1

$$1 \tag{1}$$

```
plotseq := proc(f,x0, n)
  local x, i, t;
   x[0] := x0;
  for i from 1 to n do x[i] := simplify(f(x[i − 1])); end;
  for i from 1 to n do x[i] := evalf(x[i]); end;
   plot([[t, x[t]]$t = 0 ..n], style = point)
end:

plotseqs := proc(f,xs, n)
   local myplots, x, i, t, x0;
   myplots := Array([ ]);
   for x0 in xs do
      x[0] := (x0);
       for i from 1 to n do x[i] := simplify(f(x[i − 1])); end;
     # print(x);
      myplots := ArrayTools:-Append(myplots, plot([[t, x[t]]$t = 0 ..n], style = point));
      Delete(x);
  end;
  plots:-display( convert( myplots, list ) );
end:
w := [1 , 2, 3];
for u in w do print(u); end
```

$$w := [1, 2, 3]$$

$$1$$

$$2$$

$$3 \tag{2}$$

(a)

$$a \tag{3}$$

$$f11(x) := -\frac{1}{2}x$$

$$f11 := x \mapsto -\frac{x}{2} \tag{4}$$

```
x0 := solve(x = f11(x));
```

$$x0 := 0 \tag{5}$$

```
abs(D(f11) (x0)) < 1
```

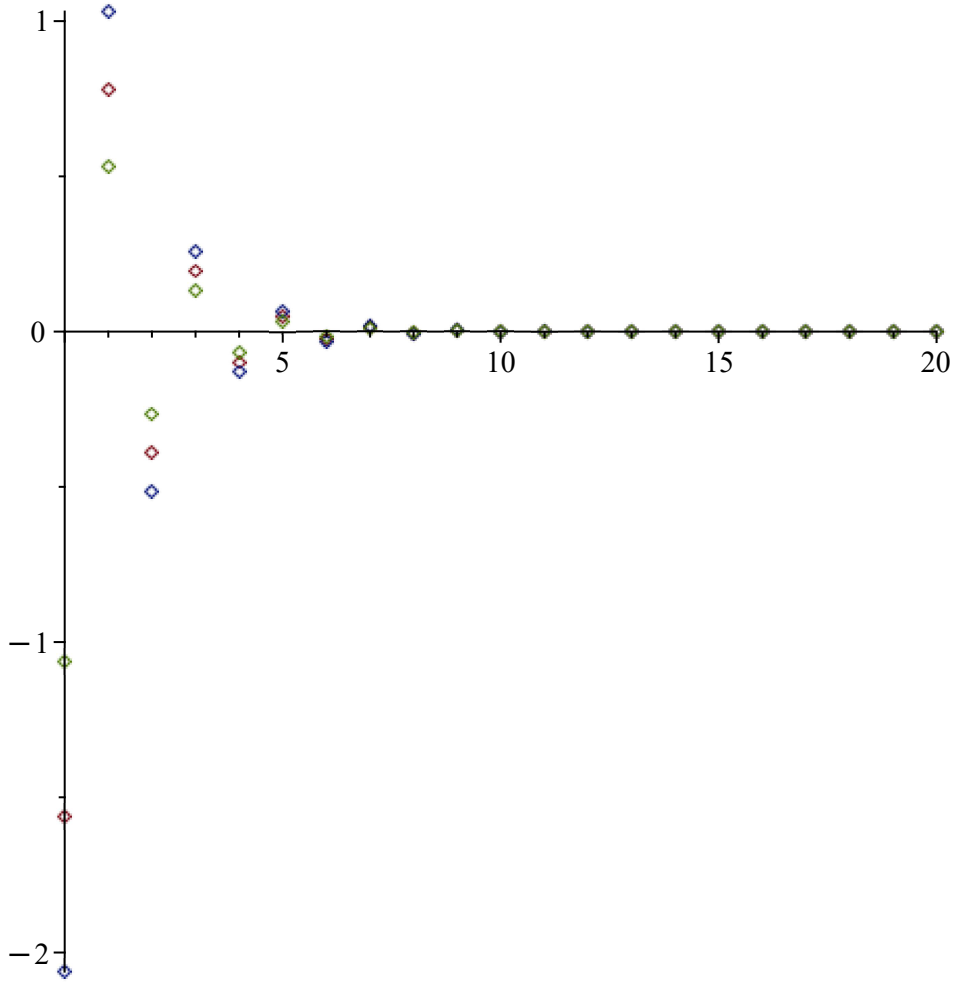
$$0 < 1 \tag{6}$$

 # x0 locally asymptotically stable

(7)

