## 1.2 Instruction, exécution et résultat

```
> 2 + 2;
```
$$4 \qquad \textbf{(1.1)}$$

```
> 2 + 2 :
> 2 + 2
```
$$4 \qquad \textbf{(1.2)}$$

```
> 2 + 3;
  4 + 5;
```
$$5$$
$$9 \qquad \textbf{(1.3)}$$

```
>
```

## 1.3 Opérations de bases

> $\mathrm{sqrt}\left(2 - \frac{3\cdot 7}{5}\right);$

$$\frac{1}{5}\, I\, \sqrt{55} \qquad \textbf{(2.1)}$$

> $\mathit{evalf}\left(\mathrm{sqrt}\left(2 - \frac{3\cdot 7}{5}\right)\right);$

$$1.483239697\, I \qquad \textbf{(2.2)}$$

> $\mathrm{abs}(1 - 2\cdot\cdot 5);$

$$31 \qquad \textbf{(2.3)}$$

> $\cos\left(\frac{\mathrm{Pi}}{2}\right);$

$$0 \qquad \textbf{(2.4)}$$

> $\exp(1); \ln(1);$

$$e$$
$$0 \qquad \textbf{(2.5)}$$

> $\mathit{evalf}(\exp(1));$

$$2.718281828 \qquad \textbf{(2.6)}$$

> $\mathit{print}(\mathit{Coucou});$

$$\mathit{Coucou} \qquad \textbf{(2.7)}$$

> ?*plot*

>

## 1.4 Les variables

> $I \cdot I$;

$$-1 \quad (3.1)$$

> *Digits*;
*evalf*(Pi);

$$10$$
$$3.141592654 \quad (3.2)$$

> $a$;
$a := 1$;
$a$;

$$a$$
$$a := 1$$
$$1 \quad (3.3)$$

> *Digits* := 50;
*evalf*(Pi);

$$Digits := 50$$
$$3.1415926535897932384626433832795028841971693993751 \quad (3.4)$$

> Pi := 3.14;

Error, attempting to assign to `Pi` which is protected

> $a := 1$:
$a$;
*unassign*('a'):
$a$;

$$1$$
$$a \quad (3.5)$$

> $a := 2$;
$b := 14$;
*restart*:
$a$; $b$;

$$a := 2$$
$$b := 14$$
$$a$$
$$b \quad (3.6)$$

> $x :=$ sqrt(3) + 27·Pi + sqrt(37);

$$x := \sqrt{3} + 27\pi + \sqrt{37} \quad (3.7)$$

> $x := \frac{x}{(4 \cdot \mathrm{Pi}) \cdot 13}$;

$$x := \frac{1}{380204032} \frac{\sqrt{3} + 27\pi + \sqrt{37}}{\pi^5} \quad (3.8)$$

> $x := 2$:

> $x := x \cdot 5$;

(3.9)

$x := 1250$ **(3.9)**

>

## 1.5 Boucles et instructions conditionnelles

### 1.5.1 Boucles

```
> montant := 0 :
  for i from 1 to 35
  do montant := montant + 10 :
  od:
  montant;
```

350 **(4.1.1)**

>

### 1.5.2 Test if/while

```
> x := 11 :
  if (x < 10) then
  print(Coucou) :
  else evalf(Pi);
  fi:
```

```
> x := 11 :
  if (x < 10) then
  print(Coucou) :
  else evalf(Pi);
  fi;
```

3.141592654 **(4.2.1)**

```
> x := 1000 :
  if (x < 10) then
  print(Coucou);
  elif (x > 100) then
  print(grand) :
  else evalf(Pi);
  fi;
```

*grand* **(4.2.2)**

```
> n := 0;
  while (n^2 < 1000)
  do n := n + 1 :
  od;
  n;
```

$n := 0$

$$n := 1$$
$$n := 2$$
$$n := 3$$
$$n := 4$$
$$n := 5$$
$$n := 6$$
$$n := 7$$
$$n := 8$$
$$n := 9$$
$$n := 10$$
$$n := 11$$
$$n := 12$$
$$n := 13$$
$$n := 14$$
$$n := 15$$
$$n := 16$$
$$n := 17$$
$$n := 18$$
$$n := 19$$
$$n := 20$$
$$n := 21$$
$$n := 22$$
$$n := 23$$
$$n := 24$$
$$n := 25$$
$$n := 26$$
$$n := 27$$
$$n := 28$$
$$n := 29$$
$$n := 30$$
$$n := 31$$
$$n := 32$$
$$32 \tag{4.2.3}$$

```
> n := 0;
  while (n^2 < 1000)
  do n := n + 1 :
  od:
  n;
```

$$n := 0$$

$$32 \quad (4.2.4)$$

> $32 \cdot 32;$

$$1024 \quad (4.2.5)$$

> $31 \cdot 31;$

$$961 \quad (4.2.6)$$

>

### 1.5.3 Opérateurs logiques

> $a := 0 : b := 2 : c := 0 :$
> **if** $((a = 1)$ **and** $(b = 2))$ **then**
> $c := 10 :$
> **end if**:
> $c;$

$$0 \quad (4.3.1)$$

> $a := 0 : b := 2 : c := 0 :$
> **if** $((a = 1)$ **or** $(b = 2))$ **then**
> $c := 10 :$
> **end if**:
> $c;$

$$10 \quad (4.3.2)$$

>

## 1.6 Les fonctions

### 1.6.1 Fonctions et expressions

> $f := x \rightarrow x^2 + 1;$

$$f := x \rightarrow x^2 + 1 \quad (5.1.1)$$

> $f(0.1);$

$$1.01 \quad (5.1.2)$$

> $f(0.5);$

$$1.25 \quad (5.1.3)$$

> *restart*;

> $f := x^2 + 1;$

$$f := x^2 + 1 \quad (5.1.4)$$

> $subs(x = 0.1, f);$

$$1.01 \quad (5.1.5)$$

> $subs(x = 0.5, f);$

$$1.25 \qquad (5.1.6)$$

> $f(0.1);$

$$x(0.1)^2 + 1 \qquad (5.1.7)$$

> $f := x^2 + 1 : f := unapply(f, x);$

$$f := x \rightarrow x^2 + 1 \qquad (5.1.8)$$

> $f := x \rightarrow x^2 + 1 : f := f(x);$

$$f := x^2 + 1 \qquad (5.1.9)$$

>

## 1.6.2 Procédures

> $toto := \textbf{proc}(f, N)$
> $\textbf{local}\ i, tmp;$
> $tmp := 0 :$
> $\textbf{for}\ i\ \textbf{from}\ 1\ \textbf{to}\ N$
> $\textbf{do}\ tmp := tmp + \frac{1}{N} \cdot evalf\left( subs\left( x = \frac{i}{N}, f \right) \right);$
> $\textbf{od}:$
> $tmp;$
> $\textbf{end proc}:$

> $f := x^2; N := 10 :$
> $toto(f, N);$
> $evalf\left(\frac{1}{3}\right);$

$$f := x^2$$
$$0.3850000000$$
$$0.3333333333 \qquad (5.2.1)$$

> $f := x^2; N := 1000000 :$
> $toto(f, N);$
> $evalf\left(\frac{1}{3}\right);$

$$f := x^2$$
$$0.3333338373$$
$$0.3333333333 \qquad (5.2.2)$$

> $f := \exp(-x^2) :$
> $toto(f, 100);$

$$0.7436573982 \qquad (5.2.3)$$

>

## 1.7 Les tableaux

### 1.7.1 La commande array

> $N := 100:$
$c := array(1..N):$

> $c[6];$

$$c_6 \quad \textbf{(6.1.1)}$$

> $c[6] := 1;$
$c[6];$

$$c_6 := 1$$
$$1 \quad \textbf{(6.1.2)}$$

> $c[-5] := 2;$

Error, 1st index, -5, smaller than lower array bound 1

> $deb := -10 : fin := 15 :$
$c := array(deb..fin);$

$$c := array(-10..15, [\,]) \quad \textbf{(6.1.3)}$$

> $c[-5] := 12;$

$$c_{-5} := 12 \quad \textbf{(6.1.4)}$$

> $N := 10; M := 12;$
$L := array(1..N, 1..M);$

$$N := 10$$
$$M := 12$$
$$L := array(1..10, 1..12, [\,]) \quad \textbf{(6.1.5)}$$

