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Banded Linear Equations

Subroutine subprograms RBEQN and DBEQN solve a system of N simultaneous linear equations with K right-hand sides, the coefficient matrix being a band matrix with bandwidth $2M+1$:

$$\sum_{j=1}^{N} a_{ij}x_{jk} = b_{ik}, \qquad (i = 1,2,\ldots,N,\ k = 1,2,\ldots,K); \qquad (a_{ij} = 0 \text{ for } |i-j| > M).$$

Only those coefficients a_{ij} for which $|i-j| \le M$ need be supplied on entry (see **Usage**).

Structure:

SUBROUTINE subprograms
User Entry Names: RBEQN, DBEQN
Files Referenced: Printer
External References: KERMTR (N001), ABEND (Z035)

Usage:

For t = R (type REAL), t = D (type DOUBLE PRECISION),

```
CALL tBEQN(N,M,ABAND,IDIM,IFAIL,K,B)
```

N	(INTEGER) Number of equations.
M	(INTEGER) Band parameter M.
ABAND	(type according to t) Two-dimensional array whose first dimension has the value IDIM.
IDIM	(INTEGER) First dimension of array ABAND (and of array B if K $>$ 1).
IFAIL	(INTEGER) On exit, IFAIL will be set to -1 if the coefficient matrix is singular, and to 0 otherwise.
K	(INTEGER) Number of right-hand sides in array B.
B	(type according to t) In general, a two-dimensional array whose first dimension has the value IDIM. B may be one-dimensional if K = 1.

On entry, ABAND must contain the packed form of the coefficient matrix as described below, and array B must contain the matrix of right-hand sides b_{ik}. Then, provided the coefficient matrix is non-singular, IFAIL will be set to 0 and the solution x_{ik} will replace b_{ik} in B. The contents of ABAND are destroyed. If the coefficient matrix is singular, IFAIL will be set to -1. In this case the contents of ABAND and B are unpredictable.

The storage convention for ABAND is that it must contain, on entry, those coefficients a_{ij} for which $|i-j| \le$ M, stored "left-justified" as an array of N rows and at most 2M + 1 columns. For example, if N = 4 and M = 1, the coefficient matrix

$$\begin{pmatrix} a_{11} & a_{12} & 0 & 0 \\ a_{21} & a_{22} & a_{23} & 0 \\ 0 & a_{32} & a_{33} & a_{34} \\ 0 & 0 & a_{43} & a_{44} \end{pmatrix} \quad \text{is stored as} \quad \begin{pmatrix} a_{11} & a_{12} & X \\ a_{21} & a_{22} & a_{23} \\ a_{32} & a_{33} & a_{34} \\ a_{43} & a_{44} & X \end{pmatrix}$$

where X denotes elements whose value need not to be set.

If ALPHA(I,J) is a function subprogram or statement function which computes a_{ij}, the following Fortran statements will set ABAND correctly:

```
      DO 2 I =1,N
      L = 1
      DO 1 J = MAX(I-M,1),MIN(I+M,N)
      ABAND(I,L) = ALPHA(I,J)
      L = L+1
    1 CONTINUE
    2 CONTINUE
```

Method:

Gaussian elimination with row interchanges. The storage organization is as described in the reference.

Error handling:

If the integer arguments do not satisfy the conditions $1 \le M + 1 \le N \le IDIM$, $K \le 0$, a message is printed and program execution is terminated by calling ABEND (Z035).

References:

1. J.H. Wilkinson and C. Reinsch (eds.), Handbook for automatic computation, Vol.2: Linear algebra (Springer-Verlag, New York 1971) 54.

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