$$4.123105626 \tag{8}$$

$$plotseqs\left(f11, \left[x0, x0 - \frac{1}{2}, x0 + \frac{1}{2}\right], 20\right)$$



b

$$b \tag{9}$$

$f12(x) := x^2 - 4$

$$f12 := x \mapsto x^2 - 4 \tag{10}$$

$x0, x1 := solve(x = f12(x))$

$$x0, x1 := \frac{1}{2} - \frac{\sqrt{17}}{2}, \frac{1}{2} + \frac{\sqrt{17}}{2} \tag{11}$$

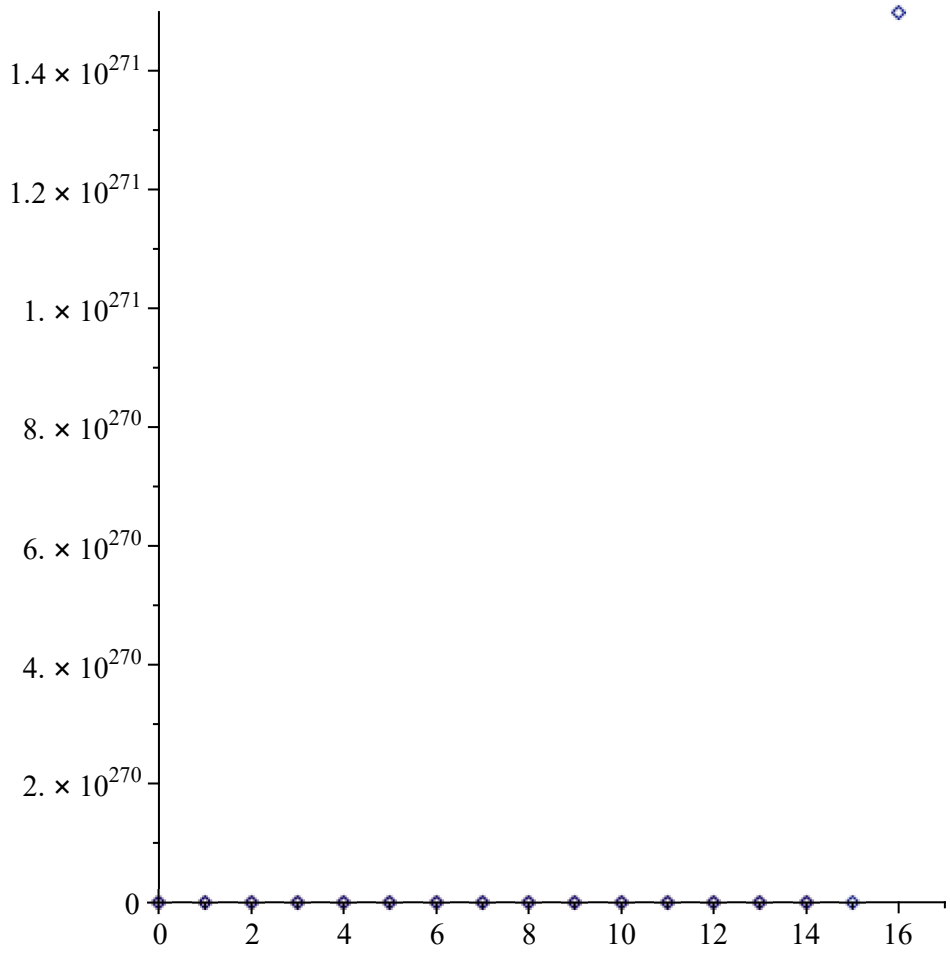
$evalf(\mathrm{abs}(\mathrm{D}(f12)(x0))) < 1$

