```
> restart
> ec:=diff(T(t),t)=-k*(T(t)-Tm)
```

$$ec := \frac{d}{dt} T(t) = -k\left(T(t) - Tm\right) \tag{1}$$

```
> sol:=dsolve(ec,T(t))
```

$$sol := T(t) = Tm + e^{-kt} c_1 \tag{2}$$

```
> f:=unapply(rhs(sol),t,Tm,k,c__1)
```

$$f := \left(t, Tm, k, c_1\right) \mapsto Tm + e^{-k\cdot t}\cdot c_1 \tag{3}$$

```
> solve(f(0,5,k,c__1)=40,c__1)
```

$$35 \tag{4}$$

```
> solve(f(1,5,k,35)=10,k)
```

$$\ln(7) \tag{5}$$

```
> restart
> with(plots)
```

$$[\,animate,\ animate3d,\ animatecurve,\ arrow,\ changecoords,\ complexplot,\ complexplot3d,\ conformal, \tag{6}$$

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, shadebetween, spacecurve,

sparsematrixplot, surfdata, textplot, textplot3d, tubeplot]

```
> ec1:=diff(x(t),t)=4*x(t)+6*y(t)
```

$$ec1 := \frac{d}{dt} x(t) = 4 x(t) + 6 y(t) \tag{7}$$

```
> ec2:=diff(y(t),t)=2*x(t)+3*y(t)
```

$$ec2 := \frac{d}{dt} y(t) = 2 x(t) + 3 y(t) \tag{8}$$

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

$$sist := \frac{d}{dt} x(t) = 4 x(t) + 6 y(t),\ \frac{d}{dt} y(t) = 2 x(t) + 3 y(t) \tag{9}$$

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

$$sol := \left\{ x(t) = c_1 + c_2 e^{7t}, y(t) = \frac{c_2 e^{7t}}{2} - \frac{2 c_1}{3} \right\} \tag{10}$$

```
> cond:=x(0)=2,y(0)=2
```

$$cond := x(0) = 2, y(0) = 2 \tag{11}$$

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

$$sol2 := \left\{ x(t) = -\frac{6}{7} + \frac{20\, e^{7t}}{7}, y(t) = \frac{10\, e^{7t}}{7} + \frac{4}{7} \right\} \tag{12}$$
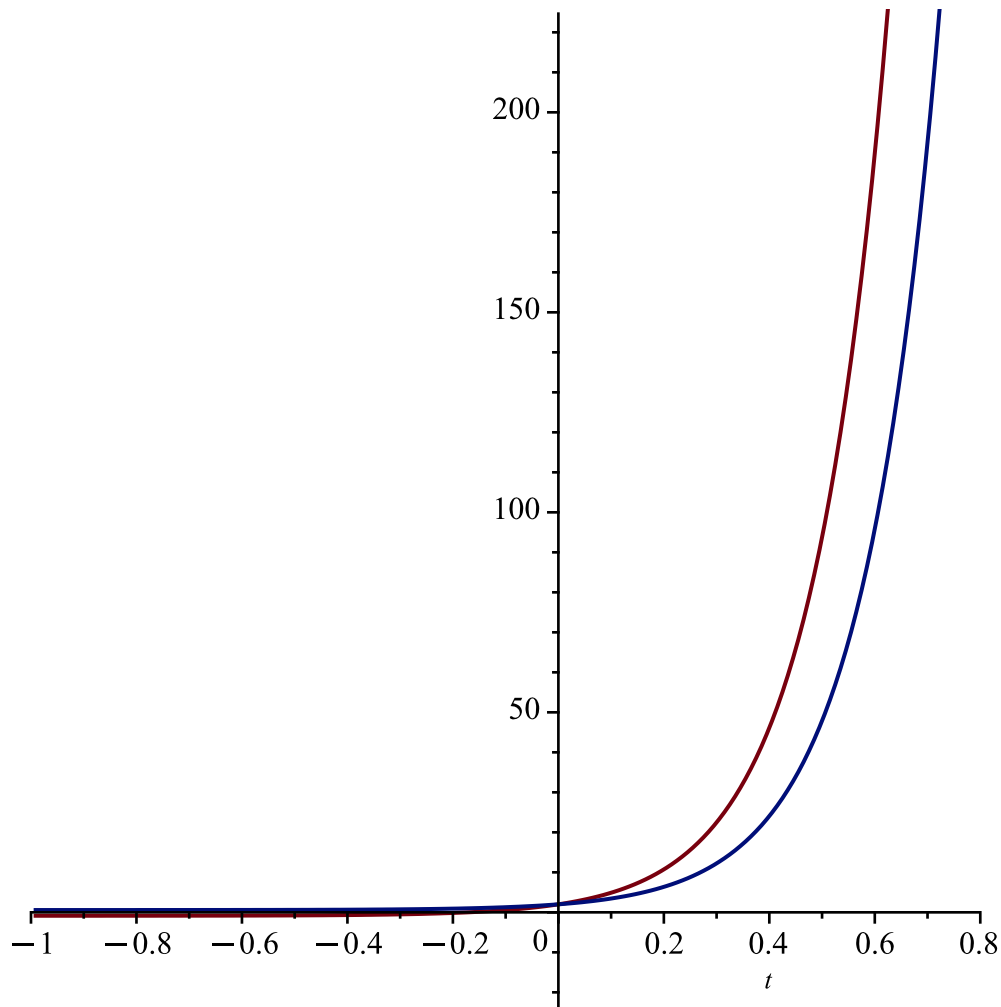
```
> xx:=unapply(rhs(sol2[1]),t)
```

