

**Práce se základními grafy
v programu *Mathematica***

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Struktura prezentace

Proč práce s grafy

Jak vkládat grafy

Základní typy grafů a jejich ukázka

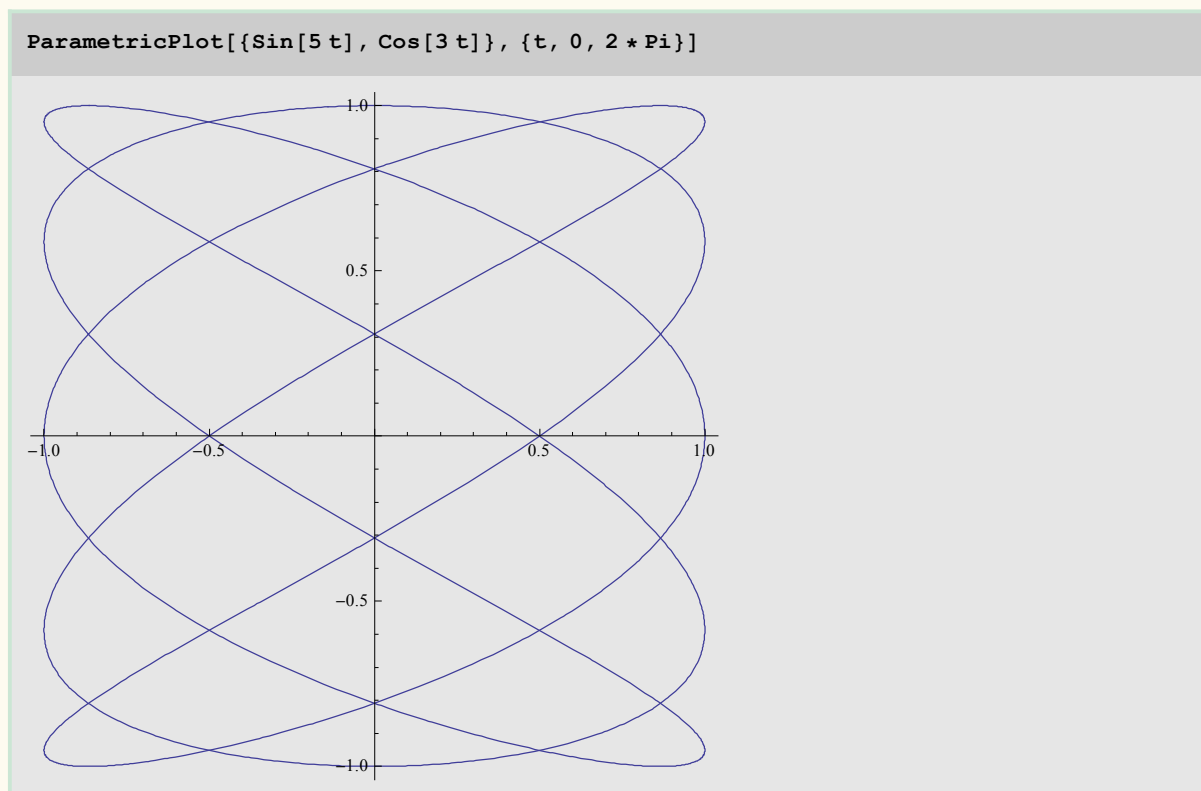
Nastavení grafů

Využití grafů při řešení úloh ve fyzice

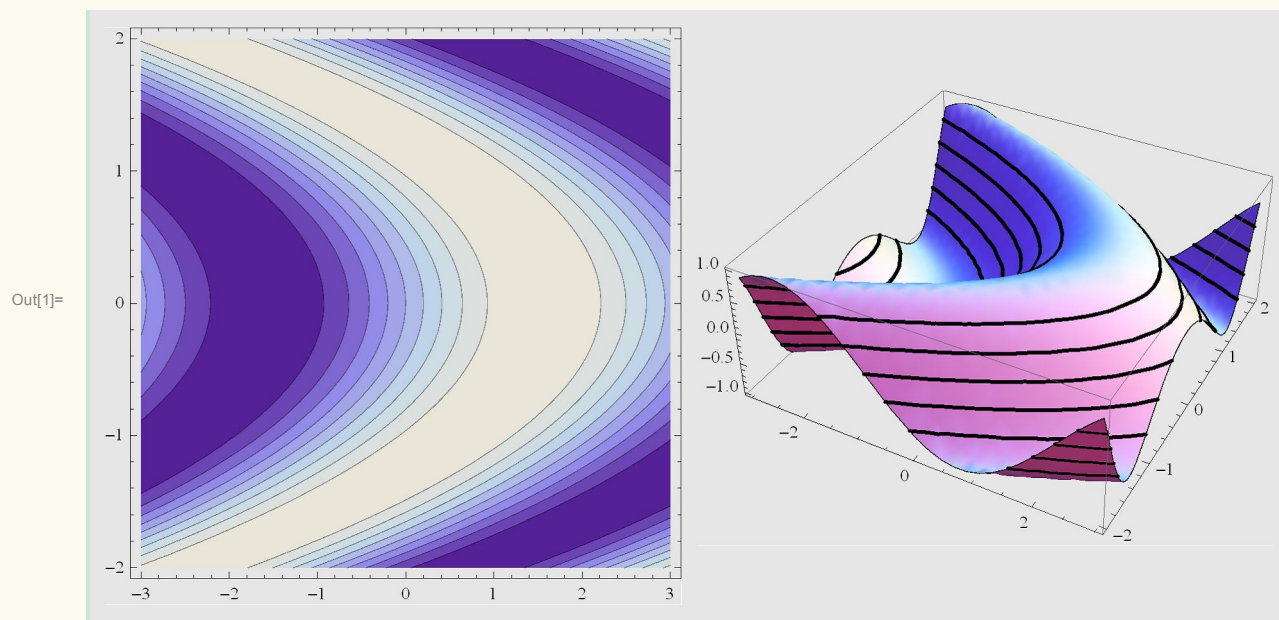
Jak na práci s grafy

Proč práce s grafy

Vizualizace již známých problémů



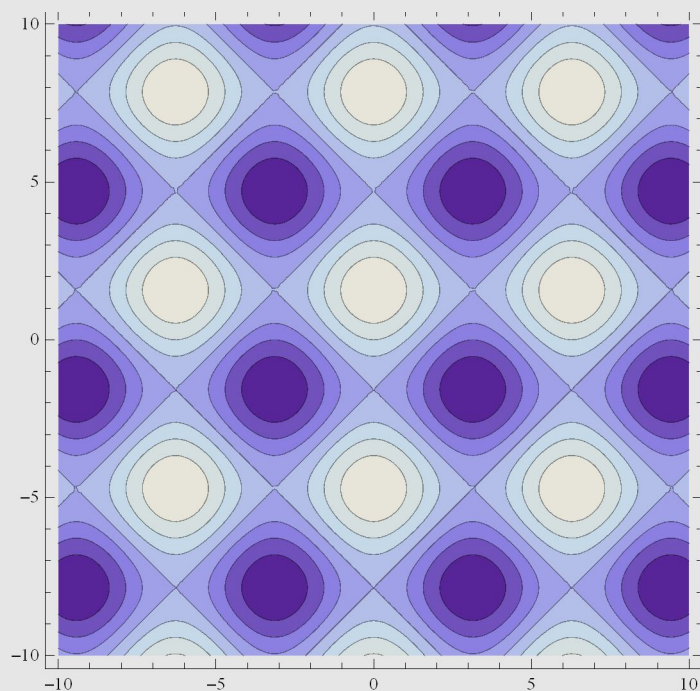
Jiný pohled na již známé věci, ale někdy i nový pohled na daný problém



Jak vkádat grafy

Pomocí příkazů

```
ContourPlot[Cos[x] + Sin[y], {x, -10, 10}, {y, -10, 10}]
```



Pomocí palet

```
Plot3D[function, {var1, min, max}, {var2, min, max}]
```

Pomocí Free Form

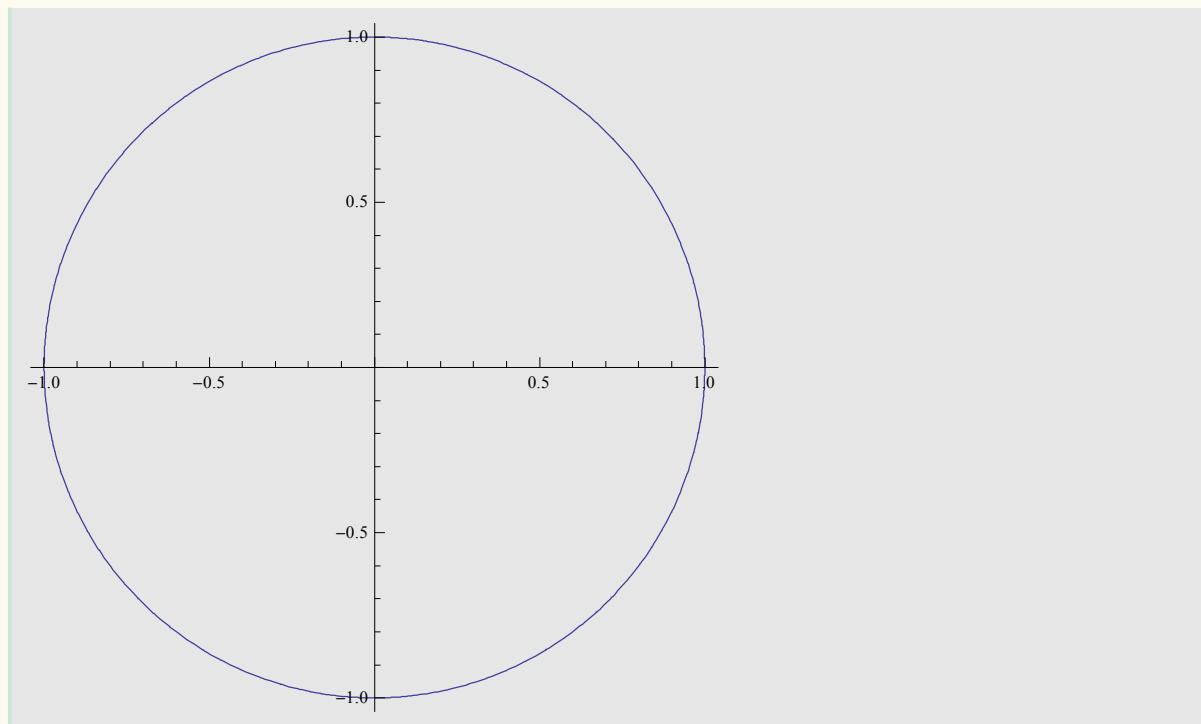


parametric plot {cos x, sin x}



↳ Parametric plot

```
ParametricPlot[{Cos[x], Sin[x]}, {x, 0, 2 * Pi}]
```

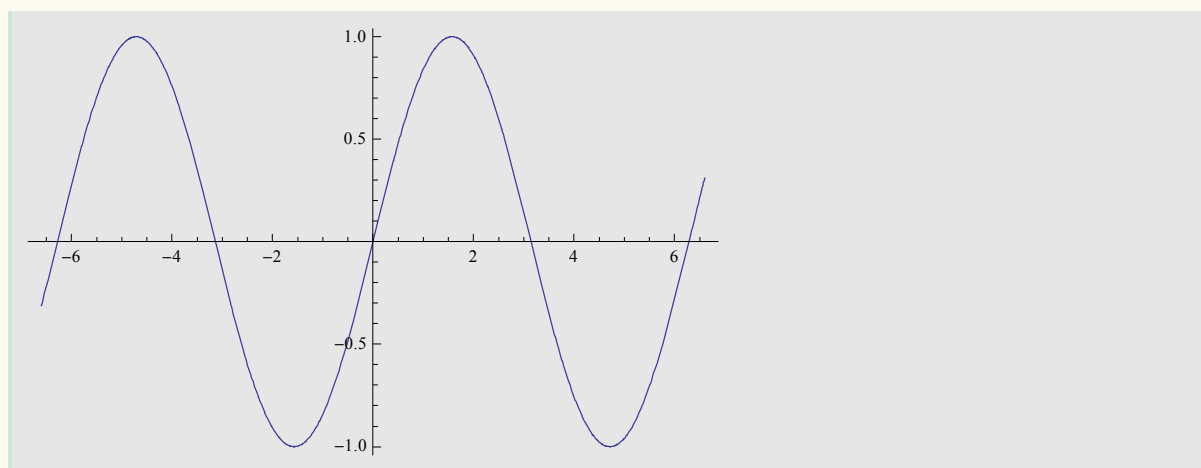


plot sin x



↳ Plots (1 of 2)

```
Plot[Sin[x], {x, -6.6, 6.6}]
```



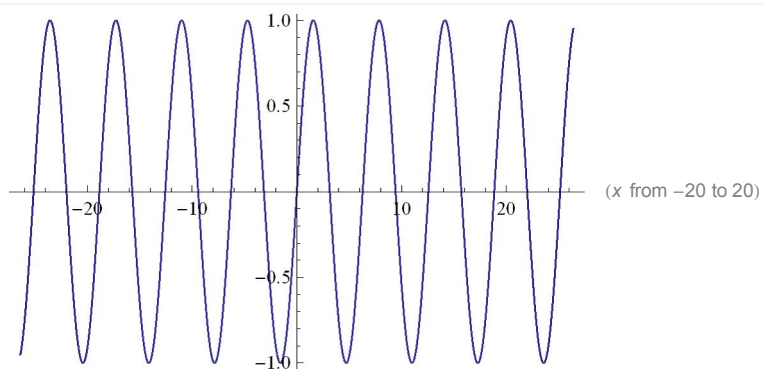
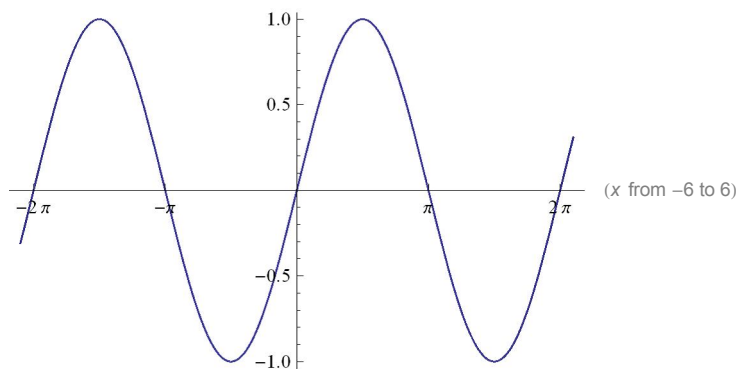
Pomocí www.wolframalpha.com

 plot sin x

Input interpretation:

plot sin(x)

Plots:



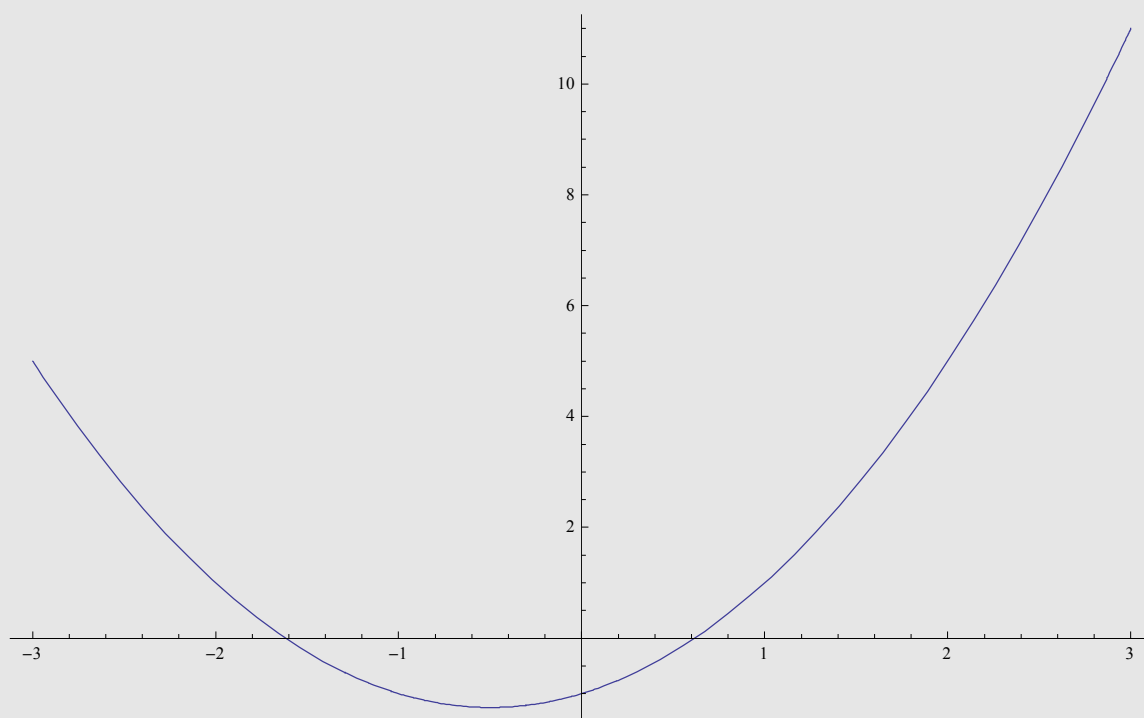
WolframAlpha 

```
{WolframAlpha["plot sin(x)", {"Plot", 1}, "Input"],
 WolframAlpha["plot sin(x)", {"Plot", 2}, "Input"]}
```

```
{HoldComplete[Plot[Sin[x], {x, -6.6, 6.6}]],
 HoldComplete[Plot[Sin[x], {x, -26, 26}]]}
```

Výrazy nebo funkce

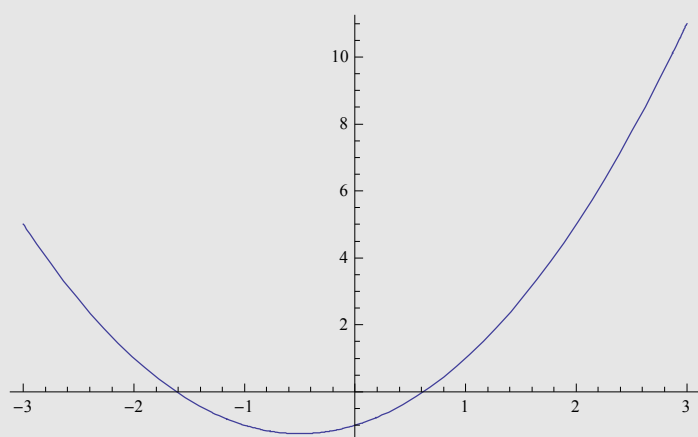
```
Plot[x2 + x - 1, {x, -3, 3}]
```



```
vyraz = x2 + x - 1
```

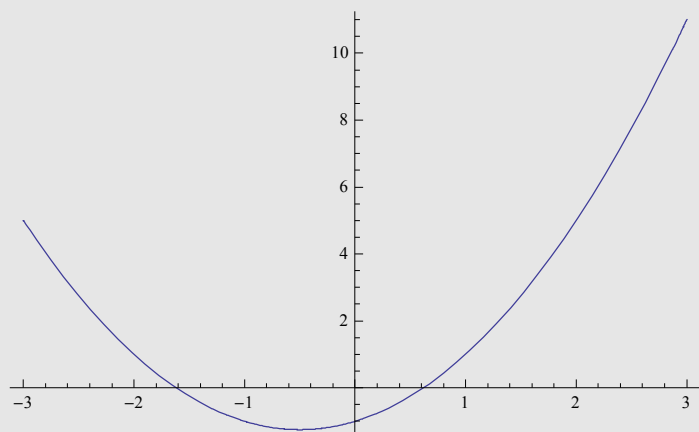
```
- 1 + x + x2
```

```
Plot[vyraz, {x, -3, 3}]
```



```
f[x_] := x2 + x - 1
```

```
Plot[f[x], {x, -3, 3}]
```



Grafy, Grafy, Grafy

? *Plot*

▼ System`

ArrayPlot	NyquistPlot
BodePlot	ParametricPlot
ContourPlot	ParametricPlot3D
ContourPlot3D	Plot
DateListLogPlot	Plot3D
DateListPlot	Plot3Matrix
DensityPlot	PlotDivision
DiscretePlot	PlotJoined
DiscretePlot3D	PlotLabel
GraphPlot	PlotLayout
GraphPlot3D	PlotMarkers
LayeredGraphPlot	PlotPoints
LineIntegralConvolutionPlot	PlotRange
ListContourPlot	PlotRangeClipping
ListContourPlot3D	PlotRangePadding
ListCurvePathPlot	PlotRegion
ListDensityPlot	PlotStyle
ListLineIntegralConvolutionPlot	PolarPlot
ListLinePlot	ProbabilityPlot
ListLogLinearPlot	ProbabilityScalePlot
ListLogLogPlot	QuantilePlot
ListLogPlot	RegionPlot
ListPlot	RegionPlot3D
ListPlot3D	ReliefPlot
ListPointPlot3D	RevolutionPlot3D
ListPolarPlot	RootLocusPlot
ListStreamDensityPlot	SingularValuePlot
ListStreamPlot	SphericalPlot3D
ListSurfacePlot3D	StreamDensityPlot
ListVectorDensityPlot	StreamPlot
ListVectorPlot	TreePlot
ListVectorPlot3D	VectorDensityPlot
LogLinearPlot	VectorPlot
LogLogPlot	VectorPlot3D
LogPlot	WaveletImagePlot
MatrixPlot	WaveletListPlot
MaxPlotPoints	WaveletMatrixPlot
NicholsPlot	

