```
> #ex1:
> with(DEtools): with(plots):
> f__1:=x->x^2-2*x
```

$$f_1 := x \mapsto x^2 - 2 \cdot x \tag{1}$$

```
> ec1:=diff(x(t),t)=f__1(x(t))
```

$$ec1 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = x(t)^2 - 2\,x(t) \tag{2}$$

```
> pct_ech1:=solve(f__1(x)=0,x)
```

$$pct\_ech1 := 0, 2 \tag{3}$$

```
> #aproximatie
> D(f__1)(pct_ech1[1])
```

$$-2 \tag{4}$$

```
> # pct_ech1[1] = 0 e local asimptotic stabil
> D(f__1)(pct_ech1[2])
```

$$2 \tag{5}$$

```
> # pct_ech1[2] = 2 e instabil
> #grafic
> DEplot(ec1,x(t), t=-2..3, [[x(0)=-3],[x(0)=-2],[x[0]=-1/2],[x(0)=
  -1],[x[0]=0],[x(0)=1/2],[x(0)=1],[x(0)=2],[x(0)=3]])
Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.25541281, probably
a singularity
Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -.34657359, probably
a singularity

Error, (in dsolve/numeric/type_check) insufficient initial/boundary
value information for procedure defined problem
> f__2:=x->x*(x-1)*(x-2)
```

$$f_2 := x \mapsto x \cdot (x-1) \cdot (x-2) \tag{6}$$

```
> ec2:=diff(x(t),t)=f__2(x(t))
```

$$ec2 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = x(t)\,(x(t)-1)\,(x(t)-2) \tag{7}$$

```
> pct_ech2:=solve(f__2(x)=0,x)
```

$$pct\_ech2 := 0, 1, 2 \tag{8}$$

```
> D(f__2)(pct_ech2[1])
```

$$2 \tag{9}$$

```
> D(f__2)(pct_ech2[2])
```

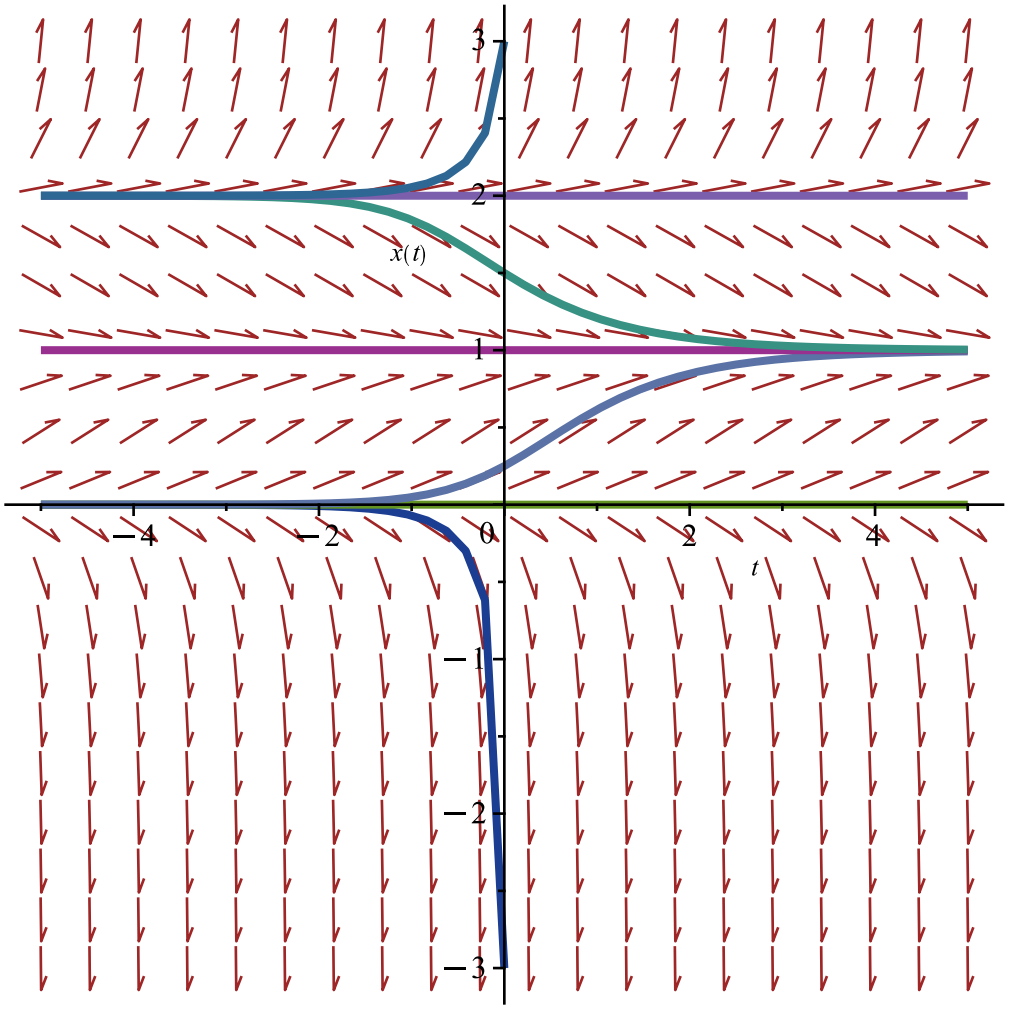
$$-1 \tag{10}$$

```
> D(f__2)(pct_ech2[3])
```

$$2 \tag{11}$$

```
> # 0 si 2 sunt puncte instabile, iar 1 e pct l.a.s
> DEplot(ec2,x(t),t=-5..5, [[x(0)=-3],[x(0)=0],[x(0)=1/4],[x(0)=1],
  [x(0)=3/2],[x(0)=2],[x(0)=3]])
Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .32269256e-1,
probably a singularity
```

```
Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further right of .14384100, probably
a singularity
```




```
> f__3:=x->sin(x)
```

$$f_3 := x \mapsto \sin(x) \tag{12}$$

```
> ec3:=diff(x(t),t)=f__3(x(t))
```

$$ec3 := \frac{\mathrm{d}}{\mathrm{d}t}\, x(t) = \sin(x(t)) \tag{13}$$

```
> _EnvAllSolutions:=true:
> pct_ech3:=solve(f__3(x)=0,x)
```

$$pct\_ech3 := \pi \_Z12\sim \tag{14}$$

```
> about(_Z11)
Originally _Z11, renamed _Z11~:
  is assumed to be: integer
```

```
> #ex2:
> restart:
```

```
> with(DEtools): with(plots): with(linalg):
> ec1:=diff(x(t),t)=2*x(t)+y(t)
```

$$ec1 := \frac{d}{dt} x(t) = 2\,x(t) + y(t) \tag{15}$$

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

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

```
> sist1:=ec1,ec2
```

$$sist1 := \frac{d}{dt} x(t) = 2\,x(t) + y(t),\ \frac{d}{dt} y(t) = x(t) + 2\,y(t) \tag{17}$$

```
> A:=matrix([[2,1],[1,2]])
```

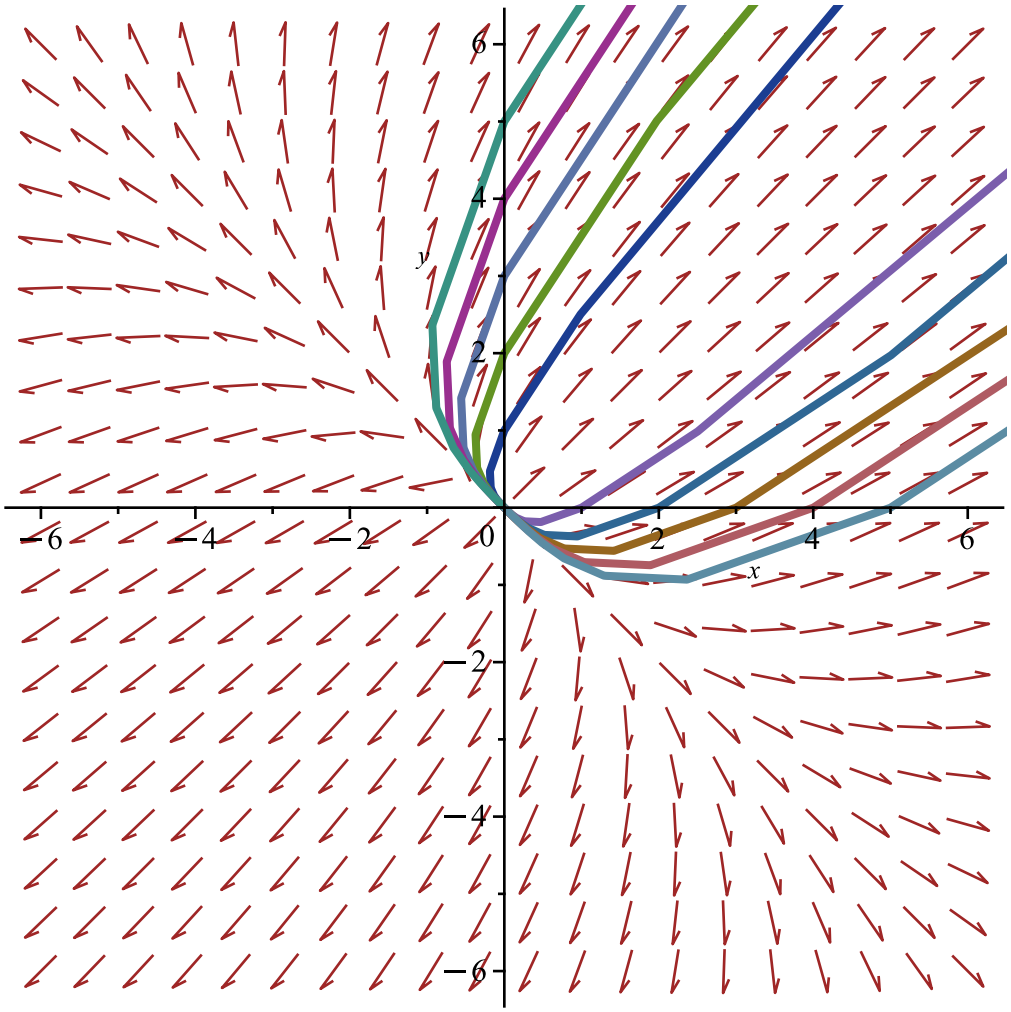
$$A := \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} \tag{18}$$

```
> eigenvals(A)
```

