Abs(z)
Returns the complex modulus (or magnitude) of a complex number.

abs(-3)
3

abs(-x)
abs[x]

abs(\im)
1

AiryAi(z)
Returns the **Airy** function **Ai**(z).

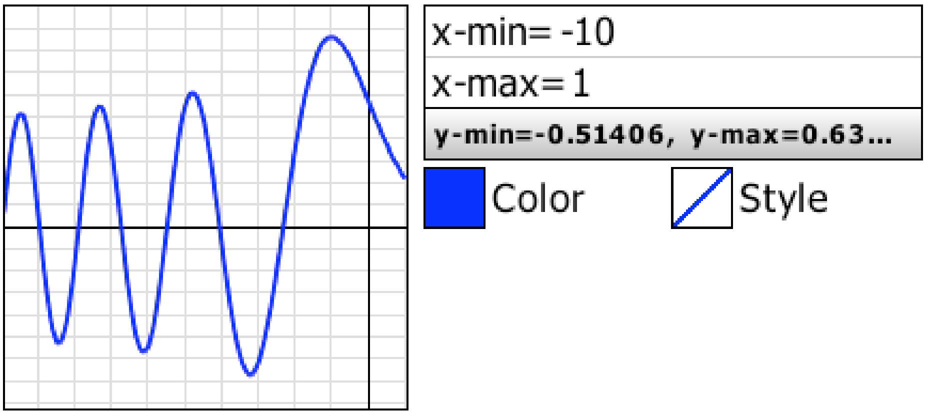
AiryAi(2)
0.03492413

AiryAi(3-\im)
-0.00180757+0.00730724ⅈ

AiryAi(\pi/2)
0.06512049

AiryAi(-9)
-0.02213365

Plot(AiryAi(x),x=[-10,1],numbers=0)



AiryBi(z)

Returns the **Airy** function **Bi**(z).

AiryBi(0)

0.61492663

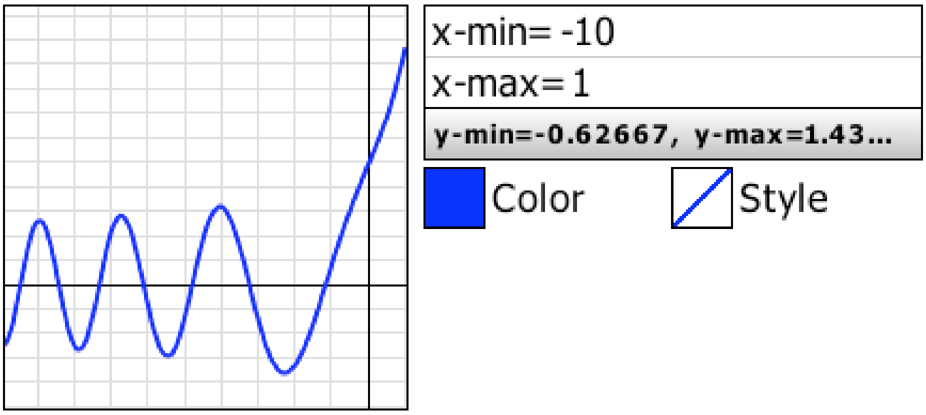
AiryBi(10)

455641153.54822493

AiryBi(1+\im)

0.71666+0.61989ı

Plot(AiryBi(x),x=[-10,1],numbers=0)



AlternatingSeries(n, [terms])

This function approximates the given real number in an alternating series.

The result is returned in a matrix with the top row = numerator and the bottom row = denominator of the different terms.

Note the alternating sign in the numerator!

AlternatingSeries(\pi,7)

3	1	-1	1	-1	1	-1
1	7	742	11978	3740526	1099482930	2202719155

AlternatingSeries(ln(2),10)

0	1	-1	1	-1	1	-1	1	-1	1
1	1	3	30	130	1144	24376	101105	234330	1058658

AlternatingSeries(sqrt(2),10)

1	1	-1	1	-1	1	-1	1	-1	1
1	2	10	60	348	2030	11830	68952	401880	2342330

AlternatingSeries(-3.23)

-3	-1	1	-1	1
1	4	36	117	1300

AlternatingSeries(123456789/987654321)

0	1	-1
1	8	877914888

AlternatingSeries(.666)

0	1	-1	1	-1
1	1	2	6	1500

AlternatingSeries(.12121212)

0	1	-1	1	-1
1	8	200	825	825000000

AlternatingSeries(.36363)

0	1	-1	1	-1	1	-1
1	2	6	33	157091	408051013	2857300000

Angle(A, B)

Returns the angle between the two vectors A and B.

Angle([a@1,b@1,c@1],[a@2,b@2,c@2])

$$\operatorname{acos}\left[\frac{a_1 a_2}{\sqrt{\operatorname{abs}[a_2]^2+\operatorname{abs}[b_2]^2+\operatorname{abs}[c_2]^2}\sqrt{\operatorname{abs}[a_1]^2+\operatorname{abs}[b_1]^2+\operatorname{abs}[c_1]^2}}+\frac{b_1 b_2}{\sqrt{\operatorname{abs}[a_2]^2+\operatorname{abs}[b_2]^2+\operatorname{abs}[c_2]^2}\sqrt{\operatorname{abs}[a_1]^2+\operatorname{abs}[b_1]^2+\operatorname{abs}[c_1]^2}}+\frac{c_1 c_2}{\sqrt{\operatorname{abs}[a_2]^2+\operatorname{abs}[b_2]^2+\operatorname{abs}[c_2]^2}\sqrt{\operatorname{abs}[a_1]^2+\operatorname{abs}[b_1]^2+\operatorname{abs}[c_1]^2}}\right]$$

Angle([1,2,3],[4,5,6])

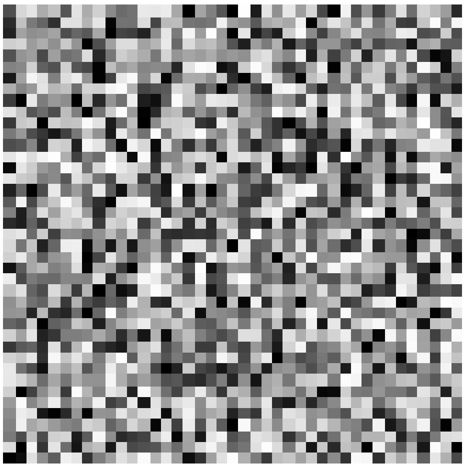
0.22573

Animate(variable, start, end, [step])

This function creates an animated entry. The **variable** is initialized to the **start** value and at each frame is incremented by **step** and the entry is reevaluated creating animation.

When the **variable** is greater than the value **end** it is set back to **start**.

Animate(n,1,100) ImagePlot(Random(0,1,n,n))



Apart(f(x), x)

Performs partial fraction decomposition on the polynomial function.

Apart performs the opposite operation of Together.

Apart((a+b)/(a*b),a)

$$\frac{a+b}{a\,b}$$

Apart((a+b)/(a*b),b)

$$\frac{a+b}{a\,b}$$

Apart((x^2+x+1)/((x-2)(x^2+3)))

$$\frac{1}{x-2}+\frac{1}{x^{2}+3}$$

Apart((2x^2+3x+5)/(x^2+2x+1))

$$-\frac{1}{x+1}+\frac{4}{\left[x+1\right]^{2}}+2$$

Append(expression1, expression2)

Appends one expression to end of another expression.

Append([1,2,3],4)
$[1, 2, 3, 4]$

Append([1,2,3],[4,5,6])
$[1, 2, 3, 4, 5, 6]$

Append(ab,c)
abc

Append(a,1)
a1

Arg(z)

Returns the argument (or phase) of a complex number.

The value is dependent on the angle setting which can be radians or degrees. You can manually set the angle mode per entry by using the keyword **radians** or **degrees**.

radians arg(2+2\im)
0.7854

degrees arg(2+2\im)
45

Bernoulli(n, [z])

Returns the n^{th} Bernoulli number n.

If **z** is given, returns the n^{th} Bernoulli polynomial of z.

Bernoulli(3,a)

$$a^3 - \frac{3a^2}{2} + \frac{a}{2}$$

Bernoulli(n,1/2)

$$-\mathrm{Bernoulli}[n] + 2^{[-n+1]}\mathrm{Bernoulli}[n]$$

Bernoulli(n,3)

$$n + n\,2^{[n-1]} + \mathrm{Bernoulli}[n]$$

Bernoulli(n,-z)

$$\frac{n z^n [-1]^n}{z} + [-1]^n \mathrm{Bernoulli}[n,\ z]$$

Bernoulli(n,5)

$$n + n\,4^{[n-1]} + n\,3^{[n-1]} + n\,2^{[n-1]} + \mathrm{Bernoulli}[n]$$

Bernoulli(n,-5)

$$\frac{n 5^n [-1]^n}{5} + n[-1]^n + n\,4^{[n-1]}[-1]^n + n\,3^{[n-1]}[-1]^n + n[-1]^n\,2^{[n-1]} + [-1]^n \mathrm{Ber}$$

Bernoulli(3,5)

90

Bernoulli(4,5)

$$\frac{11999}{30}$$

BesselI(v, z)

Returns the Modified Bessel function of the first kind.

BesselI(0,15\im)

-0.01422

BesselI(1,14.99)

BesselI(-1,15)

328124.92197

BesselI(1,30)

768532038938.95691

BesselI(1/2,x)+BesselK(1/2,x)+BesselY(1/2,x)+BesselJ(1/2,x)

$$-\sqrt{\frac{2}{x\,\pi}}\cos\left[x\right]+\frac{\sqrt{\frac{2\,\pi}{x}}\,e^{\left[-x\right]}}{2}+\sqrt{\frac{2}{x\,\pi}}\sinh\left[x\right]+\sqrt{\frac{2}{x\,\pi}}\sin\left[x\right]$$

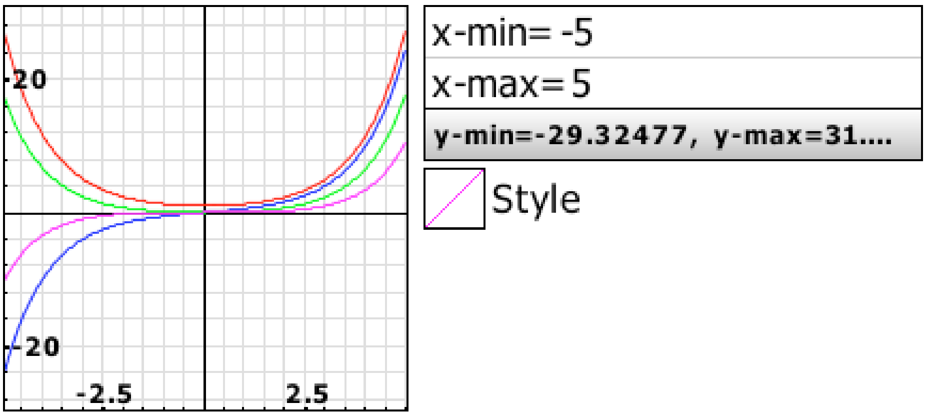
BesselI(3,x+1)

$$-\frac{4\,\mathrm{BesselI}\left[0,\ x+1\right]}{x+1}+\frac{8\,\mathrm{BesselI}\left[1,\ x+1\right]}{\left[x+1\right]^{2}}+\mathrm{BesselI}\left[1,\ x+1\right]$$

BesselI(3,x)

$$-\frac{4\,\mathrm{BesselI}\left[0,\ x\right]}{x}+\frac{8\,\mathrm{BesselI}\left[1,\ x\right]}{x^{2}}+\mathrm{BesselI}\left[1,\ x\right]$$

Plot([BesselI(0,x),BesselI(1,x),BesselI(2,x),BesselI(3,x)],colors=[red,blue,green,magenta])



BesselJ(v, z)

Returns the Bessel function of the first kind.

BesselJ(0,1)

0.76519769

BesselJ(1,1)

0.44005059

BesselJ(2,1-\im)

0.04157989-0.24739764$\mathbb{i}$

BesselJ(2,x)

$$-\mathrm{BesselJ}[0,\ x]+\frac{2\,\mathrm{BesselJ}[1,\ x]}{x}$$

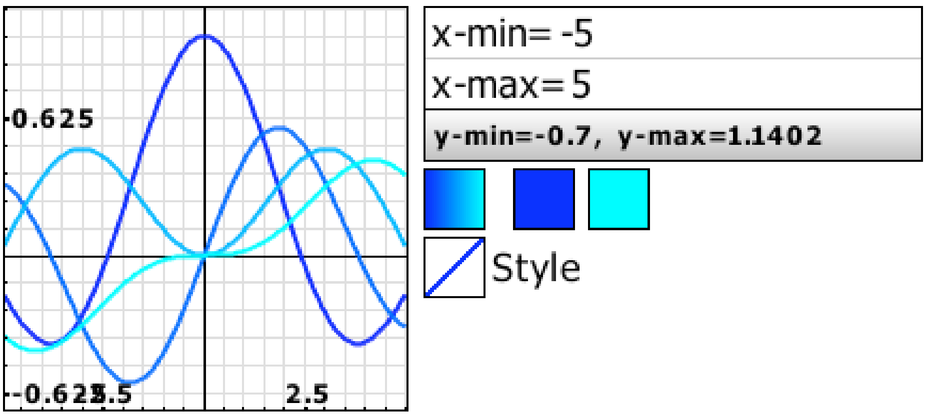
BesselJ(3,-x)

$$-\frac{8\,\mathrm{BesselJ}[1,\ x]}{x^{2}}+\frac{4\,\mathrm{BesselJ}[0,\ x]}{x}+\mathrm{BesselJ}[1,\ x]$$

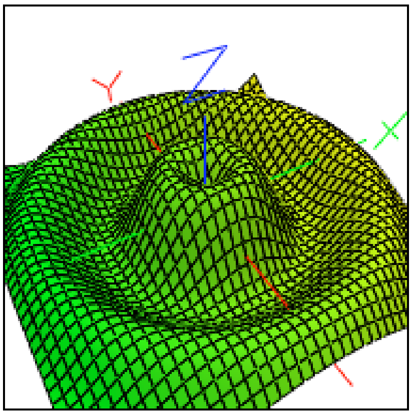
BesselJ(5/2,x)

$$-\frac{3\sqrt{\frac{2}{x\,\pi}}\cos[x]}{x}-\sqrt{\frac{2}{x\,\pi}}\sin[x]+\frac{3\sqrt{\frac{2}{x\,\pi}}\sin[x]}{x^{2}}$$

Plot([BesselJ(0,x),BesselJ(1,x),BesselJ(2,x),BesselJ(3,x)])



Plot3D(BesselJ(1,sqrt(x^2+y^2)),x=[-10,10],y=[-10,10],z=[-2,2])



x-min= -10
x-max= 10
y-min= -10
y-max= 10
z-min=-2, z-max=2, PlotPoint...

Diff(BesselJ(2,3z),z)

$$\frac{2\left[-\frac{\mathrm{BesselJ}\left[1,\ 3z\right]}{z^{2}}+\frac{3\left[-\frac{\mathrm{BesselJ}\left[1,\ 3z\right]}{3z}+\mathrm{BesselJ}\left[0,\ 3z\right]\right]}{z}\right]}{3}+3\,\mathrm{BesselJ}\left[1,\ 3z\right]$$

BesselK(v, z)

Returns the Modified Bessel function of the second kind.

BesselK(0,0)

∞

BesselK(0,2)

0.11389

BesselK(2.3,1.5)

0.79212

BesselK(3/2,x)

$$\frac{\sqrt{\frac{2\pi}{x}}\,e^{\left[-x\right]}}{2x}+\frac{\sqrt{\frac{2\pi}{x}}\,e^{\left[-x\right]}}{2}$$

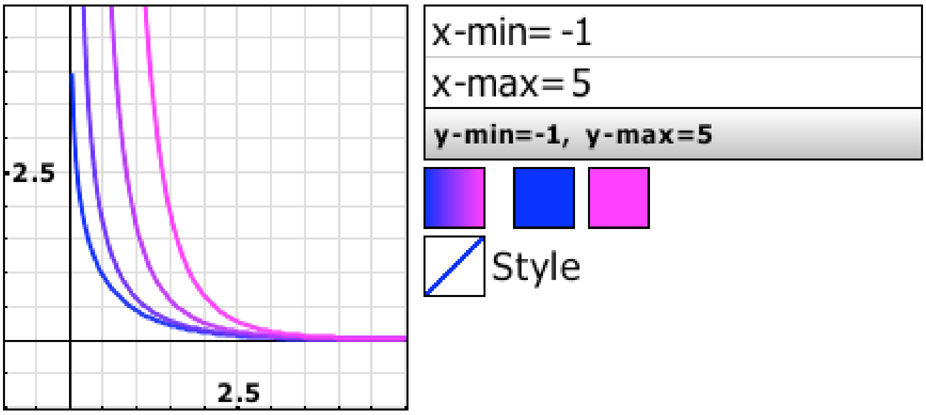
BesselK(3/2,-z)

$$-\frac{\sqrt{-\frac{2\pi}{z}}\,e^{z}}{2z}+\frac{\sqrt{-\frac{2\pi}{z}}\,e^{z}}{2}$$

BesselK(1,2+3\im)

$-0.0865+0.03906i$

Plot([BesselK(0,x),BesselK(1,x),BesselK(2,x),BesselK(3,x)],x=[-1,5])



BesselY(v, z)

Returns the Bessel function of the second kind.

BesselY(0,1)

$$\frac{0.27727}{\pi}$$

BesselY(2,x)

$$-\mathrm{BesselY}[0,\ x]+\frac{2\,\mathrm{BesselY}[1,\ x]}{x}$$

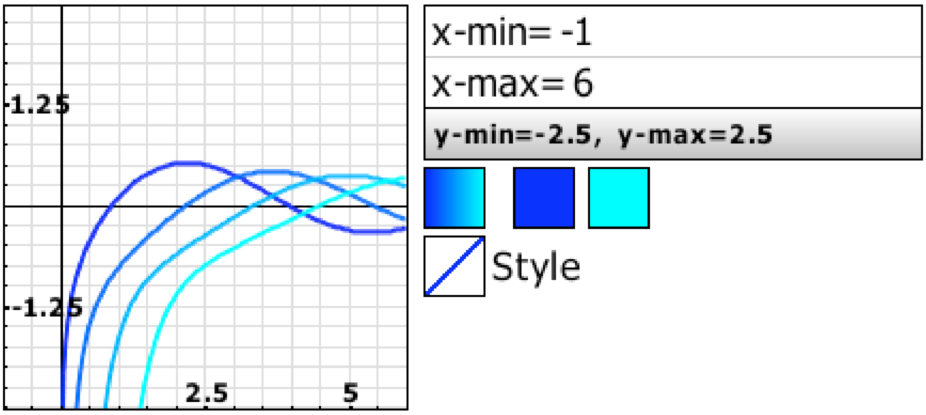
BesselY(1.23,45.67)

-0.10037

BesselY(3/2,x)

$$-\frac{\sqrt{\frac{2}{x\,\pi}}\cos[x]}{x}-\sqrt{\frac{2}{x\,\pi}}\sin[x]$$

Plot([BesselY(0,x),BesselY(1,x),BesselY(2,x),BesselY(3,x)],x=[-1,6],y=[-2.5,2.5])



Beta(m, n)

Calculates the Beta function of **m, n** both real or complex variables.

Beta(m,n)

$$\frac{\text{Gamma}[m]\,\text{Gamma}[n]}{\text{Gamma}[m+n]}$$

Beta(2n,n)

$$\frac{2\,\pi\,3^{\left[-3\,n+\frac{1}{2}\right]}\,2^{\left[2\,n-\frac{1}{2}\right]}\,\text{Gamma}[n]\,\text{Gamma}\left[n+\frac{1}{2}\right]}{\sqrt{2\,\pi}\,\text{Gamma}\left[n+\frac{1}{3}\right]\text{Gamma}\left[n+\frac{2}{3}\right]}$$

Beta(n+3,n)

$$\frac{[n+1][n+2]\sqrt{2\,\pi}\,2^{\left[-2\,n+\frac{1}{2}\right]}\,\text{Gamma}[n]}{2\,[2\,n+1][2\,n+2]\,\text{Gamma}\left[n+\frac{1}{2}\right]}$$

Beta(a/2,3)

$$\frac{4}{a\left[\frac{a}{2}+1\right]\left[\frac{a}{2}+2\right]}$$

Beta(a,-b)

$$-\frac{\pi\,\mathrm{Gamma}\left[a\right]\csc\left[b\,\pi\right]}{b\,\mathrm{Gamma}\left[a-b\right]\mathrm{Gamma}\left[b\right]}$$

Beta(5,2)-Beta(2,5)

0

Binomial(n, r)

Finds the binomial coefficient. This function is the symbolic equivalent to nCr(n,r).

Binomial(n,3)

$$\frac{n\left[n-2\right]\left[n-1\right]}{6}$$

Binomial(1,4/5)

1.16936

Binomial(2,1/2)

$$\frac{16}{3\,\pi}$$

Binomial(n-5,n-7)

$$\frac{\left[n-6\right]\left[n-5\right]}{2}$$

Binomial(n,7)

$$\frac{n\left[n-6\right]\left[n-5\right]\left[n-4\right]\left[n-3\right]\left[n-2\right]\left[n-1\right]}{5040}$$

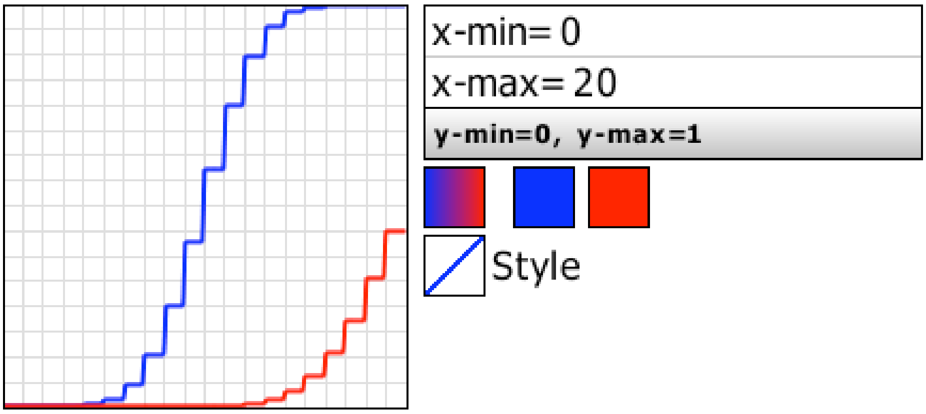
Binomial(n,5)

$$\frac{n[n-4][n-3][n-2][n-1]}{120}$$

BinomialCDF(n, p, x)

Computes the cumulative Binomial distribution at x with number of trials **n** and probability of success **p** on each trial.

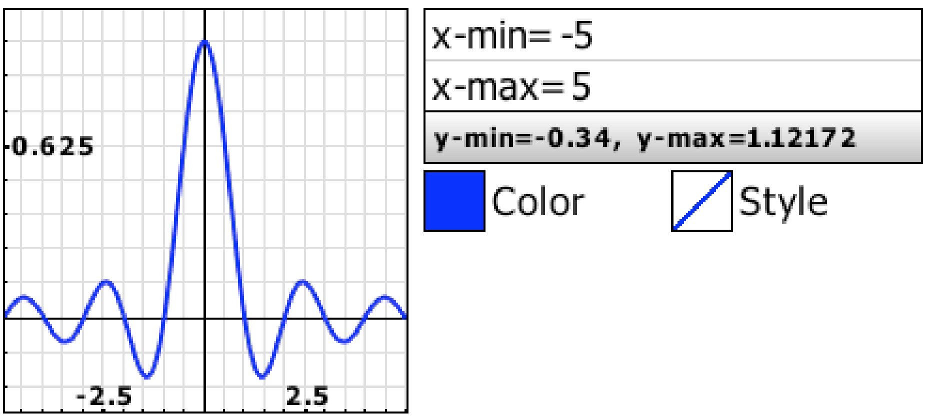
Plot(BinomialCDF(20,0.5,x),BinomialCDF(40,0.5,x),x=[0,20],y=[0,1],numbers=0)



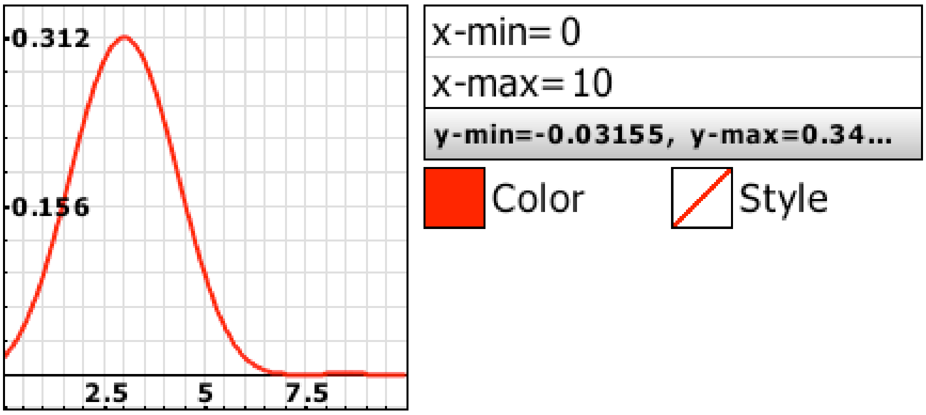
BinomialPDF(n, p, x)

Computes the binomial distribution at **x** with number of trials **n** and probability of success **p** on each trial.

Plot(BinomialPDF(0,0.5,x))



Plot(BinomialPDF(6,0.5,x),x=[0,10])



BodePlot(function, variable, minimum, maximum, mode)

BodePlot creates a Bode plot for the given function.

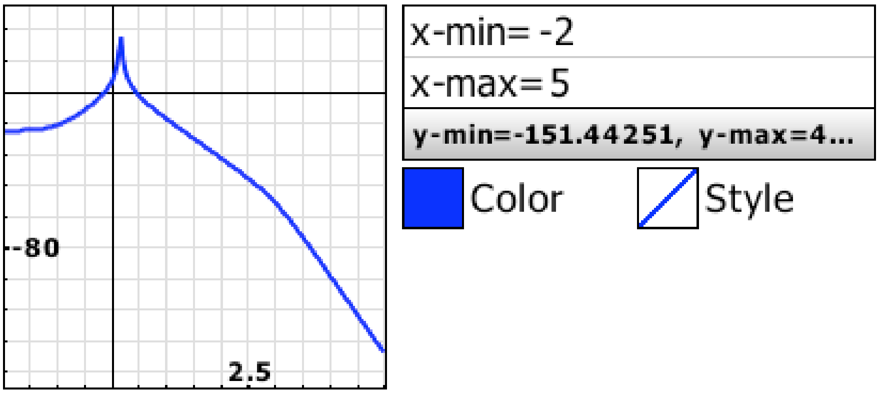
The x-axis is a logarithmic scale and represents the frequency in rad/sec.

- x = -2 : => ? = 0.01 rad/sec
- x = -1 : => ? = 0.1 rad/sec
- x = 0 : => ? = 1 rad/sec
- x = 1 : => ? = 10 rad/sec
- x = 2 : => ? = 100 rad/sec
- x = 3 : => ? = 1000 rad/sec

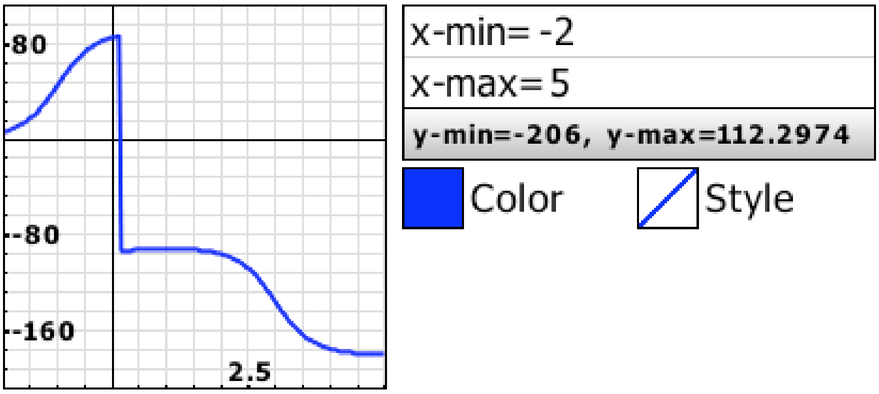
When the frequency is not given, then $?_{min}$ = 0.01 rad/sec and $?_{max}$ = 1000 rad/sec.

The y-axis is either the magnitude in dB (mode=0) or the phase in degrees (mode=1) or the phase in radians (mode=2).

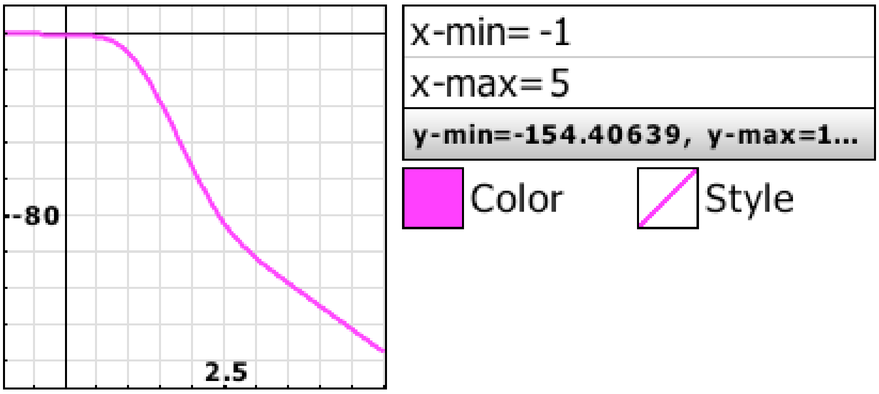
BodePlot((0.1+s)/((0.001s+1)*(1+0.5s^2)),s,0.01,10000,0)



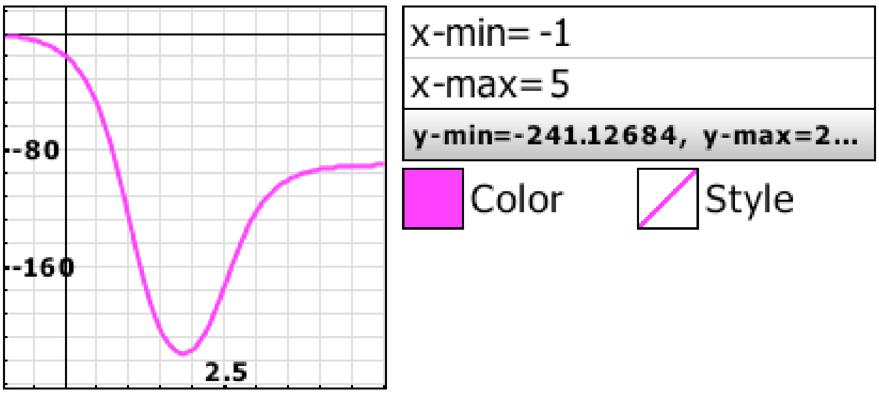
BodePlot((0.1+s)/((0.001s+1)*(1+0.5s^2)),s,0.01,10000,1)



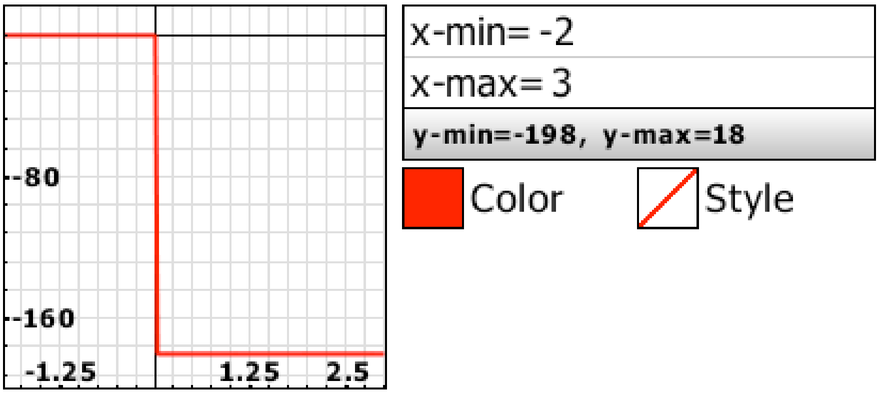
BodePlot((30+s/10)^2/((s+10)^3),s,0.1,1000)



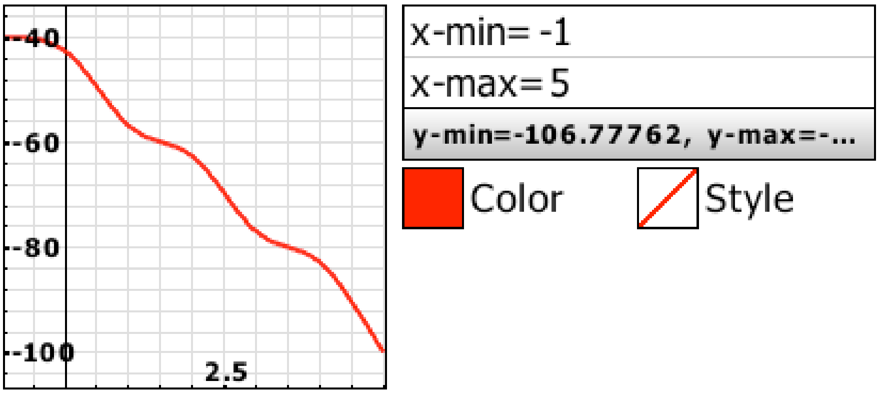
BodePlot((30+s/10)^2/((s+10)^3),s,0.1,1000,1)



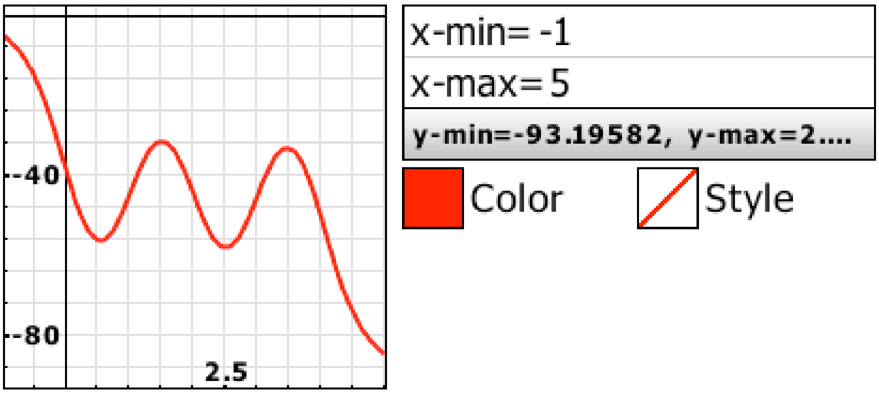
BodePlot(1/(1+s^2),s,0.01,1000,1)



BodePlot((s+10)(s+1000)/((s+1)*(s+100)*(s+10000)),s,0.1,100000,0)



BodePlot((s+10)(s+1000)/((s+1)*(s+100)*(s+10000)),s,0.1,100000,1)



Call(function, parameter1, parameter2, ...)

Executes a call to the given function and passes the included parameters to the function. The function is evaluated.

Call(sin,\pi/4)

$$\frac{\sqrt{2}}{2}$$

Call(Binomial,10,2)
45

Caps(string, index, [mode])
Tests for uppercase and lowercase letters in strings.

The mode parameter can be set to **upper** or **lower**.

Caps(Abc,1)
1

Caps(Abc,2)
0

Caps(Abc,2,upper)
ABc

Caps(Abc,1,lower)
abc

Catalan(n)
Returns the n^{th} Catalan number.

Catalan(n)

$$\frac{\text{Factorial}[2\,n]}{\text{Factorial}[n]\,\text{Factorial}[n+1]}$$

Catalan(3)
5

Catalan(10)
16796

Ceil(z)
Returns the smallest integer of the given value.

If z is a complex number, then ceil works on both the real and the imaginary part.

ceil(1.234)
2

ceil(-9.8765)
-9

ceil(-1.001)
-1

ceil(0.5)
1

---

cFrac(n, [terms])
Calculates the simple continued fraction representation of the given number n.

The result is given as a list, where the first term equals the constant term (a0) and the others the fraction terms (a1, a2, a3, ...).

n = a0 + 1/(a1 + 1/ (a2 + 1/(a3 + ...)))

cFrac(\pi)
$[3, 7, 15, 1, 292, 1, 1, 1, 2, 1, 3, 1, 14, 2, 1, 1, 2, 2, 2, 2, 1, 84, 2, 2]$

cFrac(sqrt(2),10)
$[1, 2, 2, 2, 2, 2, 2, 2, 2, 2]$

cFrac(\e,10)

$[2, 1, 2, 1, 1, 4, 1, 1, 6, 1]$

cFrac(BesselI(1,2)/BesselI(0,2))

$[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]$

cFrac(3.245)

$[3, 4, 12, 4]$

cFrac(2.25)

$[2, 4]$

Char(x)

Returns the numerical ASCII value of a character or the character of a numerical ASCII value.

char(97)

a

char(a)

97

char(A)

65

char(65)

A

ChebyshevT(n, z)

Returns the Chebyshev polynomial of the first kind.

ChebyshevT(3,a)

$4a^3 - 3a$

ChebyshevT(7,x)

$64x^7 - 112x^5 + 56x^3 - 7x$

ChebyshevT(n,1)

1

ChebyshevT(n,x)

$\cos\left[n\,\mathrm{acos}\left[x\right]\right]$

ChebyshevT(n,-1)

$\cos\left[n\pi\right]$

ChebyshevT(n,0)

$\cos\left[\frac{n\pi}{2}\right]$

ChebyshevT(n,-5)

$\cos\left[n\,\mathrm{acos}\left[-5\right]\right]$

ChebyshevT(3,5)

485

ChebyshevT(3,-5)

-485

ChebyshevT(4,5)

4801

ChebyshevT(4,-5)

4801

ChebyshevU(n, z)

Returns the Chebyshev polynomial of the second kind.

ChebyshevU(3,a)

$8 a^3 - 4 a$

ChebyshevU(7,x)

$128 x^7 - 192 x^5 + 80 x^3 - 8 x$

ChebyshevU(n,1)

$n+1$

ChebyshevU(n,x)

$$\frac{\sin\left[\left[n+1\right]\operatorname{acos}\left[x\right]\right]}{\sqrt{-x^2+1}}$$

ChebyshevU(n,-1)

ComplexInfinity

ChebyshevU(n,0)

$$\cos\left[\frac{n \pi}{2}\right]$$

ChebyshevU(n,-5)

$$\frac{-i \sin\left[\left[n+1\right]\operatorname{acos}\left[-5\right]\right]}{2\sqrt{6}}$$

ChebyshevU(3,5)

980

ChebyshevU(3,-5)

-980

ChebyshevU(4,5)

9701

ChebyshevU(4,-5)
9701

CheckBox(variable, [value])
This function dynamically changes the value of a variable or list of variables using a check box control.

The value of the variable when the control is checked is **1** and **0** when unchecked.

Chi(z)
Finds the Hyperbolic Cosine Integral of z.