`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 . >>

? *Chart*

▼ System`

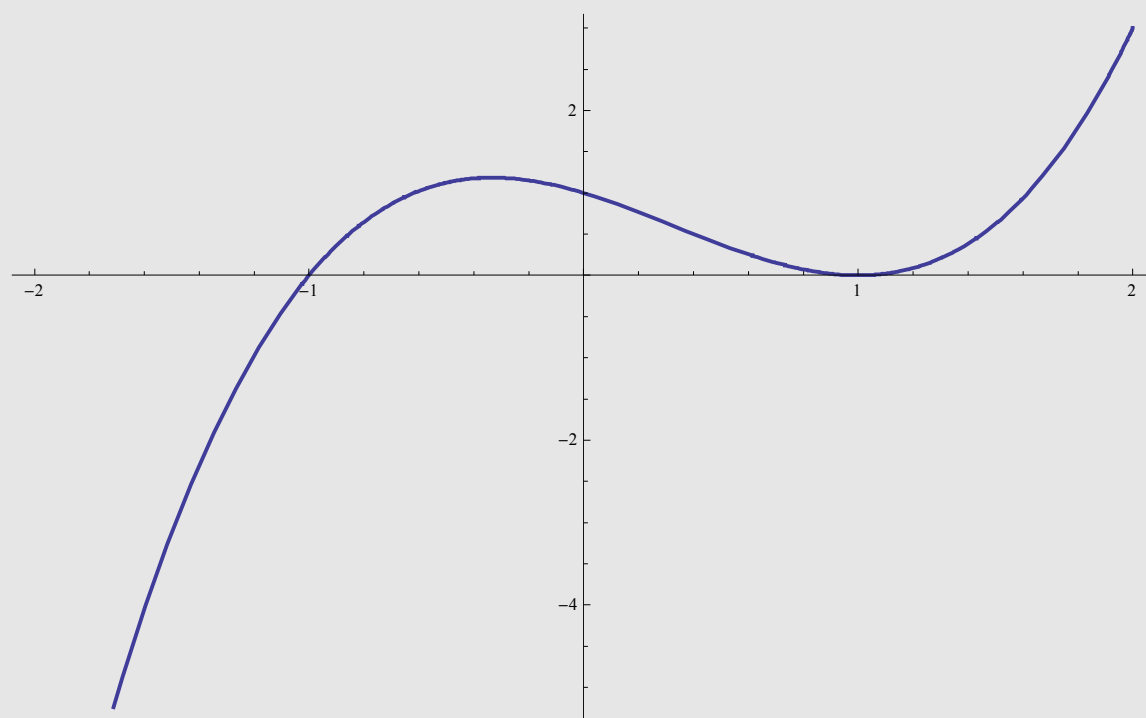
BarChart	ChartBaseStyle	ChartLayout	LineBreakChart	RectangleChart3D
BarChart3D	ChartElementData	ChartLegends	PairedBarChart	RenkoChart
BoxWhiskerChart	ChartElementDataFunction	ChartStyle	PieChart	SectorChart
BubbleChart	ChartElementFunction	DistributionChart	PieChart3D	SectorChart3D
BubbleChart3D	ChartElements	InteractiveTradingChart	PointFigureChart	TradingChart
CandlestickChart	ChartLabels	KagiChart	RectangleChart	

ChartLabels is an option for charting functions that specifies what labels should be used for chart elements. >>

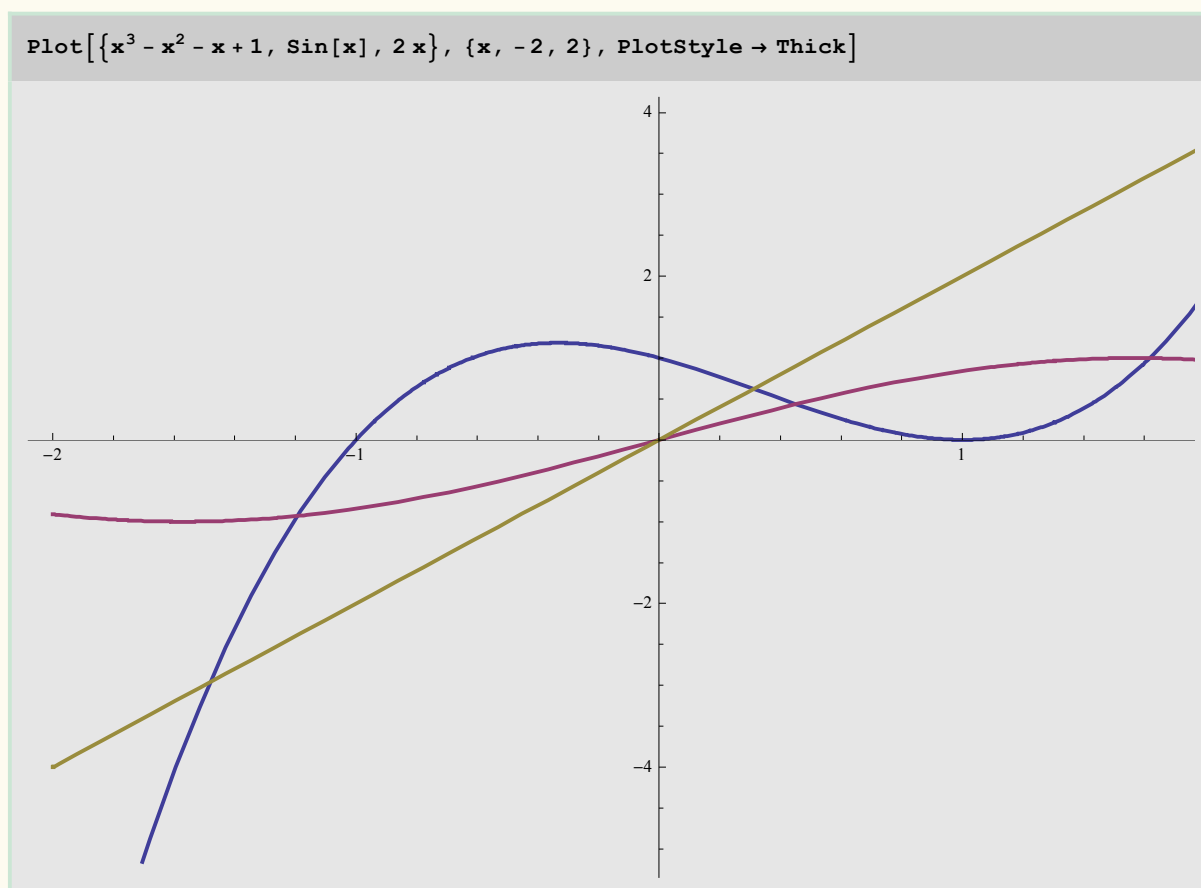
2D Grafy

Zobrazujeme “pěkné” funkce - příkaz Plot

```
Plot[x3 - x2 - x + 1, {x, -2, 2}, PlotStyle -> Thick]
```

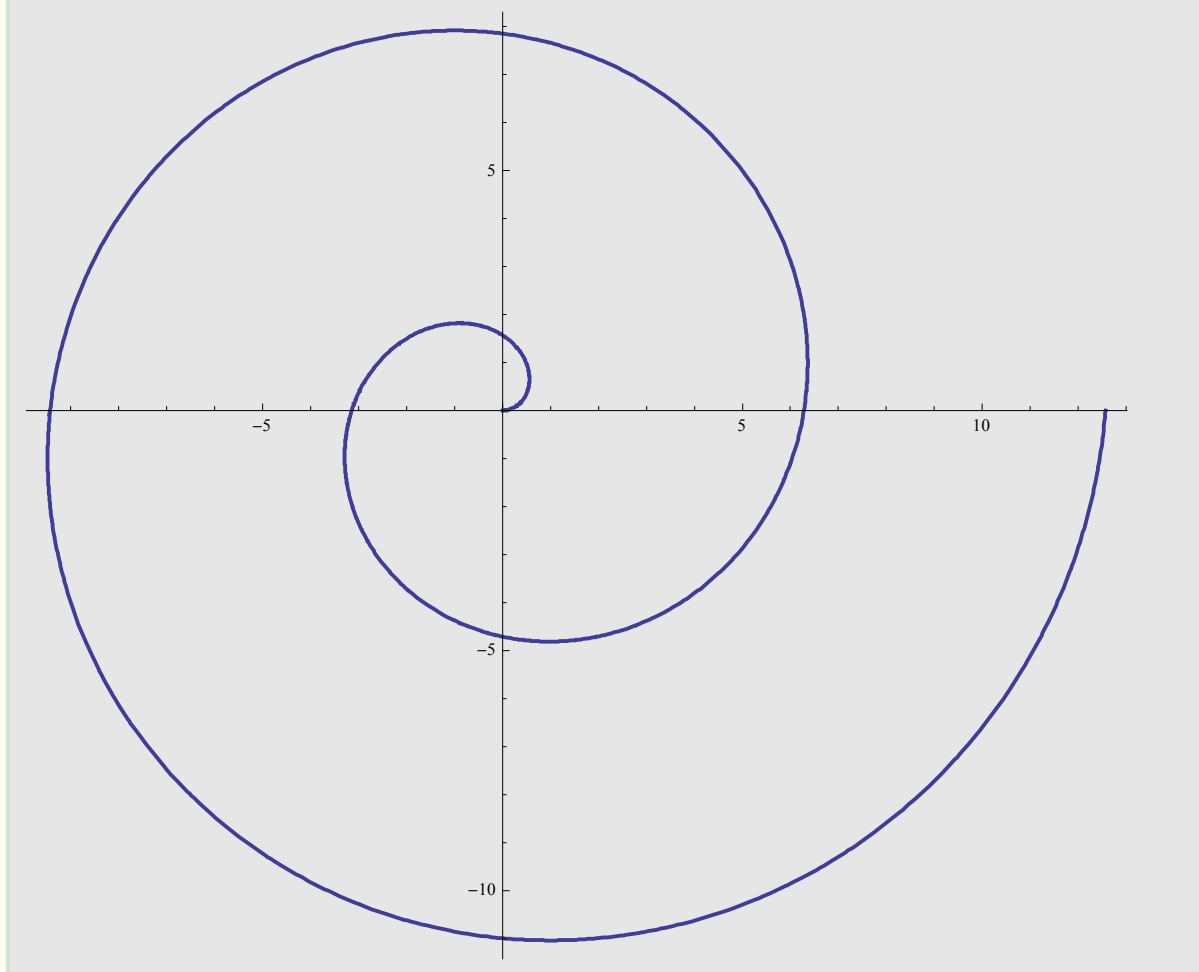


```
{1, 2, 3}
```



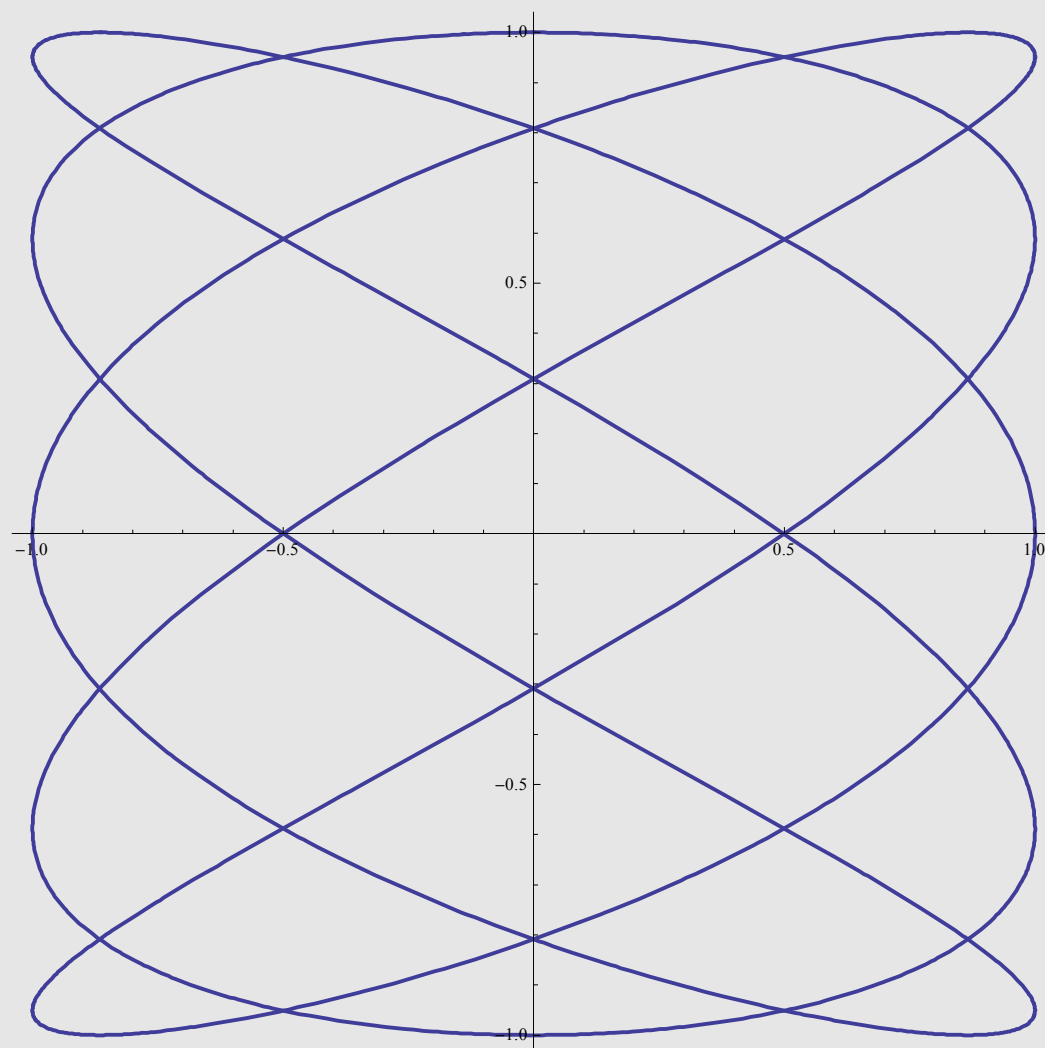
Polární graf

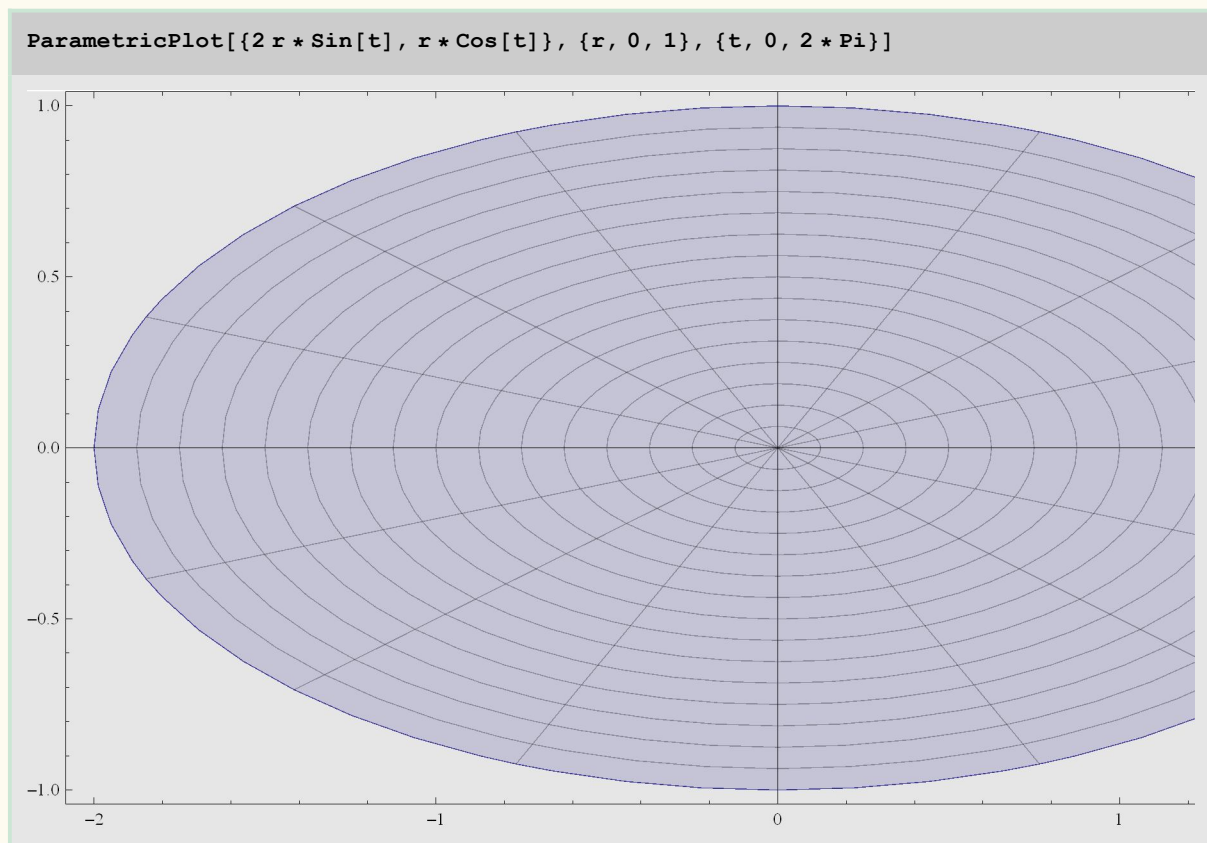
```
PolarPlot[ $\varphi$ , { $\varphi$ , 0, 4 *  $\pi$ }, PlotStyle  $\rightarrow$  Thick]
```



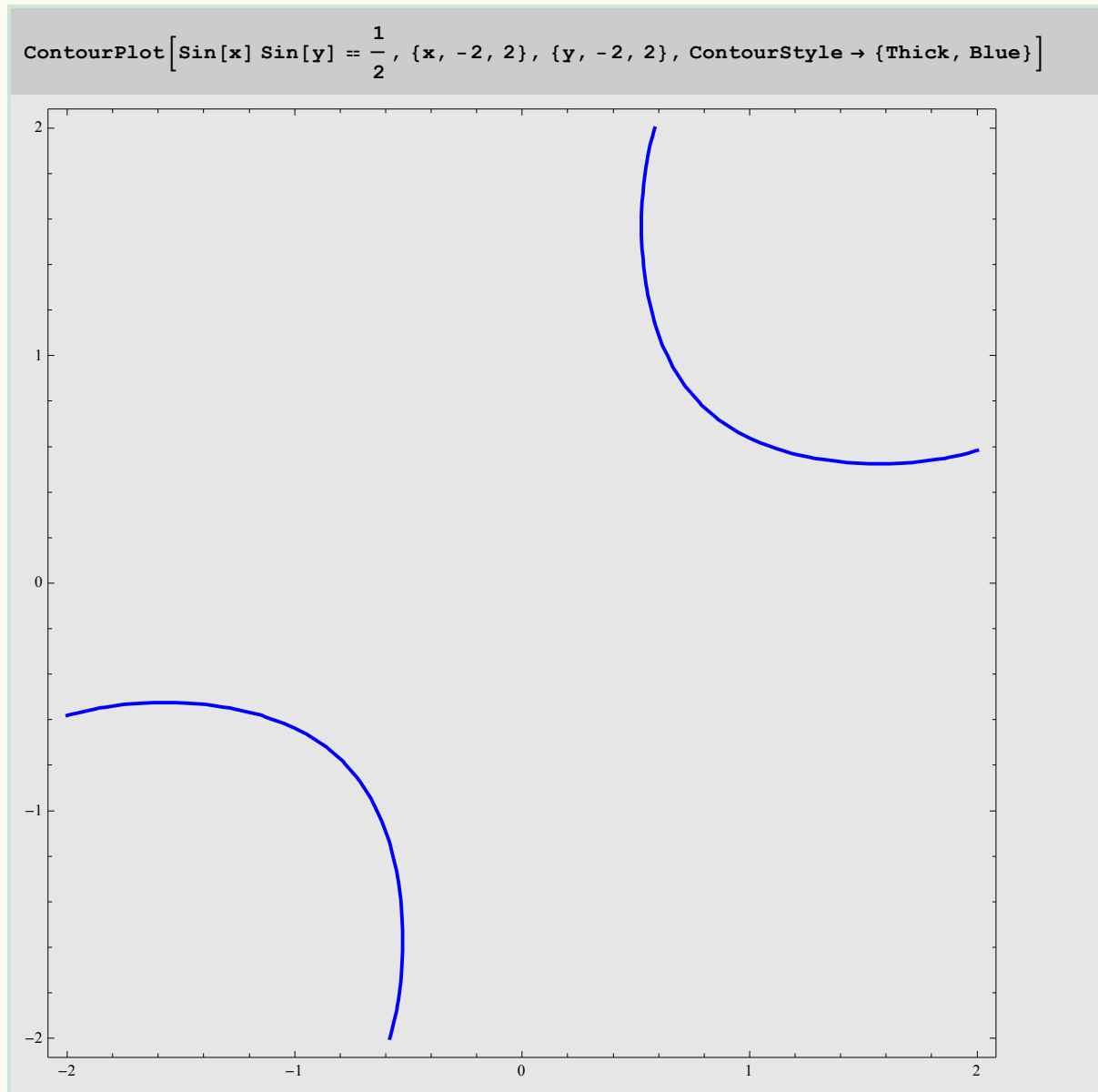
Grafy křivek a ploch zadaných parametricky

```
ParametricPlot[{Sin[5 t], Cos[3 t]}, {t, 0, 2 * Pi}, PlotStyle -> Thick]
```

