPASDOCUMENT1	9	PROLOG	EXTERN
RESVEC	NUMPASDOCUMENT1	9	PROLOG	EXTERN
SYMRESVEC	NUMPASDOCUMENT1	9	PROLOG	EXTERN

3. MATRIX MATRIX PRODUCTS

HSHVECMAT	NUMPASDOCUMENT1	11	PROLOG	EXTERN
HSHCOLMAT	NUMPASDOCUMENT1	11	PROLOG	EXTERN
HSHROWMAT	NUMPASDOCUMENT1	11	PROLOG	EXTERN
HSHVECTAM	NUMPASDOCUMENT1	11	PROLOG	EXTERN
HSHCOLTAM	NUMPASDOCUMENT1	11	PROLOG	EXTERN
HSHROWTAM	NUMPASDOCUMENT1	11	PROLOG	EXTERN

5. ELIMINATION

ELMVEC	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMCOL	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMROW	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMVECCOL	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMCOLVEC	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMVECROW	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMROWVEC	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMCOLROW	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ELMROWCOL	NUMPASDOCUMENT1	13	PROLOG	EXTERN

1. 1. 5.
6. INTERCHANGING

7. ROTATION

8. NORMS

9. SCALING

10. STORAGE MODE CONVERSION

2. COMPL VECT AND MAT OPERATIONS

1.
2.
3. MULTIPLICATION

4. SCALAR PRODUCTS

5. ELIMINATION

6. INTERCHANGING
7. ROTATION

8. NORMS
8.

1. 2.

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
MAXELMROW	NUMPASDOCUMENT1	13	PROLOG	EXTERN
ICHVEC	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ICHCOL	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ICHROW	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ICHROWCOL	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ICHSERVEC	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ICHSEQ	NUMPASDOCUMENT1	15	PROLOG	EXTERN
ROTCOL	NUMPASDOCUMENT1	17	PROLOG	EXTERN
ROTRON	NUMPASDOCUMENT1	17	PROLOG	EXTERN
INFNRHVEC	NUMPASDOCUMENT1	19	PROLOG	EXTERN
INFNRMROW	NUMPASDOCUMENT1	19	PROLOG	EXTERN
INFNRMCOL	NUMPASDOCUMENT1	19	PROLOG	EXTERN
INFNRMMAT	NUMPASDOCUMENT1	19	PROLOG	EXTERN
ONENRHVEC	NUMPASDOCUMENT1	19	PROLOG	EXTERN
ONENRMROW	NUMPASDOCUMENT1	19	PROLOG	EXTERN
ONENRMCOL	NUMPASDOCUMENT1	19	PROLOG	EXTERN
ONENRMMAT	NUMPASDOCUMENT1	19	PROLOG	EXTERN
ABSMAXMAT	NUMPASDOCUMENT1	19	PROLOG	EXTERN
REASCL	NOT YET AVAILABLE			
PVCVTBF	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTFB	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTFO	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTFS	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTQF	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTQS	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTSF	NUMPASFINDOC		NMP, IMSL	FORTRAN
PVCVTSQ	NUMPASFINDOC		NMP, IMSL	FORTRAN
SP1	NUMPASFINDOC		NUMPAS	FORTRAN
SP2	NUMPASFINDOC		NUMPAS	FORTRAN
COMCOLCST	NUMPASDOCUMENT3	1	PROLOG	EXTERN
COHROWCST	NUMPASDOCUMENT3	1	PROLOG	EXTERN
COMMATVEC	NUMPASDOCUMENT3	3	PROLOG	EXTERN
HSHCCOL	NUMPASDOCUMENT3	3	PROLOG	EXTERN
HSHCPRD	NUMPASDOCUMENT3	3	PROLOG	EXTERN
ELMCVECCOL	NUMPASDOCUMENT3	5	PROLOG	EXTERN
ELMCCOL	NUMPASDOCUMENT3	5	PROLOG	EXTERN
ELMCROWVEC	NUMPASDOCUMENT3	5	PROLOG	EXTERN
ROTCOL	NUMPASDOCUMENT3	7	PROLOG	EXTERN
ROTCROW	NUMPASDOCUMENT3	7	PROLOG	EXTERN
CHSH2	NOT YET AVAILABLE			
CONEUCNRM	NUMPASDOCUMENT3	9	PROLOG	EXTERN

