NAG Library Routine Document

C06DBF

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

C06DBF returns the value of the sum of a Chebyshev series through the routine name.

2 Specification

```
FUNCTION C06DBF (X, C, N, S)
REAL (KIND=nag_wp) C06DBF
INTEGER            N, S
REAL (KIND=nag_wp) X, C(N)
```

3 Description

C06DBF evaluates the sum of a Chebyshev series of one of three forms according to the value of the parameter S:

$$\mathrm{S} = 1: \quad 0.5c_1 + \sum_{j=2}^{n} c_j T_{j-1}(x),$$

$$\mathrm{S} = 2: \quad 0.5c_1 + \sum_{j=2}^{n} c_j T_{2j-2}(x),$$

$$\mathrm{S} = 3: \quad \sum_{j=1}^{n} c_j T_{2j-1}(x)$$

where x lies in the range $-1.0 \leq x \leq 1.0$. Here $T_r(x)$ is the Chebyshev polynomial of order r in x, defined by $\cos(ry)$ where $\cos y = x$.

The method used is based upon a three-term recurrence relation; for details see Clenshaw (1962).

4 References

Clenshaw C W (1962) Chebyshev Series for Mathematical Functions *Mathematical tables* HMSO

5 Parameters

1: X – REAL (KIND=nag_wp) *Input*

On entry: the argument x of the series.

Constraint: $-1.0 \leq \mathrm{X} \leq 1.0$.

2: C(N) – REAL (KIND=nag_wp) array *Input*

On entry: C(j) must contain the coefficient c_j of the Chebyshev series, for $j = 1, 2, \ldots, n$.

3: N – INTEGER *Input*

On entry: n, the number of terms in the series.

4: S – INTEGER *Input*

On entry: must have the value 1, 2 or 3 according to whether the series is general, even or odd respectively (see Section 3). For all other values of S, the routine behaves as though S = 2.

6 Error Indicators and Warnings

If an error is detected in an input parameter C06DBF will act as if a soft noisy exit has been requested (see Section 3.3.4 in the Essential Introduction).

7 Accuracy

There may be a loss of significant figures due to cancellation between terms. However, provided that n is not too large, C06DBF yields results which differ little from the best attainable for the available ***machine precision*** .

8 Further Comments

The time taken increases with n.

C06DBF has been prepared in the present form to complement a number of integral equation solving routines which use Chebyshev series methods, e.g., D05AAF and D05ABF.

9 Example

This example evaluates

$$0.5 + T_1(x) + 0.5T_2(x) + 0.25T_3(x)$$

at the point $x = 0.5$.

9.1 Program Text

```
    Program c06dbfe

!     C06DBF Example Program Text

!     Mark 24 Release. NAG Copyright 2012.

!     .. Use Statements ..
      Use nag_library, Only: c06dbf, nag_wp
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter                :: n = 4, nout = 6
      Real (Kind=nag_wp), Parameter     :: c(n) = (/1.0E0_nag_wp,1.0E0_nag_wp,  &
                                           0.5E0_nag_wp,0.25E0_nag_wp/)
!     .. Local Scalars ..
      Real (Kind=nag_wp)                :: calc, x
      Integer                           :: s
!     .. Executable Statements ..
      Write (nout,*) 'C06DBF Example Program Results'

      x = 0.5E0_nag_wp
      s = 1

      calc = c06dbf(x,c,n,s)

      Write (nout,*)
      Write (nout,99999) 'Sum =', calc

99999 Format (1X,A,F8.4)
    End Program c06dbfe
```

9.2 Program Data

None.

9.3 Program Results

```
C06DBF Example Program Results

Sum =  0.5000
```