```
> #ex1
> with(plots);with(DEtools);
```

[*animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d,*
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]

[*AreSimilar, Closure, DEnormal, DEplot, DEplot3d, DEplot_polygon, DFactor,*   **(1)**
DFactorLCLM, DFactorsols, Dchangevar, Desingularize, FunctionDecomposition, GCRD,
Gosper, Heunsols, Homomorphisms, IVPsol, IsHyperexponential, LCLM, MeijerGsols,
MultiplicativeDecomposition, ODEInvariants, PDEchangecoords, PolynomialNormalForm,
RationalCanonicalForm, ReduceHyperexp, RiemannPsols, Xchange, Xcommutator, Xgauge,
Zeilberger, abelsol, adjoint, autonomous, bernoullisol, buildsol, buildsym, canoni, caseplot,
casesplit, checkrank, chinisol, clairautsol, constcoeffsols, convertAlg, convertsys,
dalembertsol, dcoeffs, de2diffop, dfieldplot, diff_table, diffop2de, dperiodic_sols, dpolyform,
dsubs, eigenring, endomorphism_charpoly, equinv, eta_k, eulersols, exactsol, expsols,
exterior_power, firint, firtest, formal_sol, gen_exp, generate_ic, genhomosol, gensys,
hamilton_eqs, hypergeomsols, hyperode, indicialeq, infgen, initialdata, integrate_sols,
intfactor, invariants, kovacicsols, leftdivision, liesol, line_int, linearsol, matrixDE,
matrix_riccati, maxdimsystems, moser_reduce, muchange, mult, mutest, newton_polygon,
normalG2, ode_int_y, ode_y1, odeadvisor, odepde, parametricsol, particularsol,
phaseportrait, poincare, polysols, power_equivalent, rational_equivalent, ratsols, redode,
reduceOrder, reduce_order, regular_parts, regularsp, remove_RootOf, riccati_system,
riccatisol, rifread, rifsimp, rightdivision, rtaylor, separablesol, singularities, solve_group,
super_reduce, symgen, symmetric_power, symmetric_product, symtest, transinv, translate,
untranslate, varparam, zoom]

```
> ec:=diff(y(x),x)+y(x)*tan(x)=1/cos(x);
```