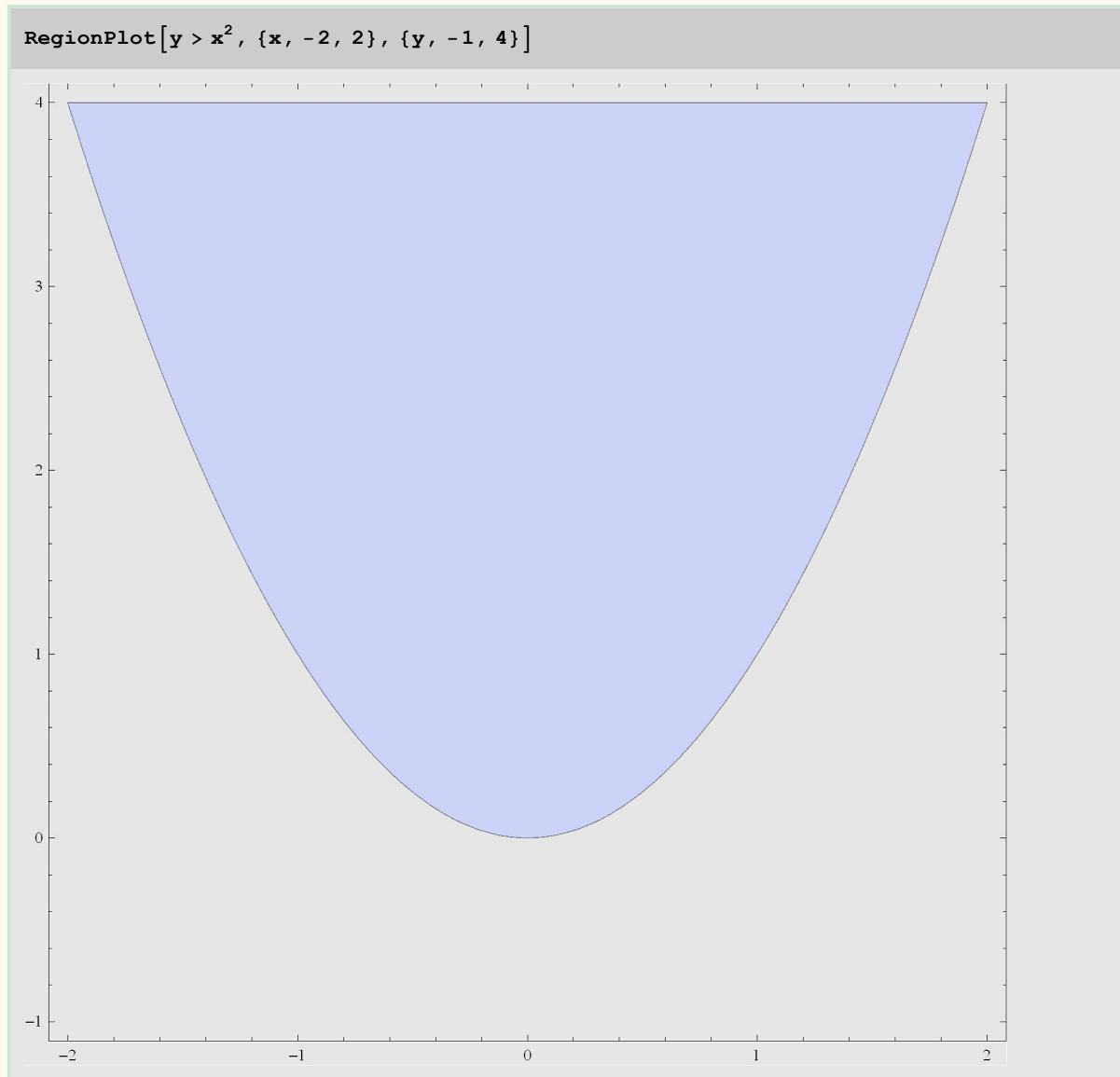


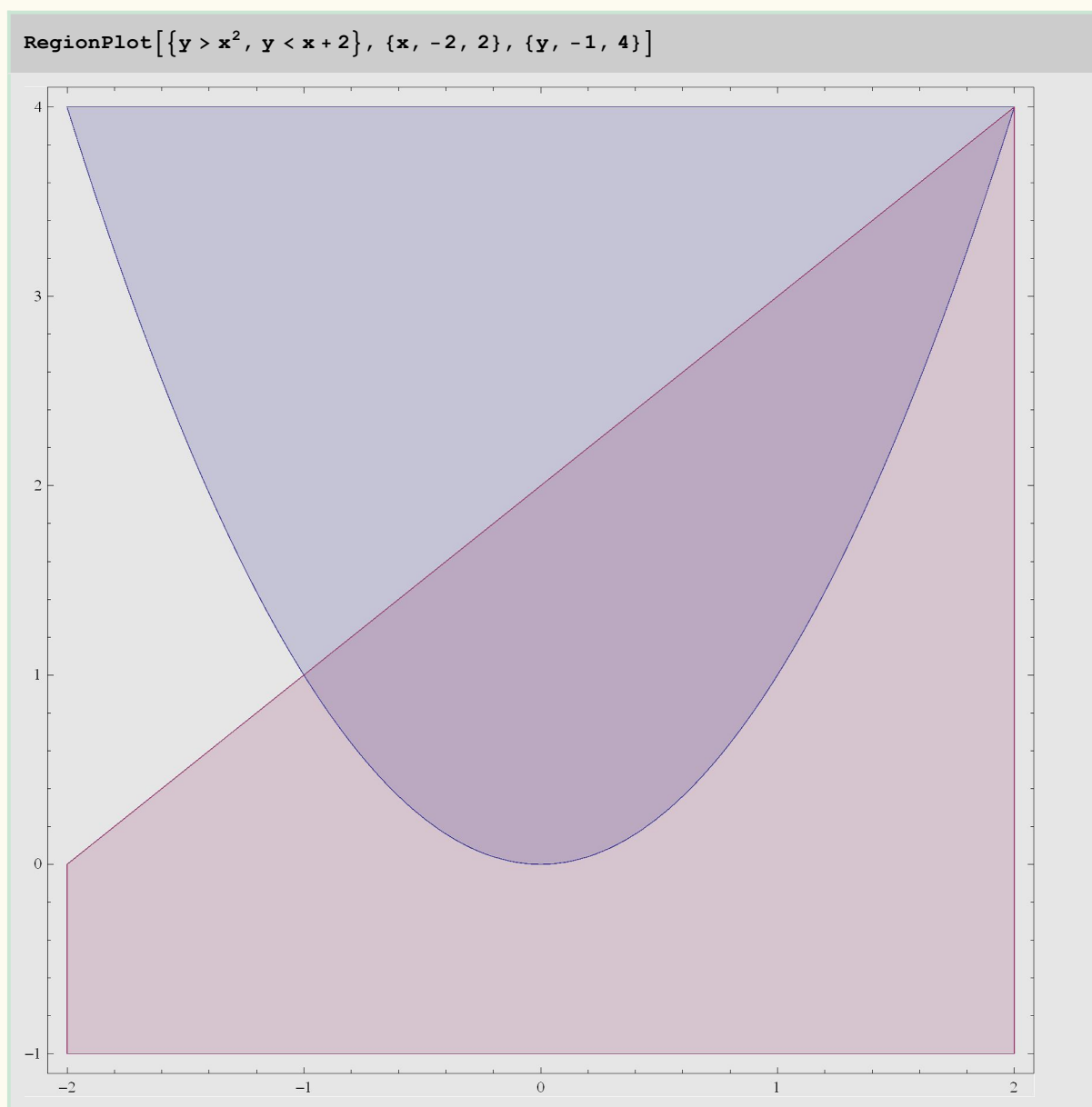


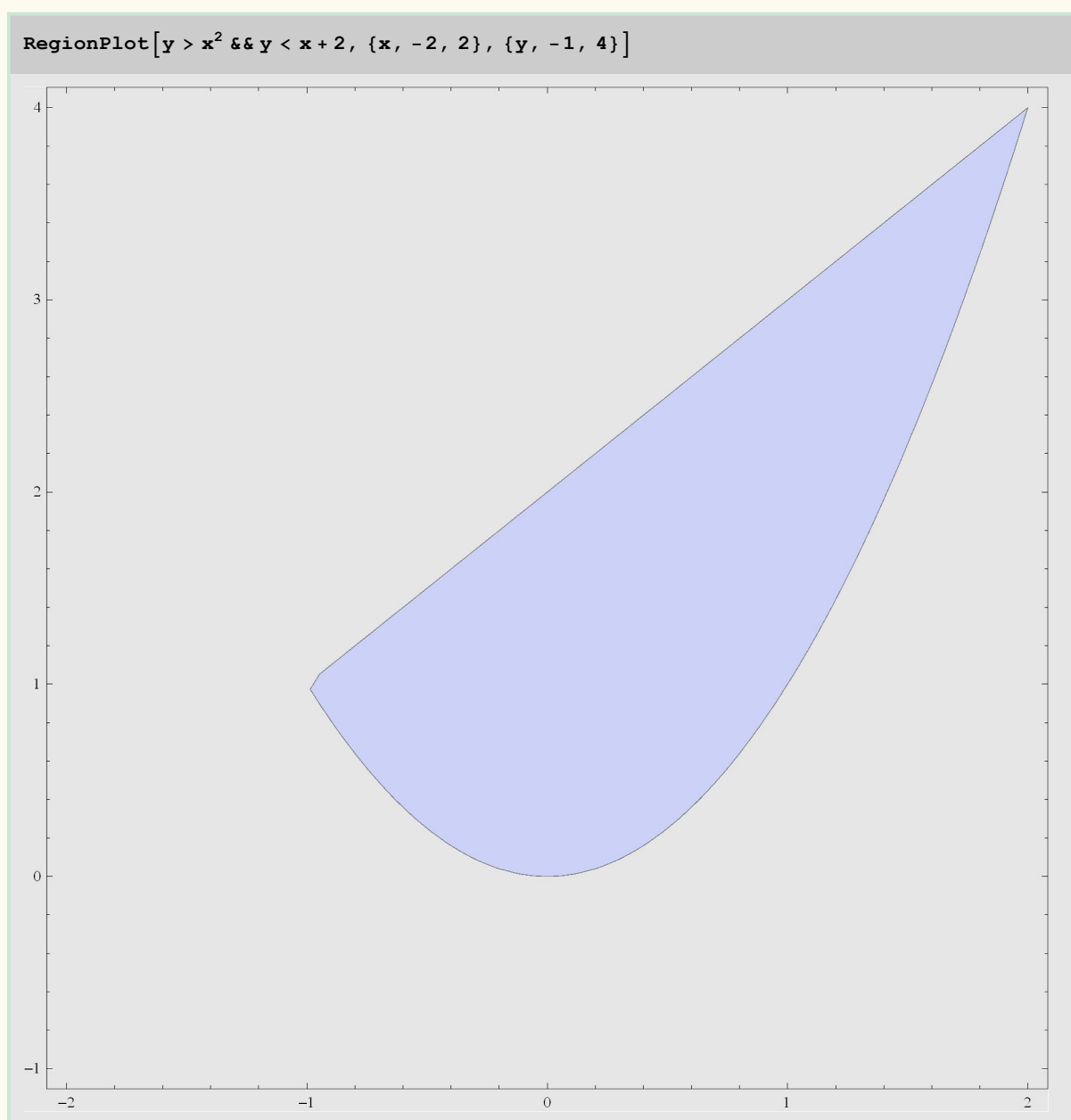
Graf funkce zadané implicitně



Zobrazujeme oblasti - RegionPlot







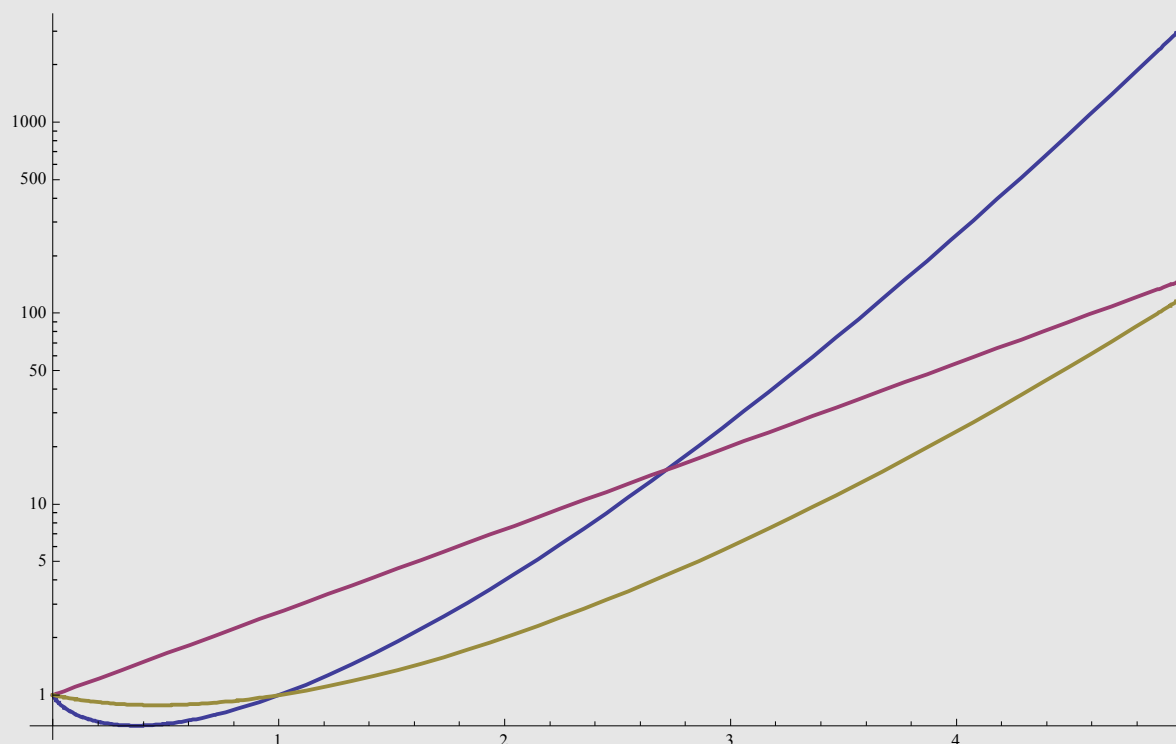
Zobrazení dat na velkých škálách

? Plot

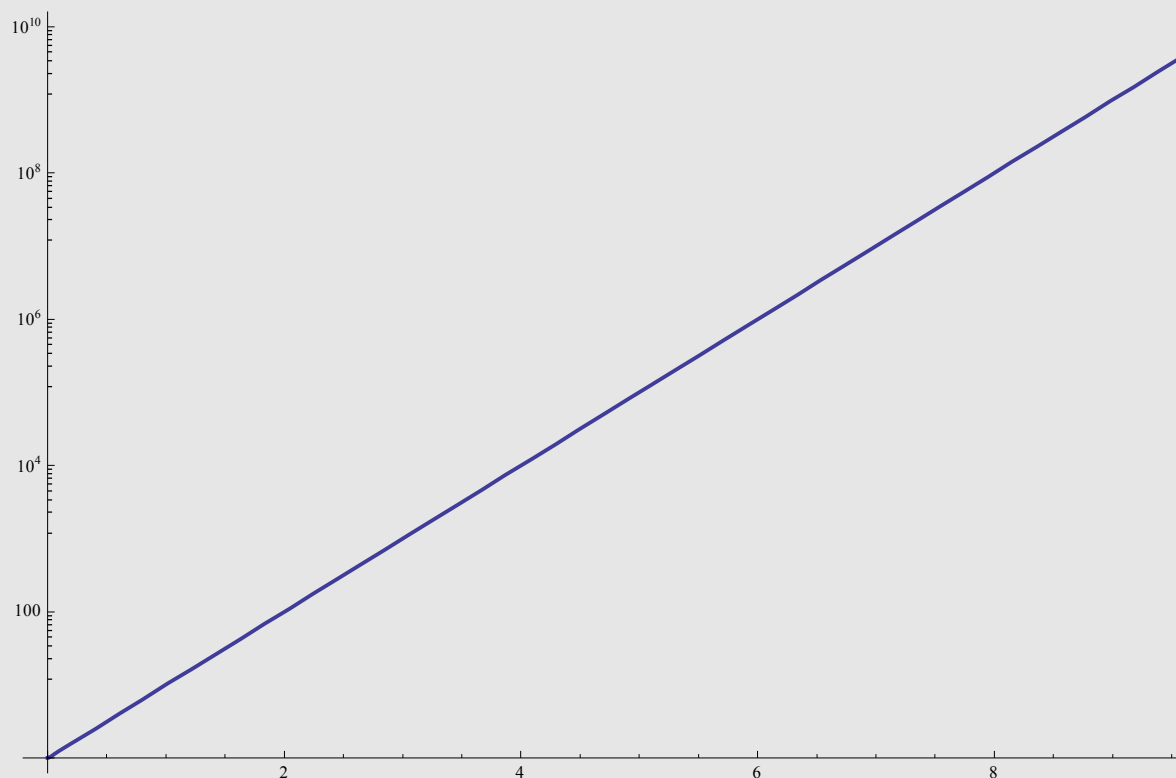
`Plot[f, {x, xmin, xmax}]` generates a plot of f as a function of x from x_{min} to x_{max} .

