Anyagok
http://www.math.u - szeged.hu/~vajda/TMP

Mathematica: Kernel+Front End

Verziószám (rendszerinformációk, globális rendszerváltozók):

```
$Version
```

```
6.0 for Microsoft Windows (32-bit) (May 21, 2008)
```

A legújabb verzió 7.0

CAS: Computer Algebra System
MAS: Mathematical Assistant System

A munkafüzetek (notebooks) cellákból épülnek fel.
Alapértelmezett cella stílus: Input (ez nem az, ez egy szöveges cella!)

Input cellában lévõ kifekezés kiértékelése: [Shift]+[Enter]!
Soremelés: [Enter]

```
1 + 3
```

```
4
```

A szimbólumokhoz rendelt szabályok alapján történik az input kifejezések átalakítása: 1+3(≡Plus[1,3]) A Plus operátorhoz van built-in szabály, az f fgv. szimbólumhoz nincs:

```
f[3]
```

```
f[3]
```

```
f[3, 4]
```

```
f[3, 4]
```

```
Head[f[3, 4]]
```

```
f
```

```
f[3, 4][[0]]
```

```
f
```

```
Plus[3, 4]
```

```
7
```

```
f[3, 4][[0]]
```

```
f
```

```
f[3, 4][[1]]
```

```
3
```

Szimbolikus és Numerikus Számítások

- **Példák**

```
N[π, 5]
```

```
3.1416
```

```
1 / 2 + 1 / 3
```

$\frac{5}{6}$

```
Sin[Pi / 2]
```

```
1
```

```
(1 + I) (2 - I)
```

```
3 + ⅈ
```

$\frac{\sqrt{2}}{2} + \frac{\sqrt{3}}{3}$ `// Together`

$\frac{1}{6}\left(3\sqrt{2} + 2\sqrt{3}\right)$

```
N[Sqrt[2], 20]
```

```
1.4142135623730950488
```

`N[`$\sqrt{2}$`, 10]`

```
1.414213562
```

```
? N
```

```
N[expr] gives the numerical value of expr.
   N[expr, n] attempts to give a result with n-digit precision.
```
More…

Megjegyzés. Figyeljük meg a [], (), {} zárójelek szerepét.

```
Expand[a (b + c)]
```

```
a b + a c
```

```
Length[{5, 7, 10}]
```

```
3
```

Help rendszer információkérés

```
? Length
```

Length[*expr*] gives the number of elements in *expr*. ≫

```
?? Length
```

Length[*expr*] gives the number of elements in *expr*. ≫

```
Attributes[Length] = {Protected}
```

■ Aritmetika

```
{1, 2, 3}[[2]]
```

```
2
```

Speciális karakterek vagy ESC syekvenciákkal vagy palettából

```
A ∧ B A ⟹ B
```

$\sqrt{16}$

```
4
```

■ ℤ

```
FactorInteger[60]
```

```
{{2, 2}, {3, 1}, {5, 1}}
```

```
PrimeQ[23]
```

```
True
```

```
PrimeQ[25]
```

```
False
```

```
Range[20]
```

```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20}
```

```
Table[i, {i, 1, 20, 2}]
```

```
{1, 3, 5, 7, 9, 11, 13, 15, 17, 19}
```

```
{1, 2, 4} // Length
```

```
3
```

```
Length[{1, 2, 4}]
```

```
3
```

```
Map[{#, PrimeQ[#]} &, Range[20]]
```

1	False
2	True
3	True
4	False
5	True
6	False
7	True
8	False
9	False
10	False
11	True
12	False
13	True
14	False
15	False
16	False
17	True
18	False
19	True
20	False

```
Map[{#, PrimeQ[#]} &, Range[20]] // TableForm
```

1	False
2	True
3	True
4	False
5	True
6	False
7	True
8	False
9	False
10	False
11	True
12	False
13	True
14	False
15	False
16	False
17	True
18	False
19	True
20	False

```
GCD[112, 55]
```

1

```
FactorInteger[112] // FullForm
```

```
List[List[2, 4], List[7, 1]]
```

```
MatrixForm[FactorInteger[112]]
```

