```
> with(DETools);with(plots);
```

[*AreSimilar*, *Closure*, *DEnormal*, *DEplot*, *DEplot3d*, *DEplot_polygon*, *DFactor*, *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*]

[*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*] **(1)**

```
> ec:=diff(y(x),x)=1/cos(x)-y(x)*tan(x);#ex1
```

$$ec := \frac{d}{dx} y(x) = \frac{1}{\cos(x)} - y(x) \tan(x) \quad \textbf{(2)}$$

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

$$sol := y(x) = \cos(x) \tan(x) + \cos(x) \_C1 \quad \textbf{(3)}$$

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

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

```
> sol2:=dsolve({ec,cond},y(x));
```

$$sol2 := y(x) = \cos(x) \tan(x) - \cos(x) \quad \textbf{(5)}$$

```
> ec2:=(1+x^2)*diff(y(x),x,x)+4*x*diff(y(x),x)+2*y(x)-sin(x)=0;#ex2
```

$$ec2 := \left(1 + x^2\right) \left(\frac{d^2}{dx^2} y(x) \right) + 4x \left(\frac{d}{dx} y(x) \right) + 2y(x) - \sin(x) = 0 \quad \textbf{(6)}$$

```
> sol3:=dsolve(ec2,y(x));
```

$$sol3 := y(x) = \frac{\_C2}{1 + x^2} + \frac{\_C1\, x}{1 + x^2} - \frac{\sin(x)}{1 + x^2} \quad \textbf{(7)}$$

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

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

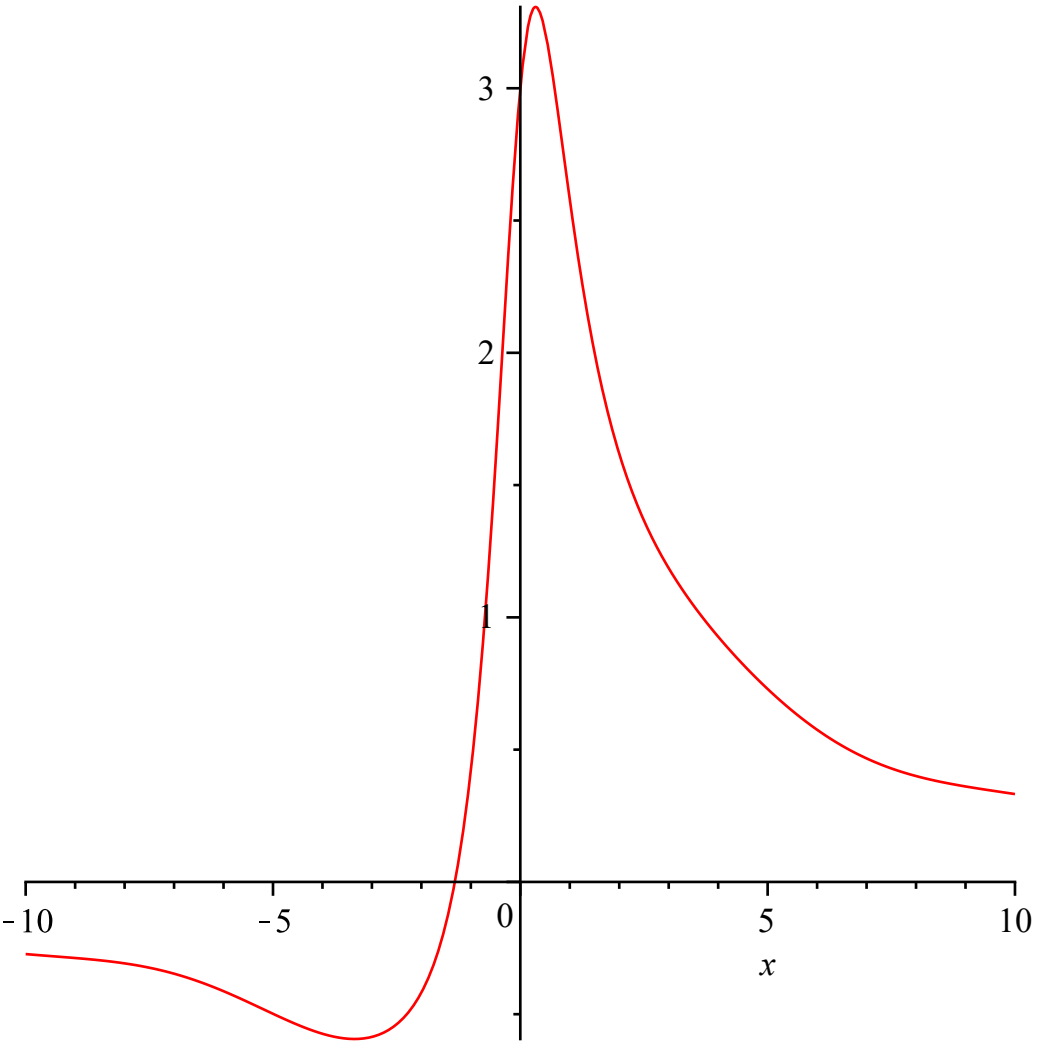
```
> sol4:=dsolve({ec2,cond}, y(x));
```