1. 2. 9. SCALING

10. STORAGE MODE CONVERSION

3. COMPLEX ARITHMETIC
1. MONADIC OPERATIONS

2. DYADIC OPERATIONS

4. LONG INTEGER ARITHMETIC

5. LONG REAL ARITHMETIC
1. ELEM. ARITHMETIC OPERATIONS

2. SCALAR PRODUCTS
1. VECTOR VECTOR PRODUCTS

2. MATPIX VECTOR PRODUCTS

2. ALGEBRAIC EVALUATIONS
2. 1. EVAL. OF A FINITE SERIES

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
COMSCL	NOT YET AVAILABLE			
SCLCOM	NOT YET AVAILABLE			
PVCVTCH	NUMPASFTNDOC		NMP,IMSL	FORTRAN
PVCVTHC	NUMPASFTNDOC		NMP,IMSL	FORTRAN
SPC1	NUMPASFTNDOC		NUMPAS	FORTRAN
SPC2	NUMPASFTNDOC		NUMPAS	FORTRAN
COMARS	NUMPASDOCUMENT3	11	NUMPAS	EXTERN
COMSORT	NUMPASDOCUMENT3	11	NUMPAS	EXTERN
CARPOL	NUMPASDOCUMENT3	11	NUMPAS	EXTERN
COMADD	NUMPASDOCUMENT3	13	NUMPAS	EXTERN
COMSUBT	NUMPASDOCUMENT3	13	NUMPAS	EXTERN
COMMUL	NUMPASDOCUMENT3	13	NUMPAS	EXTERN
COMDIV	NUMPASDOCUMENT3	13	NUMPAS	EXTERN
COMPOWER	NUMPASDOCUMENT3	13	NUMPAS	EXTERN
LNGIADD	NUMPASDOCUMENT2	1	PROLOG	EXTERN
LNGISUBTRACT	NUMPASDOCUMENT2	1	PROLOG	EXTERN
LNGISQR	NUMPASDOCUMENT2	1	PROLOG	EXTERN
LNGIMULT	NUMPASDOCUMENT2	1	PROLOG	EXTERN
LNGIDIVIDE	NUMPASDOCUMENT2	1	PROLOG	EXTERN
LNGIPOWER	NUMPASDOCUMENT2	1	PROLOG	EXTERN
DP ADD	NOT YET AVAILABLE			
DP SUB	NOT YET AVAILABLE			
DP MUL	NOT YET AVAILABLE			
DP DIV	NOT YET AVAILABLE			
LNG ADD	NOT YET AVAILABLE			
LNG SUB	NOT YET AVAILABLE			
LNG MUL	NOT YET AVAILABLE			
LNG DIV	NOT YET AVAILABLE			
LNGVECVEC	NOT YET AVAILABLE			
LNGMATVEC	NOT YET AVAILABLE			
LNGTAMVEC	NOT YET AVAILABLE			
LNGMATMAT	NOT YET AVAILABLE			
LNGTAMMAT	NOT YET AVAILABLE			
LNGMATTAM	NOT YET AVAILABLE			
LNGSEQVEC	NOT YET AVAILABLE			
LNGSCAPRD1	NOT YET AVAILABLE			
LNGSYMMATVEC	NOT YET AVAILABLE			
LNGFULMATVEC	NOT YET AVAILABLE			
LNGFULTAMVEC	NOT YET AVAILABLE			
LNGFULSYMMATVEC	NOT YET AVAILABLE			
LNGRESVEC	NOT YET AVAILABLE			
LNGSYHRESVEC	NOT YET AVAILABLE			

	PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
2. 2.EVAL. OF POLYNOMIALS					
1.EVAL. OF GENERAL POLYNOMIALS					
1.POLYNOMIALS IN GRUNERT FORM	POL	NOT YET AVAILABLE			
	TAYPOL	NOT YET AVAILABLE			
	NORDERPOL	NOT YET AVAILABLE			
	DERPOL	NOT YET AVAILABLE			
2.POLYNOMIALS IN NEWTON FORM	NEWPOL	NOT YET AVAILABLE			
2.EVAL. OF ORTHOGON. POLYNOMIALS					
1.GENERAL ORTHOGON. POLYNOMIALS	ORTPOL	NOT YET AVAILABLE			
	ALLORTPOL	NOT YET AVAILABLE			
	ORTPOLSER	NOT YET AVAILABLE			
2.CHEBYSHEV POLYNOMIALS	CHEPOL	NOT YET AVAILABLE			
	ALLCHEPOL	NOT YET AVAILABLE			
	CHEPOLSER	NOT YET AVAILABLE			
3.EVAL. OF TRIGONON. POLYNOMIALS					
1.EVAL. OF FOURIER SERIES	SINSER	NOT YET AVAILABLE			
SEE ALSO SECTION 2.5.	COSSER	NOT YET AVAILABLE			
	FOUSER	NOT YET AVAILABLE			
	FOUSER1	NOT YET AVAILABLE			
	FOUSER2	NOT YET AVAILABLE			
	COMFOUSER	NOT YET AVAILABLE			
	COMFOUSER1	NOT YET AVAILABLE			
	COMFOUSER2	NOT YET AVAILABLE			
4.EVAL. OF SPLINES					
1.1-DIM. SPLINES	PICSEVU	NUMPASFTNDOC		NMP,IMSL	FORTRAN
2.2-DIM. SPLINES	PIRCEVU	NUMPASFTNDOC		NMP,IMSL	FORTRAN
3.EVAL. OF CONTINUED FRACTIONS	JFRAC	NOT YET AVAILABLE			
4.OPERATIONS ON POLYNOMIALS					
1.TRANSF. OF REPRESENTATION	NEWGRN	NOT YET AVAILABLE			
	POLCHS	NOT YET AVAILABLE			
	POWCHS	NOT YET AVAILABLE			
2.OP. ON GENERAL POLYNOMIALS	ADDPOL	NOT YET AVAILABLE			
	SUBPOL	NOT YET AVAILABLE			
	MULPOL	NOT YET AVAILABLE			
	DIFPOL	NOT YET AVAILABLE			
	INTPOL	NOT YET AVAILABLE			
3.OP. ON ORTHOGONAL POLYNOMIALS	INTCHS	NOT YET AVAILABLE			
5.FAST FOURIER TRANSFORM					
1.REVERSE BINARY ORDER CONVERSION	FFRDR2	NUMPASFTNDOC		IMSL	FORTRAN
2.TRANSFORM OF REAL VECTOR	FFTR	NUMPASFTNDOC		IMSL	FORTRAN
2. 5. 3.TRANSFORM OF COMPLEX VECTOR					

2. 5. 3.

