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> #Bahdanau Aliaksandr 153502 LAB 3.1 variant 5
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> #Task 1
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```
> diff(y(x), x) = (y(x) - 1) · x
```

$$\frac{d}{dx} y(x) = (y(x) - 1) x$$

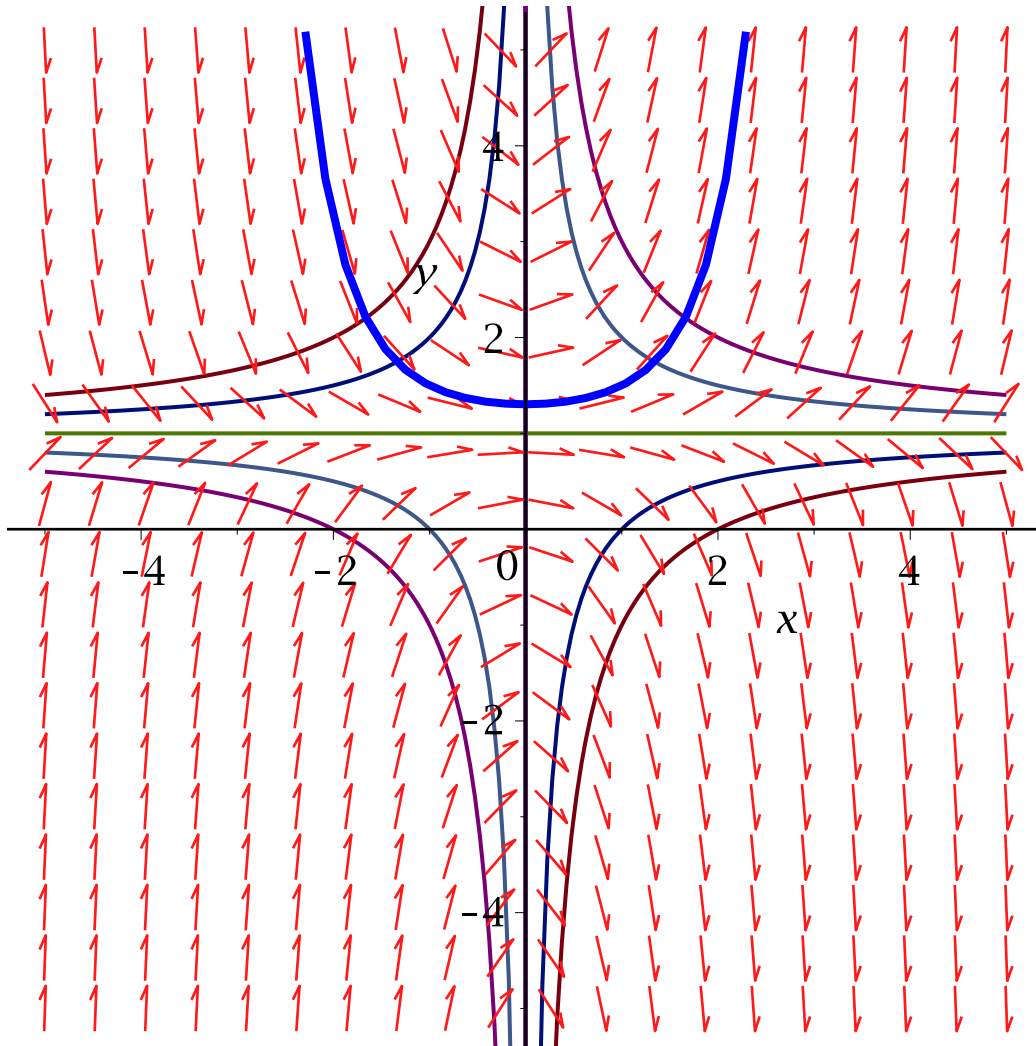
(1)

```
> with(DETools) :
```

```
> isoc1 := plot( [ seq( C/x + 1, C=-2..2 ) ], x=-5..5, y=-5..5 ) :
```

```
> dplot := DEplot( diff(y(x), x) = (y(x) - 1) · x, y(x), x=-5..5, y=-5..5, [ y(1) = 3/2 ],  
    linecolor = blue ) :
```