$$3,\ 1 \tag{19}$$

```
> # ambele valori sunt pozitive => pct de tip nod

> DEplot([sist1],[x(t),y(t)],t=-10..10,x=-6..6,y=-6..6,[[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]])
```




```
> ec3:=diff(x(t),t)=-3*x(t)+4*y(t)
```

$$ec3 := \frac{d}{dt} x(t) = -3\,x(t) + 4\,y(t) \tag{20}$$

```
> ec4:=diff(y(t),t)=-2*x(t)+3*y(t)
```

$$ec4 := \frac{d}{dt} y(t) = -2\,x(t) + 3\,y(t) \tag{21}$$

```
> sist2:=ec3,ec4
```

$$sist2 := \frac{d}{dt} x(t) = -3\,x(t) + 4\,y(t),\ \frac{d}{dt} y(t) = -2\,x(t) + 3\,y(t) \tag{22}$$

```
> B:=matrix([[-3,4],[-2,3]])
```

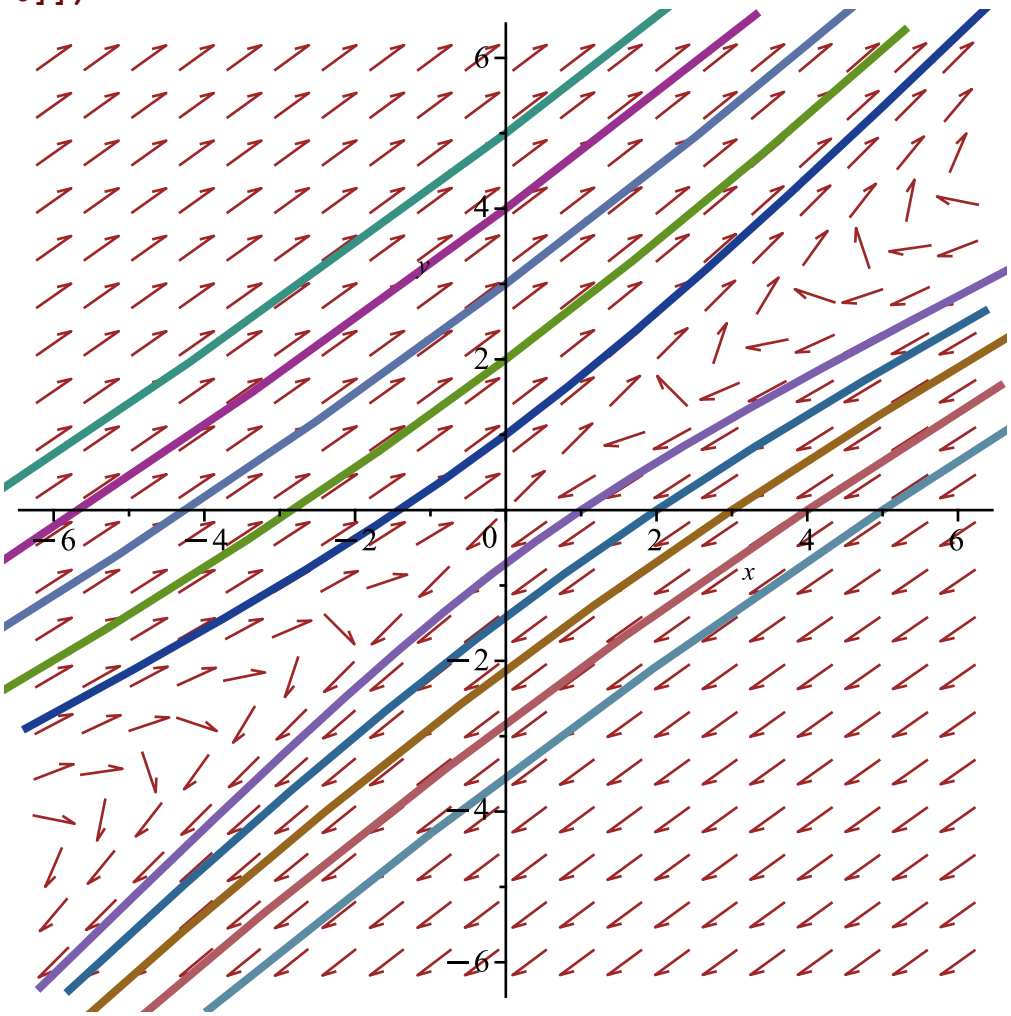
$$B := \begin{bmatrix} -3 & 4 \\ -2 & 3 \end{bmatrix} \tag{23}$$

```
> eigenvals(B)
```

$$eigenvals(B) \tag{24}$$

```
> #instabil de tip sa
> DEplot([sist2],[x(t),y(t)],t=-5..5,x=-6..6,y=-6..6,[[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]])
```




```
> ec5:=diff(x(t),t)=-x(t)-y(t)
```

$$ec5 := \frac{d}{dt}x(t) = -x(t) - y(t) \tag{25}$$

```
> ec6:=diff(y(t),t)=x(t)+3*y(t)
```

$$ec6 := \frac{d}{dt}y(t) = x(t) + 3\,y(t) \tag{26}$$

```
> sist3:=ec5,ec6
```

$$sist3 := \frac{d}{dt}x(t) = -x(t) - y(t),\ \frac{d}{dt}y(t) = x(t) + 3\,y(t) \tag{27}$$

```
> C:=matrix([[-1,-1],[1,3]])
```

$$C := \begin{bmatrix} -1 & -1 \\ 1 & 3 \end{bmatrix} \tag{28}$$

```
> eigenvals(C)
```

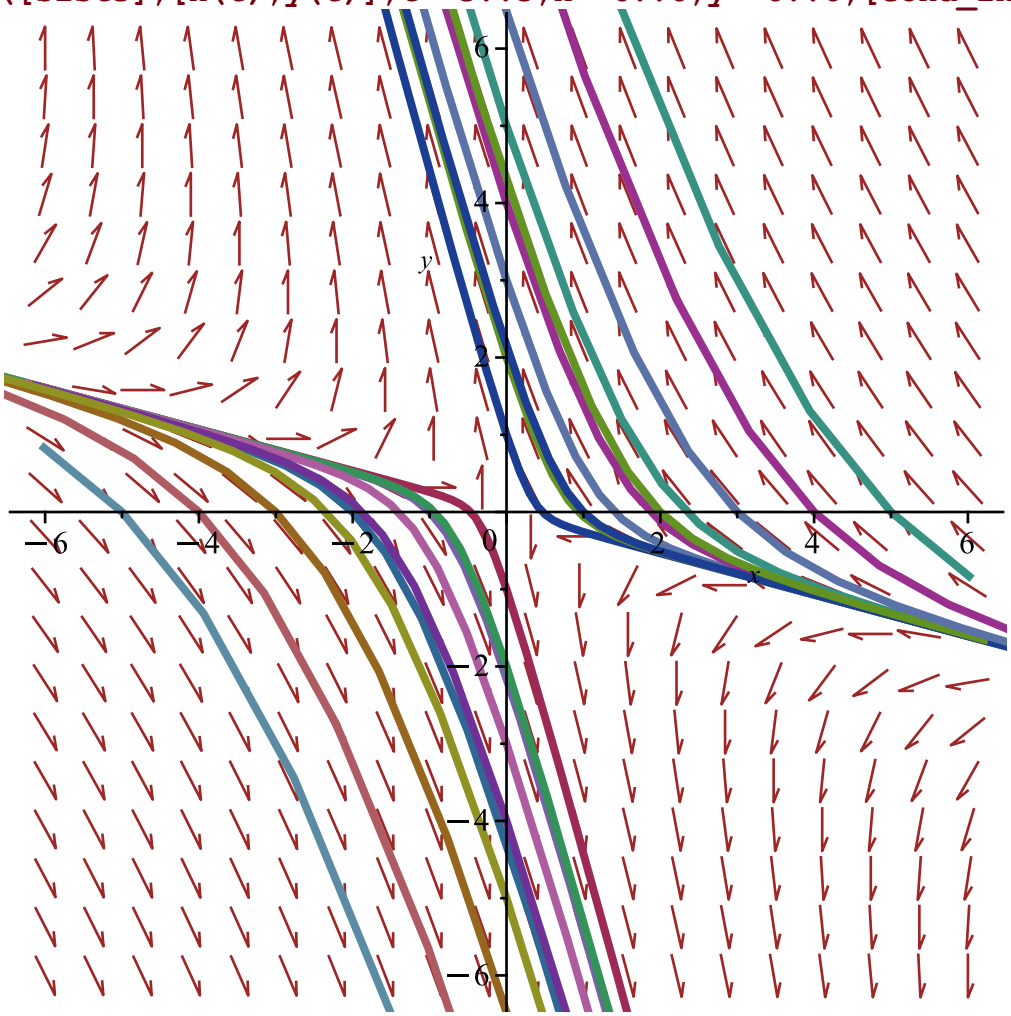
$$1 + \sqrt{3},\ 1 - \sqrt{3} \tag{29}$$

```
> #instabil de tip sa
> 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
```

$$cond\_in := [x(0) = 0, y(0) = 1], [x(0) = 0, y(0) = 2], [x(0) = 0, y(0) = 3], [x(0) = 0, y(0) \tag{30}$$