$$3.123105626 < 1 \tag{12}$$

$evalf(\mathrm{abs}(\mathrm{D}(f12)(x1))) < 1$

$$5.123105626 < 1 \tag{13}$$

$plotseqs(f12, [x0 + 0.01, x0 - 0.01], 17)$



c

$$c \tag{14}$$

$$f13(x) := \frac{2x}{1+x}$$

$$f13 := x \mapsto \frac{2 \cdot x}{x+1} \tag{15}$$

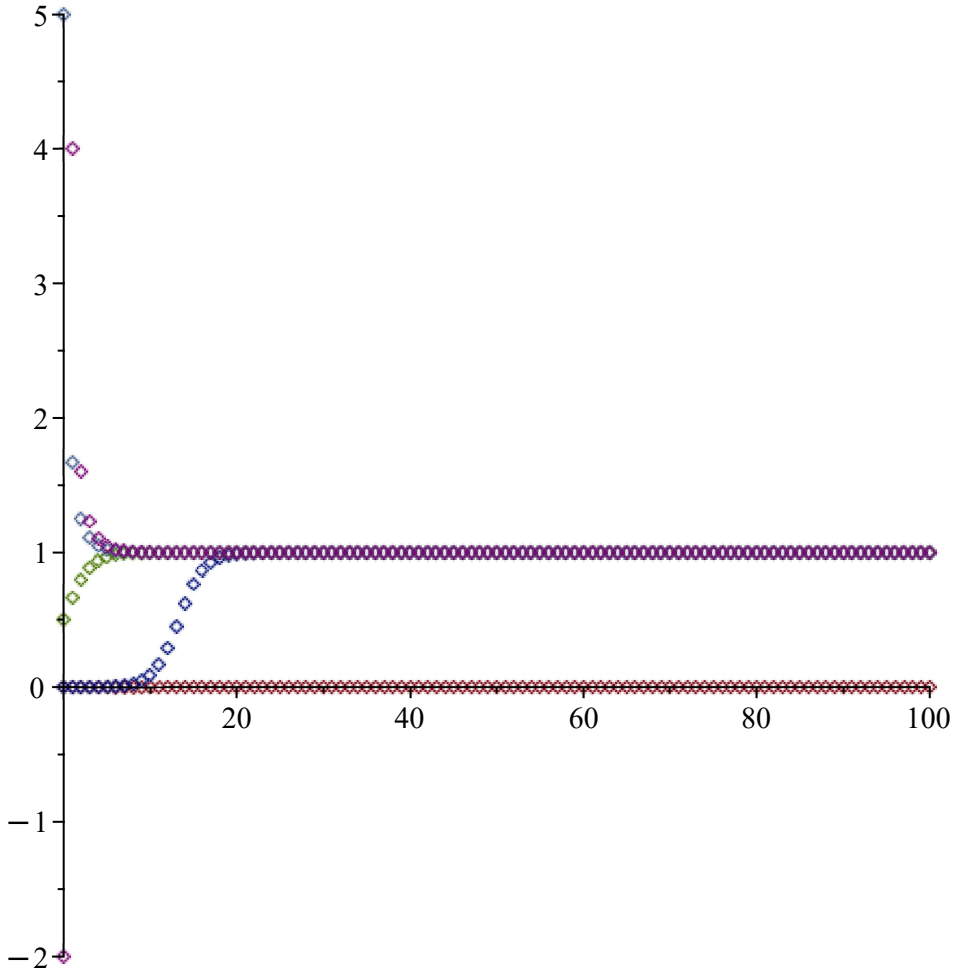
$$x0, x1 := solve(x = f13(x))$$

$$x0, x1 := 0, 1 \tag{16}$$

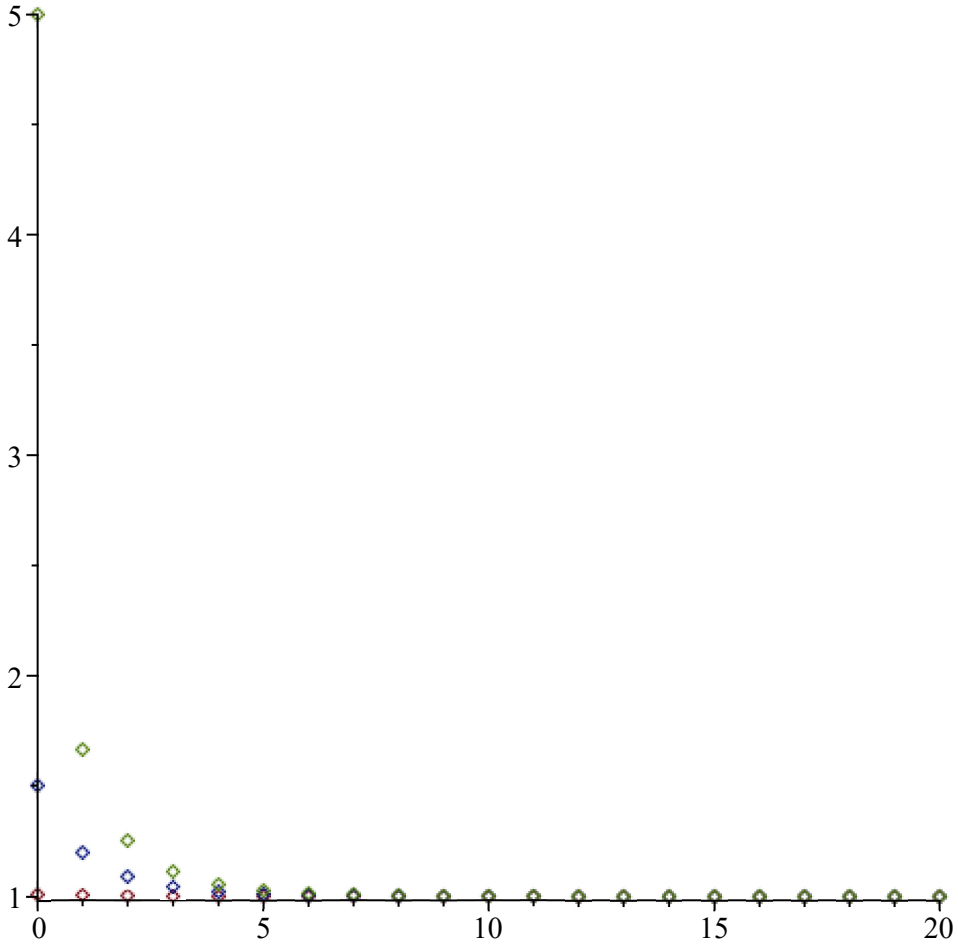
$$evalf(\mathrm{abs}(\mathrm{D}(f13)(x0))) < 1;$$
$$evalf(\mathrm{abs}(\mathrm{D}(f13)(x1))) < 1$$

$$2. < 1$$
$$0.5000000000 < 1 \tag{17}$$

$$plotseqs\left(f13, \left[x0, x0 + 0.0001, x0 + \frac{1}{2}, x0 + 5, x0 - 2\right], 100\right)$$



$$plotseqs\left(f13, \left[x1 + 0.01, x1 + \frac{1}{2}, x1 + 4, \right], 20 \right)$$



2

$$2 \tag{18}$$

restart( ) :
$a := 1; b := 2;$

$$a := 1$$

$$b := 2 \tag{19}$$

$f(x,y) := (a \cdot x + b \cdot y \cdot \exp(-y)) \cdot \exp(-x)$

$$f := (x,y) \mapsto (a \cdot x + b \cdot y \cdot e^{-y}) \cdot e^{-x} \tag{20}$$