Chi(-1)
$i\pi+\gamma+0.26065$

Chi(2+\im)
$\gamma+[1.45308+1.7227i]$

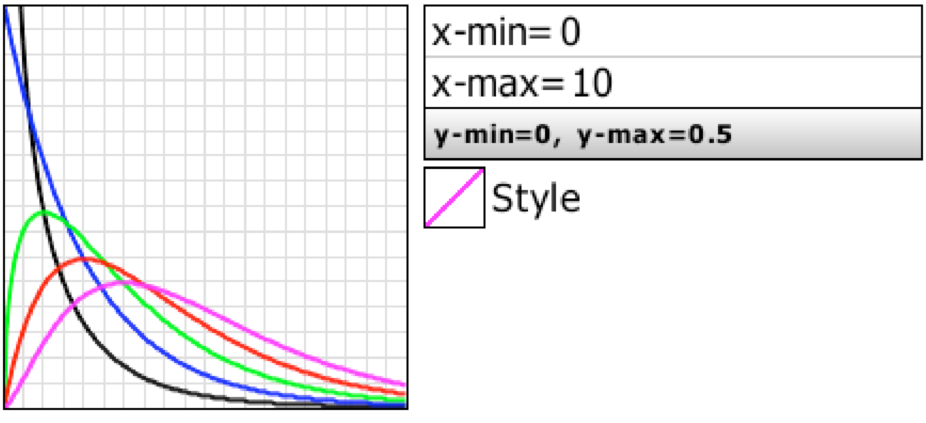
Chi(-x)
$-\ln[x]+\mathrm{Chi}[x]+\ln[-x]$

ChiSquareCDF(lower, upper, df)
Computes the ChiSquare distribution cumulative density function over the interval defined by **lower** and **upper** with degrees of freedom **df**.

ChiSquarePDF(x, df)

Plot(ChiSquarePDF(x,1),ChiSquarePDF(x,2),ChiSquarePDF(x,3),ChiSquareP

DF(x,4),ChiSquarePDF(x,5),x=[0,10],y=[0,0.5],numbers=0,colors=[black,blue, green,red,magenta])



Cholesky(A)

Returns a list with singular values of a positive definite matrix A.

This routine uses the [TNT library].

Cholesky([[10,5],[5,20]])

3.16228	0
1.58114	4.1833

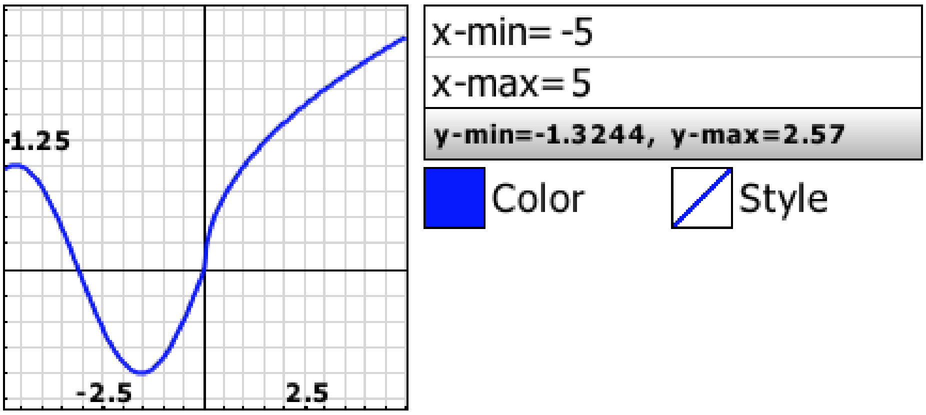
Cholesky([[5,2],[2,14]])

2.23607	0
0.89443	3.63318

Choose(test1, value1, test2, value2, ...)

Creates a piecewise-defined function.

Plot(Choose(x=0,sqrt(x)))



f(x)=Choose(x=0,sqrt(x)) f(9)

3

Ci(z)

The Cosine Integral of z.

[Ci(0),Ci(\inf),Ci(-\inf),Ci(-x)]

$\left[-\infty,\ 0,\ 3.14159 i,\ -\ln\left[x\right]+\mathrm{Ci}\left[x\right]+\ln\left[-x\right]\right]$

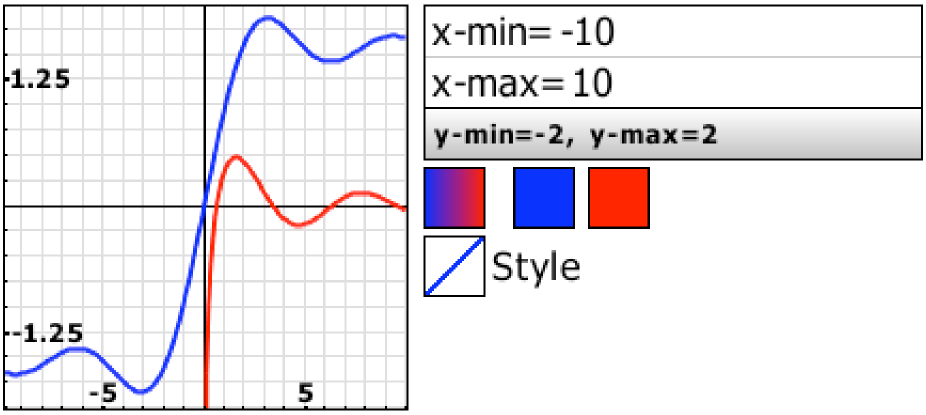
a=list(3) b=list(3) loop(i,1,3) a(i)=Si(i) b(i)=Ci(i) end [a,b]

0.94608	1.60541	1.84865
$\gamma-0.23981$	$\gamma+\ln\left[2\right]-0.84738$	$\gamma+\ln\left[3\right]-1.5562$

Ci(2+\im)

$\gamma+\left[0.007260332-0.2974951776 i\right]$

Plot([Si(x),Ci(x)],x=[-10,10],y=[-2,2])



Clear(variable, ...)

Clears a variable or list of variables.

The variable must be entered using **quotes**. You can use the keyword all to clear all variables.

a=2 Clear("a") a

a

a=2;b=3;b=4 Clear("a", "b", "c") [a,b,c]

[a, b, c]

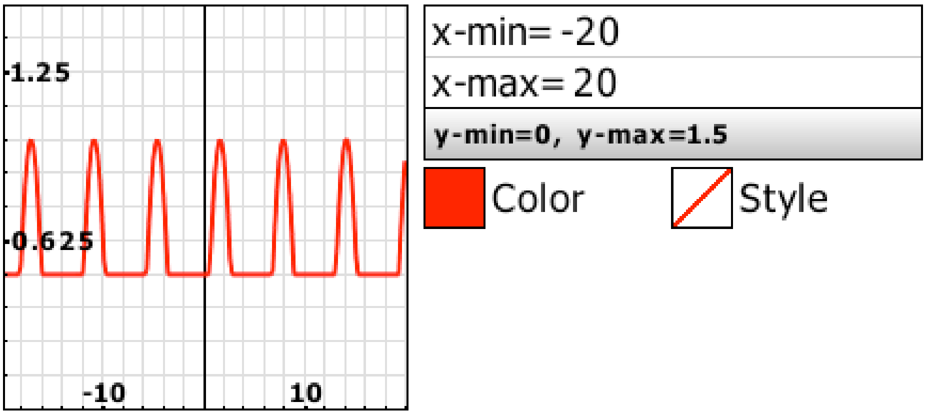
a=2;b=3;b=4 Clear(all) [a,b,c]

[a, b, c]

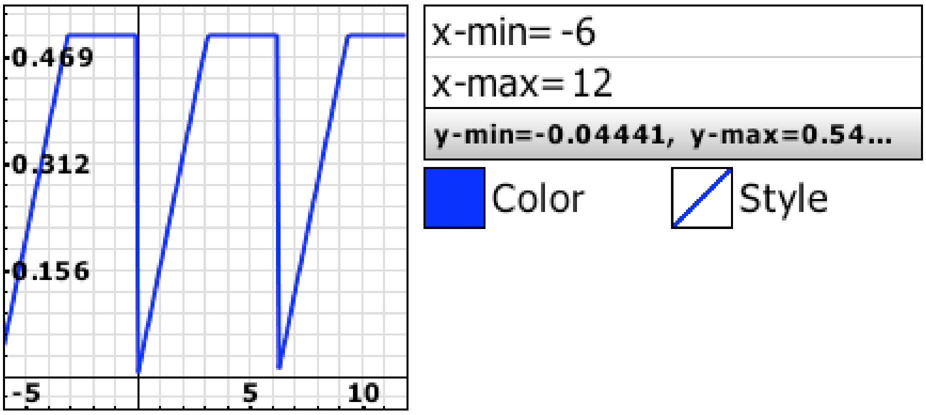
clip(x, [min], [max])

Clips 2D plot functions. Min and max are optional parameters and set to [-1,1] when not given.

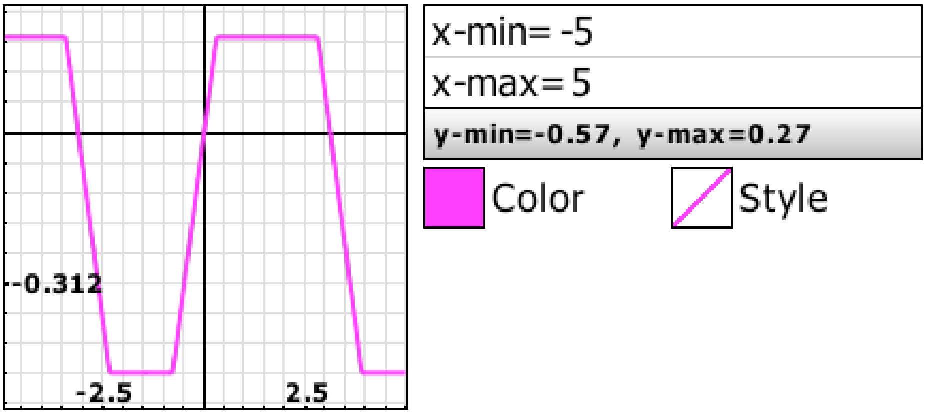
Plot(clip(HalfRectSineWave(x),0.5,1),x=[-20,20],y=[0,1.5])



Plot(clip(SawToothWave(x),0,0.5),x=[-6,12])



Plot(clip(TriangleWave(x),-0.5,0.2)



Coefficient(degree, x, f(x))

Returns the coefficient of a term in a polynomial.

Coefficient(7x^3+5x^2+3x+6,x,3)

7

Coefficient(7x^3+5x^2+3x+6,x,2)
5

Coefficient(7x^3+5x^2+3x+6,x,1)
3

Coefficient(7x^3+5x^2+3x+6,x,0)
6

---

coFactor(matrix, i, j)
Calculates the cofactor of the (i, j) entry of a matrix.

Command(setting)
This function sets or gets options for the computer algebra system in an entry. Any changes to options only affect the entry locally. You cannot globally change these options.

MatrixDetection
This option automatically detects whether a list of equal-length lists is a matrix.

List Multiplication
Command(MatrixDetection=0) [[1,2],[3,4]]*[[5,6],[7,8]]
$[[5, 12], [21, 32]]$

Matrix Multiplication
Command(MatrixDetection=1) [[1,2],[3,4]]*[[5,6],[7,8]]

19	22
43	50

Command(MatrixDetection)
1

Command(MatrixDetection=0) Command(MatrixDetection)
0

Conj(z)

Returns the complex conjugate of a complex number.

Constant(name)

Returns fundamental physical constants as a real number. The value of the constant is given in SI-units

Speed of light
light
299792458 m s^{-1}

Planck constant
6.62607554e-34 J s

Planck constant eV
4.135669212e-15 eV s

Planck hbar
hbar
1.0545726663e-34 J s

Planck hbar eV
hbar eV
6.58212202e-16 eV s

Planck mass
Pmass
2.1767114e-08 kg

Planck time
Ptime

5.3905634e-44 sec

Acceleration of gravity
gravity
9.80665 m s^{-2}

Gravitation constant
gravitation
6.6725985e-11 m^3 kg^{-1} s^{-2}

Permeability of vacuum
magnetic
1.2566370614359172e-06 N A^{-2}

Permittivity of vacuum
electric
8.8541878176208e-12 F m^{-1}

Avogadro constant
Avogadro
6.022136736e+23 mol^{-1}

Boltzmann constant
Boltzmann
1.38065812e-23 J K^{-1}

Boltzmann constant eV
Boltzmann eV
8.61738573e-05 eV K^{-1}

Molar gas constant
Molar gas
8.3145107 J mol^{-1} K^{-1}

Magnetic flux quantum
flux
2.0678346161e-15 Wb

Bohr magneton

9.274015431e-24 J T^{-1}

Bohr magneton eV
5.7883826352e-05 eV T^{-1}

Bohr radius
5.2917724924e-11 m

Rydberg constant
Rydberg
10973731.53413 m^{-1}

Faraday constant
Faraday
96485.30929 C mol^{-1}

Stefan-Boltzmann constant
Stefan-Boltzmann
5.6705119e-08 W m^{-2} K^{-4}

Wien displacement constant
Wien
0.00289775624 m K

Standard atmosphere
atm
101325 Pa

Elementary charge
electron
1.6021773349e-19 C

Electron mass
9.109389754e-31 kg

Electron mass eV
510999.0615 eV

Proton mass

1.67262311e-27 kg

Proton mass eV
938272312.8 eV

Neutron mass
1.67492861e-27 kg

Neutron mass eV
939565632.8 eV

Constant("light")
299792458

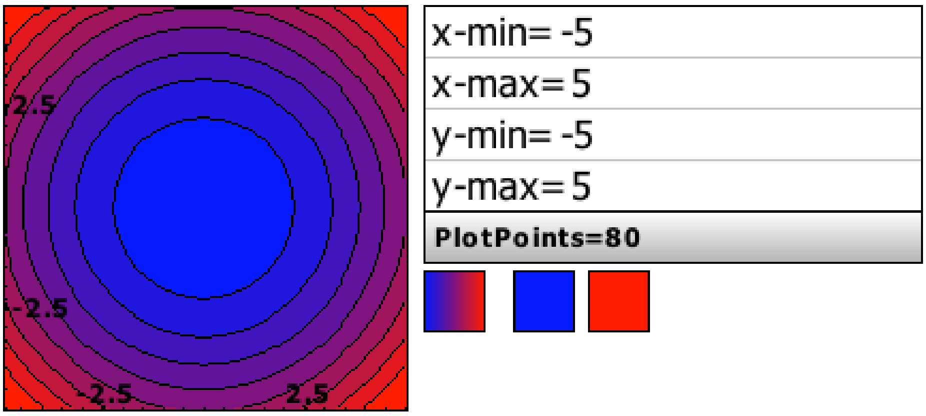
Constant("electron")
1.60218E-19

G=Constant("gravitation") g=Constant("gravity") r=6.378\sci6 Solve(G*m1*mass/r^2=m1*g,mass)
5.97853E24

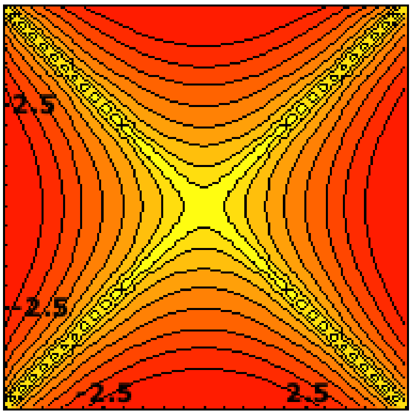
ContourPlot(expression, ...)

Plots 2D contour graphs.

ContourPlot(x^2+y^2)



ContourPlot(sqrt(abs(x^2-y^2)))



x-min= -5
x-max= 5
y-min= -5
y-max= 5
PlotPoints=80

Convergents(n, [mode=0], [terms])

The Convergent of a given number or a given continued fraction is the rational number obtained by keeping only a limited number of terms in the continued fraction (or the continued fraction of the number).

Convergents([3,7,15,1,292,1,1])

3	22	333	355	103993	104348	208341
1	7	106	113	33102	33215	66317

Convergents([3,7,15,1,292,1,1],1)

$$\left[3, \frac{22}{7}, \frac{333}{106}, \frac{355}{113}, \frac{103993}{33102}, \frac{104348}{33215}, \frac{208341}{66317}\right]$$

Convergents(2/\pi,-1)

5703436923116
8958937768937

Convergents(\pi,1,10)

$$\left[3, \frac{22}{7}, \frac{333}{106}, \frac{355}{113}, \frac{103993}{33102}, \frac{104348}{33215}, \frac{208341}{66317}, \frac{312689}{99532}, 3.14159, 3.14159\right]$$

Convergents([1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1, 1,1,1,1,1],-2)

1.61803

Cross(A, B)

Calculates the cross product of two 3-dimensional vectors A and B.

Cross([5,-8,3],[1,2,4])

$\left[-38,\ -17,\ 18\right]$

Cross([sqrt(2)/2,1,sqrt(3)/2],[x@1,x@2,x@3])

$$\left[x_{3}-\frac{x_{2}\sqrt{3}}{2},\ -\frac{x_{3}\sqrt{2}}{2}+\frac{x_{1}\sqrt{3}}{2},\ -x_{1}+\frac{x_{2}\sqrt{2}}{2}\right]$$

Curl(vector, [varlist], [mode])

Returns the curl of a vector field.

This is normally denoted as **Curl(F) = ? x F**

Curl([x/y,y/z,z/x])

$$\left[\frac{y}{z^{2}},\ \frac{z}{x^{2}},\ \frac{x}{y^{2}}\right]$$

Curl([t^2/u,u*v,v+t],[t,u,v])

$$\left[-u,\ -1,\ \frac{t^{2}}{u^{2}}\right]$$

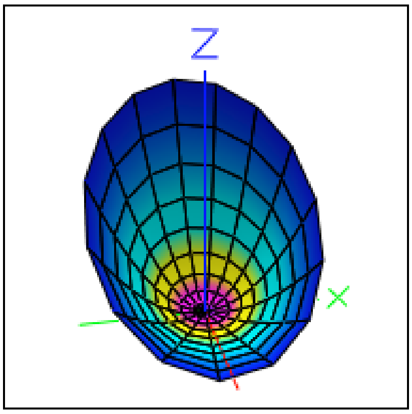
Curl([x*exp(z),y^2/(x*z),cos(z)])

$$\left[\frac{y^{2}}{x\,z^{2}},\ x\,e^{z},\ -\frac{y^{2}}{x^{2}\,z}\right]$$

CylindricalPlot3D(expression, ...)

Plots 3D parametric graphs in cylindrical coordinates.

CylindricalPlot3D((1+sin(\phi))r^2,r=[0,1],\phi=[0,2\pi])



r-min= 0
r-max= 1
r-points= 10
ϕ-min= 0
ϕ-max= 2π
ϕ-points= 16
x-min=-1, x-max=1, y-min=-1,...

D(f(x), x, [n])

Finds the derivative of the **expression** to **variable**. The optional parameter **n** finds the n[th] derivative of the expression.

See Diff for derivatives of both common and special functions.

D(x^6+3x^5-4x^3+x-1)

$6x^5+15x^4-12x^2+1$

D(f(x),x)

f'[x]

D(exp(-s*t),t)

$-s\,e^{[-st]}$

D(f(x)*g(x),x)

f'[x]g[x]+f[x]g'[x]

D(cos(x)*sin(x),x)

$-\sin[x]^2+\cos[x]^2$

D(sin(a*x)/x,x)

$-\frac{\sin[a\,x]}{x^2}+\frac{a\cos[a\,x]}{x}$

D(a^(x^2),x)

$2\,x\,a^{[x^2]}\ln[a]$

D(sqrt(x)^sqrt(x),x)

$\left[\frac{1}{2\sqrt{x}}+\frac{\ln[\sqrt{x}]}{2\sqrt{x}}\right]\sqrt{x}^{\sqrt{x}}$

Derivatives with optional nth parameter.

D(sin(3x+6),x,3)

$-27\cos[3\,x+6]$

D(exp(-s*t),t,2)

$s^2\,e^{[-s\,t]}$

D(tan(2x-4),x,3)

$16\sec[2\,x-4]^4+32\tan[2\,x-4]^2\sec[2\,x-4]^2$

D(x^6-2x^4-3x^2+1,x,6)

720

Date(letter)

Returns the current date.

date(h)

12

date(a)
pm

date(y)
2009

String(date(d),"-",date(m),"-",date(y))
4-10-2009

Animate(500) String(date(h),":",date(i),":",date(s))
12:59:55

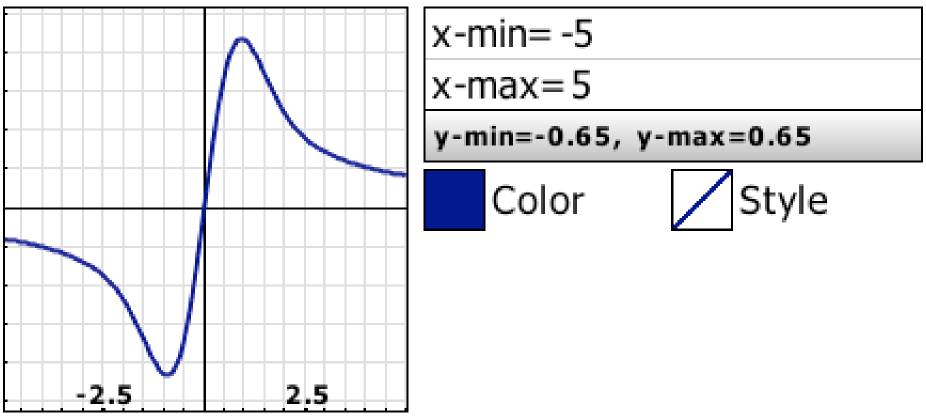
Dawson(z)
Finds the Dawson Integral.

Dawson(0)
0

Dawson(1)
0.53808

Dawson(2)
0.30134

Plot(Dawson(x))



Degree(expression)
Returns the degree of a polynomial.

Degree(x^2)
2

Degree(x^3+x^2)
3

Degree(x^10+3x+6)
10

Degree(x^10+y^6,y)
6

DEGtoDMS(angle, [digits])
Converts an angle into a string represented the angle, minutes and seconds in degrees.

DEGtoDMS(90)
90° 0'0''.000

DEGtoDMS(90.123)
90° 7'22''.800

DEGtoDMS(12.5)
12° 30'0''.000

DEGtoDMS(12.345)
12° 20'42''.000

Delete(expression, position, [length])
Deletes an expression in a list or a character in a string.

Delete([1,2,3,4,5],2)

$[1, 3, 4, 5]$

Delete("Hello World",3,7)

Held

Denominator(expression)

Returns the denominator of an expression.

Denominator(a/b)

b

Denominator(1/2)

2

Denominator((x+1)/(x+2))

$x+2$

Denominator(f(x)/g(x))

$g[x]$

Det(A)

Finds the determinant of the square matrix A.

Det([[1,2,3],[1,8,6],[2,7,9]])

9

Det([[a,b],[c,d]])

$-b\,c+a\,d$

Diff(f(x), x)

Diff is equivalent to D and finds the first derivative to a function. Diff finds the derivative to both common and special functions.

Diff(FresnelCos(f(z))^3,z)

$$3\,\mathrm{FresnelCos}\left[f\left[z\right]\right]^{2}\,f'\left[z\right]\cos\left[1.5708\,f\left[z\right]^{2}\right]$$

Diff(z^2*Zeta(z,a),z)

$$z^{2}\,\mathrm{Zeta}\left[1,\ z,\ a\right]+2\,z\,\mathrm{Zeta}\left[z,\ a\right]$$

Expand(Diff(BesselJ(3,z),z))

$$-\frac{24\,\mathrm{BesselJ}\left[1,\ z\right]}{z^{3}}-\mathrm{BesselJ}\left[0,\ z\right]+\frac{5\,\mathrm{BesselJ}\left[1,\ z\right]}{z}+\frac{12\,\mathrm{BesselJ}\left[0,\ z\right]}{z^{2}}$$

Diff(Beta(f(z1),g(z2)),z2)

$$-\frac{\mathrm{Gamma}\left[f\left[z1\right]\right]\mathrm{Gamma}\left[g\left[z2\right]\right]\mathrm{Psi}\left[f\left[z1\right]+g\left[z2\right]\right]g'\left[z2\right]}{\mathrm{Gamma}\left[f\left[z1\right]+g\left[z2\right]\right]}+\frac{\mathrm{Gamma}\left[f\left[z1\right]\right]\mathrm{Gamma}\left[g\left[z2\right]\right]\mathrm{Psi}\left[g\left[z2\right]\right]g'\left[z2\right]}{\mathrm{Gamma}\left[f\left[z1\right]+g\left[z2\right]\right]}$$

Diff(tan(x)/(-6x+7)+7*exp(2x+x^2/7)^5-ln(x)/(exp(y)*x^2),x)

$$-\frac{e^{\left[-y\right]}}{x^{3}}+\frac{\sec\left[x\right]^{2}}{-6\,x+7}+\frac{2\ln\left[x\right]e^{\left[-y\right]}}{x^{3}}+\frac{6\tan\left[x\right]}{\left[-6\,x+7\right]^{2}}+35\left[\frac{2\,x}{7}+2\right]e^{\left[5\left[\frac{x^{2}}{7}+2\,x\right]\right]}$$

Diff(Gamma(a,f(z))+Psi(h(z)),z)

$$-f\left[z\right]^{\left[a-1\right]}f'\left[z\right]e^{\left[-f\left[z\right]\right]}+\mathrm{PolyGamma}\left[1,\ h\left[z\right]\right]h'\left[z\right]$$

Diff(Erf(3x)-Erfc(x),x)

$$\frac{2\,e^{\left[-x^{2}\right]}}{\sqrt{\pi}}+\frac{6\,e^{\left[-9\,x^{2}\right]}}{\sqrt{\pi}}$$

Diff(Si(2z)+Ci(3z)+Ei(4z)+Li(5z),z)

$$\frac{\cos[3z]}{z}+\frac{\sin[2z]}{z}+\frac{e^{[4z]}}{z}+\frac{5}{\ln[5z]}$$

DiGamma(z)

Returns the logarithmic derivative of the gamma function.

Plot(DiGamma(x))

x-min= -5
x-max= 5
y-min=-5, y-max=5
Color Style

DiGamma(0)

$-\infty$

DiGamma(2)

0.42278

DiGamma(4)

1.25612

DiLog(z)

This function is the same as PolyLog(2,z).

Dirichlet_Eta(z)

This function is closely related to the Riemann Zeta function.

Dirichlet_Eta(z)

$$\left[-2^{\left[-z+1\right]}+1\right]\mathrm{Zeta}\left[z\right]$$

Dirichlet_Eta(2z+1)

$$\left[-2^{\left[-2z\right]}+1\right]\mathrm{Zeta}\left[2z+1\right]$$

Dirichlet_Eta(1)

$$\ln\left[2\right]$$

Dirichlet_Eta(3)

0.90154

Dirichlet_Eta(-3)

$$-\frac{1}{8}$$

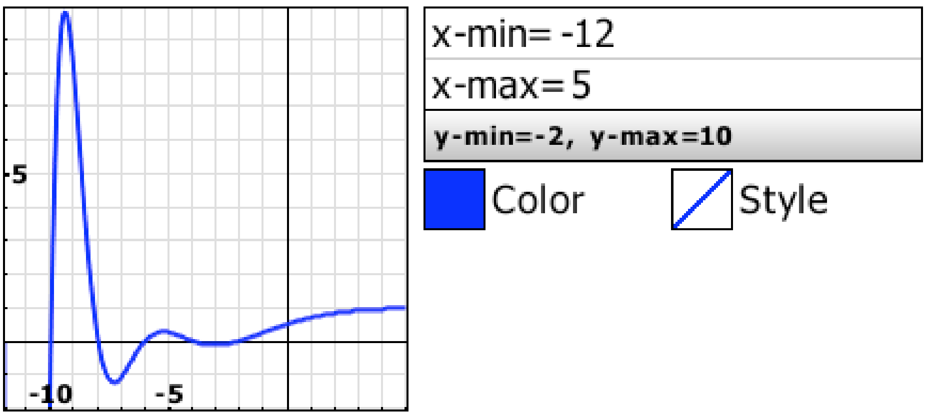
Dirichlet_Eta(-10)

0

Dirichlet_Eta(-11)

$$-\frac{691}{8}$$

Plot(Dirichlet_Eta(x),x=[-12,5],y=[-2,10])



Dirichlet_Lambda(z)

Returns the Dirichlet L-series and is closely related to the Riemann Zeta function.

Dirichlet_Lambda(z)

$\left[-2^{\left[-z\right]}+1\right]\mathrm{Zeta}\left[z\right]$

Dirichlet_Lambda(2z+1)

$\left[-2^{\left[-2z-1\right]}+1\right]\mathrm{Zeta}\left[2z+1\right]$

Dirichlet_Lambda(1)

ComplexInfinity

Dirichlet_Lambda(3)

1.0518

Dirichlet_Lambda(-3)

$-\frac{7}{120}$

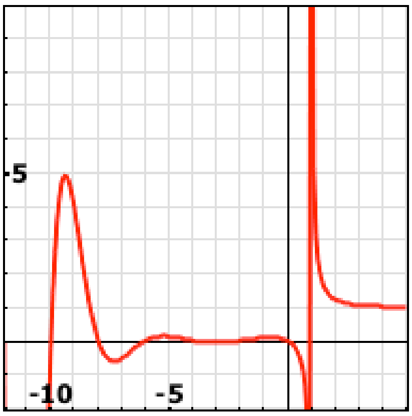
Dirichlet_Lambda(-10)

0

Dirichlet_Lambda(-11)

-43.17695

Plot(Dirichlet_Lambda(x),x=[-12,5],y=[-2,10])



x-min= -12
x-max= 5
y-min=-2, y-max=10
Color Style

Divergence(vector, [varlist], [mode])
Returns the divergence of a vector field.

This is normally denoted as **Divergence(F) = ?.F**

Divergence([3*x*y^2,y*z,y*z/x],[x,y,z])

$$3y^2+z+\frac{y}{x}$$

Divergence([3*x*y^2,y*z,y*z/x])

$$3y^2+z+\frac{y}{x}$$

Divergence([a*b^2,a^2*b],[a,b])

$$a^2+b^2$$

Divisors(n)
Returns a list of integers that can be evenly divided into **n** without leaving a remainder.

Divisors(10)

$$\left[1,\ 2,\ 5,\ 10\right]$$

Divisors(11)

$$\left[1,\ 11\right]$$

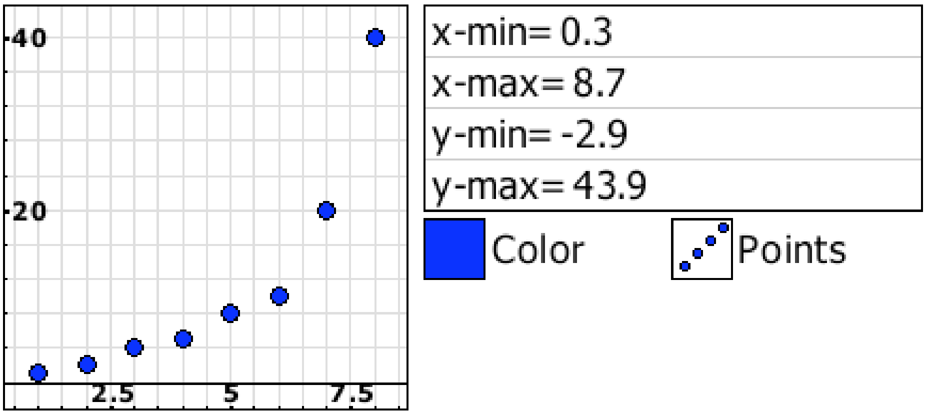
Divisors(20)

$$\left[1,\ 2,\ 4,\ 5,\ 10,\ 20\right]$$

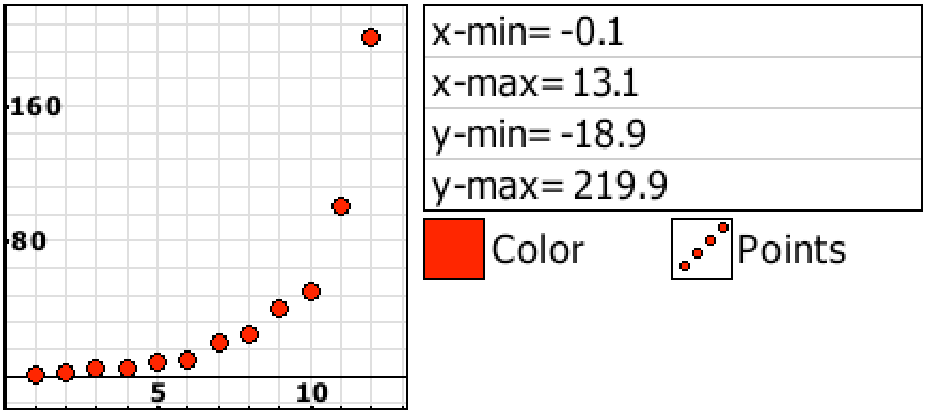
Divisors(99)

$$\left[1,\ 3,\ 9,\ 11,\ 33,\ 99\right]$$

ListPlot(Divisors(40))



ListPlot(Divisors(200))



DivisorSigma(n)

Returns the sum of all factors of the given integer.

DivisorSigma(2)

3

DivisorSigma(7)

8

DivisorSigma(20)

42

DivisorSigma(100)

217

Dot(A, B)

Calculates the dot product of the two vectors A and B. Vectors A and B can be of any size, but should be equal to each other.

Euler angles

R1=[[cos(u),sin(u),0],[-sin(u),cos(u),0],[0,0,1]]
R2=[[1,0,0],[0,cos(v),sin(v)],[0,-sin(v),cos(v)]]
R3=[[cos(w),sin(w),0],[-sin(w),cos(w),0],[0,0,1]] Dot(R3,Dot(R2,R1))

- cos[v] sin[w] sin[u]+cos[w] cos[u]	cos[w] sin[u]+cos[v] cos[u] sin[w]	
- cos[w] cos[v] sin[u] - cos[u] sin[w]	- sin[u] sin[w]+cos[w] cos[v] cos[u]	
sin[u] sin[v]	- cos[u] sin[v]	

Dot([[1,2],[3,4]],[[a,b],[c,d]])

a+2 c	b+2 d
3 a+4 c	3 b+4 d

Dot([3,2],[a,b])

3 a+2 b

Dot([5,-8],[1,2])

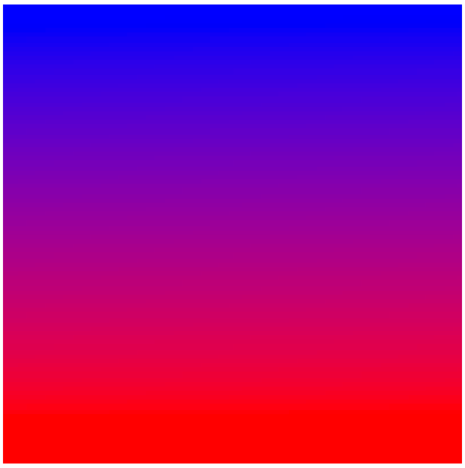
-11

Draw(mode)

Draws the colors with an optional mode. This mode parameter is reserved for future use and should be set to zero.

You can also plot images using ImagePlot but Draw is much faster because it bypasses the computer algebra system and draws directly to a block of memory.

width=100 height=100 DrawWindow(width,height) pixels=width*height loop(i,1,pixels) DrawColor(i/pixels,0,1-i/pixels) end Draw(0)



DrawColor(red, green, blue)

Draws a color to the draw window created by DrawWindow. The color values are between 0.0 and 1.0.

You can also input a single value for a gray color value.

DrawWindow(width, height)

Sets the width and height of the drawing window. This is the first function needed to call to start drawing.

DSolve(equation, dependent(independent), values, mode=1)

DSolve is a differential equation solver.

The **derivative of the variable** is notated using derivative notation. SpaceTime uses the single quotation character to represent the derivative of a variable or function.

f**'**(x) - First derivative
f**''**(x) - Second derivative

f**'''**(x) - Third derivative

Derivative Examples
Solve: y' + y = sin(t)
DSolve(y'(t)+y(t)=sin(t), y(t), ...)

Solve: y'' + 2y' + y = x
DSolve(y''(x)+2y'(x)+y(x)=x, y(x), ...)

The definite **integral of the variable** is represented by **I**(f(t), t) and denotes the integral of the variable **f(t)** with lower bound 0 and upper bound **t**. These bounds cannot be changed.

Integral Examples
?(y) + y = sin(t)
DSolve(I(y(t),t) + y(t) = sin(t), y(t), ...)

The upper case character **I** indicates the integral and is a mandatory condition.

Initial values
When no initial values are given, then simple write the word **no**. The result returned contains the Constant **C@1**.

For first order differential equations the initial value can be given as y(t)=value. When you ommit y(t), then y(0) is assumed.

For higher order differential equations, the initial values should be given as a **list** and are always referred to zero : [y(0), y'(0), y''(0), ...]

Examples with different initial values
Solve: y' + y = sin(t) with y(0) = 5
DSolve(y'(t) + y(t) = sin(t) , y(t) , y(0) = 5)
or
DSolve(y(t)' + y(t) = sin(t) , y(t) , 5)

Solve: y' + y = sin(t) with y(2) = 5
DSolve(y(t)' + y(t) = sin(t) , y(t) , y(2)=5)

Solve: y'' + 2y' + y = x with y(0) = 1 and y'(0) = 2

DSolve(y''(x) + 2y'(x) + y(x) = x, y(x), [1,2])

Solve: y'' + 2y' + y = x with no initial values
DSolve(y''(x) + 2y'(x) + y(x) = x, y(x), no)

Different form for exact first order differential equations.
Exact first order differential equation can be given with d@x , d@t , d@y, ect.

First Order Examples
*Solve: dy = sin(t) * dt*
DSolve(d@y = sin(t) * d@t, y(t), ...)

Of course, this can also be written as the following equation.
DSolve(y'(t), t) = sin(t) , y(t), ...)
Note: The *variable* to be solved should still be written as y(t).

Results
Normally, DSolve tries to return the result as **y(t) = function(t)**.

In case y(t) cannot be represented in a simple form then the result is returned in **implicit form**.
function(y , t) = 0

In the latter case, the text **Implicit result** is added to call the users attention that the result is not of the form y(t)=function(t).