> $L[3, 11];$

$$L_{3,\,11} \quad \textbf{(6.1.6)}$$

> $N := 100;$
$c := array(1..N);$
$c[1] := \frac{1}{7};$
**for** $k$ **from** 2 **to** $N$
**do** $S := add(c[j], j = 1..k-1):$
$T := add(j \cdot c[j] \cdot c[k-j], j = 1..k-1):$
$c[k] := \frac{6}{5 \cdot k + 9} \cdot \left(T + \frac{1}{3} - S\right);$
**od**:

$$N := 100$$
$$c := array(1..100, [\,])$$

**(6.1.7)**

$$c_1 := \frac{1}{7} \tag{6.1.7}$$

```
> c[100];
```

24437833291126452629510975480779174178758738074039770592618698695522038 7\ (6.1.8)
16377644797454578921818952652368226895298751402776676333308459687691\
80026717426928314339695828958609341102111317660759802411926757204655\
38894591748251050725629434006272439442781009509165246791754411313427\
83357448348474530166859217894314787565991870769040127974987707339397\
32204586664445985332316133390798038019681761472383635195791329900565\
74351324923175784093293136619187078175306015872173393142717204548517\
2810729529214505820662207975592365804 9 /
81752956929286990512987740640367786969849433922110250485764524418523\
70448647494171207453393407600191388080031834009230614855288800846626\
87210462073397694999296081471022507357589428214393627109120678939869\
66871622078232497908334227940441037551899749551009496764737597834211\
81111395904398099730980788813816947936249378073402094872588580287107\
42811478815485899642329797382337754637445432606439974536679792588773\
28120116529123361396175784285013942494256703927662010270949775719709\
98590464718224636350031449997253859778795224210380 8

```
> evalf(c[100]);
```

$$2.989229284\ 10^{-10} \tag{6.1.9}$$

```
> #eval(c);
> #Procédure pour calculer c[N]
> N := 100;
  toto := proc(N)
  local k, S, T, c;
  c := array(1..N);
  c[1] := 1/7;
  for k from 2 to N
  do S := add(c[j], j = 1..k - 1) :
  T := add(j·c[j]·c[k - j], j = 1..k - 1) :
  c[k] := 6/(5·k + 9)·(T + 1/3 - S);
  od:
  end proc:
```

$$N := 100 \tag{6.1.10}$$

```
> evalf(toto(10));
```

$$0.003372444163 \tag{6.1.11}$$

```
>
```

### 1.7.2 Les listes

```
> L := [1, 4, 7];
```
$$L := [1, 4, 7] \quad (6.2.1)$$

```
> nops(L);
```
$$3 \quad (6.2.2)$$

```
> op(2, L);
```
$$4 \quad (6.2.3)$$

```
> L[2];
```
$$4 \quad (6.2.4)$$

```
> seq(i·i, i = 1 ..5);
```
$$1, 4, 9, 16, 25 \quad (6.2.5)$$

```
> L := [seq(i·i, i = 1 ..5)];
```
$$L := [1, 4, 9, 16, 25] \quad (6.2.6)$$

$$> N := 10 :$$
$$L := \left[seq\left(\frac{i}{N}, i = 1 ..N\right)\right];$$
$$f := x \rightarrow \exp(x) :$$
$$map(f, L);$$

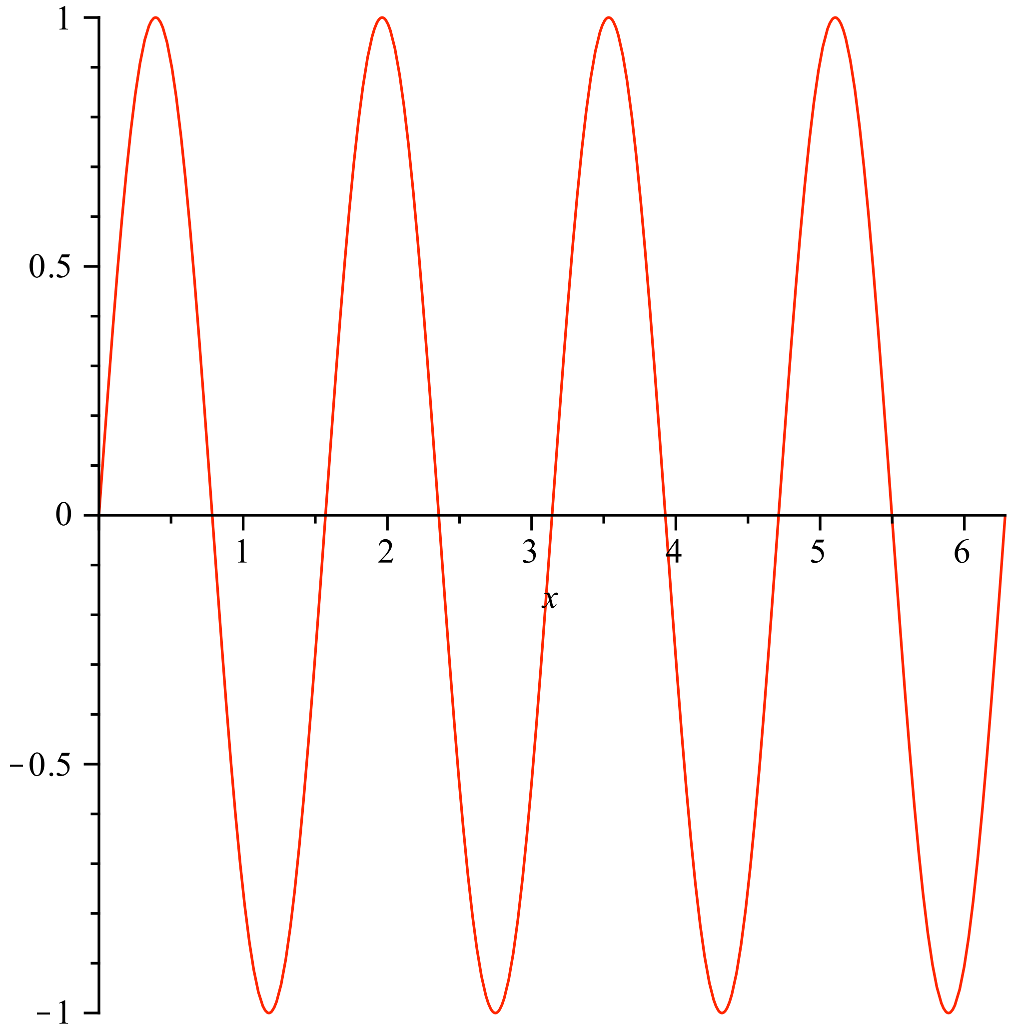
$$L := \left[\frac{1}{10}, \frac{1}{5}, \frac{3}{10}, \frac{2}{5}, \frac{1}{2}, \frac{3}{5}, \frac{7}{10}, \frac{4}{5}, \frac{9}{10}, 1\right]$$
$$\left[e^{\frac{1}{10}}, e^{\frac{1}{5}}, e^{\frac{3}{10}}, e^{\frac{2}{5}}, e^{\frac{1}{2}}, e^{\frac{3}{5}}, e^{\frac{7}{10}}, e^{\frac{4}{5}}, e^{\frac{9}{10}}, e\right] \quad (6.2.7)$$

```
>
```

