```
> priklad:="01";Digits:=30;
```

$$priklad := "01"$$

$$Digits := 30$$

```
> xznacky:=proc(sezx)
  local tmp,i;
  tmp:={};
  for i from 1 by 1 to nops(sezx) do
  tmp:=tmp union
  {line([sezx[i],-1],[sezx[i],1],linestyle=1,thickness=1,color=bla
  ck)};
  end do;
  return(tmp);
  end proc;
```

```
xznacky := proc(sezx)
local tmp, i;
    tmp := {  };
    for i to nops(sezx) do tmp := tmp union {
        plottools:-line([ sezx[ i ], -1 ], [ sezx[ i ], 1 ], linestyle = 1, thickness = 1, color = black)
        }
    end do;
    return tmp
end proc
```

```
> yznacky:=proc(sezx)
  local tmp,i;
  tmp:={};
  for i from 1 by 1 to nops(sezx) do
  tmp:=tmp union
  {line([-0.1,sezx[i]],[0.1,sezx[i]],linestyle=1,thickness=1,color
  =black)};
  end do;
  return(tmp);
  end proc;
```

```
yznacky := proc(sezx)
local tmp, i;
    tmp := {  };
    for i to nops(sezx) do tmp := tmp union { plottools:-line( [ -0.1, sezx[ i ] ], [ 0.1, sezx[ i ] ],
        linestyle = 1, thickness = 1, color = black) }
    end do;
    return tmp
end proc
```

```
> box:=proc(x,y)
  `if`(type(x,realcons) and
  type(y,realcons),{line([0,y],[x,y],linestyle=3,thickness=1,color
  =black),line([x,0],[x,y],linestyle=3,thickness=1,color=black)},{
  });
  end proc;
```

*box* := **proc**(*x*, *y*)

`if`(type(*x*, *realcons*) **and** type(*y*, *realcons*), {

*plottools*:-*line*([0, *y*], [*x*, *y*], *linestyle* = 3, *thickness* = 1, *color* = *black*),

*plottools*:-*line*([*x*, 0], [*x*, *y*], *linestyle* = 3, *thickness* = 1, *color* = *black*)}, { })

**end proc**

```
> jednotky:=proc(x,y)
  {line([-0.1,y],[0.1,y],linestyle=1,thickness=1,color=black),line
  ([x,-0.1],[x,0.1],linestyle=1,thickness=1,color=black)}
  end proc;
```

*jednotky* := **proc**(*x*, *y*)

{*plottools*:-*line*([-0.1, *y*], [0.1, *y*], *linestyle* = 1, *thickness* = 1, *color* = *black*),

*plottools*:-*line*([*x*, -0.1], [*x*, 0.1], *linestyle* = 1, *thickness* = 1, *color* = *black*)}

**end proc**

```
> f:=x->x^3+3*x^2-9*x-10;
```

$$f := x \to x^3 + 3\,x^2 - 9\,x - 10$$

```
> df:=unapply(combine(simplify(D(f)(x)),power),x);
```

$$df := x \to 3\,x^2 + 6\,x - 9$$

```
> d2f:=unapply(combine(simplify(D(df)(x)),power),x);
```

$$d2f := x \to 6\,x + 6$$

```
> _nulove_body_f:={solve(f(x)=0,x)};_nulove_body_df:={solve(df(x)=
  0,x)};_nulove_body_d2f:={solve(d2f(x)=0,x)};stac_body:={seq([_nu
  love_body_df[i],f(nulove_body_df[i])],i=1..nops(_nulove_body_df)
  )};
```

$$_nulove\_body\_f := \left\{ \frac{(-4+4\,I\sqrt{255})^{(1/3)}}{2} + \frac{8}{(-4+4\,I\sqrt{255})^{(1/3)}} - 1, \right.$$

$$-\frac{(-4+4\,I\sqrt{255})^{(1/3)}}{4} - \frac{4}{(-4+4\,I\sqrt{255})^{(1/3)}} - 1$$

$$-\frac{1}{2}\,I\sqrt{3}\left(\frac{(-4+4\,I\sqrt{255})^{(1/3)}}{2} - \frac{8}{(-4+4\,I\sqrt{255})^{(1/3)}}\right), -\frac{(-4+4\,I\sqrt{255})^{(1/3)}}{4}$$