DSolve(y'(t)+y(t)=sin(t),y(t),no)

$$-0.5\cos[t]+0.5\sin[t]+0.5\,e^{[-t]}+y[0]\,e^{[-t]}$$

DSolve(y''(x)+2y'(x)+y(x)=x, y(x), no)

$$x+y[0]\,e^{[-x]}+x\,e^{[-x]}+x\,y'[0]\,e^{[-x]}+x\,y[0]\,e^{[-x]}+2\,e^{[-x]}-2$$

DSolve(y''(x)+2y'(x)+y(x)=x, y(x), [1, 5])

$$x+3\,e^{[-x]}+7\,x\,e^{[-x]}-2$$

DSolve(R*q'(t)+q(t)/C=U*sin(t), q(t), no)

$$-\frac{C^2 R U \cos[t]}{C^2 R^2+1}+q[0]e^{\left[-\frac{t}{CR}\right]}+\frac{C^2 R U e^{\left[-\frac{t}{CR}\right]}}{C^2 R^2+1}+\frac{C U \sin[t]}{C^2 R^2+1}$$

DSolve(4*q'(t)+2q(t)=U*sin(t), q(t), y(0)=0)

$$-\frac{U\cos[t]}{5}+\frac{U\sin[t]}{10}+\frac{U e^{\left[-\frac{t}{2}\right]}}{5}$$

DSolve(d@y=sin(t)*d@t, y(t), no)

$$-C_1-\cos[t]$$

DSolve(d@y=sin(t)*d@t, y(t), y(0)=1)

$$-\cos[t]+2$$

DSolve(exp(x)*sin(y(x))*d@x+((y(x)+exp(x)*cos(y(x)))*d@y, y(x), no)

$$d_x \sin\left[y[x]\right] e^x$$

DSolve(x'(t)=-2*x(t)^2, x(t), no)

$$\frac{1}{C_1+2t}$$

DSolve(x'(t)=-2*x(t)^2, x(t), y(1)=2)

$$\frac{1}{2t-\frac{3}{2}}$$

DSolve(y'(t)=3t^2*exp(-y(t)), y(t), y(0)=1)

$$\ln\left[t^3+e\right]$$

DSolve(x^2*y'(x)+3*x*y(x)=x^3, y(x), y(1)=A)

$$\frac{x^2}{5}-\frac{1}{5x^3}+\frac{A}{x^3}$$

DSolve(x'(t)=6*sin(t)/x(t), x(t), no)

$$\left[\sqrt{-2\,C_1-12\cos[t]},\ -\sqrt{-2\,C_1-12\cos[t]}\right]$$

DSolve(x'(t)=6*sin(t)/x(t), x(t), y(\pi/4)=2)

$$\left[\sqrt{-12\cos[t]+16},\ -\sqrt{-12\cos[t]+16}\right]$$

DSolve(x'(t)=6*sin(t)/x(t), x(t), y(\pi/4)=2, 0)

Implicit Result ‼
$-\frac{12}{\sqrt{2}}+12\cos[t]+x[t]^2-4$

DSolve(f(z)^2+2*z*f(z)*f'(z), f(z), no, 0)

Implicit Result ‼
$-C_1+z\,f[z]^2$

DSolve(f(z)^2+2*z*f(z)*f'(z), f(z), no)

$$\left[\sqrt{\frac{C_1}{z}},\ -\sqrt{\frac{C_1}{z}}\right]$$

DSolve(f(z)^2+2*z*f(z)*f'(z), f(z), f(1)=5)

$$\left[\sqrt{\frac{25}{z}},\ -\sqrt{\frac{25}{z}}\right]$$

DSolve((a+b*x)*d@x+(e+x+c)*d@y, y(x), no)

$$-C_1-b\,x-a\ln[c+e+x]+b\,c\ln[c+e+x]+b\,e\ln[c+e+x]$$

DSolve((a+b*x)*d@x+(e+x+c)*d@y, y(x), a)

$$a-b\,x-a\ln[c+e+x]-b\,c\ln[c+e]-b\,e\ln[c+e]+b\,c\ln[c+e+x]+b\,e\ln[c+e+x]+a\ln[c+e]$$

DSolve((a+b*x)+(e+x+c)*y'(x), y(x), no)

$$-C_1-bx-a\ln[c+e+x]+bc\ln[c+e+x]+be\ln[c+e+x]$$

DSolve((a+b*x)+(e+x+c)*y'(x), y(x), a)

$$a-bx-a\ln[c+e+x]-bc\ln[c+e]-be\ln[c+e]+bc\ln[c+e+x]+be\ln[c+e+x]+a\ln[c+e]$$

DSolve(x*f'(x)+x+f(x), f(x), f(1)=a, 0)

Implicit Result ‼
$-a+\frac{x^2}{2}+xf[x]-\frac{1}{2}$

DSolve(y'(t)+2a*y(t)=t^2, y(t), y(1)=0)

$$\frac{1}{4a^3}-\frac{e^{[2a-2at]}}{2a}-\frac{t}{2a^2}-\frac{e^{[2a-2at]}}{4a^3}+\frac{e^{[2a-2at]}}{2a^2}+\frac{t^2}{2a}$$

Duf(function, [varlist], [point], [direction])

Calculates the directional derivative of a given function.

Duf(x^2*y^2*z^2,[x,y,z],[1,2,3],[1,1,-2])

$$\frac{60}{\sqrt{6}}$$

Duf(x^2*y^2*z^2)

$$\frac{2x^2y^2z}{\sqrt{3}}+\frac{2xy^2z^2}{\sqrt{3}}+\frac{2x^2yz^2}{\sqrt{3}}$$

Duf(f(x,y,z))

$$\frac{D[f[x,\ y,\ z],\ x]}{\sqrt{3}}+\frac{D[f[x,\ y,\ z],\ y]}{\sqrt{3}}+\frac{D[f[x,\ y,\ z],\ z]}{\sqrt{3}}$$

Duf(x^2*y*z,[x,y,z],[1,-1,1],[4,0,-3])

-1

Duf(3x^2-3y^2,[x,y],[1,2],[0,1])
-12

Duf(sqrt(x^2+y^2),[x,y,z],[0,-2,1],[2,2,1])
$\frac{2}{3}$

Duf(sin(x)+cos(y)+sin(z),[x,y,z],[\pi,0,\pi],[\pi,\pi,0])
$-\frac{\pi}{\sqrt{2\,\mathrm{abs}[\pi]^2}}$

Ei(z)
Finds the Exponential Integral of z.

Eigenvalues(A)
Returns the eigenvalues of matrix A.

This routine uses the TNT library.

Eigenvalues([[1,2],[2,3]])
$[-0.23607,\ 4.23607]$

Eigenvalues([[-1,-1,2],[0,2,-1],[4,-6,2]])
$[-2.9338,\ 5.28938,\ 0.64441]$

Eigenvectors(A)
Returns the eigenvectors of matrix A.

This routine uses the TNT library.

Eigenvectors([[1, 2], [2, 3]])

-0.85065	0.52573
0.52573	0.85065

Eigenvectors([[-1, -1, 2], [0, 2, -1], [4, -6, 2]])

-0.67341	-0.3594	0.69532
0.14685	0.29825	0.66819
0.72454	-0.98107	0.90579

Else If(condition)

Evaluates a block of code if **condition** is a non-zero value.

This function was be preceded by an **if** code block or another **else if** code block.

n=5 if(n>0) result="Positive" else if(n

Positive

Erf(z)

Returns the Error Function of z.

Erfc(z)

Returns the Complementary Error Function of z.

Error(string)

This function stops all computations and displays an error message along with the line number where the error message occurred.

n=5 if(n>0) Error("Positive") else if(n

! Line: 3
Error: Positive

Euler(n, [z])

If only **n** is given then Euler returns the Euler number n.

If **z** is also given then Euler returns the nth Euler polynomial of z.

Euler(3,a)

$$a^{3}-\frac{3a^{2}}{2}+\frac{1}{4}$$

Euler(n,1/2)

$$2^{[-n]}\mathrm{Euler}[n]$$

Euler(n,1)

$$-\mathrm{Euler}[n,\ 0]$$

Euler(n,-1)

$$[\mathrm{Euler}[n,\ 0]+2][-1]^{n}$$

Euler(n,-5)

$$-[-1]^{n}\mathrm{Euler}[n,\ 5]+2\,5^{n}[-1]^{n}$$

Euler(4,5)

380

Euler(4,-5)

870

Eulerian(n, k)

Returns the number of permutations of **{1,2,..n}** having k permutation ascents.

The parameters **n, k** should both be positive integers > 0 with k

Eulerian(5,0)

0

Eulerian(5,1)

1

Eulerian(5,2)

26

Eulerian(5,3)

66

Eulerian(5,4)

26

Eulerian(5,5)

1

Eulerian(5,6)

0

Eulerian(10,3)

47840

Eval(function, variable, value)

Replaces the *variable* in the function with the new *value*.

Eval(sin(x),x,\pi/4)

$$\frac{1}{\sqrt{2}}$$

Eval(3x^2+4x-6,x,3)

33

Eval([sin(x),cos(x)],x,\pi/3)

$\left[\frac{\sqrt{3}}{2}, \frac{1}{2}\right]$

Eval(x^y+3x+2y,[x,y],[2,a])

$2a+2^{a}+6$

Eval(x+sin(y)-cos(z),[x,z],[1,\pi/3])

$\sin[y]+\frac{1}{2}$

Eval(Diff(a*x^3,x),a,5)

$15x^{2}$

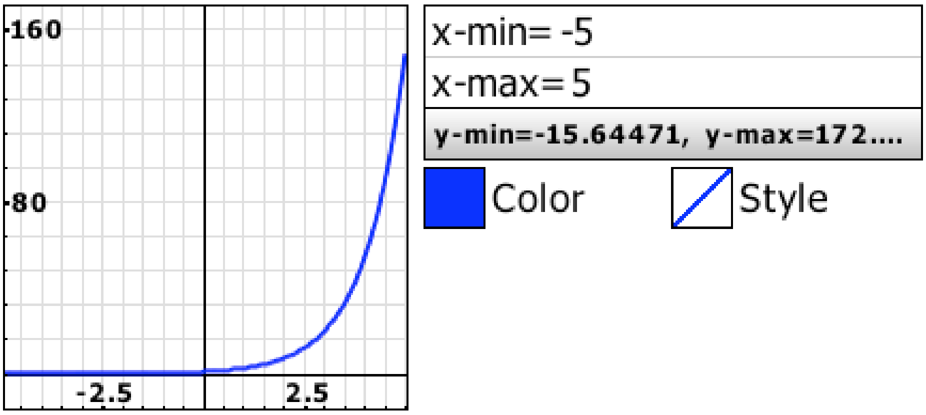
Exp(z)

Exp(z) or *e*^z raises *e* (base of natural logarithm) to the power z.

exp(1)

e

Plot(exp(x))



Expand(expression)

Returns the expanded form of a function.

Expand(3(x-2)(x+4))

$3x^2+6x-24$

Expand((2x^2-y)(x-y-z))

$2x^3+y^2-2x^2z-2x^2y-xy+yz$

Expand((1+sin(z))^2)

$2\sin[z]+\sin[z]^2+1$

Expand(3*(y+x)/sin(y))

$3y\csc[y]+3x\csc[y]$

ExpConvert(expression)

Converts exponential functions to trigonometric functions.

ExpConvert(exp(x))

$\cosh[x]+\sinh[x]$

ExpConvert(exp(x^2))

$\cosh[x^2]+\sinh[x^2]$

ExpConvert(exp(2x))

$2\cosh[x]\sinh[x]+2\cosh[x]^2-1$

ExpConvert(exp(3x))

$-3\cosh[x]-\sinh[x]+4\cosh[x]^2\sinh[x]+4\cosh[x]^3$

Extract(expression, position, [length])

Extracts an expression from a list or a substring from a string.

Extract([1,2,3,4,5],2,3)

$\left[2,\ 3,\ 4\right]$

Extract("abcde",2,3)

bcd

Extract("abcde",4)

d

Factor(expression)

Returns the factored form of a polynomial. It does the reverse of what Expand does, but limited to polynomials.

For polynomials of degree > 2 this function makes use of pSolve. If pSolve can find real roots, then Factor can return a factored form of the given function.

Factor(x^4-18x^2+81)

$\left[x+3\right]^2\left[x-3\right]^2$

Factor(x^5+111105x^4+1121766570x^3+1118845033650x^2+108868944188565x+890011088900109)

$\left[x+9\right]\left[x+99\right]\left[x+999\right]\left[x+9999\right]\left[x+99999\right]$

Factor(x^12-21x^10+175x^8-735x^6+1624x^4-1764x^2+720)

$\left[x-2\right]\left[x-1\right]\left[x+\sqrt{6}\right]\left[x-\sqrt{3}\right]\left[x+\sqrt{3}\right]\left[x+\sqrt{5}\right]\left[x+\sqrt{2}\right]\left[x-\sqrt{5}\right]\left[x-\sqrt{2}\right]\left[x-\sqrt{6}\right]\left[x+1\right]\left[x+2\right]$

Factor(x^8-26x^6+236x^4-886x^2+1155)

$\left[x+\sqrt{3}\right]\left[x+\sqrt{5}\right]\left[x+\sqrt{11}\right]\left[x-\sqrt{5}\right]\left[x-\sqrt{3}\right]\left[x-\sqrt{7}\right]\left[x+\sqrt{7}\right]\left[x-\sqrt{11}\right]$

Factor(2x^6+18x^5+63x^4-324x^3-1620x^2+1458x+8019)

$$\left[2x^{2}+18x+99\right]\left[x-3\right]^{2}\left[x+3\right]^{2}$$

Factor(x^7-3x^6-27x^5+81x^4+243x^3-729x^2-729x+2187)

$$\left[x+3\right]^{3}\left[x-3\right]^{4}$$

Factor(x^4+5x^2-6)

$$\left[x-1\right]\left[x+1\right]\left[x^{2}+6\right]$$

Factorial(n)

Returns the number of ways n elements can be ordered.

n! = 1 * 2 * 3 * ..... (n-1) * n

Factorial(6)

720

6!

720

Fcdf(x, d1, d2)

F-distribution cumulative density function.

---

fDiff(f(x,y,z,..), (x,y,z,...))

Finds the exact differential of the given function.

fDiff(3*x*y+5x*z^2,[x,y,z])

$$d_{x}\left[3y+5z^{2}\right]+3d_{y}x+10d_{z}xz$$

fDiff(y^4+4y-3x^3sin(y)-2x-1,[x,y])

$$d_y\left[4y^3-3x^3\cos\left[y\right]+4\right]+d_x\left[-9x^2\sin\left[y\right]-2\right]$$

fDiff(x^2+5x-4y^2+3y+21,[x,y])

$$d_x\left[2x+5\right]+d_y\left[-8y+3\right]$$

fDiff(x^3-7x^2y^3+4y^2+16,[x,y])

$$d_x\left[3x^2-14xy^3\right]+d_y\left[8y-21x^2y^2\right]$$

fDiff(sin(2x-7y)-16y,[x,y])

$$d_y\left[-7\cos\left[2x-7y\right]-16\right]+2d_x\cos\left[2x-7y\right]$$

fDiff(y-x^(p/q),[x,y])

$$d_y-\frac{d_x p x^{\left[\frac{p}{q}-1\right]}}{q}$$

fDiff(a*x^3*y-2*y/z-z^2,[x,y])

$$d_y\left[-\frac{2}{z}+ax^3\right]+3ad_x x^2 y$$

fDiff([3sin(x)*cos(y),x^2-3y],[x,y])

$$\left[-3d_y\sin\left[y\right]\sin\left[x\right]+3d_x\cos\left[x\right]\cos\left[y\right],\ -3d_y+2d_x x\right]$$

fDiff([R*cos(\theta),R*sin(\theta)],[R,\theta])

$$\left[-R d_\theta\sin\left[\theta\right]+d_R\cos\left[\theta\right],\ d_R\sin\left[\theta\right]+R d_\theta\cos\left[\theta\right]\right]$$

fDiff(x^2+y^2,[x,y])

$$2d_x x+2d_y y$$

Fibonacci(n, [z])

Returns the n^{th} Fibonacci number of **n**.

If **z** is given, returns the n^{th} Fibonacci polynomial of z.

Fibonacci(5,z)
z^4+3z^2+1

Finance(PV, FV, Pmt, i, n, [mode=0])

This is a simple financial function to calculate loan or investments. In case of loan, Pmt is a positive value. In case of investments, Pmt is a negative value.

Fill in the known values in the indicated order and use any variable name for the unknown. In the examples below, the unknown is indicated with it's own name but you can use any variable name.

Based on the examples from Stan Brown, Oak Road Systems.

You have a $18,000 car load at 14.25% per year for a period of 36 months. Every month you pay $620. How big is the payoff amount after 24 months?
Finance(18000, FV, 620, 14.25/12, 24)
6794.98008

You are buying a $250,000 house, with 10% down, on a 30-year mortgage at a fixed rate of 7.8%. What is the monthly payment?
Finance(225000, 0, Pmt, 7.8/12, 30*12)
1619.70863

If you loan $3500 at 6% rate and and you pay back $100 per month. How many months do you have to pay?
Finance(3500, 0, 100, 6/12, n)
38.57048

In the above example, you will make payments for 38 month. How much will you pay for the last month?
Finance(3500,FV,100,6/12,38)
56.82542

You have $15,000 in a 5% savings account, which is compounded monthly. How long can you withdraw $100 a month?

Finance(15000,0, 100, 5/12, n)

235.8891

If you deposit $100 per month over 5 years at 6% interest, how much money will you have at the end?

Finance(0, FV, -100, 6/12, 60)

6977.00305

You want to purchase a 20-year annuity that will pay $500 a month. If the guaranteed interest rate is 4%, how much will the annuity cost?

Finance(PV, 0, 500, 4/12, 20*12)

82510.92912

On the same day every year, you put $2000 into stocks. If the market rises 8% a year, how many years will it take you to accumulate $40,000?

Finance(0, 40000, -2000, 8, n)

12.41552

Assume you want to set apart $50 at the end of each month for your child starting the same month as the child was born. How much will be available if the child turns 19 years old. Assume an interest rate of 5% compounded monthly.

Finance(0, FV, -50, 5/12, 18*12)

17460.10107

If you deposit $300 at the beginning of each month over 6 years at 10% interest, how much money will be in the fund at the end?

Finance(0, FV, -300, 10/12, 72, 1)

29678.67237

The monthly rent on an apartment is $950 payable at the beginning of the month. If the current interest is 12% compounded monthly, what single payment 12 months in advance would be equal to a year's rent.

Finance(PV, 0, 950, 12/12, 12, 1)

10799.24684

To obtain an amount of $3,000 ten years from now, earning 10% annually, what amount would have to be invested on a yearly basis in an annuity due form?

Finance(0, -3000, Pmt, 10, 10, 1)

171.1238

The time $1,500 is needed and you know in advance that you have 10 years to obtain it. What annual interest rate would a $100 annuity due have to earn for you to achieve this goal?

Finance(0, 1500, -100, i, 10, 1)

7.25674

You are doing a one time investment of $2,500. What is accumulated value after 10 years at a fixed interest rate of 5%?

Finance(2500, FV, 0, 5, 10)

4072.23657

You need $19,500 within 5 years from now. How much do you need to deposit today at a fixed interest rate of 3.25%?

Finance(PV, 19500, 0, 3.25, 5)

16618.21256

What interest rate would be needed to receive $20,000 after 20 years when you deposit $8,000 now?

Finance(8000, 20000, 0, i, 20)

4.68802

Floor(z)

Returns the greatest integer of the given value.

If z is a complex number, then floor works on both the real and the imaginary part.

floor(1.234)

1

floor(-9.8765)
-10

floor(-1.001)
-2

floor(0.5)
0

floor(7/2+7/3\im)
$3+2\mathrm{i}$

FourierCos(f(x), x, w)

Takes the Fourier Cosine Transform of the given function.

Current implementation is very limited.

FourierCos(sin(x),x,w)

$$\frac{\sqrt{\frac{2}{\pi}}}{2\left[-w+1\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2\left[w+1\right]}$$

FourierCos(exp(t/2)*sin(t),t,w)

$$-\frac{w\sqrt{\frac{2}{\pi}}}{2\left[w^{2}-2w+\frac{5}{4}\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2\left[w^{2}-2w+\frac{5}{4}\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2\left[w^{2}+2w+\frac{5}{4}\right]}+\frac{w\sqrt{\frac{2}{\pi}}}{2\left[w^{2}+2w+\frac{5}{4}\right]}$$

FourierCos(exp(-a*t),t,w)

$$\frac{a\sqrt{\frac{2}{\pi}}}{a^{2}+w^{2}}$$

FourierCos(sin(t),t,w)

$$\frac{\sqrt{\frac{2}{\pi}}}{2\left[-w+1\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2\left[w+1\right]}$$

FourierSeries(f(x), x, [n], [mode])

Creates the Fourier series of a given function.

Trigonometric Series

FourierSeries([[-1,-\pi,0],[1,0,\pi]],x,8)

$$\frac{4\sin\left[7x\right]}{7\pi}+\frac{4\sin\left[5x\right]}{5\pi}+\frac{4\sin\left[3x\right]}{3\pi}+\frac{4\sin\left[x\right]}{\pi}$$

FourierSeries([[-x,-\pi,0],[1,0,\pi]],x,6)

$$\frac{\pi}{4}-\frac{2\cos\left[x\right]}{\pi}-\sin\left[x\right]-\frac{1}{3}\sin\left[3x\right]-\frac{2\cos\left[3x\right]}{9\pi}-\frac{1}{5}\sin\left[5x\right]-\frac{2\cos\left[5x\right]}{25\pi}+\frac{1}{6}\sin\left[6x\right]+\frac{1}{4}\sin\left[4x\right]+\frac{2\sin\left[5x\right]}{5\pi}+\frac{1}{2}\sin\left[2x\right]+\frac{2\sin\left[3x\right]}{3\pi}+\frac{2\sin\left[x\right]}{\pi}+\frac{1}{2}$$

FourierSeries([-1,-\pi,\pi],x,6)

-1

FourierSeries([-1,0,2\pi],x,6)

-1

FourierSeries([sin(z),0,\pi],z,6)

$$\frac{2}{\pi}-\frac{4\cos\left[2z\right]}{3\pi}-\frac{4\cos\left[4z\right]}{15\pi}-\frac{4\cos\left[6z\right]}{35\pi}-\frac{4\cos\left[8z\right]}{63\pi}-\frac{4\cos\left[10z\right]}{99\pi}-\frac{4\cos\left[12z\right]}{143\pi}$$

FourierSeries([[0,-\pi,0],[\pi,0,\pi]],x,10)

$$\frac{\pi}{2}+\frac{2}{9}\sin\left[9x\right]+\frac{2}{7}\sin\left[7x\right]+\frac{2}{5}\sin\left[5x\right]+\frac{2}{3}\sin\left[3x\right]+2\sin\left[x\right]$$

FourierSeries([x^2,-\pi,\pi],x,6)

$$\frac{\pi^{2}}{3}-4\cos\left[x\right]-\frac{4}{9}\cos\left[3x\right]-\frac{4}{25}\cos\left[5x\right]+\frac{1}{9}\cos\left[6x\right]+\frac{1}{4}\cos\left[4x\right]+\cos\left[2x\right]$$

FourierSeries([[-cos(z),-\pi,0],[cos(z),0,\pi]],z,10)

$$\frac{40\sin[10z]}{99\pi}+\frac{32\sin[8z]}{63\pi}+\frac{24\sin[6z]}{35\pi}+\frac{16\sin[4z]}{15\pi}+\frac{8\sin[2z]}{3\pi}$$

Complex Form

FourierSeries([[-1,-\pi,0],[1,0,\pi]],x,6,1)

$$\frac{-2i\,e^{[3ix]}}{3\pi}+\frac{-2i\,e^{[ix]}}{\pi}+\frac{-2i\,e^{[5ix]}}{5\pi}+\frac{2i\,e^{[-3ix]}}{3\pi}+\frac{2i\,e^{[-5ix]}}{5\pi}+\frac{2i\,e^{[-ix]}}{\pi}$$

FourierSeries([[-x,-\pi,0],[x,0,\pi]],x,6,1)

$$\frac{\pi}{2}-\frac{2e^{[ix]}}{\pi}-\frac{2e^{[-ix]}}{\pi}-\frac{2e^{[3ix]}}{9\pi}-\frac{2e^{[-3ix]}}{9\pi}-\frac{2e^{[5ix]}}{25\pi}-\frac{2e^{[-5ix]}}{25\pi}$$

FourierSeries([[x,-\pi,\pi]],x,4,1)

$$\frac{i}{4}e^{[4ix]}+\frac{i}{3}e^{[-3ix]}\frac{-i}{2}e^{[-2ix]}-i\,e^{[ix]}+\frac{i}{2}e^{[2ix]}+i\,e^{[-ix]}\frac{-i}{3}e^{[3ix]}\frac{-i}{4}e^{[-4ix]}$$

FourierSeries([[t, 0,2\pi]],t,4,1)

$$\pi+i\,e^{[it]}-i\,e^{[-it]}\frac{-i}{2}e^{[-2it]}\frac{-i}{3}e^{[-3it]}\frac{-i}{4}e^{[-4it]}+\frac{i}{4}e^{[4it]}+\frac{i}{3}e^{[3it]}+\frac{i}{2}e^{[2it]}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,6,1)

$$\frac{1}{\pi}-\frac{e^{[-2iz]}}{3\pi}-\frac{e^{[2iz]}}{3\pi}-\frac{e^{[-4iz]}}{15\pi}-\frac{e^{[4iz]}}{15\pi}-\frac{e^{[-6iz]}}{35\pi}-\frac{e^{[6iz]}}{35\pi}+\frac{i}{4}e^{[-iz]}\frac{-i}{4}e^{[iz]}$$

FourierSeries([[cos(z),-\pi/2,\pi/2],[0,\pi/2,3\pi/2]],z,6,1)

$$\frac{1}{\pi}-\frac{e^{[-4iz]}}{15\pi}-\frac{e^{[4iz]}}{15\pi}+\frac{e^{[6iz]}}{35\pi}+\frac{e^{[-6iz]}}{35\pi}+\frac{e^{[2iz]}}{3\pi}+\frac{e^{[-2iz]}}{3\pi}$$

Single Coefficient

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,0,1)

$$\frac{1}{\pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-1,1)

$$\frac{i}{4} e^{(-i z)} - \frac{i}{4} e^{(i z)}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-2,1)

$$-\frac{e^{(-2 i z)}}{3 \pi} - \frac{e^{(2 i z)}}{3 \pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-3,1)

$$0$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-4,1)

$$-\frac{e^{(-4 i z)}}{15 \pi} - \frac{e^{(4 i z)}}{15 \pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-5,1)

$$0$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,0,0)

$$\frac{1}{\pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-1,0)

$$\frac{1}{2} \sin[z]$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-2,0)

$$-\frac{2 \cos[2 z]}{3 \pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-3,0)

$$0$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-4,0)

$$-\frac{2 \cos[4 z]}{15 \pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,-5,0)

0

Formula

FourierSeries([[-1,\pi,0],[1,0,\pi]],x,f,1)

0

FourierSeries([[x,-\pi,\pi]],x,f,1)

$$\frac{\mathrm{Sum}\left[\frac{i\,\pi\,[-1]^{[-n]}\,e^{[i\,n\,x]}}{n}+\frac{i\,\pi\,[-1]^{n}\,e^{[i\,n\,x]}}{n}-\frac{[-1]^{n}\,e^{[i\,n\,x]}}{n^{2}}+\frac{[-1]^{[-n]}\,e^{[i\,n\,x]}}{n^{2}},\ n,\ -\infty,\ \infty\right]}{2\,\pi}$$

FourierSeries([[t,0,2\pi]],x,f,1)

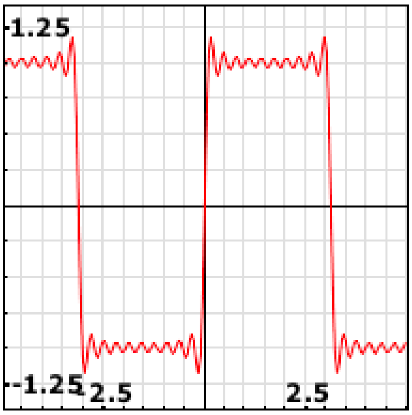
$$\frac{\mathrm{Sum}\left[\frac{-i\,t\,e^{[i\,n\,x]}}{n}+\frac{i\,t\,[-1]^{[-2\,n]}\,e^{[i\,n\,x]}}{n},\ n,\ -\infty,\ \infty\right]}{2\,\pi}$$

FourierSeries([[sin(z),0,\pi],[0,\pi,2\pi]],z,f,1)

$$\frac{\mathrm{Sum}\left[\frac{e^{[i\,n\,z]}}{-n^{2}+1}+\frac{[-1]^{[-n]}\,e^{[i\,n\,z]}}{-n^{2}+1},\ n,\ -\infty,\ \infty\right]}{2\,\pi}$$

Graphs

Plot(FourierSeries([[-1,-\pi,0],[1,0,\pi]],x,20),color=red)



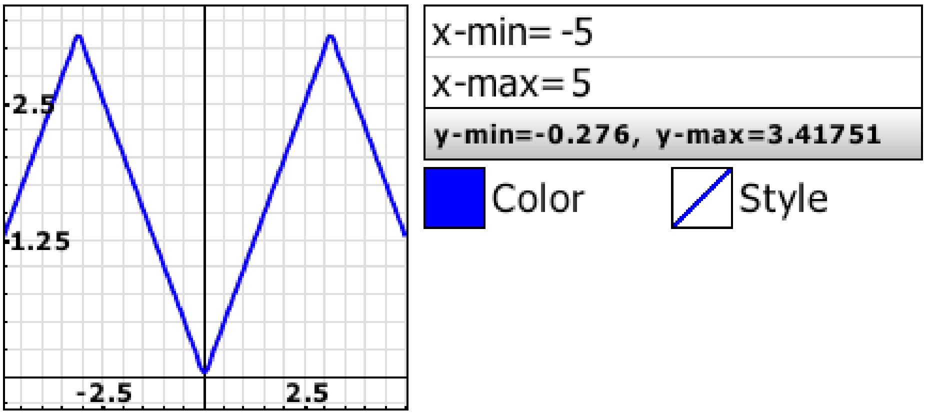
x-min= -5

x-max= 5

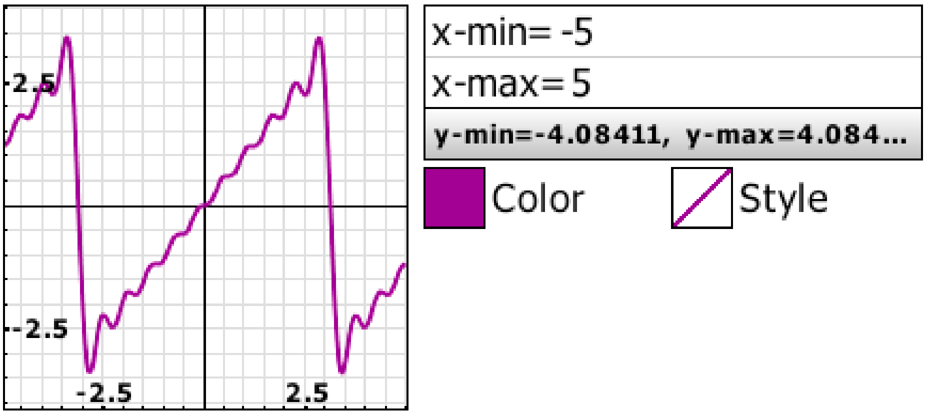
y-min=-1.41575, y-max=1.415...

Color Style

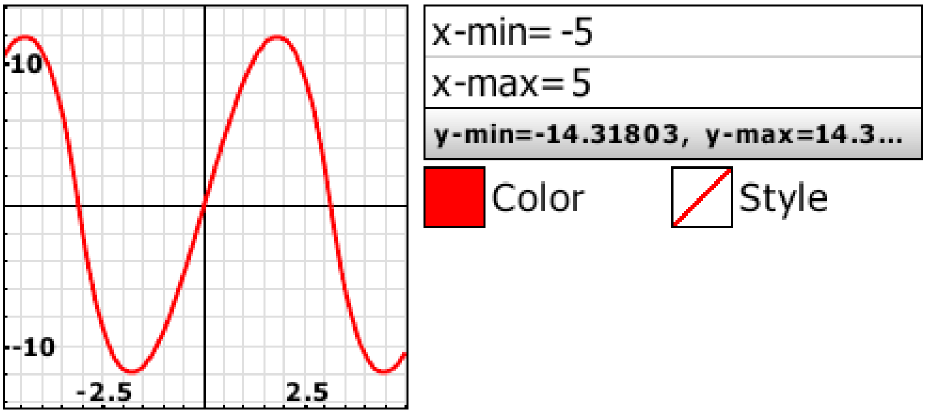
Plot(FourierSeries([[-x,-\pi,0],[x,0,\pi]],x,10),color=blue)



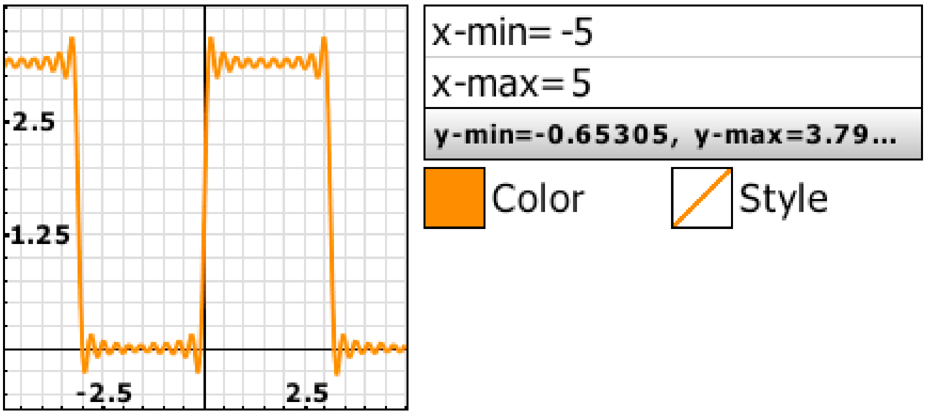
Plot(FourierSeries([x,-\pi,\pi],x,20),color=purple)



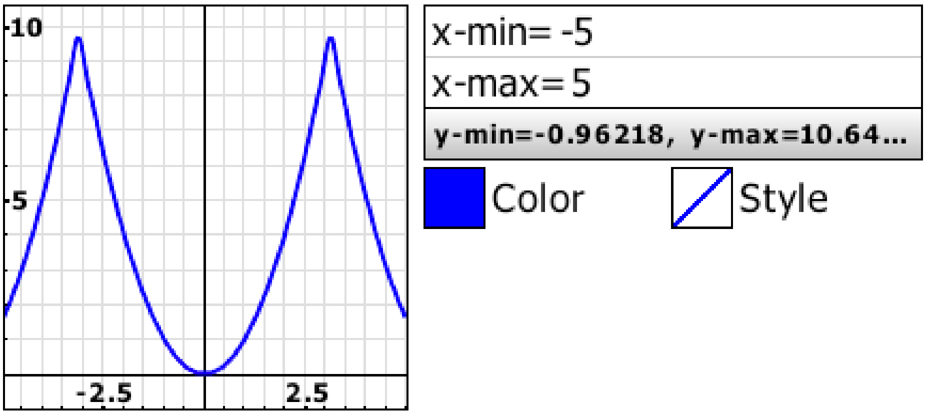
Plot(FourierSeries([x*(\pi-x)(\pi+x),-\pi,\pi],x,10),color=red)



Plot(FourierSeries([[0,-\pi,0],[\pi,0,\pi]],x,20),color=orange)



Plot(FourierSeries([x^2,-\pi,\pi],x,20),color=blue)



FourierSin(f(x), x, w)

Takes the Fourier Sine Transform of the given function.

Current implementation is very limited.

FourierSin(sin(x)^2,x,w)

$$-\frac{\sqrt{\frac{2}{\pi}}}{4\left[w+2\right]}+\frac{\sqrt{\frac{2}{\pi}}}{4\left[-w+2\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2w}$$

FourierSin(exp(a*t)*sin(2t)*cos(t),t,w)

$$-\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^2+w^2-2w+1\right]}-\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^2+w^2-6w+9\right]}+\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^2+w^2+6w+9\right]}+\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^2+w^2+2w+1\right]}$$

FourierSin(exp(a*t)*sin(t)*cos(t),t,w)

$$-\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^{2}+w^{2}-4w+4\right]}+\frac{a\sqrt{\frac{2}{\pi}}}{4\left[a^{2}+w^{2}+4w+4\right]}$$

FourierSin(exp(-a*t),t,w)

$$\frac{w\sqrt{\frac{2}{\pi}}}{a^{2}+w^{2}}$$

FourierSin(cos(t),t,w)

$$\frac{\sqrt{\frac{2}{\pi}}}{2\left[w+1\right]}+\frac{\sqrt{\frac{2}{\pi}}}{2\left[w-1\right]}$$

FourierSin(k,t,w)

$$\frac{k\sqrt{\frac{2}{\pi}}}{w}$$

---

fPart(z)

Returns the fractional part of z.

fPart(4/3)

$$\frac{1}{3}$$

fPart(1.234)

0.234

fPart(-9.8765)

-0.8765

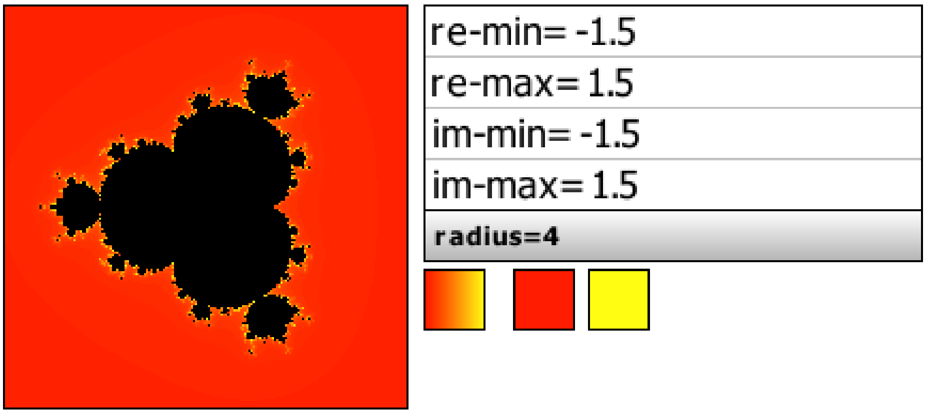
Fpdf(x, d1, d2)

F-distribution probability density function.

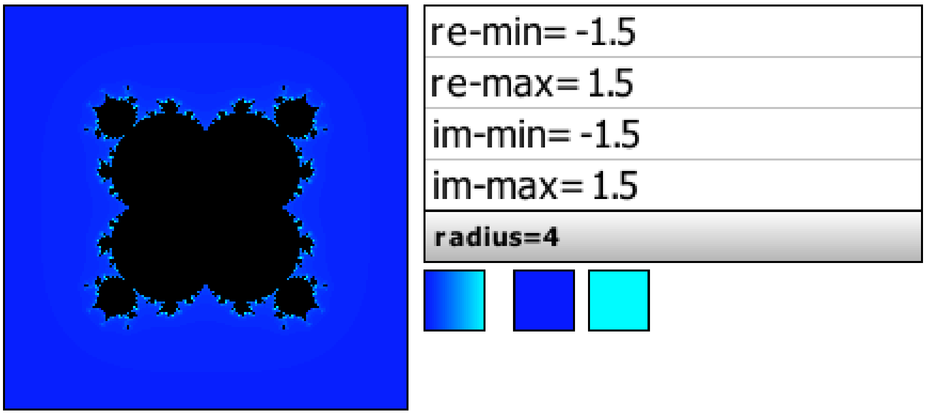
FractalPlot(expression, ...)

Plots Mandelbrot set fractals.

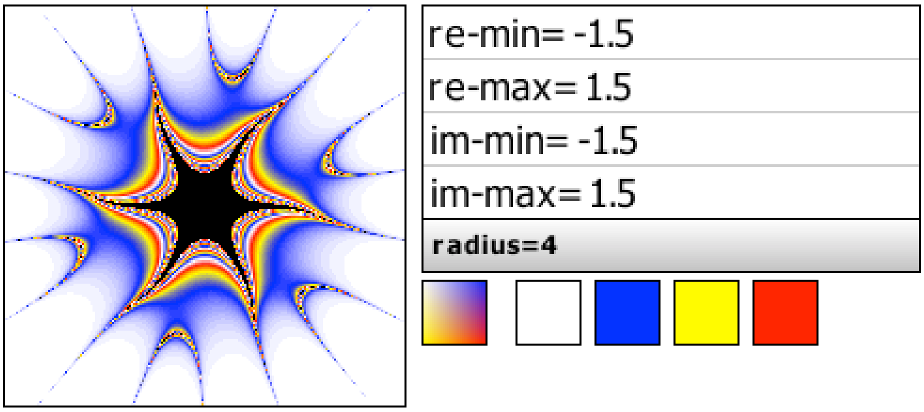
FractalPlot(z^4+c)



FractalPlot(z^5+c)



FractalPlot(Real(c^9)+Imag(c^3)+z)



FresnelCos(z)

Returns the Fresnel Cosine Integral of z.