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

```
> DEplot([sist3],[x(t),y(t)],t=-5..5,x=-6..6,y=-6..6,[cond_in])
```




```
> ec7:=diff(x(t),t)=-2*x(t)
```

$$ec7 := \frac{d}{dt} x(t) = -2\,x(t) \tag{31}$$

```
> ec8:=diff(y(t),t)=-4*x(t)-2*y(t)
```

$$ec8 := \frac{d}{dt} y(t) = -4\,x(t) - 2\,y(t) \tag{32}$$

```
> sist4:=ec7,ec8
```

$$sist4 := \frac{d}{dt} x(t) = -2\,x(t),\ \frac{d}{dt} y(t) = -4\,x(t) - 2\,y(t) \tag{33}$$

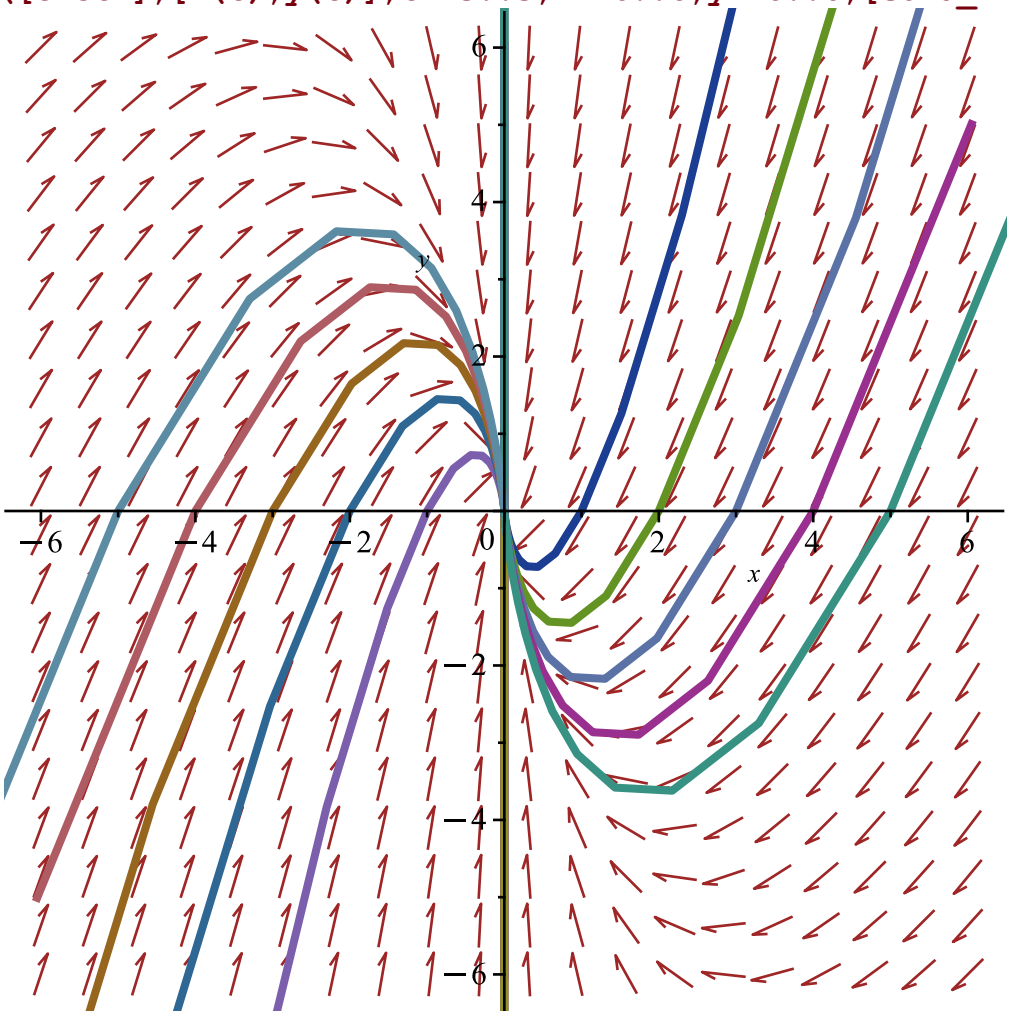
```
> DD:=matrix([[-2,0],[-4,-2]])
```

$$DD := \begin{bmatrix} -2 & 0 \\ -4 & -2 \end{bmatrix} \tag{34}$$

```
> eigenvals(DD)
```

$$-2, -2 \tag{35}$$

```
> DEplot([sist4],[x(t),y(t)],t=-5..5,x=-6..6,y=-6..6,[cond_in])
```




```
> #
> ec9:=diff(x(t),t)=x(t)+4*y(t)
```

$$ec9 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = x(t) + 4\,y(t) \tag{36}$$

```
> ec10:=diff(y(t),t)=x(t)+y(t)
```

$$ec10 := \frac{\mathrm{d}}{\mathrm{d}t} y(t) = x(t) + y(t) \tag{37}$$

```
> sist5:=ec9,ec10
```

$$sist5 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = x(t) + 4\,y(t),\ \frac{\mathrm{d}}{\mathrm{d}t} y(t) = x(t) + y(t) \tag{38}$$

```
> E:=matrix([[1,4],[1,1]])
```

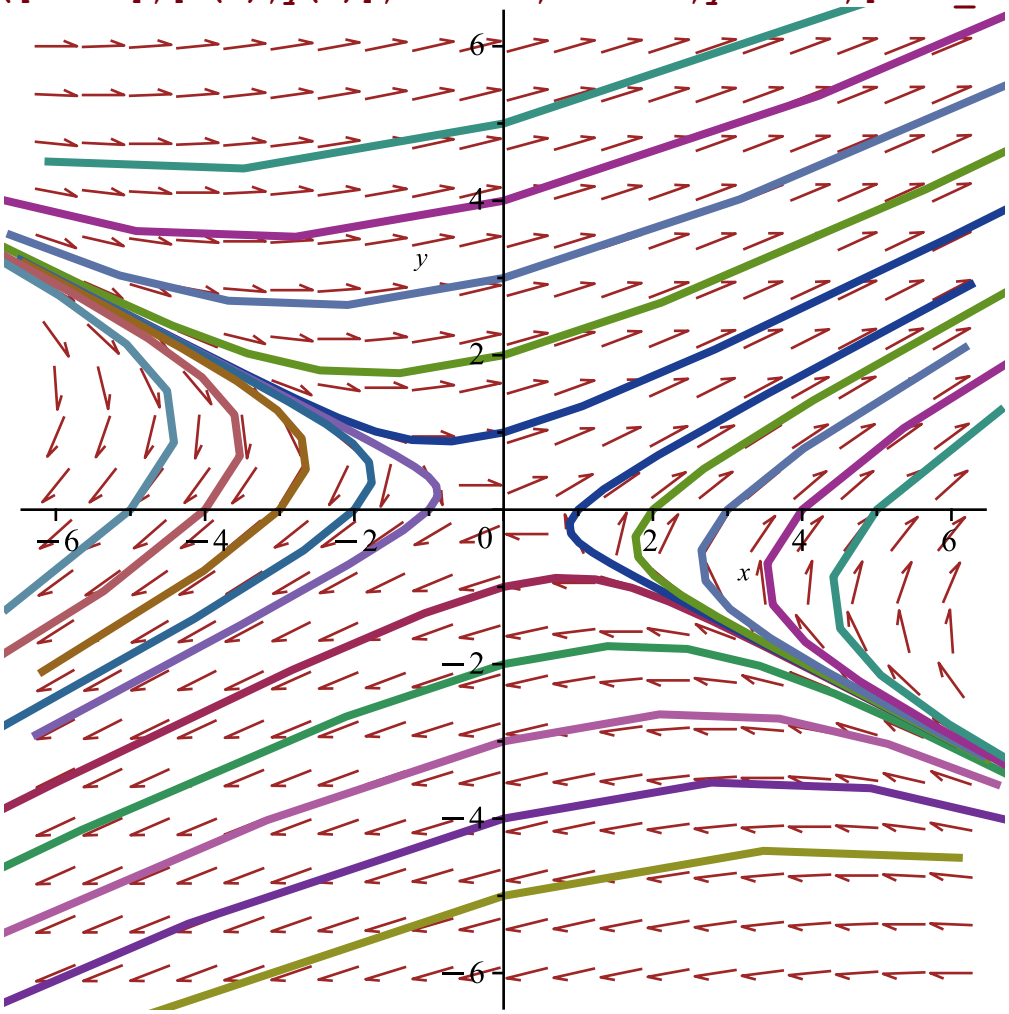
$$E := \begin{bmatrix} 1 & 4 \\ 1 & 1 \end{bmatrix} \tag{39}$$

```
> eigenvals(E)
```

$$3, -1 \tag{40}$$

```
> #instabil de tip sa
```

```
> DEplot([sist5],[x(t),y(t)],t=-5..5,x=-6..6,y=-6..6,[cond_in])
```




```
> ec11:=diff(x(t),t)=2*x(t)-y(t)
```

$$ec11 := \frac{d}{dt}\,x(t) = 2\,x(t) - y(t) \tag{41}$$

```
> ec12:=diff(y(t),t)=x(t)+2*y(t)
```

$$ec12 := \frac{d}{dt}\,y(t) = x(t) + 2\,y(t) \tag{42}$$

```
> sist6:=ec11,ec12
```

$$sist6 := \frac{d}{dt}\,x(t) = 2\,x(t) - y(t),\ \frac{d}{dt}\,y(t) = x(t) + 2\,y(t) \tag{43}$$