```
> plots[display](isoc1, dplot)
```



```
> #Task 2.1
```

```
> restart
```

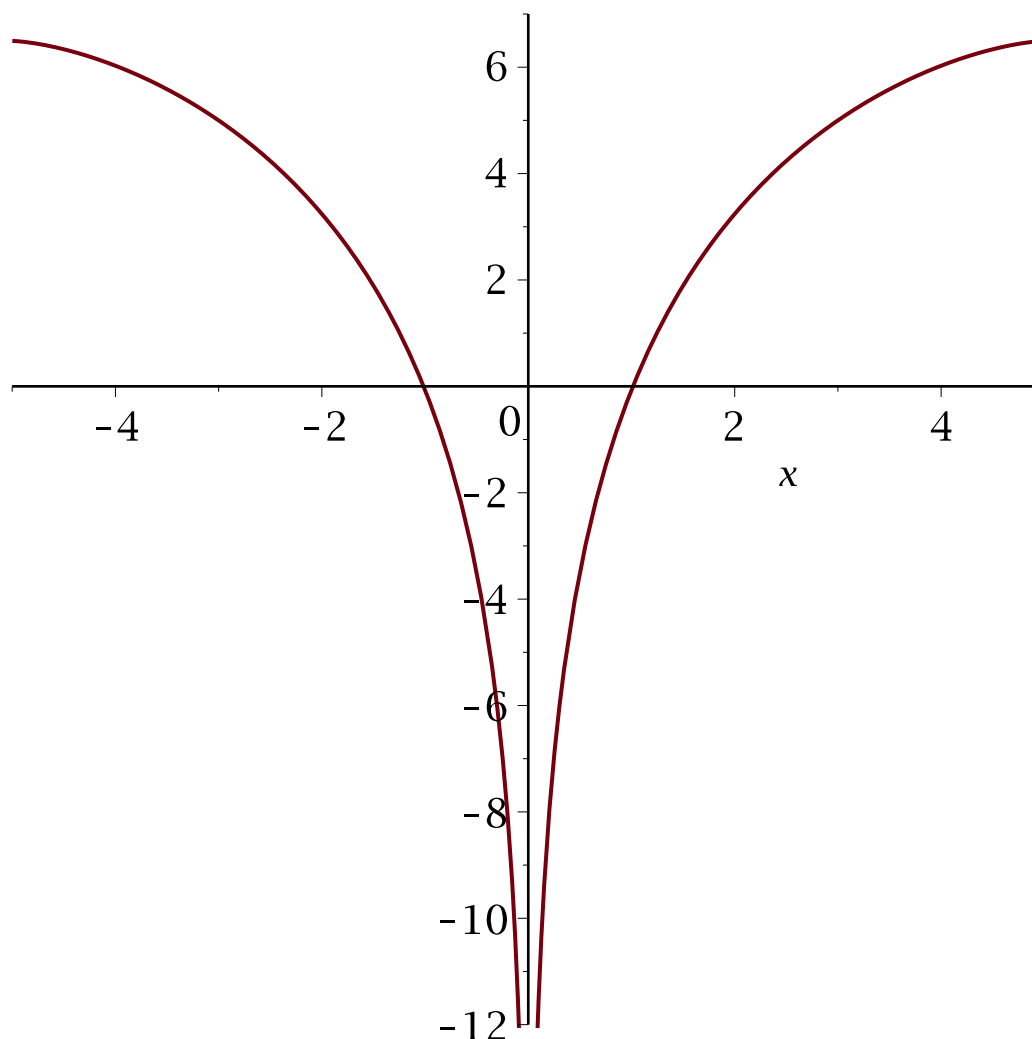
```
> line := dsolve( { diff(y(x), x) =  $\frac{\sqrt{25-x^2}}{x}$ , y(3) = 5 } )
```

$$\text{line} := y(x) = \sqrt{-x^2 + 25} - 5 \operatorname{arctanh}\left(\frac{5}{\sqrt{-x^2 + 25}}\right) + 1 + 5 \operatorname{arctanh}\left(\frac{5}{4}\right) \quad (2)$$