$$\left. -\frac{4}{(-4+4\,I\sqrt{255})^{(1/3)}} - 1 + \frac{1}{2}\,I\sqrt{3}\left(\frac{(-4+4\,I\sqrt{255})^{(1/3)}}{2} - \frac{8}{(-4+4\,I\sqrt{255})^{(1/3)}}\right) \right\}$$

$$_nulove\_body\_df := \{-3, 1\}$$

$$\_nulove\_body\_d2f := \{-1\}$$

$$stac\_body := \{[-3, 17], [1, -15]\}$$

```
> nulove_body_f:={}:evalf(_nulove_body_f):
  for i from 1 by 1 to nops(_nulove_body_f) do

  nulove_body_f:=nulove_body_f union
  `if`(typematch(_nulove_body_f[i],realcons),{_nulove_body_f[i]},{
  });
  end do:

  nulove_body_df:={}:evalf(_nulove_body_df):
  for i from 1 by 1 to nops(_nulove_body_df) do

  nulove_body_df:=nulove_body_df union
  `if`(typematch(_nulove_body_df[i],realcons),{_nulove_body_df[i]}
  ,{});
  end do:

  nulove_body_d2f:={}:evalf(_nulove_body_d2f):
  for i from 1 by 1 to nops(_nulove_body_d2f) do

  nulove_body_d2f:=nulove_body_d2f union
  `if`(typematch(_nulove_body_d2f[i],realcons),{_nulove_body_d2f[i
  ]},{});
  end do:
```

```
>
```

```
> nulove_body_f;evalf(nulove_body_f);evalf(nulove_body_df);evalf(n
  ulove_body_d2f);
```

$$\{\ \}$$

$$\{\ \}$$

$$\{-3., 1.\}$$

$$\{-1.\}$$

```
> f_rostouci:=x->piecewise(df(x)>0,f(x),infinity);
  f_klesajici:=x->piecewise(df(x)<0,f(x),infinity);
  df_rostouci:=x->piecewise(d2f(x)>0,df(x),infinity);
  df_klesajici:=x->piecewise(d2f(x)<0,df(x),infinity);
```

$$f\_rostouci := x \rightarrow \text{piecewise}(0 < \text{df}(x), \text{f}(x), \infty)$$

$$f\_klesajici := x \rightarrow \text{piecewise}(\text{df}(x) < 0, \text{f}(x), \infty)$$

$$df\_rostouci := x \rightarrow \text{piecewise}(0 < \text{d2f}(x), \text{df}(x), \infty)$$

$$df\_klesajici := x \rightarrow \text{piecewise}(\text{d2f}(x) < 0, \text{df}(x), \infty)$$

```
> f_konkavni:=x->piecewise(d2f(x)>0,f(x),infinity);
  f_konvexni:=x->piecewise(d2f(x)<0,f(x),infinity);
  d2f_kladna:=x->piecewise(d2f(x)>0,d2f(x),infinity);
```

$$f\_konkavni := x \to \text{piecewise}(0 < \text{d2f}(x), \text{f}(x), \infty)$$

$$f\_konvexni := x \to \text{piecewise}(\text{d2f}(x) < 0, \text{f}(x), \infty)$$

$$d2f\_kladna := x \to \text{piecewise}(0 < \text{d2f}(x), \text{d2f}(x), \infty)$$

```
> lokalni_minima:={}:
  for i from 1 by 1 to nops(nulove_body_df) do
  tmp:=`if`(evalf(d2f(nulove_body_df[i]))>0,{[evalf(nulove_body_df
  [i]),evalf(f(nulove_body_df[i]))]},{}):
  lokalni_minima:=lokalni_minima union tmp:
  end do:
  lokalni_minima;
```

$$\{[1., -15.]\}$$

```
> lokalni_maxima:={}:
  for i from 1 by 1 to nops(nulove_body_df) do
  tmp:=`if`(evalf(d2f(nulove_body_df[i]))<0,{[evalf(nulove_body_df
  [i]),evalf(f(nulove_body_df[i]))]},{}):
  lokalni_maxima:=lokalni_maxima union tmp:
  end do:
  lokalni_maxima;
```