4. COSINE AND SINE TRANSFORM

3. LINEAR ALGEBRA

1. LINEAR SYSTEMS

1. FULL MATRICES

1. SQUARE NON-SINGULAR MATRICES

1. REAL MATRICES

1. GENERAL MATRICES

1. PREPARATORY PROCEDURES

2. CALCULATION OF DETERMINANT

3. SOLUTION OF LINEAR EQUATIONS

4. MATRIX INVERSION

5. ITERATIVELY IMPROVED SOLUTION

2. SYMMETRIC POS DEF MATRICES

1. PREPARATORY PROCEDURES

2. CALCULATION OF DETERMINANT

3. SOLUTION OF LINEAR EQUATIONS

3. 1. 1. 1. 1. 2. 3.

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
FFTP	NUMPASFTNDOC		IMSL	FORTRAN
FFT2	NUMPASFTNDOC		IMSL	FORTRAN
FFT2RV	NUMPASFTNDOC		IMSL	FORTRAN
FFCSIN	NUMPASFTNDOC		IMSL	FORTRAN
DEC	NUMPASDOCUMENT2	3	PROLOG	EXTERN
GSSELM	NOT YET AVAILABLE			
ONENRMINV	NOT YET AVAILABLE			
ERBELM	NOT YET AVAILABLE			
GSSERB	NOT YET AVAILABLE			
GSSNRI	NOT YET AVAILABLE			
DETERM	NUMPASDOCUMENT2	5	PROLOG	EXTERN
PLINV3F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
SOL	NUMPASDOCUMENT2	7	PROLOG	EXTERN
DECSOL	NUMPASDOCUMENT2	7	PROLOG	EXTERN
SOLELM	NOT YET AVAILABLE			
GSSSOL	NOT YET AVAILABLE			
GSSSOLERB	NOT YET AVAILABLE			
PLINV3F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
PLEQT1F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
INV	NOT YET AVAILABLE			
DECINV	NOT YET AVAILABLE			
INV1	NOT YET AVAILABLE			
GSSINV	NOT YET AVAILABLE			
GSSINVERB	NOT YET AVAILABLE			
PLINV1F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
PLINV2F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
PLINV3F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
ITISOL	NOT YET AVAILABLE			
GSSITISOL	NOT YET AVAILABLE			
ITISOLERB	NOT YET AVAILABLE			
GSSITISOLERB	NOT YET AVAILABLE			
PLEQT2F	NUMPASFTNDOC		NMP, IMSL	FORTRAN
CHLDEC2	NOT YET AVAILABLE			
CHLDEC1	NUMPASDOCUMENT2	9	PROLOG	EXTERN
CHLDETERM2	NOT YET AVAILABLE			
CHLDETERM1	NUMPASDOCUMENT2	11	PROLOG	EXTERN
CHLSOL2	NOT YET AVAILABLE			
CHLSOL1	NUMPASDOCUMENT2	13	PROLOG	EXTERN
CHLDECSOL2	NOT YET AVAILABLE			

					PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
3.	1.	1.	3.	1.	3.SOLUTION HOMOGENEOUS EQUATION	HOMSOLSVD HOMSOL			
					4.PSEUDO-INVERSION	PSDINVSVD PSDINV PLPSDQR			
					2.COMPLEX MATRICES				
					2.SPARSE MATRICES				
					1.DIRECT METHODS				
					1.REAL MATRICES				
					1.NON-SYMMETRIC MATRICES				
					1.BAND MATRICES				
					1.PREPARATORY PROCEDURES	DECBND			
					2.CALCULATION OF DETERMINANT	DETERMBND			
					3.SOLUTION OF LINEAR EQUATIONS	SOLBND DECSOLBND PLEQT1B PLEQT2B			
					2.TRIDIAGONAL MATRICES				
					1.PREPARATORY PROCEDURES	DECTRI DECTRIPIV			
					2.CALCULATION OF DETERMINANT				
					3.SOLUTION OF LINEAR EQUATIONS	SOLTRI DECSOLTRI SOLTRIPIV DECSOLTRIPIV			
					3.BLOCK-TRIDIAGONAL MATRICES				
					4.OTHER SPARSE MATRICES				
					1.PREPARATORY PROCEDURES	PF03AJF PF03AKF			
					3.SOLUTION OF LINEAR EQUATIONS	PF04APF			
					2.SYMMETRIC POS DEF MATRICES				
					1.BAND MATRICES				
					1.PREPARATORY PROCEDURES	CHLDECBND			
					2.CALCULATION OF DETERMINANT	CHLDETERMBND			
					3.SOLUTION OF LINEAR EQUATIONS	CHLSOLBND CHLDECSOLBND PLEQ1PB PLEQ2PB			
					2.TRIDIAGONAL MATRICES				
					1.PREPARATORY PROCEDURES	DECSYMTRI			
					2.CALCULATION OF DETERMINANT				
3.	1.	2.	1.	1.	2.	2.			
					3.SOLUTION OF LINEAR EQUATIONS				

3. 1. 2. 1. 1. 2. 2. 3.