`Plot[{f1, f2, ...}, {x, xmin, xmax}]` plots several functions f_i . >>

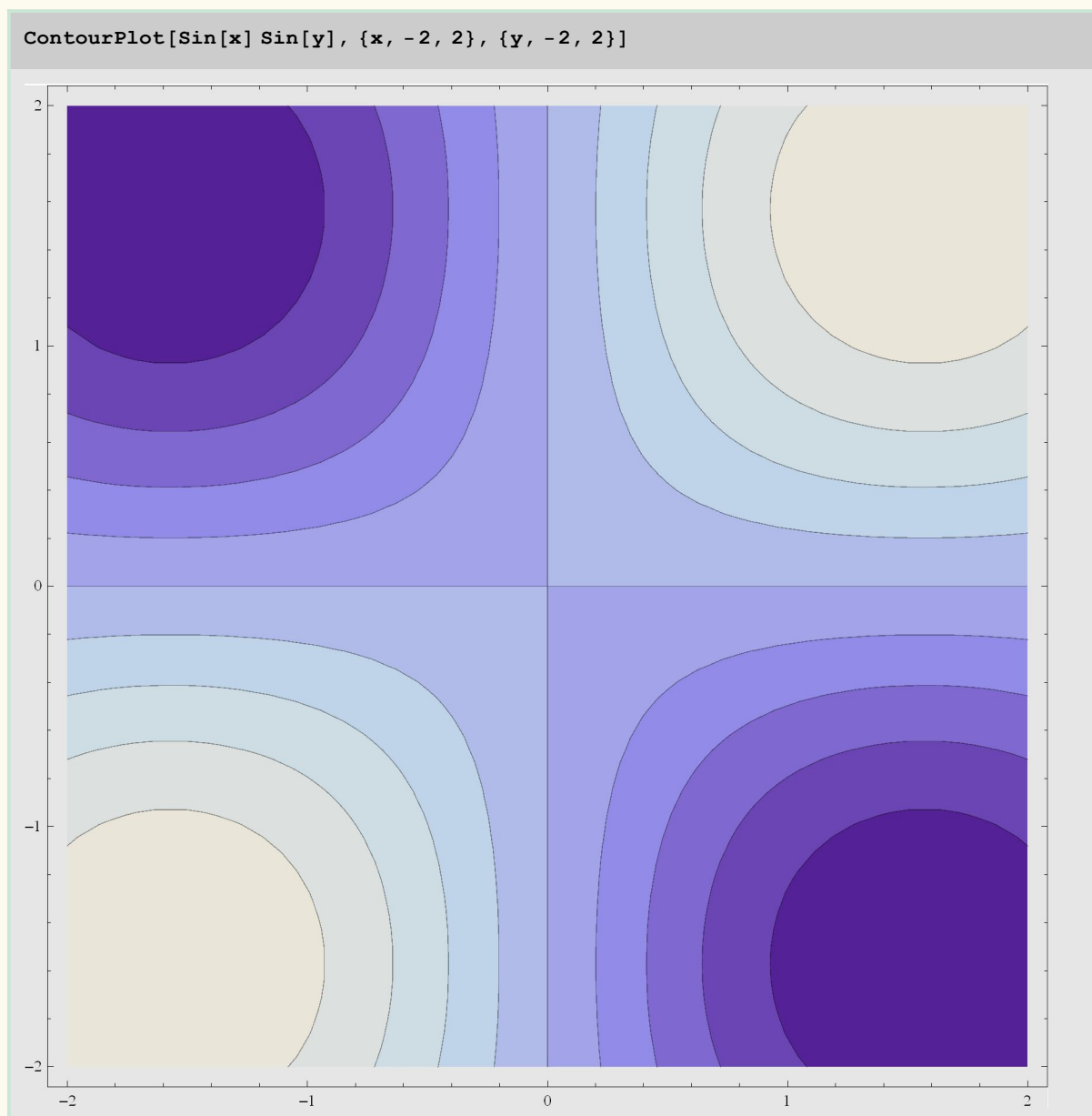
```
LogPlot[{x^x, Exp[x], x!}, {x, 0, 5}, PlotStyle -> Thick, PlotRange -> Full]
```

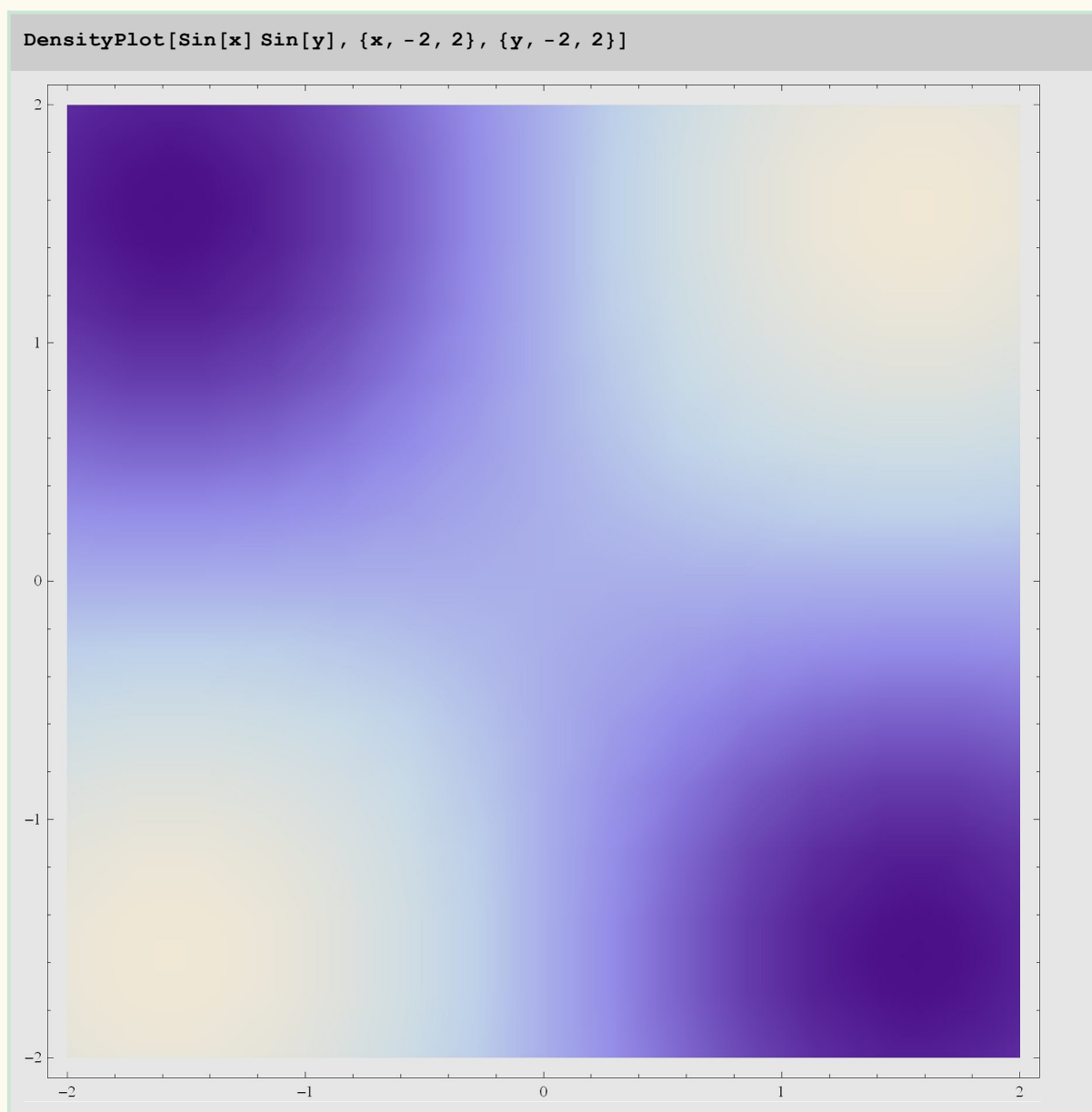


```
LogPlot[{10^x}, {x, 0, 10}, PlotStyle -> Thick, PlotRange -> Full]
```



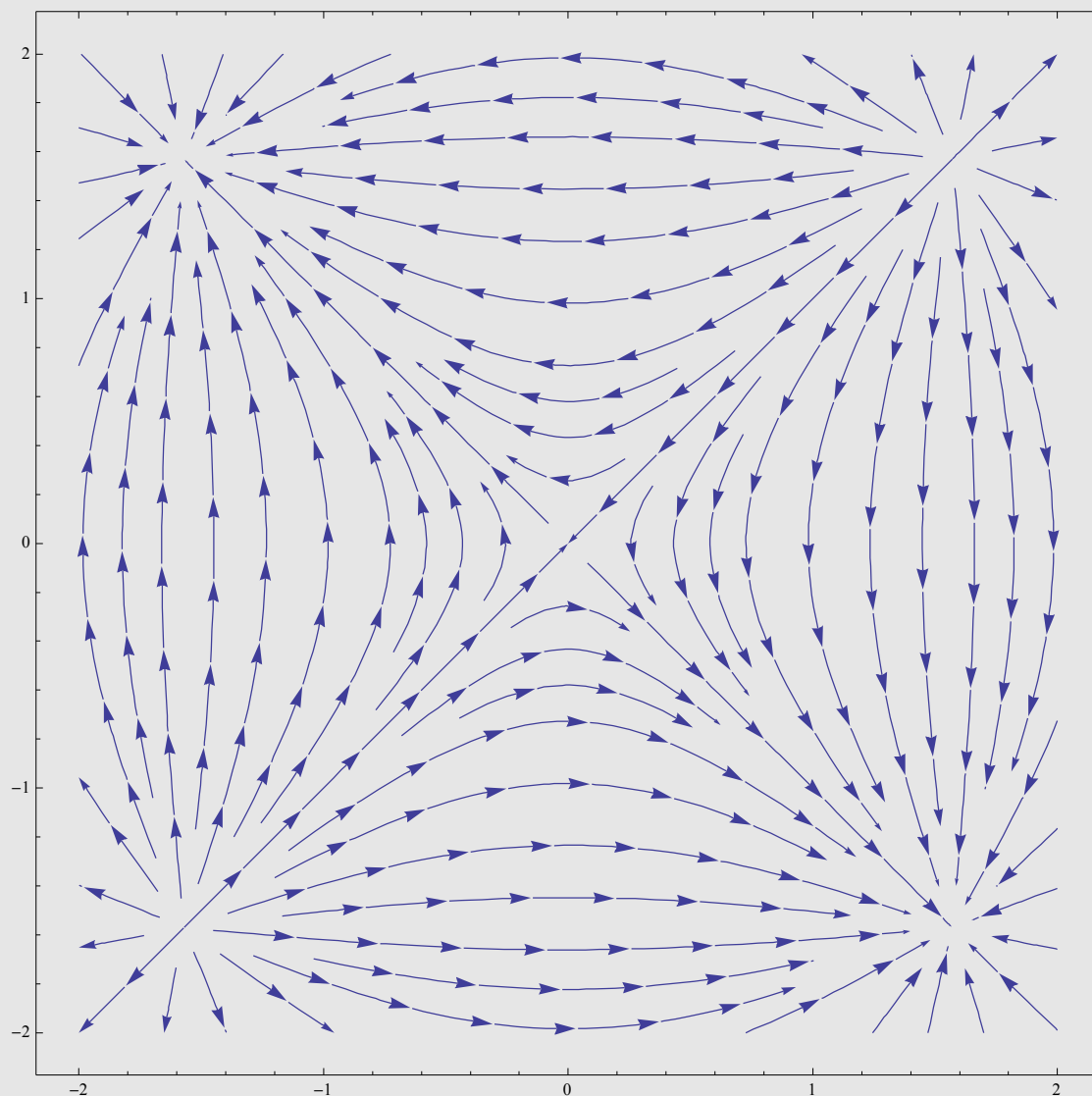
Zobrazení ekvipotenciál - Contour Plot II



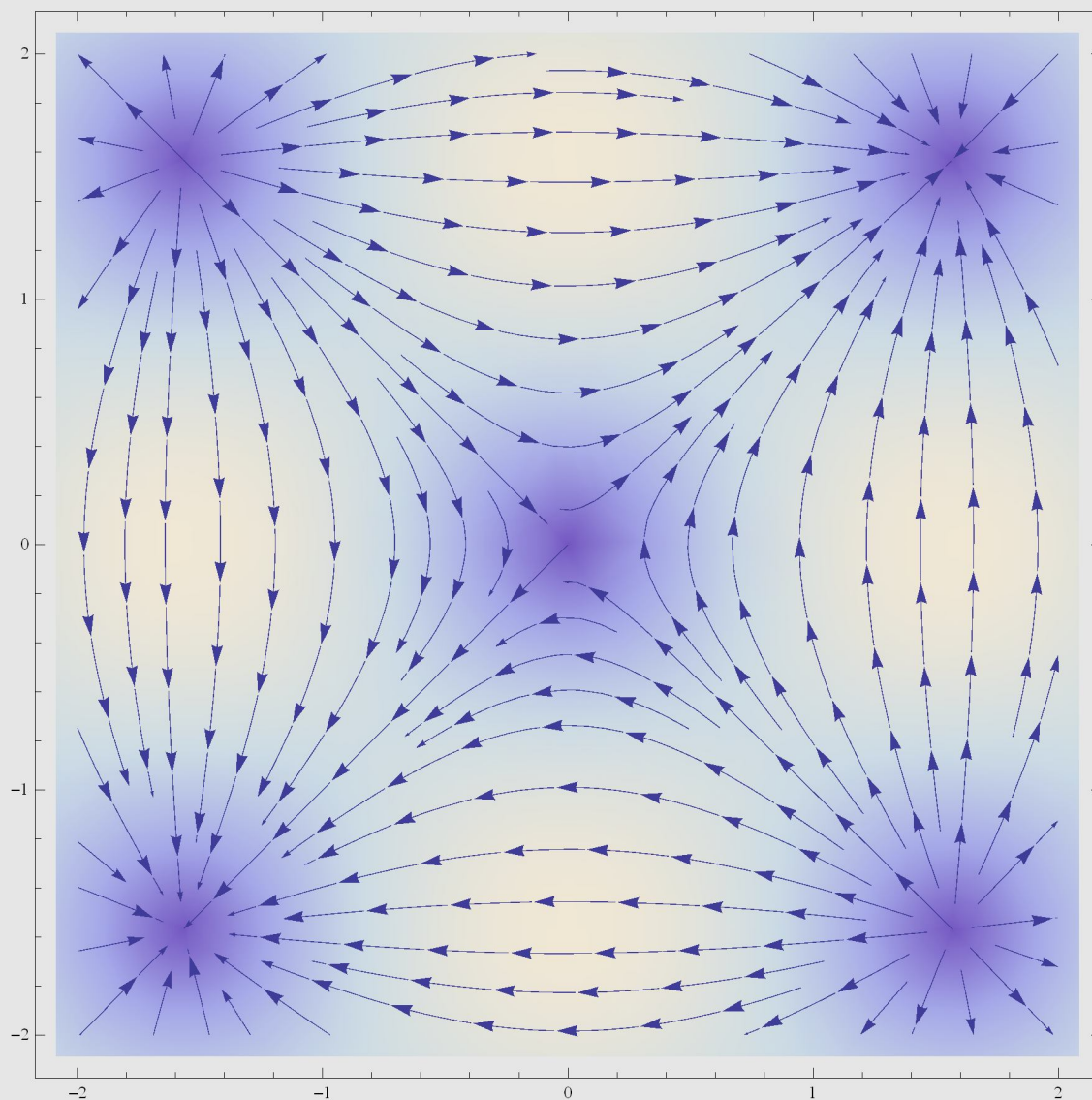


Zobrazujeme proudnice

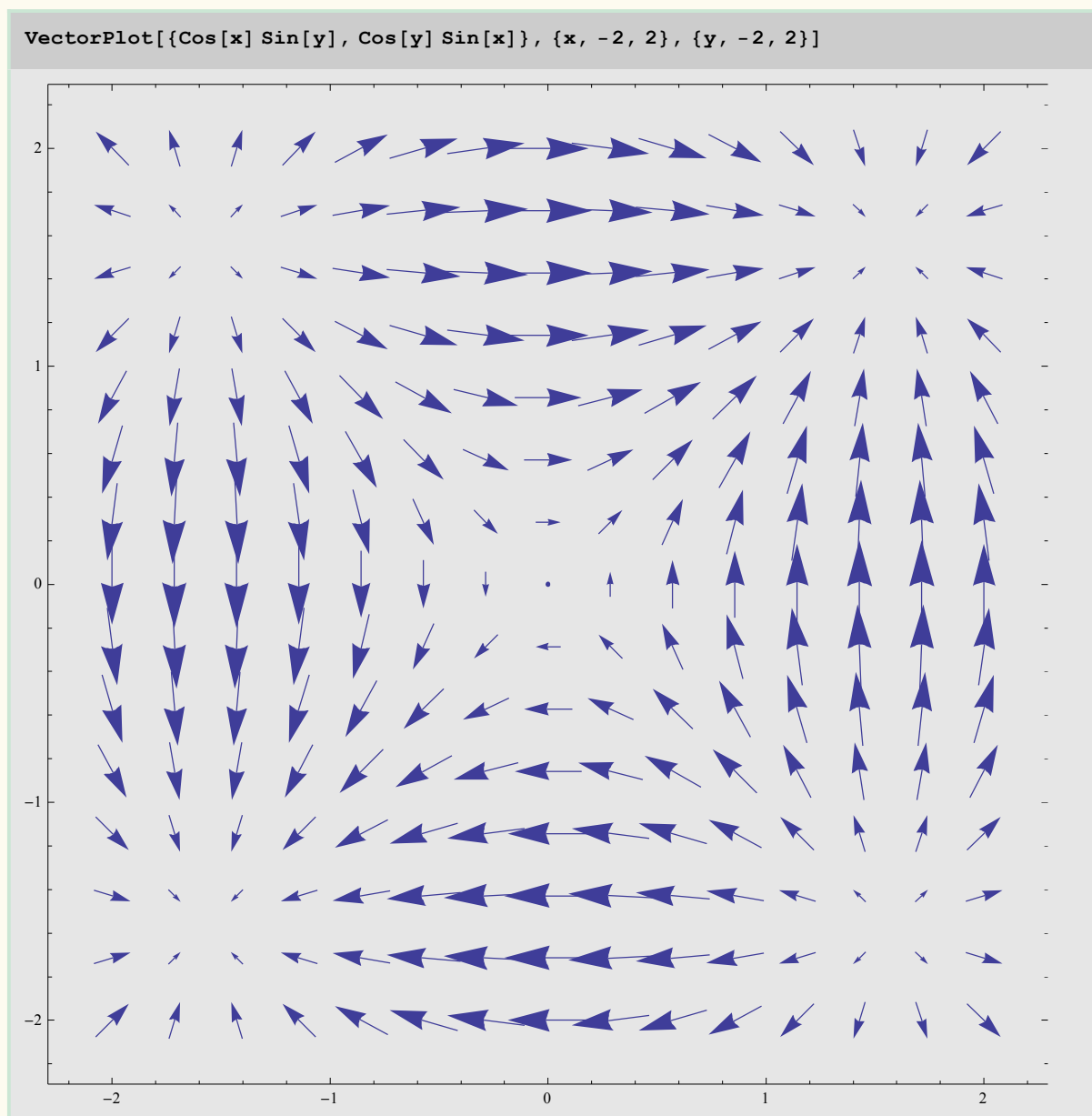
```
StreamPlot[-{Cos[x] Sin[y], Cos[y] Sin[x]}, {x, -2, 2}, {y, -2, 2}]
```



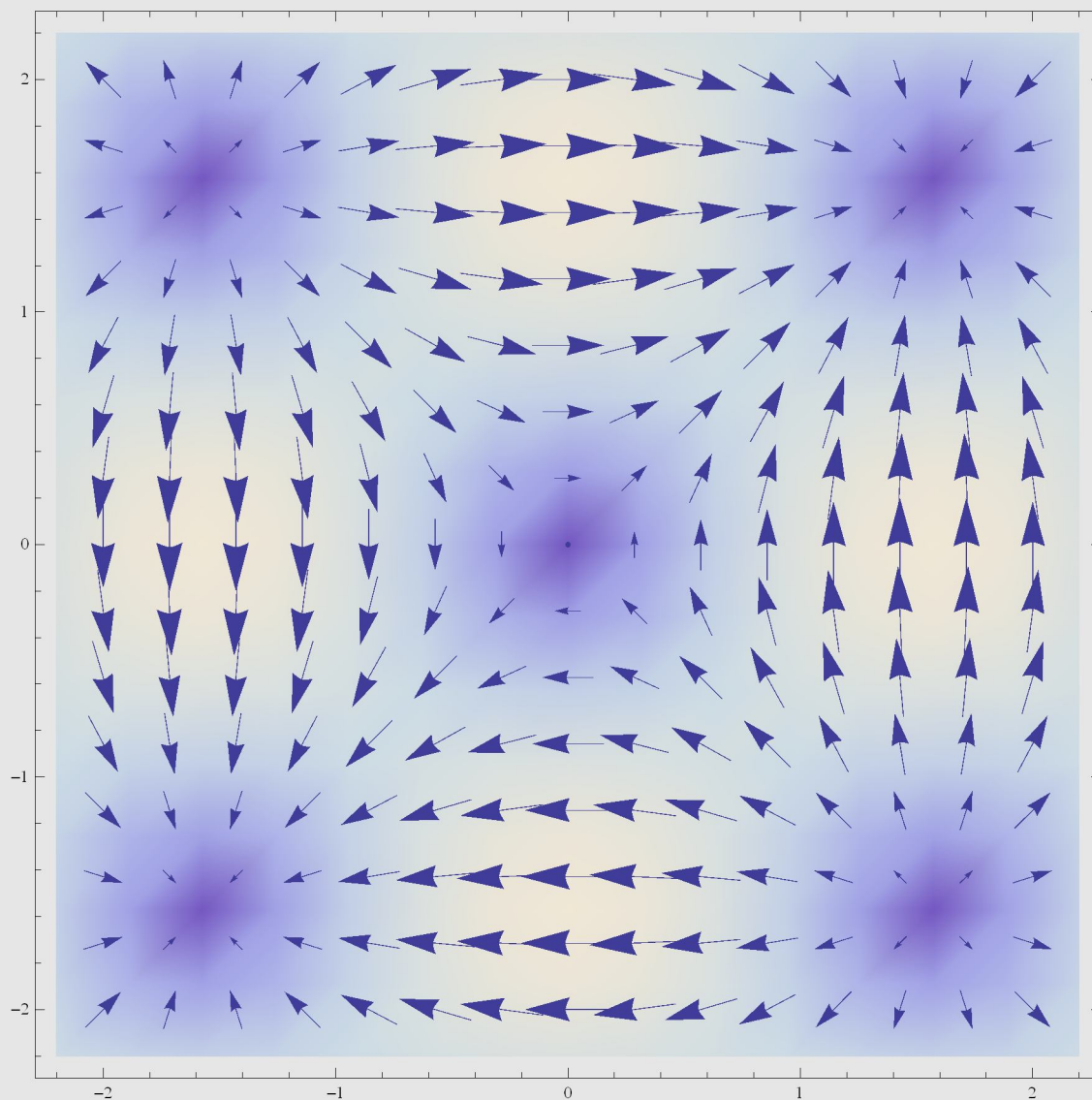
```
StreamDensityPlot[{Cos[x] Sin[y], Cos[y] Sin[x]}, {x, -2, 2}, {y, -2, 2}]
```