$$\{[-3., 17.]\}$$

```
> inflexe:={}:
  for i from 1 by 1 to nops(nulove_body_df) do
  tmp:=`if`(evalf(d2f(nulove_body_df[i]))=0.0,{[nulove_body_df[i],
  f(nulove_body_df[i])]},{}):
  inflexe:=inflexe union tmp:
  end do:
  inflexe;
```

$$\{\ \}$$

```
> fx_min:=-5;fx_max:=3;fy_min:=-15.5;fy_max:=17.5;
  dfx_min:=fx_min;dfx_max:=fx_max;
  d2fx_min:=fx_min;d2fx_max:=fx_max;
  dfy_min:=-12.5;dfy_max:=36.5;
  d2fy_min:=-24.5;d2fy_max:=24.5;

  limit(f(x),x=infinity);
  limit(df(x),x=infinity);
  limit(d2f(x),x=infinity);

  with(plots):
  setoptions(tickmarks=[0,0],titlefont=[TIMES,ROMAN,16],scaling=UN
  CONSTRAINED):
```

$$fx\_min := -5$$

$$fx\_max := 3$$

$$fy\_min := -15.5$$

$$fy\_max := 17.5$$

$$dfx\_min := -5$$

$$dfx\_max := 3$$

$$d2fx\_min := -5$$

$$d2fx\_max := 3$$

$$dfy\_min := -12.5$$

$$dfy\_max := 36.5$$

$$d2fy\_min := -24.5$$

$$d2fy\_max := 24.5$$

$$\infty$$

$$\infty$$

$$\infty$$

```
> minimize(df(x),x=fx_min..fx_max);maximize(df(x),x=fx_min..fx_max
  );
```

$$-12$$

$$36$$

```
> minimize(d2f(x),x=fx_min..fx_max);maximize(d2f(x),x=fx_min..fx_m
  ax);
```

$$-24$$

$$24$$

```
> cary_f:=xznacky([-3,1]) union yznacky([-15,17]):
  with(plottools):
  for i from 1 by 1 to nops(nulove_body_df) do
  tmp:=nulove_body_df[i]:
  cary_f:=cary_f union box(evalf(tmp),evalf(f(tmp))):
  end do:
  graf_f:={plot([f_rostouci(x),f(x)],x=fx_min..fx_max,y=fy_min..fy
  _max,numpoints=400,color=[blue,red],thickness=[3,2])} union
  cary_f:
```

```
>
```

```
> cary_df:=xznacky([-1]) union yznacky([-12]):

  for i from 1 by 1 to nops(nulove_body_d2f) do
  tmp:=nulove_body_d2f[i]:
  cary_df:=cary_df union box(evalf(tmp),evalf(df(tmp))):
  end do:
  graf_df:={plot([df_rostouci(x),df(x)],x=dfx_min..dfx_max,y=dfy_m
  in..dfy_max,color=[blue,red],discont=true,thickness=[3,2])}
  union cary_df:
```

```
> cary_d2f:=xznacky([-1]) union yznacky([6]);
```