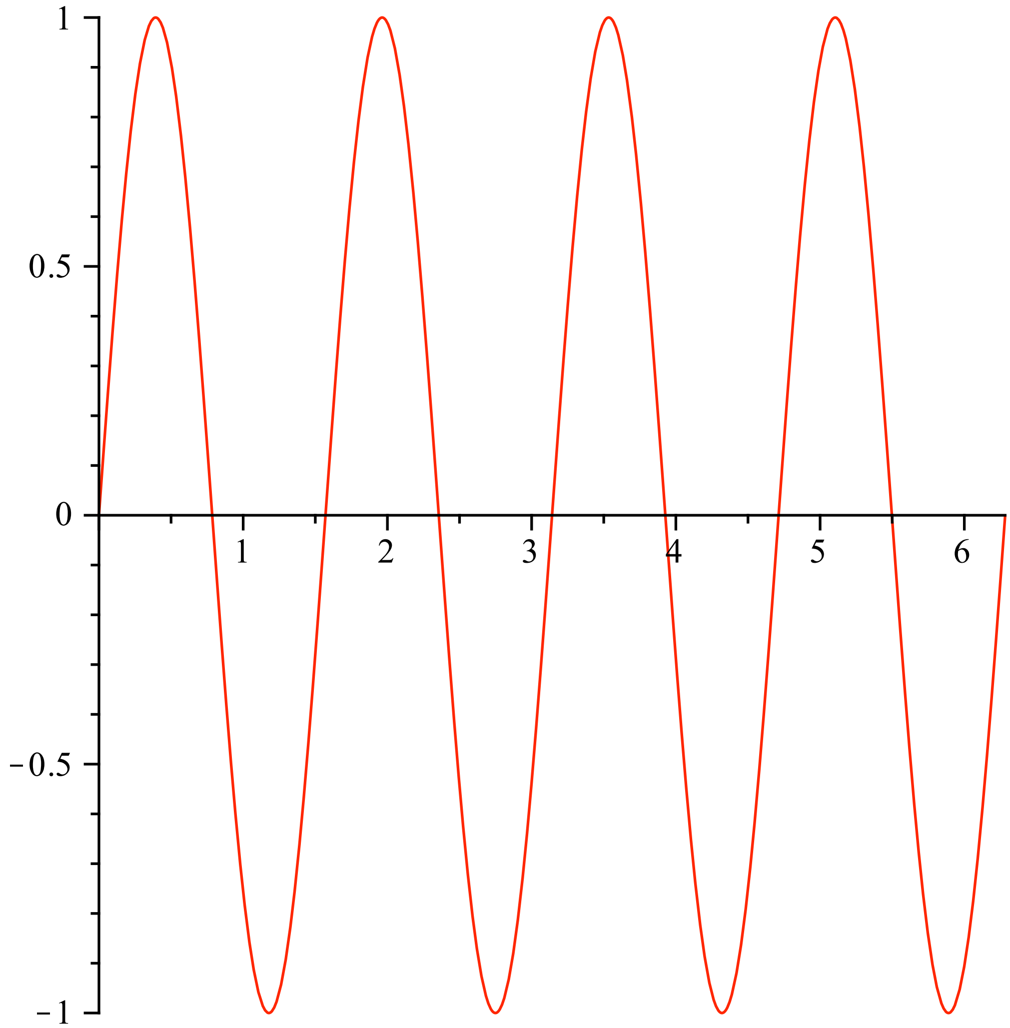
## 1.8 Graphiques

### 1.8.1 Des fonctions

$$> f := \sin(4 \cdot x) :$$
$$plot(f, x = 0 ..2 \cdot \mathrm{Pi});$$



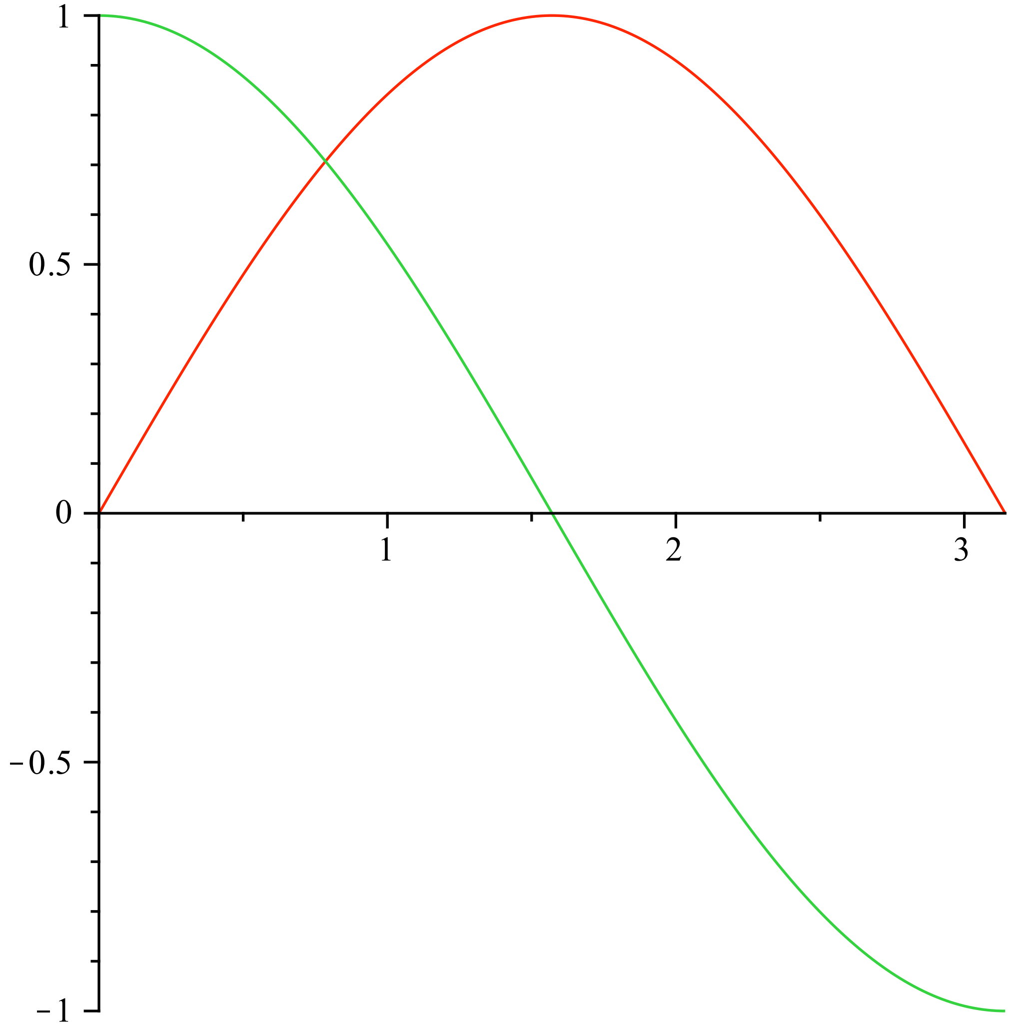

$> f := x \rightarrow \sin(4 \cdot x) :$
$plot(f, 0..2 \cdot \mathrm{Pi});$



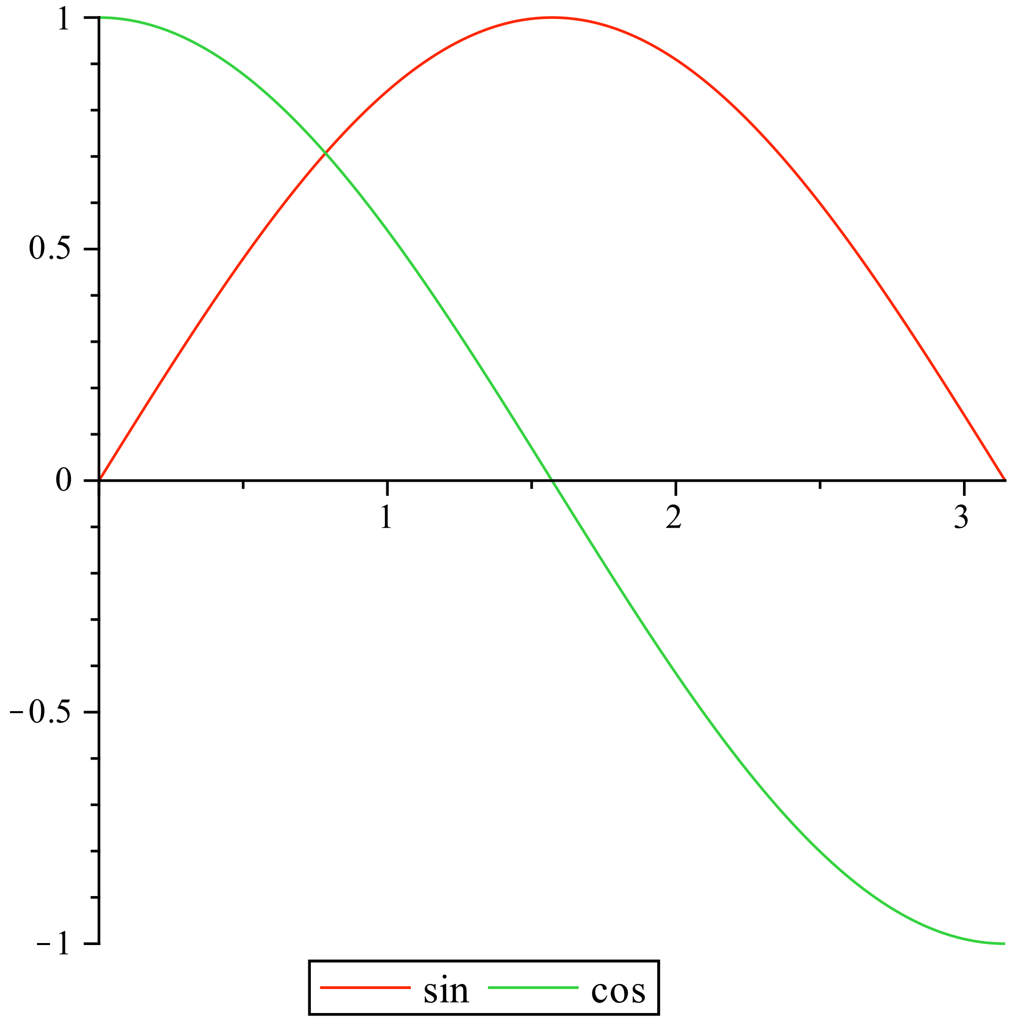

> *plot*( *f*, *x* = 0 ..2 · Pi );

Error, (in plot) expected a range but received x = 0 .. 2*Pi

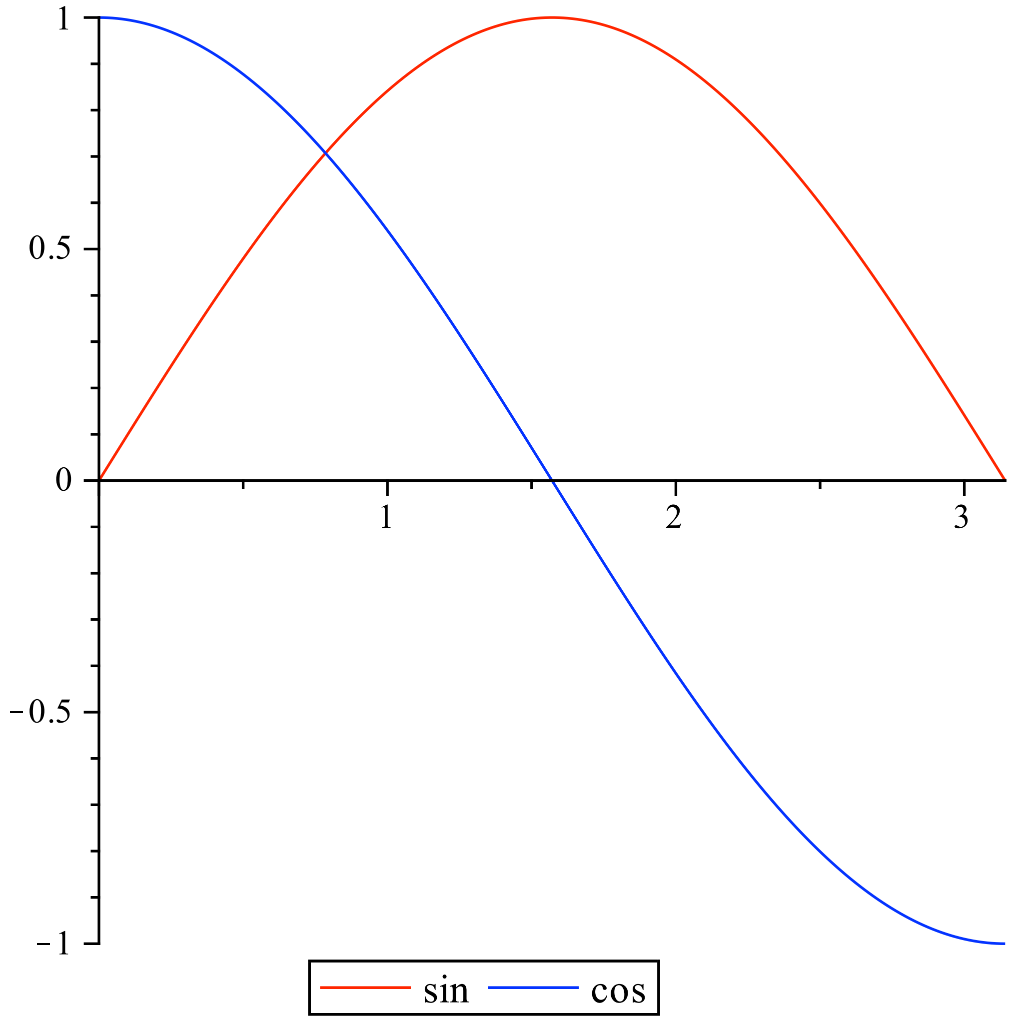
> *plot*( [ sin, cos ], 0 ..Pi );