FresnelCos(\inf)

$\frac{1}{2}$

FresnelCos(1)

0.77989

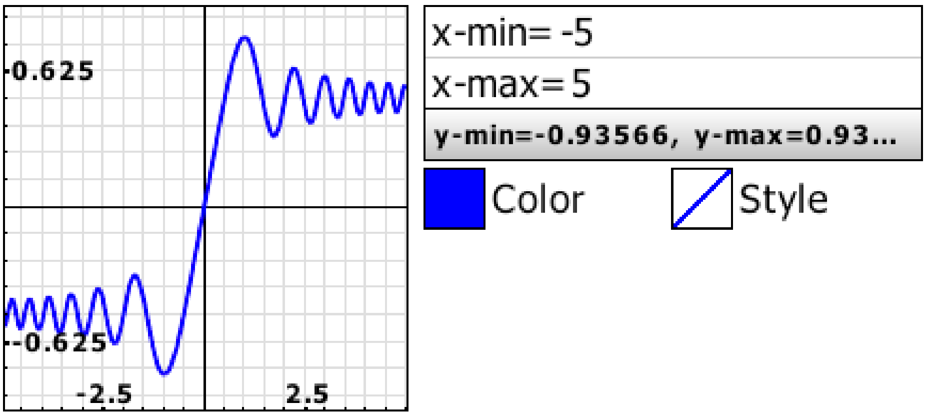
FresnelCos(-2)

-0.48825

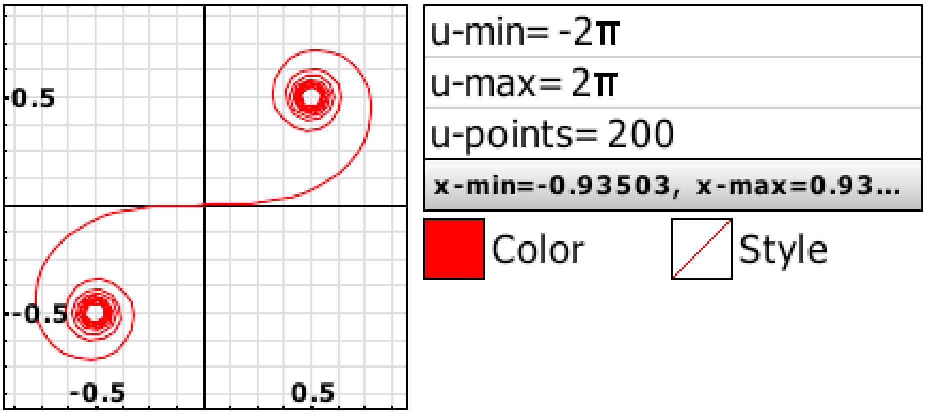
FresnelCos(1+3\im)

607.75099+184.37367$\mathbb{i}$

Plot(FresnelCos(x))



ParametricPlot(FresnelCos(u), FresnelSin(u), u=[-2\pi, 2\pi, 200], numbers=4)



FresnelSin(z)

Returns the Fresnel Sine Integral of z.

FresnelSin(\inf)

$\frac{1}{2}$

FresnelSin(1)

0.43826

FresnelSin(-2)

-0.34342

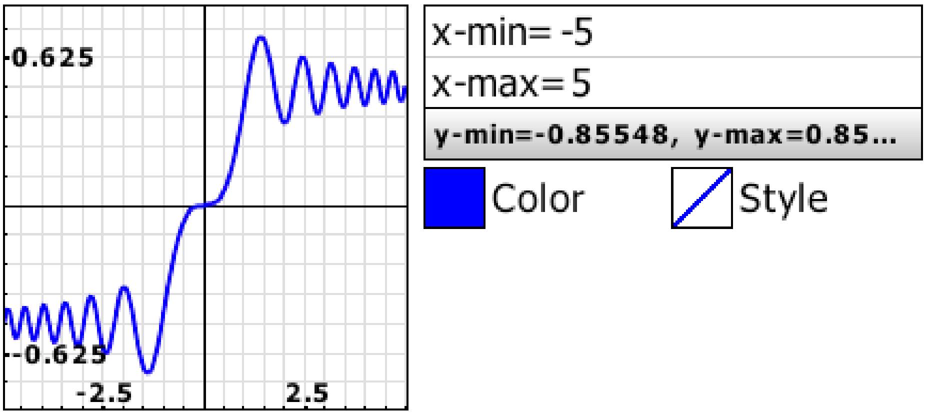
FresnelSin(1+3\im)

-183.87368+607.251i

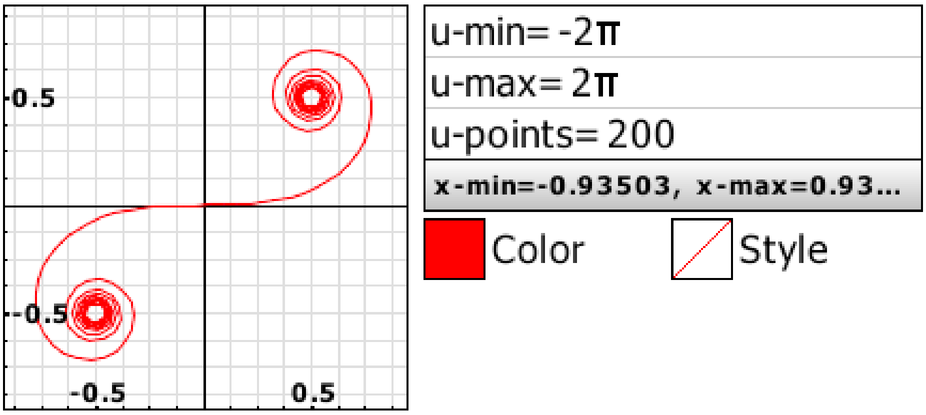
Diff(FresnelSin(f(z)),z)

$$f'[z]\sin\left[\frac{\pi f[z]^2}{2}\right]$$

Plot(FresnelSin(x))



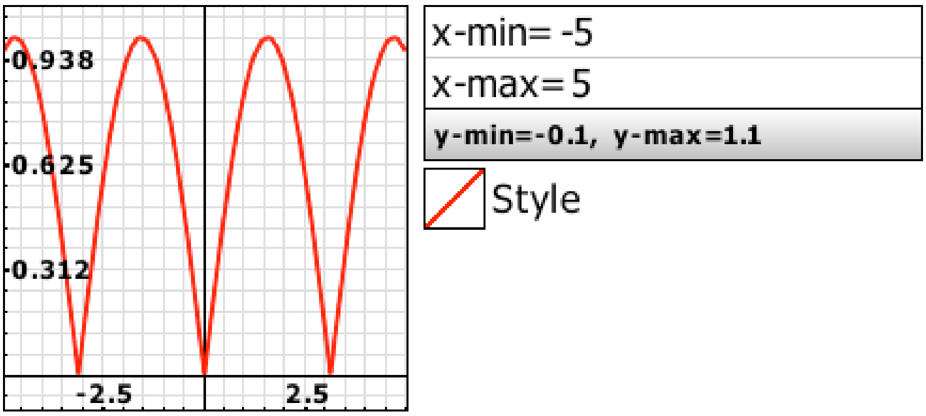
ParametricPlot(FresnelCos(u), FresnelSin(u), u=[-2\pi, 2\pi, 200], numbers=4)



FullRectSineWave(x, [T])

Creates a predefined 2D full rectified sine wave with period = T.

Plot(FullRectSineWave(x),color=red)



Function(function, parameter1, parameter2, ...)

Returns the function unevaluated with it's parameters.

Function(sin,\pi/4)

$\sin\left[\frac{\pi}{4}\right]$

Function(BesselJ,0,2)

$\mathrm{BesselJ}\left[0,\ 2\right]$

Gamma(z)

Calculates Gamma(z) where z can be any complex number.

Gamma(0)

∞

Gamma(1/2)

$\sqrt{\pi}$

Gamma(-7/2)

$\frac{16\sqrt{\pi}}{105}$

Gamma(10-3\im)

$197624.13895-113252.91896i$

Gamma(-3.6)

0.07858π

Gamma(4.2)

7.75669

Gamma(n+3)

$n\left[n+1\right]\left[n+2\right]\mathrm{Gamma}\left[n\right]$

Gamma(3z)

$$\frac{3^{\left[3z-\frac{1}{2}\right]}\mathrm{Gamma}[z]\,\mathrm{Gamma}\left[z+\frac{1}{3}\right]\mathrm{Gamma}\left[z+\frac{2}{3}\right]}{2\,\pi}$$

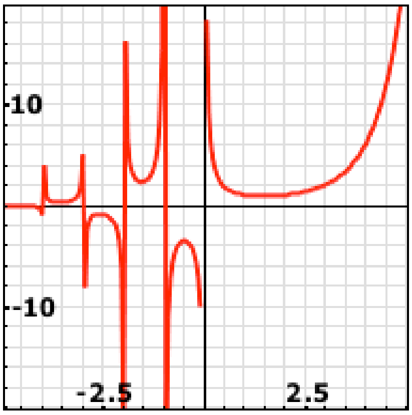
Gamma(2x+3)

$$\frac{2\,x\,[2\,x+1][2\,x+2]\,2^{\left[2x-\frac{1}{2}\right]}\mathrm{Gamma}[x]\,\mathrm{Gamma}\left[x+\frac{1}{2}\right]}{\sqrt{2\,\pi}}$$

Gamma(1-2n)

$$\frac{\pi\sqrt{2\,\pi}\,2^{\left[-2n+\frac{1}{2}\right]}\csc[2\,n\,\pi]}{\mathrm{Gamma}[n]\,\mathrm{Gamma}\left[n+\frac{1}{2}\right]}$$

Plot(Gamma(z))



x-min= -5
x-max= 5
y-min=-20, y-max=20
Color Style

GCD(n1, n2)

Finds the greatest common factor between two integers.

gcd(10,2)
2

gcd(12,8)

4

gcd(21,99)
3

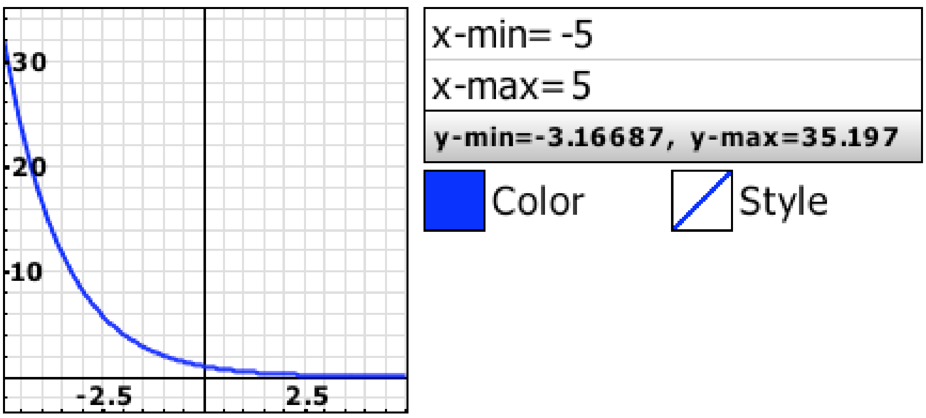
gcd(1000, 15)
5

GegenbauerC(n, a, z)
Returns the Gegenbauer polynomial.

GeoCDF(p, x)
Computes the cumulative geometric distribution at **x** with probability of success **p**.

GeoPDF(p, x)
Computes the geometric distribution at **x** with probability of success **p**.

Plot(GeoPDF(0.5,x))



Gradient(function, [varlist], [mode])

Returns the Gradient of the function.

This is normally denoted as **Grad(F) = ?F**

Gradient(x+y^2,[x,y])

$$\left[1,\ 2y\right]$$

Gradient(x^2*y^3,[x,y])

$$\left[2xy^{3},\ 3x^{2}y^{2}\right]$$

Gradient(1/sqrt(x^2+y^2+z^2))

$$\left[-\frac{x}{\left[x^{2}+y^{2}+z^{2}\right]^{1.5}},\ -\frac{y}{\left[x^{2}+y^{2}+z^{2}\right]^{1.5}},\ -\frac{z}{\left[x^{2}+y^{2}+z^{2}\right]^{1.5}}\right]$$

Gradient(sin(x)*exp(y)*ln(z))

$$\left[\cos[x]\ln[z]e^{y},\ \sin[x]\ln[z]e^{y},\ \frac{\sin[x]e^{y}}{z}\right]$$

Gradient([a/b,c*d^2,a^2*c],[d,c])

0	0
$2cd$	d^2
0	a^2

Gradient([x*y/z,y*z^2,z^2*x])

$\frac{y}{z}$	$\frac{x}{z}$	$-\frac{xy}{z^2}$
0	z^2	$2yz$
z^2	0	$2xz$

Cartesian coordinate system

Gradient(f(x,y,z))

$$\left[D\left[f\left[x,\ y,\ z\right],\ x\right],\ D\left[f\left[x,\ y,\ z\right],\ y\right],\ D\left[f\left[x,\ y,\ z\right],\ z\right]\right]$$

Cylindrical coordinate system

Gradient(f(r,\phi,z),[r,\phi,z],1)

$$\left[D\left[f\left[r,\ \phi,\ z\right],\ r\right],\ \frac{D\left[f\left[r,\ \phi,\ z\right],\ \phi\right]}{r},\ D\left[f\left[r,\ \phi,\ z\right],\ z\right]\right]$$

Spherical coordinate system

Gradient(f(r,\theta,\phi),[r,\theta,\phi],2)

$$\left[D\left[f\left[r,\ \theta,\ \phi\right],\ r\right],\ \frac{D\left[f\left[r,\ \theta,\ \phi\right],\ \theta\right]}{r},\ \frac{\csc\left[\theta\right]D\left[f\left[r,\ \theta,\ \phi\right],\ \phi\right]}{r}\right]$$

Gudermannian(z)

Returns the Gudermannian function of z.

Gudermannian(0)

0

Gudermannian(-\inf)

$$-\frac{\pi}{2}$$

Gudermannian(\inf)

$$\frac{\pi}{2}$$

Gudermannian(3)

$$-\frac{\pi}{2}+3.04210067$$

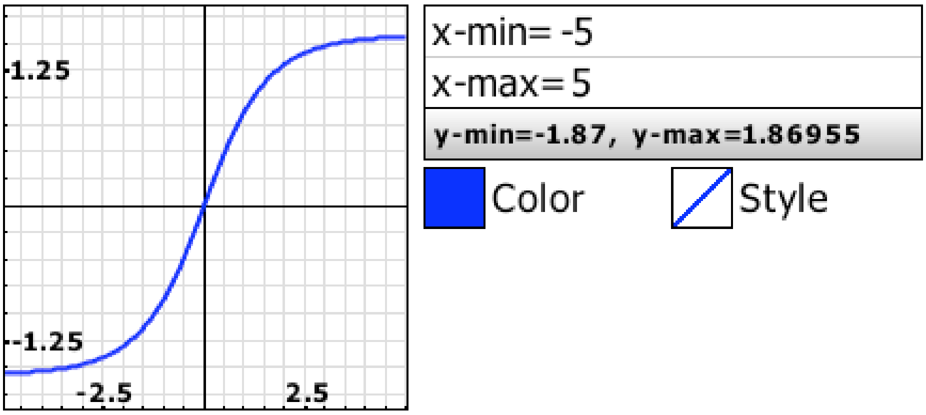
Gudermannian(3-2\im)

$$-\frac{\pi}{2}-\left[3.10007609+0.09056543i\right]$$

Diff(Gudermannian(x),x)

$\mathrm{sech}\left[x\right]$

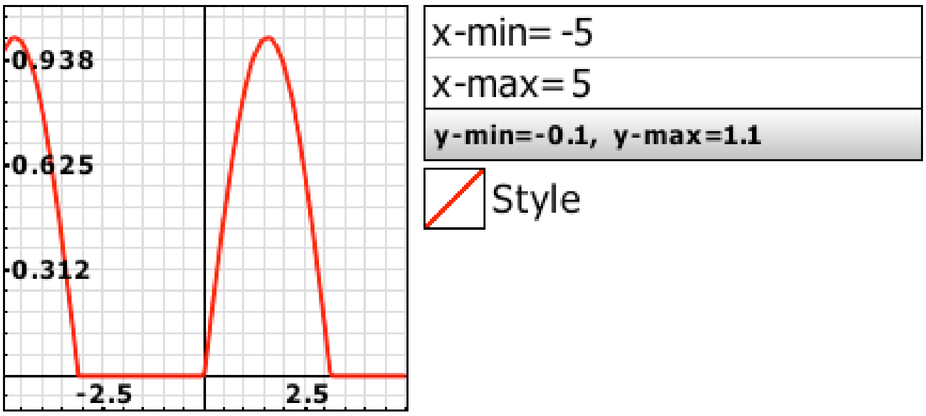
Plot(Gudermannian(x))



HalfRectSineWave(x, [T])

Creates a predefined 2D half rectified sine wave with period = T.

Plot(HalfRectSineWave(x),color=red)



HankelH1(v, z)

Calculates the Hankel function of the first kind.

HankelH1(0,z)

$i\,\text{BesselY}[0,\ z]+\text{BesselJ}[0,\ z]$

HankelH1(v,2)

$i\,\text{BesselY}[v,\ 2]+\text{BesselJ}[v,\ 2]$

HankelH1(0,5)

$\frac{-0.96924 i}{\pi} - 0.1776$

HankelH1(0,-5)

$\frac{1.11587-0.96924 i}{\pi} - 0.1776$

Expand(HankelH1(0,z)+HankelH2(0,z))

$2\,\text{BesselJ}[0,\ z]$

Diff(HankelH1(-1,z),z)

$-\text{BesselJ}[0,\ z]+\frac{\text{BesselJ}[1,\ z]}{z}-i\left[-\frac{\text{BesselY}[1,\ z]}{z}+\text{BesselY}[0,\ z]\right]$

HankelH2(v, z)

Calculates the Hankel function of the second kind.

HankelH2(0,z)

$-i\,\text{BesselY}[0,\ z]+\text{BesselJ}[0,\ z]$

HankelH2(v,2)

$-i\,\text{BesselY}[v,\ 2]+\text{BesselJ}[v,\ 2]$

HankelH2(0,5+\im)

$-0.39576+0.87775 i$

HankelH2(0,-5-\im)

$0.07495+0.10514\mathrm{i}$

Expand(HankelH1(1,z)+HankelH2(1,z))

$2\,\mathrm{BesselJ}[1,\ z]$

Diff(HankelH2(1/2,z),z)

$$-\frac{\sin[z]}{z^{2}\pi\sqrt{\frac{2}{z\pi}}}+\sqrt{\frac{2}{z\pi}}\cos[z]+\mathrm{i}\left[-\frac{\cos[z]}{z^{2}\pi\sqrt{\frac{2}{z\pi}}}-\sqrt{\frac{2}{z\pi}}\sin[z]\right]$$

Harmonic(z)

Calculates the Harmonic Number of z.

Harmonic(2)

$$\frac{3}{2}$$

Harmonic(a+3)

$$\frac{1}{a}+\gamma+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}+\mathrm{Psi}[a]$$

Harmonic(1-2a)

$$\gamma+\frac{\mathrm{Psi}[a]+\mathrm{Psi}\left[a+\frac{1}{2}\right]}{2}+\pi\cot[2\,a\,\pi]+\frac{1}{-2\,a+1}+\ln[2]$$

Harmonic(3a)

$$\frac{1}{3\,a}+\gamma+\frac{\mathrm{Psi}[a]+\mathrm{Psi}\left[a+\frac{1}{3}\right]+\mathrm{Psi}\left[a+\frac{2}{3}\right]}{3}+\ln[3]$$

Harmonic(100/3)

$$-\frac{3}{2}\ln[3]-\frac{\pi\sqrt{3}}{6}+6.65352$$

Harmonic(2+3\im)

$$\gamma+[1.36183+0.87336\mathrm{i}]$$

Harmonic(-z)

$$\gamma+\pi\cot[z\,\pi]+\mathrm{Psi}[z]$$

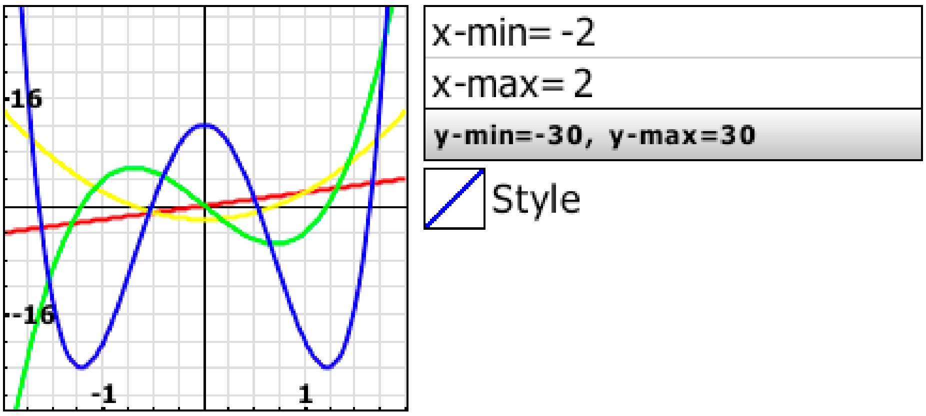
Diff(Harmonic(x),x)

$$-\frac{1}{x^2}+\mathrm{PolyGamma}[1,\ x]$$

HermiteH(n, z)

Returns the Hermite polynomial.

Plot(HermiteH(1, x), HermiteH(2, x), HermiteH(3, x), HermiteH(4, x), x=[-2, 2], y=[-30, 30], color=[red, yellow, green, blue], numbers=4)



Hessian(function, [varlist], [mode])

Returns the Hessian matrix (mode=0) or Hessian determinant (mode=1) of a given function.

Hessian(f(x,y,z))

$D[D[f[x, y, z], x], x]$	$D[D[f[x, y, z], x], y]$	$D[D[f[x, y, z], x], z]$
$D[D[f[x, y, z], y], x]$	$D[D[f[x, y, z], y], y]$	$D[D[f[x, y, z], y], z]$
$D[D[f[x, y, z], z], x]$	$D[D[f[x, y, z], z], y]$	$D[D[f[x, y, z], z], z]$

Hessian(x^2*y^3/z^2)

$\frac{2y^3}{z^2}$	$\frac{6xy^2}{z^2}$	$-\frac{4xy^3}{z^3}$
$\frac{6xy^2}{z^2}$	$\frac{6x^2y}{z^2}$	$-\frac{6x^2y^2}{z^3}$
$-\frac{4xy^3}{z^3}$	$-\frac{6x^2y^2}{z^3}$	$\frac{6x^2y^3}{z^4}$

Hessian(r^2*x^2+s^3*y^3,[r,s])

$2x^2$	0
0	$6sy^3$

Hessian(r^2*x^2+s^3*y^3,[r,s],1)

$12sx^2y^3$

HRStoHMS(hours, [digits])

Converts a number representing hours into a string representation of hours, minutes and seconds.

HRStoHMS(5)

5h0m0s.000

HRStoHMS(5.5)
5h30m0s.000

HRStoHMS(1.234)
1h14m2s.400

HRStoHMS(1.23456789,6)
1h14m4s.444404

Hypergeom_2F1(a, b, c, z, [mode])

Calculates the Hyper Geometric 2F1 function.

Hypergeom_2F1(a,b,c,1)

$$\frac{\text{Gamma}\left[c\right]\text{Gamma}\left[-a-b+c\right]}{\text{Gamma}\left[-a+c\right]\text{Gamma}\left[-b+c\right]}$$

Hypergeom_2F1(a,b,a,z)

$$\left[-z+1\right]^{\left[-b\right]}$$

Hypergeom_2F1(5,2,1,z)

$$\frac{4z+1}{\left[-z+1\right]^{6}}$$

Hypergeom_2F1(1,1,5,z)

$$\frac{22}{3z}-\frac{10}{z^{2}}+\frac{4}{z^{3}}-\frac{12\ln\left[-z+1\right]}{z^{3}}-\frac{4\ln\left[-z+1\right]}{z}+\frac{4\ln\left[-z+1\right]}{z^{4}}+\frac{12\ln\left[-z+1\right]}{z^{2}}$$

Hypergeom_2F1(4,1,1/2,z)

$$\frac{8z^{3}-38z^{2}+87z+48}{48\left[-z+1\right]^{4}}+\frac{35\sqrt{z}\,\text{asin}\left[\sqrt{z}\right]}{16\left[-z+1\right]^{\left[\frac{9}{2}\right]}}$$

Hypergeom_2F1(1/2,1,3/2,2.4)

$$\frac{\sqrt{5}\,\operatorname{atanh}\left[\frac{2\sqrt{3}}{\sqrt{5}}\right]}{2\sqrt{3}}$$

Hypergeom_2F1(-1/2,1,1/2,z)

$$-\sqrt{z}\,\operatorname{atanh}\left[\sqrt{z}\right]+1$$

Hypergeom_2F1(1,1/2,3/4,z,8)

$$\frac{16640\,z^{8}}{40641}+\frac{1664\,z^{7}}{3933}+\frac{192\,z^{6}}{437}+\frac{96\,z^{5}}{209}+\frac{16\,z^{4}}{33}+\frac{40\,z^{3}}{77}+\frac{4\,z^{2}}{7}+\frac{2\,z}{3}+1$$

Identity(n)

Returns the **n x n** identity matrix.

Identity(3)

1	0	0
0	1	0
0	0	1

Identity(4)*a

a	0	0	0
0	a	0	0
0	0	a	0
0	0	0	a

---

iDiff(f(x,y,z,..), dependant_variables,

independant_variables)

Finds the implicit derivative of the given function.

The dependant variable(s) are an unspecified function of the independant variable(s).

iDiff(a*x^3*y-2*y/z-z^2,y,x)

$$-\frac{3\,a\,x^{2}\,y}{-\frac{2}{z}+a\,x^{3}}$$

iDiff(sin(y)+x^2*y^2-x*y,y,x)

$$\frac{y-2\,x\,y^{2}}{-x+2\,x^{2}\,y+\cos[y]}$$

iDiff(y^3-y-x,y,x)

$$\frac{1}{3\,y^{2}-1}$$

iDiff(x^2*y+x*y^2-1,y,x)

$$\frac{-y^{2}-2\,x\,y}{x^{2}+2\,x\,y}$$

iDiff(sin(r*t)-r,r,t)

$$-\frac{r\cos[r\,t]}{t\cos[r\,t]-1}$$

iDiff(x^2+y^2,y,x)

$$-\frac{x}{y}$$

iDiff(x^2*tan(y)+y^10*sec(x)=2x,y,x)

$$\frac{-2\,x\tan[y]-y^{10}\tan[x]\sec[x]+2}{x^{2}\sec[y]^{2}+10\,y^{9}\sec[x]}$$

iDiff(exp(2x+3y)+ln(x*y^3)=x^2,y,x)

$$\frac{2x-\frac{1}{x}-2e^{[2x+3y]}}{\frac{3}{y}+3e^{[2x+3y]}}$$

If(condition)

Evaluates a block of code if **condition** is a non-zero value. The **end** keyword is used to end the block of code.

This function can also be used with the **else** statement which will execute a different block of code if **condition** is zero for false.

The following comparisons are also typically used with **If**.
(Equal to) ==
(Not equal to) !=
(Greater than) >
(Greater than or equal to) >=
(Less than)
n=5 if(n>0) result="Positive" else if(n
Positive

---

iLaplace(F(s), s)

Finds the Time function f(t) of the given Laplace function F(s).

iLaplace(10/p^(3/2),p)

$$\frac{20\sqrt{t}}{\sqrt{\pi}}$$

iLaplace(b/\sqrt(a*s),s)

$$\frac{b}{\sqrt{a}\sqrt{t}\sqrt{\pi}}$$

iLaplace(b/(a*s)^5,s)

$$\frac{b\,t^4}{24\,a^5}$$

iLaplace(2/s+3/s^2-4/s^4,s)

$$-\frac{2\,t^3}{3}+3\,t+2$$

iLaplace(-1/(-s-3)+(c^3)/s,s)

$$c^3+e^{\left[-3\,t\right]}$$

iLaplace(1/s+1/(s^2)-4/(s^3)-18/(s^4)+(-a)/(a^2+s^2)+(-s)/(a^2+s^2),s)

$$-3\,t^3-2\,t^2+t-\cos\left[a\,t\right]-\sin\left[a\,t\right]+1$$

iLaplace(-288b*s^2/(b^2+s^2)^4+24b/(b^2+s^2)^3+384b*s^4/(b^2+s^2)^5,s)

$$t^4\,\sin\left[b\,t\right]$$

iLaplace(exp(k\sqrt(s)),s)

$$-\frac{k\,e^{\left[-\frac{k^2}{4\,t}\right]}}{2\,\sqrt{t^3\,\pi}}$$

iLaplace(\sqrt(3)exp(3/s)/(7\sqrt(13)\sqrt(s)),s)

$$\frac{\sqrt{3}\,\cosh\left[2\,\sqrt{3\,t}\right]}{7\,\sqrt{13}\,\sqrt{t\,\pi}}$$

iLaplace(\sqrt(3)exp(3/s)/(\sqrt(b)s*\sqrt(s)),s)

$$\frac{\sqrt{3}\,\sinh\left[2\,\sqrt{3\,t}\right]}{\sqrt{b}\,\sqrt{3\,\pi}}$$

iLaplace(exp(k/s),s)

$$\frac{k\,\mathrm{BesselJ}\left[1,\;2\,\sqrt{-k\,t}\right]}{\sqrt{-k\,t}}+\mathrm{Dirac}\left[t\right]$$

iLaplace(3*a*b*exp(a*\sqrt(s)-b),s)

$$-\frac{3a^2 b e^{\left[-b-\frac{a^2}{4t}\right]}}{2\sqrt{t^3\pi}}$$

iLaplace(I(a/(s^3*(a^2+s^2)),s,3),s)

$$-\frac{1}{a^3t^3}+\frac{1}{2at}+\frac{\cos\left[at\right]}{a^3t^3}$$

iLaplace(I(a/(a^2+s^2),s,3),s)

$$\frac{\sin\left[at\right]}{t^3}$$

iLaplace(I(s/(a^2+s^2),s,4),s)

$$\frac{\cos\left[at\right]}{t^4}$$

iLaplace(d(s/(s^2+1),s,3),s)

$$-t^3\cos\left[t\right]$$

iLaplace(d(s/(s^2+1),s,-3),s)

$$\frac{\cos\left[t\right]}{t^3}$$

iLaplace(d(F(s),s,2)+d(G(s),s,-3),s)

$$t^2f\left[t\right]+\frac{g\left[t\right]}{t^3}$$

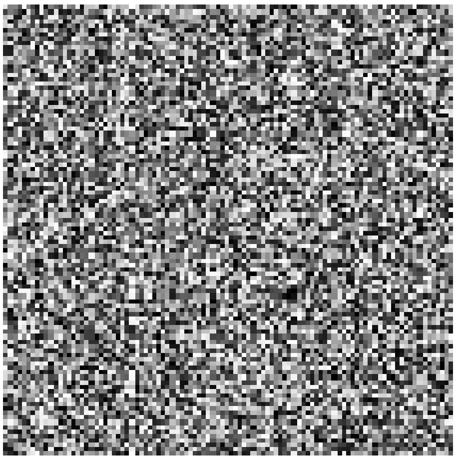
iLaplace(d(F(s),s,3)+d(G(s),s,-3)+I(H(s),s,3),s)

$$-t^3f\left[t\right]+\frac{g\left[t\right]}{t^3}+\frac{h\left[t\right]}{t^3}$$

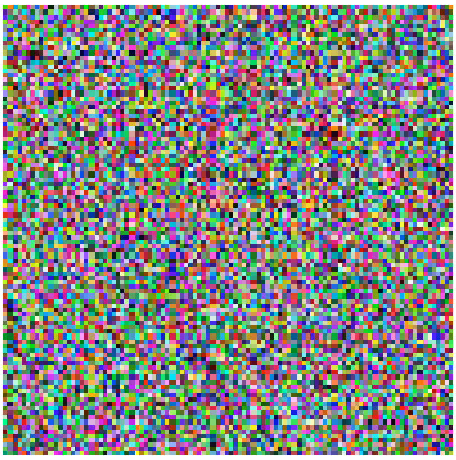
Im(z)
Returns the imaginary part of a complex number.

ImagePlot(data)
Plots matrices as images. If the element of the matrix is a number a gray scale color is plotted. If the element of the matrix is a list of 3 values a color is plotted where each component represents red, green and blue.

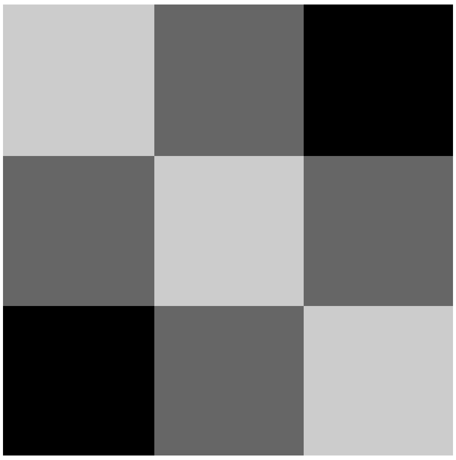
ImagePlot(Random(0,1,100,100))



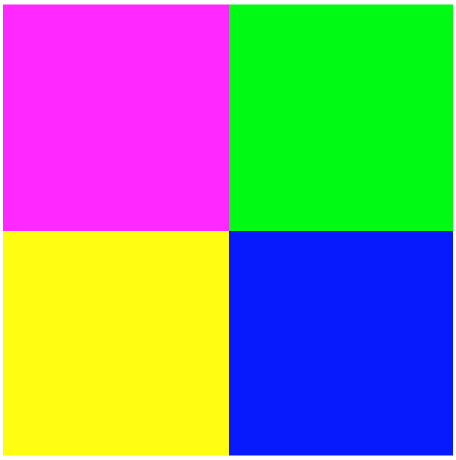
ImagePlot(Random(0,1,100,100,3))



ImagePlot([[0.8,0.4,0],[0.4,0.8,0.4],[0,0.4,0.8]])



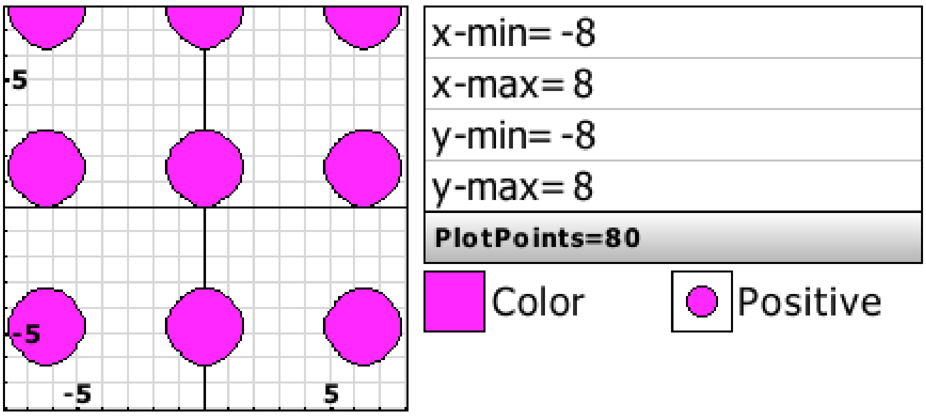
ImagePlot([[[1,0,1],[0,1,0]],[[1,1,0],[0,0,1]]])



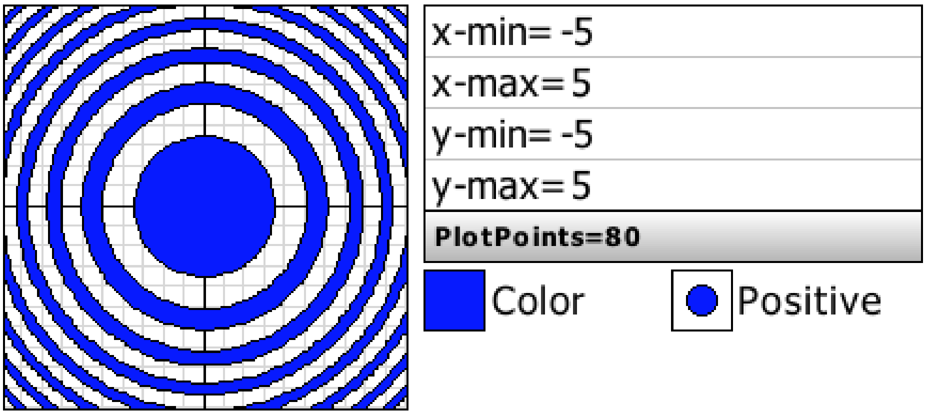
ImplicitPlot(expression, ...)

Plots 2D implicit graphs.

ImplicitPlot(cos(x)+sin(y)=1,x=[-8,8],y=[-8,8])



ImplicitPlot(sin(x^2+y^2)=0, numbers=0)



Include(filename)

Includes the scripts from SpaceTime files.

Insert(expression, item, position)

Inserts an expression into a list or string at the specified position.

Insert("acde",b,2)

abcde

Insert([1,2,4,5],333,3)

[1, 2, 333, 4, 5]

Integrate(f(x), x, [a], [b])

Finds the indefinite integral of the given function.

If parameters **a** and **b** are given then **Integrate** returns the definite integral. You can also use NIntegrate for definite integrals.