$$ec := \frac{d}{dx} y(x) + y(x) \tan(x) = \frac{1}{\cos(x)}$$ **(2)**
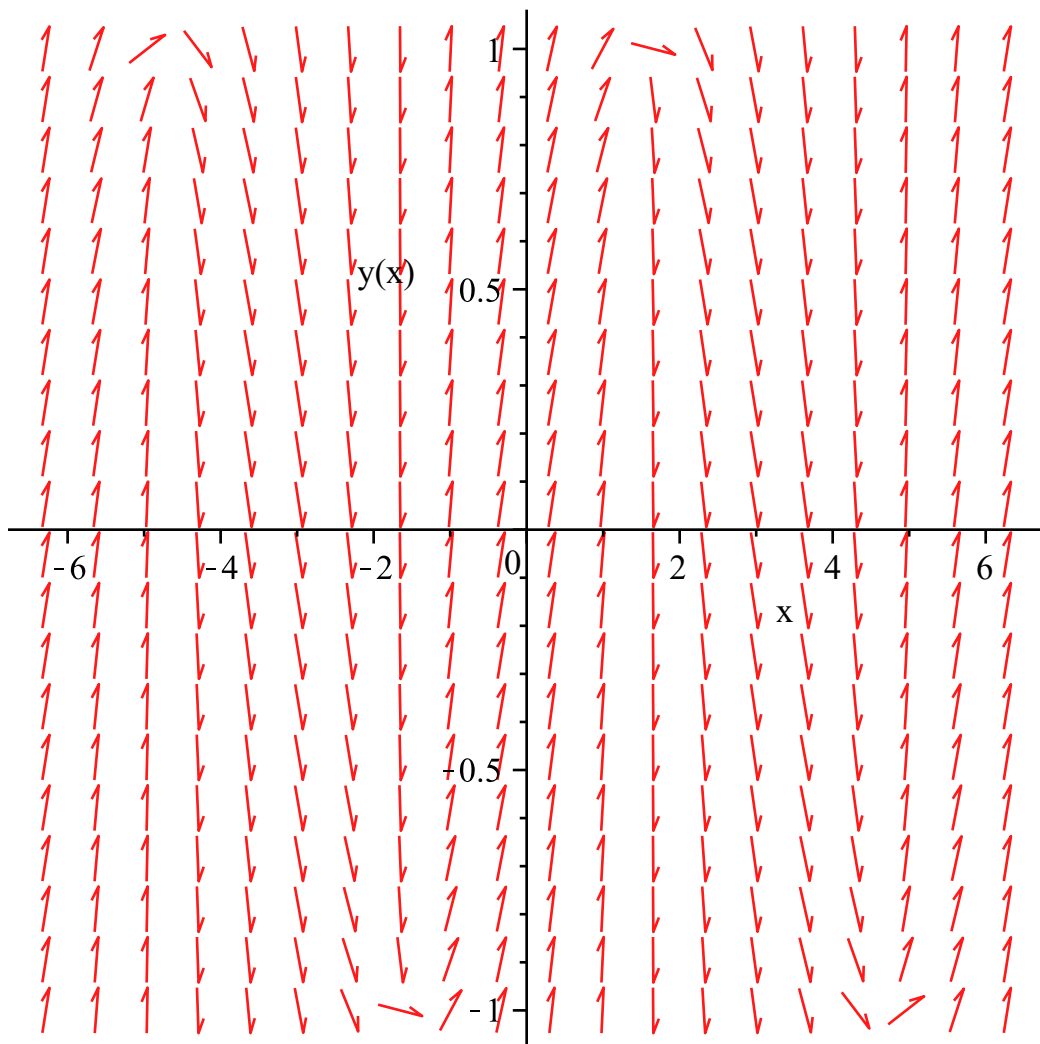
```
> sol:=dsolve(ec,y(x));
```

$$sol := y(x) = \cos(x) \tan(x) + \cos(x) \_C1$$ **(3)**

```
> DEplot(ec,y(x),x=-2*Pi..2*Pi,y=-1..1);
```

```
> cond:=y(Pi)=1;
```

$$cond := y(\pi) = 1 \tag{4}$$

```
> sol_c:=dsolve({ec,cond},y(x));
```

$$sol\_c := y(x) = \cos(x)\,\tan(x) - \cos(x) \tag{5}$$

```
> #ex2
> ec:=(1+x^2)*diff(y(x),x,x)+4*x*diff(y(x),x)+2*y(x)-sin(x)=0;
```

$$ec := \left(1 + x^2\right)\left(\frac{d^2}{dx^2}\,y(x)\right) + 4\,x\left(\frac{d}{dx}\,y(x)\right) + 2\,y(x) - \sin(x) = 0 \tag{6}$$

```
> sol:=dsolve(ec,y(x));
```

$$sol := y(x) = \frac{\_C2}{1 + x^2} + \frac{\_C1\,x}{1 + x^2} - \frac{\sin(x)}{1 + x^2} \tag{7}$$

```
> cond:=y(0)=3,D(y)(0)=2;
```

$$cond := y(0) = 3, \mathrm{D}(y)(0) = 2 \tag{8}$$

```
> sol_c:=dsolve({ec,cond},y(x));
```