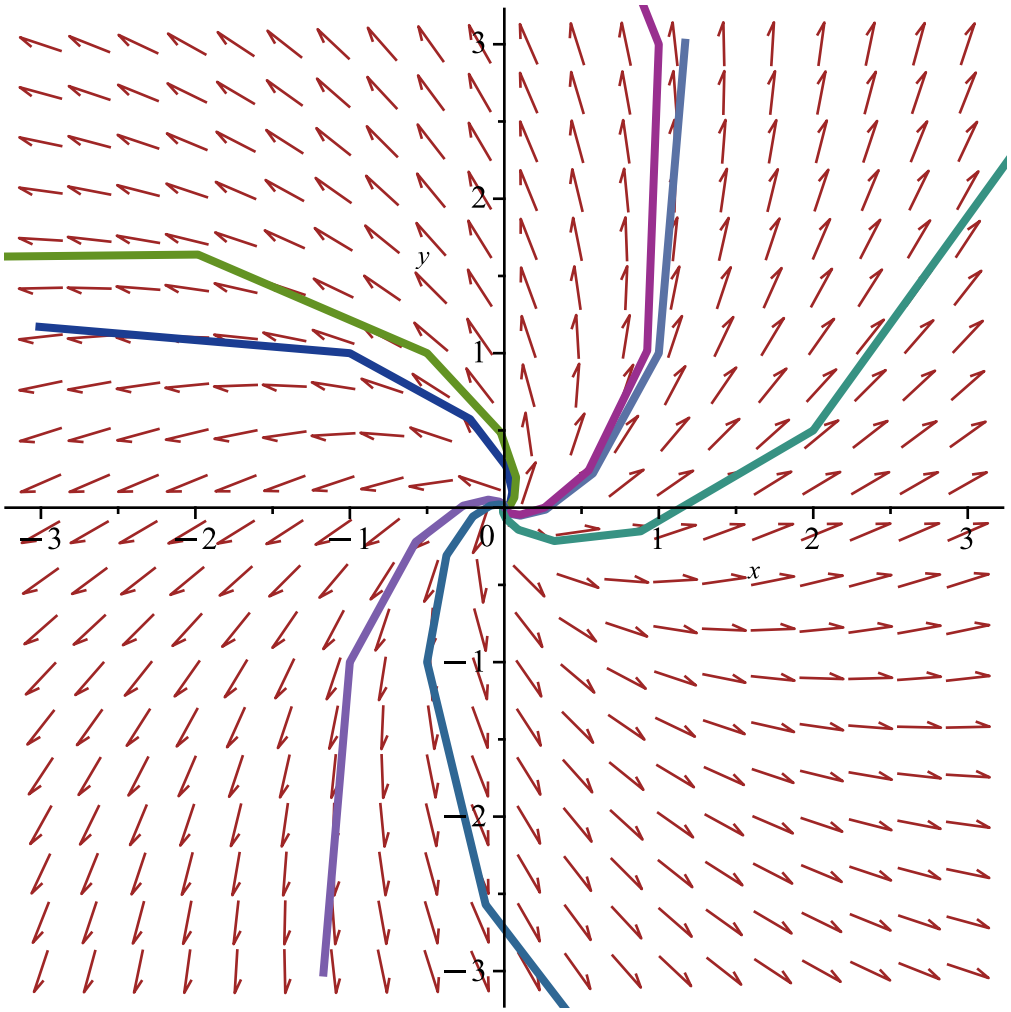
```
> F:=matrix([[2,-1],[1,2]])
```

$$F := \begin{bmatrix} 2 & -1 \\ 1 & 2 \end{bmatrix} \tag{44}$$

```
> eigenvals(F)
```

$$2 + I,\ 2 - I \tag{45}$$

```
> #stabil de tip focus
> DEplot([sist6],[x(t),y(t)],t=-10..10,x=-3..3,y=-3..3,[[x(0)=-1,y
  (0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x(0)=
  2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> ec13:=diff(x(t),t)=-y(t)
```

$$ec13 := \frac{d}{dt}\,x(t) = -y(t) \tag{46}$$

```
> ec14:=diff(y(t),t)=x(t)
```

$$ec14 := \frac{d}{dt}\,y(t) = x(t) \tag{47}$$

```
> sist7:=ec13,ec14
```

$$sist7 := \frac{d}{dt}\,x(t) = -y(t),\ \frac{d}{dt}\,y(t) = x(t) \tag{48}$$

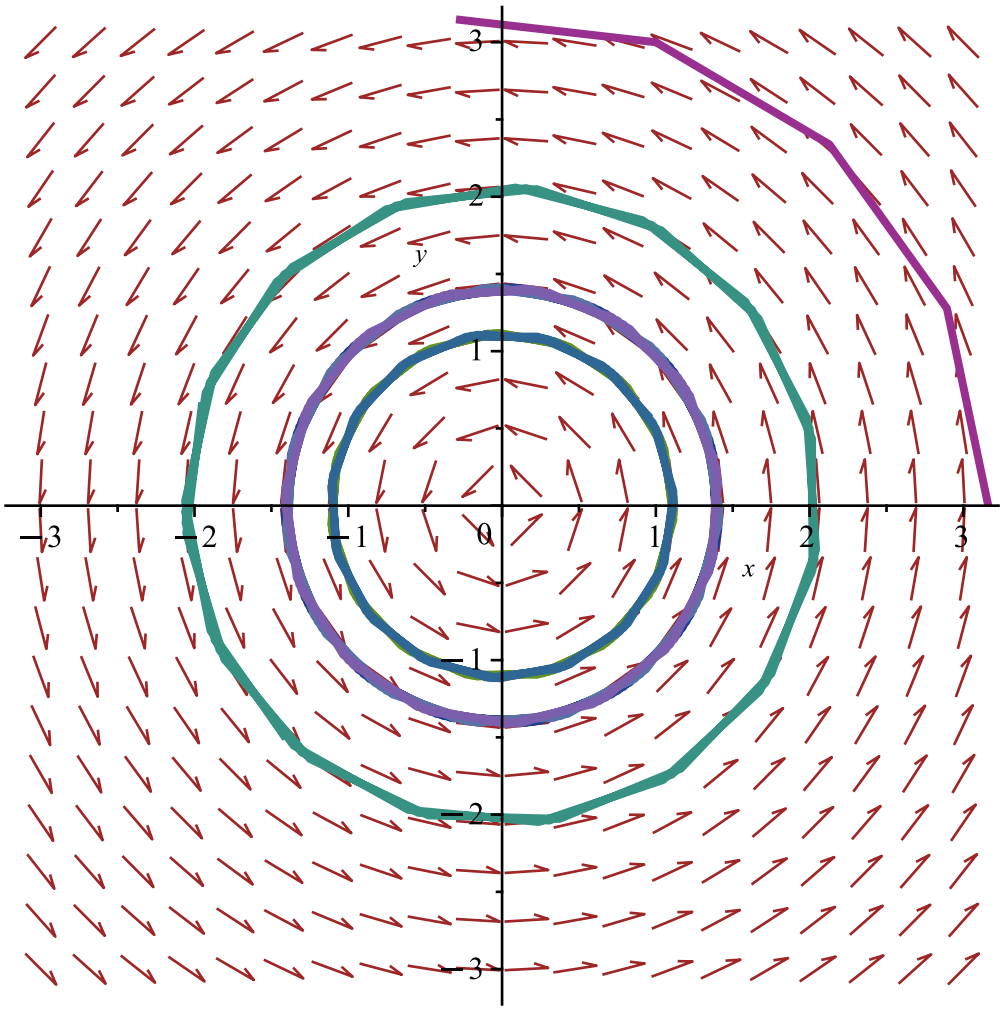
```
> G:=matrix([[0,-1],[1,0]])
```

$$G := \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \tag{49}$$

```
> eigenvals(G)
```

$$I,\ -I \tag{50}$$

```
> #stabil de tip focus
> DEplot([sist7],[x(t),y(t)],t=-10..10,x=-3..3,y=-3..3,[[x(0)=-1,y
  (0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x(0)=
  2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> ec15:=diff(x(t),t)=x(t)-4*y(t)
```

$$ec15 := \frac{d}{dt}\,x(t) = x(t) - 4\,y(t) \tag{51}$$

```
> ec16:=diff(y(t),t)=5*x(t)-3*y(t)
```

$$ec16 := \frac{d}{dt}\,y(t) = 5\,x(t) - 3\,y(t) \tag{52}$$

```
> sist8:=ec15,ec16
```

$$sist8 := \frac{d}{dt}\,x(t) = x(t) - 4\,y(t),\ \frac{d}{dt}\,y(t) = 5\,x(t) - 3\,y(t) \tag{53}$$