```
> simplify(line)
```

$$y(x) = \sqrt{-x^2 + 25} - 5 \operatorname{arctanh}\left(\frac{5}{\sqrt{-x^2 + 25}}\right) + 1 + 5 \operatorname{arctanh}\left(\frac{5}{4}\right) \quad (3)$$

```
> plot(rhs(line))
```



```
> #Task 2.2
```

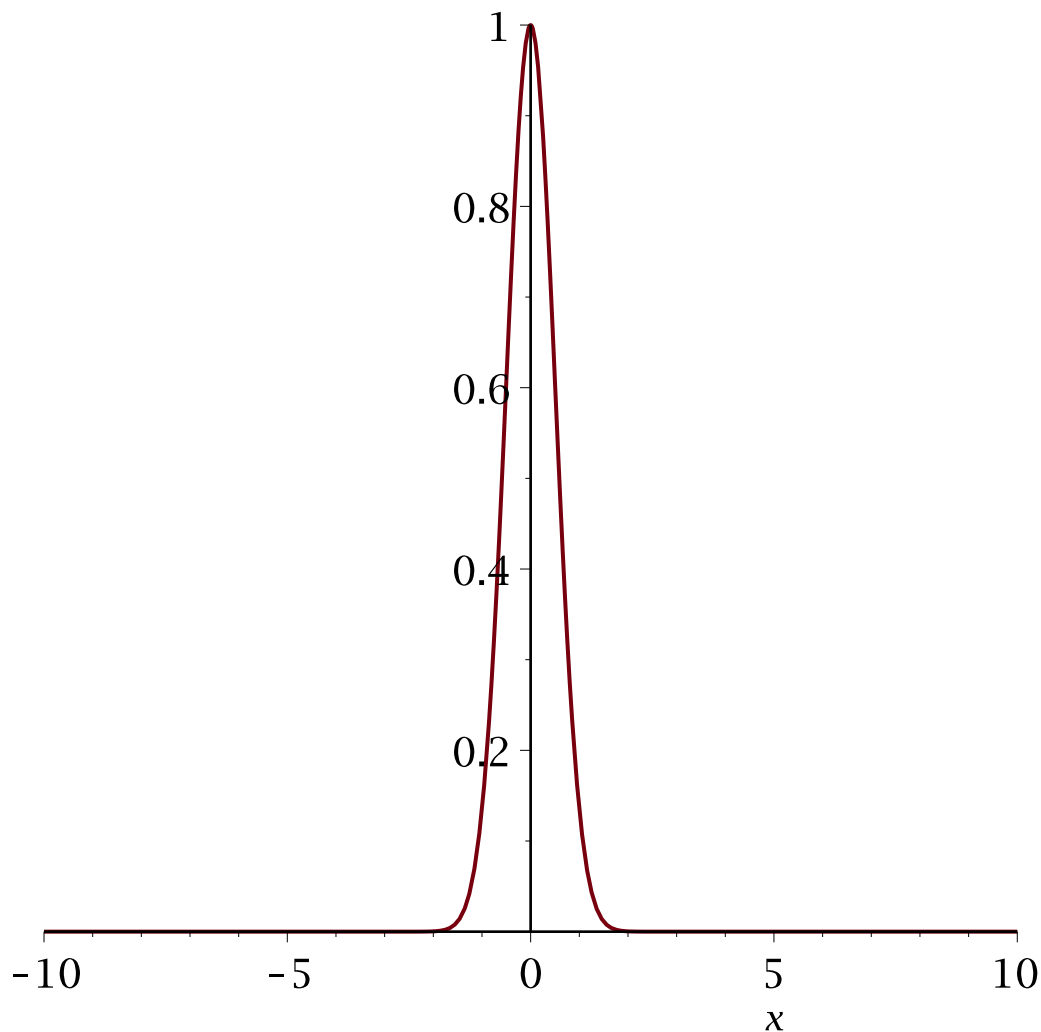
```
> restart
```

```
> a :=  $\frac{1}{4}$  :
```

```
> line := simplify( dsolve( { diff(y(x), x) = -  $\frac{y(x) \cdot x}{a}$ , y(1) =  $\frac{1}{e^2}$  } ) ) )
```

$$\text{line} := y(x) = e^{-2x^2} \quad (4)$$