Simple Integrals

Integrate(x^2+3x-6,x)

$$\frac{x^3}{3}+\frac{3x^2}{2}-6x$$

Integrate(ln(x)+1/x,x)

$$-x+x\ln[x]+\ln[x]$$

Integrate(exp(x)*sin(x),x)

$$-\frac{\cos[x]e^x}{2}+\frac{\sin[x]e^x}{2}$$

Integrate(sin(3x)*cos(4x-2),x)

$$-\frac{1}{14}\cos[7x-2]+\frac{1}{2}\cos[x-2]$$

Integrate((x+1)/(x^2+1),x)

$$\frac{1}{2}\ln[x^2+1]+\mathrm{atan}[x]$$

Integrate(1/(a*x^2+b*x),x)

$$-\frac{\ln[b+ax]}{b}+\frac{\ln[x]}{b}$$

Integrate(1/cos(x),x)

$$\ln[\mathrm{abs}[\tan[x]+\sec[x]]]$$

Integrate(1/tan(x),x)

$$\ln[\sin[x]]$$

Integrate(sin(x)^2*cos(x),x)

$$-\frac{1}{12}\sin[3x]+\frac{1}{4}\sin[x]$$

Integrate(sin(3x)/sin(x),x)

$$x+\sin[2x]$$

Integrals with trigonometric functions

Integrate(-3/x^2+sin(x)/(1-sin(x)),x)

$$-x+\frac{3}{x}-\frac{2}{\tan\left[\frac{x}{2}\right]-1}$$

Integrate((1+2cos(x))/(1+2sin(x)),x)

$$-\frac{\ln\left[2\sqrt{3}\cos\left[x\right]+2\sin\left[x\right]+4\right]}{\sqrt{3}}+\frac{\ln\left[2\sin\left[x\right]+1\right]}{\sqrt{3}}+\ln\left[2\sin\left[x\right]+1\right]$$

Integrate(cos(a*x+b)/x^3,x)

$$-\frac{\cos\left[b+a\,x\right]}{2\,x^{2}}-\frac{a^{2}\,\mathrm{Ci}\left[a\,x\right]\cos\left[b\right]}{2}+\frac{a\sin\left[b+a\,x\right]}{2\,x}+\frac{a^{2}\,\mathrm{Si}\left[a\,x\right]\sin\left[b\right]}{2}$$

Integrate(2/sin(2x),x)

$$-\ln\left[\cos\left[x\right]\right]+\ln\left[\sin\left[x\right]\right]$$

Integrate(sin(x)/sqrt(1+cos(x)),x)

$$-2\sqrt{\cos\left[x\right]+1}$$

Integrate(2sin(3x)/sqrt(5+cos(3x))^3,x)

$$\frac{4}{3\sqrt{\cos\left[3\,x\right]+5}}$$

Integrate(x*cos(x)^3/(3+sin(x)),x)

$$-8\,y\ln\left[\sin\left[x\right]+3\right]-\frac{y\sin\left[x\right]^{2}}{2}+3\,y\sin\left[x\right]$$

Integrals with reciprocals

Integrate(1/(1+sqrt(x)),x)

$$2\sqrt{x}-2\ln\left[\sqrt{x}+1\right]$$

Integrate(x+1/(x^(1/4)*sqrt(1+sqrt(x))),x)

$$\frac{x^{2}}{2}-2\,\mathrm{asinh}\left[x^{\left[\frac{1}{4}\right]}\right]+2\,x^{\left[\frac{1}{4}\right]}\sqrt{\sqrt{x}+1}$$

Integrate(sqrt(x^2-y),x)

$$-\frac{y\ln\left[x+\sqrt{x^{2}-y}\right]}{2}+\frac{x\sqrt{x^{2}-y}}{2}$$

Integrate(sqrt(x)/sqrt(x-2),x)

$$\sqrt{x}\,\sqrt{x-2}+\frac{2\sqrt{x-2}\,\mathrm{asin}\left[\frac{\sqrt{-x+2}}{\sqrt{2}}\right]}{\sqrt{-x+2}}$$

Integrate(sqrt(2x)/sqrt(x-1),x)

$$\sqrt{x}\,\sqrt{2}\,\sqrt{x-1}+\frac{\sqrt{2}\,\sqrt{x-1}\,\mathrm{asin}\left[\sqrt{-x+1}\right]}{\sqrt{-x+1}}$$

Integrate(sqrt(2x-1)/sqrt(x+2),x)

$$-\frac{5\ln\left[\sqrt{2}\,\sqrt{x+2}+\sqrt{2\,x-1}\right]}{\sqrt{2}}+\sqrt{-x-2}\,\sqrt{-2\,x+1}$$

Integrate((3x+2)/sqrt(x-9),x)

$$2\,x\sqrt{x-9}+40\sqrt{x-9}$$

Integrate(x^(1/4)/(1+sqrt(x)),x)

$$\frac{4\,x^{\left[\frac{3}{4}\right]}}{3}-4\,x^{\left[\frac{1}{4}\right]}+4\,\mathrm{atan}\left[x^{\left[\frac{1}{4}\right]}\right]$$

Integrate(sqrt(x)/(sqrt(x)+sqrt(x+1)),x)

$$-\frac{x^{2}}{2}-\frac{1}{4}\mathrm{asinh}\left[\sqrt{x}\right]+\frac{\sqrt{x}\,\sqrt{x+1}}{4}+\frac{x^{\left[\frac{3}{2}\right]}\sqrt{x+1}}{2}$$

Integrate((1+x^4)/(1+x^3),x)

$$\frac{x^2}{2}-\frac{1}{3}\ln\left[x^2-x+1\right]+\frac{2}{3}\ln\left[x+1\right]$$

Integrate(1/(1+x^3),x)

$$-\frac{1}{6}\ln\left[x^2-x+1\right]+\frac{1}{3}\ln\left[x+1\right]+\frac{\operatorname{atan}\left[-\frac{1}{\sqrt{3}}+\frac{2\,x}{\sqrt{3}}\right]}{\sqrt{3}}$$

Integrate(1/(a*x^2+b)^2,x)

$$-\frac{x}{b\left[-2\,b-2\,a\,x^2\right]}+\frac{\operatorname{atan}\left[\frac{\sqrt{a}\,x}{\sqrt{b}}\right]}{2\,\sqrt{a}\,b^{\left[\frac{3}{2}\right]}}$$

Integrals with polynomials

Integrate(1/sqrt(1+sqrt(x)),x)

$$-\frac{8\,\sqrt{\sqrt{x}+1}}{3}+\frac{4\,\sqrt{x}\,\sqrt{\sqrt{x}+1}}{3}$$

Integrate(1/(x^2*sqrt(4+x^2)),x)

$$-\frac{\sqrt{x^2+4}}{4\,x}$$

Integrate(1/(x^4+4),x)

$$-\frac{1}{16}\ln\left[x^2-2\,x+2\right]+\frac{1}{16}\ln\left[x^2+2\,x+2\right]+\frac{1}{8}\operatorname{atan}\left[x-1\right]+\frac{1}{8}\operatorname{atan}\left[x+1\right]$$

Integrate(x/(x^2+2x+5),x)

$$-\frac{1}{2}\operatorname{atan}\left[\frac{x}{2}+\frac{1}{2}\right]+\frac{1}{2}\ln\left[x^2+2\,x+5\right]$$

Integrate(x^(2/3)/(x-1),x)

$$\frac{3x^{\left[\frac{2}{3}\right]}}{2}-\frac{1}{2}\ln\left[x^{\left[\frac{2}{3}\right]}+x^{\left[\frac{1}{3}\right]}+1\right]+\frac{3\,\mathrm{atan}\left[\frac{2x^{\left[\frac{1}{3}\right]}}{\sqrt{3}}+\frac{1}{\sqrt{3}}\right]}{\sqrt{3}}+\ln\left[x^{\left[\frac{1}{3}\right]}-1\right]$$

Integrate(x^2/(x^2+3x+1),x)

$$x-\frac{7\,\mathrm{atanh}\left[\frac{2x}{\sqrt{5}}+\frac{3}{\sqrt{5}}\right]}{\sqrt{5}}-\frac{3}{2}\ln\left[x^{2}+3x+1\right]$$

Integrate(x^3/(7x^2+2x-3),x)

$$\frac{x^{2}}{14}-\frac{2x}{49}+\frac{25}{686}\ln\left[7x^{2}+2x-3\right]+\frac{67\sqrt{7}\,\mathrm{atanh}\left[\frac{\sqrt{7}}{\sqrt{154}}+\frac{7x}{\sqrt{22}}\right]}{343\sqrt{154}}$$

Integrate(x^4*(x+1)^(5/3),x)

$$-\frac{12\left[x+1\right]^{\left[\frac{11}{3}\right]}}{11}-\frac{12\left[x+1\right]^{\left[\frac{17}{3}\right]}}{17}+\frac{3\left[x+1\right]^{\left[\frac{20}{3}\right]}}{20}+\frac{3\left[x+1\right]^{\left[\frac{8}{3}\right]}}{8}+\frac{9\left[x+1\right]^{\left[\frac{14}{3}\right]}}{7}$$

Integrals with logarithmic functions

Integrate(ln(2*x+1),x)

$$-x+\frac{1}{2}\ln\left[2x+1\right]+x\ln\left[2x+1\right]$$

Integrate((x^2+3x)*ln(x),x)

$$-\frac{x^{3}}{9}-\frac{3x^{2}}{4}+\frac{x^{3}\ln\left[x\right]}{3}+\frac{3x^{2}\ln\left[x\right]}{2}$$

Integrate(ln(x)/(x+3)^2,x)

$$-\frac{\ln\left[x\right]}{x+3}-\frac{1}{3}\ln\left[x+3\right]+\frac{1}{3}\ln\left[x\right]$$

Integrate(sin(x)*ln(cos(x)),x)

$$-\cos[x]\ln[\cos[x]]+\cos[x]$$

Integrate(ln(x)/sqrt(x+1),x)

$$-4\sqrt{x+1}-2\ln[\sqrt{x+1}-1]+2\sqrt{x+1}\ln[x]+2\ln[\sqrt{x+1}+1]$$

Integrate(ln(x^2+3)/(x+1)^2,x)

$$-\frac{\ln[x^2+3]}{x+1}-\frac{1}{2}\ln[x+1]+\frac{1}{4}\ln[x^2+3]+\frac{3\,\mathrm{atan}\left[\frac{x}{\sqrt{3}}\right]}{2\sqrt{3}}$$

Integrate(x^4*ln(x)^(5/2),x)

$$-\frac{x^5\ln[x]^{\left[\frac{3}{2}\right]}}{10}-\frac{3\sqrt{\pi}\,\mathrm{Erfi}\left[\sqrt{5\ln[x]}\right]}{200\sqrt{5}}+\frac{3x^5\sqrt{\ln[x]}}{100}+\frac{x^5\ln[x]^{\left[\frac{5}{2}\right]}}{5}$$

Integrate(x^3/ln(x)^(5/2),x)

$$-\frac{16x^4}{3\sqrt{\ln[x]}}-\frac{2x^4}{3\ln[x]^{\left[\frac{3}{2}\right]}}+\frac{32\sqrt{\pi}\,\mathrm{Erfi}\left[\sqrt{4\ln[x]}\right]}{3}$$

Integrals with exponential functions

Integral(exp(x)/((exp(x)-1)*(exp(x)+3)),x)

$$-\frac{1}{4}\ln[e^x+3]+\frac{1}{4}\ln[e^x-1]$$

Integral(exp(3x)/(1+exp(2x)),x)

$$-\mathrm{atan}[e^x]+e^x$$

Integral(exp(-2x)/(1+exp(-2x)),x)

$$-\frac{1}{2}\ln\left[e^{[-2x]}+1\right]$$

Integral(1/(1+exp(2x)),x)

$$x - \frac{1}{2}\ln\left[e^{[2x]} + 1\right]$$

Integral(exp(5x)/(1+exp(2x)),x)

$$-e^{x} + \frac{1}{3}e^{[3x]} + \operatorname{atan}\left[e^{x}\right]$$

Integral(exp(x+a)/(1+exp(2x+1)),x)

$$\frac{\operatorname{atan}\left[\sqrt{e}\, e^{x}\right] e^{a}}{\sqrt{e}}$$

Integral(sqrt(1+exp(3x)),x)

$$-\frac{1}{3}\ln\left[\sqrt{e^{[3x]}+1}+1\right] + \frac{1}{3}\ln\left[\sqrt{e^{[3x]}+1}-1\right] + \frac{2\sqrt{e^{[3x]}+1}}{3}$$

Integral(1/sqrt(1+exp(3x)),x)

$$-\frac{2}{3}\operatorname{atanh}\left[\sqrt{e^{[3x]}+1}\right]$$

Integrate(exp(-3*x^2),x)

$$\frac{\sqrt{\pi}\,\operatorname{Erf}\left[\frac{3x}{\sqrt{3}}\right]}{2\sqrt{3}}$$

Integrals with inverse trigonometric functions

Integrate(asin(2x-1),x)

$$\frac{-\operatorname{asin}\left[2x-1\right] + 2x\operatorname{asin}\left[2x-1\right]}{2} + \sqrt{-x^{2}+x}$$

Integrate(x*asinh(x-7),x)

$$-\frac{97}{4}\operatorname{asinh}\left[x-7\right] - \frac{21\sqrt{x^{2}-14x+50}}{4} - \frac{x\sqrt{x^{2}-14x+50}}{4} + \frac{x^{2}\operatorname{asinh}\left[x-7\right.}{2}$$

Integrate(x^2*asin(3x),x)

$$\frac{2\sqrt{-9x^2+1}}{243}+\frac{x^2\sqrt{-9x^2+1}}{27}+\frac{x^3\,\mathrm{asin}[3x]}{3}$$

Integrate(x^3*atanh(x-1),x)

$$\frac{x^3}{12}+\frac{x^2}{4}+x+\frac{x^4\,\mathrm{atanh}[x-1]}{4}+2\ln[x-2]$$

Integrate(x^4*atan(x),x)

$$-\frac{x^4}{20}+\frac{x^2}{10}-\frac{1}{10}\ln[x^2+1]+\frac{x^5\,\mathrm{atan}[x]}{5}$$

Integrate((x+1/x^2)*atan(x),x)

$$-\frac{x}{2}-\frac{\mathrm{atan}[x]}{x}-\frac{1}{2}\ln[x^2+1]+\frac{x^2\,\mathrm{atan}[x]}{2}+\frac{1}{2}\mathrm{atan}[x]+\ln[x]$$

Integrate(x*asin(x-2),x)

$$-\frac{9}{4}\mathrm{asin}[x-2]+\frac{x\sqrt{-x^2+4x-3}}{4}+\frac{x^2\,\mathrm{asin}[x-2]}{2}+\frac{3\sqrt{-x^2+4x-3}}{2}$$

Integrals with forced substitution

Integrate(sqrt(2+sqrt(4+sqrt(x))),x,u=2+sqrt(4+sqrt(x)))

$$-\frac{48\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{7}{2}\right]}}{7}+\frac{8\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{9}{2}\right]}}{9}+\frac{64\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{5}{2}\right]}}{5}$$

Integrate(sqrt(2+sqrt(1+sqrt(x))),x,u=2+sqrt(1+sqrt(x)))

$$-16\left[\sqrt{\sqrt{x}+1}+2\right]^{\left[\frac{3}{2}\right]}-\frac{48\left[\sqrt{\sqrt{x}+1}+2\right]^{\left[\frac{7}{2}\right]}}{7}+\frac{8\left[\sqrt{\sqrt{x}+1}+2\right]^{\left[\frac{9}{2}\right]}}{9}+\frac{88\left[\sqrt{\sqrt{x}+1}+2\right]^{\left[\frac{5}{2}\right]}}{5}$$

Integrate(sqrt(2+sqrt(4+sqrt(x))),x,u=2+sqrt(4+sqrt(x)))

$$-\frac{48\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{7}{2}\right]}}{7}+\frac{8\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{9}{2}\right]}}{9}+\frac{64\left[\sqrt{\sqrt{x}+4}+2\right]^{\left[\frac{5}{2}\right]}}{5}$$

Integrate((1+sqrt(x-3))^(1/3),x,u=sqrt(x-3))

$$-\frac{3\left[\sqrt{x-3}+1\right]^{\left[\frac{4}{3}\right]}}{2}+\frac{6\left[\sqrt{x-3}+1\right]^{\left[\frac{7}{3}\right]}}{7}$$

Integrate(ln(x+1)^2*x,x,u=x+1)

$$\frac{x^{2}}{4}-\frac{3x}{2}-\frac{x^{2}\ln\left[x+1\right]}{2}-\frac{\ln\left[x+1\right]^{2}}{2}+\frac{x^{2}\ln\left[x+1\right]^{2}}{2}+x\ln\left[x+1\right]+\frac{3}{2}\ln\left[x+1\right]$$

Integrate(asin(sqrt(x)),x,u=sqrt(x),1)

Input	Output
u	$\sqrt{x}$
$\frac{d_{u}}{d_{x}}$	$\frac{1}{2\sqrt{x}}$
x	u^{2}
$\frac{d_{x}}{d_{u}}$	$2u$
$\text{asin}\left[\sqrt{x}\right]$	$2u\,\text{asin}\left[u\right]$
Integral	$\frac{u\sqrt{-u^{2}+1}}{2}+2\left[\frac{u^{2}}{2}-\frac{1}{4}\right]\text{asin}\left[u\right]$
Final Result	$-\frac{1}{2}\text{asin}\left[\sqrt{x}\right]+\frac{\sqrt{x}\sqrt{-x+1}}{2}+x\,\text{asin}\left[\sqrt{x}\right]$

Inverse(A)

Calculates the inverse of a given square matrix A.

Inverse([[1,5,6],[2,4,5],[1,1,7]])

$-\frac{23}{34}$	$\frac{29}{34}$	$-\frac{1}{34}$
$\frac{9}{34}$	$-\frac{1}{34}$	$-\frac{7}{34}$
$\frac{1}{17}$	$-\frac{2}{17}$	$\frac{3}{17}$

Inverse([[a,b],[c,d]])

$\frac{1}{a}+\frac{b\,c}{a^{2}\left[d-\frac{b\,c}{a}\right]}$	$-\frac{b}{a\left[d-\frac{b\,c}{a}\right]}$
$-\frac{c}{a\left[d-\frac{b\,c}{a}\right]}$	$\frac{1}{d-\frac{b\,c}{a}}$

InverseNormal(p, [mu], [sigma])

Computes the x value to a corresponding area p using the inverse cumulative normal distribution function.

---

invGudermannian(z)

Returns the inverse Gudermannian function of **z**.

invGudermannian(0)

0

invGudermannian(-\pi/2)

$-\infty$

invGudermannian(\pi/2)

∞

invGudermannian(1)

$$\frac{1}{2}\ln\left[\frac{\sin\left[1\right]+1}{-\sin\left[1\right]+1}\right]$$

number(invGudermannian(1))

1.22619117

invGudermannian(1.5)

3.34067754

Diff(invGudermannian(x),x)

$\sec\left[x\right]$

Series(invGudermannian(x),x,8)

$$\frac{277\,x^{9}}{72576}+\frac{61\,x^{7}}{5040}+\frac{x^{5}}{24}+\frac{x^{3}}{6}+x$$

---

iPart(z)

Returns the integer part of z.

iPart(4/3)

1

iPart(1.234)

1

iPart(-9.8765)

-9

IsList(expression)
Returns **1** if the expression is a list or returns **0** if the expression is not a list.

IsMatrix(expression)
Returns **1** if the expression is a matrix or returns **0** if the expression is not a matrix.

IsNumber(expression)
Returns 1 if the expression is a real or complex number otherwise it returns 0.

IsPoly(expression)
Returns 1 if the expression is a polynomial or returns 0 if it is not a polynomial.

IsPrime(n)
Returns 1 if the number is prime or 0 if it is not prime.

Jacobian(function, [varlist], [point])
Returns either the Jacobian matrix or the Jacobian determinant of a function list **function(varlist)** evaluated at **point**.

Jacobian(x^2-y^2,[x,y],[u,v])

$\begin{bmatrix} 2u, & -2v \end{bmatrix}$

Jacobian([x^2-y^2,2x*y,3*x^2*y],[x,y],[a,b])

$2a$	$-2b$
$2b$	$2a$
$6ab$	$3a^2$

Jacobian([f(x,y,z),g(x,y,z),h(x,y,z)],[x,y,z])

D[f[x, y, z], x]	D[f[x, y, z], y]	D[f[x, y, z], z]
D[g[x, y, z], x]	D[g[x, y, z], y]	D[g[x, y, z], z]
D[h[x, y, z], x]	D[h[x, y, z], y]	D[h[x, y, z], z]

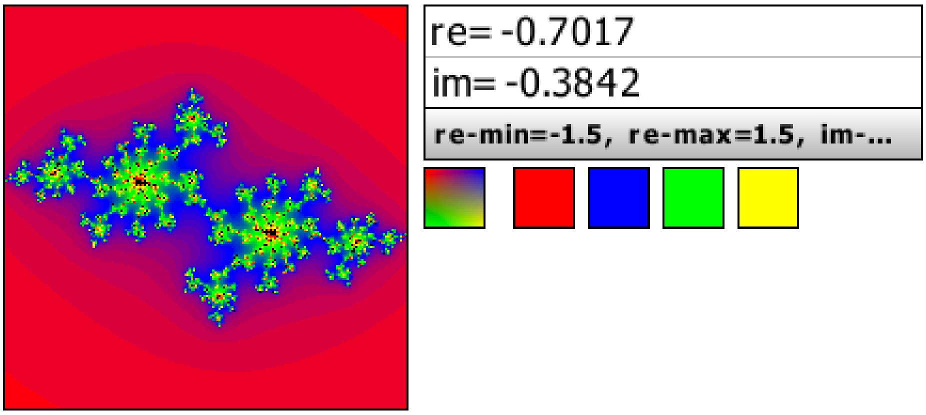
Jacobian([x@1,5x3,4x@2^2-2*x@3,x@3*sin(x@1)],[x@1,x@2,x@3])

1	0	0
0	0	0
0	$8x_2$	-2
$x_3 \cos[x_1]$	0	$\sin[x_1]$

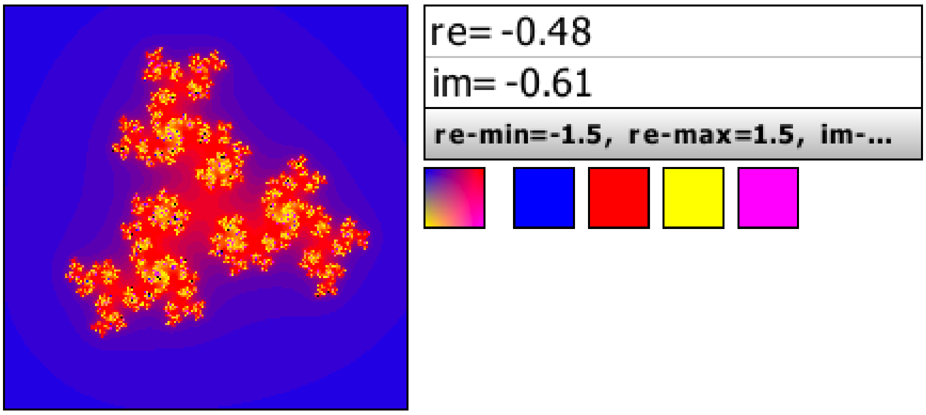
JuliaPlot(expression, ...)

Plots a julia set fractal.

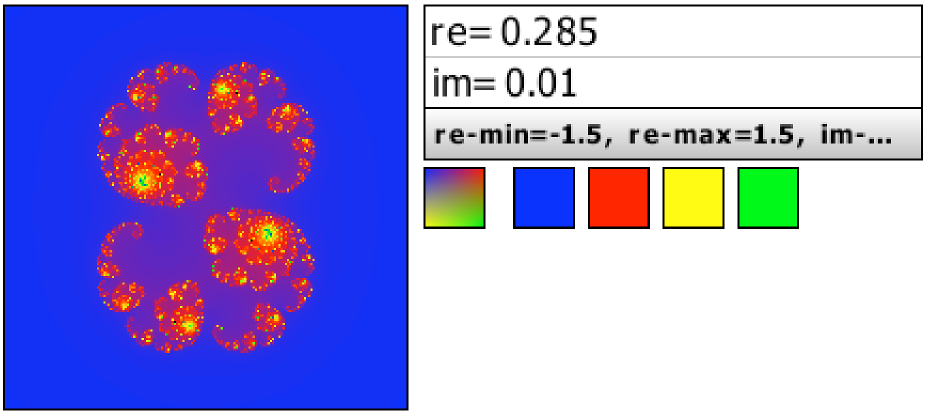
JuliaPlot(z^2+c,re=-0.7017,im=-0.3842)



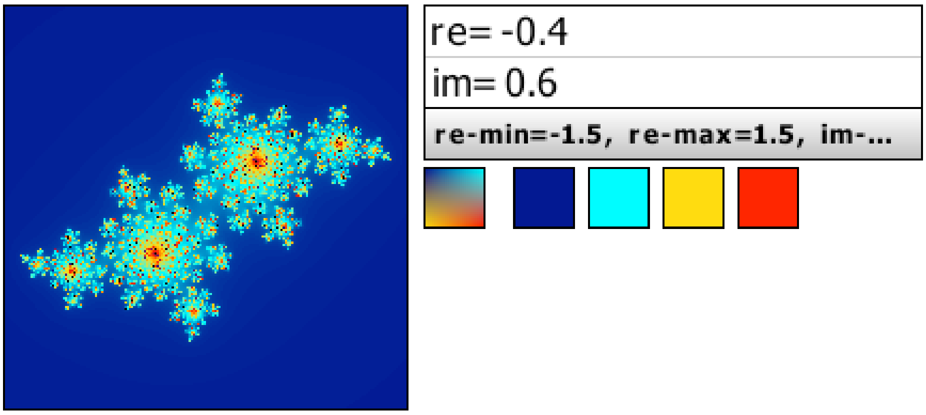
JuliaPlot(z^3+c, re=-0.48, im=-0.61)



JuliaPlot(z^2+c,re=0.285,im=0.01)



JuliaPlot(z^2+c,re=-0.4,im=0.6)



KelvinBei(v, z)

Calculates KelvinBei(v,z).

KelvinBei(0,z)

$$\frac{i}{2}\text{BesselJ}\left[0,\ z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]\frac{-i}{2}\text{BesselJ}\left[0,\ z\,e^{\left[\frac{3i\pi}{4}\right]}\right]$$

KelvinBei(1,z)

$$\frac{i}{2}\text{BesselJ}\left[1,\ z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]\frac{-i}{2}\text{BesselJ}\left[1,\ z\,e^{\left[\frac{3i\pi}{4}\right]}\right]$$

KelvinBei(1/2,z)

$$\frac{i\sqrt{\frac{2\,e^{\left[\frac{3i\pi}{4}\right]}}{z\,\pi}}\ \sin\left[z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]}{2}+\frac{-i\sqrt{\frac{2\,e^{\left[\frac{-3i\pi}{4}\right]}}{z\,\pi}}\ \sin\left[z\,e^{\left[\frac{3i\pi}{4}\right]}\right]}{2}$$

KelvinBei(3,2-\im)

0.00111-0.20083i

KelvinBer(v, z)

Calculates KelvinBer(v,z).

KelvinBer(0,z)

$$\frac{1}{2}\text{BesselJ}\left[0,\ z\,e^{\left[\frac{3i\pi}{4}\right]}\right]+\frac{1}{2}\text{BesselJ}\left[0,\ z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]$$

KelvinBer(1,z)

$$\frac{1}{2}\text{BesselJ}\left[1,\ z\,e^{\left[\frac{3i\pi}{4}\right]}\right]+\frac{1}{2}\text{BesselJ}\left[1,\ z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]$$

KelvinBer(1/2,z)

$$\frac{\sqrt{\frac{2\,e^{\left[\frac{-3i\pi}{4}\right]}}{z\pi}}\ \sin\left[z\,e^{\left[\frac{3i\pi}{4}\right]}\right]}{2}+\frac{\sqrt{\frac{2\,e^{\left[\frac{3i\pi}{4}\right]}}{z\pi}}\ \sin\left[z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]}{2}$$

KelvinBer(3,5+\im)

$-0.73986-2.72806i$

Expand(Diff(KelvinBer(0,z),z))

$$-\frac{\text{BesselJ}\left[1,\ z\,e^{\left[\frac{-3i\pi}{4}\right]}\right]e^{\left[\frac{-3i\pi}{4}\right]}}{2}-\frac{\text{BesselJ}\left[1,\ z\,e^{\left[\frac{3i\pi}{4}\right]}\right]e^{\left[\frac{3i\pi}{4}\right]}}{2}$$

KelvinKei(v, z)

Calculates KelvinKei(v,z).

KelvinKei(0,z)

$$\frac{i}{2}\text{BesselK}\left[0,\ z\,e^{\left[\frac{-i\pi}{4}\right]}\right]\frac{-i}{2}\text{BesselK}\left[0,\ z\,e^{\left[\frac{i\pi}{4}\right]}\right]$$

KelvinKei(-1,z)

$$\frac{i\ \text{BesselK}\left[1,\ z\,e^{\left[\frac{-i\pi}{4}\right]}\right]e^{\left[\frac{-i\pi}{2}\right]}}{2}+\frac{-i\ \text{BesselK}\left[1,\ z\,e^{\left[\frac{i\pi}{4}\right]}\right]e^{\left[\frac{i\pi}{2}\right]}}{2}$$

KelvinKei(-1/2,z)

$$\frac{i\sqrt{\frac{2\pi e^{\left[\frac{i\pi}{4}\right]}}{z}}\,e^{\left[\frac{-i\pi}{4}-z e^{\left[\frac{-i\pi}{4}\right]}\right]}}{4}+\frac{-i\sqrt{\frac{2\pi e^{\left[\frac{-i\pi}{4}\right]}}{z}}\,e^{\left[\frac{i\pi}{4}-z e^{\left[\frac{i\pi}{4}\right]}\right]}}{4}$$

KelvinKei(3,sqrt(2)-\im/3)

$-1.75732-1.32007i$

KelvinKer(v, z)

Calculates KelvinKer(v,z).

KelvinKer(0,z)

$$\frac{1}{2}\mathrm{BesselK}\left[0,\ z e^{\left[\frac{i\pi}{4}\right]}\right]+\frac{1}{2}\mathrm{BesselK}\left[0,\ z e^{\left[\frac{-i\pi}{4}\right]}\right]$$

KelvinKer(-1,z)

$$\frac{\mathrm{BesselK}\left[1,\ z e^{\left[\frac{i\pi}{4}\right]}\right]e^{\left[\frac{i\pi}{2}\right]}}{2}+\frac{\mathrm{BesselK}\left[1,\ z e^{\left[\frac{-i\pi}{4}\right]}\right]e^{\left[\frac{-i\pi}{2}\right]}}{2}$$

KelvinKer(-1/2,z)

$$\frac{\sqrt{\frac{2\pi e^{\left[\frac{-i\pi}{4}\right]}}{z}}\,e^{\left[\frac{i\pi}{4}-z e^{\left[\frac{i\pi}{4}\right]}\right]}}{4}+\frac{\sqrt{\frac{2\pi e^{\left[\frac{i\pi}{4}\right]}}{z}}\,e^{\left[\frac{-i\pi}{4}-z e^{\left[\frac{-i\pi}{4}\right]}\right]}}{4}$$

KelvinKer(3,sqrt(2)-\im/3)

$0.87278+1.0672i$

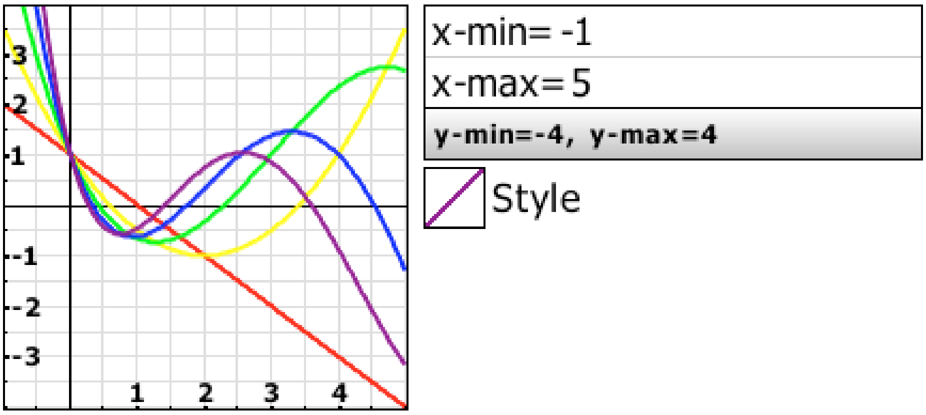
Expand(Diff(KelvinKer(1,z),z))

$$-\frac{\mathrm{BesselK}\left[0,\ z e^{\left[\frac{-i\pi}{4}\right]}\right]e^{\left[\frac{i\pi}{4}\right]}}{2}-\frac{\mathrm{BesselK}\left[0,\ z e^{\left[\frac{i\pi}{4}\right]}\right]e^{\left[\frac{-i\pi}{4}\right]}}{2}-\frac{\mathrm{BesselK}\left[1,\ z e^{\left[\frac{-i\pi}{4}\right]}\right]e^{\left[\frac{i\pi}{2}\right]}}{2z}-\frac{\mathrm{BesselK}\left[1,\ z e^{\left[\frac{i\pi}{4}\right]}\right]e^{\left[\frac{-i\pi}{2}\right]}}{2z}$$

LaguerreL(n, z)

Returns the Laguerre polynomial.

Plot(LaguerreL(1,x),LaguerreL(2,x),LaguerreL(3,x),LaguerreL(4,x),LaguerreL(5,x),x=[-1,5],y=[-4,4],color=[red,yellow,green,blue,purple],numbers=2)



LambertW(z)

Calculates the **LambertW** function of **z**.

LambertW(0)

0

LambertW(-1/\e)

-1

LambertW(-\pi/2)

$$\frac{i\,\pi}{2}$$

Solve(LambertW(x)=1.3267246652422002,x,1)

5

Diff(LambertW(3x+2),x)

$$\frac{3\,\mathrm{LambertW}\left[3x+2\right]}{\left[\mathrm{LambertW}\left[3x+2\right]+1\right]\left[3x+2\right]}$$

Series(LambertW(2x),x,6)

$$-\frac{3456\,x^{6}}{5}+\frac{500\,x^{5}}{3}-\frac{128\,x^{4}}{3}+12\,x^{3}-4\,x^{2}+2\,x$$

Laplace(f(t), t)

Finds the Laplace Transformation F(s) of the given function f(t).

Laplace(exp(a*t)+c^3-t^2,t)

$$-\frac{2}{s^{3}}+\frac{c^{3}}{s}+\frac{1}{-a+s}$$

Laplace(1+t-2t^2-3t^3-sin(a*t)-cos(a*t),t)

$$\frac{1}{s}+\frac{1}{s^{2}}-\frac{4}{s^{3}}-\frac{18}{s^{4}}-\frac{a}{a^{2}+s^{2}}-\frac{s}{a^{2}+s^{2}}$$

Laplace(t^4*sin(a*t)+sin(b*t)^3,t)

$$-\frac{288\,a\,s^{2}}{\left[a^{2}+s^{2}\right]^{4}}-\frac{3\,b}{4\left[9\,b^{2}+s^{2}\right]}+\frac{3\,b}{4\left[b^{2}+s^{2}\right]}+\frac{24\,a}{\left[a^{2}+s^{2}\right]^{3}}+\frac{384\,a\,s^{4}}{\left[a^{2}+s^{2}\right]^{5}}$$

Laplace(exp(a*t)*sinh(b*t)^3,t)

$$-\frac{3\,b}{4\left[-b^{2}+\left[-a+s\right]^{2}\right]}+\frac{3\,b}{4\left[-9\,b^{2}+\left[-a+s\right]^{2}\right]}$$

Laplace(1/sqrt(\pi*t)-1/sqrt(t^3)+sqrt(a*t^3),t)

$$\frac{1}{\sqrt{s}}+\frac{3\sqrt{a}\,\sqrt{\pi}}{4\,s^{\left[\frac{5}{2}\right]}}+2\sqrt{s}\,\sqrt{\pi}$$

Laplace((exp(b*t)-exp(a*t))/(2sqrt(\pi*t^3)),t)

$$-\sqrt{-b+s}+\sqrt{-a+s}$$

Laplace(-6exp(-4t)-3exp(-t)+9exp(-2t),t)

$$-\frac{6}{s+4}-\frac{3}{s+1}+\frac{9}{s+2}$$

Laplace(t^2*exp(-a*t)/2,t)

$$\frac{1}{\left[a+s\right]^{3}}$$

Laplace(Heaviside(t-3)*sin(c*(t-3)),t)

$$\frac{c\,e^{\left[-3\,s\right]}}{c^{2}+s^{2}}$$

Laplace(BesselJ(0,a*t)+BesselJ(0,2sqrt(k*t)),t)

$$\frac{e^{\left[-\frac{k}{s}\right]}}{s}+\frac{1}{\sqrt{a^{2}+s^{2}}}$$

Laplace(BesselJ(1,a*t),t)

$$\frac{a}{\left[s+\sqrt{a^{2}+s^{2}}\right]\sqrt{a^{2}+s^{2}}}$$

Laplace(BesselI(1,a*t),t)

$$\frac{s-\sqrt{-a^{2}+s^{2}}}{a\sqrt{-a^{2}+s^{2}}}$$

Laplace(Erf(a*t),t)

$$\frac{\left[-\operatorname{Erf}\left[\frac{s}{2\,a}\right]+1\right]e^{\left[\frac{s^{2}}{4\,a^{2}}\right]}}{s}$$

Laplace(Erf(a*sqrt(t)),t)

$$\frac{a}{s\sqrt{a^{2}+s}}$$

Laplace(Erfc(a*sqrt(b*t)),t)

$$\frac{1}{s}-\frac{a\sqrt{b}}{s\sqrt{s+a^{2}b}}$$

Expand(Laplace((t+3)^(3/2),t))

$$-\frac{3\sqrt{\pi}\,\mathrm{Erf}\left[\sqrt{3s}\right]e^{[3s]}}{4s^{\left[\frac{5}{2}\right]}}+\frac{[3s]^{\left[\frac{3}{2}\right]}}{2s^{\left[\frac{7}{2}\right]}}+\frac{3\sqrt{\pi}\,e^{[3s]}}{4s^{\left[\frac{5}{2}\right]}}+\frac{[3s]^{\left[\frac{3}{2}\right]}}{s^{\left[\frac{5}{2}\right]}}$$

Laplace(f(t)/t,t)

$$I\left[F[s],\ s\right]$$

Laplace(t^3*f(t),t)

$$-F'''[s]$$

Laplace(R*i(t)+L*d(i(t),t)=u(t),t)

$$-U[s]+L\left[-i[0]+s\,I[s]\right]+R\,I[s]$$

Solve_Equation(Laplace(R*i(t)+L*d(i(t), t)=u(t), t), I(s))

$$\frac{L\,i[0]+U[s]}{R+L\,s}$$

Laplace(f(t)*sin(3t),t)

$$\mathrm{Convolution}\left[F[s],\ \frac{3}{s^{2}+9}\right]$$

Laplace(t^4*f(t)*sin(3t),t)

$$D\left[D\left[D\left[D\left[\mathrm{Convolution}\left[F[s],\ \frac{3}{s^{2}+9}\right],\ s\right],\ s\right],\ s\right],\ s\right]$$

Laplace(f(t)*cos(2t)/t,t)

$$I\left[\text{Convolution}\left[F[s],\ \frac{s}{s^2+4}\right],\ s\right]$$

Laplace(R*i(t)+1/C*I(i(t),t)=U,t)

$$-\frac{U}{s}+R\ I[s]+\frac{I[s]}{C\ s}$$

Solve_Equation(Laplace(R*i(t)+1/C*I(i(t),t)=U(t),t),I(s))

$$\frac{U[s]}{R+\frac{1}{C\ s}}$$

Laplacian(function, [varlist], [mode])

Returns the Laplacian of the function.