$$sol4 := y(x) = \frac{3}{1+x^2} + \frac{3x}{1+x^2} - \frac{\sin(x)}{1+x^2} \tag{9}$$

```
> ap:=unapply(rhs(sol4), x);
```

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

```
> plot(ap(x), x=-10..10);
```




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

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

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

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

```
> sist:=ec1,ec2;
```

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

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

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

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

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

```
> sol2:=dsolve({sist,cond},{x(t),y(t)});
```

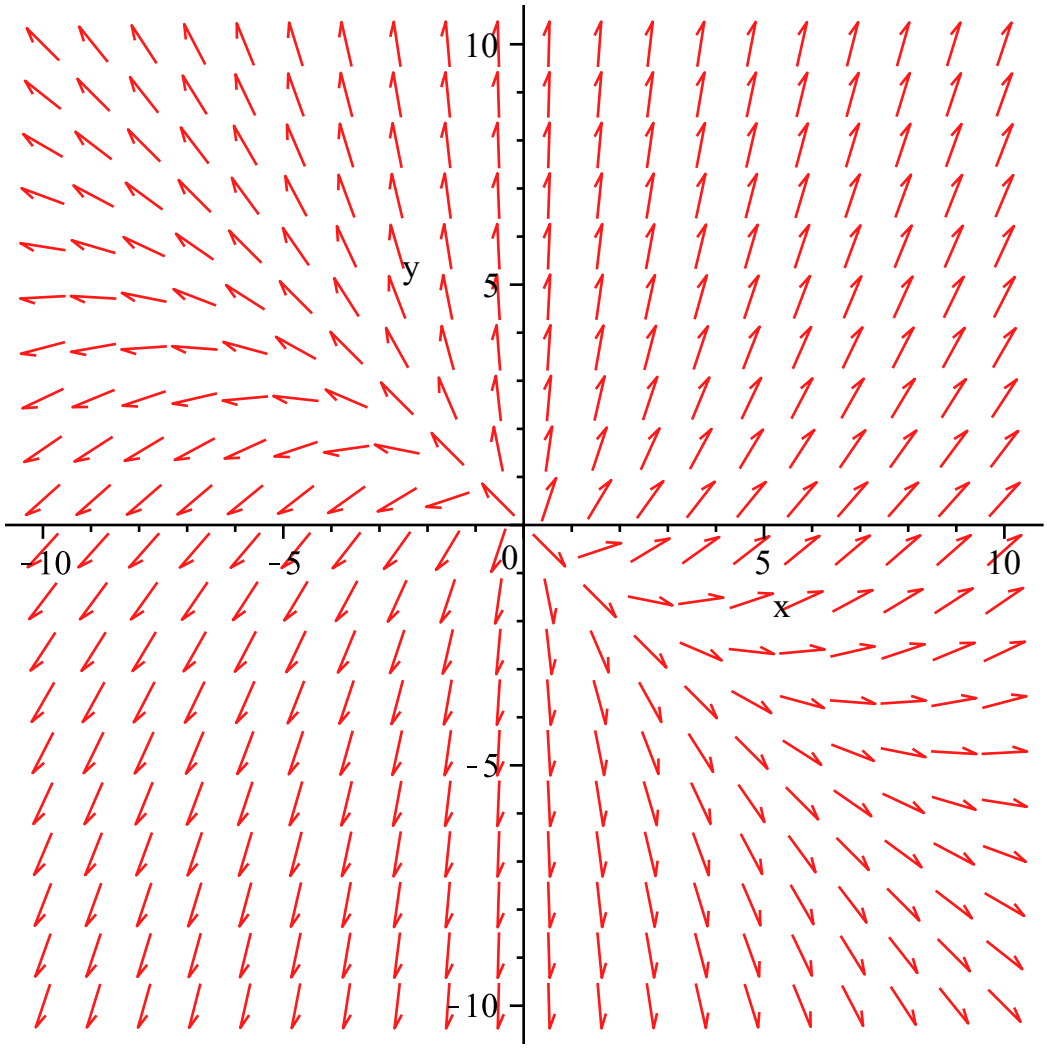
$$sol2 := \{x(t) = e^{t}, y(t) = -e^{t} + 5\, e^{2t}\} \tag{16}$$

```
> #(0,0) e solutie pentru ambele functii => punct de echilibru
```