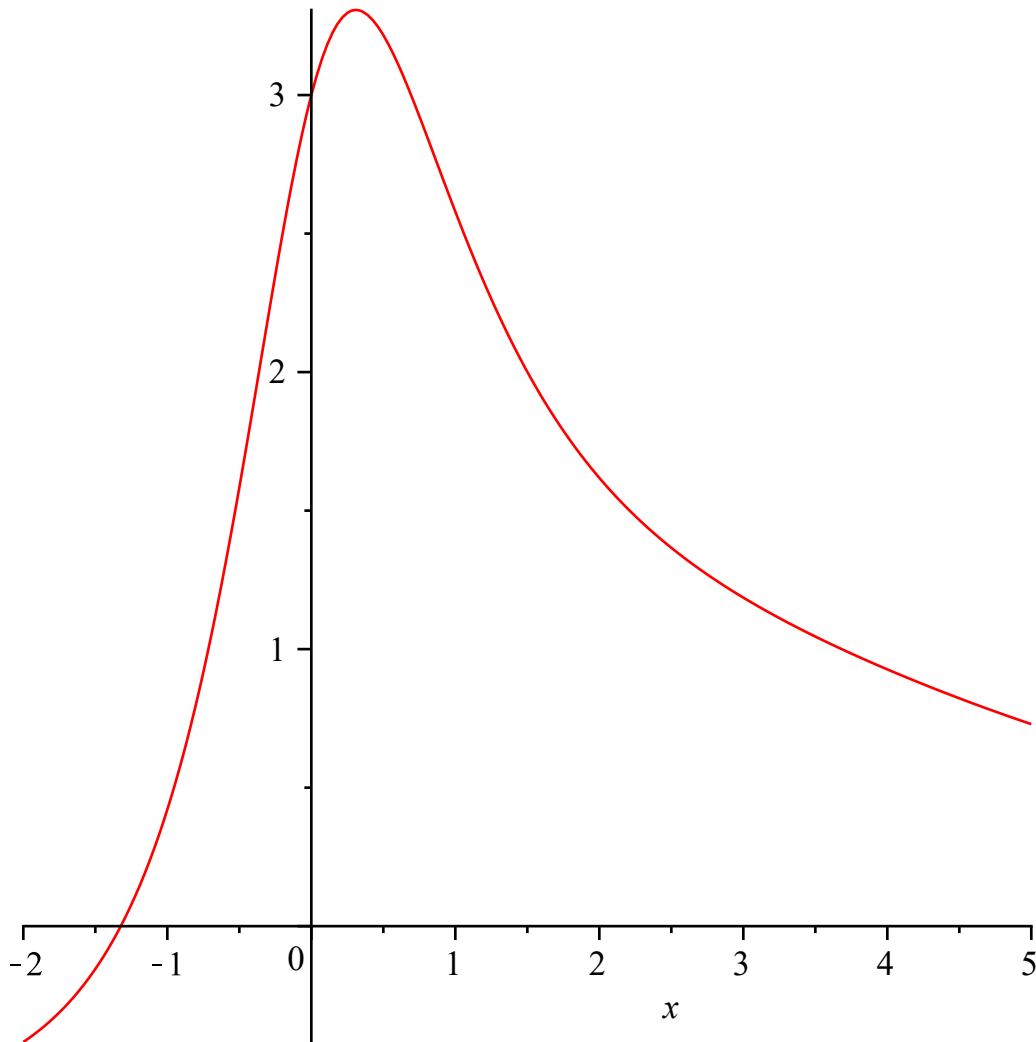$$sol\_c := y(x) = \frac{3}{1 + x^2} + \frac{3\,x}{1 + x^2} - \frac{\sin(x)}{1 + x^2} \tag{9}$$

```
> y1:=unapply(rhs(sol_c),x);
```

$$y1 := x \rightarrow \frac{3}{1+x^2} + \frac{3x}{1+x^2} - \frac{\sin(x)}{1+x^2} \tag{10}$$

> `plot(y1(x),x=-2..5);`

> `#ex3`
> `ec1:=diff(x(t),t)=x(t);`

$$ec1 := \frac{d}{dt} x(t) = x(t) \tag{11}$$

> `ec2:=diff(y(t),t)=x(t)+2*y(t);`

$$ec2 := \frac{d}{dt} y(t) = x(t) + 2 y(t) \tag{12}$$

> `sist:=ec1,ec2;`

$$sist := \frac{d}{dt} x(t) = x(t), \frac{d}{dt} y(t) = x(t) + 2 y(t) \tag{13}$$

> `sol:=dsolve({sist},{x(t),y(t)});`

$$sol := \left\{ x(t) = \_C2\, e^t, y(t) = -\_C2\, e^t + e^{2t}\, \_C1 \right\} \tag{14}$$