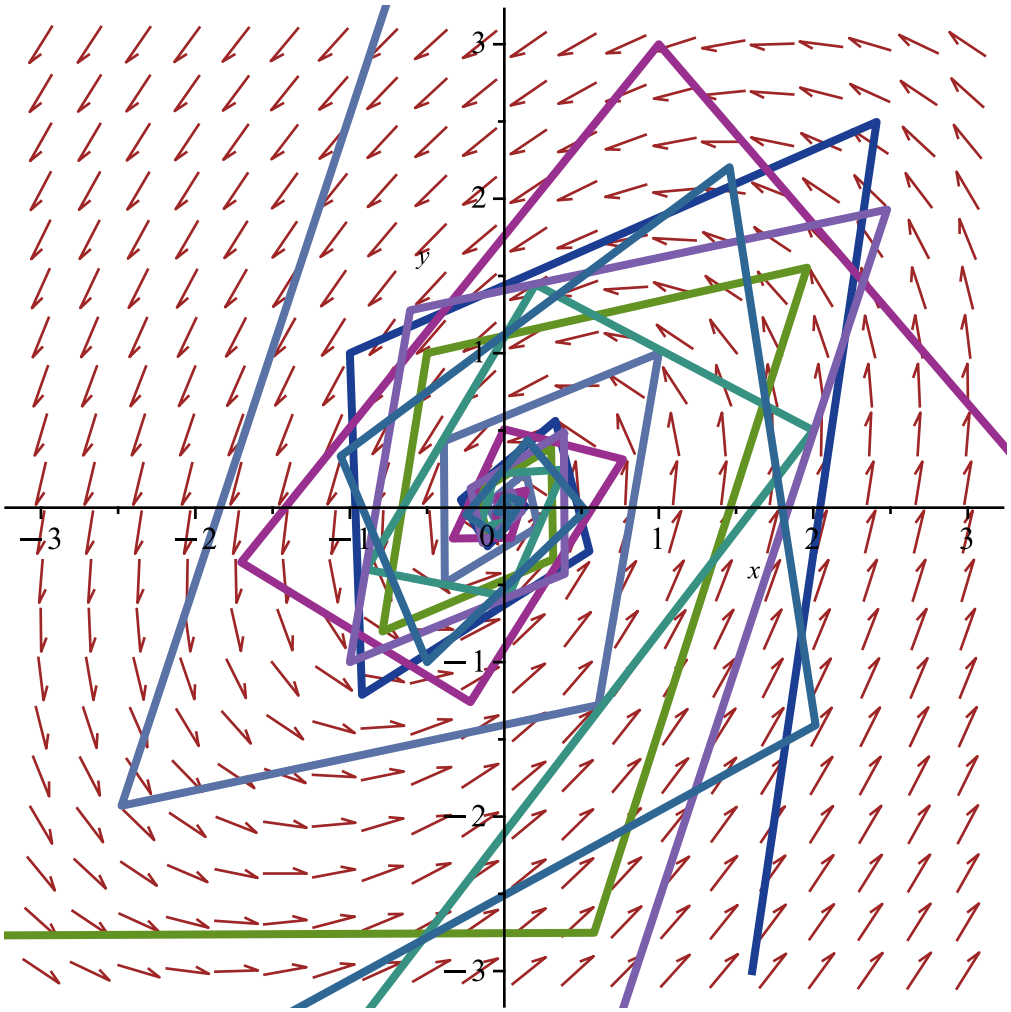
```
> H:=matrix([[1,-4],[5,-3]])
```

$$H := \begin{bmatrix} 1 & -4 \\ 5 & -3 \end{bmatrix} \tag{54}$$

```
> eigenvals(H)
```

$$-1 + 4\,I,\ -1 - 4\,I \tag{55}$$

```
> #stabil de tip focus
> DEplot([sist8],[x(t),y(t)],t=-10..10,x=-3..3,y=-3..3,[[x(0)=-1,y
  (0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x(0)=
  2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> #ex3
> restart:
> with(DEtools): with(plots): with(linalg):
> f1:=(x,y)->y
```

$$f1 := (x, y) \mapsto y \tag{56}$$

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

$$f2 := (x, y) \mapsto x \cdot \left(1 - x^2\right) + y \tag{57}$$

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

$$ec1 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = y(t) \tag{58}$$

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

$$ec2 := \frac{\mathrm{d}}{\mathrm{d}t} y(t) = x(t) \left(1 - x(t)^2\right) + y(t) \tag{59}$$

```
> sist1:=ec1,ec2
```

$$sist1 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = y(t), \frac{\mathrm{d}}{\mathrm{d}t} y(t) = x(t) \left(1 - x(t)^2\right) + y(t) \tag{60}$$

```
> PctEch1:=solve({f1(x,y)=0,f2(x,y)=0},{x,y})
```

$$PctEch1 := \{x = 0, y = 0\}, \{x = 1, y = 0\}, \{x = -1, y = 0\} \tag{61}$$

```
> J1:=jacobian([f1(x,y),f2(x,y)],[x,y])
```

$$J1 := \begin{bmatrix} 0 & 1 \\ -3x^2+1 & 1 \end{bmatrix} \quad (62)$$

```
> A1:=subs(PctEch1[1,1],PctEch1[1,2],eval(J1))
```

$$A1 := \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} \quad (63)$$

```
> eigenvals(A1)
```

$$\frac{\sqrt{5}}{2}+\frac{1}{2}, -\frac{\sqrt{5}}{2}+\frac{1}{2} \quad (64)$$

```
> #instabil de tip sa
> A2:=subs(PctEch1[2,1],PctEch1[2,2],eval(J1))
```

$$A2 := \begin{bmatrix} 0 & 1 \\ -2 & 1 \end{bmatrix} \quad (65)$$

```
> eigenvals(A2)
```

$$\frac{1}{2}+\frac{I\sqrt{7}}{2}, \frac{1}{2}-\frac{I\sqrt{7}}{2} \quad (66)$$

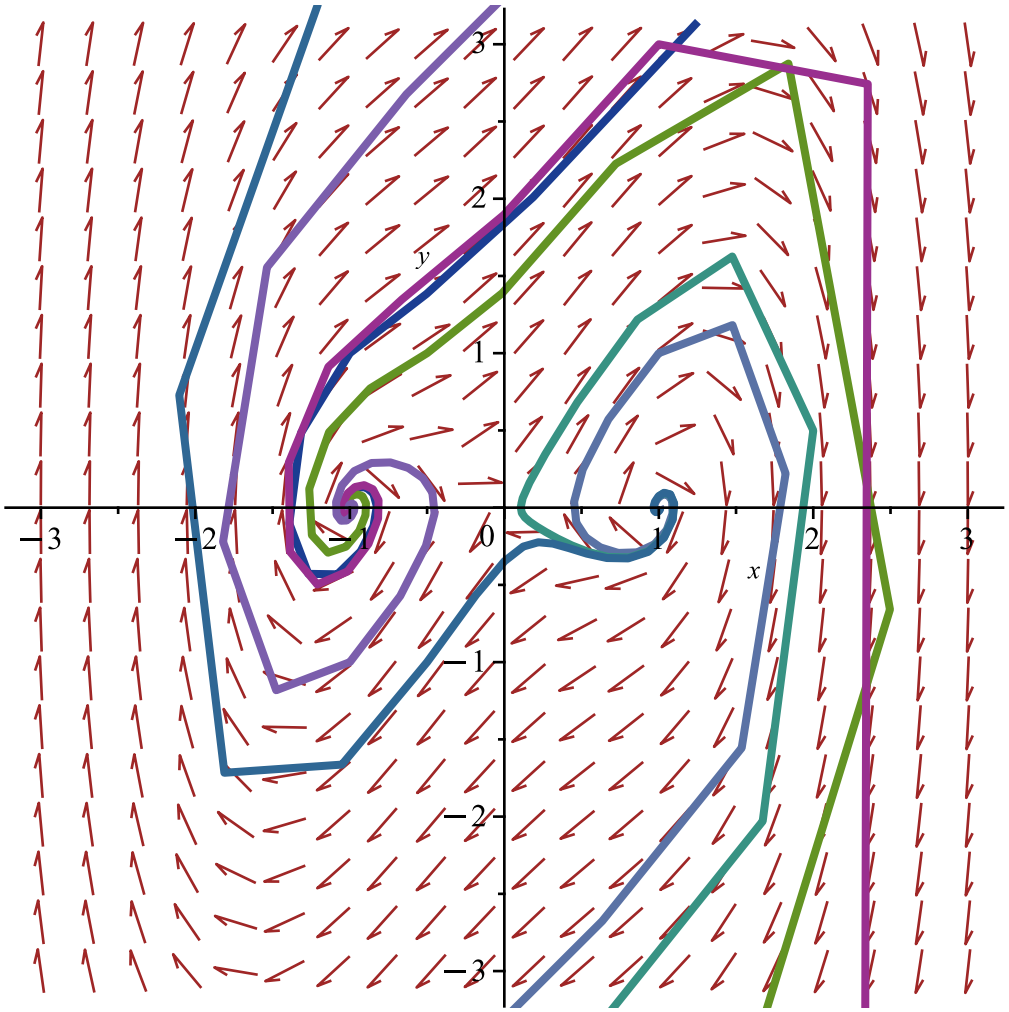
```
> stabil de tip focus
> A3:=subs(PctEch1[3,1],PctEch1[3,2],eval(J1))
```

$$A3 := \begin{bmatrix} 0 & 1 \\ -2 & 1 \end{bmatrix} \quad (67)$$

```
> eigenvals(A3)
```

$$\frac{1}{2}+\frac{I\sqrt{7}}{2}, \frac{1}{2}-\frac{I\sqrt{7}}{2} \quad (68)$$

```
> #stabil de tip focus
> DEplot([sist1],[x(t),y(t)],t=-10..10,x=-3..3,y=-3..3,[[x(0)=-1,y
  (0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x(0)=
  2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> f3:=(x,y)->-2*x+y+2
```

$$f3 := (x, y) \mapsto -2 \cdot x + y + 2 \tag{69}$$

```
> f4:=(x,y)->x*y
```

$$f4 := (x, y) \mapsto y \cdot x \tag{70}$$

```
> ec3:=diff(x(t),t)=f3(x(t),y(t))
```