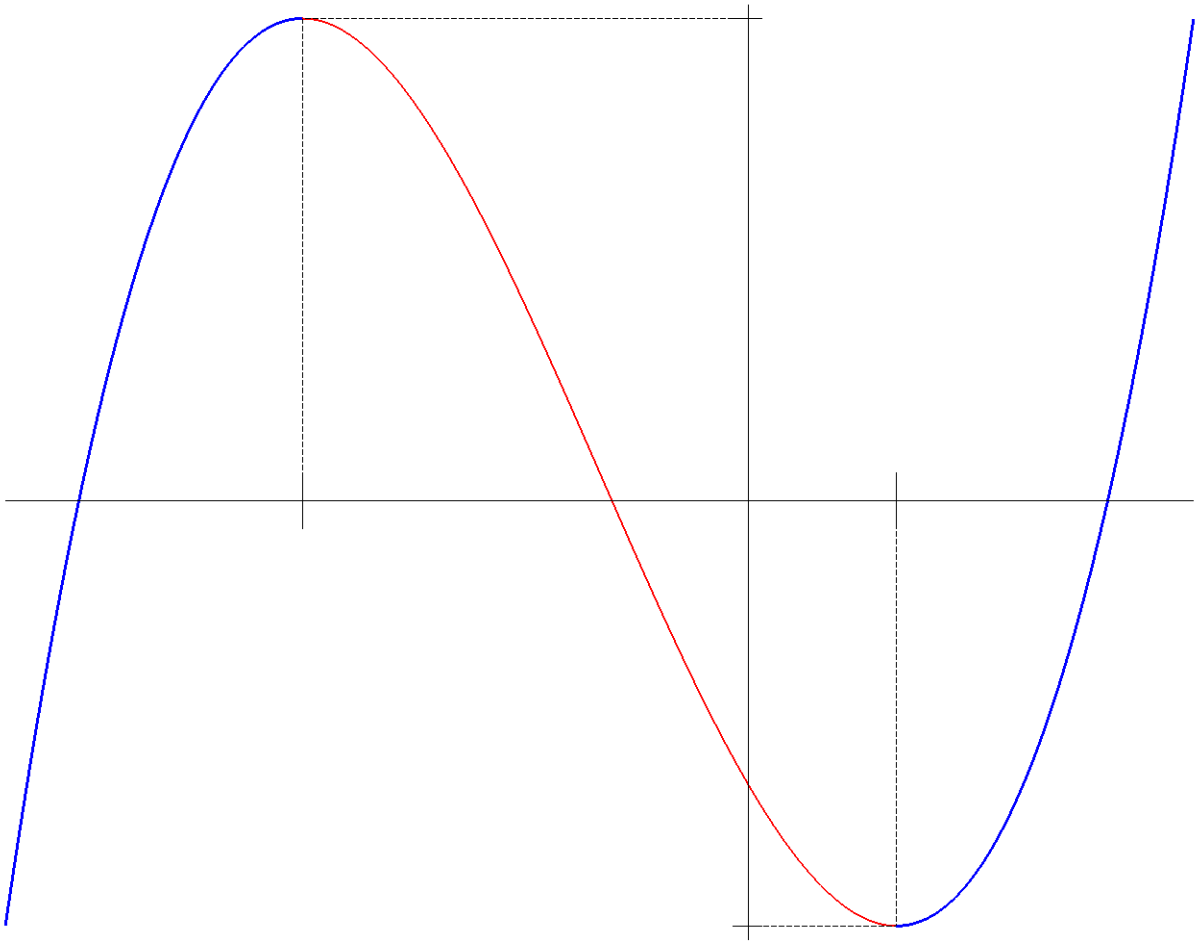
```
graf_d2f:={plot([d2f_kladna(x),d2f(x)],x=d2fx_min..d2fx_max,y=d2
fy_min..d2fy_max,color=[green,red],thickness=[3,2],discont=true)
} union cary_d2f:
>
```