```
> plot(e-2·x²)
```



> **#Task 3**

> restart

> $de := \text{diff}(y(x), x) = \frac{-30 \cdot x - 7 \cdot y(x) + 51}{4 \cdot x + y(x) - 7}$

$$de := \frac{d}{dx} y(x) = \frac{-30x - 7y(x) + 51}{4x + y(x) - 7} \quad (5)$$

> $s := \text{dsolve}(de)$

$$s := y(x) = 3 - \frac{1}{2} \frac{12(x-1) _C1 + 1 + \sqrt{4(x-1) _C1 + 1}}{_C1} \quad (6)$$

> **#Find incompatible dot**

> $\text{solve}(\{-30 \cdot x - 7 \cdot y + 51 = 0, 4 \cdot x + y - 7 = 0\})$
 $\{x = 1, y = 3\}$

(7)

> $dfield := \text{DETools}[\text{DEplot}](de, y(x), x = -100..100, y = -100..100, [y(1) = 5, y(9) = 10]) :$

Warning, plot may be incomplete, the following error(s) were issued:

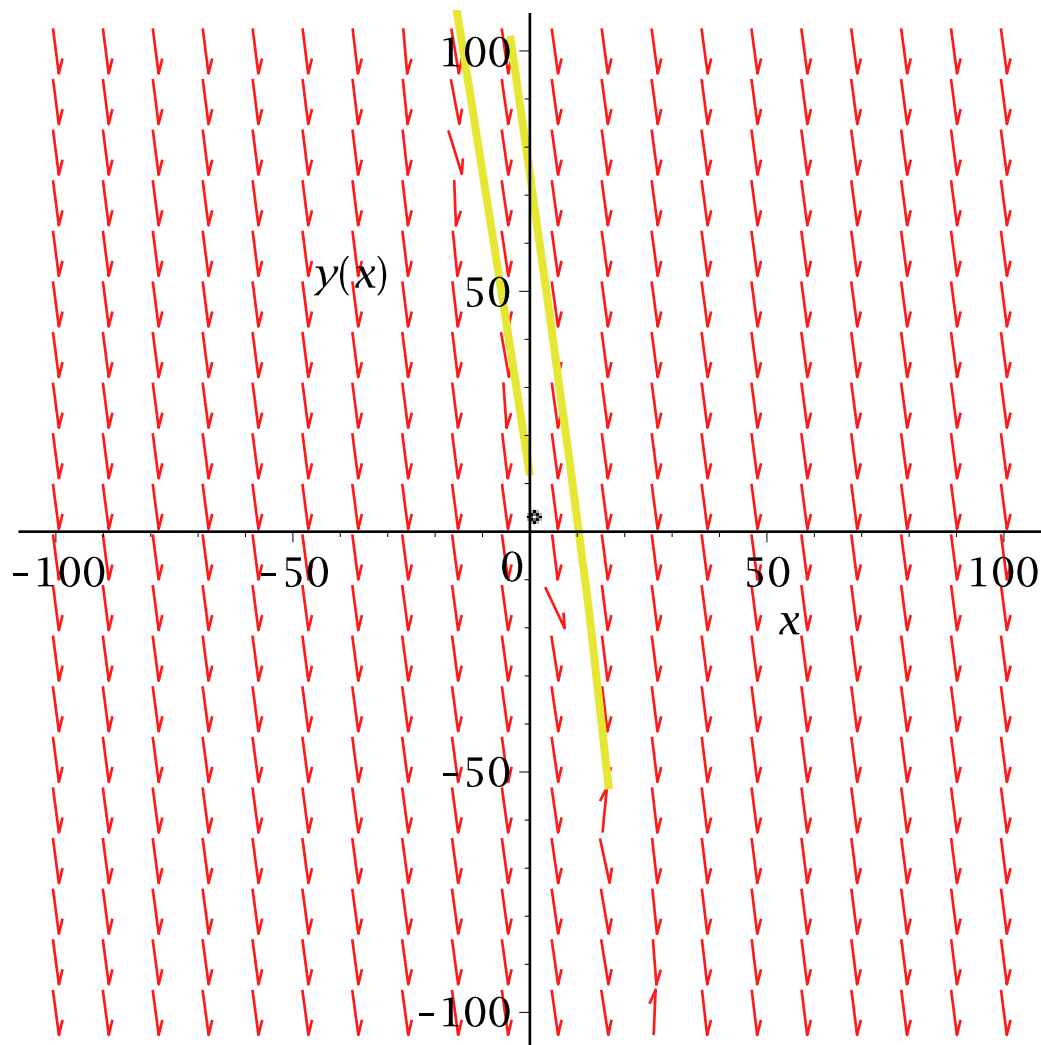
cannot evaluate the solution further right of 1.5000001,