3. BLOCK-TRIDIAGONAL MATRICES
 2. COMPLEX MATRICES
 2. ITERATIVE METHODS
 1. REAL MATRICES

2. COMPLEX MATRICES
 1. FULL MATRICES
 2. TRANSFORMATION TO SPECIAL FORM
 1. SIMILARITY TRANSFORMATIONS
 1. EQUILIBRATION
 1. REAL MATRICES

2. COMPLEX MATRICES

2. TRANSF TO HESSENBERG FORM
 1. REAL MATRICES
 1. SYMMETRIC MATRICES

2. ASYMMETRIC MATRICES

2. COMPLEX MATRICES
 1. HERMITIAN MATRICES

2. NON-HERMITIAN MATRICES

2. OTHER TRANSFORMATIONS
 1. TRANSF TO BIDIAGONAL FORM
 1. REAL MATRICES

2. COMPLEX MATRICES
 3. THE (ORDINARY) EIGENV PROBLEM
 1. REAL MATRICES
 1. SYMMETRIC MATRICES
 1. TRIDIAGONAL MATRICES

3. 3. 1. 1. 1.

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
SOLSYMTRI	NOT YET AVAILABLE			
DECSOLSYMTRI	NOT YET AVAILABLE			
CONJ GRAD	NOT YET AVAILABLE			
CONJ RESI	NOT YET AVAILABLE			
EQILBR	NOT YET AVAILABLE			
BAKLBR	NOT YET AVAILABLE			
EQILBRCOM	NOT YET AVAILABLE			
BAKLBRCOM	NOT YET AVAILABLE			
TFMSYMTRI2	NOT YET AVAILABLE			
BAKSYMTRI2	NOT YET AVAILABLE			
TFMPREVEC	NOT YET AVAILABLE			
TFMSYMTRI1	NOT YET AVAILABLE			
BAKSYMTRI1	NOT YET AVAILABLE			
TFMREAHES	NOT YET AVAILABLE			
BAKREAHES1	NOT YET AVAILABLE			
BAKREAHES2	NOT YET AVAILABLE			
HSHHRMTRI	NOT YET AVAILABLE			
HSHHRMTRIVAL	NOT YET AVAILABLE			
BAKHRMTRI	NOT YET AVAILABLE			
HSHCOMHES	NOT YET AVAILABLE			
BAKCOMHES	NOT YET AVAILABLE			
HSHREABIO	NOT YET AVAILABLE			
PSTTFMMAT	NOT YET AVAILABLE			
PRETFMMAT	NOT YET AVAILABLE			
VALSYMTRI	NOT YET AVAILABLE			
VECSYMTRI	NOT YET AVAILABLE			
QRIVALSYMTRI	NOT YET AVAILABLE			
QRISYMTRI	NOT YET AVAILABLE			
RATQRI	NOT YET AVAILABLE			

3. 3. 1. 1. 2. FULL MATRICES

2. ASYMMETRIC MATRICES

1. MATRICES IN HESSENBERG FORM

2. FULL MATRICES

2. COMPLEX MATRICES

1. HERMITIAN MATRICES

2. NON-HERMITIAN MATRICES

1. MATRICES IN HESSENBERG FORM

2. FULL MATRICES

4. THE GENERALIZED EIGENV PROBLEM

1. REAL MATRICES

1. SYMMETRIC MATRICES

2. ASYMMETRIC MATRICES

3. 4. 1. 2.

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
EIGVALSYM2	NOT YET AVAILABLE			
EIGSYH2	NOT YET AVAILABLE			
EIGVALSYM1	NOT YET AVAILABLE			
EIGSYH1	NOT YET AVAILABLE			
QRIVALSYM2	NOT YET AVAILABLE			
QRISYM	NOT YET AVAILABLE			
QRIVALSYM1	NOT YET AVAILABLE			
PEIGRS	NUMPASFTNDOC		NMP,IMSL	FORTRAN
REAVLQRI	NOT YET AVAILABLE			
REAVECHES	NOT YET AVAILABLE			
REAGR1	NOT YET AVAILABLE			
COMVALQRI	NOT YET AVAILABLE			
COMVECHES	NOT YET AVAILABLE			
REAEIGVAL	NOT YET AVAILABLE			
REAEIG1	NOT YET AVAILABLE			
REAEIG2	NOT YET AVAILABLE			
REAEIG3	NOT YET AVAILABLE			
COMEIGVAL	NOT YET AVAILABLE			
COMEIG1	NOT YET AVAILABLE			
COMEIG2	NOT YET AVAILABLE			
PEIGRF	NUMPASFTNDOC		NMP,IMSL	FORTRAN
EIGVALHRM	NOT YET AVAILABLE			
EIGHRM	NOT YET AVAILABLE			
QRIVALHRM	NOT YET AVAILABLE			
QR1HRM	NOT YET AVAILABLE			
PEIGCH	NUMPASFTNDOC		NMP,IMSL	FORTRAN
VALRRICOM	NOT YET AVAILABLE			
GRICOM	NOT YET AVAILABLE			
EIGVALCOM	NOT YET AVAILABLE			
EIGCOM	NOT YET AVAILABLE			
PEIGCC	NUMPASFTNDOC		NMP,IMSL	FORTRAN
QZIVAL	NOT YET AVAILABLE			
QZI	NOT YET AVAILABLE			
HSHDECMUL	NOT YET AVAILABLE			
HSTGL3	NOT YET AVAILABLE			
HSTGL2	NOT YET AVAILABLE			
HSH2COL	NOT YET AVAILABLE			
HSH3COL	NOT YET AVAILABLE			
HSH2ROW3	NOT YET AVAILABLE			
HSH2ROW2	NOT YET AVAILABLE			
HSH3ROW3	NOT YET AVAILABLE			
HSH3ROW2	NOT YET AVAILABLE			

	PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
3. 4. 1. 2. 5. SINGULAR VALUES	PEIGZF	NUMPASFTNDOC		NMP, IMSL	FORTRAN
1. REAL MATRICES					
1. BIDIAGONAL MATRICES					
2. FULL MATRICES	GRISNGVALBID GRISNGVALDEC BIO	NOT YET AVAILABLE NOT YET AVAILABLE			
2. COMPLEX MATRICES	GRISNGVAL GRISNGVALDEC PLSVALR	NOT YET AVAILABLE NOT YET AVAILABLE NUMPASFTNDOC		NMP, IMSL	FORTRAN
6. ZEROS OF POLYNOMIALS					
1. ZEROS OF GENERAL REAL POLYNOM.	POLZEROS ZPOLR ZRPOLY ZOADR	NOT YET AVAILABLE NUMPASFTNDOC NUMPASFTNDOC NUMPASFTNDOC		IMSL IMSL IMSL	FORTRAN FORTRAN FORTRAN
2. ZEROS OF ORTHOGONAL POLYNOM.	ALLZERORTPOL LUPZERORTPOL SELZERORTPOL	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
3. ZEROS OF COMPLEX POLYNOMIALS	COMKWD ZCPOLY ZQADC	NOT YET AVAILABLE NUMPASFTNDOC NUMPASFTNDOC		IMSL IMSL	FORTRAN FORTRAN
4. ANALYTIC EVALUATIONS					
1. EVAL. OF AN INFINITE SERIES	EULER SUMPOSSERIES	NUMPASDOCUMENT3 NUMPASDOCUMENT3	15 15	NUMPAS NUMPAS	EXTERN EXTERN
2. QUADRATURE					
1. ONE-DIMENSIONAL QUADRATURE	QADRAT INTEGRAL PDCS0DU	NUMPASDOCUMENT2 NUMPASDOCUMENT3 NUMPASFTNDOC	21 17	NUMPAS NUMPAS NMP, IMSL	EXTERN EXTERN FORTRAN
2. MULTIDIMENSIONAL QUADRATURE	TRICUB PDCS2QU	NUMPASDOCUMENT3 NUMPASFTNDOC	19	NUMPAS NMP, IMSL	EXTERN FORTRAN
3. GAUSSIAN WEIGHTS	RECCOF GSSWGT	NOT YET AVAILABLE NOT YET AVAILABLE			
3. NUMERICAL DIFFERENTIATION					
1. FUNCTIONS OF ONE VARIABLE					
1. 1-ST & 2-ND DERIV. OF SPLINE	PDCSEVU	NUMPASFTNDOC		NMP, IMSL	FORTRAN
2. FUNCTIONS OF MORE VARIABLES	JACOBINF JACOBNMF JACOBNBDF	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
1. CALC. WITH DIFFERENCE FORMULAS					
2. 1. & 2. PART. DER. OF BICUB. SPLINE	PDBCEVU	NUMPASFTNDOC		NMP, IMSL	FORTRAN
5. ANALYTICAL PROBLEMS					
1. ANALYTICAL EQUATIONS					
5. 1. 1. NON-LINEAR EQUATIONS					

	PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
5. 1. 1. 1.A SINGLE EQUATION 1.NO DERIVATIVE AVAILABLE	ZEROIN ZERDINRAT	NUMPASDOCUMENT2 NOT YET AVAILABLE	23	NUMPAS	EXTERN
2.DERIVATIVE AVAILABLE	ZEROINDER	NOT YET AVAILABLE			
2.A SYSTEM OF EQUATIONS 1.AUXILIARY PROCEDURES 2.JACOBIAN MATRIX NOT AVAILABLE	BROWNL5 QUANEW QUANEW1 QUANEWBND QUANEWBND1	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
3.JACOBIAN MATRIX AVAILABLE	NEWRAP DAMPED NEWTON	NOT YET AVAILABLE NOT YET AVAILABLE			
3.POLYNOMIAL EQUATIONS SEE ALSO SECTION 3.6					
2.UNCONSTRAINED OPTIMIZATION 1.FUNCTIONS OF ONE VARIABLE 1.DERIVATIVE NOT AVAILABLE	MININ	NUMPASDOCUMENT2	25	NUMPAS	EXTERN
2.DERIVATIVE AVAILABLE	MININDER	NUMPASDOCUMENT2	27	NUMPAS	EXTERN
2.FUNCTIONS OF MORE VARIABLES 1.AUXILIARY PROCEDURES	LINEMIN RNKIUPD DAVUPD FLEUPD	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
2.NO DERIVATIVES AVAILABLE	PRAXIS	NOT YET AVAILABLE			
3.GRAIDENT AVAILABLE	RNKIMIN FLEMIN	NOT YET AVAILABLE NOT YET AVAILABLE			
4.GRAIDENT & JACOBIAN AVAILABLE	NEWTONMIN	NOT YET AVAILABLE			
3.OVERDETERMINED NONLINEAR SYST. 1.LEAST SQUARES SOLUTIONS SEE ALSO SECTION 7. 1.AUXILIARY PROCEDURES 2.JACOBIAN MATRIX NOT AVAILABLE SEE ALSO SECTION 5.1.2.2.2. 3.JACOBIAN MATRIX AVAILABLE	MARQUARDT GSSNEWTON	NOT YET AVAILABLE NOT YET AVAILABLE			
4.CONSTRAINED OPTIMIZATION 1.LINEAR PROGRAMMING	PZX1LP PZX2LP PZX3LP	NUMPASFTNDOC NUMPASFTNDOC NUMPASFTNDOC		NMP,IMSL NMP,IMSL NMP,IMSL	FORTRAN FORTRAN FORTRAN
2.FUNCTIONAL EQUATIONS 1.DIFFERENTIAL EQUATIONS					
5. 2. 1. 1.INITIAL VALUE PROBLEMS					

5. 2. 1. 1. 1. FIRST ORDER ORDINARY D.E.
 1. NO DERIVATIVES RHS AVAILABLE
 SEE ALSO SECTION 5.2.1.1.1.1.

2. JACOBIAN MATRIX AVAILABLE

SEE ALSO PROC. MULTISTEP (5.2.1.1.1.1)
 3. SEVERAL DERIVATIVES AVAILABLE

2. SECOND ORDER ORDINARY D.E.
 1. NO DERIVATIVES RHS AVAILABLE
 SEE ALSO SECTION 5.2.1.1.2.1.

2. SEVERAL DERIV. RHS AVAILABLE
 3. PARTIAL DIFFERENTIAL EQUATIONS
 2. BOUNDARY VALUE PROBLEMS
 1. TWO POINT B.V.P.

1. SHOOTING METHODS
 SEE ALSO SECTION 5.2.1.3.1
 2. LINEAR GLOBAL METHODS

1. SECOND ORDER TPBVP
 1. SELF ADJOINT TPBVP

2. SKEW ADJOINT TPBVP

2. FOURTH ORDER TPBVP
 1. SELF ADJOINT TPBVP

2. SKEW ADJOINT TPBVP

3. NON-LINEAR GLOBAL METHODS
 2. TWO-DIMENSIONAL B.V.P.
 1. ELLIPTIC B.V.P.S
 1. DISCRETIZATION PROCEDURES
 2. SPECIAL LINEAR SYSTEMS

5. 2. 1. 2. 2. 1. SEE ALSO SECTION 3.1.2

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
RK1	NOT YET AVAILABLE			
RKE	NUMPASDOCUMENT2	29	PROLOG	EXTERN
RK4A	NOT YET AVAILABLE			
RK4NA	NOT YET AVAILABLE			
RK5NA	NOT YET AVAILABLE			
MULTISTEP	NOT YET AVAILABLE			
DIFFSYS	NOT YET AVAILABLE			
ARK	NOT YET AVAILABLE			
EFRK	NOT YET AVAILABLE			
EFSIRK	NOT YET AVAILABLE			
EFERK	NOT YET AVAILABLE			
LINIGER1VS	NOT YET AVAILABLE			
LINIGER2	NOT YET AVAILABLE			
IMPEX	NOT YET AVAILABLE			
GMS	NOT YET AVAILABLE			
MODIFIED TAYLOR	NOT YET AVAILABLE			
EXPONENTIALLY FITTED	NOT YET AVAILABLE			
RK2	NOT YET AVAILABLE			
RK2H	NOT YET AVAILABLE			
RK3	NOT YET AVAILABLE			
RK3N	NOT YET AVAILABLE			
FEM LAG	NOT YET AVAILABLE			
FEM LAG SYM	NOT YET AVAILABLE			
FEM LAG SKEW	NOT YET AVAILABLE			
FEM HERM SYM	NOT YET AVAILABLE			
RICHARDSON	NOT YET AVAILABLE			
ELIMINATION	NOT YET AVAILABLE			

	PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
5. 2. 1. 2. 2. 1. 3. SPECIAL NON-LINEAR SYSTEMS					
2. PARABOLIC & HYPERBOLIC B.V.P.S					
3. MULTI-DIMENSIONAL B.V.P.					
4. OVER-DETERMINED PROBLEMS					
3. PARAMETER ESTIMATION IN D.E.					
1. P.E. IN INITIAL VALUE PROBLEMS	PEIDE	NOT YET AVAILABLE			
2. INTEGRAL EQUATIONS					
3. INTEGRO-DIFFERENTIAL EQS					
4. DIFFERENCE EQUATIONS					
5. CONVOLUTION EQUATIONS					
6. SPECIAL FUNCTIONS & CONSTANTS					
1. MATHEMATICAL CONSTANTS	CONSTPI E (= EXP(1))			PASCLIB	EXTERN
2. MACHINE CONSTANTS	MBASE ARPER DWARF GIANT MAXINT (STANDARD) OVRFLOW UNDFLOW	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
3. RANDOM NUMBERS	RANDOM RANDSET			PASCLIB PASCLIB	EXTERN EXTERN
4. ELEMENTARY FUNCTIONS					
1. CIRCULAR FUNCTIONS	TAN ARCSIN ARCCOS	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
2. HYPERBOLIC FUNCTIONS	SINH COSH TANH ARCSINH ARCCOSH ARCTANH	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
3. LOGARITHMIC FUNCTIONS	ALOG10			FORTRAN	FORTRAN
5. EXPONENTIAL INTEGRAL, ETC.	EI EI ALPHA ENX NONEXP ENX MMDEI	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE NUMPASFTNDOC		IMSL	FORTRAN
1. EXPONENTIAL INTEGRAL	SINCOSINT SINCOSFG S13ABF S13ACF	NOT YET AVAILABLE NOT YET AVAILABLE NUMPASFTNDOC NUMPASFTNDOC		NAGF NAGF	FORTRAN FORTRAN
2. SINE AND COSINE INTEGRAL	MMDELE MMDELK	NUMPASFTNDOC NUMPASFTNDOC		IMSL IMSL	FORTRAN FORTRAN
3. ELLIPTIC INTEGRAL					
6. 5. 3.					

6. 6. GAMMA FUNCTION, ETC.

PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
GAMMA	NOT YET AVAILABLE			
RECIP GAMMA	NOT YET AVAILABLE			
LOG GAMMA	NOT YET AVAILABLE			
INCOMGAM	NOT YET AVAILABLE			
INCBETA	NOT YET AVAILABLE			
IBPPLUSN	NOT YET AVAILABLE			
IBQPLUSN	NOT YET AVAILABLE			
IXQFIX	NOT YET AVAILABLE			
IXPFIX	NOT YET AVAILABLE			
FORWARD	NOT YET AVAILABLE			
BACKWARD	NOT YET AVAILABLE			
MDBETA	NUMPASFTNDOC		IMSL	FORTRAN
MDBETI	NUMPASFTNDOC		IMSL	FORTRAN
MDGAM	NUMPASFTNDOC		IMSL	FORTRAN
HGAMMA	NUMPASFTNDOC		IMSL	FORTRAN
MLGAMA	NUMPASFTNDOC		IMSL	FORTRAN

7. ERROR FUNCTION, ETC.

ERRORFUNCTION	NOT YET AVAILABLE			
NONEXPERFC	NOT YET AVAILABLE			
INVERSE ERROR FUNCTI	NOT YET AVAILABLE			
FRESNEL	NOT YET AVAILABLE			
FG	NOT YET AVAILABLE			
MERF	NUMPASFTNDOC		IMSL	FORTRAN
MERFC	NUMPASFTNDOC		IMSL	FORTRAN
MERFI	NUMPASFTNDOC		IMSL	FORTRAN
MERFCI	NUMPASFTNDOC		IMSL	FORTRAN
MDNRIS	NUMPASFTNDOC		IMSL	FORTRAN
MMDAW	NUMPASFTNDOC		IMSL	FORTRAN
S20AAF	NUMPASFTNDOC		NAGF	FORTRAN
S20ABF	NUMPASFTNDOC		NAGF	FORTRAN

8. LEGENDRE FUNCTIONS

9. BESSEL FUNCTIONS OF INT. ORDER

1. BESSEL FUNCTIONS J AND Y

BESS J0	NOT YET AVAILABLE			
BESS J1	NOT YET AVAILABLE			
BESS J	NOT YET AVAILABLE			
BESS Y01	NOT YET AVAILABLE			
BESS Y	NOT YET AVAILABLE			
BESS PQ0	NOT YET AVAILABLE			
BESS PQ1	NOT YET AVAILABLE			
S17AAF	NUMPASFTNDOC		NAGF	FORTRAN
S17ABF	NUMPASFTNDOC		NAGF	FORTRAN
S17ACF	NUMPASFTNDOC		NAGF	FORTRAN

2. BESSEL FUNCTIONS I AND K

BESS I0	NOT YET AVAILABLE			
BESS I1	NOT YET AVAILABLE			
BESS I	NOT YET AVAILABLE			
BESS K01	NOT YET AVAILABLE			
BESS K	NOT YET AVAILABLE			
NONEXP BESS I0	NOT YET AVAILABLE			
NONEXP BESS I1	NOT YET AVAILABLE			
NONEXP BESS I	NOT YET AVAILABLE			
NONEXP BESS K01	NOT YET AVAILABLE			
NONEXP BESS K	NOT YET AVAILABLE			

6. 9. 2.