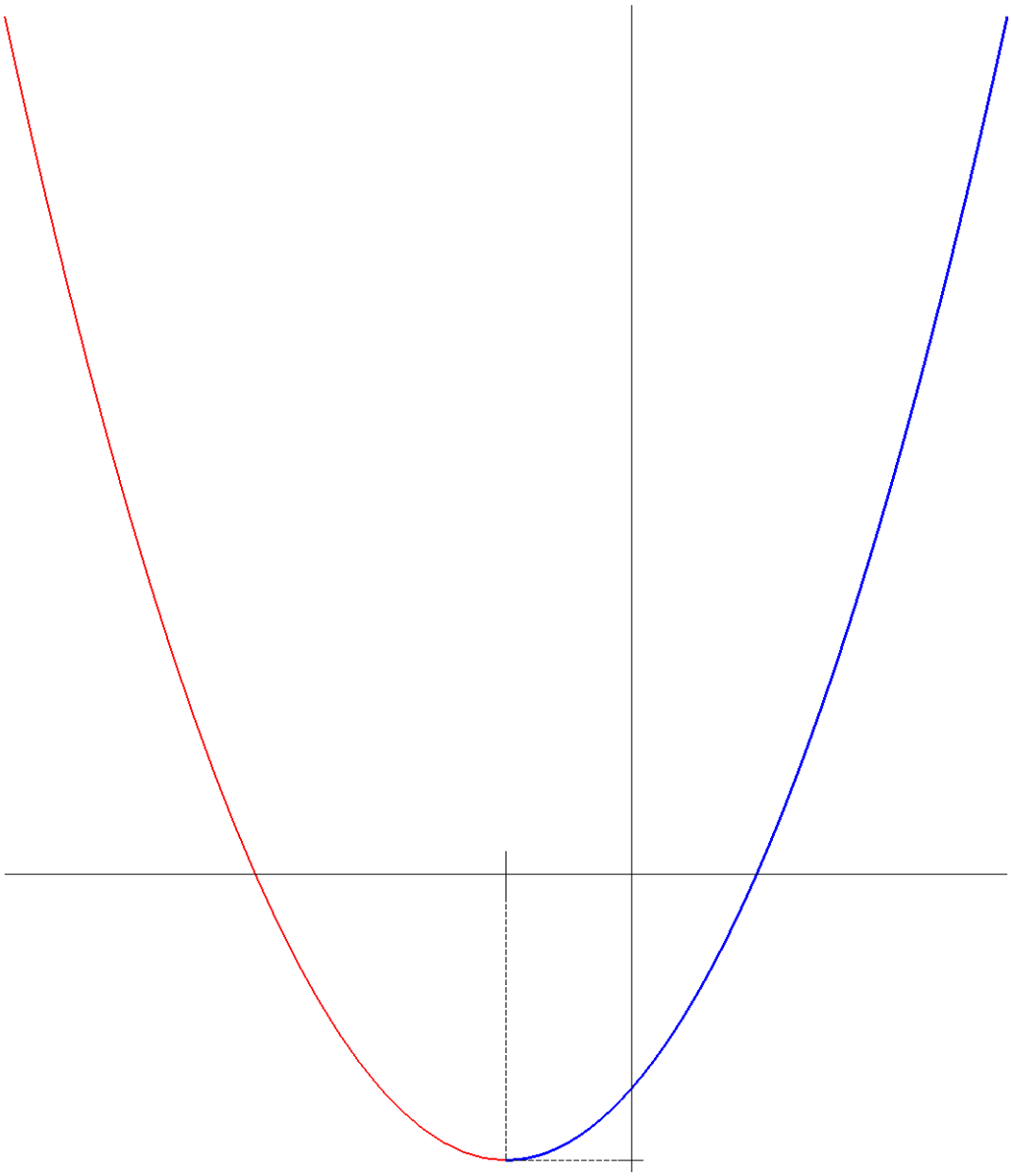
*cary_d2f* := {CURVES([[-1., -1.], [-1., 1.]], COLOUR(*RGB*, 0., 0., 0.), LINESTYLE(1), THICKNESS(1)), CURVES([[-0.1, 6.], [0.1, 6.]], COLOUR(*RGB*, 0., 0., 0.), LINESTYLE(1), THICKNESS(1))}