probably a singularity
Warning, plot may be incomplete, the following errors(s) were issued:

cannot evaluate the solution further right of 17.090427,
maxfun limit exceeded (see ?dsolve,maxfun for details)

> *ppoint* := plot([1, 3], style = point, color = black) :

> plots[display](dfield, ppoint)



> *A* := Matrix([[4 - x, 1], [-30, -7 - x]])

$$A := \begin{bmatrix} 4 - x & 1 \\ -30 & -7 - x \end{bmatrix}$$

(8)

> solve(LinearAlgebra[Determinant](A) = 0)

-1, -2

(9)

> **#Roots are negative, knot is stable**

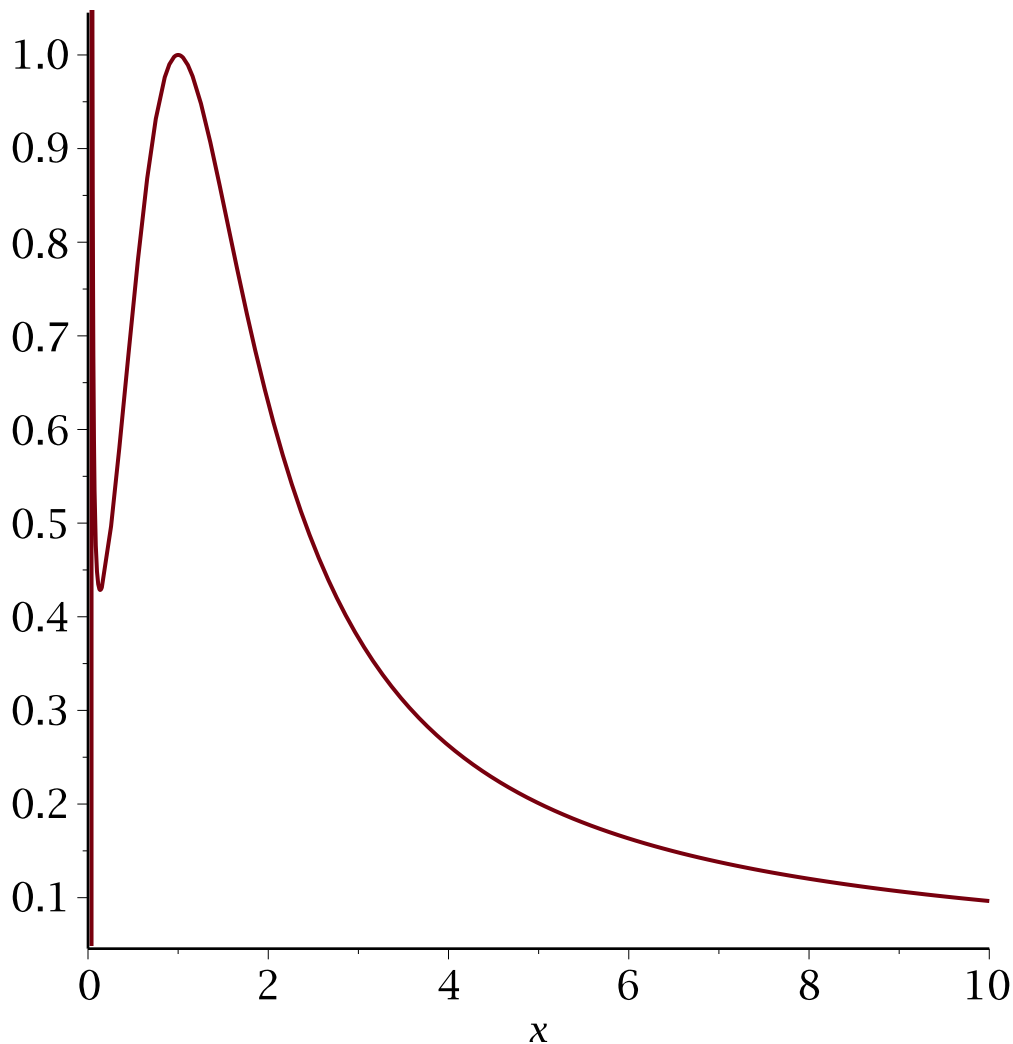
> **#Task 4**

> restart

$$\begin{aligned} > de := x \cdot \text{diff}(y(x), x) = -y^2(x) \cdot (\ln(x) + 2) \cdot \ln(x) \\ & \quad de := x \left(\frac{d}{dx} y(x) \right) = -y(x)^2 (\ln(x) + 2) \ln(x) \end{aligned} \quad (10)$$