3. KELVIN FUNCTIONS

10. BESSEL FUNCTIONS OF REAL ORDER

1. BESSEL FUNCTIONS J AND Y

2. BESSEL FUNCTIONS I AND K

3. SPHERICAL BESSEL FUNCTIONS

4. AIRY FUNCTIONS

7. INTERPOLATION & APPROXIMATION

1. REAL DATA IN ONE DIMENSION

1. INTERPOLATION, WITH

1. POLYNOMIALS

1. GENERAL POLYNOMIALS

2. ORTHOGONAL POLYNOMIALS

2. SPLINES

1. GENERAL SPLINES

2. NATURAL SPLINES

3. TRIGONOMETRIC SERIES

SEE ALSO SECTION 2.5.4.

1. FOURIER SERIES

2. SINE SERIES

3. COSINE SERIES

4. RATIONAL FUNCTIONS

5. EXPONENTIAL FUNCTIONS

2. APPROXIMATION IN 2-NORM, WITH

1. GENERAL FUNCTIONS

7. 1. 2. SEE ALSO SECTION 5.1.3.1

PROCEDURE

DESCRIPTION
FILENAMEREC
NR

USE

EXT
REFS18AAF
S18ABF
S18ACF
S18ADFNUMPASFTNDOC
NUMPASFTNDOC
NUMPASFTNDOC
NUMPASFTNDOCNAGF
NAGF
NAGF
NAGFFORTRAN
FORTRAN
FORTRAN
FORTRANMMKELD
MMKELO
MMKELINUMPASFTNDOC
NUMPASFTNDOC
NUMPASFTNDOCIMSL
IMSL
IMSLFORTRAN
FORTRAN
FORTRANBESS JAPLUSN
BESS YA01
BESS YAPLUSN
BESS PQA01
S17ADFNOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NUMPASFTNDOC

NAGF

FORTRAN

BESS IAPLUSN
BESS KA01
BESS KAPLUSN
NONEXP BESS IAPLUSN
NONEXP BESS KA01
NONEXP BESS KAPLUSNNOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLESPHER BESS J
SPHER BESS Y
SPHER BESS I
SPHER BESS K
NONEXP SPHER BESS I
NONEXP SPHER BESS KNOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLE
NOT YET AVAILABLEAIRY
AIRYZEROSNOT YET AVAILABLE
NOT YET AVAILABLENEWTON
E01AAF
E01ABFNOT YET AVAILABLE
NUMPASFTNDOC
NUMPASFTNDOCNAGF
NAGFFORTRAN
FORTRAN

PICSIU

NUMPASFTNDOC

NMP, IMSL

FORTRAN

	PROCEDURE	DESCRIPTION FILENAME	REC NR	USE	EXT REF
7. 1. 2. 2. POLYNOMIALS 1. GENERAL POLYNOMIALS 2. ORTHOGONAL POLYNOMIALS	RLFOTH RLFOTW	NUMPASFTNDOC NUMPASFTNDOC		IMSL IMSL	FORTRAN FORTRAN
3. SPLINES 1. GENERAL SPLINES 2. NATURAL SPLINES SEE ALSO SECTION 2.2.4. 1. WITH FIXED KNOTS 2. WITH VARIABLE KNOTS	PICSPFKU PICSVKU	NUMPASFTNDOC NUMPASFTNDOC		NMP, IMSL NMP, IMSL	FORTRAN FORTRAN
4. TRIGONOMETRIC POLYNOMIALS SEE ALSO SECTION 2.5.4. 5. RATIONAL FUNCTIONS 6. EXPONENTIAL FUNCTIONS 7. SPECIAL FUNCTIONS	PRSMITZ	NOT YET AVAILABLE			
3. APPROXIMATION IN INF-NORM, WITH 1. GENERAL FUNCTIONS 2. POLYNOMIALS 1. GENERAL POLYNOMIALS	INI SNDREMEZ MINMAXPOL	NOT YET AVAILABLE NOT YET AVAILABLE NOT YET AVAILABLE			
2. ORTHOGONAL POLYNOMIALS 3. TRIGONOMETRIC POLYNOMIALS SEE ALSO SECTION 2.5.4. 4. RATIONAL FUNCTIONS	E02ACF	NUMPASFTNDOC		NAGF	FORTRAN
4. APPROXIMATION IN 1-NORM, WITH 1. GENERAL FUNCTIONS 2. POLYNOMIALS	PICSSCU	NUMPASFTNDOC		NMP, IMSL	FORTRAN
5. SMOOTHING, BY 1. SPLINES					
2. REAL DATA IN MORE DIMENSIONS 1. INTERPOLATION, WITH 1. SPLINES SEE ALSO SECTION 2.2.4.	PIBCICU PIBCIEU	NUMPASFTNDOC NUMPASFTNDOC		NMP, IMSL NMP, IMSL	FORTRAN FORTRAN
3. REAL FUNCTIONS IN 1 DIMENSION 1. POLYNOMIALS					
8. NUMBER THEORY					
9. TABLE HANDLING					