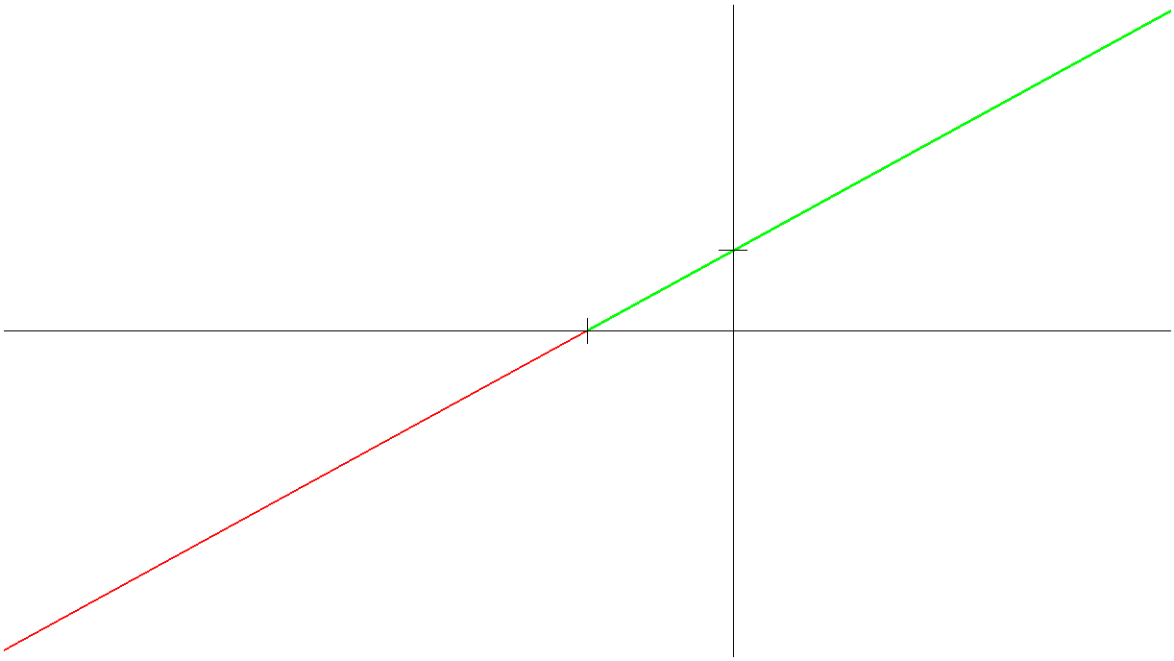
```
> fsolve(f(x)=0,x);
```

-4.505039724619893106820897698 44, -0.916618357439208289376430547030, 2.421658082059101396197328245 47

```
> with(plots):plotsetup(default);display(graf_f);display(graf_df);
display(graf_d2f);
```







```
> limit(df(x),x=1,right);evalf(exp(-2));d2f(0.2);f(0.243);
```