Zobrazujeme vektorové pole



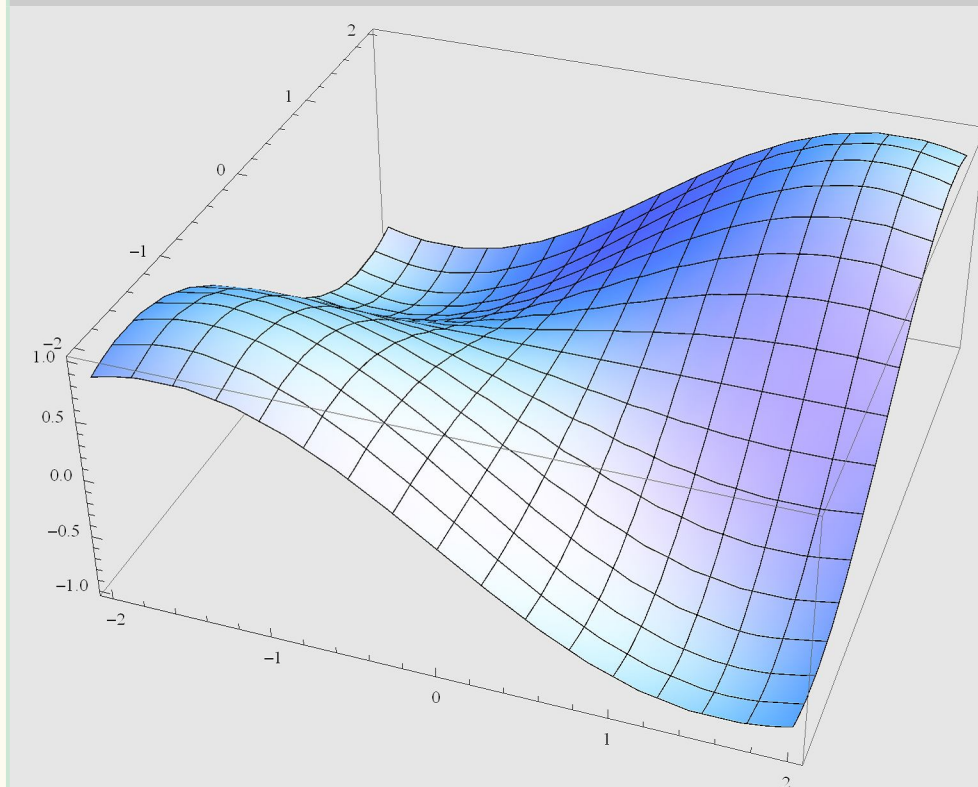
```
VectorDensityPlot[{Cos[x] Sin[y], Cos[y] Sin[x]}, {x, -2, 2}, {y, -2, 2}]
```



3D grafy

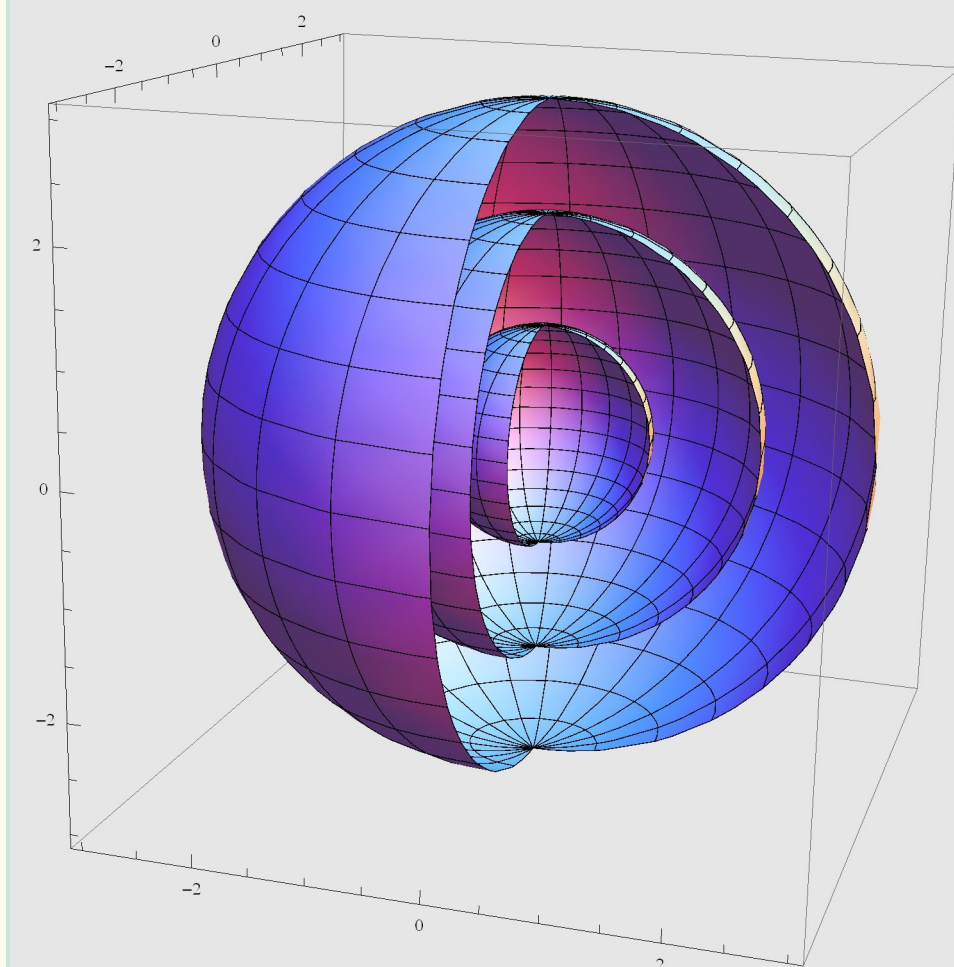
Funkce dvou proměnných

```
Plot3D[Sin[x] Sin[y], {x, -2, 2}, {y, -2, 2}]
```

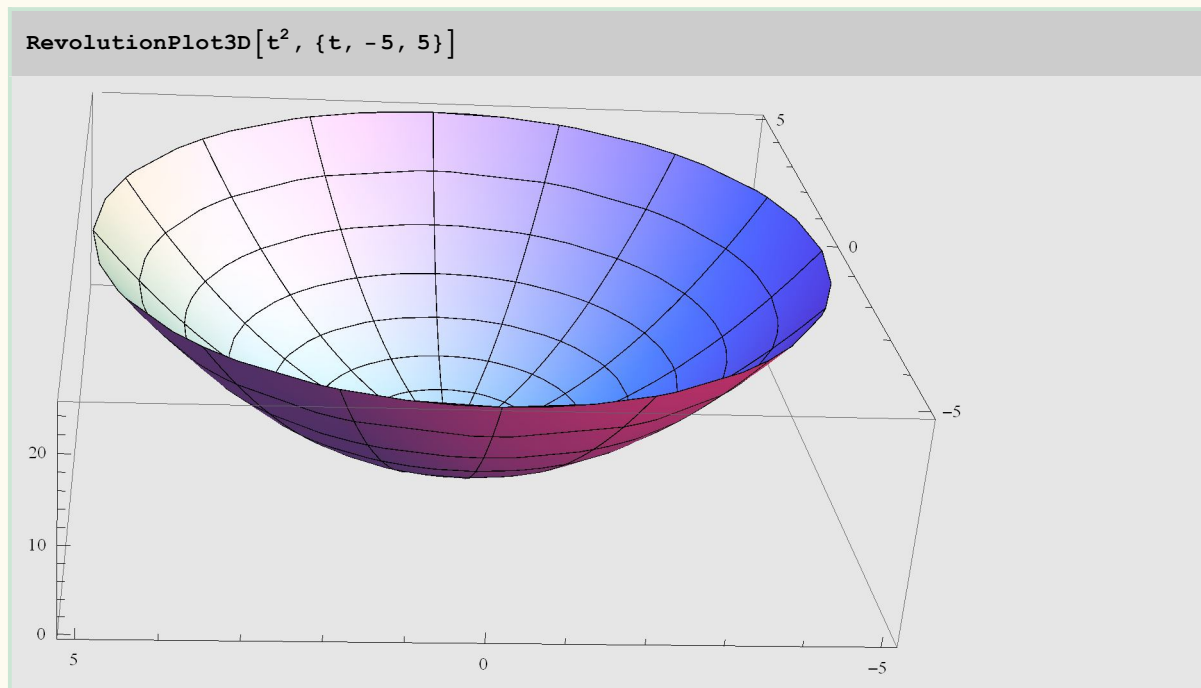


Sférický graf

```
SphericalPlot3D[{1, 2, 3}, { $\theta$ , 0,  $\text{Pi}$ }, { $\phi$ , 0,  $3 \text{ Pi} / 2$ }]
```

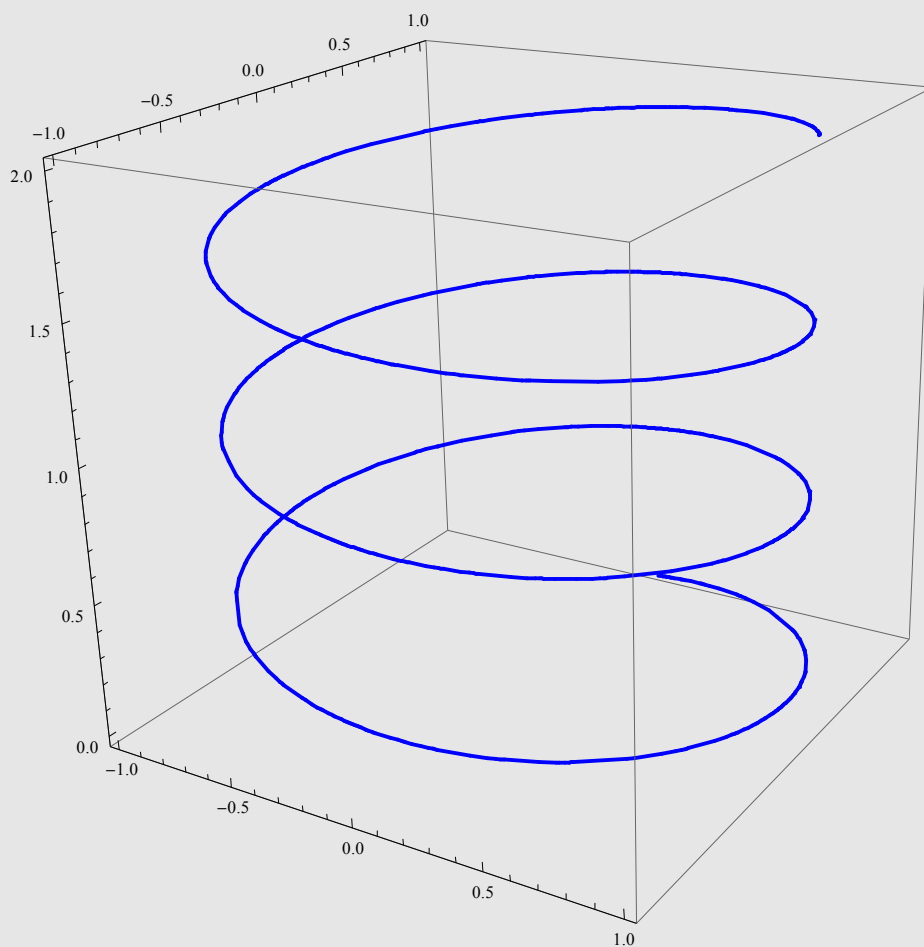


Zobrazování rotačně symetrických objektů

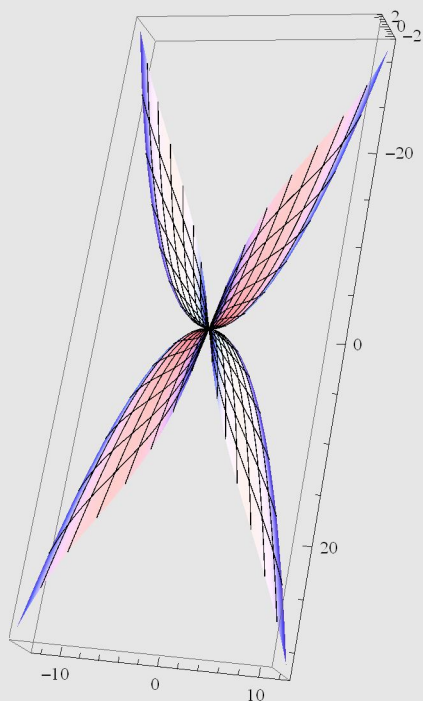


Grafy křivek a ploch zadanych parametricky 3D

```
ParametricPlot3D[{Sin[u], Cos[u], u / 10}, {u, 0, 20}, PlotStyle -> {Thick, Blue}]
```

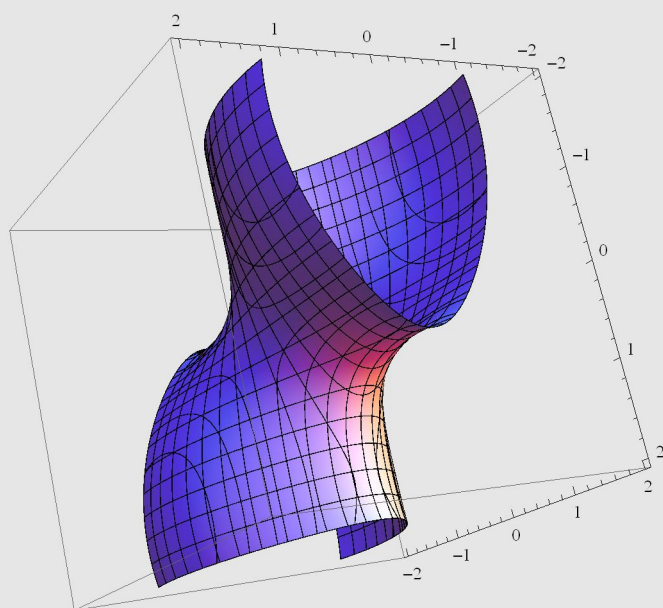


```
ParametricPlot3D[{u * Sin[t], t * u^2, u * t}, {t, -5, 5}, {u, -2.5, 2.5}]
```



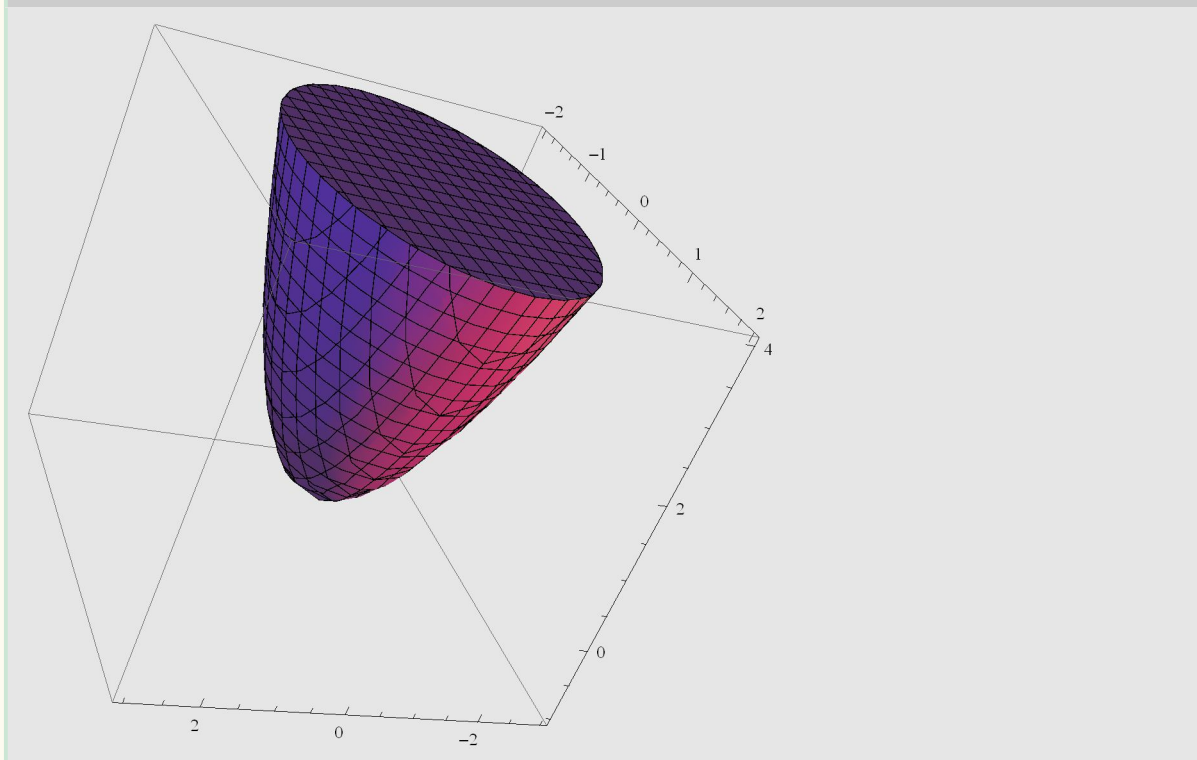
Graf funkce zadané implicitně 3D

```
ContourPlot3D[Sin[x] Sin[y] + z^2 == 1/2, {x, -2, 2}, {y, -2, 2}, {z, -2, 2}]
```

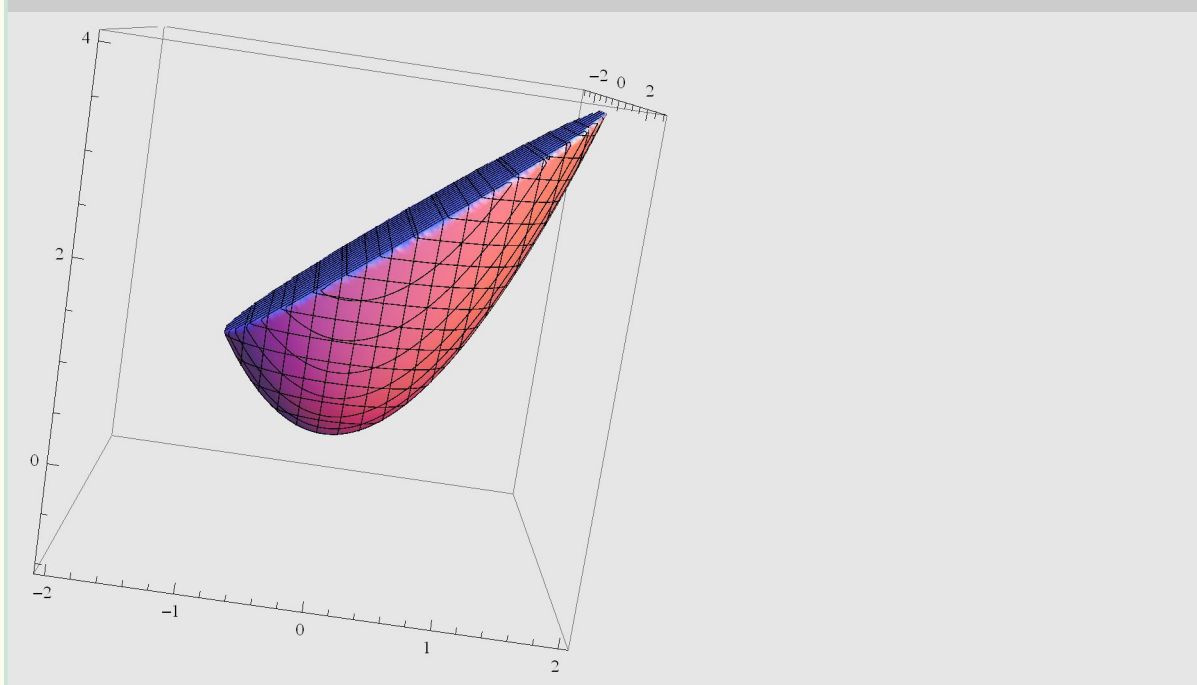


Zobrazujeme oblasti 3D

```
RegionPlot3D[y > x^2 + z^2, {x, -2, 2}, {y, -1, 4}, {z, -3, 3}]
```