> *plot*([sin, cos], 0..Pi, *legend* = ["sin", "cos"]);



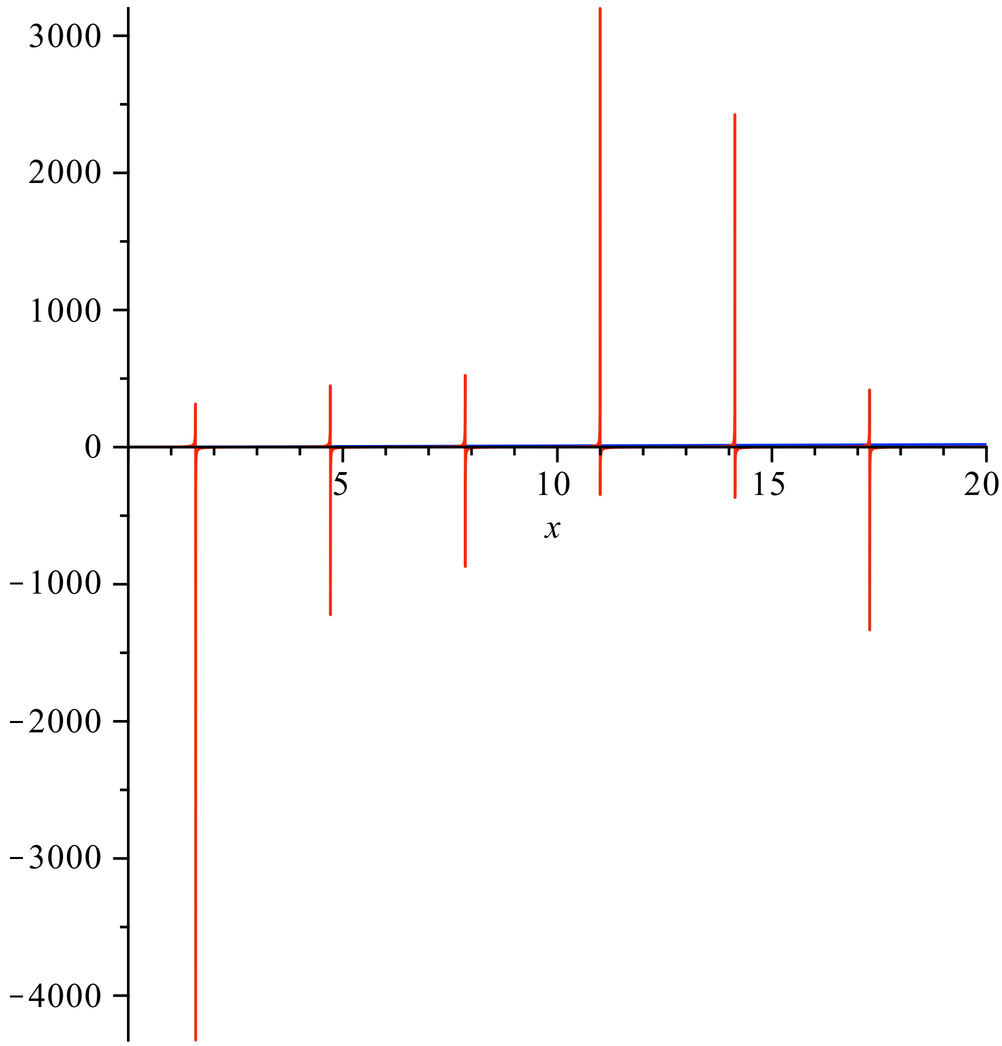

> *plot*( [ sin, cos ], 0 ..Pi, *color* = [ *red*, *blue* ], *legend* = [ "sin", "cos" ] );