This is normally denoted as **Laplacian(F) = ?^{2}F**

Laplacian(x^2+y^2+z^2)

6

Laplacian(x*y/z)

$$\frac{2\ x\ y}{z^3}$$

Laplacian(sin(x)*exp(y)/ln(z))

$$\frac{\sin[x]\,e^{y}}{z^2\ \ln[z]^2}+\frac{2\ \sin[x]\,e^{y}}{z^2\ \ln[z]^3}$$

Laplacian(r*sin(\theta)*cos(\phi),0,2)

$$-\frac{\cos[\phi]\csc[\theta]}{r}+\frac{\left[-\sin[\theta]^2+\cos[\theta]^2\right]\cos[\phi]\csc[\theta]}{r}+\frac{2\cos[\phi]\sin[\theta]}{r}$$

Laplacian(z^2*r*cos(\phi),0,1)

$$2\,r\cos\left[\phi\right]$$

Cartesian coordinates

Laplacian(f(x,y,z))

$$D\left[D\left[f\left[x,\ y,\ z\right],\ z\right],\ z\right]+D\left[D\left[f\left[x,\ y,\ z\right],\ x\right],\ x\right]+D\left[D\left[f\left[x,\ y,\ z\right],\ y\right],\ y\right]$$

Cylindrical coordinates

Laplacian(f(r,\phi,z),0,1)

$$\frac{r\,D\left[D\left[f\left[r,\ \phi,\ z\right],\ r\right],\ r\right]+D\left[f\left[r,\ \phi,\ z\right],\ r\right]}{r}+\frac{D\left[D\left[f\left[r,\ \phi,\ z\right],\ \phi\right],\ \phi\right]}{r^{2}}+D\left[D\left[f\left[r,\ \phi,\ z\right],\ z\right],\ z\right]$$

Spherical coordinates

Laplacian(h(r,\theta,\phi),0,2)

$$\frac{r^{2}D\left[D\left[h\left[r,\ \theta,\ \phi\right],\ r\right],\ r\right]+2\,r\,D\left[h\left[r,\ \theta,\ \phi\right],\ r\right]}{r^{2}}+\frac{\csc\left[\theta\right]^{2}D\left[D\left[h\left[r,\ \theta,\ \phi\right],\ \phi\right],\ \phi\right]}{r^{2}}+\frac{\left[\cos\left[\theta\right]D\left[h\left[r,\ \theta,\ \phi\right],\ \theta\right]+\sin\left[\theta\right]D\left[D\left[h\left[r,\ \theta,\ \phi\right],\ \theta\right],\ \theta\right]\right]\csc\left[\theta\right]}{r^{2}}$$

LCM(n1, n2)

Finds the least common multiple between two integers.

Left(expression)

Returns the left side of an expression.

Left(x^2=9)

$$x^{2}$$

Left(a+1=b)

$$a+1$$

LegendreP(n, z)

Returns the Legendre polynomial or Legendre function of the first kind.

LegendreP(n,0)

$$\frac{2\sqrt{\pi}}{n\,\mathrm{Gamma}\left[\frac{n}{2}\right]\mathrm{Gamma}\left[\frac{-n+1}{2}\right]}$$

LegendreP(n,1)

$$1$$

LegendreP(0,z)

$$1$$

LegendreP(1,z)

$$z$$

LegendreP(7,z)

$$\frac{429\,z^{7}}{16}-\frac{693\,z^{5}}{16}+\frac{315\,z^{3}}{16}-\frac{35\,z}{16}$$

LegendreP(7,1/2)

$$\frac{457}{2048}$$

LegendreP(7,-1/2z)

$$-\frac{429\,z^{7}}{2048}+\frac{693\,z^{5}}{512}-\frac{315\,z^{3}}{128}+\frac{35\,z}{32}$$

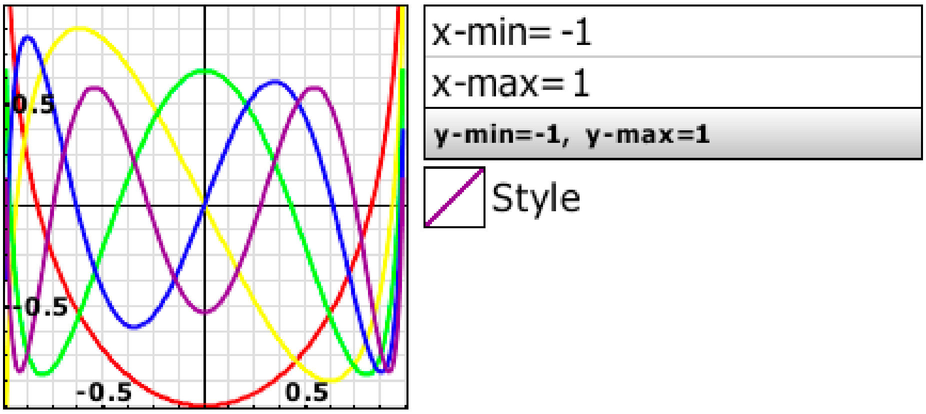
LegendreP(4,z+1/2)

$$\frac{35\,z^{4}}{8}+\frac{35\,z^{3}}{4}+\frac{45\,z^{2}}{16}-\frac{25\,z}{16}-\frac{37}{128}$$

LegendreQ(n, z)

Returns the Legendre function of the second kind.

Plot(LegendreQ(1, x), LegendreQ(2, x), LegendreQ(3, x), LegendreQ(4, x), LegendreQ(5, x), x=[-1, 1], y=[-1, 1], color=[red, yellow, green, blue, purple], numbers=4)



Length(expression)

Returns the length of the expression.

Length([1, 2, 3, 4, 5, 6])

6

Length([[1,2,3],[4,5,6]])

2

Length(a)

1

Length(a+b+c)

3

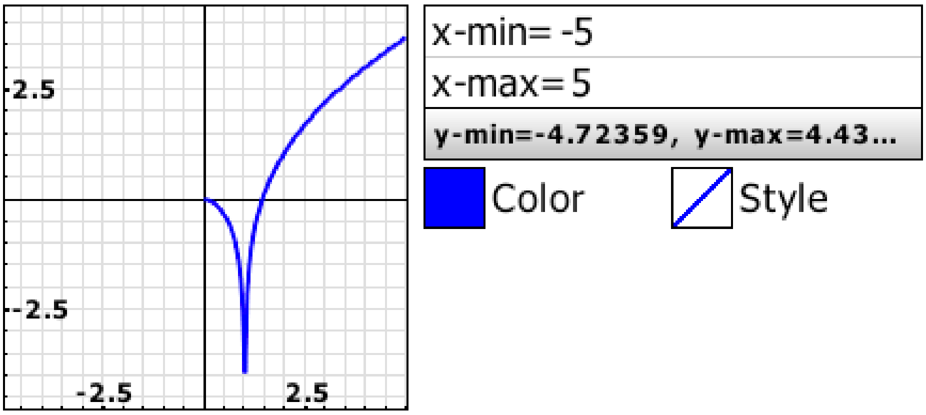
Li(x)

Finds the Logarithmic Integral of x.

Li(3)

$\gamma+1.58637$

Plot(Li(x))



Limit(function, variable, point, [direction])

Returns the limit of function as variable approaches point from the direction direction.

The default value of direction is right side (+1).

Limit((3x-15)/\sqrt(x^2-10x+25),x,5,1)

3

Limit((3x-15)/\sqrt(x^2-10x+25),x,5,-1)

-3

Limit((atan(x)-\pi/4)/\sqrt(1-x^2),x,1)

0

Limit((3-3tan(x))/(sin(x)-cos(x)),x,\pi/4)

$-\frac{6}{\sqrt{2}}$

Limit(-1/x,x,0)

$-\infty$

Limit(1/x,x,\inf)

0

Limit(3z+p*(1+5m/x)^(a*x)+f*x^(1/x)-g*(1+1/x^2)^(d*x)-h*((x-7*n)/x)^(b*x),x,\inf)

$f-g+3z-he^{[-7bn]}+pe^{[5am]}$

Limit(-n^n/n!,n,\inf)

$-\infty$

Limit(n!/4^n,n,\inf)

∞

Limit(n!/n^n,n,\inf)

0

Limit(1^n/n^5,n,\inf)

0

Limit((3*sin(\pi*x) - sin(3*\pi*x))/x^3,x,0)

$4\pi^3$

Limit(\sqrt(sin(3*\pi*x)/x^3 - 3*sin(\pi*x)/x^3),x,0)

$\sqrt{-4\pi^3}$

Limit(cos(a*x)/x^2 - cos(b*x)/x^2,x,0)

$$\frac{-a^2+b^2}{2}$$

Limit(2sin(a*x)/(x-sin(x))-sin(2a*x)/(x-sin(x)),x,0)

$6a^3$

Limit((2sin(x)-sin(2x))/(b*x-sin(b*x))+(2sin(p*x)-sin(2p*x))/(q*x-sin(q*x)),x,0)

$$\frac{6q^3+6b^3p^3}{b^3q^3}$$

List(length)
Creates a list of the given length.

This function can also take the following input to create a list of expressions.
list(*expression*, *variable*, *start*, *step*, *length*)

list(4)
$[0, 0, 0, 0]$

list(8)+2
$[2, 2, 2, 2, 2, 2, 2, 2]$

list(x^2,x,2,1,10)
$[4, 9, 16, 25, 36, 49, 64, 81, 100, 121]$

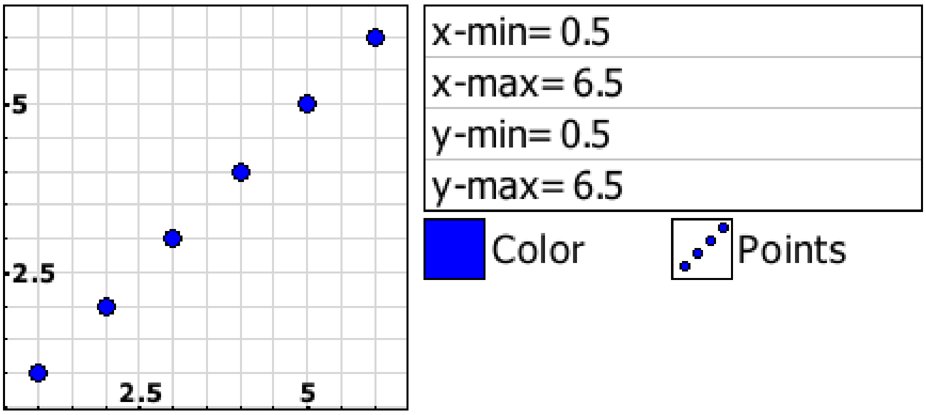
ListPlot(x, [y], [x2], [y2], ...)
ListPlot plots single or multiple lists of numeric data.

The following are additional plot parameters for ListPlot.

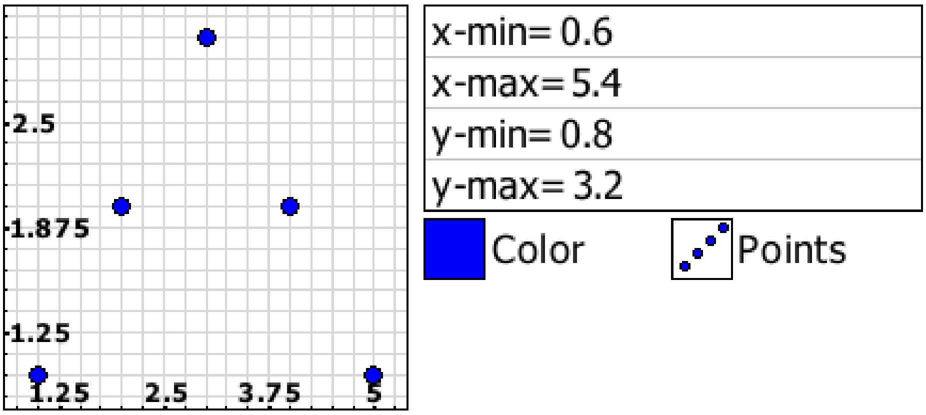
type
Sets the type of list to plot.

regression
Sets the regression analysis to perform.

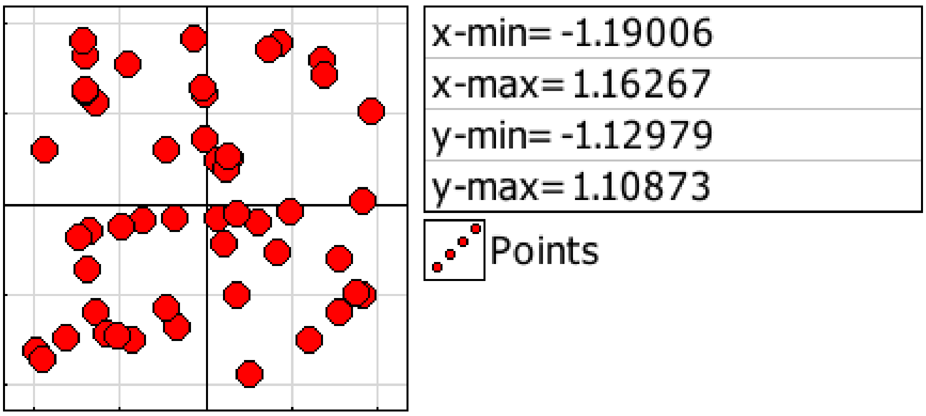
ListPlot([1,2,3,4,5,6])



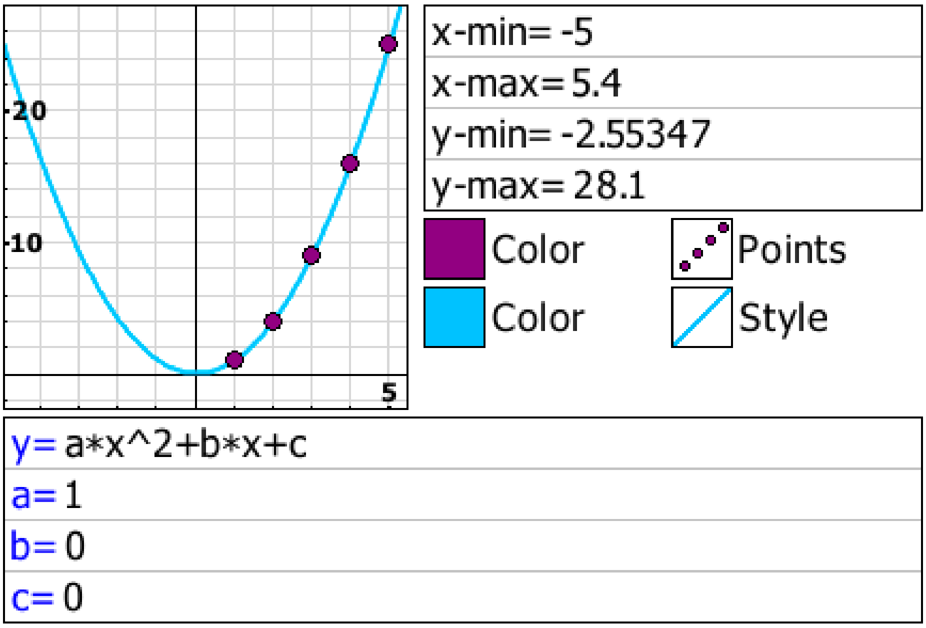
ListPlot([1,2,3,4,5],[1,2,3,2,1])



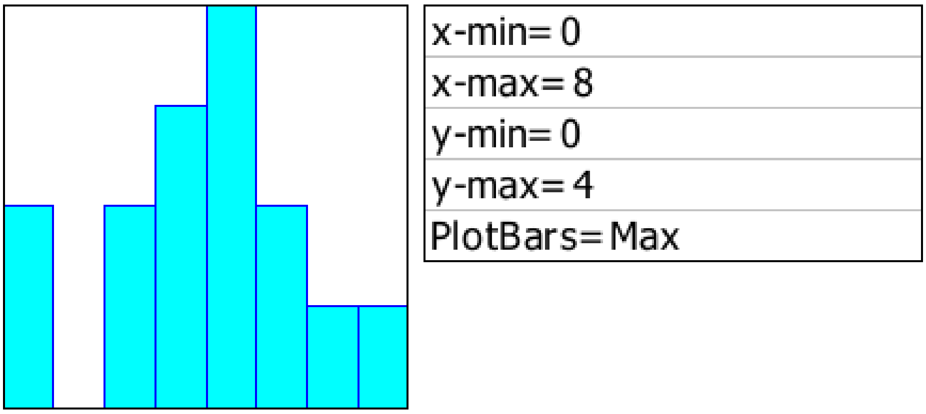
size=50 ListPlot(random(-1,1,size),random(-1,1,size),color=red,points=12,gridLines=5)



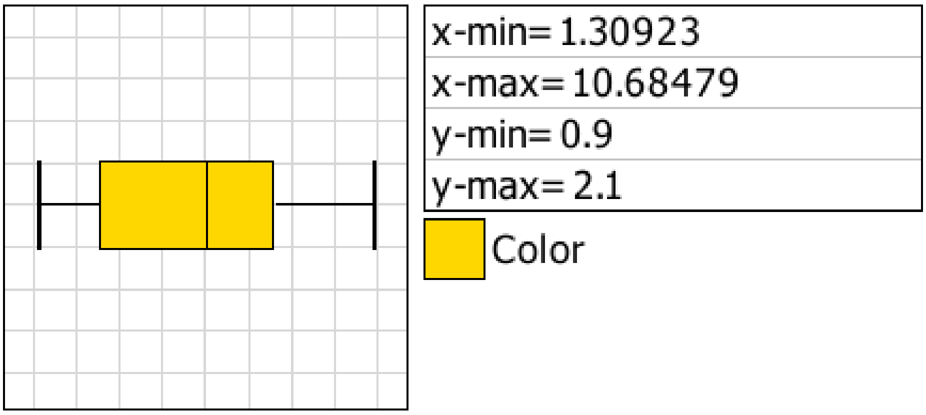
ListPlot([1,4,9,16,25],regression=quadratic)



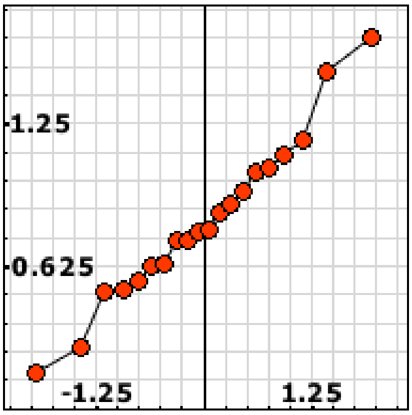
ListPlot([1,1,3,3,4,4,4,5,5,5,5,6,6,7,8],type=bar,color=red,gridLines=0,color=skyBlue,lineColor=blue)



ListPlot(random(2,10,40),type=box,numbers=0,gridLines=10)



ListPlot(random(0,2,20),type=probability)



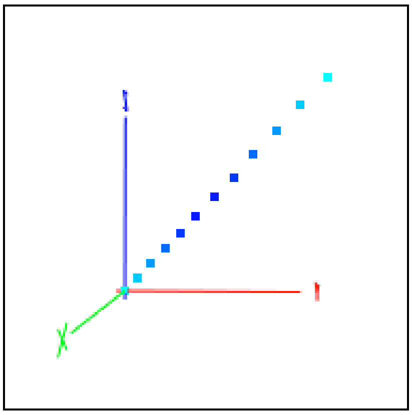
x-min= -2.35196
x-max= 2.35196
y-min= 0
y-max= 1.77353

Color Style
X-Axis

ListPlot3D(x, y, z, [x2], [y2], [z2], ...)

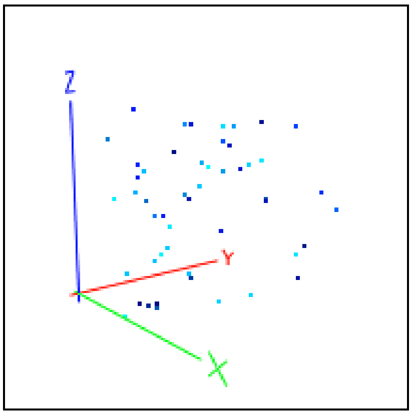
Plots 3D list data.

ListPlot3D(1:12,1:12,1:12)



x-min= 1
x-max= 12
y-min= 1
y-max= 12
z-min= 1
z-max= 12

ListPlot3D(Random(0,1,3,50), points=2)

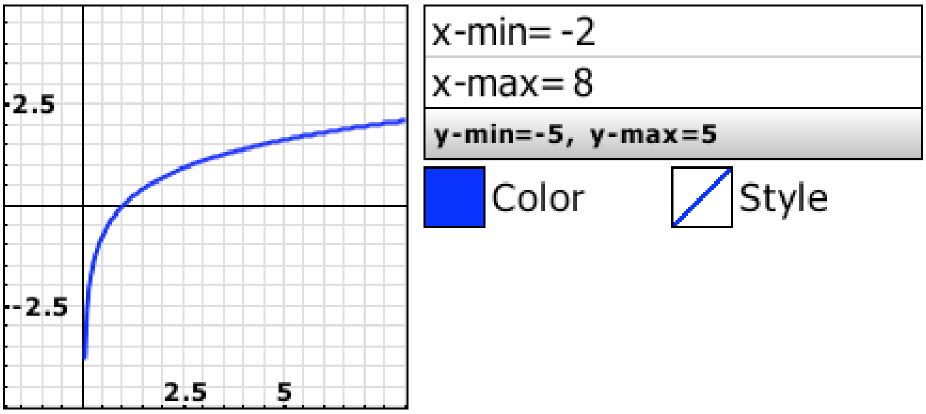


x-min= 0
x-max= 0.97095
y-min= 0.022
y-max= 1
z-min= 0.02241
z-max= 1

Ln(z)

Returns the natural logarithm (base: *e*) of the given number z.

Plot(ln(x),x=[-2,8],y=[-5,5])



ln(2)

0.69314718

ln(\e)

1

ln(-5)

$\dot{\imath}\ \pi+\ln[5]$

LnGamma(z)

Returns the Log Gamma(z) function.

LnGamma(z)

$\ln[\mathrm{Gamma}[z]]$

LnGamma(10)

$\ln[362880]$

LnGamma(20)

39.33988

LnGamma(10000)
82099.7175

LnGamma(-5)
ComplexInfinity

LnGamma(3z)

$$\ln\left[\frac{3^{\left[3z-\frac{1}{2}\right]}\mathrm{Gamma}[z]\,\mathrm{Gamma}\left[z+\frac{1}{3}\right]\mathrm{Gamma}\left[z+\frac{2}{3}\right]}{2\pi}\right]$$

LnGamma(z-3)

$$\ln\left[\frac{\mathrm{Gamma}[z]}{[z-3][z-2][z-1]}\right]$$

LnGamma(2z+4)

$$\ln\left[\frac{2z[2z+1][2z+2][2z+3]\,2^{\left[2z-\frac{1}{2}\right]}\mathrm{Gamma}\left[z+\frac{1}{2}\right]\mathrm{Gamma}[z]}{\sqrt{2\pi}}\right]$$

LoadList(filename)

This function loads data from a text file (.txt) and outputs a list. The data can be tab or comma delineated.

LoadMatrix(filename)

This function loads data from a text file (.txt) and outputs a matrix.

Log([n], z)

Returns the common or Briggs logarithm (base: 10) of the given number z.

log(2)
0.30103

log(1000)
1

log(1\sci-5)
-5

log(\e)
0.43429448

Loop(variable, start, end, [step=1])

Loops through a block of code.

If the **step** is ***positive*** this functions loops until the **variable** initially set to start is ***greater*** than **end**.

If the **step** is ***negative*** this functions loops until the **variable** initially set to start is ***less*** than **end**.

length=10 a=list(length) loop(i,1,length) a(i)=i^2 end a
$[1, 4, 9, 16, 25, 36, 49, 64, 81, 100]$

Lucas(n, [z])

Returns the n^{th} Lucas number.

If **z** is given, returns the Lucas polynomial of z.

Lucas(6,a)
$a^6+6a^4+9a^2+2$

LUDecomposition(matrix, [mode])

Returns the matrix decomposition as the product of a lower triangular matrix and an upper triangular matrix.

LUDecomposition([[1,2],[3,4]])

$$\left[\begin{bmatrix}0 & 1\\1 & 0\end{bmatrix}, \begin{bmatrix}1 & 0\\\frac{1}{3} & 1\end{bmatrix}, \begin{bmatrix}3 & 4\\0 & \frac{2}{3}\end{bmatrix}\right]$$

Matrix(rows, [columns])

Creates a matrix.

matrix(3)

0	0	0
0	0	0
0	0	0

matrix(2,3)

0	0	0
0	0	0

matrix(2,6)+2

2	2	2	2	2	2
2	2	2	2	2	2

Max(list)

Finds the largest number in a list.

Max([3,0,-5,0.5,4])
4

Mean(list)
Finds the average of a given list of numbers.

Mean([3,0,-5,0.5,4])
$\frac{1}{2}$

Message(string)
This will stop all computations and display a message.

n=5 if(n>0) Message("Positive") else if(n
! Positive

Min(list)
Finds the smallest number in a list.

Min([3,0,-5,0.5,4])
-5

Mod(m, n)
Calculates the following formula.
m-n*floor(m/n)

The sign of mod(m,n) always equals the sign of n.

Multinomial(nList)

Finds the Multinomial coefficient.

Multinomial([n@1,n@2,n@3])/Multinomial([n@1-1,n@2+2,n@3-1])

$$\frac{[n_2+1][n_2+2]}{n_1 n_3}$$

Multinomial([n@1,n@2,n@3])/Multinomial([n@1+1,n@2-1,n@3])

$$\frac{n_1+1}{n_2}$$

Multinomial([2+\im,-1+2\im,4.5-3\im])

$$[40.2943-41.00487i]\sqrt{\pi}$$

Multinomial([7/2,5/2,3/2])

$$\frac{858}{\pi}$$

Multinomial([n,3,3])

$$\frac{[n+1][n+2][n+3][n+4][n+5][n+6]}{36}$$

Multinomial([n,3])

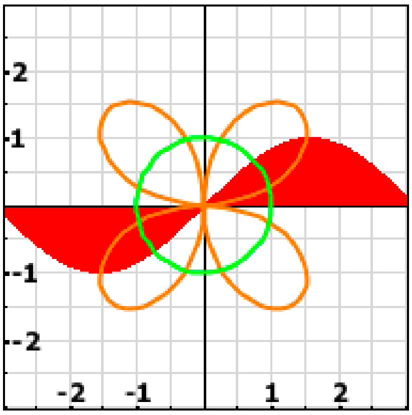
$$\frac{n[n-2][n-1]}{6}$$

MultiPlot(plot1, plot2, ...)

Plots multiple types of 2D plots on the same graph. Each parameter must be a plot function or an integer which represents the index of an entry.

MultiPlot supports the following plot functions as parameters.
Plot, ParametricPlot, PolarPlot, ImplicitPlot, ContourPlot, VectorPlot.

MultiPlot(Plot(sin(x), color=red, style=middleShade), PolarPlot(2sin(2\theta),color=orange), ParametricPlot(cos(u),sin(u), color=green), x=[-3,3], numbers=2)



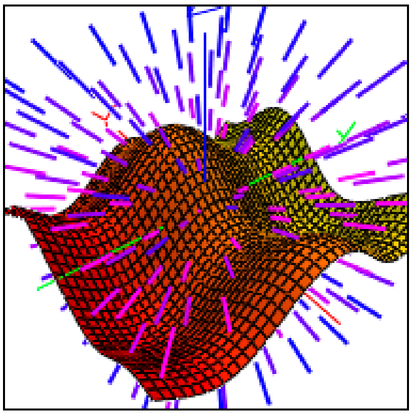
x-min= -3
x-max= 3
y-min= -3
y-max= 3

MultiPlot3D(expression, ...)

Plots multiple types of 3D plots on the same graph. Each parameter must be a plot function or an integer which represents the index of an entry.

MultiPlot3D supports the following plot functions as parameters.
Plot3D, ParametricPlot3D, SphericalPlot3D, CylindricalPlot3D, ContourPlot, VectorPlot3D.

MultiPlot3D(Plot3D(cos(x)+sin(y),colors=[red,yellow]),VectorPlot3D([x,y,z], colors=[blue,magenta]))



x-min= -5
x-max= 5
y-min= -5
y-max= 5
z-min=-5, z-max=5

---

nCr(n, r)
Returns the number of unordered subsets of **r** elements out of a set of **n** elements

nCr(n,r) = n! / ((n-r)! * r!)

---

nFactors(n)
Finds all the dividing factors of the given number n. The result is returned as a list.

nFactors(6)

$\left[1,\ 2,\ 3,\ 6\right]$

nFactors(99)

$\left[1,\ 3,\ 9,\ 11,\ 33,\ 99\right]$

nFactors(997)

$\left[1,\ 997\right]$

nFactors(12345)

$\left[1,\ 3,\ 5,\ 15,\ 823,\ 2469,\ 4115,\ 12345\right]$

NIntegrate(f(x), x, a, b)
Finds the definite integral of the given function by a numerical integration method. The limits of integration are a (lower limit) and b (upper) limit.

NIntegrate(sin(x),x,0,\pi)

2

NIntegrate(cos(x),x,-\pi/2,\pi/2)

2

Norm(z)

Returns the norm of the given vector A.

Norm([x,y,z])

$$\sqrt{\mathrm{abs}[x]^{2}+\mathrm{abs}[y]^{2}+\mathrm{abs}[z]^{2}}$$

Norm([1,5,6,3,6])

$$\sqrt{107}$$

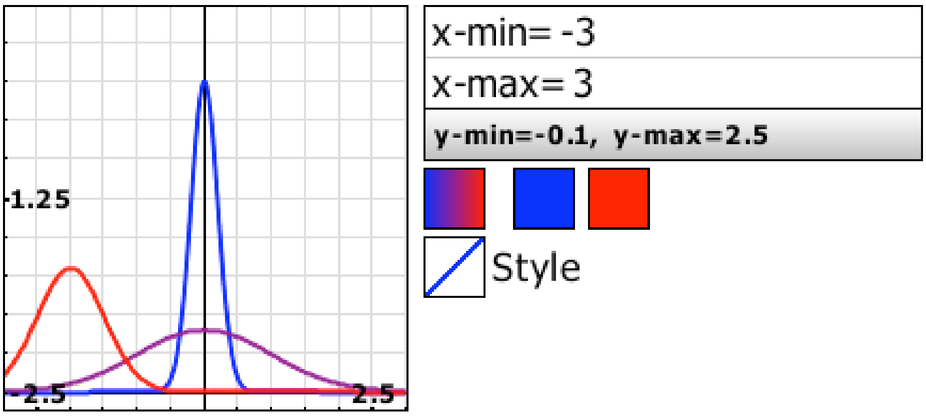
NormalCDF(lower, upper, [mu], [sigma])

Computes the normal cumulative density function over the interval from **lower** to **upper** with mean **mu** and standard deviation **sigma**.

NormalPDF(x, mu, sigma)

Computes either the normal probability density function at x with mean mu and standard deviation sigma. The default values are mu = 0 and sigma = 1.

Plot(NormalPDF(x,0,0.2),NormalPDF(x,0,1.0),NormalPDF(x,-2,0.5),x=[-3,3],y=[-0.1,2.5])



---

nPr(n, r)

Returns the number of permutations of a subset of **r** elements from a set of **n** elements.

nPr(n,r) = n! / (n-r)!

---

nPrimes(n)

Finds all prime factors and their exponent of a given number.

The result is returned as a nested list. The first number is the prime factor and the second number is the exponent.

1 * 2^1 * 5^1

nPrimes(10)

$$\left[1,\ \left[2,\ 1\right],\ \left[5,\ 1\right]\right]$$

1 * 31^1

nPrimes(13)

$$\left[1,\ \left[13,\ 1\right]\right]$$

1 * 2^3 * 5^2

nPrimes(200)

$$\left[1,\ \left[2,\ 3\right],\ \left[5,\ 2\right]\right]$$

1 * 3^2 * 11^1 * 101^1

nPrimes(9999)

$$\left[1,\ \left[3,\ 2\right],\ \left[11,\ 1\right],\ \left[101,\ 1\right]\right]$$

---

nRoot(z, n, [mode])

Finds the **nth root** of a given value. All roots are returned as a list.

nRoot(z,n)

$z^{\frac{1}{n}}$

nRoot(-8,3)

$\left[-2,\ -i\sqrt{3}+1,\ i\sqrt{3}+1\right]$

nRoot(81,4)

$\left[-3i,\ -3,\ 3i,\ 3\right]$

nRoot(279841,4)

$\left[-23i,\ -23,\ 23i,\ 23\right]$

nRoot(279841,4,0)

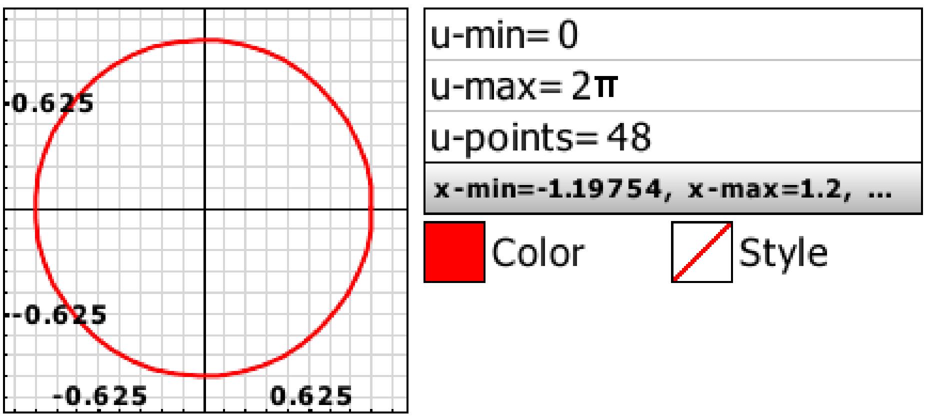
$\left[23,\ -23\right]$

ParametricPlot(expression, ...)

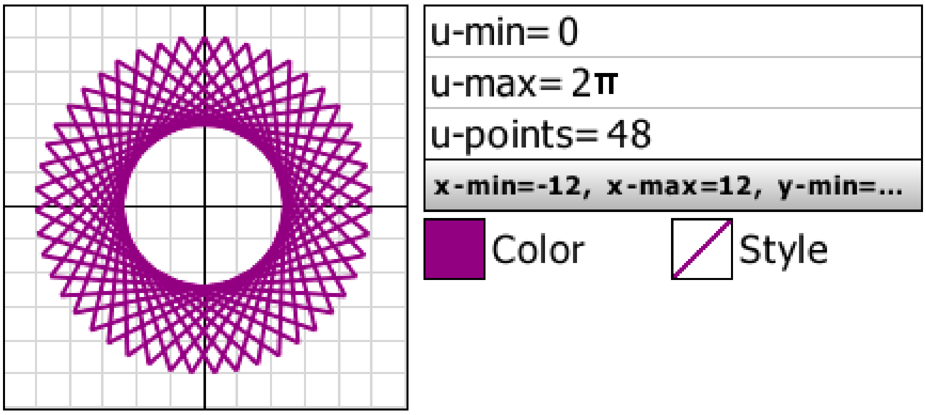
Plots 2D parametric graphs.

See Plot for documentation on plot parameters.

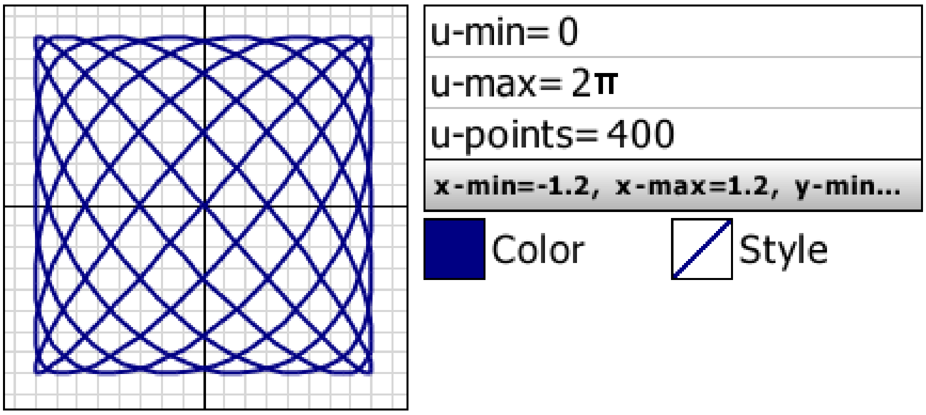
ParametricPlot(cos(u),sin(u),color=red)



ParametricPlot(10sin(31u),10cos(31u),numbers=0,color=purple)



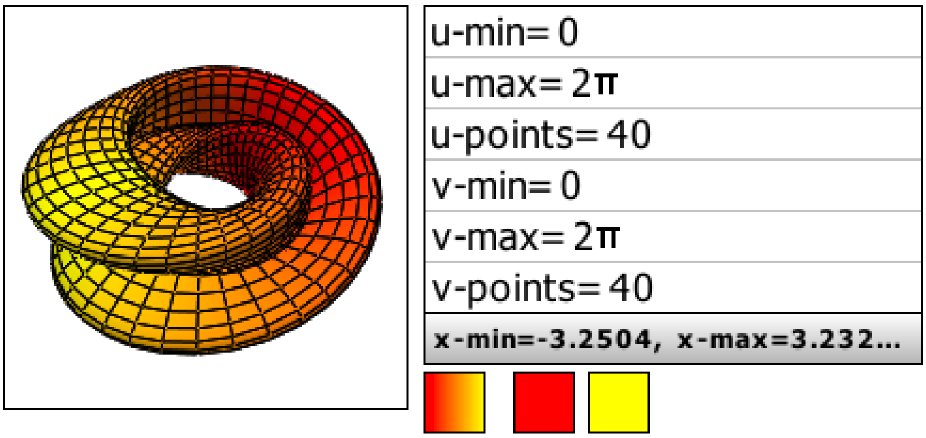
ParametricPlot([sin(7u),sin(8u)], u=[0,2\pi,400], numbers=0, color=navyBlue)



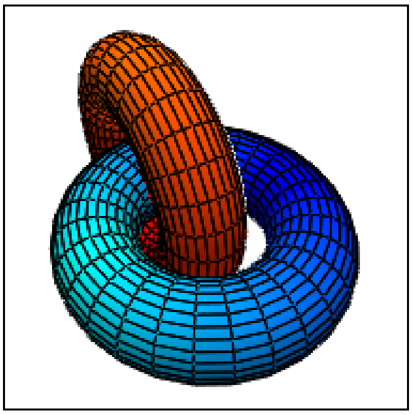
ParametricPlot3D(expression, ...)

Plots 3D parametric graphs.

c1=u/2 c2=v/2 c3=sin(c1) c4=sin(v) c5=cos(c1) c6=sin(2v) c7=2 c8=c7+c5*c4-c3*c6 ParametricPlot3D(c8*cos(u),c8*sin(u),c3*c4+c5*c6,[u,0,2\pi,40],[v,0,2\pi,40],axis=0)



a=(1+0.4cos(v))cos(u) b=(1+0.4cos(v))sin(u) c=0.4sin(v) ParametricPlot3D([[c,b+1,a],[a,b,c]], colors=[[orange,red],[blue,skyBlue]], axis=0,u=[0,2\pi,30],v=[0,2\pi,30])



u-min= 0
u-max= 2π
u-points= 30
v-min= 0
v-max= 2π
v-points= 30
x-min=-2, x-max=2, y-min=-1...

Part(expression, n)

Returns the n^{th} part of the expression.

This function can be used to iterate recursively through an entire expression.

When **n=0** the part of the expression is returned as a string.

Part(a+b,1)

a

Part(a+b,2)

b

Part(a+b,0)

+

Part(sin(x),1)

x

Part(sin(x),0)

sin

Part((x+1)^2,1)

$x+1$

Part((x+1)^2,0)
^

Part(a+b+c+d+e,3)
c

---

pDiff(f(x,y,z,..), dependent_variables, dependent_equations, independent_variables)

Finds the partial derivative of the function to the independent variable list.