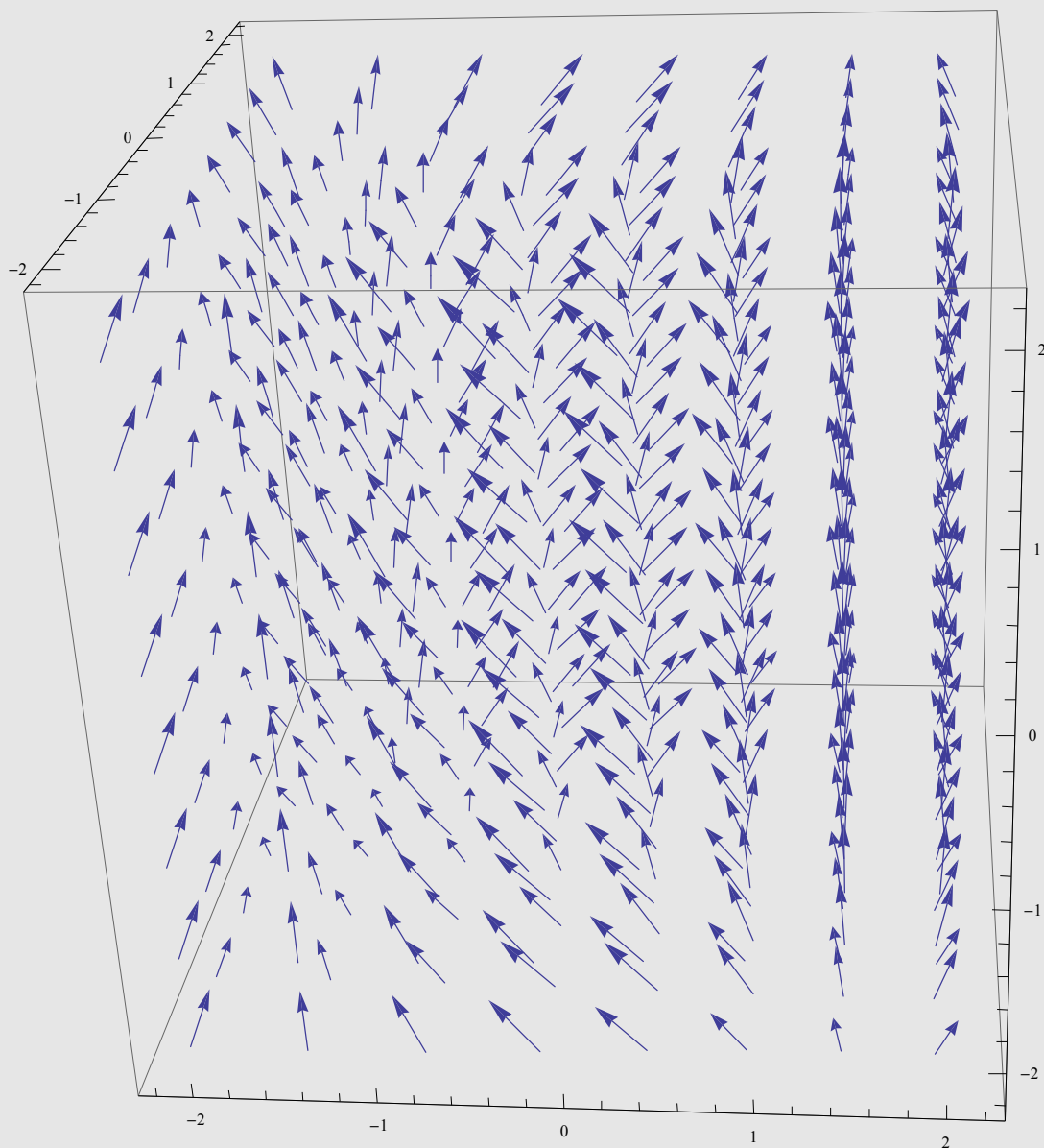


```
RegionPlot3D[y > x^2 + z^2 && y < x + 2, {x, -2, 2}, {y, -1, 4}, {z, -3, 3}, PlotPoints -> 100]
```



Zobrazujeme vektorové pole 3D

```
VectorPlot3D[{Cos[x] Sin[y], Cos[y] Sin[x], 1},  
{x, -2, 2}, {y, -2, 2}, {z, -2, 2}, VectorScale -> Small]
```



Zobrazení více typů grafů v jednom

Měníme nastavení grafu

Options[Plot]

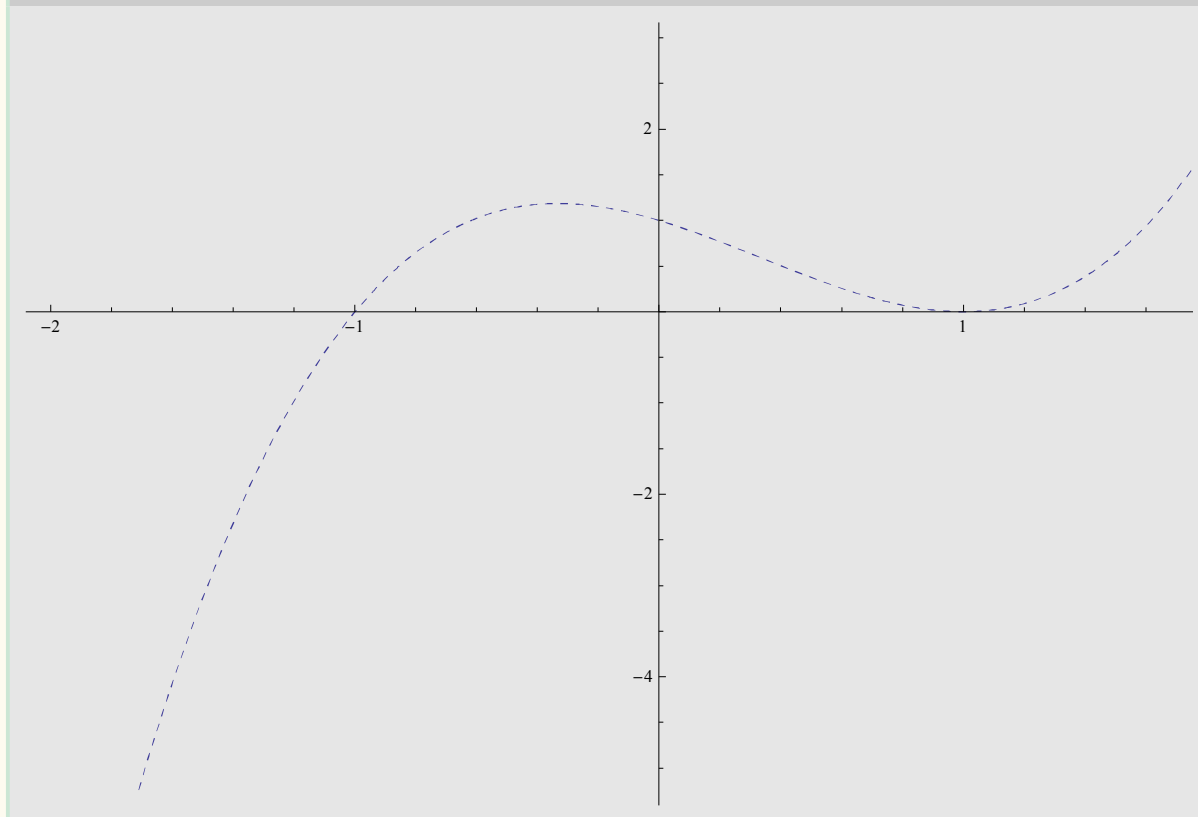
```

{AlignmentPoint → Center, AspectRatio →  $\frac{1}{\text{GoldenRatio}}$ , Axes → True,
 AxesLabel → None, AxesOrigin → Automatic, AxesStyle → {}, Background → None,
 BaselinePosition → Automatic, BaseStyle → {}, ClippingStyle → None,
 ColorFunction → Automatic, ColorFunctionScaling → True, ColorOutput → Automatic,
 ContentSelectable → Automatic, CoordinatesToolOptions → Automatic,
 DisplayFunction → $DisplayFunction, Epilog → {}, Evaluated → Automatic,
 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,
 ImageSizeRaw → 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}

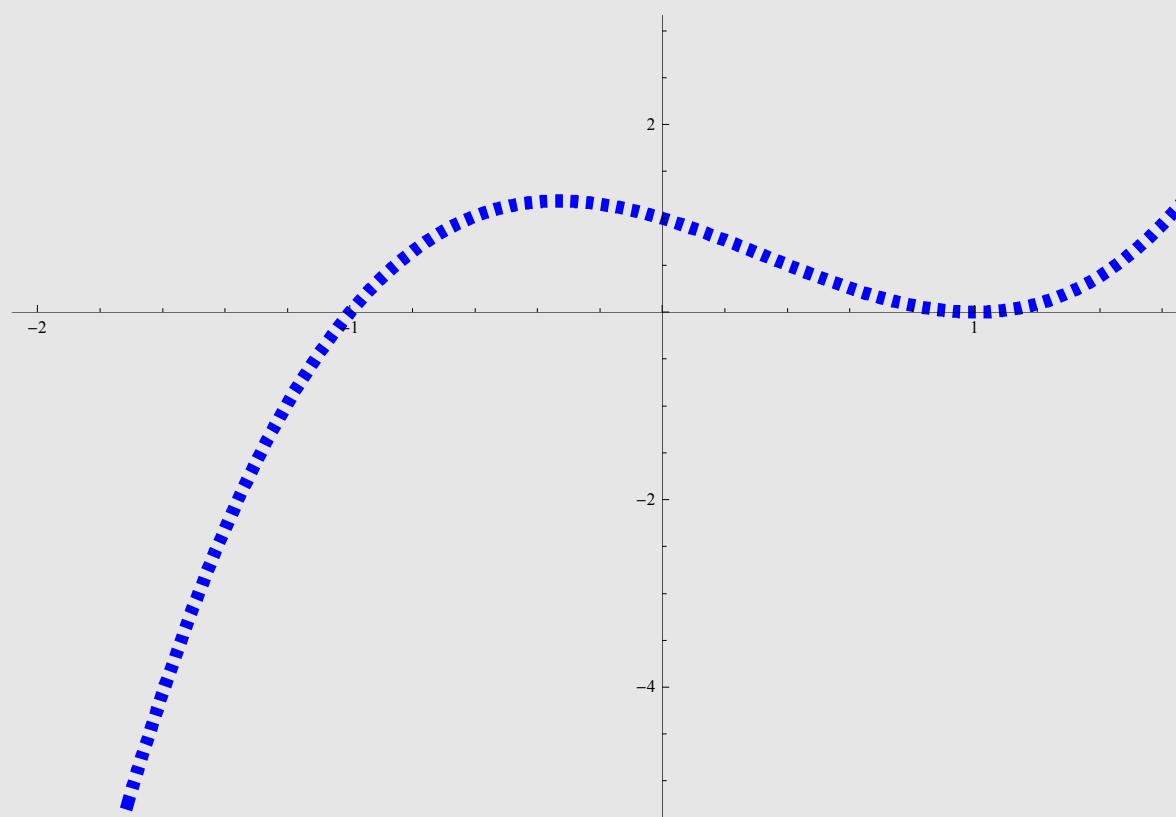
```

Měníme vzhled jedné funkce

```
Plot[x3 - x2 - x + 1, {x, -2, 2},  
PlotStyle -> Dashed]
```

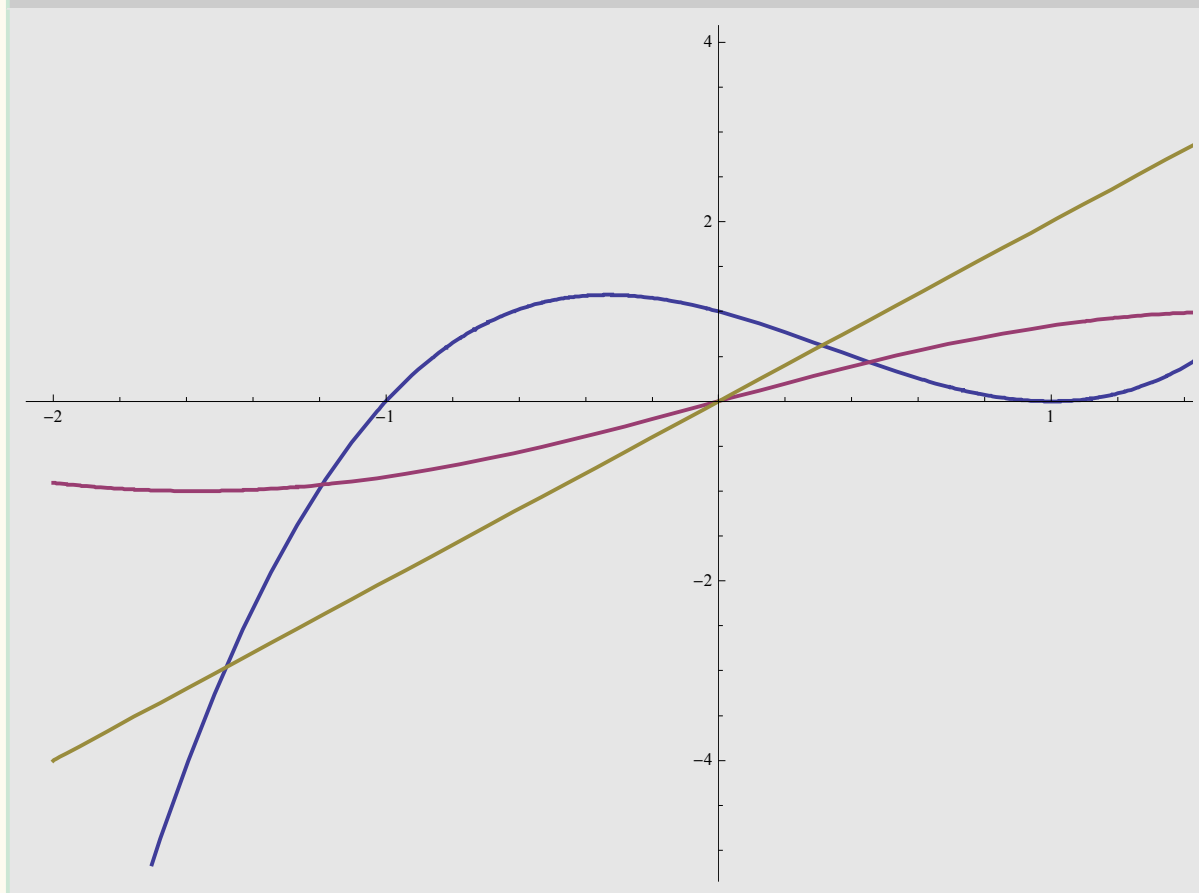


```
Plot[ $\alpha^3 - \alpha^2 - \alpha + 1$ , { $\alpha$ , -2, 2},  
PlotStyle -> {Blue, Thickness[0.01], Dashed}]
```



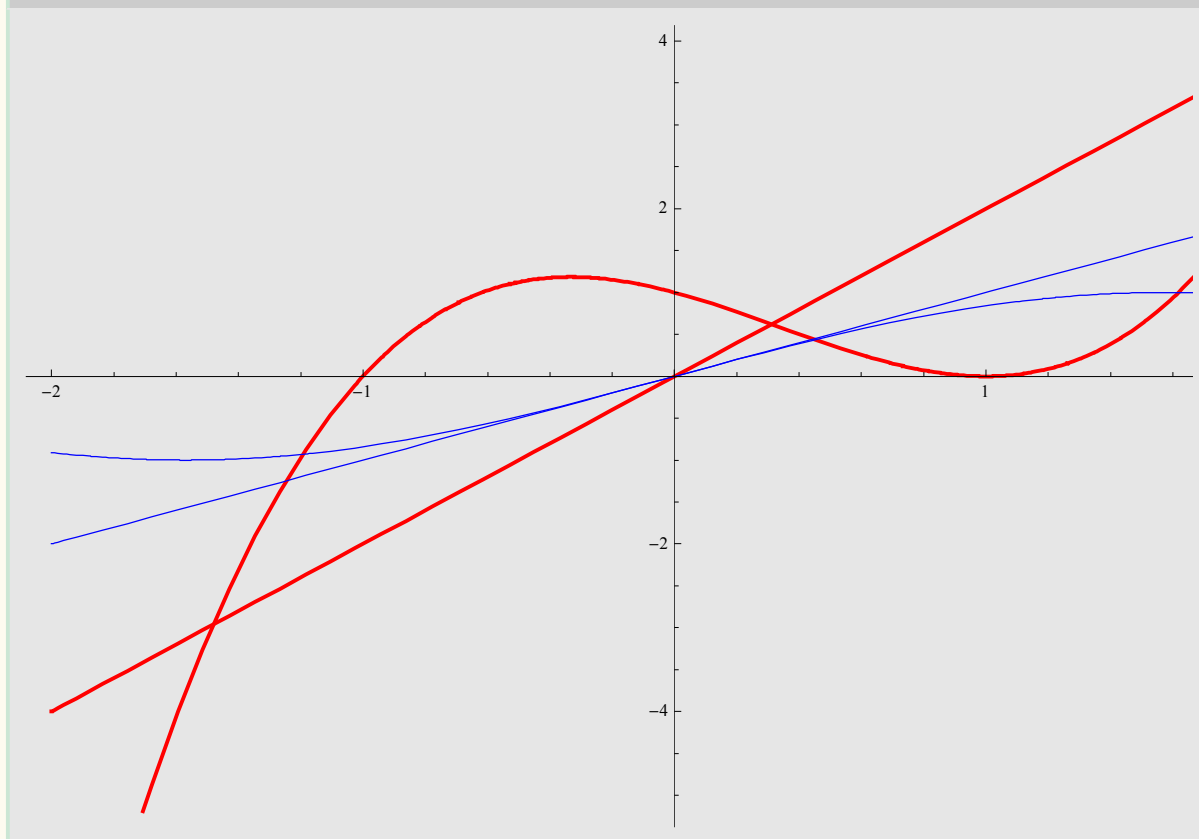
Stejné nastavení pro všechny funkce ve grafu

```
Plot[{x^3 - x^2 - x + 1, Sin[x], 2 x}, {x, -2, 2},  
PlotStyle -> Thick  
]
```

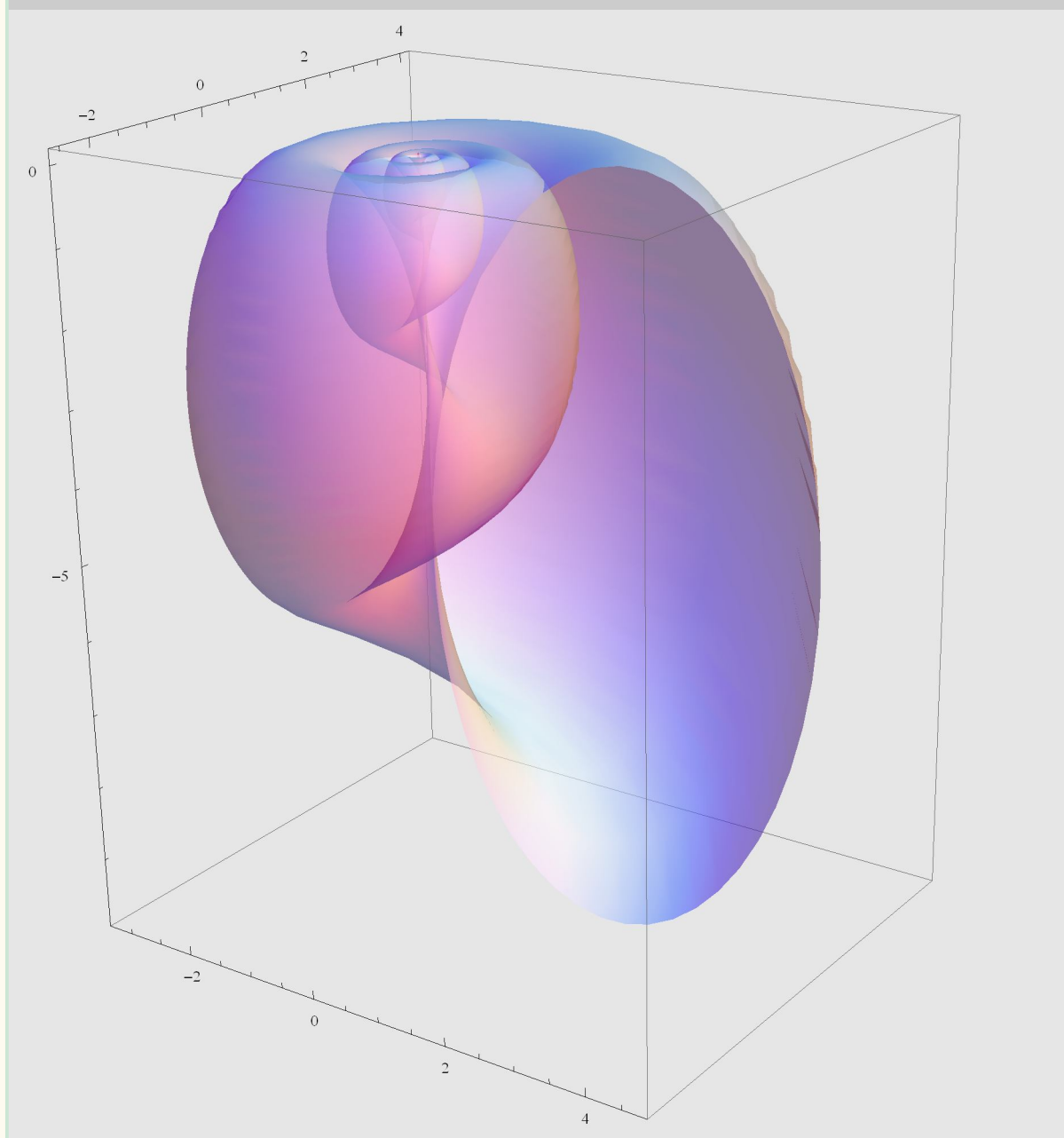


Každá funkce podle našich představ

```
Plot[{x^3 - x^2 - x + 1, Sin[x], 2 x, x}, {x, -2, 2},  
PlotStyle -> {{Thick, Red}, Blue}]
```