> `cond:=x(0)=1,y(0)=4;`

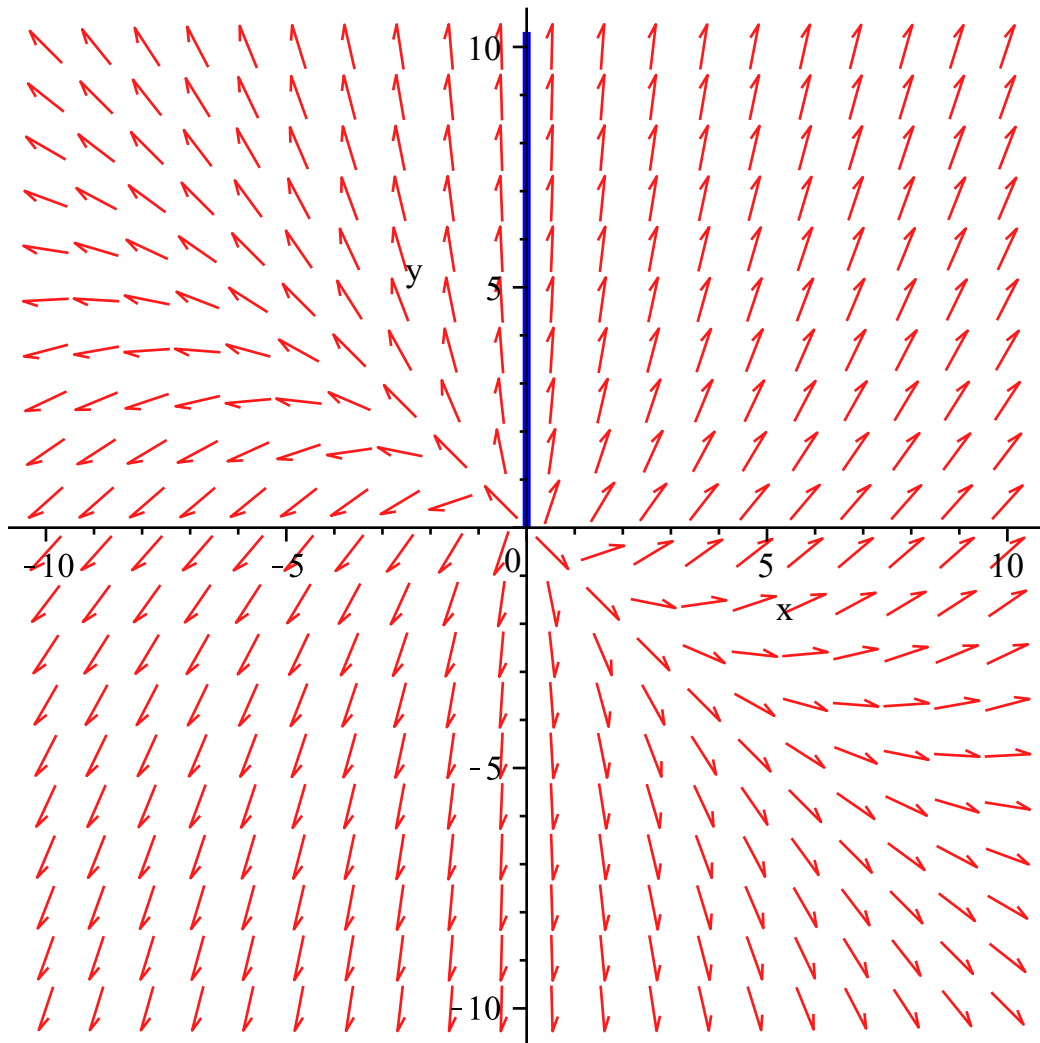$$cond := x(0) = 1, y(0) = 4 \tag{15}$$

> `sol_c:=dsolve({sist,cond},{x(t),y(t)});`

(16)