The dependent variables are a given function of the independant variables. This equation is given in the equation list.

pDiff(4x+y^2+z^3,[x,y,z],[\e^(r*s^2),ln((r+s)/t),r*s*t^2],s)

$$\frac{2\ln\left[\frac{r+s}{t}\right]}{r+s}+3r^{3}s^{2}t^{6}+8rse^{\left[rs^{2}\right]}$$

pDiff(x^4*y+y^2*z^3,[x,y,z],[r*s*\e^t,r*s^2*\e^(-t),r^2*s*sin(t)],r)

$$s^{2}\left[r^{4}s^{4}e^{[4t]}+2r^{7}s^{5}\sin[t]^{3}e^{[-t]}\right]e^{[-t]}+4r^{4}s^{6}e^{[3t]}+6r^{7}s^{7}\sin[t]^{3}e^{[-2t]}$$

pDiff(x^4*y+y^2*z^3,[x,y,z],[r*s*\e^t,r*s^2*\e^(-t),r^2*s*sin(t)],s)

$$2rs\left[r^{4}s^{4}e^{[4t]}+2r^{7}s^{5}\sin[t]^{3}e^{[-t]}\right]e^{[-t]}+3r^{8}s^{6}\sin[t]^{3}e^{[-2t]}+4r^{5}s^{5}e^{[3t]}$$

pDiff(x^4*y+y^2*z^3,[x,y,z],[r*s*\e^t,r*s^2*\e^(-t),r^2*s*sin(t)],t)

$$-rs^{2}\left[r^{4}s^{4}e^{[4t]}+2r^{7}s^{5}\sin[t]^{3}e^{[-t]}\right]e^{[-t]}+3r^{8}s^{7}\sin[t]^{2}\cos[t]e^{[-2t]}+4r^{5}s^{6}e^{[3t]}$$

pDiff(x^2+y,[x,y],[R*cos(t),R*sin(t)],t)

$$-2R^{2}\cos[t]\sin[t]+R\cos[t]$$

pDiff(x^2+y^3-5,[x,y],[R*cos(t),R*sin(t)],t)

$-2R^{2}\cos[t]\sin[t]+3R^{3}\sin[t]^{2}\cos[t]$

pDiff(f(x,y),[x,y],[g(t),h(t)],t)

$h'[t]D\left[f\left[g[t],\ h[t]\right],\ h[t]\right]+g'[t]D\left[f\left[g[t],\ h[t]\right],\ g[t]\right]$

pDiff(x^4*y^2,[x,y],[sin(t),t^2],t)

$4t^{3}\sin[t]^{4}+4t^{4}\sin[t]^{3}\cos[t]$

Pi_Digits(n)

Calculates Pi up to the requested number of digits.

The maximum number of digits which can be calculated is 500.

Please note that the larger the number n, the slower the calculation.

Pi_Digits(10)

3.1415926535

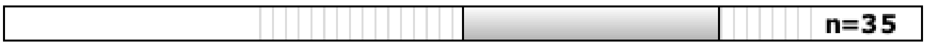
Pi_Digits(20)

3.14159265358979323846

Pi_Digits(30)

3.141592653589793238462643383279

Pi_Digits(Scroll(n,1,50))



3.1415926535897932384626433832795028 8

Plot(expression, ...)

Plots 2D function graphs. This function can also have many additional parameters which are entered in the form of parameter=value.

The following parameters can be set to a single value or a list of values for multiple plots.

alpha
Sets the transparency of the plot from 0 (completely transparent) to 1 (fully opaque). The default value is 1.

color
Sets the color of the plot.

points
Sets the size of the points.

lines
Sets the size of the lines.

style
Set the style of the plot.

The following parameters are used for the graph and can only be set to a single value.

backgroundColor
Sets the background color of the graph.

axisColor
Sets the axis color of the graph.

textColor
Sets the text color of the graph.

gridLines
Sets how many grid lines to show on the graph.

gridColor
Sets the color of the grid lines.

numbers
Sets how many number to show per graph tick. The default setting is 5 which prints a number every 5 graph ticks.

timeStart
The initial value of the time variable. The default value is 0.

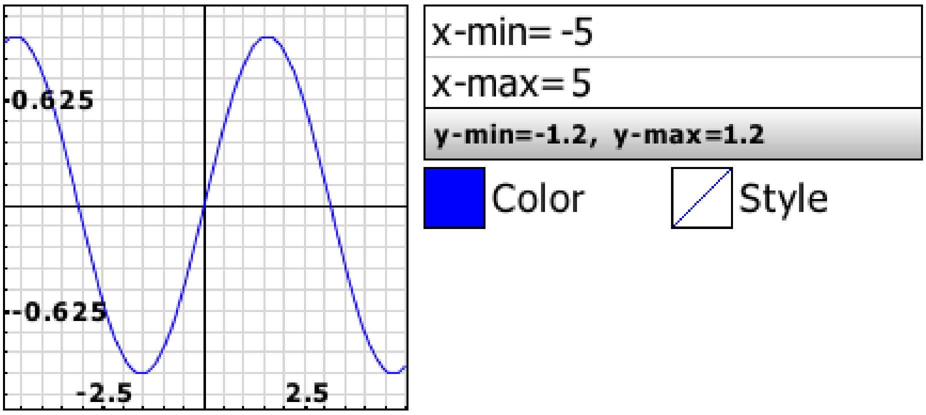
timeStep
The step value of the time variable. The default value is 0.1.

Parameters for colors can be set in three different ways.
1) Value between 0 and 1 will create a gray color. For example, color=0.5 will set the color to gray.

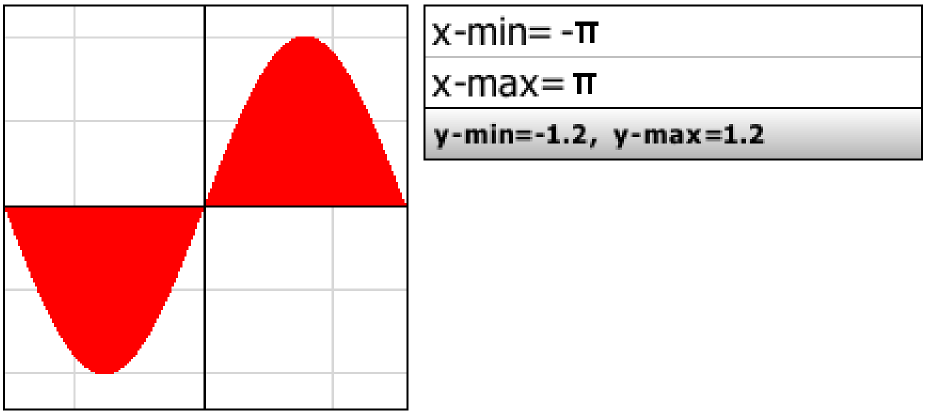
2) A list of three values that represent red, green and blue. For example, color=[1,0,0] will set the color to red.

3) Use a named color value. Available named colors are blue, green, yellow, orange, red, magenta, white, gray, black, skyBlue, lightGray, navyBlue, darkGreen, gold, orangeRed, darkRed, purple, deepSkyBlue, brown, darkGray, lightBlue, lightGreen, khaki, coral, chestnut, olive, beige and pink.

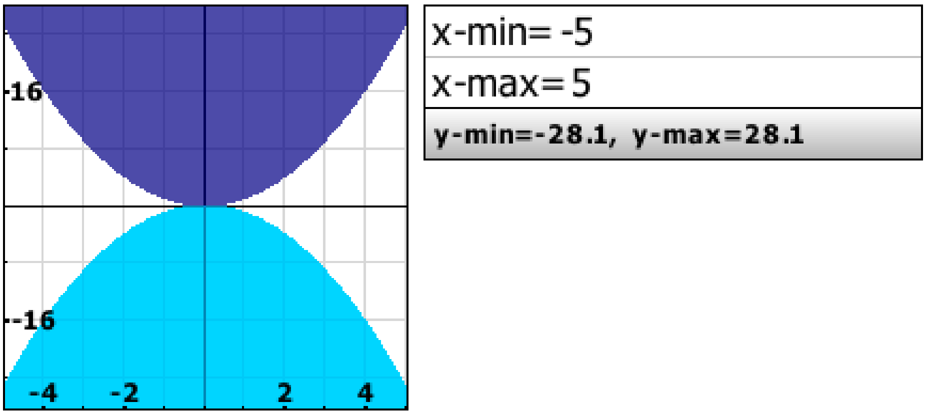
Plot(sin(x))



Plot(sin(x), x=[-\pi,\pi], style=middleShade, color=red, numbers=0, gridLines=5)



Plot([x^2,-x^2],colors=[navyBlue,deepSkyBlue],style=[topShade,bottomShade],alpha=0.7,gridLines=10,numbers=2)



Plot3D(expression, ...)

Plots 3D function graphs. This function can also have many additional parameters which are entered in the form of parameter=value.

The following parameters can be set to a single value or a list of values for multiple plots.
See examples below.

colors
Sets the colors of the plot. This can be a list of up to 4 colors or a list of up to 6 colors if the gradient parameter is set to height. See example below.

points
Sets the size of the points.

pointColor
Sets the color of the points.

lines
Sets the size of the lines.

lineColor
Sets the color of the lines.

solid
Sets whether to use solid shading. This takes a value of 0 or 1.

gradient
Sets how to color the graph.
height colors the plot based on the height of the points.

The following parameters are used for the graph and can only be set to a single value.

backgroundColor
Sets the background color of the graph.

axisColorX
Sets the x-axis color of the graph.

axisColorY
Sets the y-axis color of the graph.

axisColorZ
Sets the z-axis color of the graph.

axisColor
Sets all axis colors of the graph.

shade
This can take *smooth* for smooth shading or *flat* for flat shading. The default value is smooth.

timeStart

The initial value of the time variable. The default value is 0.

timeStep
The step value of the time variable. The default value is 0.1.

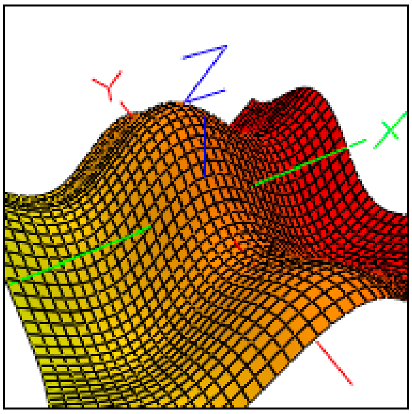
Parameters for colors can be set in three different ways.

1) Value between 0 and 1 will create a gray color. For example, color=0.5 will set the color to gray.

2) A list of three values that represent red, green and blue. For example, color=[1,0,0] will set the color to red.

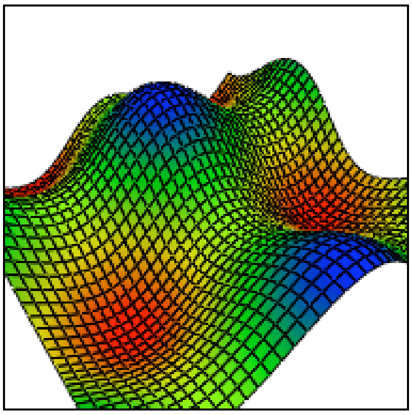
3) Use a named color value. Available named colors are blue, green, yellow, orange, red, magenta, white, gray, black, skyBlue, lightGray, navyBlue, darkGreen, gold, orangeRed, darkRed, purple, deepSkyBlue, brown, darkGray, lightBlue, lightGreen, khaki, coral, chestnut, olive, beige and pink.

Plot3D(cos(x)+sin(y),colors=[yellow,red])



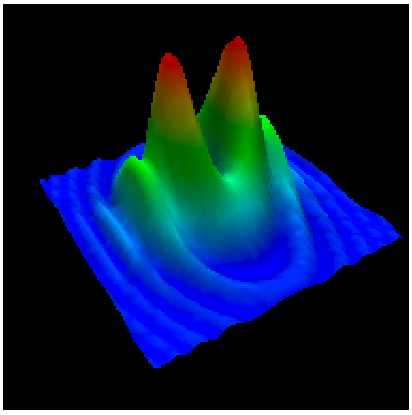
x-min= -5
x-max= 5
y-min= -5
y-max= 5
z-min=-5, z-max=5, PlotPoint...

Plot3D(cos(x)+sin(y), gradient=height, axis=0, colors=[blue,green,yellow,red])



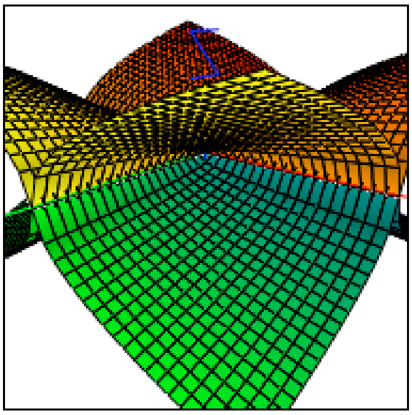
x-min= -5
x-max= 5
y-min= -5
y-max= 5
z-min=-5, z-max=5, PlotPoint...

r=sqrt(x^2+y^2) Plot3D(sin(x^2+3y^2)/(0.1+r^2)+(x^2+5y^2)*exp(1-r^2)/2,gradient=height,colors=[red,yellow,green,skyBlue,blue],backgroundColor=black,x=[-3,3],y=[-3,3],z=[-3,3],axis=0)



x-min= -3
x-max= 3
y-min= -3
y-max= 3
z-min=-3, z-max=3, PlotPoint...

Plot3D(sqrt(abs(x*y)),-sqrt(abs(x*y)),colors=[[red,yellow],[blue,green]])



x-min= -5
x-max= 5
y-min= -5
y-max= 5
z-min=-11.25, z-max=6.25, Pl...

Pochhammer(n, k)

Finds the value of **n*(n+1)*(n+2)*..*(n+k-1)**

Pochhammer(n,5)

$n[n+1][n+2][n+3][n+4]$

Pochhammer(n,-5)

$$\frac{1}{[n-5][n-4][n-3][n-2][n-1]}$$

Pochhammer(3,k)

$0.5k\,[k+1][k+2]\,\mathrm{Gamma}[k]$

Pochhammer(n,k)

$$\frac{\mathrm{Gamma}[k+n]}{\mathrm{Gamma}[n]}$$

Pochhammer(n,k-1)

$$\frac{\mathrm{Gamma}[k+n]}{[k+n-1]\,\mathrm{Gamma}[n]}$$

Pochhammer(n-1,k)

$$\frac{[n-1]\,\mathrm{Gamma}[k+n]}{[k+n-1]\,\mathrm{Gamma}[n]}$$

Pochhammer(n-1,k-1)

$$\frac{[n-1]\,\mathrm{Gamma}[k+n]}{[k+n-2][k+n-1]\,\mathrm{Gamma}[n]}$$

Pochhammer(n-1,k)/Pochhammer(n-1,k-1)

$k+n-2$

Pochhammer(-10,5)

-30240

Pochhammer(5,-2)

$$\frac{1}{12}$$

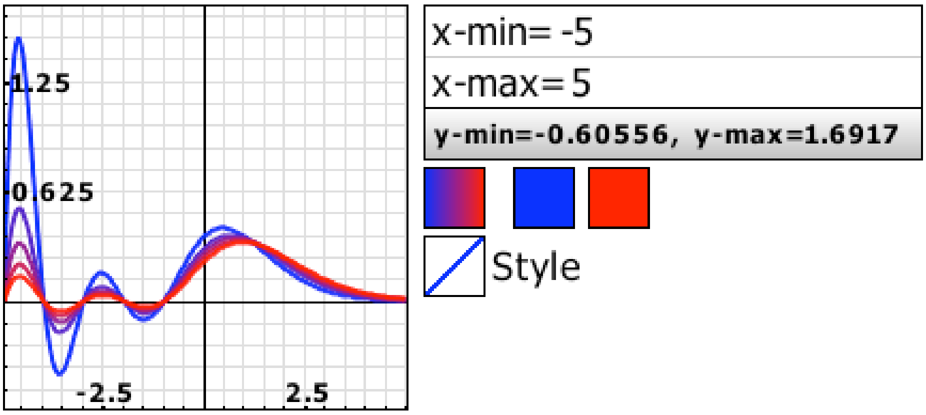
PoissonCDF(mu, x)

Computes the cumulative Poisson distribution at **x** with mean **mu**.

PoissonPDF(mu, x)

Computes the Poisson distribution at x with mean mu.

Plot(PoissonPDF(1,x),PoissonPDF(1.2,x),PoissonPDF(1.3,x),PoissonPDF(1.4,x),PoissonPDF(1.5,x))

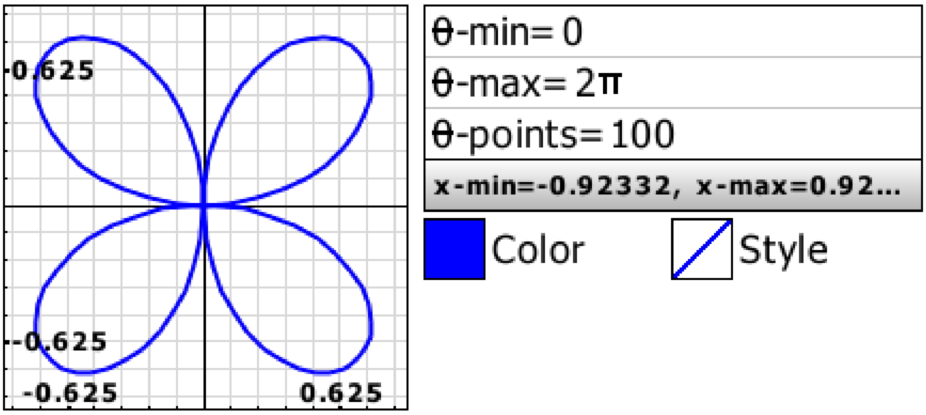


PolarPlot(expression, ...)

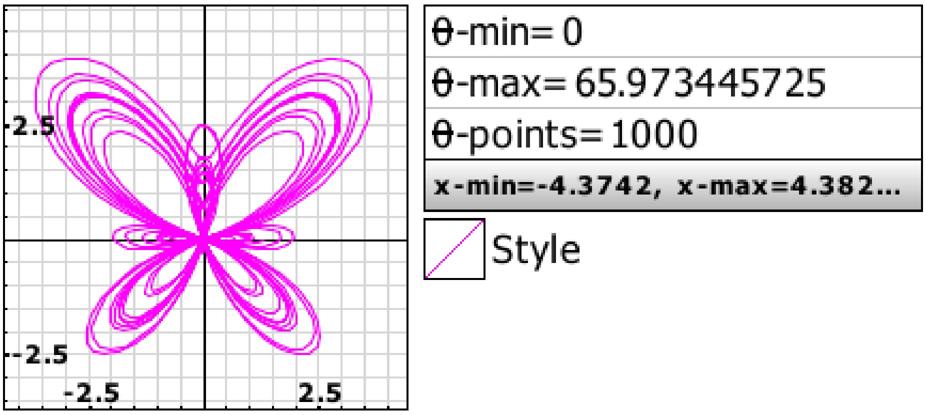
Plots 2D polar plots.

See Plot for documentation on plot parameters.

PolarPlot(sin(2\theta))



PolarPlot(\e^sin(\theta)-2cos(4\theta)+sin(1/24(-\pi+2\theta))^5, \theta=[0,21\pi,1000], color=magenta)



PolyDivide(f(z), g(z))

Returns both the quotient and remainder from the polynomial division of numerator f(z) and denominator g(z).

Both numerator and denominator should be polynomial functions.

The returned result is a list with the first term the quotient and the second term the remainder.

PolyDivide(x^2+x+6,x+7)

$[x-6,\ 48]$

PolyDivide(4x^3-x^2+x+6,x+1)

$[4x^2-5x+6,\ 0]$

PolyDivide(5x^7-3x^2+6,x^3-1)

$\left[5x^4+5x,\ -3x^2+5x+6\right]$

PolyFit(pList, var)

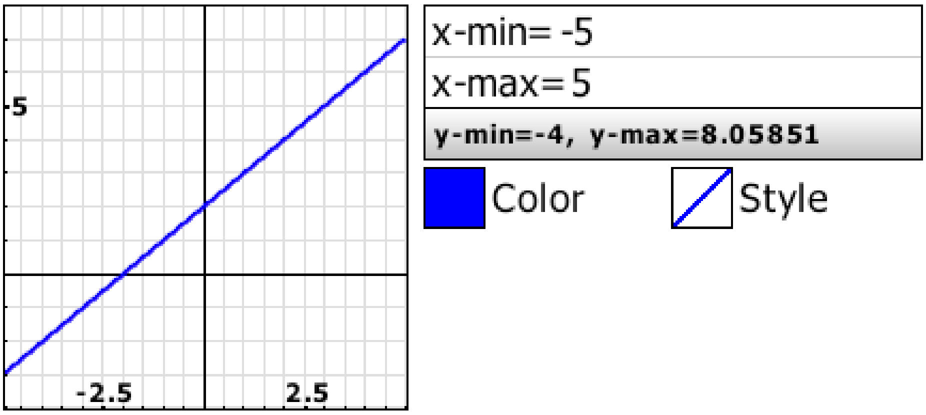
Finds a unique polynomial function of order N-1 through the given N data points.

Finds the line between the point [1,3] and [5,7]

PolyFit([[1,3],[5,7]])

$x+2$

Plot(x+2)

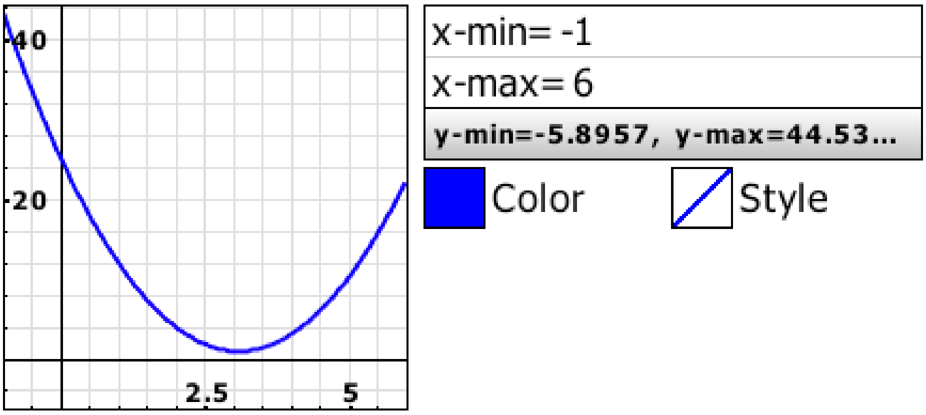


Finds the parabolic curve through the points [2,4], [3,1], [5,7]

PolyFit([[2,4],[3,1],[5,10]])

$2.5x^2-15.5x+25$

Plot(2.5x^2-15.5x+25)

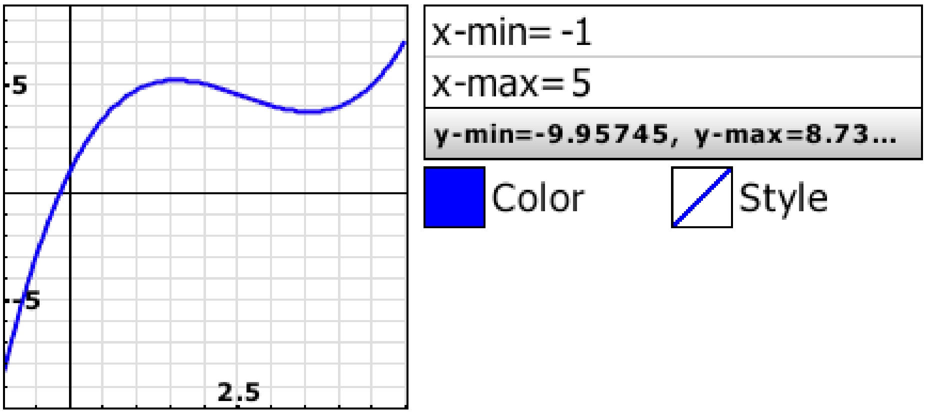


Finds the cubic curve through the points [0,1], [2,5], [3,4], [5,7]

PolyFit([[0,1],[2,5],[3,4],[5,7]])

$$\frac{11x^3}{30}-\frac{17x^2}{6}+\frac{31x}{5}+1$$

Plot((11x^3)/30+(-17x^2)/6+(31x)/5+1)



PolyGamma(n, z)

Returns the PolyGamma function.

PolyGamma(0,z)

$\mathrm{Psi}\left[z\right]$

PolyGamma(-1,z)

$\ln\left[\mathrm{Gamma}\left[z\right]\right]$

PolyGamma(2,2.5)

-0.2362040516

PolyGamma(3,-1/3)

517.3313356375

PolyGamma(4,3z)

$$\frac{1}{243}\mathrm{PolyGamma}\left[4,\ z\right]+\frac{1}{243}\mathrm{PolyGamma}\left[4,\ z+\frac{1}{3}\right]+\frac{1}{243}\mathrm{PolyGamma}\left[4,\ z+\frac{2}{3}\right]$$

PolyGamma(2,z+3)

$$\frac{2}{z^3}+\frac{2}{[z+1]^3}+\frac{2}{[z+2]^3}+\mathrm{PolyGamma}[2,\ z]$$

Diff(PolyGamma(n,z),z)

$$\mathrm{PolyGamma}[n+1,\ z]$$

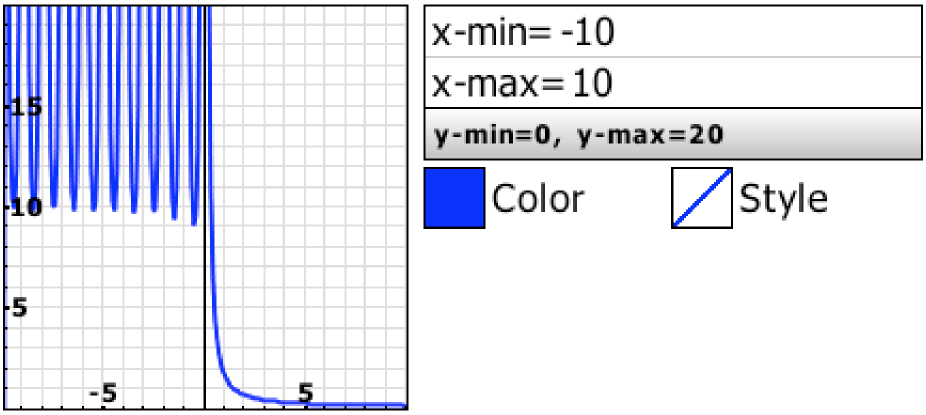
Solve(PolyGamma(1,x)=5)

[0.4961687347, ...]

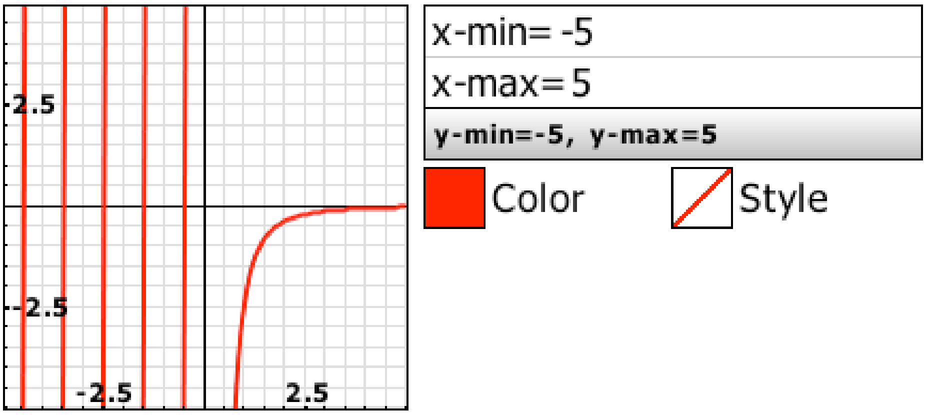
Solve(PolyGamma(2,x)=10,x,[-1,0])

-0.4461094044

Plot(PolyGamma(1,x),x=[-10,10],y=[0,20])



Plot(PolyGamma(2,x),x=[-5,5],y=[-5,5])



PolyGCD(polynomial1, polynomial2)

Finds the Greatest Common Divisor of two given polynomials.

The maximum number of polynomials that can be given inside PolyGCD is restricted to two.

PolyGCD(3x^3-9x-6,x^2-4)

$x - 2$

PolyGCD(75x^9-435x^8+852x^7-576x^6-663x^5+3027x^4-4911x^3+3402x^2-735x, 30x^6-192x^5+420x^4-354x^3+84x^2)

$15x^4 - 66x^3 + 78x^2 - 21x$

PolyGCD(x^4-1,x^3+1)

$x+1$

PolyGCD(x^2+2*x+1,x^2+3*x+2)

$x+1$

PolyGCD(x^2-2*x+1,x^3-1)

$x - 1$

PolyGCD(s^4+s^3+12s^2+s+11,2s^3+5s^2+2s+5)

s^2+1

PolyGCD(t^4-59t^3-4560t^2+45500t+50000,t^2+31t+30)

$t+1$

PolyGCD(x^4+(sqrt(2)-3)x^3+(4-3sqrt(2))x^2+6(1+sqrt(2))x-12,x^3+(3+sqrt(2))x^2+(3sqrt(2)-2)x-6)

$x^2+x\sqrt{2} - 2$

PolyLCM(polynomial1, polynomial2)

Finds the Least Common Multiple of two given polynomials.

The maximum number of polynomials that can be given inside PolyLCM is restricted to two.

PolyLCM(75x^9-435x^8+852x^7-576x^6-663x^5+3027x^4-4911x^3+3402x^2-735x,30x^6-192x^5+420x^4-354x^3+84x^2,0)

$$\left[30x^6-192x^5+420x^4-354x^3+84x^2\right]\left[5x^5-7x^4+5x^2-32x+35\right]$$

PolyLCM(x^3+x+1,x^2+3)

$$x^5+4x^3+x^2+3x+3$$

PolyLCM(4x^2-16,2x^2+2x-12)

$$4x^3+12x^2-16x-48$$

PolyLCM(6x^3-5x^2-22x+24,6x^3-23x^2+29x-12)

$$6x^4-11x^3-17x^2+46x-24$$

PolyLCM(-x^2-x+6,-x^2+x+2)

$$x^3+2x^2-5x-6$$

PolyLCM(16x-4x^3,x^2+x-6)

$$-4x^4-12x^3+16x^2+48x$$

PolyLog(n, z)

Returns the Polylogarithm function of z.

PolyLog(-5,z)

$$\frac{z\left[z^4+26z^3+66z^2+26z+1\right]}{\left[z-1\right]^6}$$

PolyLog(-4,z)

$$-\frac{z\left[z^{3}+11z^{2}+11z+1\right]}{\left[z-1\right]^{5}}$$

PolyLog(-1,z)

$$\frac{z}{\left[z-1\right]^{2}}$$

PolyLog(0,z)

$$\frac{z}{-z+1}$$

PolyLog(1,z)

$$-\ln\left[-z+1\right]$$

PolyLog(1,5)

$$-i\pi-\ln\left[4\right]$$

PolyLog(4,1)

$$\frac{\pi^{4}}{90}$$

PolyLog(n,1)

$$\mathrm{Zeta}\left[n\right]$$

PowerExpand(expression)

Expands powers.

PowerExpand(sqrt(a*b))

$$\sqrt{a}\,\sqrt{b}$$

Product(f(n), n, start, end)

Calculates the product of f(n) where n goes from start to end.

Product(n,n,1,10)

3628800

10!

3628800

Product((n+k),n,0,4)

$k[k+1][k+2][k+3][k+4]$

Product((-1)^n/n,n,1,8)

$\frac{1}{40320}$

Psi(z)

Calculates the Psi(z) or DiGamma(z).

Psi(0)

$-\infty$

Psi(1)

$-\gamma$

Psi(7/2)

$-\gamma-2\ln[2]+\frac{46}{15}$

Psi(-7/2)

$-\gamma-2\ln[2]+\frac{352}{105}$

Psi(12)

$$-\gamma+\frac{83711}{27720}$$

Psi(3-\im)

$0.99465-0.37667\mathbb{i}$

Psi(100/3)

$$-\gamma-\frac{3}{2}\ln\left[3\right]-\frac{\pi\sqrt{3}}{6}+6.62352$$

Psi(2a+4)

$$\frac{1}{2\,a}+\frac{\mathrm{Psi}\left[a\right]+\mathrm{Psi}\left[a+\frac{1}{2}\right]}{2}+\frac{1}{2\,a+1}+\frac{1}{2\,a+2}+\frac{1}{2\,a+3}+\ln\left[2\right]$$

Psi(2-3a)

$$\frac{\mathrm{Psi}\left[a\right]+\mathrm{Psi}\left[a+\frac{1}{3}\right]+\mathrm{Psi}\left[a+\frac{2}{3}\right]}{3}+\pi\cot\left[3\,a\,\pi\right]+\frac{1}{-3\,a+1}+\ln\left[3\right]$$

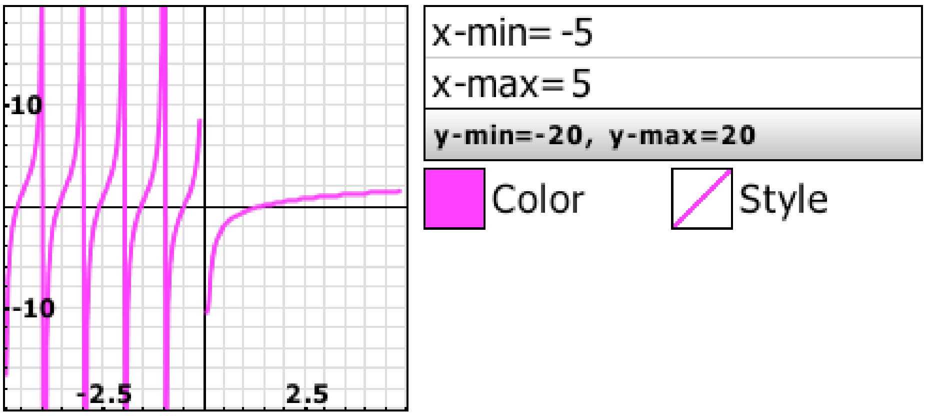
Solve(Psi(x)=1,x,[0,5])

3.20317

Solve(Psi(x)=-1/2,x,[-1,0])

-0.55913

Plot(Psi(x),x=[-5,5],y=[-20,20])



QR(A)
Returns the QR factorization or QR decomposition of matrix A.

This routine uses the TNT library.

The **first element** returned is the orthogonal matrix (usually denoted as Q). The **second element** returned is the upper triangular matrix (R).

QR([[1,2],[2,-3]])

$$\left[\begin{bmatrix} -0.44721 & 0.89443 \\ -0.89443 & -0.44721 \end{bmatrix}, \begin{bmatrix} -2.23607 & 1.78885 \\ 0 & 3.1305 \end{bmatrix}\right]$$

Quotient(f(x), g(x))
Returns the quotient from the polynomial division of numerator f(z) and denominator g(z).

Both numerator and denominator should be polynomial functions.

Quotient(x^2+x+6,x+7)

$x - 6$

Quotient(4x^3-x^2+x+6,x+1)

$4x^2 - 5x + 6$

Quotient(5x^7-3x^2+6,x^3-1)

$5x^4 + 5x$

Random(min, max)
Generates a random number between min and max.

Random(0,1)

0.53277

Random(0,1)
0.21896

floor(Random(0,100))
67

Random(-1,1)
-0.93086

Re(z)

Returns the real part of a complex number.

re(2+3\im)
2

Remainder(f(x), g(x))

Returns the remainder from the polynomial division of numerator f(x) and denominator g(x).

Both numerator and denominator should be polynomial functions.

Remainder(x^2+x+6,x+7)
48

Remainder(4x^3-x^2+x+6,x+1)
0

Remainder(5x^7-3x^2+6,x^3-1)
$-3x^2+5x+6$

Replace(expression, old, new)

Replaces an expression with another expression.

Replace(a+a^2,a^2,x^2)

$a+x^2$

Replace(sin(x),x,a^2)

$\sin\left[a^2\right]$

Replace((x+1)(x+2),x+1,a)

$a\left[x+2\right]$

Replace(sin(x)+cos(x),sin(x),tan(x))

$\cos\left[x\right]+\tan\left[x\right]$

Reshape(matrix)

Reshapes a matrix to a different size. The new size of the matrix must have the same number of elements as the original matrix.

Reshape([[1,2],[3,4]],1,4)

1	2	3	4

Reshape([[1,2],[3,4]],4,1)

1
2
3
4

Reshape([[1,2,3,4],[5,6,7,8],[9,10,11,12]],6,2)

1	7
2	8
3	9
4	10
5	11
6	12

Reshape([[1,2,3,4],[5,6,7,8],[9,10,11,12]],2,6)

1	3	5	7	9	11
2	4	6	8	10	12

Reverse(list)

Sorts a list in descending order.

Reverse([3,2,1])

$[1, 2, 3]$

Reverse([a,A,b,B,c,C])

$[C, c, B, b, A, a]$

Right(expression)

Returns the right side of an expression.

Right(x^2=9)

9

Right(a+1=b)

b

RK4(function, t, y, a, b, y0, N=10)

RK4(t-y^2,t,y,0,3,1)

0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3
1	0.8076	0.7622	0.8056	0.9031	1.0287	1.1631	1.2943	1.4169	1.5296	1.6333

RK45(function, t, y, a, b, y0, Tol=10E-5, hmax=0.25, hmin=10E-6, N=20)

The Runge-Kutta method.

RK45(s-w^2,s,w,0,3,1)

0	0.15	0.2834	0.4341	0.5961	0.766	0.941	1.1193	1.3011	1.489	1.6891	1.9173	2.1283	2.3586	2.5546	2.7388	2.9185	3
1	0.8799	0.8137	0.7735	0.762	0.7776	0.8162	0.873	0.9433	1.0237	1.1132	1.2151	1.3063	1.4006	1.4762	1.5436	1.606	1.6334

Round(number, digits)

Rounds a given **number** to the requested number of **digits**.

The parameter **number** can be a real or complex value. In case of a complex value, both real and imaginary parts will be rounded.

round(1/3,4)

0.3333

round(1/3,5)

0.33333

round(4/3,0)

1

RowReduce(A)

Performs a Gaussian elimination on the given matrix A.

Note: This function is equivalent to **rref** on the TI-Calculators.

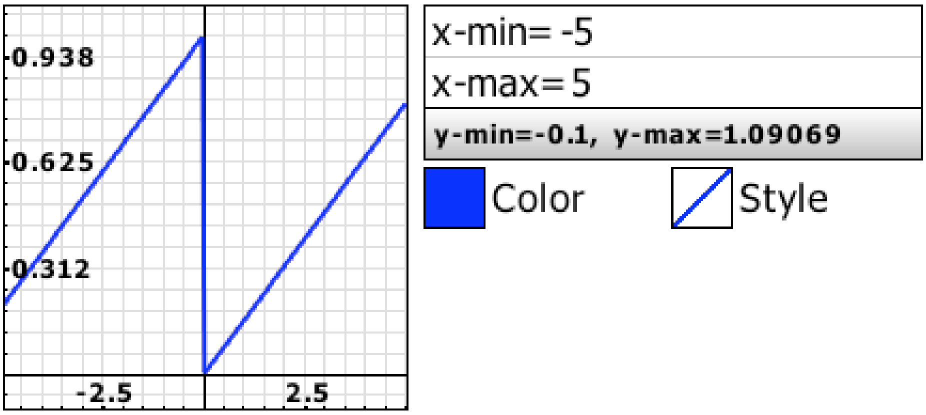
RowReduce([[1,2,3],[2,5,6]])

1	0	3
0	1	0

SawToothWave(x, [T])

Creates a predefined 2D sawtooth wave with period = T. The default value of T is 2?.