$$xx := t \mapsto -\frac{6}{7} + \frac{20 \cdot e^{7 \cdot t}}{7} \tag{13}$$

```
> yy:=unapply(rhs(sol2[2]),t)
```

$$yy := t \mapsto \frac{10 \cdot e^{7 \cdot t}}{7} + \frac{4}{7} \tag{14}$$

```
> plot([xx(t),yy(t)],t=-1..1)
```



```
> restart
> with(DETools)
```

$[AreSimilar, Closure, DEnormal, DEplot, DEplot3d, DEplot\_polygon, DFactor, DFactorLCLM, \tag{15}$

DFactorsols, Dchangevar, Desingularize, FindODE, 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, hypergeometricsols, 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]

```
> f:=x->x*(2-x)*(x-4)
```

$$f := x \mapsto x \cdot (2 - x) \cdot (x - 4) \tag{16}$$

```
> ec:=diff(x(t),t)=f(x(t))
```

$$ec := \frac{d}{dt} x(t) = x(t) (2 - x(t)) (x(t) - 4) \tag{17}$$

```
> sol:=solve(f(x)=0)
```

$$sol := 0, 2, 4 \tag{18}$$

```
> D(f)(0)
```

$$-8 \tag{19}$$

```
> D(f)(2)
```

$$4 \tag{20}$$

```
> D(f)(4)
```

$$-8 \tag{21}$$

```
> DEplot(ec,x(t),t=0..2,[[x(0)=-1],[x(0)=0],[x(0)=1],[x(0)=2],[x(0)
  =3],[x(0)=4],[x(0)=5]])
```
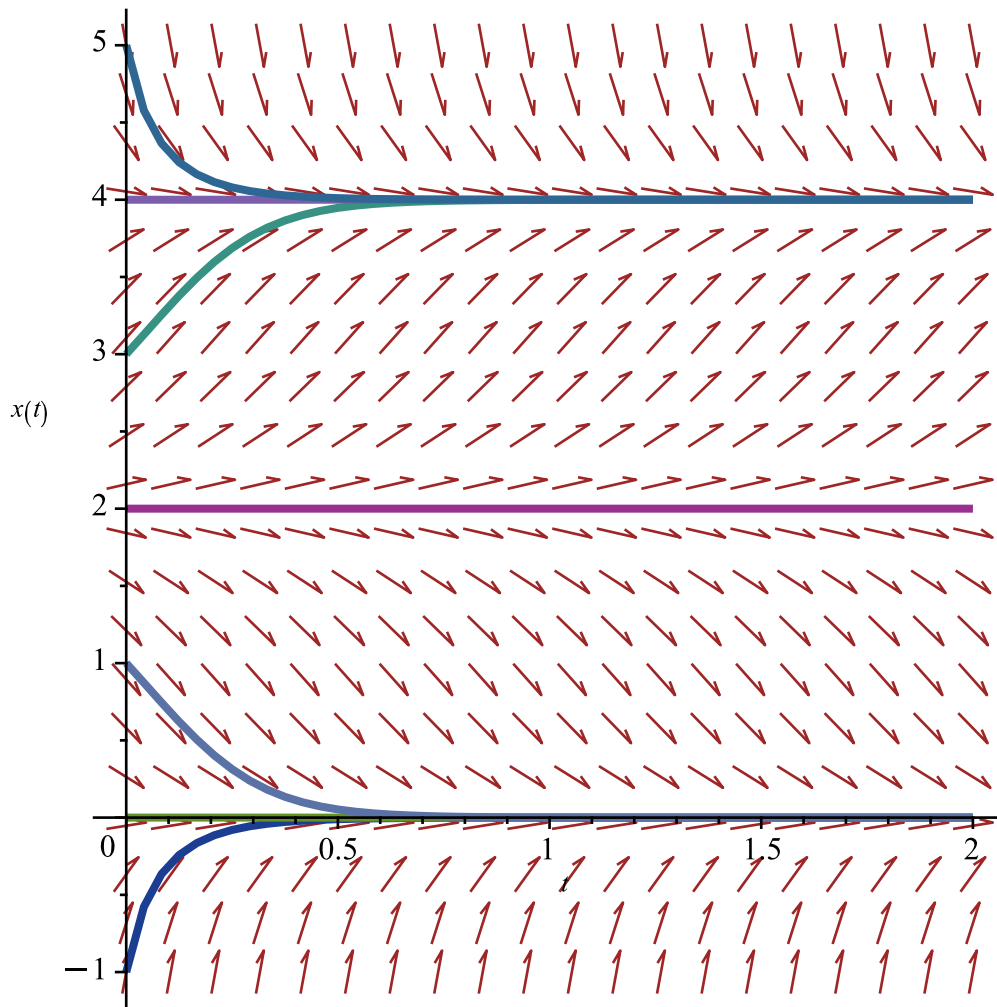
```
> restart; with(linalg); with(DEtools)
```