$$sol\_c := \{x(t) = e^t, y(t) = -e^t + 5\,e^{2\,t}\} \tag{16}$$

```
> DEplot([sist],[x(t),y(t)],t=-4..4,x=-10..10, y=-10..10, [[x(0)=0,
  y(0)=1]],linecolor=blue);
```



```
> #nu este adevarata conditia deoarece sagetiile ies din 0,daca ar
  intra atunci limitele ar fi egale cu 0
> #ex4
> ec:=diff(N(t),t)=k*N(t);
```

$$ec := \frac{\mathrm{d}}{\mathrm{d}t}\,N(t) = k\,N(t) \tag{17}$$

```
> sist:=ec,N(0)=n0;
```

$$sist := \frac{\mathrm{d}}{\mathrm{d}t}\,N(t) = k\,N(t), N(0) = n0 \tag{18}$$

```
> k:=2.5;n0:=500;
```

$$k := 2.5000000000$$
$$n0 := 500 \tag{19}$$

```
> dsolve({sist},N(t));
```

$$N(t) = 500\,e^{\frac{5}{2}\,t} \tag{20}$$

```
> restart; with(plots); with(DEtools);
```

$[$*animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d, 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$]$*

$[$*AreSimilar, Closure, DEnormal, DEplot, DEplot3d, DEplot_polygon, DFactor,*   **(21)**
DFactorLCLM, DFactorsols, Dchangevar, Desingularize, FunctionDecomposition, GCRD, Gosper, Heunsols, Homomorphisms, IVPsol, IsHyperexponential, LCLM, MeijerGsols, MultiplicativeDecomposition, ODEInvariants, PDEchangecoords, PolynomialNormalForm, RationalCanonicalForm, ReduceHyperexp, RiemannPsols, Xchange, Xcommutator, Xgauge, Zeilberger, abelsol, adjoint, autonomous, bernoullisol, buildsol, buildsym, canoni, caseplot, casesplit, checkrank, chinisol, clairautsol, constcoeffsols, convertAlg, convertsys, dalembertsol, dcoeffs, de2diffop, dfieldplot, diff_table, diffop2de, dperiodic_sols, dpolyform, dsubs, eigenring, endomorphism_charpoly, equinv, eta_k, eulersols, exactsol, expsols, exterior_power, firint, firtest, formal_sol, gen_exp, generate_ic, genhomosol, gensys, hamilton_eqs, hypergeomsols, hyperode, indicialeq, infgen, initialdata, integrate_sols, intfactor, invariants, kovacicsols, leftdivision, liesol, line_int, linearsol, matrixDE, matrix_riccati, maxdimsystems, moser_reduce, muchange, mult, mutest, newton_polygon, normalG2, ode_int_y, ode_y1, odeadvisor, odepde, parametricsol, particularsol, phaseportrait, poincare, polysols, power_equivalent, rational_equivalent, ratsols, redode, reduceOrder, reduce_order, regular_parts, regularsp, remove_RootOf, riccati_system, riccatisol, rifread, rifsimp, rightdivision, rtaylor, separablesol, singularities, solve_group, super_reduce, symgen, symmetric_power, symmetric_product, symtest, transinv, translate, untranslate, varparam, zoom$]$

```
> ec:=diff(N(t),t)=k*N(t);
```

$$ec := \frac{\mathrm{d}}{\mathrm{d}t} N(t) = k\, N(t) \qquad\qquad (22)$$

```
> cond:=N(0)=n0;
```

$$cond := N(0) = n0 \qquad\qquad (23)$$

```
> sol:=dsolve({ec,cond},N(t));
```

$$sol := N(t) = n0\, e^{kt} \qquad\qquad (24)$$

```
> e:=unapply(rhs(sol),n0,k,t);
```