$$ec3 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = -2\,x(t) + y(t) + 2 \tag{71}$$

```
> ec4:=diff(y(t),t)=f4(x(t),y(t))
```

$$ec4 := \frac{\mathrm{d}}{\mathrm{d}t} y(t) = y(t)\,x(t) \tag{72}$$

```
> sist2:=ec3,ec4
```

$$sist2 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = -2\,x(t) + y(t) + 2,\ \frac{\mathrm{d}}{\mathrm{d}t} y(t) = y(t)\,x(t) \tag{73}$$

```
> PctEch2:=solve({f3(x,y)=0,f4(x,y)=0},{x,y})
```

$$PctEch2 := \{x = 1, y = 0\},\ \{x = 0, y = -2\} \tag{74}$$

```
> J2:=jacobian([f3(x,y),f4(x,y)],[x,y])
```

$$J2 := \begin{bmatrix} -2 & 1 \\ y & x \end{bmatrix} \tag{75}$$

```
> B1:=subs(PctEch2[1,1],PctEch2[1,2],eval(J2))
```

$$B1 := \begin{bmatrix} -2 & 1 \\ 0 & 1 \end{bmatrix} \tag{76}$$

```
> eigenvals(B1)
```

$$-2, 1 \tag{77}$$

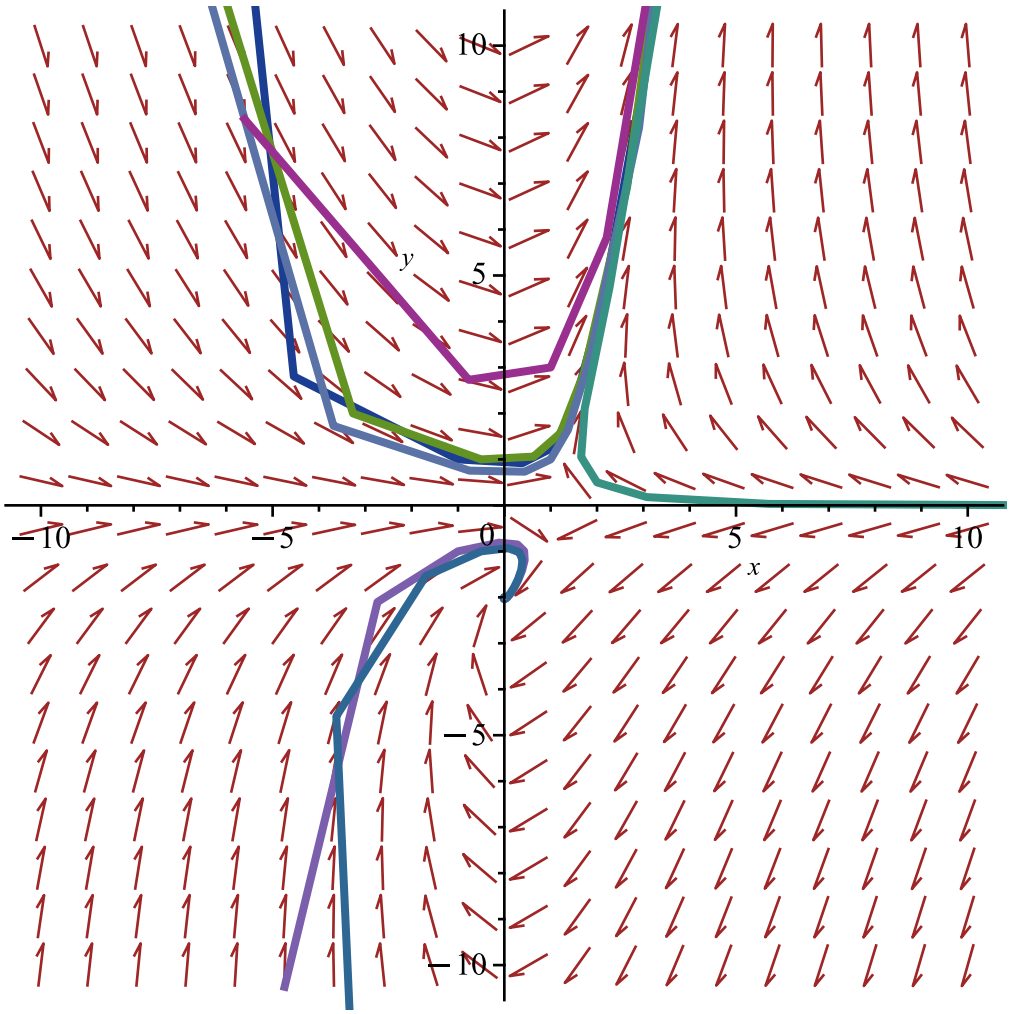
```
> #instabil de tip sa
> B2:=subs(PctEch2[2,1],PctEch2[2,2],eval(J2))
```

$$B2 := \begin{bmatrix} -2 & 1 \\ -2 & 0 \end{bmatrix} \tag{78}$$

```
> eigenvals(B2)
```

$$-1 + I, -1 - I \tag{79}$$

```
> #stabil de tip focus
> DEplot([sist2],[x(t),y(t)],t=-10..10,x=-10..10,y=-10..10,[[x(0)=
  -1,y(0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x
  (0)=2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
Warning, plot may be incomplete, the following errors(s) were issued:
   cannot evaluate the solution further left of -1.2007853, probably
a singularity
```




```
> f5:=(x,y)->y^2
```

$$f5 := (x, y) \mapsto y^2 \quad (80)$$

```
> f6:=(x,y)->x
```

$$f6 := (x, y) \mapsto x \quad (81)$$

```
> ec5:=diff(x(t),t)=f5(x(t),y(t))
```

$$ec5 := \frac{d}{dt} x(t) = y(t)^2 \quad (82)$$

```
> ec6:=diff(y(t),t)=f6(x(t),y(t))
```

$$ec6 := \frac{d}{dt} y(t) = x(t) \quad (83)$$

```
> sist3:=ec5,ec6
```

$$sist3 := \frac{d}{dt} x(t) = y(t)^2, \frac{d}{dt} y(t) = x(t) \quad (84)$$

```
> PctEch3:=solve({f5(x,y)=0,f6(x,y)=0},{x,y})
```

$$PctEch3 := \{x = 0, y = 0\} \quad (85)$$

```
> J3:=jacobian([f5(x,y),f6(x,y)],[x,y])
```

$$J3 := \begin{bmatrix} 0 & 2y \\ 1 & 0 \end{bmatrix} \quad (86)$$

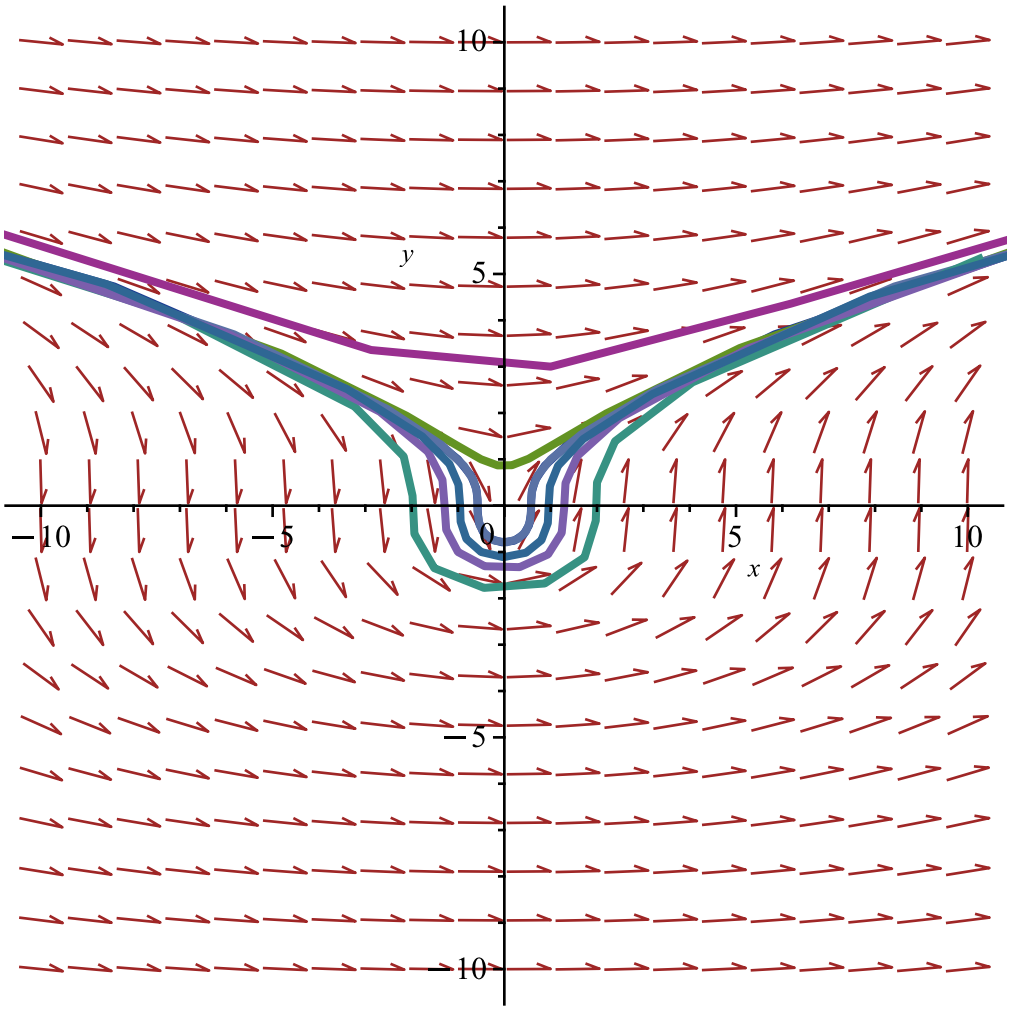
```
> C:=subs(PctEch3[1],PctEch3[2],eval(J3))
```