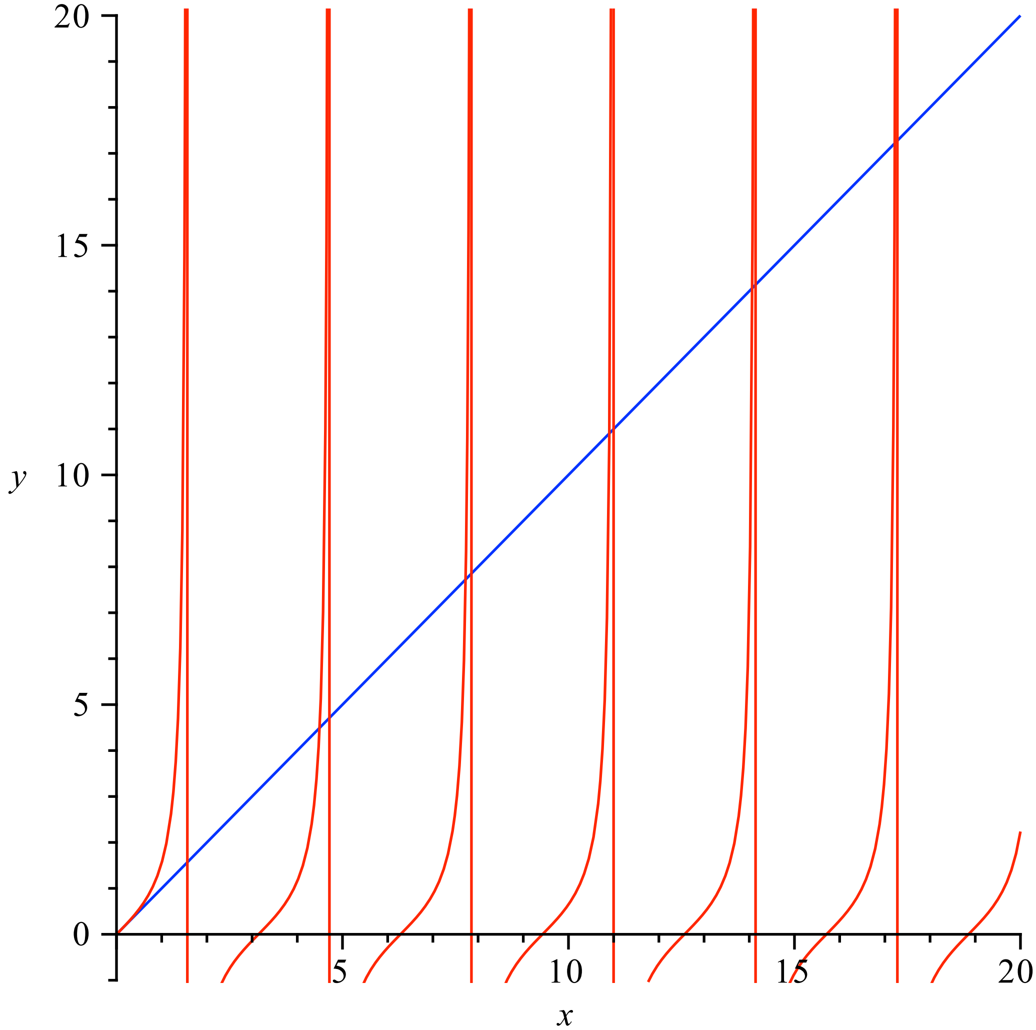

> ?*plot*

> **#Exercice**

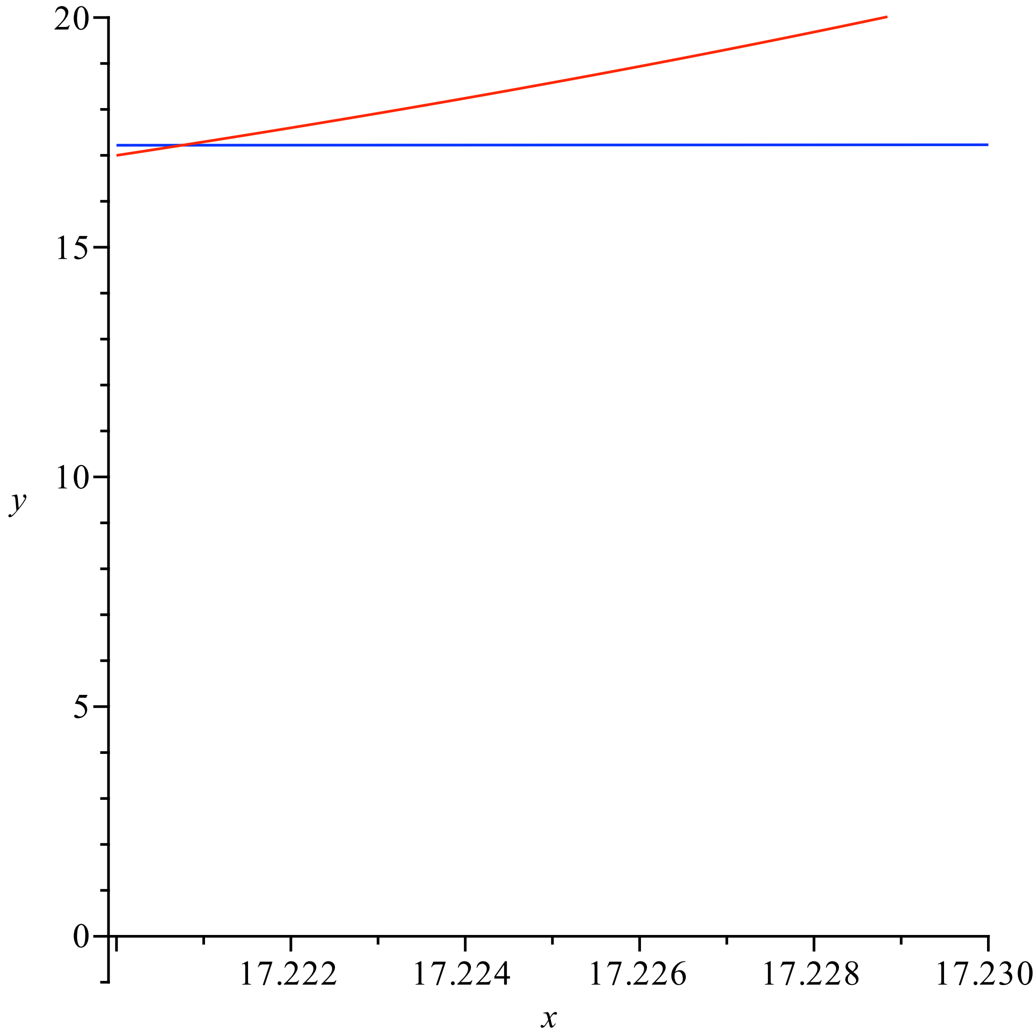
> *plot*( [ *x*, tan( *x* ) ], *x* = 0 ..20, *color* = [ *blue*, *red* ] );




> $plot([x, \tan(x)], x = 0..20, y = -1..20, color = [blue, red]);$




> plot([x, tan(x)], x = 17.22 ..17.23, y = -1 ..20, color = [blue, red]);



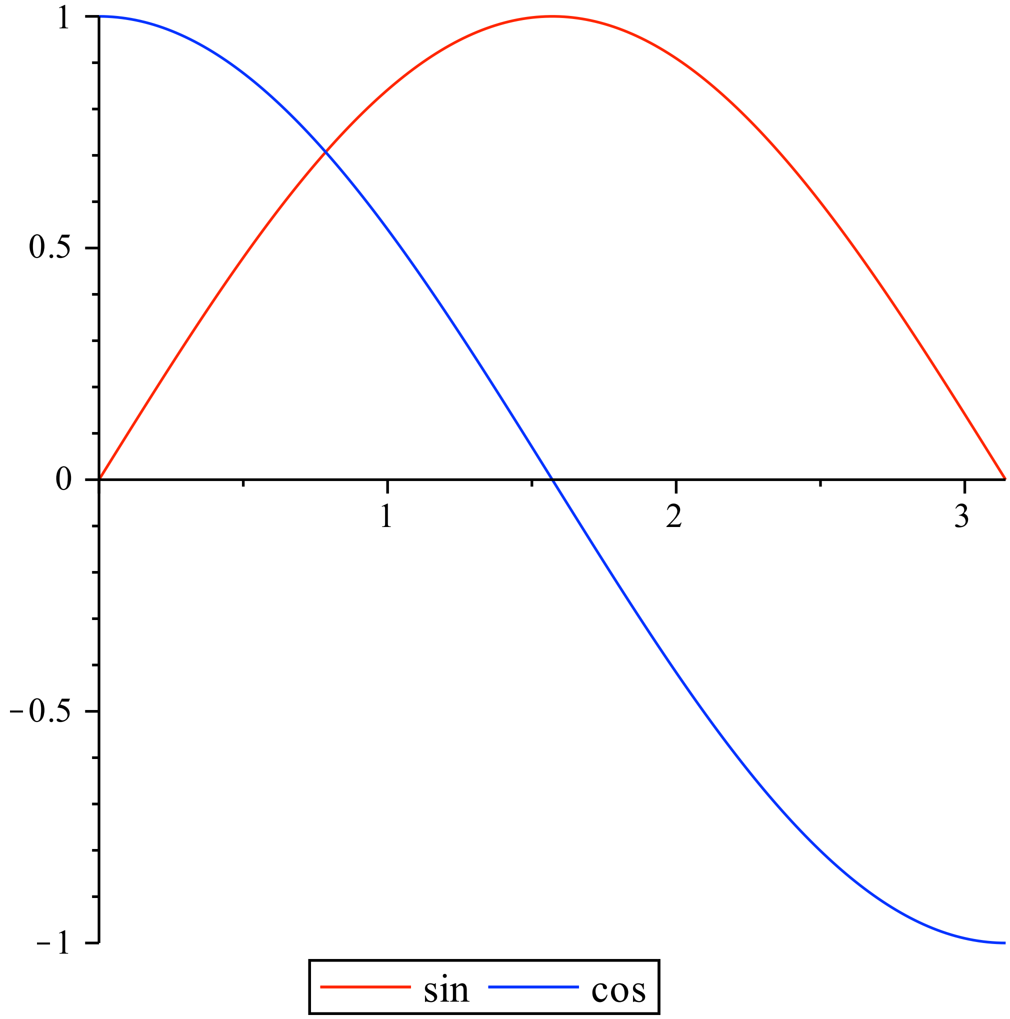

```
> fsolve(x = tan(x), x = 17.22..17.23);
                              17.22075527                                  (7.1.1)
> fsolve(x = tan(x), x = 17.23..17.25);
                    fsolve(x = tan(x), x, 17.23..17.25)                    (7.1.2)
> with(plots);
[animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d,   (7.1.3)
    conformal, conformal3d, contourplot, contourplot3d, coordplot, coordplot3d,
    densityplot, display, dualaxisplot, fieldplot, fieldplot3d, gradplot, gradplot3d,
    implicitplot, implicitplot3d, inequal, interactive, interactiveparams, intersectplot,
    listcontplot, listcontplot3d, listdensityplot, listplot, listplot3d, loglogplot, logplot,
    matrixplot, multiple, odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot,
    polygonplot, polygonplot3d, polyhedra_supported, polyhedraplot, rootlocus,
    semilogplot, setcolors, setoptions, setoptions3d, spacecurve, sparsematrixplot,
    surfdata, textplot, textplot3d, tubeplot]
> #restart;
> G1 := plot(sin, 0..Pi, color = red, legend = "sin");
```