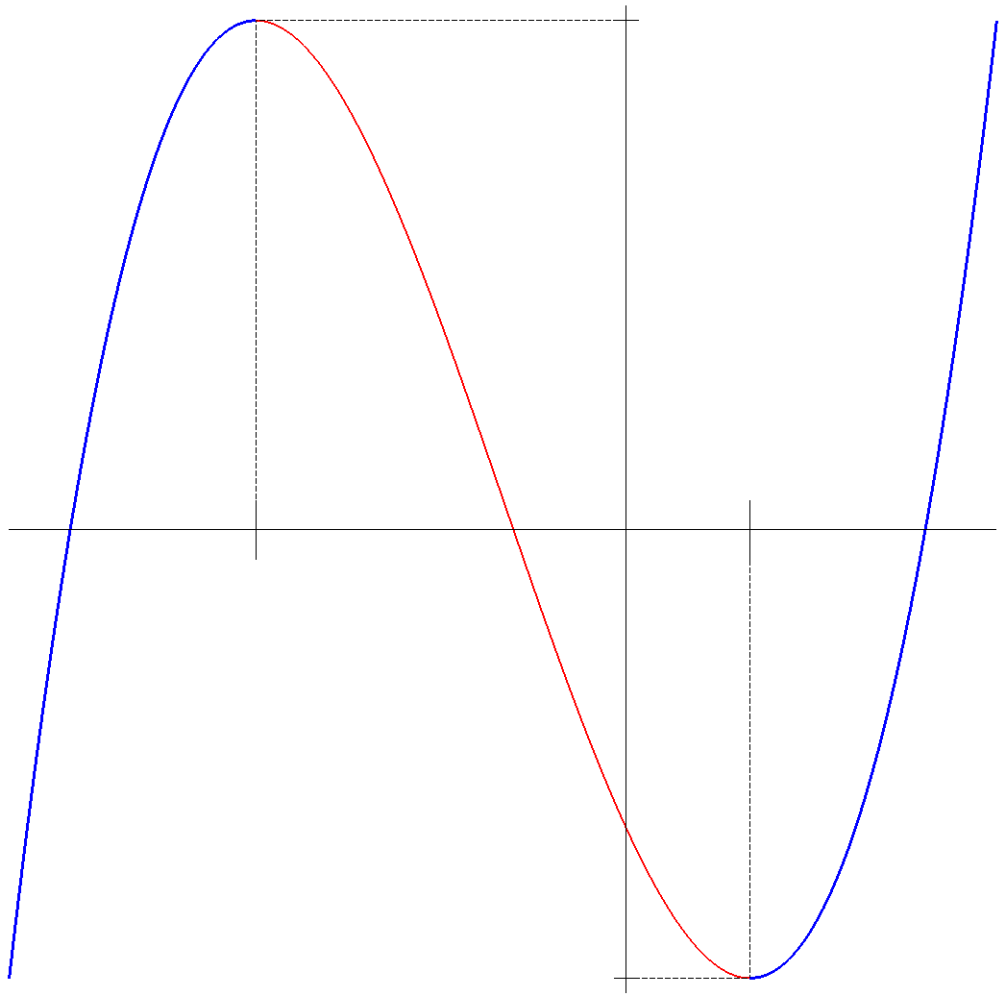
0

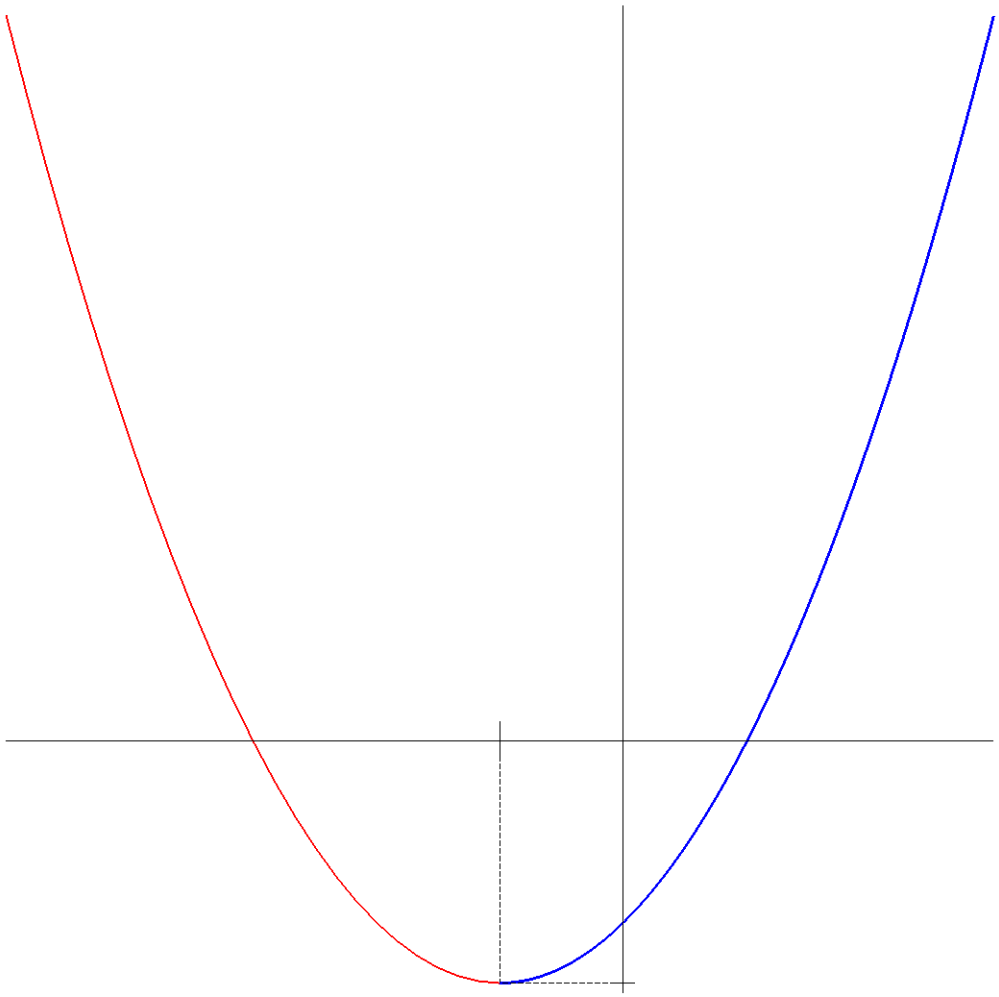
0.13533528323661269189399949497 2

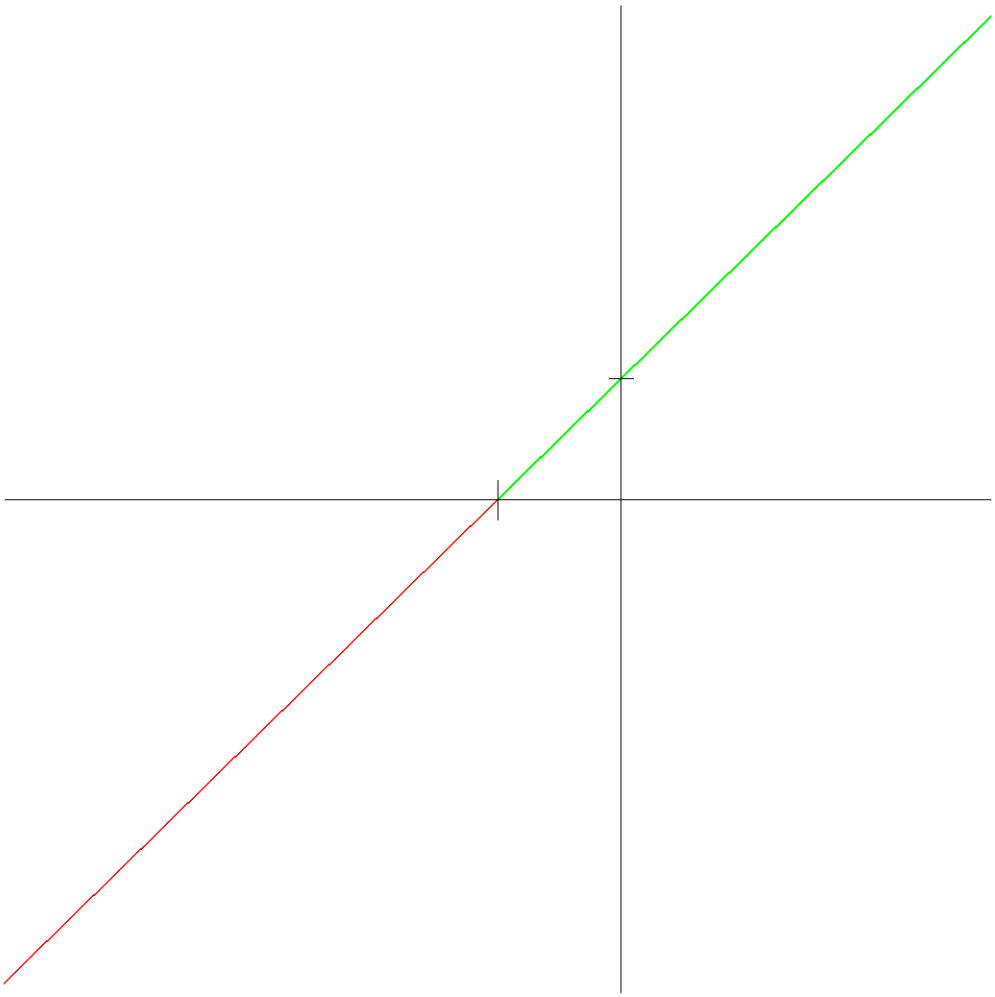
7.2

-11.995504093

```
> with(plots):
  plotsetup(default,plotoptions=`width=187pt,noborder,shrinkby=0,c
  olor=rgb`);display(graf_f);
  plotsetup(default,plotoptions=`width=187pt,noborder,shrinkby=0,c
  olor=rgb`);
  display(graf_df);
  plotsetup(default,plotoptions=`width=187pt,noborder,landscape,sh
  rinkby=0,color=rgb`);display(graf_d2f);
```







```
> evalf(df(exp(-1)));limit(df(x),x=infinity);t:=convert(evalf(nulo
  ve_body_d2f),list);
> evalf(nulove_body_d2f);zip((x,y)->df(x),t,[],0);
```

-6.386717503261507994744858894 11

$\infty$

$t := [-1.]$

$\{-1.\}$

$[-12.]$

```
>
>
>
```