

# NAG Fortran Library Chapter Contents

## F06 – Linear Algebra Support Routines

**Note:** please refer to the Users' Note for your implementation to check that a routine is available.

### F06 Chapter Introduction

Routine Name	Mark of Introduction	Purpose
F06AAF	12	Generate real plane rotation
F06BAF	12	Generate real plane rotation, storing tangent
F06BCF	12	Recover cosine and sine from given real tangent
F06BEF	12	Generate real Jacobi plane rotation
F06BHF	12	Apply real similarity rotation to 2 by 2 symmetric matrix
F06BLF	12	Compute quotient of two real scalars, with overflow flag
F06BMF	12	Compute Euclidean norm from scaled form
F06BNF	12	Compute square root of $(a^2 + b^2)$ , real $a$ and $b$
F06BPF	12	Compute eigenvalue of 2 by 2 real symmetric matrix
F06CAF	12	Generate complex plane rotation, storing tangent, real cosine
F06CBF	12	Generate complex plane rotation, storing tangent, real sine
F06CCF	12	Recover cosine and sine from given complex tangent, real cosine
F06CDF	12	Recover cosine and sine from given complex tangent, real sine
F06CHF	12	Apply complex similarity rotation to 2 by 2 Hermitian matrix
F06CLF	12	Compute quotient of two complex scalars, with overflow flag
F06DBF	12	Broadcast scalar into integer vector
F06DFF	12	Copy integer vector
F06EAF	12	Dot product of two real vectors
F06ECF	12	Add scalar times real vector to real vector
F06EDF	12	Multiply real vector by scalar
F06EFF	12	Copy real vector
F06EGF	12	Swap two real vectors
F06EJF	12	Compute Euclidean norm of real vector
F06EKF	12	Sum absolute values of real vector elements
F06EPF	12	Apply real plane rotation
F06ERF	14	Dot product of two real sparse vectors
F06ETF	14	Add scalar times real sparse vector to real sparse vector
F06EUF	14	Gather real sparse vector
F06EVF	14	Gather and set to zero real sparse vector
F06EWF	14	Scatter real sparse vector
F06EXF	14	Apply plane rotation to two real sparse vectors
F06FAF	12	Compute cosine of angle between two real vectors
F06FBF	12	Broadcast scalar into real vector
F06FCF	12	Multiply real vector by diagonal matrix
F06FDF	12	Multiply real vector by scalar, preserving input vector
F06FEF	21	Multiply real vector by reciprocal of scalar
F06FGF	12	Negate real vector
F06FJF	12	Update Euclidean norm of real vector in scaled form
F06FKF	12	Compute weighted Euclidean norm of real vector
F06FLF	12	Elements of real vector with largest and smallest absolute value
F06FPF	12	Apply real symmetric plane rotation to two vectors
F06FQF	12	Generate sequence of real plane rotations
F06FRF	12	Generate real elementary reflection, NAG style
F06FSF	12	Generate real elementary reflection, LINPACK style
F06FTF	12	Apply real elementary reflection, NAG style
F06FUF	12	Apply real elementary reflection, LINPACK style