$$\begin{aligned} > \text{dsolve}(\{de, y(1) = 1\}) \\ & \quad y(x) = \frac{3}{3 + \ln(x)^3 + 3 \ln(x)^2} \end{aligned} \quad (11)$$

$$> \text{plot}\left(\frac{3}{3 + \ln(x)^3 + 3 \ln(x)^2}\right)$$



> **#Task 5.1**

> restart

$$\begin{aligned} > de := x = \sin(\text{diff}(y(x), x)) - \text{diff}(y(x), x) \cdot \cos(\text{diff}(y(x), x)) \\ & \quad de := x = \sin\left(\frac{d}{dx} y(x)\right) - \left(\frac{d}{dx} y(x)\right) \cos\left(\frac{d}{dx} y(x)\right) \end{aligned} \quad (12)$$

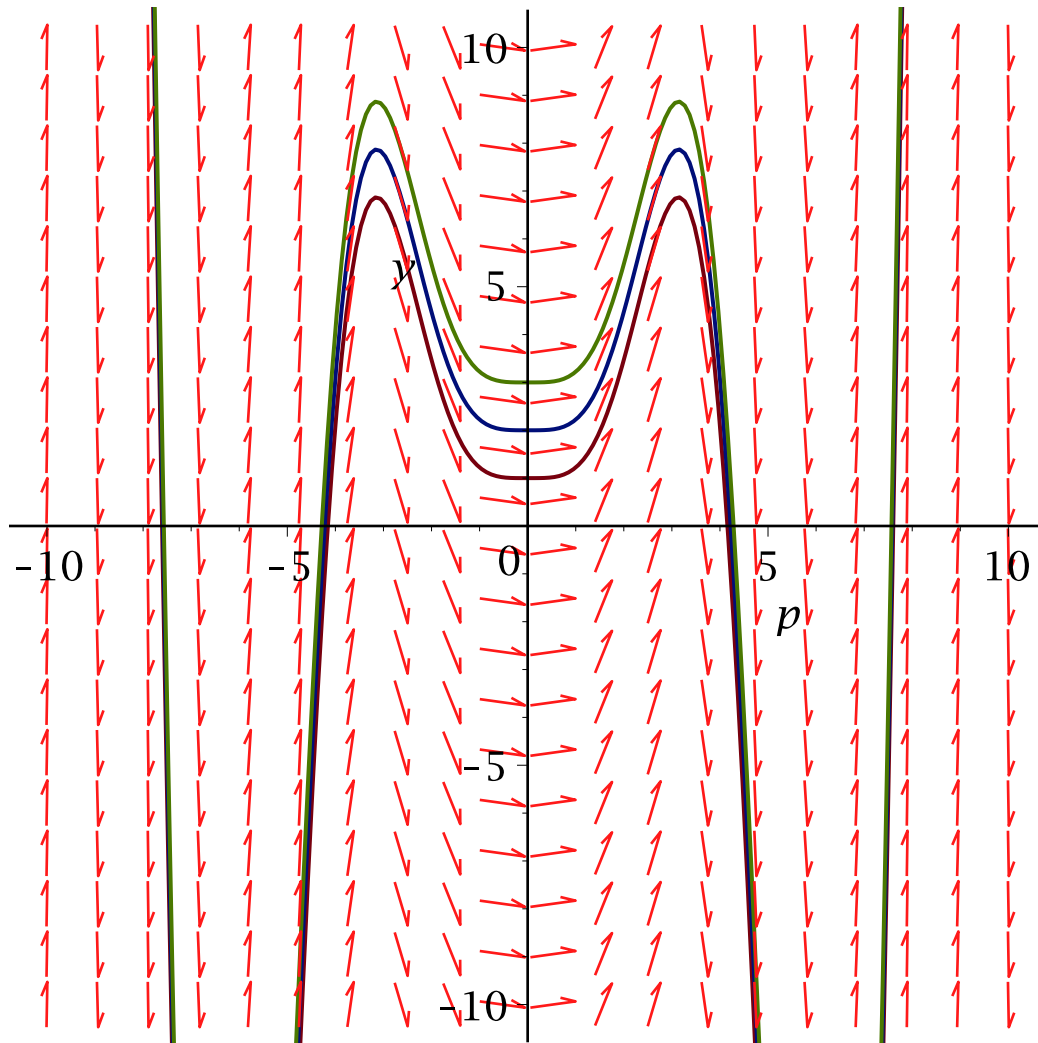
$$\begin{aligned} > deq := \text{diff}(y(p), p) = p^2 \cdot \sin(p) \\ & \quad deq := \frac{d}{dp} y(p) = p^2 \sin(p) \end{aligned} \quad (13)$$