$G1 := PLOT(\ldots)$ **(7.1.4)**

> $G2 := plot(\cos, 0..\text{Pi}, color = blue, legend = \text{"cos"});$

$G2 := PLOT(\ldots)$ **(7.1.5)**

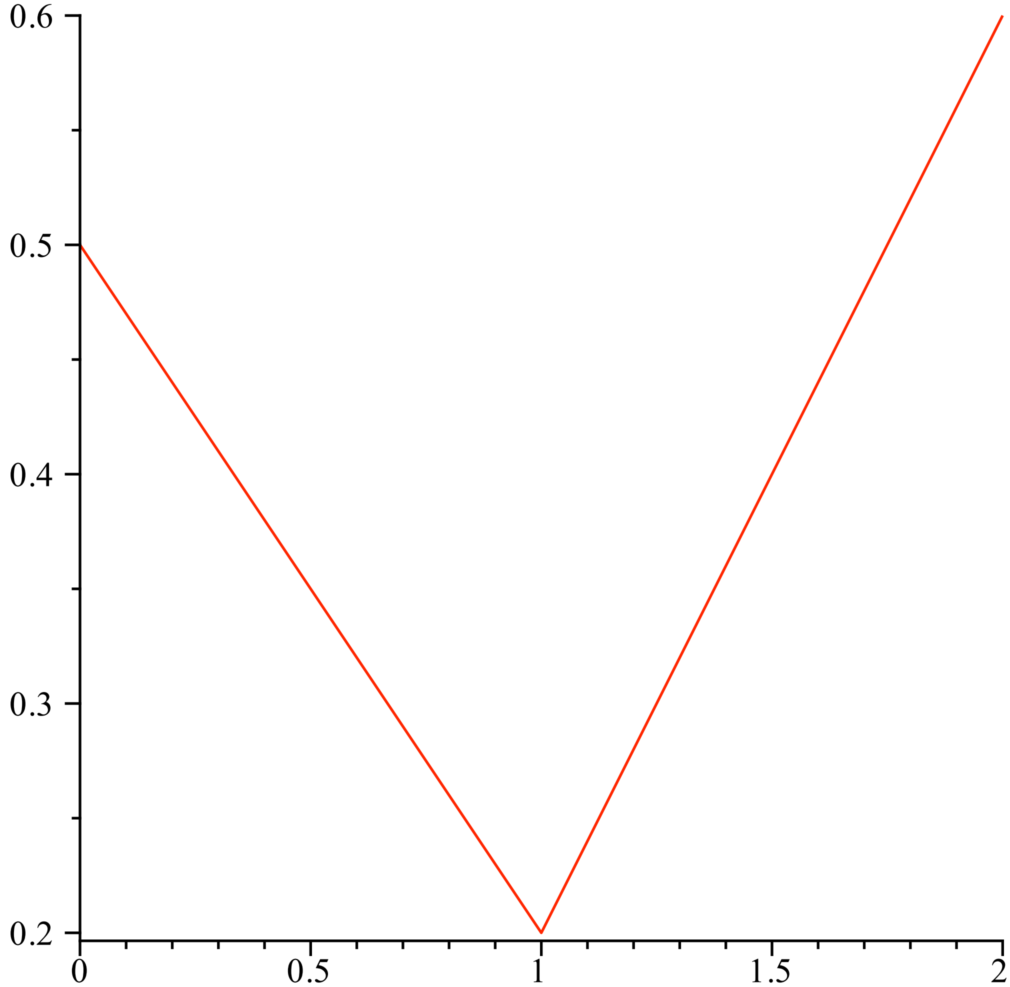
> $display(G1, G2);$



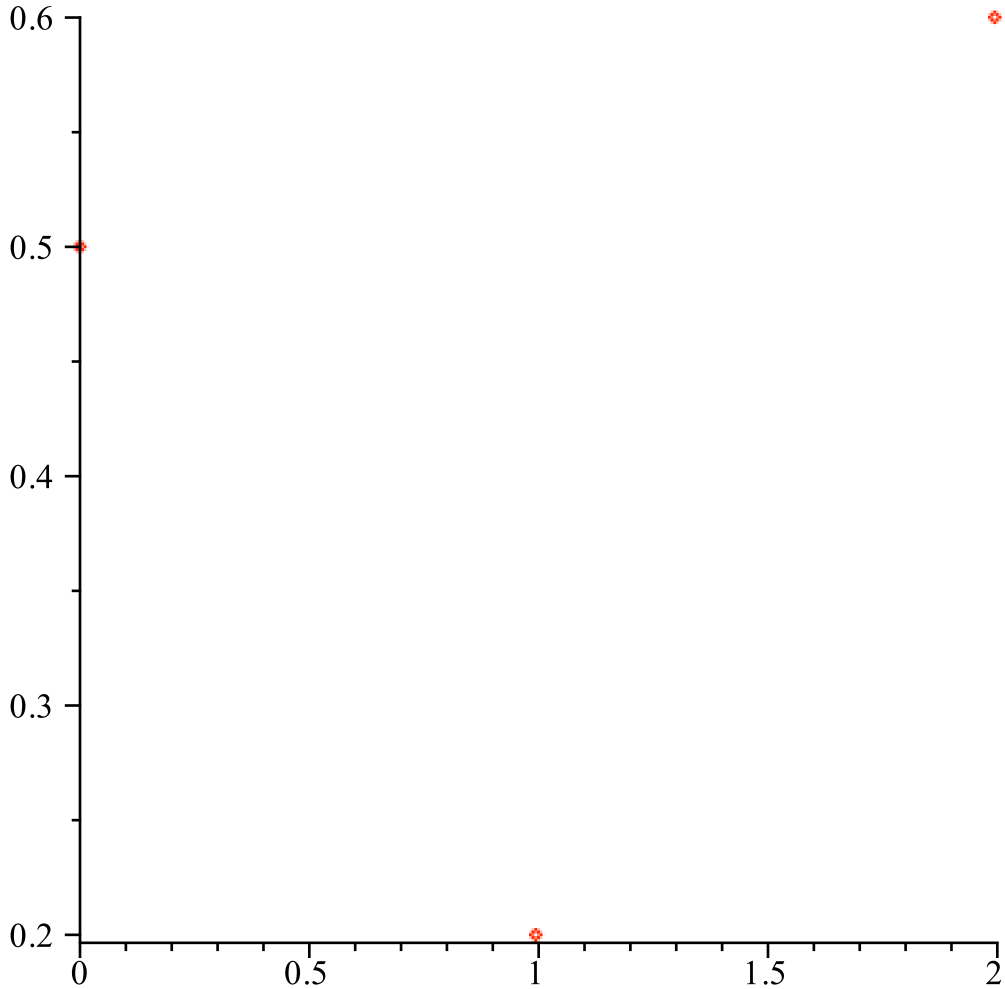

>

## 1.8.2 Un ensemble de points

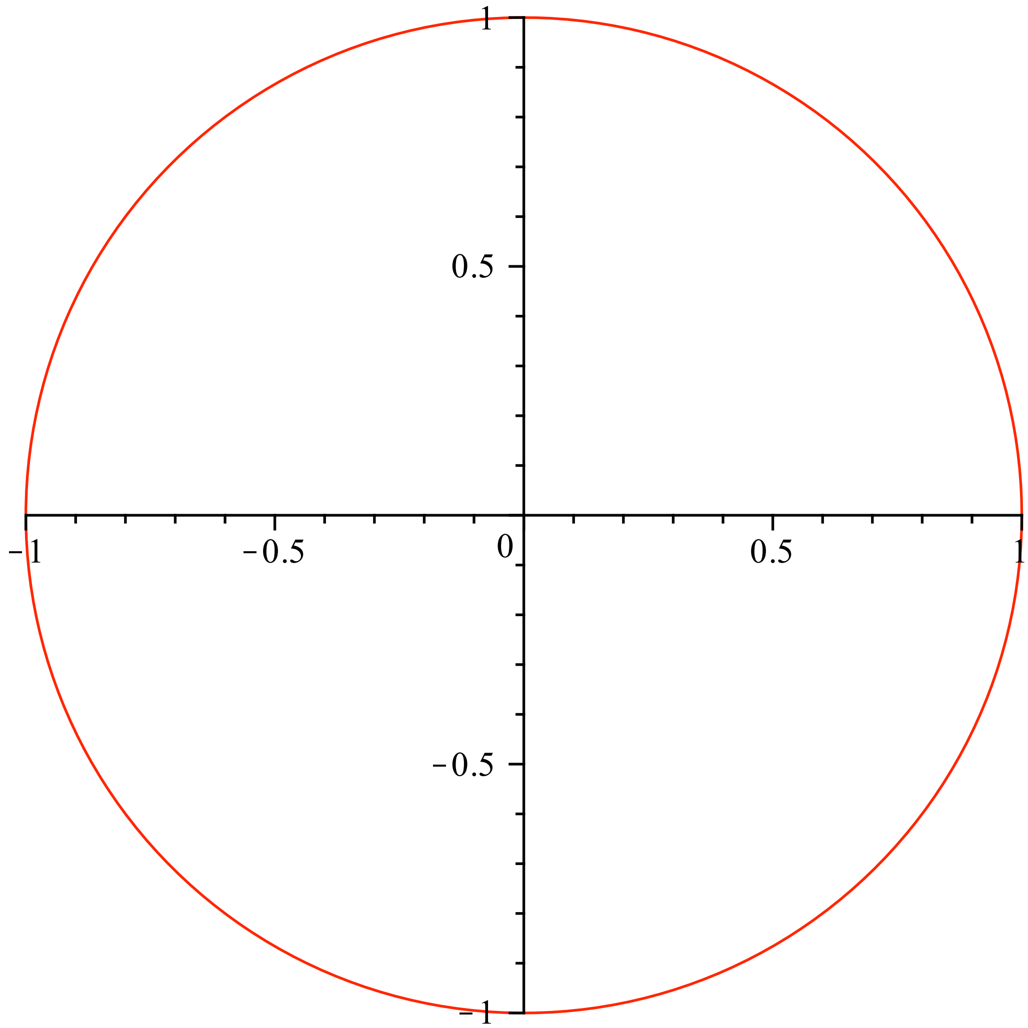
> $plot([[0, 0.5], [1, 0.2], [2, 0.6]]);$