$$e := (n0, k, t) \rightarrow n0\, e^{kt} \qquad\qquad (25)$$

```
> timee:=solve(e(n0,1.5,t)=2*n0,t);
```

$$timee := 0.4620981204 \qquad\qquad (26)$$

```
> evalf(timee);
```

$$0.4620981204 \qquad\qquad (27)$$

```
> #ex5
> f1:=(x,y)->x^2*y+y^2*x;
```

$$f1 := (x, y) \rightarrow x^2 y + y^2 x \qquad\qquad (28)$$

```
> f2:=(x,y)->x-y^2-x*y+1;
```
$$f2 := (x, y) \rightarrow x - y^2 - x y + 1 \tag{29}$$

```
> ec1:=diff(x(t),t)=f1(x(t),y(t));
```
$$ec1 := \frac{d}{dt} x(t) = x(t)^2 y(t) + y(t)^2 x(t) \tag{30}$$

```
> ec2:=diff(y(t),t)=f2(x(t),y(t));
```
$$ec2 := \frac{d}{dt} y(t) = x(t) - y(t)^2 - x(t) y(t) + 1 \tag{31}$$

```
> sist:=ec1,ec2;
```
$$sist := \frac{d}{dt} x(t) = x(t)^2 y(t) + y(t)^2 x(t), \ \frac{d}{dt} y(t) = x(t) - y(t)^2 - x(t) y(t) + 1 \tag{32}$$

```
> pct:=solve({f1(x,y)=0,f2(x,y)=0},{x,y});
```
$$pct := \{x = -1, y = 0\}, \{x = 0, y = 1\}, \{x = 0, y = -1\}, \{x = -1, y = 1\} \tag{33}$$

```
> J:=jacobian([f1(x,y),f2(x,y)],[x,y]);
```
$$J := \begin{bmatrix} 2 x y + y^2 & x^2 + 2 x y \\ -y + 1 & -2 y - x \end{bmatrix} \tag{34}$$

```
> with(linalg);
```
$[BlockDiagonal, GramSchmidt, JordanBlock, LUdecomp, QRdecomp, Wronskian, addcol,$ (35)
    $addrow, adj, adjoint, angle, augment, backsub, band, basis, bezout, blockmatrix, charmat,$
    $charpoly, cholesky, col, coldim, colspace, colspan, companion, concat, cond, copyinto,$
    $crossprod, curl, definite, delcols, delrows, det, diag, diverge, dotprod, eigenvals,$
    $eigenvalues, eigenvectors, eigenvects, entermatrix, equal, exponential, extend, ffgausselim,$
    $fibonacci, forwardsub, frobenius, gausselim, gaussjord, geneqns, genmatrix, grad,$
    $hadamard, hermite, hessian, hilbert, htranspose, ihermite, indexfunc, innerprod, intbasis,$
    $inverse, ismith, issimilar, iszero, jacobian, jordan, kernel, laplacian, leastsqrs, linsolve,$
    $matadd, matrix, minor, minpoly, mulcol, mulrow, multiply, norm, normalize, nullspace,$
    $orthog, permanent, pivot, potential, randmatrix, randvector, rank, ratform, row, rowdim,$
    $rowspace, rowspan, rref, scalarmul, singularvals, smith, stackmatrix, submatrix, subvector,$
    $sumbasis, swapcol, swaprow, sylvester, toeplitz, trace, transpose, vandermonde, vecpotent,$
    $vectdim, vector, wronskian]$

```
> A1:=subs(pct[1,1],pct[1,2],eval(J));
```
$$A1 := \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} \tag{36}$$

```
> eigenvals(A1);
```
$$\frac{1}{2} \sqrt{5} + \frac{1}{2}, \ \frac{1}{2} - \frac{1}{2} \sqrt{5} \tag{37}$$

```
> #pct de echilibru de tip focus instabil
> A2:=subs(pct[2,1],pct[2,2],eval(J));
```
$$A2 := \begin{bmatrix} 1 & 0 \\ 0 & -2 \end{bmatrix} \tag{38}$$

```
> eigenvals(A2);
```
$$1, -2 \tag{39}$$

```
> #pct de echilibru instabil de tip sa
> A3:=subs(pct[3,1],pct[3,2],eval(J));
```

