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```
Maple Worksheet for Qualitative Analysis for Nonlinear Systems
(Section 6.7 in Ledder)

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22 April 2008

```
>
> restart;
> with( DEtools ):
> with( plots ):
> with( LinearAlgebra ):
> with( plottools ):
>
> SYS2 := [
>    diff( x(t), t ) = f( x(t), y(t) ),
>    diff( y(t), t ) = g( x(t), y(t) )
> ];
> SYS3 := [
>    diff( x(t), t ) = f( x(t), y(t), z(t) ),
>    diff( y(t), t ) = g( x(t), y(t), z(t) ),
>    diff( z(t), t ) = h( x(t), y(t), z(t) )
> ];
>
>
```
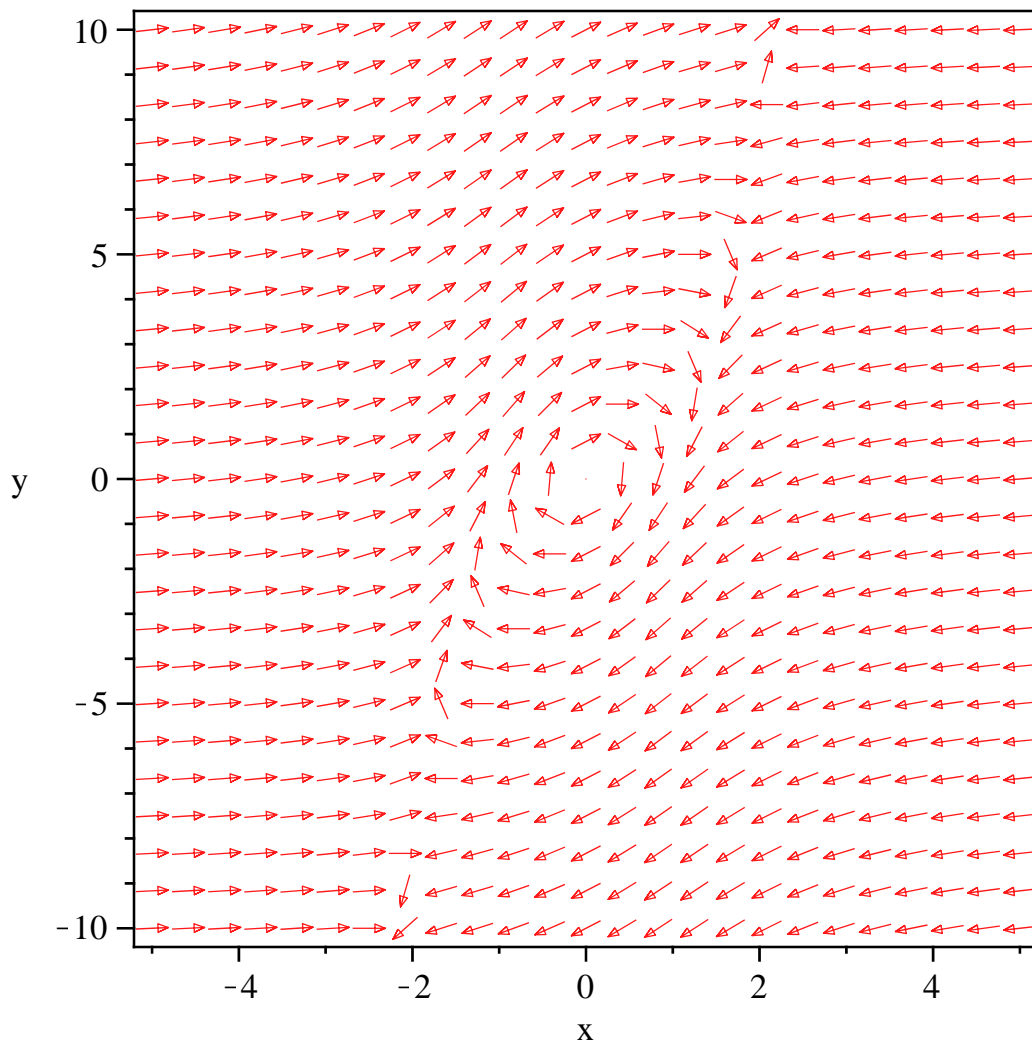
► # 2 (p. 408)

► # 3 (p. 408)