$$C := \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \quad (87)$$

```
> eigenvals(C)
```

$$0, 0 \quad (88)$$

```
> DEplot([sist3],[x(t),y(t)],t=-10..10,x=-10..10,y=-10..10,[[x(0)=
  -1,y(0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x
  (0)=2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> f7:=(x,y)->x^2-y^2
```

$$f7 := (x, y) \mapsto x^2 - y^2 \quad (89)$$

```
> f8:=(x,y)->x*y-1
```

$$f8 := (x, y) \mapsto y \cdot x - 1 \quad (90)$$

```
> ec7:=diff(x(t),t)=f7(x(t),y(t))
```

$$ec7 := \frac{d}{dt} x(t) = x(t)^2 - y(t)^2 \quad (91)$$

```
> ec8:=diff(y(t),t)=f8(x(t),y(t))
```

$$ec8 := \frac{d}{dt} y(t) = y(t)\, x(t) - 1 \quad (92)$$

```
> sist4:=ec7,ec8
```

$$sist4 := \frac{d}{dt} x(t) = x(t)^2 - y(t)^2, \frac{d}{dt} y(t) = y(t)\, x(t) - 1 \quad (93)$$

```
> PctEch4:=solve({f7(x,y)=0,f8(x,y)=0},{x,y})
```

$$PctEch4 := \{x = -RootOf(\_Z^2 + 1), y = RootOf(\_Z^2 + 1)\}, \{x = 1, y = 1\}, \{x = -1, y = -1\} \quad (94)$$

```
> J4:=jacobian([f7(x,y),f8(x,y)],[x,y])
```

$$J4 := \begin{bmatrix} 2x & -2y \\ y & x \end{bmatrix} \quad (95)$$

```
> D1:=subs(PctEch4[1,1],PctEch4[1,2],eval(J4))
```

$$D1 := \begin{bmatrix} -2\,RootOf(\_Z^2+1) & -2\,RootOf(\_Z^2+1) \\ RootOf(\_Z^2+1) & -RootOf(\_Z^2+1) \end{bmatrix} \quad (96)$$

```
> eigenvals(D)
Error, (in linalg:-eigenvals) square matrix expected
```

```
> D2:=subs(PctEch4[2,1],PctEch4[2,2],eval(J4))
```

$$D2 := \begin{bmatrix} 2 & -2 \\ 1 & 1 \end{bmatrix} \quad (97)$$

```
> eigenvals(D2)
```

$$\frac{3}{2}+\frac{I\sqrt{7}}{2}, \frac{3}{2}-\frac{I\sqrt{7}}{2} \quad (98)$$

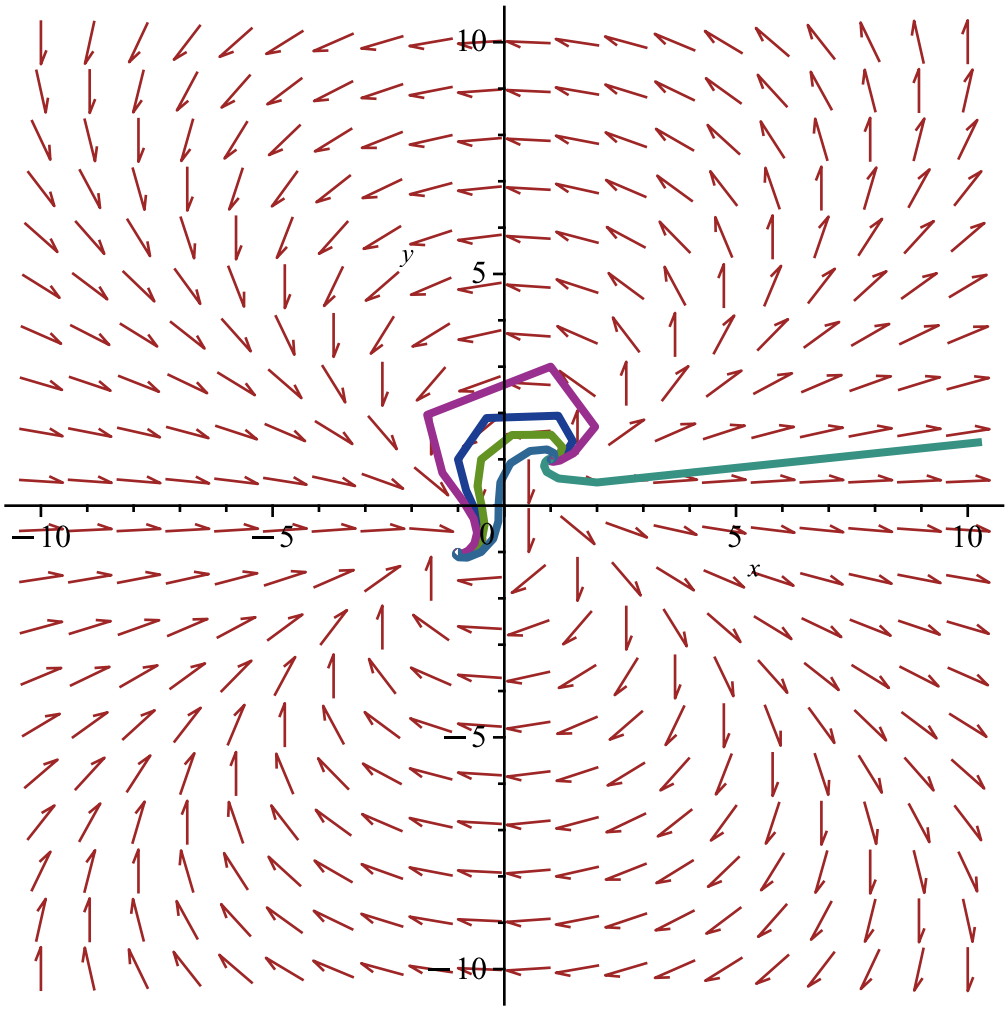
```
> #stabil de tip focus
> D3:=subs(PctEch4[3,1],PctEch4[3,2],eval(J4))
```

$$D3 := \begin{bmatrix} -2 & 2 \\ -1 & -1 \end{bmatrix} \quad (99)$$

```
> eigenvals(D3)
```

$$-\frac{3}{2}+\frac{I\sqrt{7}}{2}, -\frac{3}{2}-\frac{I\sqrt{7}}{2} \quad (100)$$

```
> #
> DEplot([sist4],[x(t),y(t)],t=-10..10,x=-10..10,y=-10..10,[[x(0)=
  -1,y(0)=1],[x(0)=-1/2,y(0)=1],[x(0)=1,y(0)=1],[x(0)=1,y(0)=3],[x
  (0)=2,y(0)=1/2],[x(0)=-1,y(0)=-1],[x(0)=-1/2,y(0)=-1]])
```




```
> #ex4
> restart
> with(DEtools): with(plots): with(linalg):
> f1:=(x,y)->2*x-1.2*x*y
```

$$f1 := (x, y) \mapsto 2 \cdot x - 1.2 \cdot y \cdot x \tag{101}$$

```
> f2:=(x,y)->-y+0.9*x*y
```

$$f2 := (x, y) \mapsto -y + 0.9 \cdot y \cdot x \tag{102}$$

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

$$ec1 := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = 2\,x(t) - 1.2\,y(t)\,x(t) \tag{103}$$

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

$$ec2 := \frac{\mathrm{d}}{\mathrm{d}t} y(t) = -y(t) + 0.9\,y(t)\,x(t) \tag{104}$$

```
> cond_in:=x(0)=0.5,y(0)=2
```