$$A3 := \begin{bmatrix} 1 & 0 \\ 2 & 2 \end{bmatrix}$$ (40)

```
> eigenvals(A3);
```

$$1, 2$$ (41)

```
> #pct de echilibru instabil de tip nod
> A4:=subs(pct[4,1],pct[4,2],eval(J));
```

$$A4 := \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix}$$ (42)

```
> eigenvals(A4);
```

$$-1, -1$$ (43)

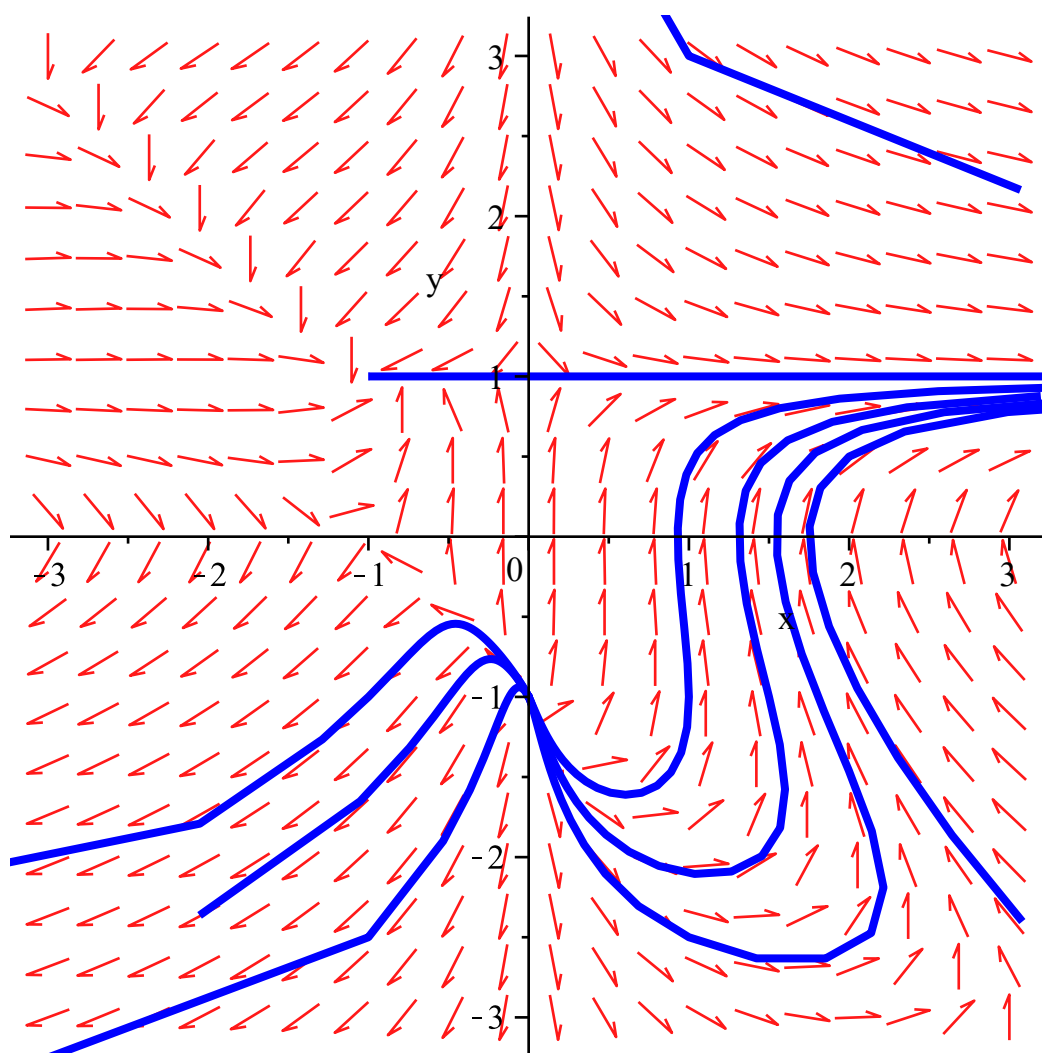```
> #pct de echilibru local asimptotic stabil de tip sa
> condin:=[x(0)=-1,y(0)=1],[x(0)=-0.5,y(0)=1],[x
> (0)=1,y(0)=3],[x(0)=2,y(0)=0.5],[x(0)=-1,y(0)=-1],[x(0)=-0.5,y
> (0)=-1],[x(0)=-1,y(0)=-2.5],[x(0)=1,y(0)=-1],[x(0)=1.5,y(0)=-1
>],[x(0)=1,y(0)=-2.5];
```

$condin := [x(0) = -1, y(0) = 1], [x(0) = -0.5000000000, y(0) = 1], [x(0) = 1, y(0) = 1],$  (44)
$\quad [x(0) = 1, y(0) = 3], [x(0) = 2, y(0) = 0.5000000000], [x(0) = -1, y(0) = -1], [x(0) =$
$\quad -0.5000000000, y(0) = -1], [x(0) = -1, y(0) = -2.5000000000], [x(0) = 1, y(0) = -1],$
$\quad [x(0) = 1.5000000000, y(0) = -1], [x(0) = 1, y(0) = -2.5000000000]$

