

# NAG Library Routine Document

## F06QSF

**Note:** before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

### 1 Purpose

F06QSF performs a  $QR$  or  $RQ$  factorization (as a sequence of plane rotations) of a real upper spiked matrix.

### 2 Specification

```
SUBROUTINE F06QSF (SIDE, N, K1, K2, C, S, A, LDA)
  INTEGER          N, K1, K2, LDA
  REAL (KIND=nag_wp) C(K2-1), S(*), A(LDA,*)
  CHARACTER(1)    SIDE
```

### 3 Description

F06QSF transforms an  $n$  by  $n$  real upper spiked matrix  $H$  to upper triangular form  $R$  by applying a real orthogonal matrix  $P$  from the left or the right.  $P$  is formed as a sequence of plane rotations in planes  $k_1$  to  $k_2$ .

If  $SIDE = 'L'$ ,  $H$  is assumed to have a row spike, with nonzero elements  $h_{k_2,k}$ , for  $k = k_1, \dots, k_2 - 1$ . The rotations are applied from the left:

$$PH = R,$$

where  $P = P_{k_2-1} \cdots P_{k_1+1} P_{k_1}$  and  $P_k$  is a rotation in the  $(k, k_2)$  plane.

If  $SIDE = 'R'$ ,  $H$  is assumed to have a column spike, with nonzero elements  $h_{k+1,k_1}$ , for  $k = k_1, \dots, k_2 - 1$ . The rotations are applied from the right:

$$HP^T = R,$$

where  $P = P_{k_1} P_{k_1+1} \cdots P_{k_2-1}$  and  $P_k$  is a rotation in the  $(k_1, k+1)$  plane.

The 2 by 2 plane rotation part of  $P_k$  has the form

$$\begin{pmatrix} c_k & s_k \\ -s_k & c_k \end{pmatrix}.$$

### 4 References

None.

### 5 Arguments

1:  $SIDE$  – CHARACTER(1) *Input*

*On entry:* specifies whether  $H$  is operated on from the left or the right.

$SIDE = 'L'$

$H$  is pre-multiplied from the left.

$SIDE = 'R'$

$H$  is post-multiplied from the right.

*Constraint:*  $SIDE = 'L'$  or  $'R'$ .

- 2: N – INTEGER *Input*  
*On entry:*  $n$ , the order of the matrix  $H$ .  
*Constraint:*  $N \geq 0$ .
- 3: K1 – INTEGER *Input*  
4: K2 – INTEGER *Input*  
*On entry:* the values  $k_1$  and  $k_2$ .  
If  $K1 < 1$  or  $K2 \leq K1$  or  $K2 > N$ , an immediate return is effected.
- 5: C(K2 – 1) – REAL (KIND=nag\_wp) array *Output*  
*On exit:*  $C(k)$  holds  $c_k$ , the cosine of the rotation  $P_k$ , for  $k = k_1, \dots, k_2 - 1$ .
- 6: S(\*) – REAL (KIND=nag\_wp) array *Input/Output*  
**Note:** the dimension of the array S must be at least  $K2 - K1$ .  
*On entry:* the nonzero elements of the spike of  $H$ :  $S(k)$  must hold  $h_{k_2,k}$  if  $SIDE = 'L'$ , and  $h_{k+1,k_1}$  if  $SIDE = 'R'$ , for  $k = k_1, \dots, k_2 - 1$ .  
*On exit:*  $S(k)$  holds  $s_k$ , the sine of the rotation  $P_k$ , for  $k = k_1, \dots, k_2 - 1$ .
- 7: A(LDA,\*) – REAL (KIND=nag\_wp) array *Input/Output*  
**Note:** the second dimension of the array A must be at least N.  
*On entry:* the upper triangular part of the  $n$  by  $n$  upper spiked matrix  $H$ .  
*On exit:* the upper triangular matrix  $R$ .
- 8: LDA – INTEGER *Input*  
*On entry:* the first dimension of the array A as declared in the (sub)program from which F06QSF is called.  
*Constraint:*  $LDA \geq \max(1, N)$ .

## 6 Error Indicators and Warnings

None.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

F06QSF is not threaded in any implementation.

## 9 Further Comments

None.

## 10 Example

None.