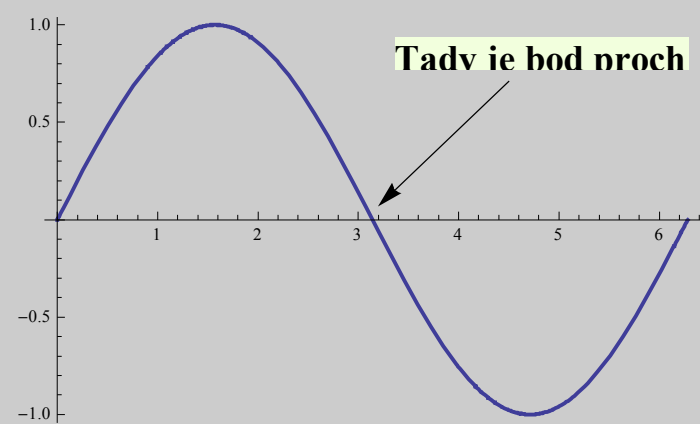
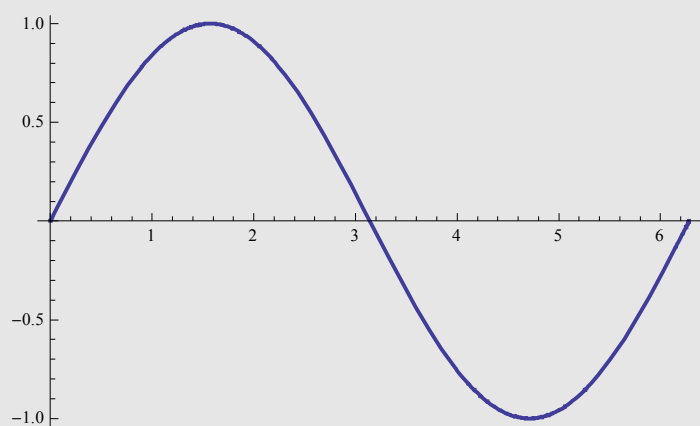
```
ParametricPlot3D[{1.16^v Cos[v] (1 + Cos[u]), -1.16^v Sin[v] (1 + Cos[u]),  
-2 1.16^v (1 + Sin[u])}, {u, 0, 2 Pi}, {v, -15, 6}, Mesh -> None,  
PlotStyle -> Opacity[0.6], PlotRange -> All, PlotPoints -> 25]
```



Popisujeme funkce

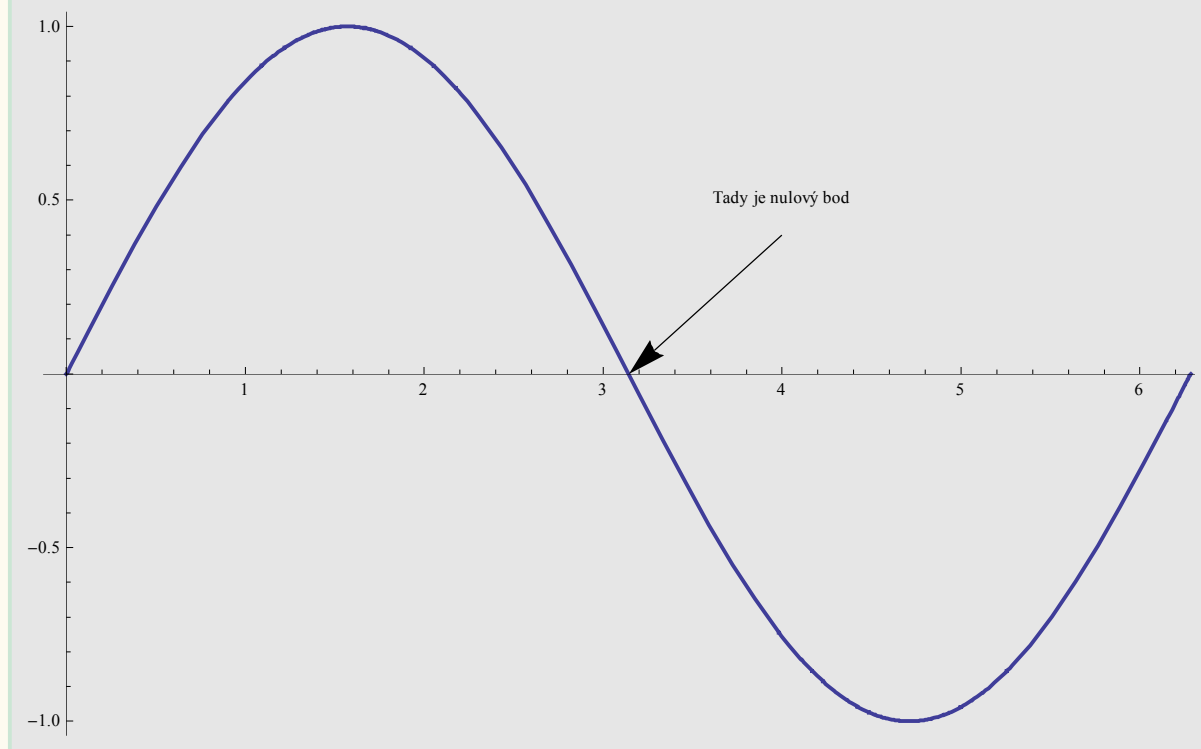
Pomocí Drawing Tools

```
Plot[Sin[x], {x, 0, 2 Pi}, PlotStyle -> Thick]
```



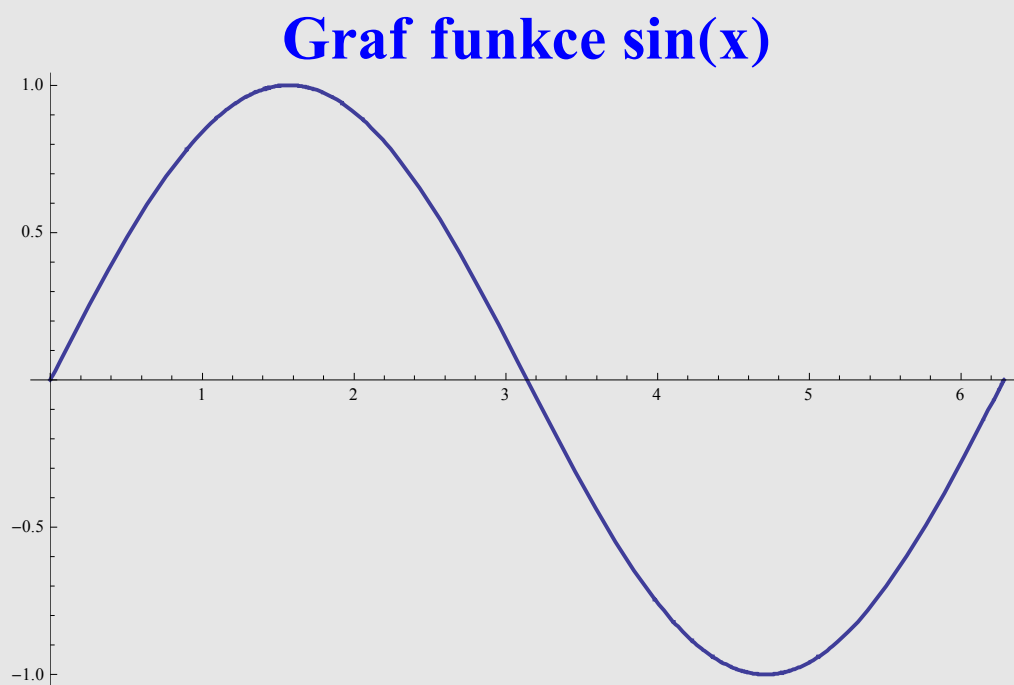
Pomocí Options grafu, případně příkaz Show

```
Show[{Plot[Sin[x], {x, 0, 2 Pi}, PlotStyle -> Thick,  
  Epilog -> {Inset["Tady je nulový bod", {4, 0.5}]}  
}, Graphics[{Arrowheads[Large], Arrow[{4, 0.4}, {Pi, 0}]}]]]
```



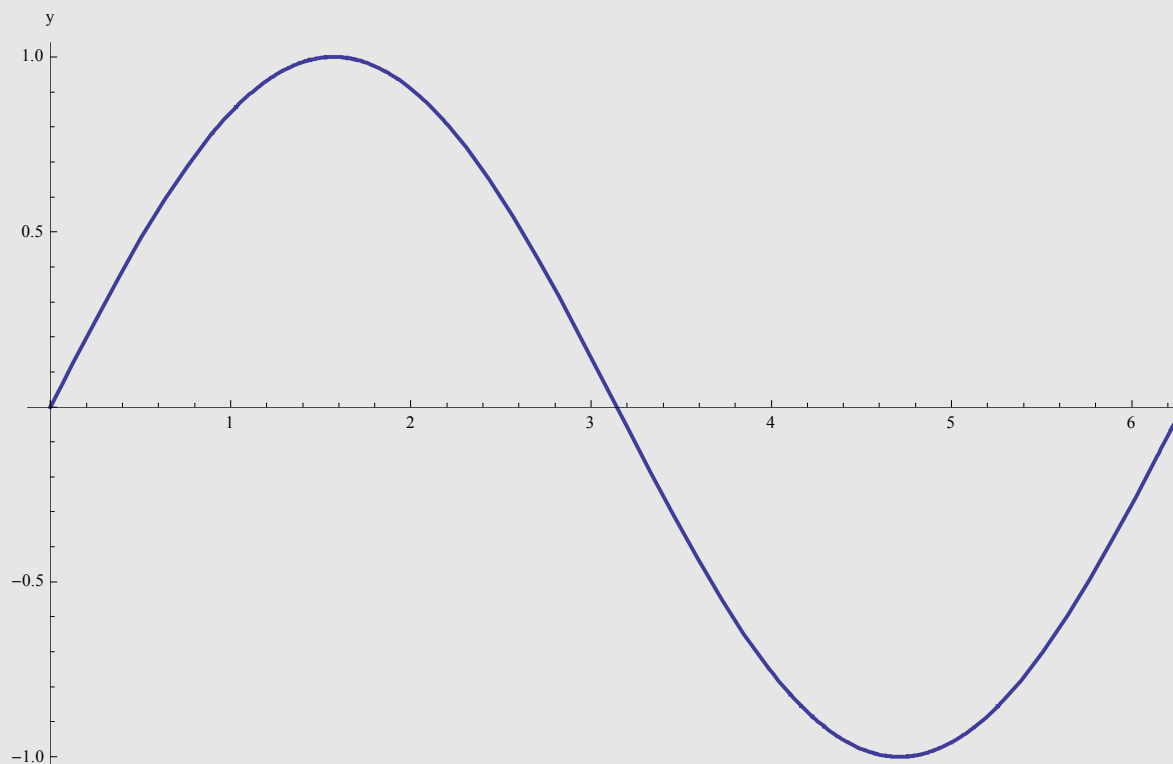
Popisujeme graf

```
Plot[Sin[x], {x, 0, 2 Pi},  
  PlotLabel → Style["Graf funkce sin(x)", Bold, Blue, 32],  
  PlotStyle → Thick]
```



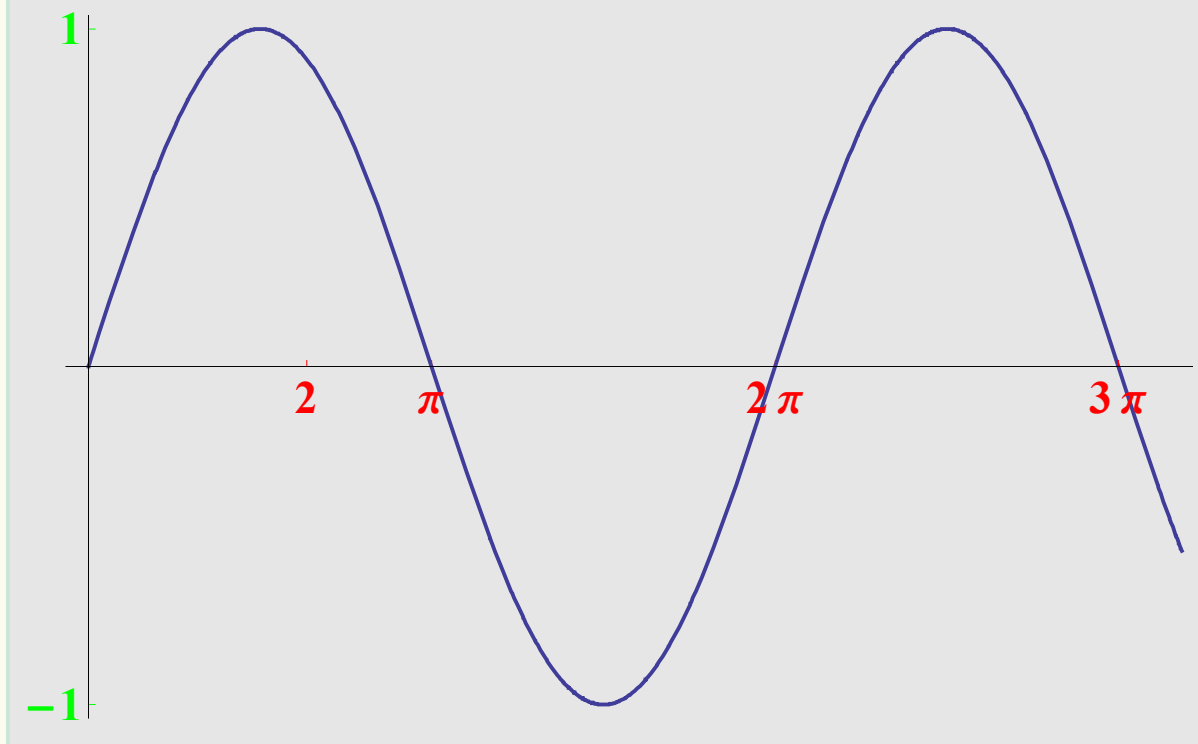
Popisujeme osy

```
Plot[Sin[x], {x, 0, 2 Pi}, PlotStyle → Thick, AxesLabel → {"x", "y"}]
```



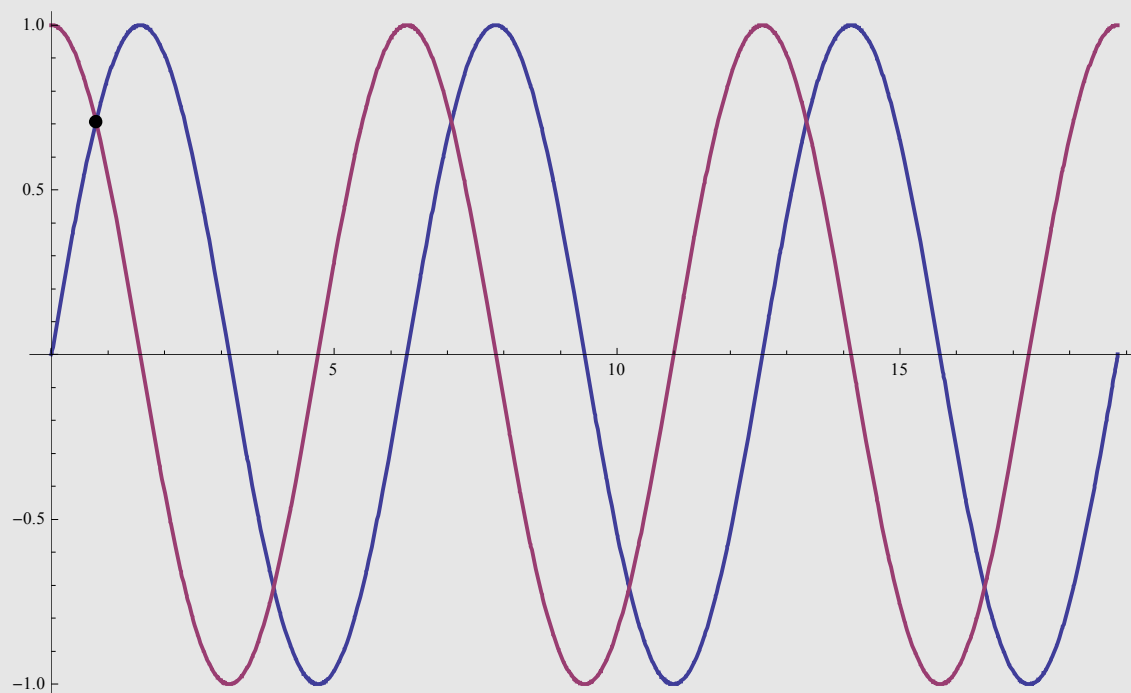
Měníme hodnoty na ose

```
Plot[Sin[x], {x, 0, 10}, PlotStyle -> Thick,  
  Ticks -> {{0, 2, Pi, 2 Pi, 3 Pi}, {-1, 1}},  
  TicksStyle -> {{Bold, 24, Red}, {Bold, 24, Green}}]
```

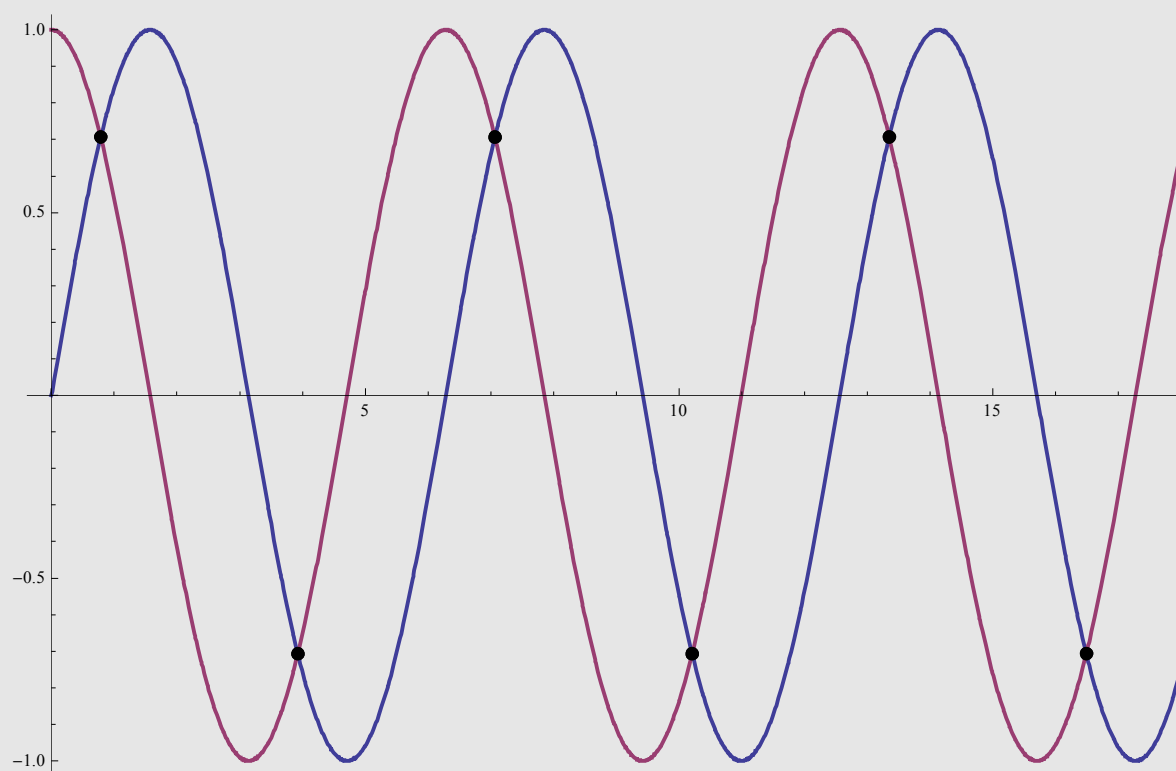


Zvýrazňujeme body ve grafu

```
Plot[{Sin[x], Cos[x]}, {x, 0, 6 Pi},  
Epilog -> {PointSize[Large], Point[{Pi/4, Sin[Pi/4]}]},  
PlotStyle -> Thick]
```