[*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]

[*AreSimilar, Closure, DEnormal, DEplot, DEplot3d, DEplot_polygon, DFactor, DFactorLCLM,*   **(22)**
DFactorsols, Dchangevar, Desingularize, FindODE, 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, hypergeometricsols, 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]

> `f1:=(x,y)->x*y-1`

$$f1 := (x, y) \mapsto y \cdot x - 1 \tag{23}$$

> `f2:=(x,y)->x^2-16*y^2`

$$f2 := (x, y) \mapsto x^2 - 16 \cdot y^2 \tag{24}$$

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

$$ec1 := \frac{d}{dt} x(t) = y(t) \, x(t) - 1 \tag{25}$$

> `ec2:=diff(y(t),t)=f2(x(t),y(t))`

$$ec2 := \frac{d}{dt} y(t) = x(t)^2 - 16 \, y(t)^2 \tag{26}$$

> `sist:=ec1,ec2`

$$sist := \frac{d}{dt} x(t) = y(t) \, x(t) - 1, \; \frac{d}{dt} y(t) = x(t)^2 - 16 \, y(t)^2 \tag{27}$$

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

$$sol := \left\{ x = -2 \, RootOf\left(\_Z^2 + 1\right), y = \frac{RootOf\left(\_Z^2 + 1\right)}{2} \right\}, \left\{ x = 2, y = \frac{1}{2} \right\}, \left\{ x = -2, y = -\frac{1}{2} \right\} \tag{28}$$

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

$$J := \begin{bmatrix} y & x \\ 2x & -32y \end{bmatrix} \tag{29}$$

```
> A1:=subs(sol[1,1],sol[1,2],eval(J))
```

$$A1 := \begin{bmatrix} \dfrac{RootOf\left(\_Z^2 + 1\right)}{2} & -2\,RootOf\left(\_Z^2 + 1\right) \\ -4\,RootOf\left(\_Z^2 + 1\right) & -16\,RootOf\left(\_Z^2 + 1\right) \end{bmatrix} \tag{30}$$

```
> evalf(eigenvals(A1))
```

$$0.9713817713\,I \tag{31}$$

```
> evalf(sol[1,1])
```

$$x = -2.000000000\,I \tag{32}$$

```
> evalf(sol[1,2])
```

$$y = 0.5000000000\,I \tag{33}$$

```
> A2:=subs(sol[2,1],sol[2,2],eval(J))
```

$$A2 := \begin{bmatrix} \dfrac{1}{2} & 2 \\ 4 & -16 \end{bmatrix} \tag{34}$$

```
> eigenvals(A2)
```

$$-\frac{31}{4} + \frac{\sqrt{1217}}{4}, \; -\frac{31}{4} - \frac{\sqrt{1217}}{4} \tag{35}$$

```
> A3:=subs(sol[3,1],sol[3,2],eval(J))
```

$$A3 := \begin{bmatrix} -\dfrac{1}{2} & -2 \\ -4 & 16 \end{bmatrix} \tag{36}$$

```
> eigenvals(A3)
```

$$\frac{31}{4} + \frac{\sqrt{1217}}{4}, \; \frac{31}{4} - \frac{\sqrt{1217}}{4} \tag{37}$$

```
> cond_in:=[x(0)=0,y(0)=i]$i=1..5,[x(0)=i,y(0)=0]$i=1..5,[x(0)=0,y
  (0)=-i]$i=1..5,[x(0)=-i,y(0)=0]$i=1..5
```

$$cond\_in := [x(0) = 0, y(0) = 1], [x(0) = 0, y(0) = 2], [x(0) = 0, y(0) = 3], [x(0) = 0, y(0) \tag{38}$$
$$= 4], [x(0) = 0, y(0) = 5], [x(0) = 1, y(0) = 0], [x(0) = 2, y(0) = 0], [x(0) = 3, y(0)$$
$$= 0], [x(0) = 4, y(0) = 0], [x(0) = 5, y(0) = 0], [x(0) = 0, y(0) = -1], [x(0) = 0, y(0)$$

$$= -2], [x(0) = 0, y(0) = -3], [x(0) = 0, y(0) = -4], [x(0) = 0, y(0) = -5], [x(0)$$
$$= -1, y(0) = 0], [x(0) = -2, y(0) = 0], [x(0) = -3, y(0) = 0], [x(0) = -4, y(0) = 0],$$
$$[x(0) = -5, y(0) = 0]$$

```
> DEplot([sist],[x(t),y(t)],t=-5..5,x=-6..6,y=-6..6,[cond_in])
```

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.62500480e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.31250014e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.20833335e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.15625000e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.12500000e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .62500480e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .31250014e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .20833335e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .15625000e-1,
probably a singularity

Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .12500000e-1,
probably a singularity