Warning: Subroutine EB07 performs functions which are adequately treated by routines in other standard subroutine libraries (for example, LAPACK). The use of this routine is not recommended, and it may be removed from future releases of this library.

1 SUMMARY

Finds **all the eigenvalues of an** *n* **by** *n* **general real matrix,** i.e. given $\mathbf{A}=\{a_{ij}\}_{n\times n}$, solves the equations

$$\det(\mathbf{A}-\lambda_i\mathbf{I})=0 \qquad i=1,2,...,n.$$

There is an option for scaling the rows and columns of **A** so that its elements are suitably balanced for accurate computation of its eigenvalues.

A QR method is used, see EB06A.

ATTRIBUTES — Version: 1.0.0. **Types:** EB07A; EB07AD. **Calls:** EB09, MC14 and MC15. **Original date:** June 1973. **Origin:** S.Marlow, Harwell.

2 HOW TO USE THE PACKAGE

2.1 The argument list and calling sequence

The single precision version:

```
CALL EB07A(A,IA,E,N,W,LFAIL)
```

The double precision version:

```
CALL EB07AD(A,IA,E,N,W,LFAIL)
```

A is a two-dimensional REAL (DOUBLE PRECISION in the D version) array of dimensions at least *n* x *n* (first dimension specified in IA) which must be set by the user to the elements of the matrix. It is overwritten by the subroutine.

IA is an INTEGER variable which must be set by the user to the first dimension of the array A. **Restriction:** IA ≥ *n*.

E is a two-dimensional REAL (DOUBLE PRECISION in the D version) array of first dimension 2 which will be set by the subroutine to the eigenvalues. E(1,I), E(2,I) containing the real and imaginary parts of the I the eigenvalue. Complex conjugate pairs are stored adjacent to each other.

N is an INTEGER variable which must be set by the user to *n* the order of the matrix.

W is a one-dimensional REAL (DOUBLE PRECISION in the D version) array of length at least *n*, which will be used by the subroutine as working space.

LFAIL is an INTEGER variable which is an error return parameter and will be set by the subroutine to have one of the following values.

0	successful return
–1	value of N was non-positive
$k>0$	the QR method failed to converge for the k^{th} eigenvalue.

2.2 The Common area

The subroutine uses a Common area which the user may reference by inserting a Common statement of the form

The single precision version:

```
COMMON/EB07B/ LP,LB
```

The double precision version:

```
COMMON/EB07BD/ LP,LB
```

`LP` is an `INTEGER` variable (default 6, line printer) and refers to the stream number on which diagnostic messages appear. To suppress these messages set `LP` to 0.

`LB` is an `INTEGER` variable (default 0) that indicates that no matrix balancing is done. If balancing is required its value must be non-zero.

3 GENERAL INFORMATION

Use of Common: uses common areas `EB07B/BD`, see §2.2.

Workspace: *n* words provided in `W`.

Other subroutines: calls `EB09A/AD`, `MC14A/AD` and `MC15A/AD`.

Input/Output: error messages may be printed.

4 METHOD

The matrix is first balanced if requested by the user (`MC15A/AD`). The matrix is then reduced to upper Hessenberg form using orthogonal similarity transformations (`MC14A/AD`). The eigenvalues of the Hessenberg form are then found by applying the QR method (`EB09A/AD`) see 'Handbook for Automatic Computation, Linear Algebra.' J.H. Wilkinson, C. Reinsch, Springer-Verlag.