▼ # 6 (p. 408)

```
> f := (x,y) -> y-x^3;
> g := (x,y) -> y-4*x;
```

$$f := (x, y) \rightarrow y - x^3$$
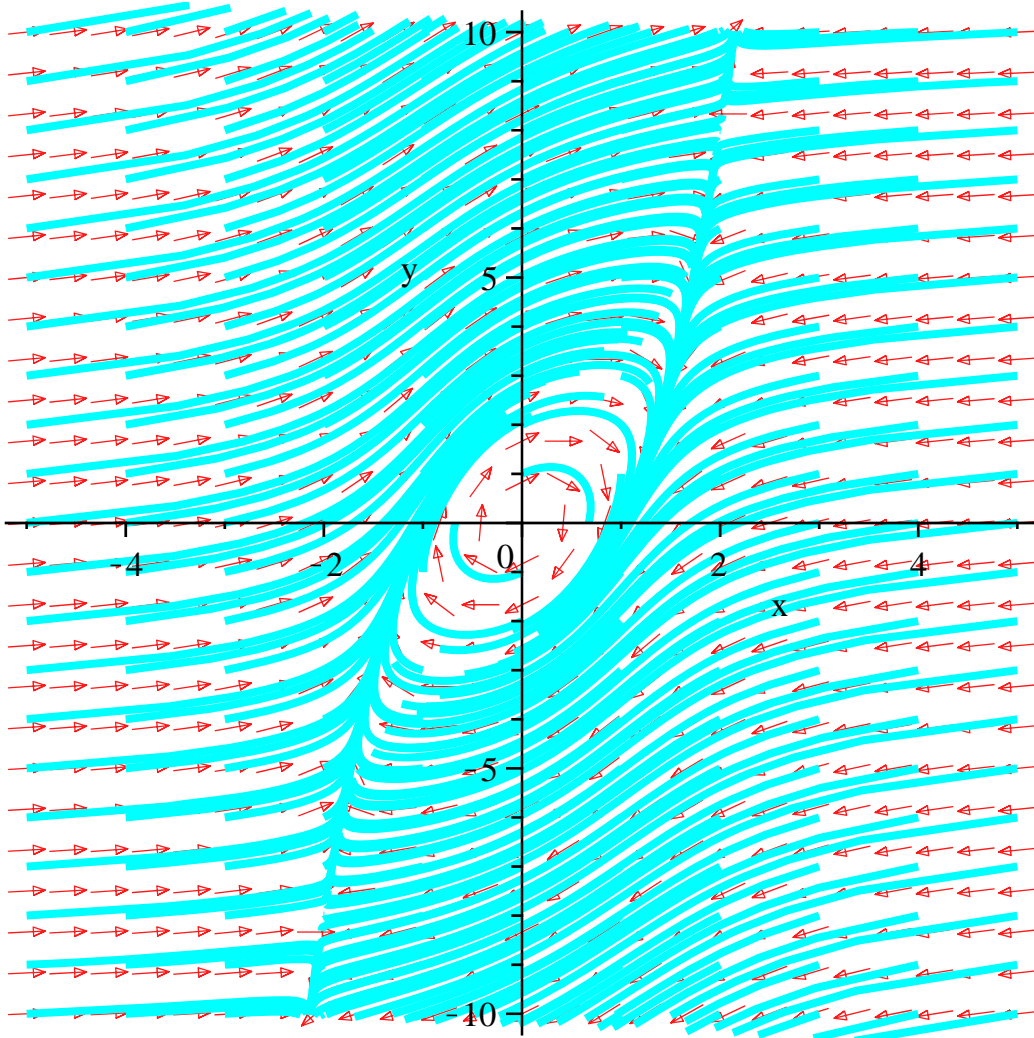$$g := (x, y) \rightarrow y - 4\,x$$

(3.1)

```
>
> DEplot( SYS2, [x(t),y(t)], t=0..1, x=-5..5, y=-10..10,
          arrows=medium, dirgrid=[25,25], axes=boxed );
```

```
>
> IC := [ seq( seq( [0,a,b], b=[$-10..10] ), a=[$-5..5] ) ]:
>
> DEplot( SYS2, [x(t),y(t)], t=0..1, x=-5..5, y=-10..10, IC,
         arrows=medium, linecolor=cyan,
         dirgrid=[25,25], stepsize=0.05
       );
```

```
>
> EqSolns := solve( [f(x,y)=0,g(x,y)=0], [x,y] );
```
$$EqSolns := [[x = 0, y = 0], [x = 2, y = 8], [x = -2, y = -8]] \tag{3.2}$$

```
>
> J := VectorCalculus:-Jacobian( [f(x,y),g(x,y)], [x,y] );
```
$$J := \begin{bmatrix} -3\,x^2 & 1 \\ -4 & 1 \end{bmatrix} \tag{3.3}$$

```
> J1 := eval( J, EqSolns[1] );
```
$$J1 := \begin{bmatrix} 0 & 1 \\ -4 & 1 \end{bmatrix} \tag{3.4}$$

```
> Eigenvalues( J1 );
```

$$\tag{3.5}$$

$$\left[\begin{array}{c} \dfrac{1}{2} + \dfrac{1}{2}\, I \sqrt{15} \\[1em] \dfrac{1}{2} - \dfrac{1}{2}\, I \sqrt{15} \end{array} \right]$$

(3.5)

```
> 
> J2 := eval( J, EqSolns[2] );
```

$$J2 := \left[\begin{array}{cc} -12 & 1 \\ -4 & 1 \end{array} \right]$$

(3.6)

```
> Eigenvalues( J2 );
```

$$\left[\begin{array}{c} -\dfrac{11}{2} + \dfrac{3}{2}\, \sqrt{17} \\[1em] -\dfrac{11}{2} - \dfrac{3}{2}\, \sqrt{17} \end{array} \right]$$

(3.7)

```
> 
> J3 := eval( J, EqSolns[3] );
```

$$J3 := \left[\begin{array}{cc} -12 & 1 \\ -4 & 1 \end{array} \right]$$

(3.8)

```
> Eigenvalues( J3 );
```

$$\left[\begin{array}{c} -\dfrac{11}{2} + \dfrac{3}{2}\, \sqrt{17} \\[1em] -\dfrac{11}{2} - \dfrac{3}{2}\, \sqrt{17} \end{array} \right]$$

(3.9)

```
> 
> 
```