

CHEBx**PURPOSE**

Compute the Chebychev polynomial of the first kind and order x where x is an integer between 0 and 10.

DESCRIPTION

Chebychev polynomials are orthogonal polynomials defined by the following equation (the value of n specifies the order):

$$T_n(x) = \cos(n \arccos(x)) \quad (\text{EQ 6-82})$$

In practice, Chebychev polynomials are calculated as:

$$C_n(x) = \sum_{m=0}^n C_m x^m \quad (\text{EQ 6-83})$$

with the C_m coefficients being tabulated on page 795 of the Handbook of Mathematical Functions (see REFERENCE below). DATAPLOT uses tabulated coefficients to compute the Chebychev polynomial for a given value of x .

Chebychev polynomials are only orthogonal in the interval $(-1,1)$. Although DATAPLOT computes values for arguments to the Chebychev functions outside of this range, these are typically not of interest.

SYNTAX 1

LET <y2> = CHEB0(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial of order 0.

SYNTAX 2

LET <y2> = CHEB1(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial of order 1.

SYNTAX 3

LET <y2> = CHEB2(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial of order 2.

SYNTAX 4

LET <y2> = CHEB3(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial of order 3.

SYNTAX 5

LET <y2> = CHEB4(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial of order 4.

SYNTAX 6

LET <y2> = CHEB5(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 5.

SYNTAX 7

LET <y2> = CHEB6(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 6.

SYNTAX 8

LET <y2> = CHEB7(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 7.

SYNTAX 9

LET <y2> = CHEB8(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 8.

SYNTAX 10

LET <y2> = CHEB9(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 9.

SYNTAX 11

LET <y2> = CHEB10(<y1>) <SUBSET/EXCEPT/FOR qualification>

where <y1> is a variable or a parameter;

<y2> is a variable or a parameter (depending on what <y1> is) where the computed Chebychev polynomial value is stored; and where the <SUBSET/EXCEPT/FOR qualification> is optional.

This syntax computes the Chebychev polynomial or order 10.

EXAMPLES

LET A = CHEB3(-2)

LET X2 = CHEB2(X1)

LET X2 = CHE5(X1-4)

NOTE

For order 0 (i.e., $n = 0$), $T_0(x) = \cos(0) = 1$.

For order 1 (i.e., $n = 1$), $T_1(x) = \cos(\arccos(x)) = x$.

For order 2 (i.e., $n = 2$), $T_2(x) = \cos(2\arccos(x)) = 2x^2 - 1$.

For order 3 (i.e., $n = 3$), $T_3(x) = 4x^3 - 3x$.

For order 4 (i.e., $n = 4$), $T_4(x) = 8x^4 - 8x^2 + 1$.

For order 5 (i.e., $n = 5$), $T_5(x) = 16x^5 - 20x^3 + 5x$.

For order 6 (i.e., $n = 7$), $T_6(x) = 32x^6 - 48x^4 + 18x^2 - 1$.

For order 7 (i.e., $n = 7$), $T_7(x) = 64x^7 - 112x^5 + 56x^3 - 7x$.

For order 8 (i.e., $n = 8$), $T_8(x) = 128x^8 - 256x^6 + 160x^4 - 32x^2 + 1$.

For order 9 (i.e., $n = 9$), $T_9(x) = 256x^9 - 576x^7 + 432x^5 - 120x^3 + 9x$.

For order 10 (i.e., $n = 10$), $T_{10}(x) = 512x^{10} - 1280x^8 + 1120x^6 - 400x^4 + 50x^2 - 1$.

DEFAULT

None

SYNONYMS

None

RELATED COMMANDS

BESS0	=	Compute the Bessel function of the first kind, order 0.
BESS1	=	Compute the Bessel function of the first kind, order 1.

REFERENCE

"Handbook of Mathematical Functions, Applied Mathematics Series, Vol. 55," Abramowitz and Stegun, National Bureau of Standards, 1964 (Chapter 22).

APPLICATIONS

Special functions, approximating functions

IMPLEMENTATION DATE

Pre-1987

PROGRAM

```
XLIMITS -1 1; XTIC OFFSET 0.1 0.1
YLIMITS -1 1; YTIC OFFSET 0.1 0.1
MULTIPLY 4 3; MULTIPLY CORNER COORDINATES 0 0 100 100
TITLE SIZE 3.5
TIC LABEL SIZE 3
LET STRING S = CHEB
LOOP FOR K = 0 1 10
  TITLE CHEBYCHEV POLYNOMIALS ORDER ^K
  LET STRING CHEB = ^S&^K
  PLOT ^CHEB(X) FOR X = -1 .05 1
END OF LOOP
END OF MULTIPLY
```