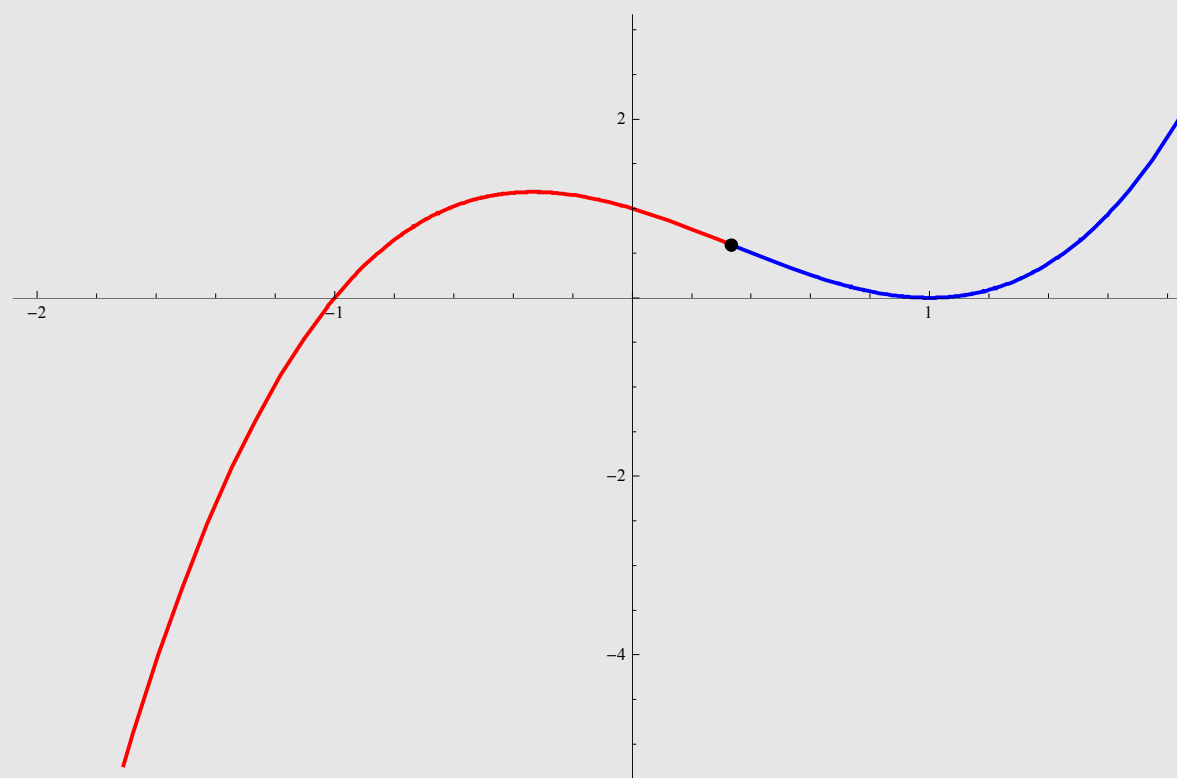
```
Plot[{Sin[x], Cos[x]}, {x, 0, 6 Pi},  
  Mesh -> {{0}}, MeshFunctions -> {Sin[#] - Cos[#] &}, MeshStyle -> PointSize[Large],  
  PlotStyle -> Thick]
```



Obarvujeme funkci podle jejích vlastností

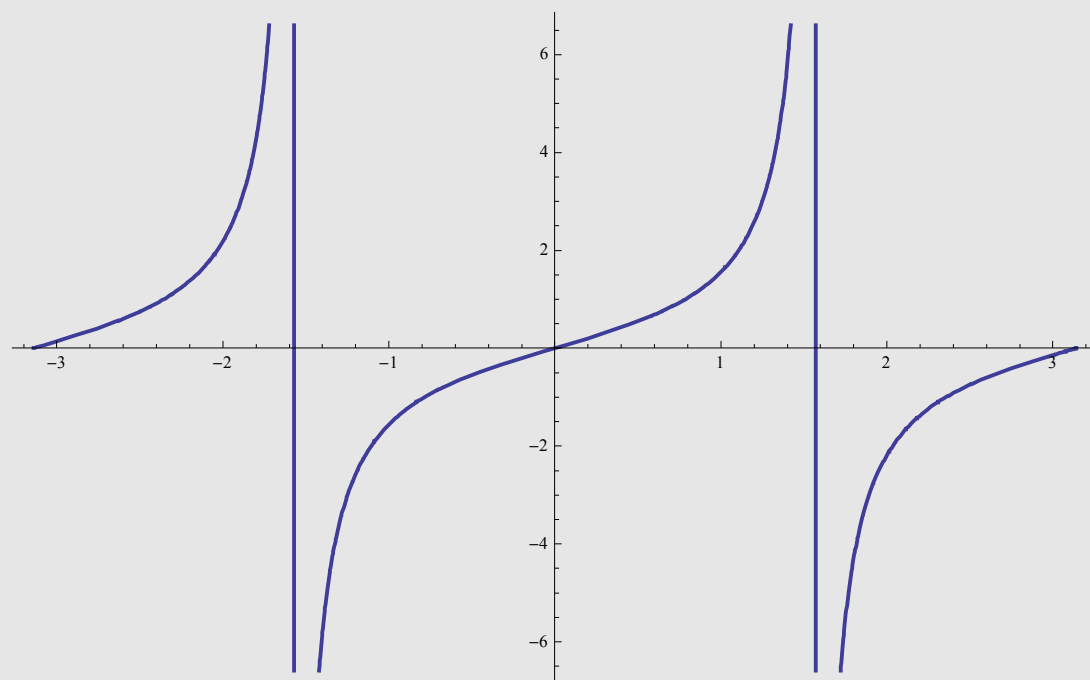
```
f2[x_] := x3 - x2 - x + 1
```

```
Plot[f2[x], {x, -2, 2}, MeshFunctions -> {f2''[#] &}, Mesh -> {{0}},  
MeshStyle -> PointSize[Large], MeshShading -> {Red, Blue},  
PlotStyle -> Thick]
```

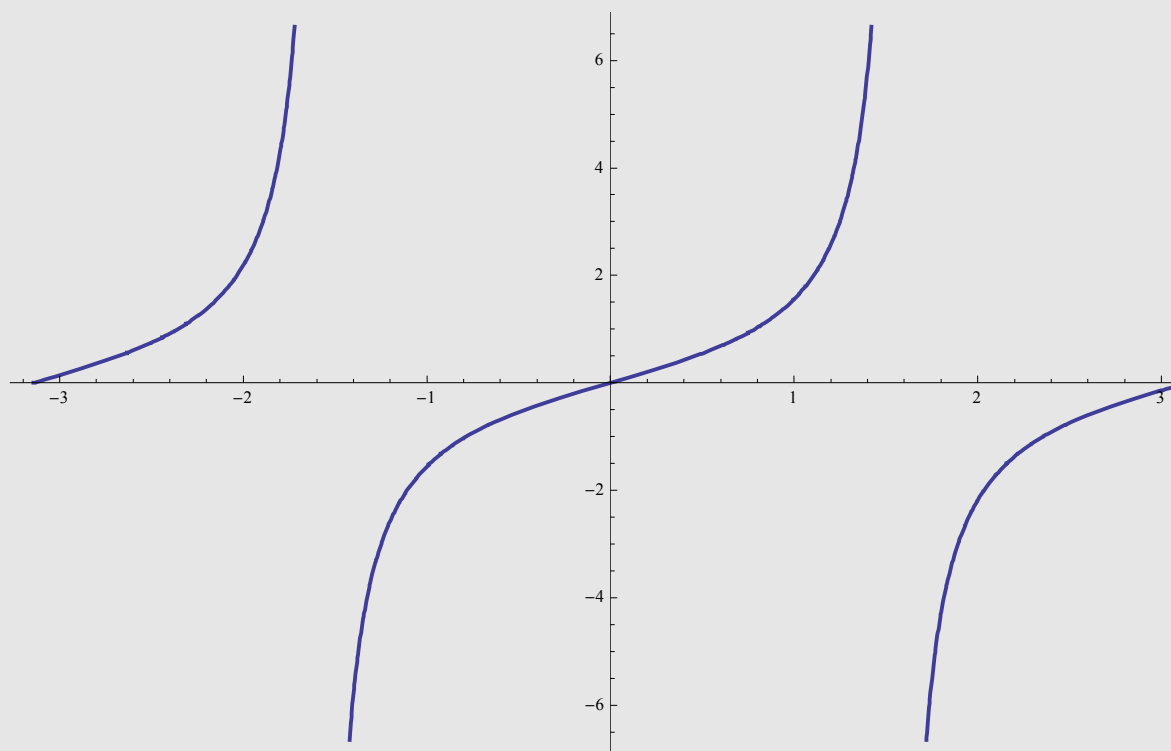


Kreslíme složitější funkce

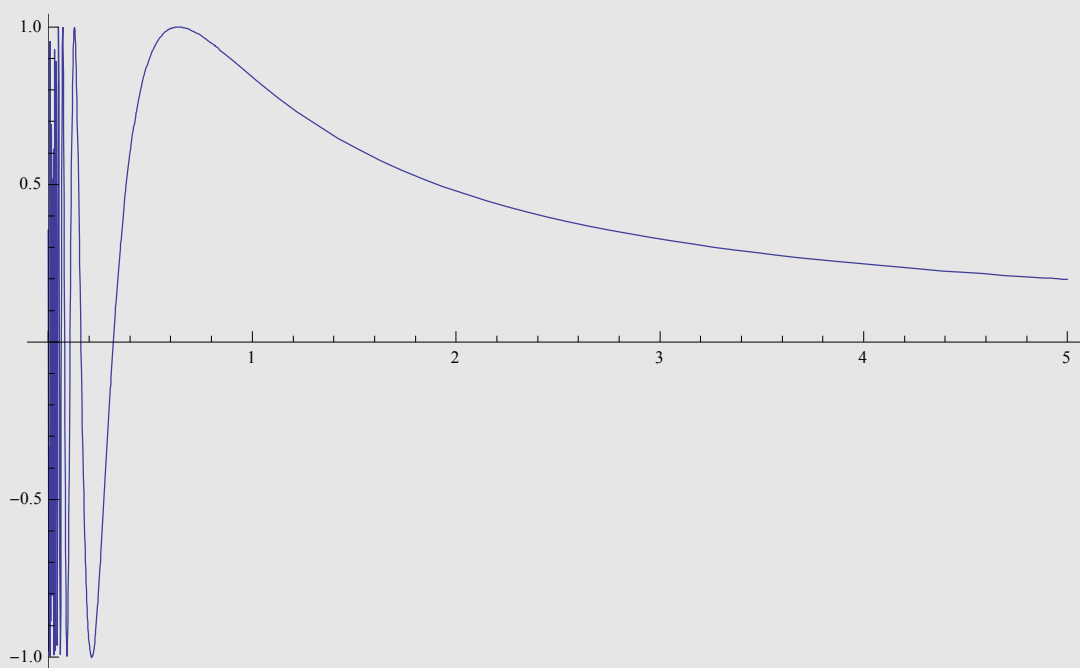
```
Plot[Tan[x], {x, -Pi, Pi},  
PlotStyle -> Thick  
]
```

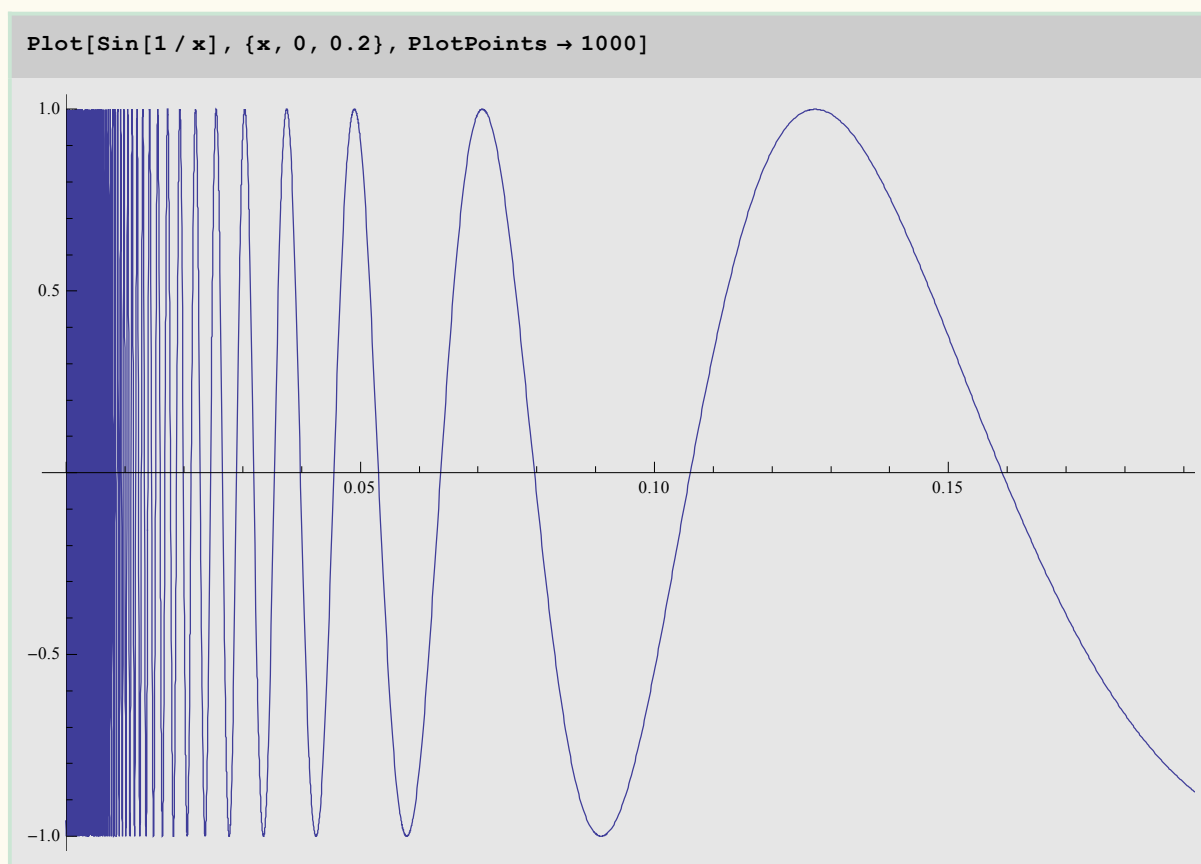


```
Plot[Tan[x], {x, -Pi, Pi},  
PlotStyle -> Thick,  
Exclusions -> {-Pi/2, Pi/2}  
]
```



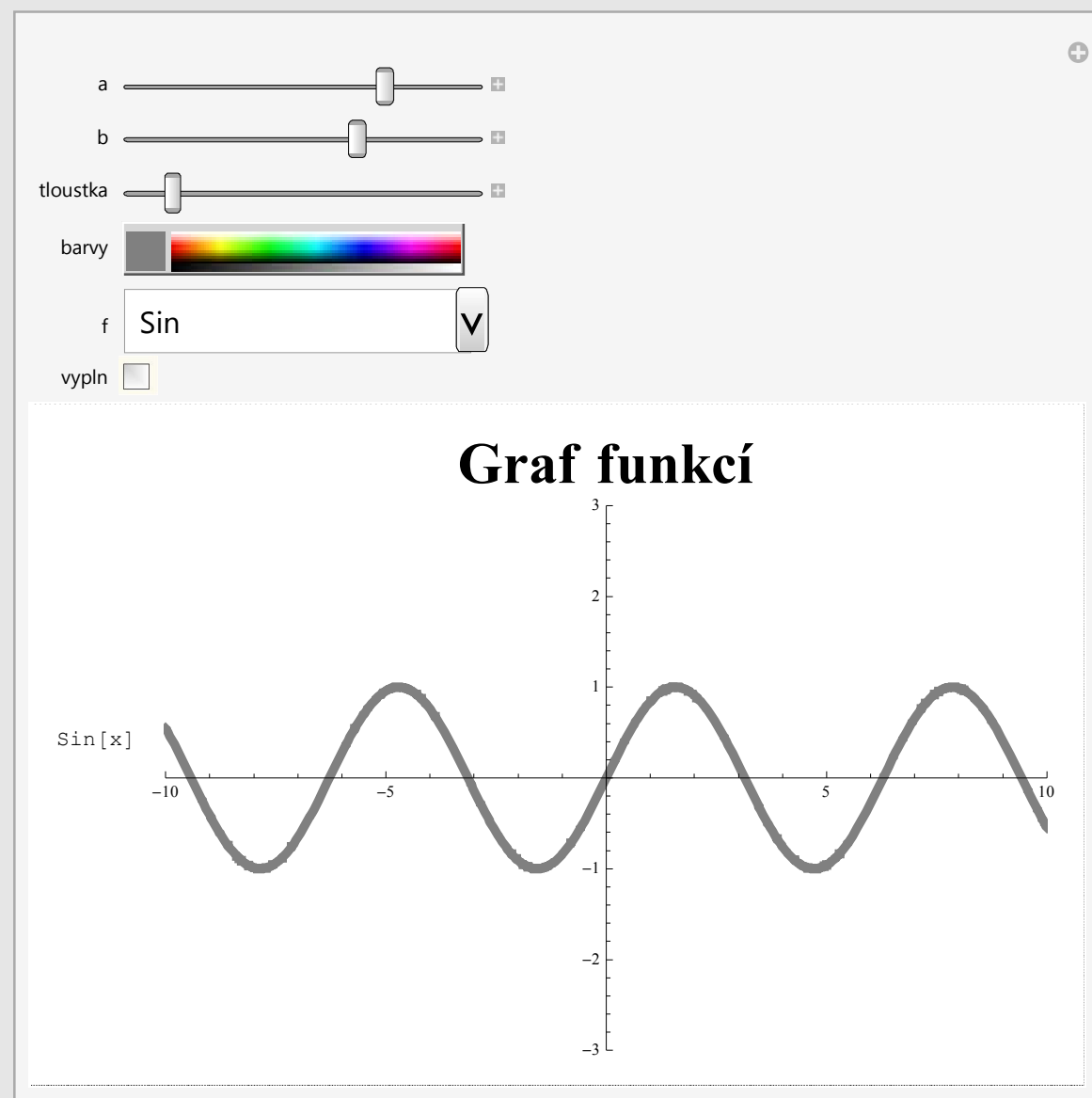
```
Plot[Sin[1/x], {x, 0, 5}]
```





Manipulate a nastavení grafu

```
Manipulate[Grid[{{a * f[b * x],
  Plot[a * f[b * x], {x, -10, 10}, PlotRange → {{-10, 10}, {-3, 3}},
  PlotStyle → {Thickness[tloustka], barvy}, ImageSize → 500,
  Evaluate[If[vypln, Filling → Axis, Filling → None]],
  PlotLabel → Style["Graf funkcí", 32, Bold]]}},
{{a, 1}, -2, 2}, {{b, 1}, -3, 3}, {{tloustka, 0.01}, 0, 0.1},
{barvy, ColorSlider}, {f, {Sin, Cos, Sqrt, Log, Exp, Function[x, x3 - x + 1]}},
{{vypln, False}, {True, False}}]
```



Použití grafů ve fyzice

Jak na grafy?

V rámci programu *Mathematica*

howto/CreatePlots

guide/FunctionVisualization

guide/GraphicsOptionsAndStyling

Projít si příslušné příkazy na kreslení grafů např. Plot

Online videa

<http://www.wolfram.com/broadcast/#Tutorials-Graphics>

Odkazy

<http://utf.mff.cuni.cz/~kusak/mathematica.php>

<http://www.karlin.mff.cuni.cz/~slavik/info.html>

<http://www.karlin.mff.cuni.cz/~hurt/>

<http://www.mathematica-forum.cz/materialy.htm>