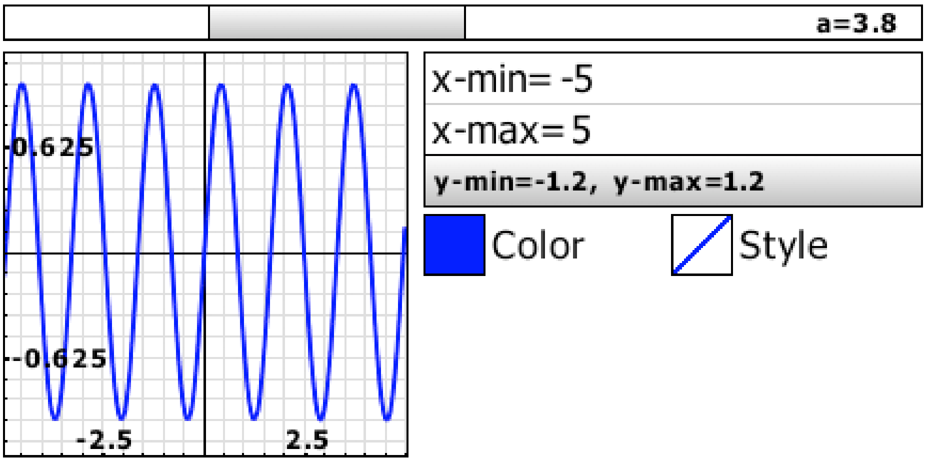
Plot(SawToothWave(x))



Scroll(variable, start, end, [step], [initial value])

The Scroll function dynamically changes the value of a variable or list of variables using a scrollbar.

Scroll(a,1,10,0.1) Plot(sin(a*x))



Scroll(n, 1, 8) Expand((a+b)^n)

n=5

$a^5+b^5+5a^4b+5ab^4+10a^3b^2+10a^2b^3$

Sequence(f(x), x, start, end, step, [start term], [number of terms])

Returns a sequence as a list.

Sequence(i,i,1,5)

$[1, 2, 3, 4, 5]$

Sequence(i^2,i,1,5)

$[1, 4, 9, 16, 25]$

Sequence(i,i,1,15,2)

$[1, 3, 5, 7, 9, 11, 13, 15]$

Sequence(1/n^2,n,1,10)

$$\left[1, \frac{1}{4}, \frac{1}{9}, \frac{1}{16}, \frac{1}{25}, \frac{1}{36}, \frac{1}{49}, \frac{1}{64}, \frac{1}{81}, \frac{1}{100}\right]$$

Sequence(1/n^2,n,1,100,10,4,3)

$$\left[\frac{1}{961}, \frac{1}{1681}, \frac{1}{2601}\right]$$

Show sequence in reversed order

Sequence(1/n^2,n,1,100,10,-4)

$$\left[\frac{1}{3721}, \frac{1}{2601}, \frac{1}{1681}, \frac{1}{961}, \frac{1}{441}, \frac{1}{121}, 1\right]$$

Show sequence in reversed order

Sequence(1/n^2,n,1,100,10,-4,3)

$$\left[\frac{1}{3721}, \frac{1}{2601}, \frac{1}{1681}\right]$$

Series(f(z), z, n)

Finds the series expansion of a function around zero. This function is the same as the Maclaurin series. This function can be used on all common and most special functions.

Series(sin(x)+cos(x),x,8)

$$\frac{x^8}{40320} - \frac{x^7}{5040} - \frac{x^6}{720} + \frac{x^5}{120} + \frac{x^4}{24} - \frac{x^3}{6} - \frac{x^2}{2} + x + 1$$

Series(exp(2z),z,10)

$$\frac{4z^{10}}{14175} + \frac{4z^9}{2835} + \frac{2z^8}{315} + \frac{8z^7}{315} + \frac{4z^6}{45} + \frac{4z^5}{15} + \frac{2z^4}{3} + \frac{4z^3}{3} + 2z^2 + 2z + 1$$

Series(tanh(3y),y,8)

$$-\frac{4131y^7}{35} + \frac{162y^5}{5} - 9y^3 + 3y$$

Series(BesselJ(0,z),z,8)

$$-\frac{z^6}{2304} + \frac{z^4}{64} - \frac{z^2}{4} + 1$$

Series(BesselJ(0,x)+BesselJ(1,x),x,6)

$$-\frac{x^7}{18432}-\frac{x^6}{2304}+\frac{x^5}{384}+\frac{x^4}{64}-\frac{x^3}{16}-\frac{x^2}{4}+\frac{x}{2}+1$$

Series(asin(x),x,15)

$$\frac{143x^{15}}{10240}+\frac{231x^{13}}{13312}+\frac{63x^{11}}{2816}+\frac{35x^9}{1152}+\frac{5x^7}{112}+\frac{3x^5}{40}+\frac{x^3}{6}+x$$

Series(FresnelCos(z),z,8)

$$z-\frac{z^5\pi^2}{40}+\frac{z^9\pi^4}{3456}$$

Series(Ei(x),x,7)

$$\frac{x^7}{35280}+\frac{x^6}{4320}+\frac{x^5}{600}+\frac{x^4}{96}+\frac{x^3}{18}+\frac{x^2}{4}+x+\gamma+\ln[x]$$

Shi(z)

Finds the Hyperbolic Sine Integral of z.

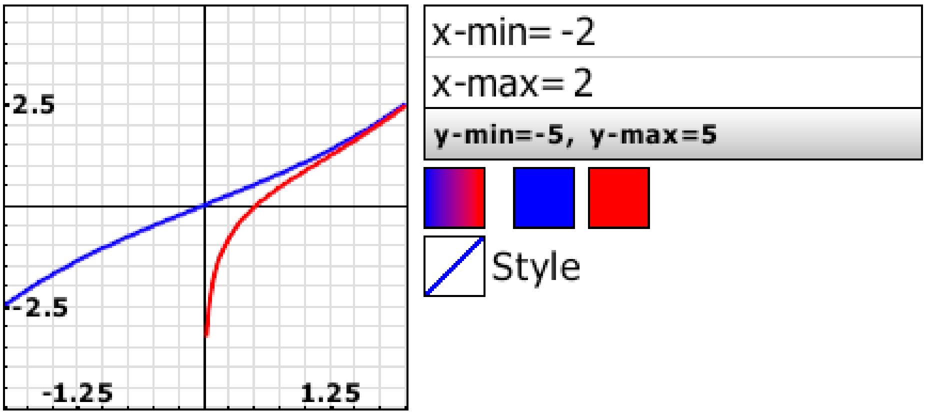
Shi(1)

1.05725

Shi(2+3\im)

-0.19319+2.64543i

Plot([Shi(x),Chi(x)],x=[-2,2],y=[-5,5])



Si(z)
Sine Integral of z.

[Si(0), Si(\inf), Si(-\inf), Si(-x)]

$\left[0, \frac{\pi}{2}, -\frac{\pi}{2}, -\mathrm{Si}\left[x\right]\right]$

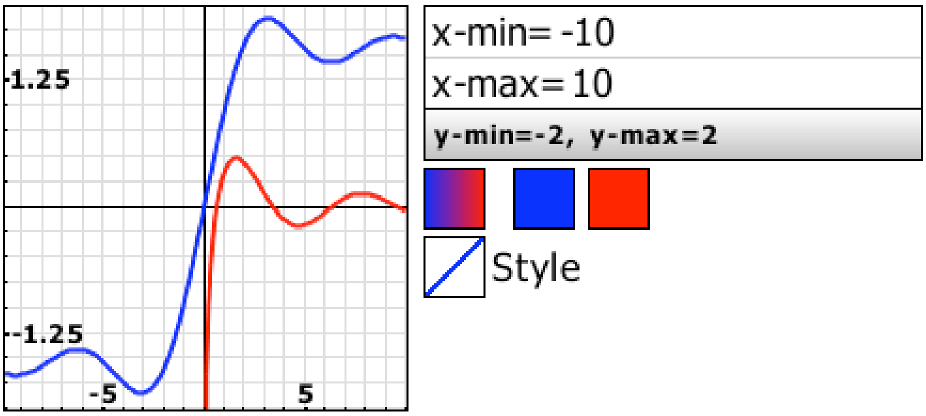
a=list(3) b=list(3) loop(i, 1, 3) a(i)=Si(i) b(i)=Ci(i) end [a, b]

0.94608	1.60541	1.84865
γ - 0.23981	γ+ln[2] - 0.84738	γ+ln[3] - 1.5562

Si(2+\im)

1.83321+0.45769i

Plot([Si(x), Ci(x)], x=[-10, 10], y=[-2, 2])



Sign(z)
Returns the sign of a given value.

If z is a complex number, then sign returns z/abs(z).

sign(1.234)

1

sign(-9.8765)

-1

sign(0)

0

sign(7/2+7/3\im)

0.83205-0.5547i

SimplifyPoly(f(x)/g(x), [variable])

Simplifies polynomial quotients **f(x)/g(x)** by factoring the numerator f(x), the denominator g(x) and then calculating the final factored form.

SimplifyPoly((x^6+11x^4+24x^2-36)/(x^4+5x^2-6))

$$x^2+6$$

SimplifyPoly((x^6-6x^5+14x^4+10x^3-111x^2+56x+156)/(x^4+5x^2-6))

$$\frac{[x-3][x-2][x+2][x^2-4x+13]}{[x-1][x^2+6]}$$

SimplifyPoly(z^2=171)

$$[z+3\sqrt{19}][z-3\sqrt{19}]$$

SimplifyPoly(a*x^2+2x+1,x)

$$2x+ax^2+1$$

SimplifyPoly(x^6+11x^4+24x^2-36)

$$[x-1][x+1][x^2+6]^2$$

SimplifyPoly(256z^8=1,z)

$$256\left[z-\frac{1}{2}\right]\left[z^2+\frac{z\sqrt{2}}{2}+\frac{1}{4}\right]\left[z^2-\frac{z\sqrt{2}}{2}+\frac{1}{4}\right]\left[z^2+\frac{1}{4}\right]\left[z+\frac{1}{2}\right]$$

Size(list)
Returns the size of the list or matrix.

size([1,2,3,4,5,6])
6

size([[1,2,3],[4,5,6]])
$\begin{bmatrix} 2, & 3 \end{bmatrix}$

Solve(f(x), x, [guess])
Solves the expression for the given variable.

When no equals sign is given, Solve assumes the expression is equal to zero. For example, **Solve(x^2-3)** will solve the expression as **x^2-3=0**.

Quadratic expressions can be solved by entering each coefficient as a parameter. For instance, **Solve(5x^2+3x+4)** may also be entered as **Solve(5,3,4)**.

Solve can also solve a system of linear equations with n unknowns.
Solve(*equation1*, *equation2*, *equation3*, *...*)
See SolveSystem to solve a system of non-linear equations.

This optional parameter **guess** is the initial guess value to solve the equation. If a list of two values is given such as **Solve(sin(x)=0,x,[0,6\pi])**, Solve will return the solutions within the given range.

Solve(3x+5=0,x)
$-\frac{5}{3}$

Solve(3x+5)
$-\frac{5}{3}$

Solve(3x^2+4x-3=0)

$$\left[\frac{-2\sqrt{13}-4}{6},\ \frac{2\sqrt{13}-4}{6}\right]$$

Solve(3,4,-3)

$$\left[\frac{-2\sqrt{13}-4}{6},\ \frac{2\sqrt{13}-4}{6}\right]$$

Solve(x+y+z=5,x+2y=6,z-x=3)

$$\left[x=-\frac{2}{3},\ y=\frac{10}{3},\ z=\frac{7}{3}\right]$$

Solve(sin(3x)+cos(3x)=0)

$$\left[\frac{\pi}{4},\ \frac{7\pi}{12},\ \frac{11\pi}{12},\ \frac{5\pi}{4},\ \frac{19\pi}{12},\ \frac{23\pi}{12}\right]$$

Solve(3*tan(x)^2=1,x)

$$\left[\frac{\pi}{6},\ \frac{5\pi}{6},\ \frac{7\pi}{6},\ \frac{11\pi}{6}\right]$$

Solve(tan(x)^2=3)

$$\left[\frac{\pi}{3},\ \frac{2\pi}{3},\ \frac{4\pi}{3},\ \frac{5\pi}{3}\right]$$

Solve(x^6+16x^3+64,x)

$$\left[-2,\ -2,\ i\sqrt{3}+1,\ i\sqrt{3}+1,\ -i\sqrt{3}+1,\ -i\sqrt{3}+1\right]$$

Solve(asin(x)=\pi/4,x)

$$\frac{\sqrt{2}}{2}$$

Solve(3sin(x)+exp(x)=2,x,[-2\pi,2\pi])

$$\left[-5.55519,\ -3.86196,\ 0.24374\right]$$

Solve(ln(x)=1,x)

e

Solve(exp(3x)=2,x)

$\frac{1}{3}\ln[2]$

Solve(4sin(x)^3+2sin(x)^2-2sin(x)=1,x)

$\left[\frac{\pi}{4}, \frac{3\pi}{4}, \frac{7\pi}{6}, \frac{5\pi}{4}, \frac{7\pi}{4}, \frac{11\pi}{6}\right]$

Solve(Si(x)=1/2)

[0.50719, ...]

Solve(BesselJ(0,x)=2/3)

[1.20894, ...]

Solve(LegendreP(3,x)-1=0)

$\left[1, \frac{-i\sqrt{15}}{10}-\frac{1}{2}, \frac{i\sqrt{15}}{10}-\frac{1}{2}\right]$

Solve(Gamma(x)=5040,x,[1,10])

8

SolveSystem(equations, [variables], [guesses])

Solves a non-linear systems of equations.

SolveSystem([x+2y=1, x^2+y^2=10])

x	y
3	-1

SolveSystem([x^2+y^2=25, y^2=x^2+3])

x	y
$\sqrt{11}$	$\sqrt{14}$

SolveSystem([x^2+y^2=25, y^2=x^2+3], [x,y], [-2,0])

x	y
$-\sqrt{11}$	$\sqrt{14}$

SolveSystem([x^2+2y^2+cos(z)-w^2=0, 3x^2+y^2+sin(z)^2-w^2=0, -2x^2-y^2-cos(z)+w^2=0, -x^2-2y^2-cos(z)^2+w^2=0],[w,x,y,z],[-1,1,0,0])

w	x	y	z
-2	-1	1	0

Sort(list)

Sorts a list in ascending order.

Sort([3,2,1])

$[1,\ 2,\ 3]$

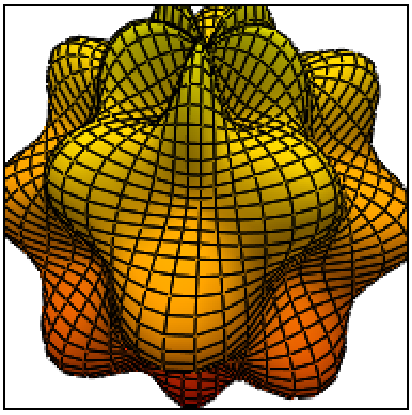
Sort([2,5,3,4,1])

$[1,\ 2,\ 3,\ 4,\ 5]$

SphericalPlot3D(expression, ...)

Plots 3D graphs in spherical coordinates.

SphericalPlot3D(1+1/5*sin(6*\theta)*sin(5*\phi), \theta=[0,\pi,60], \phi=[0,2\pi,60], axis=0)



θ-min= 0
θ-max= π
θ-points= 60
ϕ-min= 0
ϕ-max= 2π
ϕ-points= 60
x-min=-1.16627, x-max=1.162...

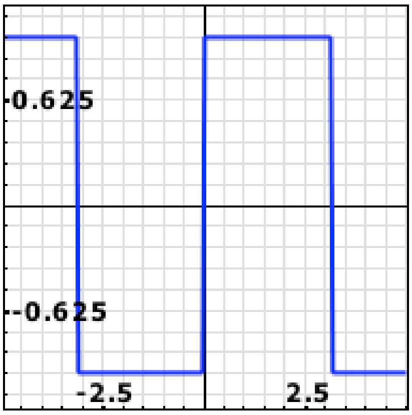
Sqrt(z)

Returns the square root of a given number real or complex.

SquareWave(x, [T])

SquareWave is a predefined 2D plot function. It creates a square wave of period = T.

Plot(SquareWave(x))

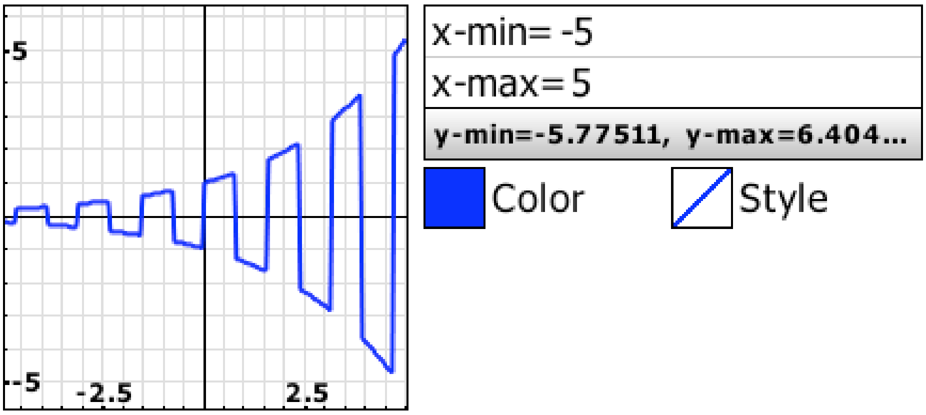


x-min= -5
x-max= 5
y-min=-1.2, y-max=1.2
Color Style

SquareWave(x,\pi/2)

$$[-1]^{\mathrm{floor}\left[\frac{4x}{\pi}\right]}$$

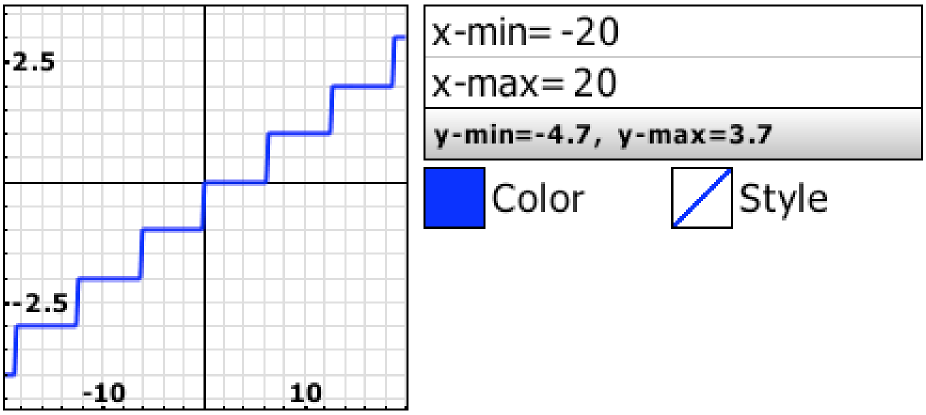
Plot(SquareWave(x,\pi/2)*exp(x/3))



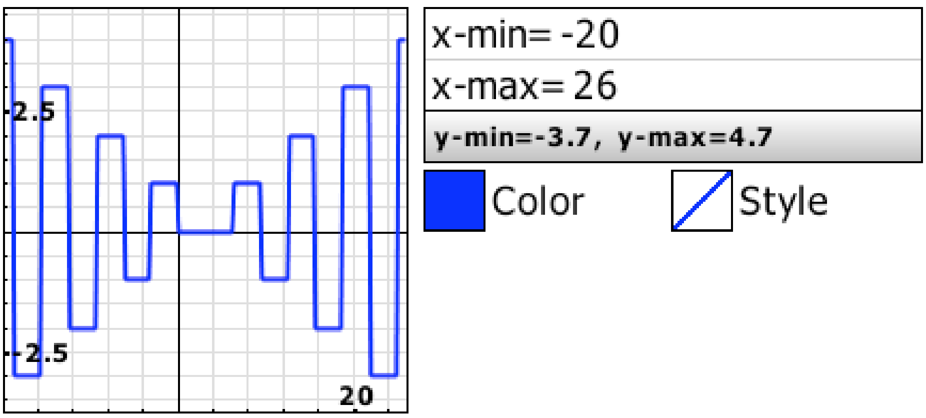
StaircaseWave(x, [T])

Creates a predefined 2D staircase wave with period = T.

Plot(StairCaseWave(x),x=[-20,20])



Plot(StairCaseWave(x)*SquareWave(x),x=[-20,26])



StandardDeviation(list)

Finds the standard deviation of a list of numbers.

StandardDeviation([3,0,-5,0.5,4])

$\frac{7}{2}$

String(expression1, expression2, ...)

Creates a string from a list of parameters.

String(A,1,B,2,C,3)

A1B2C3

String("Hello", 123)

Hello123

String(a,12)+String(b,12)

a12+b12

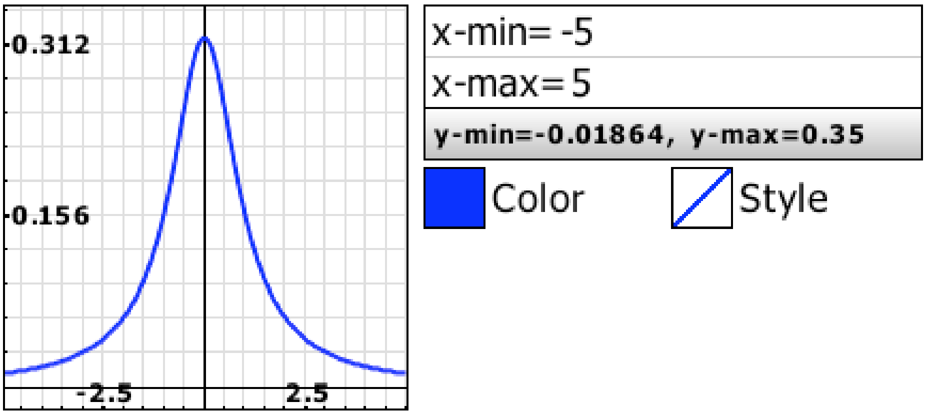
StudentTCDF(x, df)

Computes the Student-t cumulative density function over the interval defined by **lower** and **upper** with degrees of freedom **df**.

StudentTPDF(x, df)

Computes the Student-t probability density function at a value **x** with degrees of freedom **df**.

Plot(StudentTPDF(x,1))



Sum(f(n), n, start, end)

Calculates the sum of f(n) where n goes from start to end.

Sum(n,n,1,10)

55

Sum(x^2,x,1,10)

385

Sum(1/a!,a,0,20)

2.71828183

\e

2.71828183

Sum(1/a^n,n,1,5)

$$\frac{1}{a}+\frac{1}{a^{2}}+\frac{1}{a^{3}}+\frac{1}{a^{4}}+\frac{1}{a^{5}}$$

f=Sum((-1)^n*x^(2n+1)/(2n+1)!,n,0,10)

$$1.95729\text{E-}20\,x^{21}-8.22064\text{E-}18\,x^{19}+2.81146\text{E-}15\,x^{17}-7.64716\text{E-}13\,x^{15}+1.6059\text{E-}10\,x^{13}-2.50521\text{E-}8\,x^{11}+2.75573\text{E-}6\,x^{9}-0.0002\,x^{7}+0.00833\,x^{5}-0.16667\,x^{3}+x$$

Eval(f,x,\pi/4)

0.70710678

sin(\pi/4)

0.70710678

SurfaceNormal(function, [varlist], [point])
Calculates the normal vector to the surface given by function at point.

Both the positive and negative normal vectors are returned.

SurfaceNormal(x*y^3-z-2,[x,y,z],[1,1,-1])

$$\left[\begin{bmatrix} \frac{1}{\sqrt{11}} & \frac{3}{\sqrt{11}} & -\frac{1}{\sqrt{11}} \end{bmatrix}, \begin{bmatrix} -\frac{1}{\sqrt{11}} & -\frac{3}{\sqrt{11}} & \frac{1}{\sqrt{11}} \end{bmatrix}\right]$$

SurfaceNormal(x^2*y*z-1,[x,y,z],[1,1,1])

$$\left[\begin{bmatrix} \frac{2}{\sqrt{6}} & \frac{1}{\sqrt{6}} & \frac{1}{\sqrt{6}} \end{bmatrix}, \begin{bmatrix} -\frac{2}{\sqrt{6}} & -\frac{1}{\sqrt{6}} & -\frac{1}{\sqrt{6}} \end{bmatrix}\right]$$

SurfaceNormal(x^2+y^2+z^2,[x,y,z],[5,0,12])

$$\left[\begin{bmatrix} \frac{5}{13} & 0 & \frac{12}{13} \end{bmatrix}, \begin{bmatrix} -\frac{5}{13} & 0 & -\frac{12}{13} \end{bmatrix}\right]$$

SurfaceNormal(x^2+y^2,[x,y],[a,b])

$$\left[\begin{bmatrix} \frac{2\,a}{\sqrt{\mathrm{abs}[2\,a]^2+\mathrm{abs}[2\,b]^2}} & \frac{2\,b}{\sqrt{\mathrm{abs}[2\,a]^2+\mathrm{abs}[2\,b]^2}} \end{bmatrix}, \begin{bmatrix} -\frac{2\,a}{\sqrt{\mathrm{abs}[2\,a]^2+\mathrm{abs}[2\,b]^2}} & -\frac{2\,b}{\sqrt{\mathrm{abs}[2\,a]^2+\mathrm{abs}[2\,b]^2}} \end{bmatrix}\right]$$

SVD(A)
Returns a list with singular values of a matrix A.

This routine uses the TNT library.

SVD([[1,2],[3,4]])

$[5.46499,\ 0.36597]$

Table(function, [independent, start, end, step], dependent)

Prints a table of values.

Table(x^2,[x,2,10,1],y)

x	y
2	4
3	9
4	16
5	25
6	36
7	49
8	64
9	81
10	100

Together(expression)

Finds a common denominator for each additive term of a polynomial function and returns an equivalent expression with one numerator and one denominator. It performs the opposite operation as Apart.

Together(1/a+1/b)

$$\frac{a+b}{a\,b}$$

Together(2-1/(x+1)+4/(x-2))

$$\frac{2x^2+x+2}{[x-2][x+1]}$$

Together(2-1/(x+1)+4/(x+1)^2)

$$\frac{2x^2+3x+5}{[x+1]^2}$$

Together(exp(z)/a-exp(z)^2/b)

$$\frac{-a\,e^{[2z]}+b\,e^z}{a\,b}$$

Trace(variable)

This function is used for debugging scripts. It will output every instance when the specified variable's value was changed.

Trace will only work inside a script.

Transpose(A)

Calculates the transpose of a matrix A.

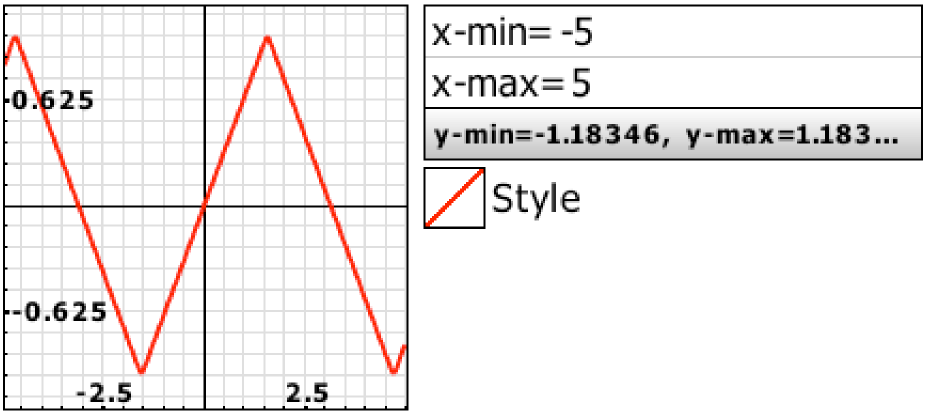
Transpose([[1,2,3,4],[5,6,7,8]])

1	5
2	6
3	7
4	8

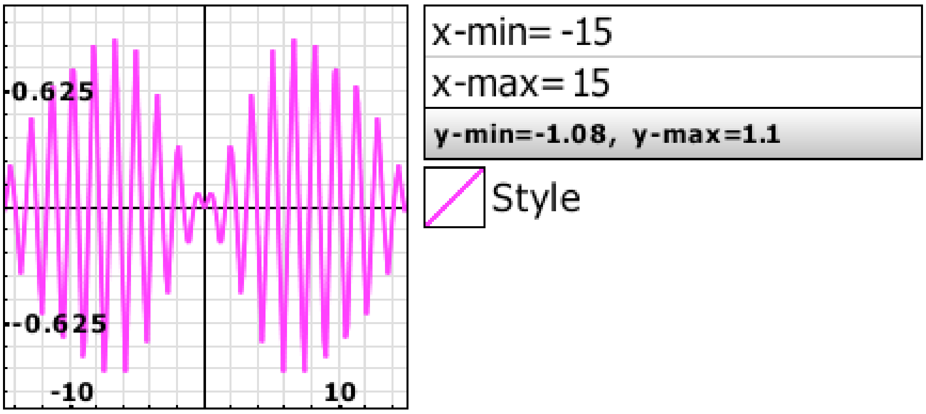
TriangleWave(x, [T])

TriangleWave is a predefine 2D plotfunction which creates a triangle wave.

Plot(TriangleWave(x),color=red)



Plot(TriangleWave(x,\pi/2)*sin(x/5),color=magenta,x=[-15,15])



TrigCollect(expression)

Equivalent of TrigReduce but even further reduces trigonometric functions.

TrigCollect(-(2*(cos(x)^2)-1)*sin(y)-2*cos(x)*cos(y)*sin(x)-4*(2*cos(y)*sin(x)*sin(y)+(2*(cos(y)^2)-1)*cos(x)))

$$-4\cos\left[x-2y\right]-\sin\left[2x+y\right]$$

TrigCollect(2*cos(y/3)*cos(x/9)*sin(y/3)+(2*(cos(y/3)^2)+-1)*sin(x/9))

$$\sin\left[\frac{x}{9}+\frac{2y}{3}\right]$$

TrigCollect((2*(2*(cos(z)^2)-1)*cos(u)*sin(u)+2*(2*(cos(u)^2)-1)*cos(z)*sin(z))*

cos((x+y)^0.5)+((2*(cos(u)^2)-1)*(2*(cos(z)^2)-1)-4*cos(u)*cos(z)*sin(u)*sin(z))*sin((x+y)^0.5))

$$\sin\left[2u+2z+\sqrt{x+y}\right]$$

TrigCollect(2*cos(x)*cos(y)*sin(x)+(2*(cos(x)^2)+-1)*sin(y)+1/(4*(cos(y)^3)+-3*cos(y)))

$$\sin\left[2x+y\right]+\sec\left[3y\right]$$

TrigConvert(expression)

Converts trigonometric functions to exponential functions.

TrigConvert(sin(x))

$$\frac{-i}{2}e^{\left[i x\right]}+\frac{i}{2}e^{\left[-i x\right]}$$

TrigConvert(cos(x))

$$\frac{1}{2}e^{\left[i x\right]}+\frac{1}{2}e^{\left[-i x\right]}$$

TrigConvert(tan(x))

$$\frac{-i\,e^{\left[i x\right]}}{e^{\left[i x\right]}+e^{\left[-i x\right]}}+\frac{i\,e^{\left[-i x\right]}}{e^{\left[i x\right]}+e^{\left[-i x\right]}}$$

TrigConvert(cot(x))

$$\frac{i\,e^{\left[i x\right]}}{-e^{\left[-i x\right]}+e^{\left[i x\right]}}+\frac{i\,e^{\left[-i x\right]}}{-e^{\left[-i x\right]}+e^{\left[i x\right]}}$$

TrigExpand(expression)

Splits up sums and integer multiples that appear in arguments of trigonometric functions and expands products of trigonometric functions into sums of powers.

TrigExpand(sin((x/3+2y)/3))

$$\left(2\cos\left(\frac{y}{3}\right)^2-1\right)\sin\left(\frac{x}{9}\right)+2\cos\left(\frac{x}{9}\right)\cos\left(\frac{y}{3}\right)\sin\left(\frac{y}{3}\right)$$

TrigExpand(cos(x^2+\sqrt(y)))

$$-\sin\left(x^2\right)\sin\left(\sqrt{y}\right)+\cos\left(x^2\right)\cos\left(\sqrt{y}\right)$$

TrigExpand(tanh(2*x))

$$\frac{2\tanh\left(x\right)}{\tanh\left(x\right)^2+1}$$

TrigExpand(tanh(x-y))

$$\frac{-\cosh\left(x\right)\sinh\left(y\right)+\cosh\left(y\right)\sinh\left(x\right)}{-\sinh\left(x\right)\sinh\left(y\right)+\cosh\left(x\right)\cosh\left(y\right)}$$

TrigReduce(expression)

Rewrites products and powers of trigonometric functions in expr in terms of trigonometric functions with combined arguments.

TrigReduce(sin(x)^2*cos(x) + 5*cos(x)^3 + 2*sin(x)*cos(x))

$$4\cos\left(x\right)+\cos\left(3x\right)+\sin\left(2x\right)$$

TrigReduce(-3cos(x)*sin(5)-cos(5)*sin(x)+4cos(x)^3*sin(5)+4cos(x)^2*cos(5)*sin(x))

$$\sin\left(3x+5\right)$$

TrigReduce(cos(x^2)*cos(\sqrt(y))-sin(\sqrt(y))*sin(x^2))

$$\cos\left(x^2+\sqrt{y}\right)$$

TrigReduce(3*sin(x)*cos(x)-sin(x)^2+cos(x)^2)

$\frac{3}{2}\sin\left[2\,x\right]+\cos\left[2\,x\right]$

TrigReduce(cos(y)*sin(z)*sin(x)+cos(z)*cos(x)*cos(y)+cos(z)*sin(y)*sin(x)+-1*cos(x)*sin(z)*sin(y))

$\cos\left[x - y - z\right]$

TrigReduce(4*(cos(x*y)^2)*sin(x*y)+-sin(x*y))

$\sin\left[3\,x\,y\right]$

TrigReduce(32*(cos(x)^3)*sin(x)+-6*cos(x)*sin(x)+-32*(cos(x)^5)*sin(x))

$-\sin\left[6\,x\right]$

TrigReduce(16*(cos(x*y)^4)*sin(x*y)+-12*(cos(x*y)^2)*sin(x*y)+sin(x*y))

$\sin\left[5\,x\,y\right]$

Value(string)

Converts a string to a value.

Variables(expression)

Returns a list variables found in the expression.

Variables(2x^2+x+1)

x

Variables(x^2+y^2+z^2)

$\left[x,\ y,\ z\right]$

Variance(list)

Finds the variance of a list of numbers.

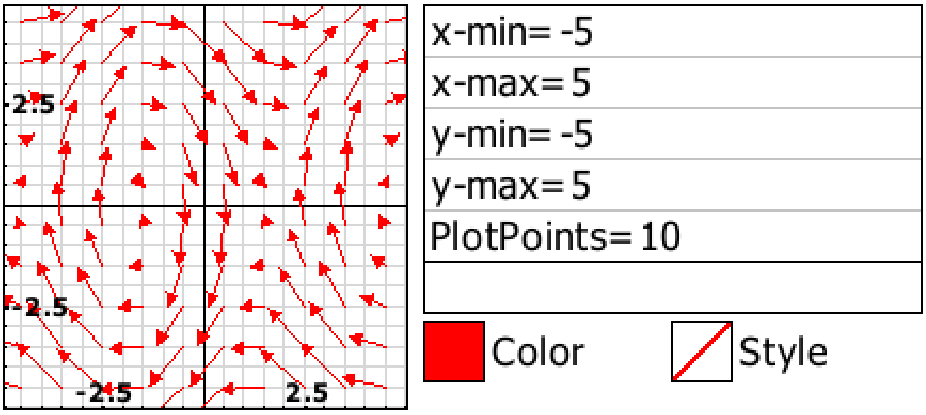
Variance([3,0,-5,0.5,4])

$\frac{49}{4}$

VectorPlot(list, ...)

Plots 2D vector fields.

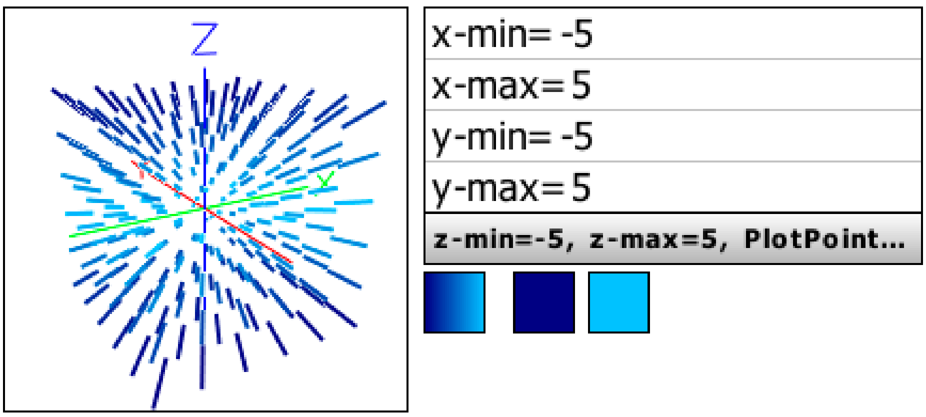
VectorPlot([y,-cos(x)])



VectorPlot3D(list, ...)

Plots a 3D vector field.

VectorPlot3D([x,y,z])



While(condition)

This will loop through and evaluate a block of code until **condition** evaluates to zero.

n=0 while(n

10

Zeta(z, [a])

If **a** is not given, finds the Riemann Zeta.

If **a** is given, finds the Hurwitz Zeta function.

Zeta(0)

$-\frac{1}{2}$

Zeta(1)

ComplexInfinity

Zeta(-1)

$-\frac{1}{12}$

Zeta(8)

$\frac{\pi^8}{9450}$

Zeta(5+\im)

$1.02597882-0.02515108i$

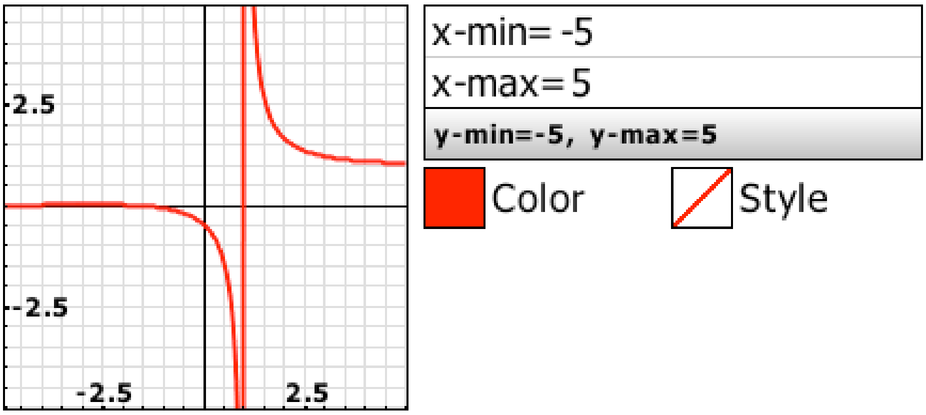
Zeta(-3.5)

$\frac{1.35903689}{\pi^5}$

Zeta(8)

$$\frac{\pi^8}{9450}$$

Plot(Zeta(x),x=[-5,5],y=[-5,5])



Zeta(0,a)

$$-a+\frac{1}{2}$$

Zeta(-3,a)

$$\frac{-a^4+2a^3-a^2+\frac{1}{30}}{4}$$

Zeta(z,5/2)

$$-\left[3^{[-z]}+1^{[-z]}\right]2^z+\left[2^z-1\right]Zeta[z]$$

Zeta(z,-5/2)

$$\left[5^{[-z]}+3^{[-z]}+1\right]2^z[-1]^{[-z]}+\left[2^z-1\right]Zeta[z]$$