F06GAF	12	Dot product of two complex vectors, unconjugated
F06GBF	12	Dot product of two complex vectors, conjugated
F06GCF	12	Add scalar times complex vector to complex vector
F06GDF	12	Multiply complex vector by complex scalar
F06GFF	12	Copy complex vector
F06GGF	12	Swap two complex vectors
F06GRF	14	Dot product of two complex sparse vector, unconjugated
F06GSF	14	Dot product of two complex sparse vector, conjugated
F06GTF	14	Add scalar times complex sparse vector to complex sparse vector
F06GUF	14	Gather complex sparse vector
F06GVF	14	Gather and set to zero complex sparse vector
F06GWF	14	Scatter complex sparse vector
F06HBF	12	Broadcast scalar into complex vector
F06HCF	12	Multiply complex vector by complex diagonal matrix
F06HDF	12	Multiply complex vector by complex scalar, preserving input vector
F06HGF	12	Negate complex vector
F06HPF	12	Apply complex plane rotation
F06HQF	12	Generate sequence of complex plane rotations
F06HRF	12	Generate complex elementary reflection
F06HTF	12	Apply complex elementary reflection
F06JDF	12	Multiply complex vector by real scalar
F06JJF	12	Compute Euclidean norm of complex vector
F06JKF	12	Sum absolute values of complex vector elements
F06JLF	12	Index, real vector element with largest absolute value
F06JMF	12	Index, complex vector element with largest absolute value
F06KCF	12	Multiply complex vector by real diagonal matrix
F06KDF	12	Multiply complex vector by real scalar, preserving input vector
F06KEF	21	Multiply complex vector by reciprocal of real scalar
F06KFF	12	Copy real vector to complex vector
F06KJF	12	Update Euclidean norm of complex vector in scaled form
F06KLF	12	Last non-negligible element of real vector
F06KPF	12	Apply real plane rotation to two complex vectors
F06PAF	12	Matrix-vector product, real rectangular matrix
F06PBF	12	Matrix-vector product, real rectangular band matrix
F06PCF	12	Matrix-vector product, real symmetric matrix
F06PDF	12	Matrix-vector product, real symmetric band matrix
F06PEF	12	Matrix-vector product, real symmetric packed matrix
F06PFF	12	Matrix-vector product, real triangular matrix
F06PGF	12	Matrix-vector product, real triangular band matrix
F06PHF	12	Matrix-vector product, real triangular packed matrix
F06PJF	12	System of equations, real triangular matrix
F06PKF	12	System of equations, real triangular band matrix
F06PLF	12	System of equations, real triangular packed matrix
F06PMF	12	Rank-1 update, real rectangular matrix
F06PPF	12	Rank-1 update, real symmetric matrix
F06PQF	12	Rank-1 update, real symmetric packed matrix
F06PRF	12	Rank-2 update, real symmetric matrix
F06PSF	12	Rank-2 update, real symmetric packed matrix
F06QFF	13	Matrix copy, real rectangular or trapezoidal matrix
F06QHF	13	Matrix initialization, real rectangular matrix
F06QJF	13	Permute rows or columns, real rectangular matrix, permutations represented by an integer array
F06QKF	13	Permute rows or columns, real rectangular matrix, permutations represented by a real array
F06QMF	13	Orthogonal similarity transformation of real symmetric matrix as a sequence of plane rotations
F06QPF	13	$QR$ factorization by sequence of plane rotations, rank-1 update of real upper triangular matrix

F06QQF	13	$QR$ factorization by sequence of plane rotations, real upper triangular matrix augmented by a full row
F06QRF	13	$QR$ or $RQ$ factorization by sequence of plane rotations, real upper Hessenberg matrix
F06QSF	13	$QR$ or $RQ$ factorization by sequence of plane rotations, real upper spiked matrix
F06QTF	13	$QR$ factorization of $UZ$ or $RQ$ factorization of $ZU$ , $U$ real upper triangular, $Z$ a sequence of plane rotations
F06QVF	13	Compute upper Hessenberg matrix by sequence of plane rotations, real upper triangular matrix
F06QWF	13	Compute upper spiked matrix by sequence of plane rotations, real upper triangular matrix
F06QXF	13	Apply sequence of plane rotations, real rectangular matrix
F06RAF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real general matrix
F06RBF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real band matrix
F06RCF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real symmetric matrix
F06RDF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real symmetric matrix, packed storage
F06REF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real symmetric band matrix
F06RJF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real trapezoidal/triangular matrix
F06RKF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real triangular matrix, packed storage
F06RLF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real triangular band matrix
F06RMF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real Hessenberg matrix
F06RNF	21	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real tridiagonal matrix
F06RPF	21	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, real symmetric tridiagonal matrix
F06SAF	12	Matrix-vector product, complex rectangular matrix
F06SBF	12	Matrix-vector product, complex rectangular band matrix
F06SCF	12	Matrix-vector product, complex Hermitian matrix
F06SDF	12	Matrix-vector product, complex Hermitian band matrix
F06SEF	12	Matrix-vector product, complex Hermitian packed matrix
F06SFF	12	Matrix-vector product, complex triangular matrix
F06SGF	12	Matrix-vector product, complex triangular band matrix
F06SHF	12	Matrix-vector product, complex triangular packed matrix
F06SJF	12	System of equations, complex triangular matrix
F06SKF	12	System of equations, complex triangular band matrix
F06SLF	12	System of equations, complex triangular packed matrix
F06SMF	12	Rank-1 update, complex rectangular matrix, unconjugated vector
F06SNF	12	Rank-1 update, complex rectangular matrix, conjugated vector
F06SPF	12	Rank-1 update, complex Hermitian matrix
F06SQF	12	Rank-1 update, complex Hermitian packed matrix
F06SRF	12	Rank-2 update, complex Hermitian matrix
F06SSF	12	Rank-2 update, complex Hermitian packed matrix
F06TAF	21	Matrix-vector product, complex symmetric matrix
F06TBF	21	Rank-1 update, complex symmetric matrix
F06TCF	21	Matrix-vector product, complex symmetric packed matrix
F06TDF	21	Rank-1 update, complex symmetric packed matrix
F06TFF	13	Matrix copy, complex rectangular or trapezoidal matrix
F06THF	13	Matrix initialization, complex rectangular matrix
F06TMF	13	Unitary similarity transformation of Hermitian matrix as a sequence of plane rotations