```

> s := dsolve(deq)
      
$$s := y(p) = -p^2 \cos(p) + 2 \cos(p) + 2 p \sin(p) + \_C1 \quad (14)$$

> deplot := DETools[DEplot](deq, y(p), p=-10..10, y=-10..10, thickness = 5) :
> dpl := plot([seq(-p^2*cos(p) + 2*cos(p) + 2*p*sin(p) + C, C=-1..1)], p=-10..10,
      y=-10..10) :
> plots[display](dpl, deplot)

```



```

> #Task 5.2

```

```

> restart

```

```

> de := y(x) = 
$$\frac{\text{diff}(y(x), x)^6}{6} \cdot \ln(\text{diff}(y(x), x)^6) - \frac{\text{diff}(y(x), x)^6}{36}$$

      
$$de := y(x) = \frac{1}{6} \left( \frac{d}{dx} y(x) \right)^6 \ln \left( \left( \frac{d}{dx} y(x) \right)^6 \right) - \frac{1}{36} \left( \frac{d}{dx} y(x) \right)^6 \quad (15)$$


```

```

> deq := diff(x(p), p) = 
$$p^4 \cdot \ln(p)$$

      
$$deq := \frac{d}{dp} x(p) = p^4 \ln(p) \quad (16)$$


```

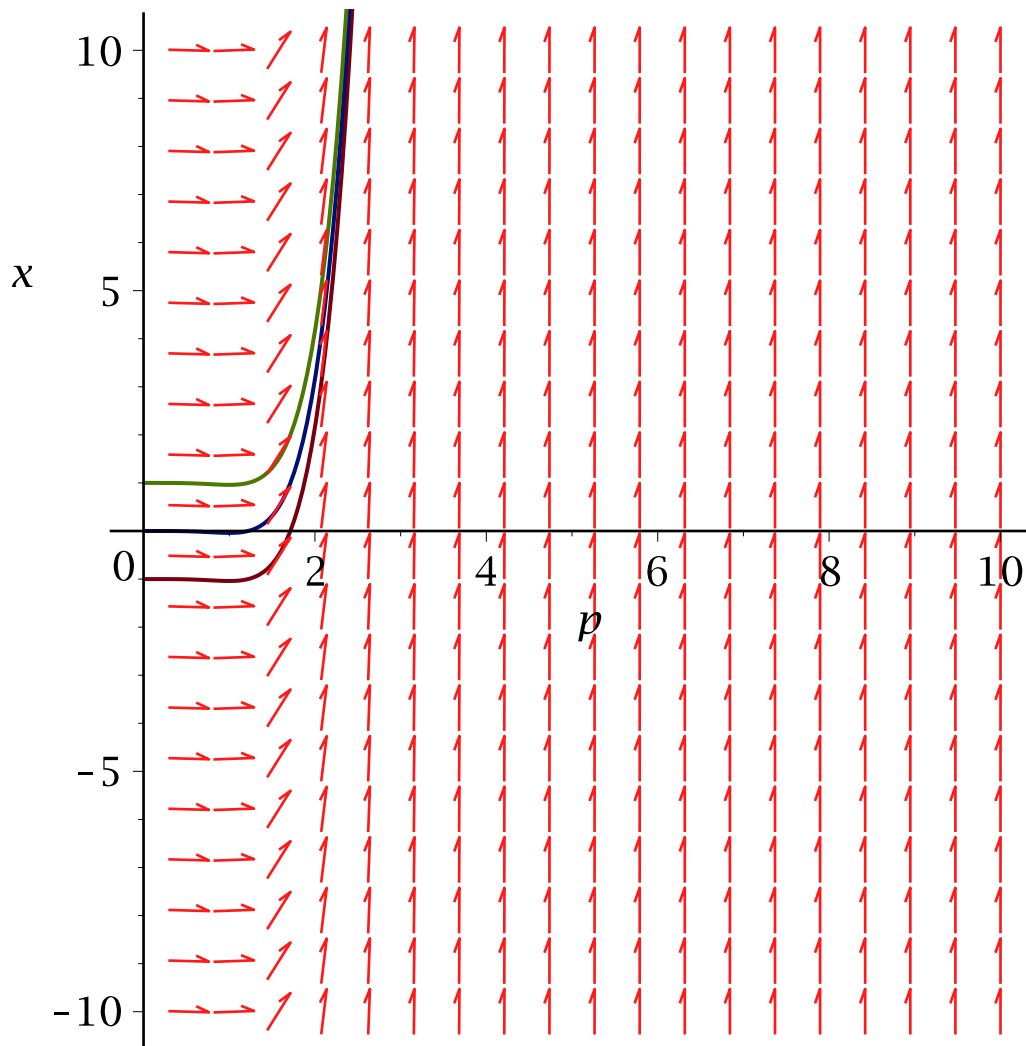
```

> dsolve(deq)

```

$$x(p) = \frac{1}{5} p^5 \ln(p) - \frac{1}{25} p^5 + _C1 \quad (17)$$

```
> dpl := plot([seq(1/5 p^5 ln(p) - 1/25 p^5 + C, C=-1..1)], p=0..10, x=-10..10):
> deplot := DETools[DEplot](deq, x(p), p=0..10, x=-10..10):
> plots[display](dpl, deplot)
```



```
> #Task 6
```

```
> restart
```

```
> de := y(x) = x·diff(y(x), x) - 2·diff(y(x), x)^2 - 1
```

$$de := y(x) = x \left(\frac{d}{dx} y(x) \right) - 2 \left(\frac{d}{dx} y(x) \right)^2 - 1 \quad (18)$$

```
> s := dsolve(de)
```

$$s := y(x) = \frac{1}{8} x^2 - 1, y(x) = -2_C1^2 +_C1 x - 1 \quad (19)$$

```
> sq := seq(-2·C^2 + C·x - 1, C=-3..3)
```

$$sq := -3 x - 19, -2 x - 9, -x - 3, -1, x - 3, 2 x - 9, 3 x - 19 \quad (20)$$

`> plot($\left[\frac{1}{8}x^2 - 1, sq\right]$)`