$$\begin{pmatrix} 2 & 4 \\ 7 & 1 \end{pmatrix}$$

$2^4\ 7^1$

112

```
FactorInteger[112][[All, 1]]
```

{2, 7}

```
FactorInteger[55][[All, 1]]
```

{5, 11}

```
ExtendedGCD[112, 55]
```

{1, {-27, 55}}

```
(-27) 112 + (55) 55
```

1

▪ *Csak matematikusoknak : $\mathbb{Z}[i]$

```
GCD[13 + 13 I, 2 - 3 I]
```

$3 + 2\,i$

▪ $\mathbb{Q}$, algebrai bővítések, algebrai számok

```
1 / 2 + 3 / 5
```

$\frac{11}{10}$

```
Root[-2 + #^2 &, 1]
```

$-\sqrt{2}$

```
MinimalPolynomial[Sqrt[2] + Sqrt[3], x]
```

$1 - 10\,x^2 + x^4$

```
Root[1 - 10 #^2 + #^4 &, 3]
```

Root[1 - 10 #1^2 + #1^4 &, 3]

```
ToRadicals[Root[1 - 10 #^2 + #^4 &, 3]]
```

$\sqrt{5 - 2\sqrt{6}}$

```
FullSimplify[%]
```

$-\sqrt{2} + \sqrt{3}$

- **ℝ,ℂ**

```
(1 - I) (1 + I)
```

2

$$\frac{1 + I}{2 + 3 I}$$

$$\frac{5}{13} - \frac{i}{13}$$

$$(1 - i)^2$$

$-2\,i$

```
RootIntervals[1 - 10 x^2 + x^4]
```

{{{-5, -1}, {-1, 0}, {0, 1}, {1, 5}}, {{1}, {1}, {1}, {1}}}

```
Solve[1 - 10 x^2 + x^4 == 0]
```

$$\left\{\left\{x \to -\sqrt{5 - 2\sqrt{6}}\right\}, \left\{x \to \sqrt{5 - 2\sqrt{6}}\right\}, \left\{x \to -\sqrt{5 + 2\sqrt{6}}\right\}, \left\{x \to \sqrt{5 + 2\sqrt{6}}\right\}\right\}$$

```
NSolve[1 - 10 x^2 + x^4 == 0, x]
```

{{x → -3.14626}, {x → -0.317837}, {x → 0.317837}, {x → 3.14626}}

- $\mathbb{Z}_p$

```
Mod[13, 3]
```

1

```
Mod[1 + 2, 3]
```

0

Globális változó

```
$ContextPath
```

{DocumentationSearch`, ResourceLocator`,
JLink`, PacletManager`, WebServices`, System`, Global`}

Csomagbetöltés, globális változó értéke megváltoyik

```
<< FiniteFields`
```

```
$ContextPath
```

{FiniteFields`, DocumentationSearch`, ResourceLocator`,
JLink`, PacletManager`, WebServices`, System`, Global`}

```
?FiniteFields`*
```

▼ FiniteFields`

Characteristic	IrreduciblePolynomial
ElementToPolynomial	PerfectPowerQ
ExtensionDegree	PolynomialToElement
FieldExp	PowerList
FieldInd	PowerListQ
FieldIrreducible	PowerListToField
FromElementCode	ReduceElement
FunctionOfCode	SetFieldFormat
FunctionOfCoefficients	Successor
GF	ToElementCode

```
?GF
```

GF[*p*, *d*] gives the Galois field that is a degree *d* extension of the prime field of *p* elements.
GF[*q*] gives, for *q* a prime power, the Galois field with *q* elements.
GF[*p*, *ilist*] represents the Galois field with
prime characteristic *p* and irreducible polynomial whose coefficient list is given by *ilist*.
GF[*p*, *ilist*][*elist*] represents an element of the Galois field GF[*p*, *ilist*] whose
polynomial representation has coefficient list *elist*. ≫

összeadás a háromelemű testben

```
GF[3][1] + GF[3][2]
```

```
0
```

■ Polinomok ℤ[x], ℚ[x,y]

```
p = x^4 - 10 x^2 + 1;
```

```
a = 5
```

```
5
```

```
a
```

```
5
```

```
p
```

$1 - 10 x^2 + x^4$

```
p^2 // Expand
```

$1 - 20 x^2 + 102 x^4 - 20 x^6 + x^8$

```
p^2 // Expand
```

$1 - 20 x^2 + 102 x^4 - 20 x^6 + x^8$

a^3

```
Solve[p == 0]
```

$\{\{x \to -\sqrt{5 - 2\sqrt{6}}\}, \{x \to \sqrt{5 - 2\sqrt{6}}\}, \{x \to -\sqrt{5 + 2\sqrt{6}}\}, \{x \to \sqrt{5 + 2\sqrt{6}}\}\}$

```
Solve[Cos[x] == x, x]
```

Solve::tdep : The equations appear to involve the variables to be solved for in an essentially non−algebraic way. ≫

```
Solve[Cos[x] == x, x]
```

```
Solve[{-x + 97 y == 97, x + y == 2}, {x, y}]
```

$\{\{x \to \frac{97}{98}, y \to \frac{99}{98}\}\}$

```
NSolve[{-x + 97 y == 97, x + y == 2}, {x, y}]
```

```
{{x → 0.989796, y → 1.0102}}
```

Helyettesítési érték meghatározásához a változó/határozatlan helyébe konkrét értéket teszünk

```
p
```

$1 - 10 x^2 + x^4$

```
p /. x → 2
```

-23

```
p /. x → y
```

$1 - 10 y^2 + y^4$

```
Clear[a]
```

```
p /. x → a + b
```

$1 - 10 (a + b)^2 + (a + b)^4$

```
p
```

$1 - 10 x^2 + x^4$

Ugyanez, ha polinomfüggvényt definiálunk hozzárendelési szabállyal:

```
p2[x_] = x^4 - 10 x^2 + 1;
```

```
p2[1]
```