$$\frac{d}{dt} x(t) \tag{17}$$

```
> #pentru functa de x este puncti instabil, solutia derivatei cu 0
  da pozitiv
> #pentru functia de y este stabila, da negativ

> DEplot([sist], {x(t),y(t)}, t=-10..10, x=-10..10,y=-10..10);
```




```
> #nu deoarece se observa ca ssagetile ies din 0, insemnand ca
  functia tinde ori la -inf ori la +inf
```

```
> ec:=diff(N(t),t)=k*N(t);#ex4
```

$$ec := \frac{d}{dt} N(t) = k\,N(t) \tag{18}$$

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

$$cond := N(0) = nz \tag{19}$$

```
> nz:=500;
```

$$nz := 500 \tag{20}$$

```
> k:=2.5;
```

$$k := 2.5 \tag{21}$$

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

$$sol := N(t) = 500\, e^{\frac{5}{2} t} \tag{22}$$

```
> k:=1.5;
```

$$k := 1.5 \tag{23}$$

```
> nz:=10;
```

$$nz := 10 \tag{24}$$

```
> #atunci N(t)=20 populatia curenta este dublata
> sol2:=dsolve({ec,cond},N(t));
```

$$sol2 := N(t) = 10\, e^{\frac{3}{2} t} \tag{25}$$

```
> t:=solve(rhs(sol2)=20,t);
```

$$t := \frac{2}{3} \ln(2) \tag{26}$$

```
> t:='t';#ex5
```

$$t := t \tag{27}$$

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

$$f1 := (x, y) \to y\,x^2 + x\,y^2 \tag{28}$$

```
> f2:=(x,y)->x-y^2-x*y+1;
```

$$f2 := (x, y) \to x - y^2 - x\,y + 1 \tag{29}$$

```
> ec1:=diff(x(t),t)=f1(x(t),y(t));
```

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

```
> 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;
```

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

```
> p:=solve({f1(x,y)=0, f2(x,y)=0}, {x,y});
```

$$p := \{x = -1, y = 0\}, \{x = 0, y = 1\}, \{x = 0, y = -1\}, \{x = -1, y = 1\} \tag{33}$$

```
> with(linalg);
```

[*BlockDiagonal, GramSchmidt, JordanBlock, LUdecomp, QRdecomp, Wronskian, addcol, addrow, adj, adjoint, angle, augment, backsub, band, basis, bezout, blockmatrix, charmat,* (34)