$x0, x1, x2 := solve(x = f(x,x))$

$$x0, x1, x2 := 0, \ln(2), -I\pi \tag{21}$$

$p1 := D[1](f)\ (x0,x0)$

$$p1 := 1 \tag{22}$$

$p2 := D[2](f)\ (x0,x0)$

$$p2 := 2 \tag{23}$$

$g(x) := p1 \cdot x + p2$

$$g := x \mapsto p1 \cdot x + p2 \tag{24}$$

 # g are eq. caract. $q^2 = p1 \cdot q + p2$ *cu sol.* $q1, q2$. *Daca* $|q1, 2| < 1 \Rightarrow x0$ *is loc. asympt. stable*
cheq :=

$g := simplify(g(x))$

$$g := x + 2 \tag{25}$$

3

if alpha+beta<1, then 0 is stable eq point;
p1 = df/du, p2 = df/dv, p3 = df/dw; y_n+2 = p1 y_n+1 + p2 y_n + p3, q^3-p1q^2+p2q+p3=> |q1,2|<1?

2

$$2 \tag{26}$$

4

$$4 \tag{27}$$

$restart;\ with(linalg)$

$$[BlockDiagonal, GramSchmidt, JordanBlock, LUdecomp, QRdecomp, Wronskian, addcol, addrow, adj, adjoint, angle, augment, backsub, band, basis, bezout, blockmatrix, charmat, charpoly, cholesky, col, coldim, colspace, colspan, companion, concat, cond, copyinto, crossprod, curl, definite, delcols, delrows, det, diag, diverge, dotprod, eigenvals, eigenvalues, eigenvectors, eigenvects, entermatrix, equal, exponential, extend, ffgausselim, fibonacci, forwardsub, frobenius, gausselim, gaussjord, geneqns, genmatrix, grad, hadamard, hermite, hessian, hilbert, htranspose, ihermite, indexfunc, innerprod, intbasis, inverse, ismith, issimilar, iszero, jacobian, jordan, kernel, laplacian, leastsqrs, linsolve, matadd, matrix, minor, minpoly, mulcol, mulrow, multiply, norm, normalize, nullspace, orthog, permanent, pivot, potential, randmatrix, randvector, rank, ratform, row, rowdim, rowspace, rowspan, rref, scalarmul, singularvals, smith, stackmatrix, submatrix, subvector, sumbasis, swapcol, swaprow, sylvester, toeplitz, trace, transpose, vandermonde, vecpotent, vectdim, vector, wronskian] \tag{28}$$

$f41(x,y) := b \cdot y$

$$f41 := (x,y) \mapsto b \cdot y \tag{29}$$

$f42(x,y) := c \cdot x + s \cdot y - d \cdot y^2$

$$f42 := (x,y) \mapsto c \cdot x + s \cdot y - d \cdot y^2 \tag{30}$$

$A := jacobian([f41(x,y), f42(x,y)], [x,y])$

$$A := \begin{bmatrix} 0 & b \\ \vdots & \vdots \end{bmatrix} \tag{31}$$

$subs(x = 0, y = 1, A)$

$$A \tag{32}$$

$A := subs(x = 0, y = 1, eval(A))$

$$A := \begin{bmatrix} 0 & b \\ \vdots & \vdots \end{bmatrix} \tag{33}$$

$l = eigenvals(A)$

$$l = \left(-d + \frac{s}{2} + \frac{\sqrt{4bc + 4d^2 - 4ds + s^2}}{2}, -d + \frac{s}{2} - \frac{\sqrt{4bc + 4d^2 - 4ds + s^2}}{2} \right) \quad (34)$$

#abs(l1, l2) <1 => x0, y0 loc. as. stable

chpoly := *simplify*(*charpoly*(*A*, lambda)); # *ec. caracteristica*

$$chpoly := \lambda^2 + (2d - s)\lambda - bc \quad (35)$$

p2, *p1*, _ := *coeffs*(*chpoly*, lambda)

$$p2, p1, \_ := -bc, 2d - s, 1 \quad (36)$$

||

Error, invalid input: eval received x, which is not valid for its 2nd argument, eqns