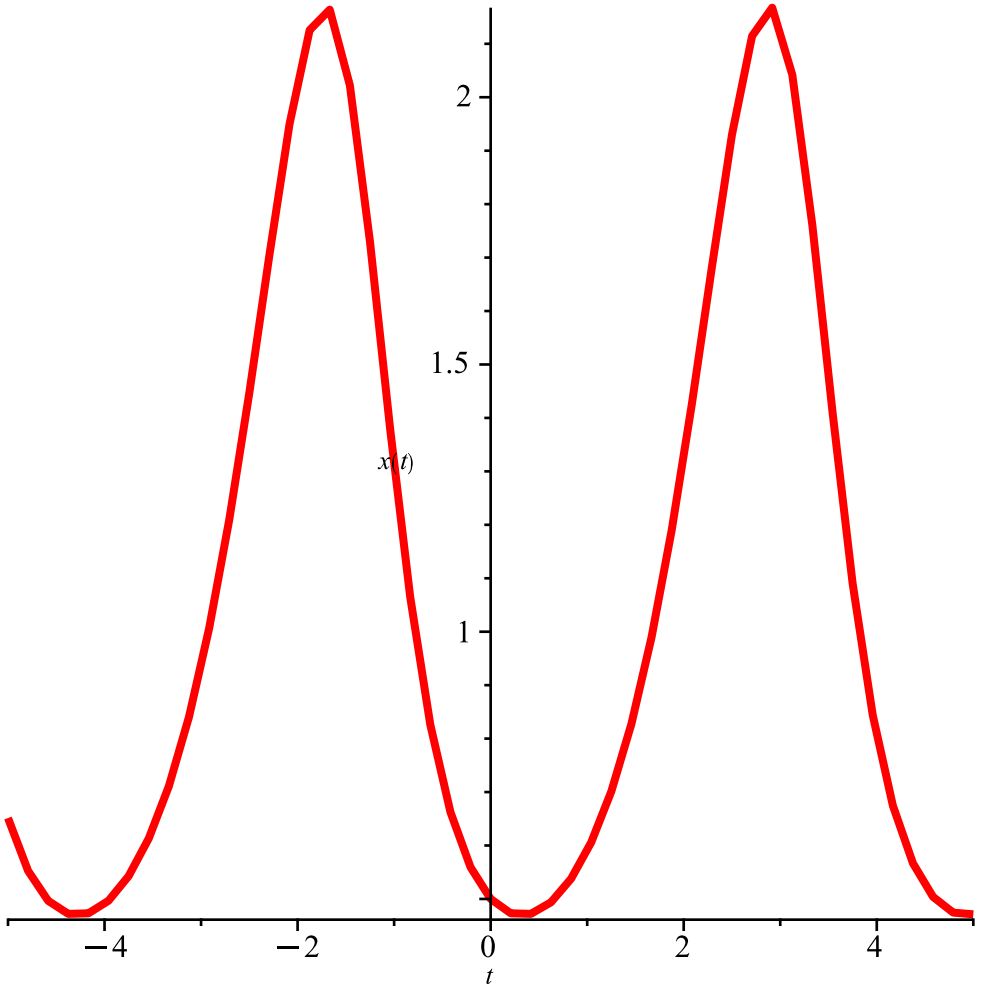
$$cond\_in := x(0) = 0.5, y(0) = 2 \tag{105}$$

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

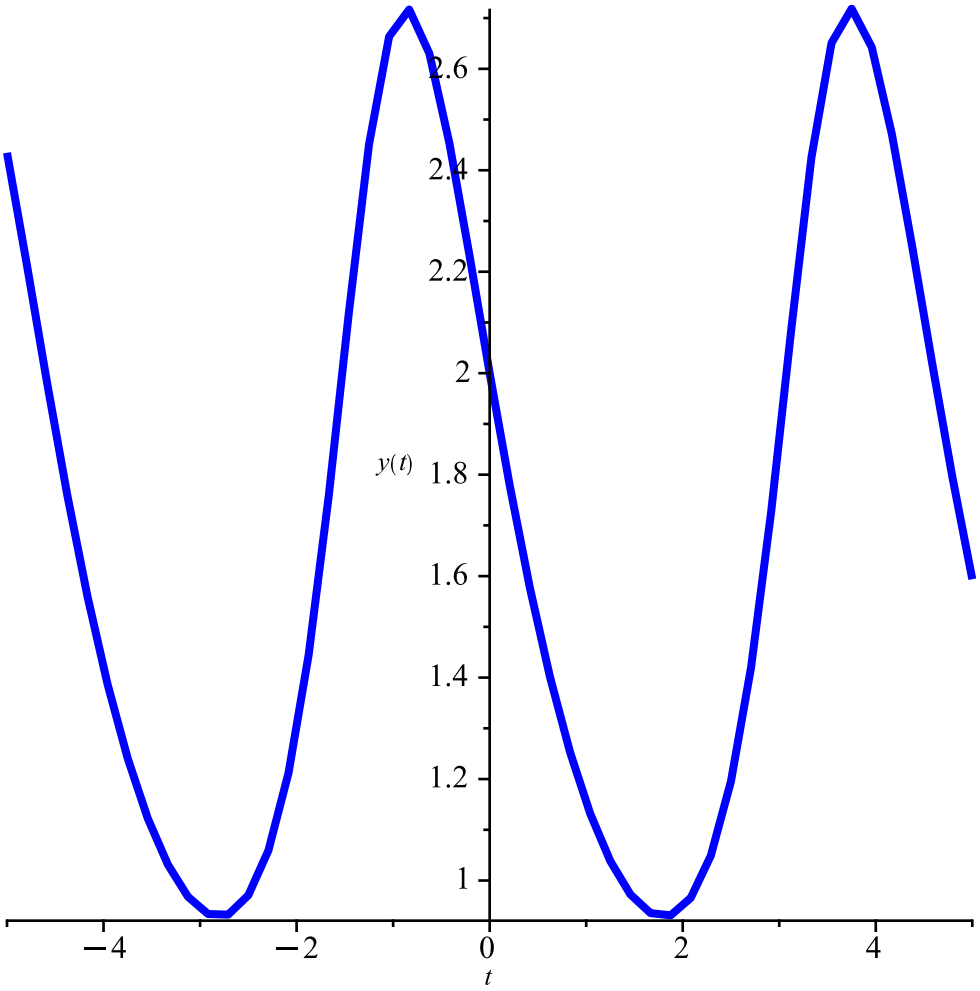
$$sist := \frac{\mathrm{d}}{\mathrm{d}t} x(t) = 2\,x(t) - 1.2\,y(t)\,x(t),\ \frac{\mathrm{d}}{\mathrm{d}t} y(t) = -y(t) + 0.9\,y(t)\,x(t) \tag{106}$$

```
> xx1:=DEplot([sist],[x,y],t=-5..5,[[cond_in]],linecolor=red,scene=
```

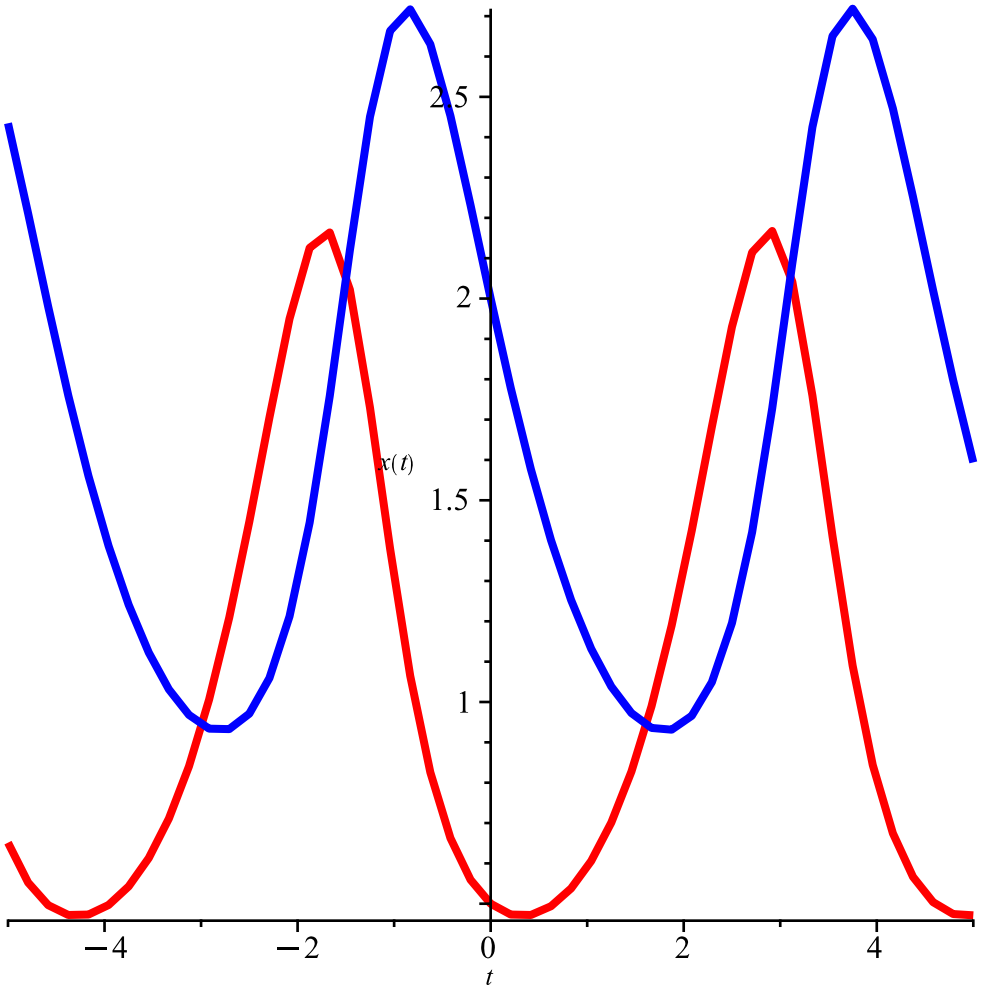
```
[t,x(t)])
```




```
> yy1:=DEplot([sist],[x,y],t=-5..5,[[cond_in]],linecolor=blue,
  scene=[t,y(t)])
```




```
> display([xx1,yy1])
```




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

$$PctEch := \{x = 0., y = 0.\}, \{x = 1.111111111, y = 1.666666667\} \quad (107)$$

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

$$J := \begin{bmatrix} 2 - 1.2\,y & -1.2\,x \\ 0.9\,y & -1 + 0.9\,x \end{bmatrix} \quad (108)$$

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

$$A1 := \begin{bmatrix} 2. & -0. \\ 0. & -1. \end{bmatrix} \quad (109)$$

```
> eigenvals(A1)
```

$$-1., 2. \quad (110)$$

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

$$A2 := \begin{bmatrix} 0. & -1.333333333 \\ 1.500000000 & -1. \times 10^{-10} \end{bmatrix} \quad (111)$$

```
> eigenvals(A2)
```

$$-5.00000000000000 \times 10^{-11} + 1.41421356219632\,I, -5.00000000000000 \times 10^{-11} - 1.41421356219632\,I \quad (112)$$

```
> #stabil de tip focus
> DEplot(
```