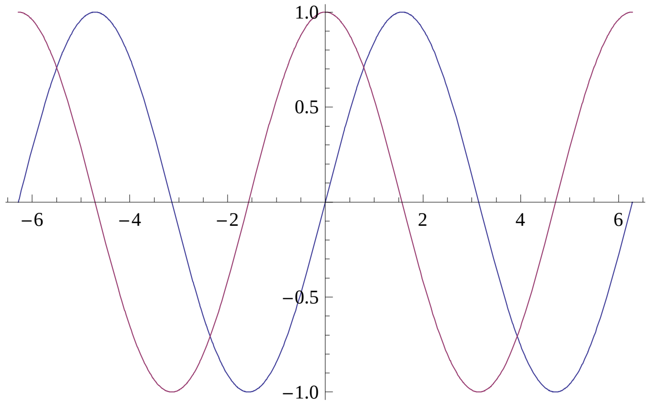
-8

Minden beépített függvénynek vannak opciói (→)

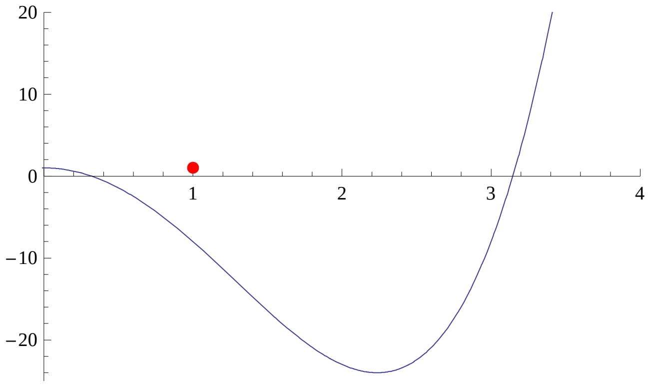
```
Factor[x^2 + y^2, Extension → {I}]
```

(x − ⅈ y) (x + ⅈ y)

```
Plot[{Sin[x], Cos[x]}, {x, -2 Pi, 2 Pi}]
```




```
Plot[p, {x, -4, 4}, PlotRange → {{0, 4}, {-25, 20}},
 Epilog → {Red, PointSize[.02], Point[{1, 1}]}]
```



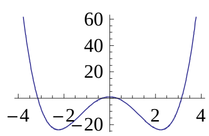

```
?? Plot
```

Plot[f, { x, x_{min}, x_{max} }] generates a plot of f as a function of x from x_{min} to x_{max}.
Plot[{ f_1, f_2, …}, { x, x_{min}, x_{max} }] plots several functions f_i. ≫

```
Attributes[Plot] = {HoldAll, Protected}

Options[Plot] = {AlignmentPoint → Center, AspectRatio → 1/GoldenRatio, Axes → True, AxesLabel → None,
  AxesOrigin → Automatic, AxesStyle → {}, Background → None, BaselinePosition → Automatic,
  BaseStyle → {}, ClippingStyle → None, ColorFunction → Automatic, ColorFunctionScaling → True,
  ColorOutput → Automatic, ContentSelectable → Automatic, DisplayFunction :→ $DisplayFunction,
  Epilog → {}, Evaluated → System`Private`$Evaluated, EvaluationMonitor → None,
  Exclusions → Automatic, ExclusionsStyle → None, Filling → None, FillingStyle → Automatic,
  FormatType :→ TraditionalForm, Frame → False, FrameLabel → None, FrameStyle → {},
  FrameTicks → Automatic, FrameTicksStyle → {}, GridLines → None, GridLinesStyle → {},
  ImageMargins → 0., ImagePadding → All, ImageSize → Automatic, LabelStyle → {},
  MaxRecursion → Automatic, Mesh → None, MeshFunctions → {#1 &}, MeshShading → None,
  MeshStyle → Automatic, Method → Automatic, PerformanceGoal :→ $PerformanceGoal,
  PlotLabel → None, PlotPoints → Automatic, PlotRange → {Full, Automatic},
  PlotRangeClipping → True, PlotRangePadding → Automatic, PlotRegion → Automatic,
  PlotStyle → Automatic, PreserveImageOptions → Automatic, Prolog → {}, RegionFunction → (True &),
  RotateLabel → True, Ticks → Automatic, TicksStyle → {}, WorkingPrecision → MachinePrecision}
```

```
Plot[p2[x], {x, -4, 4}]
```



Speciális (built–in) Polinomok

```
ChebyshevT[6, x]
```

$-1 + 18\,x^2 - 48\,x^4 + 32\,x^6$

```
Factor[x^2 + y^2]
```

$x^2 + y^2$

```
Factor[x^2 + y^2, Extension → {I}]
```

$(x - i\,y)\,(x + i\,y)$