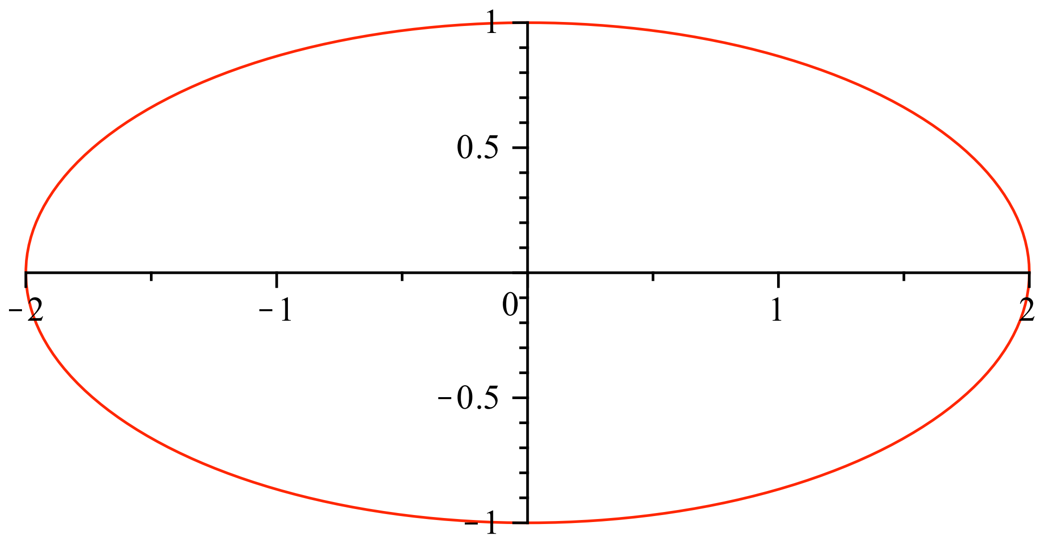

> *plot*( [ [0, 0.5 ], [1, 0.2 ], [2, 0.6 ] ], *style* = *point* );




> $plot([\cos(t), \sin(t), t = 0..2 \cdot \mathrm{Pi}], scaling = constrained);$




> $plot([2\cdot \cos(t), \sin(t), t = 0..2\cdot \mathrm{Pi}], scaling = constrained);$




>

## 1.9 Résolution d'équations différentielles

> $f := x \to x^3;$
> $D(f);$

$$f := x \to x^3$$
$$x \to 3\,x^2 \quad \textbf{(8.1)}$$

> $D(f)(0);$

$$0 \quad \textbf{(8.2)}$$

> $diff(f(x), x);$

$$3\,x^2 \quad \textbf{(8.3)}$$

> $subs(x = 0, diff(f(x), x));$

$$0 \quad \textbf{(8.4)}$$

> D(D(f));

$$x \rightarrow 6\,x \qquad (8.5)$$

> diff(f(x), x, x);

$$6\,x \qquad (8.6)$$

> f := x^3;
  diff(f, x);

$$f := x^3$$

$$3\,x^2 \qquad (8.7)$$

> diff(f(x), x);

$$3\,x(x)^2 \left(\frac{d}{dx}\,x(x)\right) \qquad (8.8)$$

> D(f);

$$3\,\mathrm{D}(x)\,x^2 \qquad (8.9)$$

> **#Résolution eq du ressort**

> m := 2; alpha := 0.5; k := 5;

$$m := 2$$

$$\alpha := 0.5$$

$$k := 5 \qquad (8.10)$$

> ressort := {m·diff(x(t), t, t) + alpha·diff(x(t), t) + k·x(t) = 0};

$$ressort := \left\{2\left(\frac{d^2}{dt^2}\,x(t)\right) + 0.5\left(\frac{d}{dt}\,x(t)\right) + 5\,x(t) = 0\right\} \qquad (8.11)$$

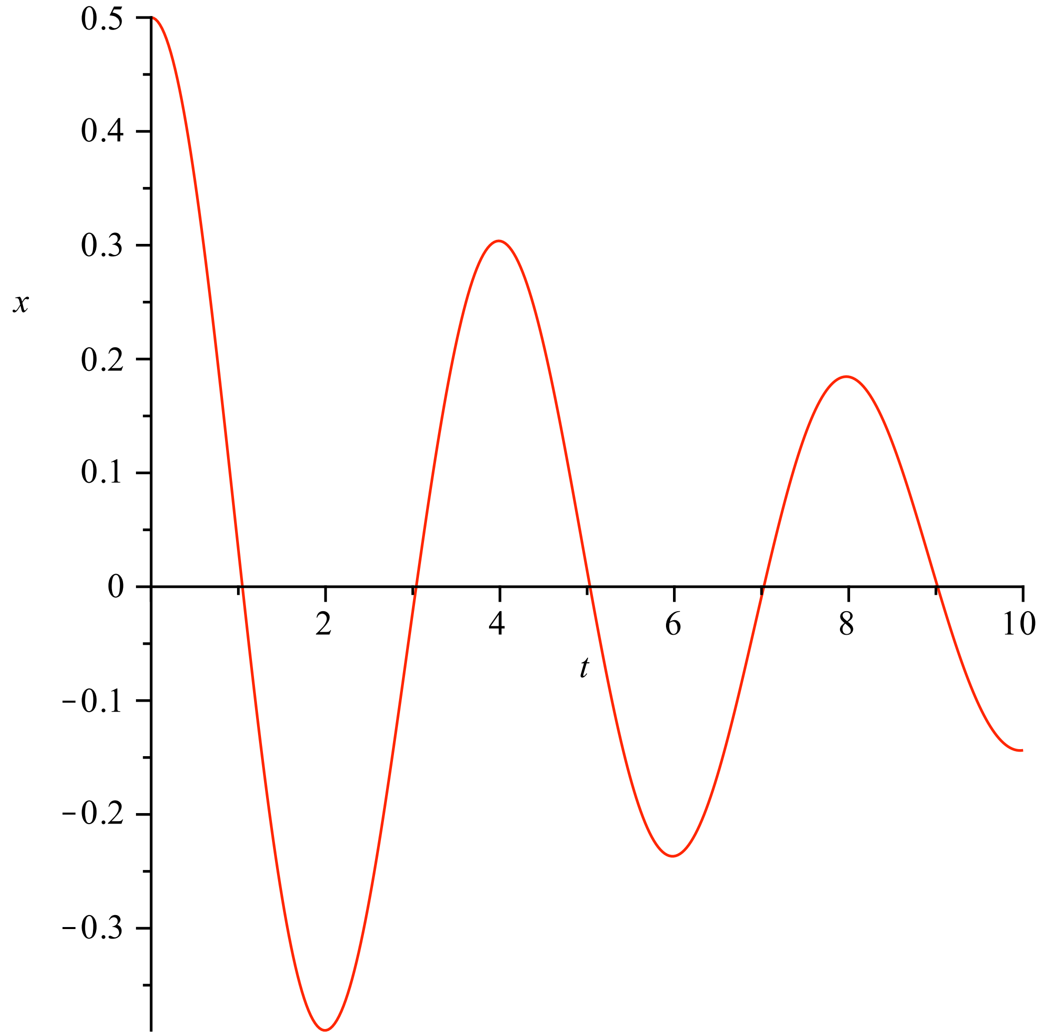
> CI := (a, b) → {x(0) = a, D(x)(0) = b};

$$CI := (a, b) \rightarrow \{x(0) = a, \mathrm{D}(x)(0) = b\} \qquad (8.12)$$

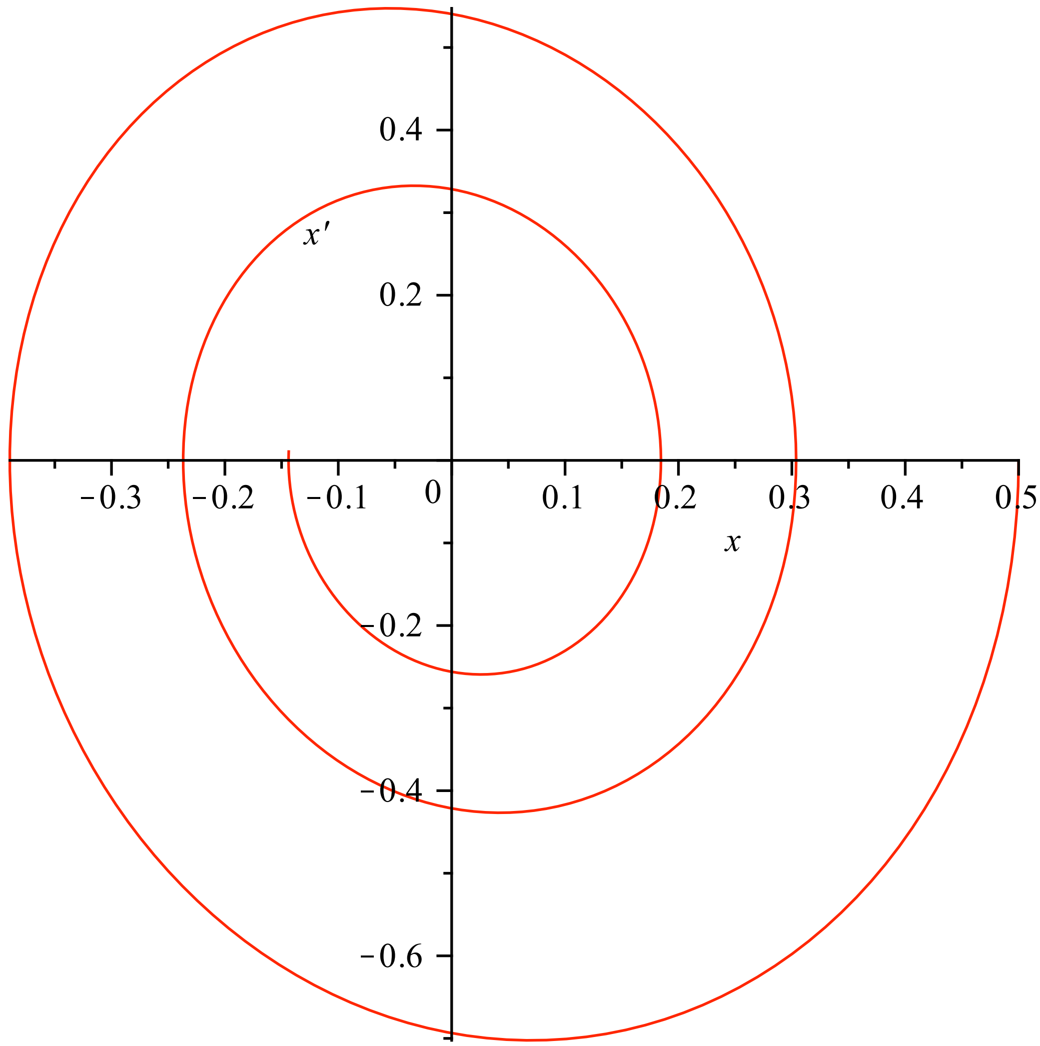
> sol := dsolve(ressort **union** CI(0.5, 0), x(t), numeric);