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*]

```
> j:=jacobian([f1(x,y), f2(x,y)],[x,y]);
```

$$j := \begin{bmatrix} 2xy + y^2 & x^2 + 2xy \\ -y + 1 & -2y - x \end{bmatrix} \tag{35}$$

```
> A1:=subs(p[1,1],p[1,2], eval(j));
```

$$A1 := \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} \tag{36}$$

```
> eigenvals(A1);
```

$$\frac{1}{2} + \frac{1}{2}\sqrt{5},\ \frac{1}{2} - \frac{1}{2}\sqrt{5} \tag{37}$$

```
> #focus instabil
> A2:=subs(p[2,1],p[2,2], eval(j));
```

$$A2 := \begin{bmatrix} 1 & 0 \\ 0 & -2 \end{bmatrix} \tag{38}$$

```
> eigenvals(A2);
```

$$1,\ -2 \tag{39}$$

```
> #sa instabil
> A3:=subs(p[3,1],p[3,2],eval(j));
```

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

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

$$1,\ 2 \tag{41}$$

```
> #tip nod instabil
> A4:=subs(p[4,1],p[4,2], eval(j));
```

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

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

$$-1,\ -1 \tag{43}$$

```
> #tip nod stabil
> cond_in:= [x(0)=-2,y(0)=-2], [x(0)=0,y(0)=0], [x(0)=-0.75,y(0)=
```

```
-0.75], [x(0)=0,y(0)=1],[x(0)=2,y(0)=3],[x(0)=0.75,y(0)=1.75],[x
(0)=0,y(0)=-3],[x(0)=2,y(0)=-1],[x(0)=0.75,y(0)=-2.75],[x(0)=0,y
(0)=i]$i=1..5, [x(0)=0,y(0)=-i]$i=1..5, [x(0)=i,y(0)=0]$i=1..5,
[x(0)=-i,y(0)=0]$i=1..5;
```

$$cond\_in := [x(0) = -2, y(0) = -2], [x(0) = 0, y(0) = 0], [x(0) = -0.75, y(0) = -0.75], [x(0) = 0, y(0) = 1], [x(0) = 2, y(0) = 3], [x(0) = 0.75, y(0) = 1.75], [x(0) = 0, y(0) = -3], [x(0) = 2, y(0) = -1], [x(0) = 0.75, y(0) = -2.75], [x(0) = 0, y(0) = 1], [x(0) = 0, y(0) = 2], [x(0) = 0, y(0) = 3], [x(0) = 0, y(0) = 4], [x(0) = 0, y(0) = 5], [x(0) = 0, y(0) = -1], [x(0) = 0, y(0) = -2], [x(0) = 0, y(0) = -3], [x(0) = 0, y(0) = -4], [x(0) = 0, y(0) = -5], [x(0) = 1, y(0) = 0], [x(0) = 2, y(0) = 0], [x(0) = 3, y(0) = 0], [x(0) = 4, y(0) = 0], [x(0) = 5, y(0) = 0], [x(0) = -1, y(0) = 0], [x(0) = -2, y(0) = 0], [x(0) = -3, y(0) = 0], [x(0) = -4, y(0) = 0], [x(0) = -5, y(0) = 0] \quad (44)$$

```
> DEplot([sist],[x(t),y(t)], t=-5..5,x=-6..6,y=-6..6, [cond_in],
  arrows=medium,linecolor=blue);
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .10419528,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .50368102,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .15555323,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .58322720,
probably a singularity
   cannot evaluate the solution further left of -.61184774,
maxfun limit exceeded (see ?dsolve,maxfun for details)
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further left of -.20273255,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .20273255,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further left of -.61588178,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further left of -.35613782,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further left of -.20422238,
probably a singularity
```

```
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .56235807,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .35049695,
probably a singularity
Warning, plot may be incomplete, the following errors(s) were
issued:
   cannot evaluate the solution further right of .20363630,
probably a singularity
```