F06TPF	13	$QR$ factorization by sequence of plane rotations, rank-1 update of complex upper triangular matrix
F06TQF	13	$QR \times k$ factorization by sequence of plane rotations, complex upper triangular matrix augmented by a full row
F06TRF	13	$QR$ or $RQ$ factorization by sequence of plane rotations, complex upper Hessenberg matrix
F06TSF	13	$QR$ or $RQ$ factorization by sequence of plane rotations, complex upper spiked matrix
F06TTF	13	$QR$ factorization of $UZ$ or $RQ$ factorization of $ZU$ , $U$ complex upper triangular, $Z$ a sequence of plane rotations
F06TVF	13	Compute upper Hessenberg matrix by sequence of plane rotations, complex upper triangular matrix
F06TWF	13	Compute upper spiked matrix by sequence of plane rotations, complex upper triangular matrix
F06TXF	13	Apply sequence of plane rotations, complex rectangular matrix, real cosine and complex sine
F06TYF	13	Apply sequence of plane rotations, complex rectangular matrix, complex cosine and real sine
F06UAF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex general matrix
F06UBF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex band matrix
F06UCF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex Hermitian matrix
F06UDF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex Hermitian matrix, packed storage
F06UEF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex Hermitian band matrix
F06UFF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex symmetric matrix
F06UGF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex symmetric matrix, packed storage
F06UHF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex symmetric band matrix
F06UJF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex trapezoidal/triangular matrix
F06UKF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex triangular matrix, packed storage
F06ULF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex triangular band matrix
F06UMF	15	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex Hessenberg matrix
F06UNF	21	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex tridiagonal matrix
F06UPF	21	1-norm, $\infty$ -norm, Frobenius norm, largest absolute element, complex Hermitian tridiagonal matrix
F06VJF	13	Permute rows or columns, complex rectangular matrix, permutations represented by an integer array
F06VKF	13	Permute rows or columns, complex rectangular matrix, permutations represented by a real array
F06VXF	13	Apply sequence of plane rotations, complex rectangular matrix, real cosine and sine
F06YAF	14	Matrix-matrix product, two real rectangular matrices
F06YCF	14	Matrix-matrix product, one real symmetric matrix, one real rectangular matrix
F06YFF	14	Matrix-matrix product, one real triangular matrix, one real rectangular matrix
F06YJF	14	Solves a system of equations with multiple right-hand sides, real triangular coefficient matrix
F06YPF	14	Rank- $k$ update of a real symmetric matrix
F06YRF	14	Rank- $2k$ update of a real symmetric matrix

F06ZAF	14	Matrix-matrix product, two complex rectangular matrices
F06ZCF	14	Matrix-matrix product, one complex Hermitian matrix, one complex rectangular matrix
F06ZFF	14	Matrix-matrix product, one complex triangular matrix, one complex rectangular matrix
F06ZJF	14	Solves system of equations with multiple right-hand sides, complex triangular coefficient matrix
F06ZPF	14	Rank- $k$ update of a complex Hermitian matrix
F06ZRF	14	Rank- $2k$ update of a complex Hermitian matrix
F06ZTF	14	Matrix-matrix product, one complex symmetric matrix, one complex rectangular matrix
F06ZUF	14	Rank- $k$ update of a complex symmetric matrix
F06ZWF	14	Rank- $2k$ update of a complex symmetric matrix

---