$$sol := \textbf{proc}(x\_rkf45)\ \ldots\ \textbf{end proc} \qquad (8.13)$$

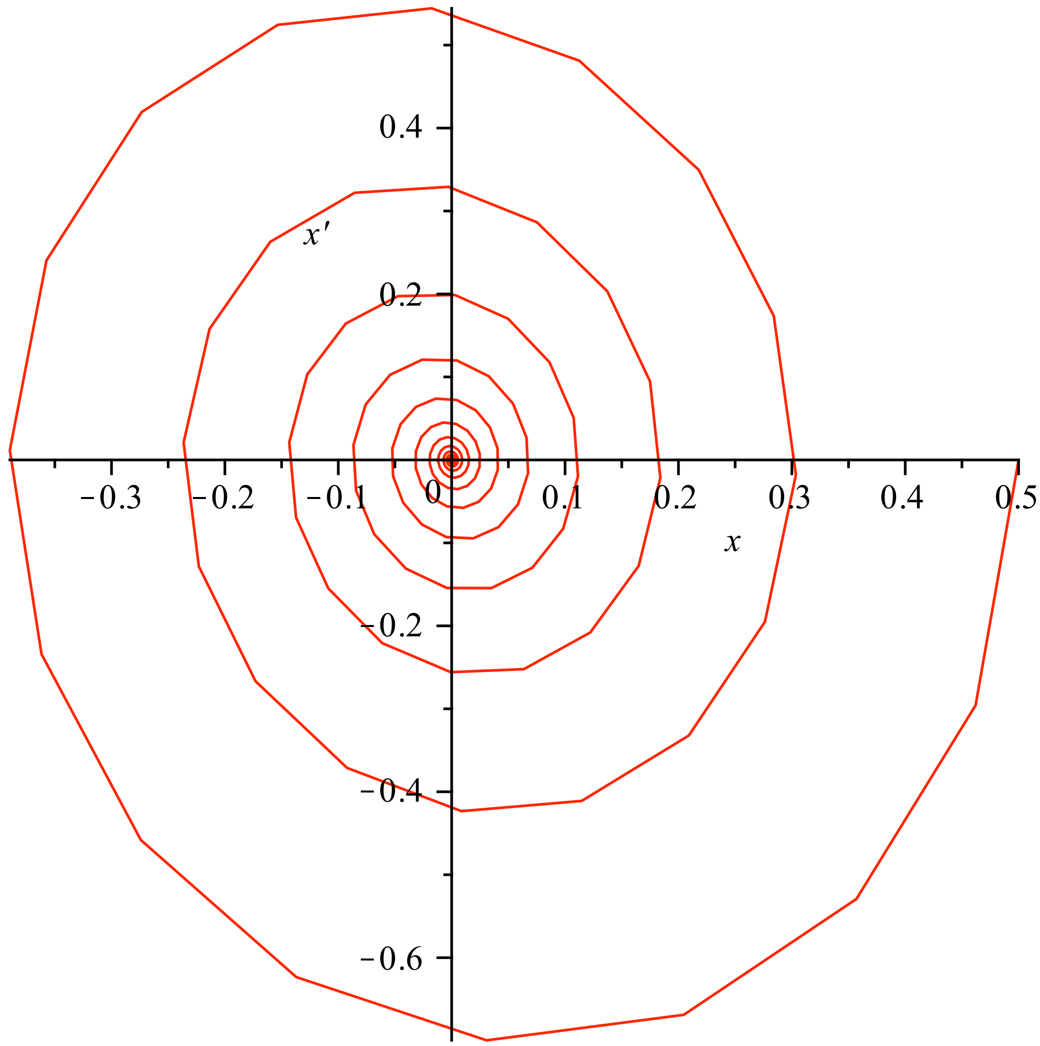
> odeplot(sol, [t, x(t)], 0 ..10, numpoints = 400);




> *odeplot*( *sol*, [ *x*( *t* ), *diff*( *x*( *t* ), *t* ) ], 0 ..10, *numpoints* = 400 );




> odeplot(sol, [x(t), diff(x(t), t)], 0..100, numpoints = 400);




>

## 1.10 Pour s'évaluer

```
> #2)
> Digits := 20;
  evalf(Pi);
```

$$Digits := 20$$

$$3.1415926535897932385 \tag{9.1.1}$$

```
> #3)
> a := 2; a;
```

$$a := 2$$

$$2 \tag{9.1.2}$$

```
> unassign('a');
```

```
> a;
```
$$a \quad (9.1.3)$$

```
> restart;
> #4)
> f := x→sin(2·x);
```
$$f := x \rightarrow \sin(2\,x) \quad (9.1.4)$$

```
> f(0.3);
```
$$0.5646424734 \quad (9.1.5)$$

```
> f(0.5);
```
$$0.8414709848 \quad (9.1.6)$$

```
> f := sin(2·x);
```
$$f := \sin(2\,x) \quad (9.1.7)$$

```
> subs(x = 0.3, f);
```
$$\sin(0.6) \quad (9.1.8)$$

```
> evalf(subs(x = 0.3, f));
```
$$0.5646424734 \quad (9.1.9)$$

```
> evalf(subs(x = 0.5, f));
```
$$0.8414709848 \quad (9.1.10)$$

```
> #5)
> somme := proc(x, y)
  x + y;
  end proc:
> somme(3, 5);
```
$$8 \quad (9.1.11)$$

```
> #6)
> harmonique := proc(N)
  add(1/k, k = 1 ..N);
  end proc:
> harmonique(10);
```
$$\frac{7381}{2520} \quad (9.1.12)$$

```
> evalf(harmonique(10));
```
$$2.928968254 \quad (9.1.13)$$

```
> #7)
> a := 15; b := 20; N := 50;
  L := [seq(a + k·(b − a)/N, k = 0 ..N)];
```
$$a := 15$$
$$b := 20$$
$$N := 50$$

**(9.1.14)**

$$L := \left[15, \frac{151}{10}, \frac{76}{5}, \frac{153}{10}, \frac{77}{5}, \frac{31}{2}, \frac{78}{5}, \frac{157}{10}, \frac{79}{5}, \frac{159}{10}, 16, \frac{161}{10}, \frac{81}{5}, \frac{163}{10}, \frac{82}{5}, \frac{33}{2}, \frac{83}{5}, \frac{167}{10}, \frac{84}{5}, \frac{169}{10}, 17, \frac{171}{10}, \frac{86}{5}, \frac{173}{10}, \frac{87}{5}, \frac{35}{2}, \frac{88}{5}, \frac{177}{10}, \frac{89}{5}, \frac{179}{10}, 18, \frac{181}{10}, \frac{91}{5}, \frac{183}{10}, \frac{92}{5}, \frac{37}{2}, \frac{93}{5}, \frac{187}{10}, \frac{94}{5}, \frac{189}{10}, 19, \frac{191}{10}, \frac{96}{5}, \frac{193}{10}, \frac{97}{5}, \frac{39}{2}, \frac{98}{5}, \frac{197}{10}, \frac{99}{5}, \frac{199}{10}, 20\right] \quad \textbf{(9.1.14)}$$

```
> #8)
> f := x→cos(Pi·x);
```

$$f := x \rightarrow \cos(\pi x) \quad \textbf{(9.1.15)}$$

```
> fL := map(f, L);
```

$$fL := \left[-1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1, \cos\left(\frac{1}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{2}{5}\pi\right), 0, -\cos\left(\frac{2}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{1}{10}\pi\right), -1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1, \cos\left(\frac{1}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{2}{5}\pi\right), 0, -\cos\left(\frac{2}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{1}{10}\pi\right), -1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1\right] \quad \textbf{(9.1.16)}$$

```
> #9)
> restart;
> N := 100 :
  c := array(0..N) :
  c[0] := 1;
  for n from 0 to N − 1
  do c[n + 1] := add(c[k], k = 0..n) :
  od:
```

$$c_0 := 1 \quad \textbf{(9.1.17)}$$

```
> c[100];
```

$$633825300114114700748351602688 \quad \textbf{(9.1.18)}$$

```
> #10;
> nbpositif := proc(L)
```

```
local nbpos, N, i :
nbpos := 0 :
N := nops(L) :
for i from 1 to N do
if (op(i, L) > 0) then
nbpos := nbpos + 1 :
fi:
od:
nbpos :
end proc:
> L := [4, 7, -6, -9, 9] :
nbpositif(L);
```

$$3 \quad (9.1.19)$$

```
>
```