```
> DEplot([sist],[x(t),y(t)],t=-10..10,x=-3..3,y=-3..3,
> [condin],linecolor=blue,stepsize=0.1);
```

Warning, plot may be incomplete, the following errors(s) were
issued:
    cannot evaluate the solution further right of .48670809,
probably a singularity

```
> restart; with(plots); with(DEtools);
```

[*animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d,*
    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]

[*AreSimilar, Closure, DEnormal, DEplot, DEplot3d, DEplot_polygon, DFactor,*   **(45)**
    DFactorLCLM, DFactorsols, Dchangevar, Desingularize, FunctionDecomposition, GCRD,
    Gosper, Heunsols, Homomorphisms, IVPsol, IsHyperexponential, LCLM, MeijerGsols,
    MultiplicativeDecomposition, ODEInvariants, PDEchangecoords, PolynomialNormalForm,
    RationalCanonicalForm, ReduceHyperexp, RiemannPsols, Xchange, Xcommutator, Xgauge,
    Zeilberger, abelsol, adjoint, autonomous, bernoullisol, buildsol, buildsym, canoni, caseplot,
    casesplit, checkrank, chinisol, clairautsol, constcoeffsols, convertAlg, convertsys,
    dalembertsol, dcoeffs, de2diffop, dfieldplot, diff_table, diffop2de, dperiodic_sols, dpolyform,
    dsubs, eigenring, endomorphism_charpoly, equinv, eta_k, eulersols, exactsol, expsols,

exterior_power, firint, firtest, formal_sol, gen_exp, generate_ic, genhomosol, gensys, hamilton_eqs, hypergeomsols, hyperode, indicialeq, infgen, initialdata, integrate_sols, intfactor, invariants, kovacicsols, leftdivision, liesol, line_int, linearsol, matrixDE, matrix_riccati, maxdimsystems, moser_reduce, muchange, mult, mutest, newton_polygon, normalG2, ode_int_y, ode_y1, odeadvisor, odepde, parametricsol, particularsol, phaseportrait, poincare, polysols, power_equivalent, rational_equivalent, ratsols, redode, reduceOrder, reduce_order, regular_parts, regularsp, remove_RootOf, riccati_system, riccatisol, rifread, rifsimp, rightdivision, rtaylor, separablesol, singularities, solve_group, super_reduce, symgen, symmetric_power, symmetric_product, symtest, transinv, translate, untranslate, varparam, zoom]