I. Differentiation Under Integral Sign

- $$\int_0^1 \frac{x^a - 1}{logx}\ dx$$

```
%using symbolic math toolbox
syms x
a = 2
```

```
a = 2
```

```
f = (x^a - 1)/log(x)
```

f =

$$\frac{x^2 - 1}{\log(x)}$$

```
int(f,0,1)
```

ans = $\log(3)$

```
eval(ans)
```

```
ans = 1.0986
```

```
% using numeric math toolbox
clear
f = @(x,a) (x.^a - 1)./log(x)
```

```
f = function_handle with value:
    @(x,a)(x.^a-1)./log(x)
```

```
integral(@(x) f(x,2),0,1)
```

```
ans = 1.0986
```

- $$\int_0^\infty \frac{dx}{x^2 + a^2}$$

```
%using symbolic math toolbox
syms x
a = 4
```

```
a = 4
```

```
f = 1/(x^2 + a^2)
```

f =

$$\frac{1}{x^2 + 16}$$

```
int(f,0,Inf)
```

ans =

$$\frac{\pi}{8}$$

```
eval(ans)
```

ans = 0.3927

```
% using numeric math toolbox
clear
f = @(x,a) 1./(x.^2 + a^2)
```

f = *function_handle with value:*

@(x,a)1./(x.^2+a^2)

```
integral(@(x) f(x,4),0,Inf)
```

ans = 0.3927

- $$\int_0^1 x^m dx$$

```
%using symbolic math toolbox
syms x
m = 3
```

m = 3

```
f = (x^m)
```

f = x^3

```
int(f,0,1)
```

ans =

$$\frac{1}{4}$$

```
eval(ans)
```

ans = 0.2500

```
% using numeric math toolbox
clear
f = @(x,m) (x.^m)
```

f = *function_handle with value:*

```
    @(x,m)(x.^m)
```

```
integral(@(x) f(x,3),0,1)
```

```
ans = 0.2500
```

- $$\int_0^{\pi} \log\left(1 + acosx\right)dx$$

```
%using symbolic math toolbox
syms x
a = 2
```

```
a = 2
```

```
f = log(1+a*cos(x))
```

f = $\log\left(2\cos\left(x\right) + 1\right)$

```
int(f,0,pi)
```

ans =

$$\frac{\pi^2 \mathrm{i}}{3}$$

```
eval(ans)
```

```
ans =
   0.0000 + 3.2899i
```

```
% using numeric math toolbox
clear
f = @(x,a) log(1 + a .* cos(x))
```

```
f = function_handle with value:
    @(x,a)log(1+a.*cos(x))
```

```
integral(@(x) f(x,2),0,pi)
```

```
ans =
   0.0000 + 3.2899i
```

- $$\int_0^{\infty} e^{-x}\frac{sinax}{x}\ dx$$

```
%using symbolic math toolbox
syms x
a = 5
```

```
a = 5
```

```
f = exp(-x) * sin(a*x) / x
```

f =

$$\frac{\sin(5x)\, e^{-x}}{x}$$

```
int(f,0,Inf)
```

ans = $\operatorname{atan}(5)$

```
eval(ans)
```

ans = 1.3734

```
% using numeric math toolbox
clear
f = @(x,a) exp(-x) .* sin(a .* x) ./ x
```

f = *function_handle with value:*

@(x,a)exp(-x).*sin(a.*x)./x

```
integral(@(x) f(x,5),0,Inf)
```

ans = 1.3734

II. Trace the following curves:

Cartesian Explicit Curves: (Use ezplot for cartesian curves)

Note: Assume suitable value for constants given in equation

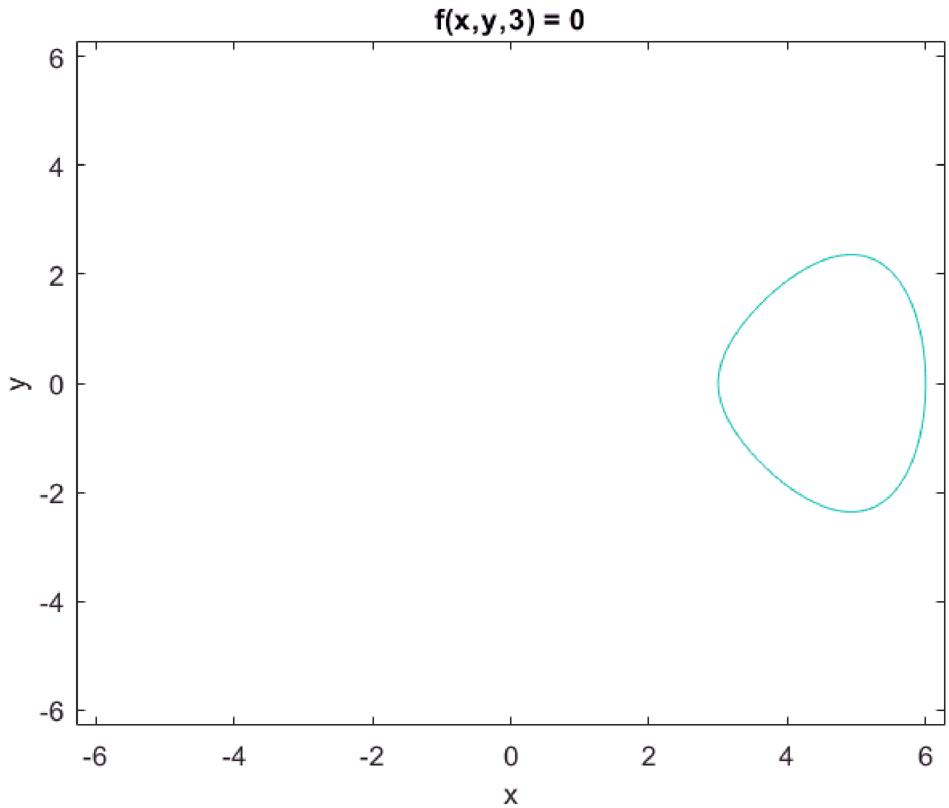
- $a^2 y^2 = x^2(2a - x)(x - a)$

```
clear
f = @(x,y,a) a .^ 2.* y .^ 2 - x .^2 .* (2 * a - x) .* (x - a)
```

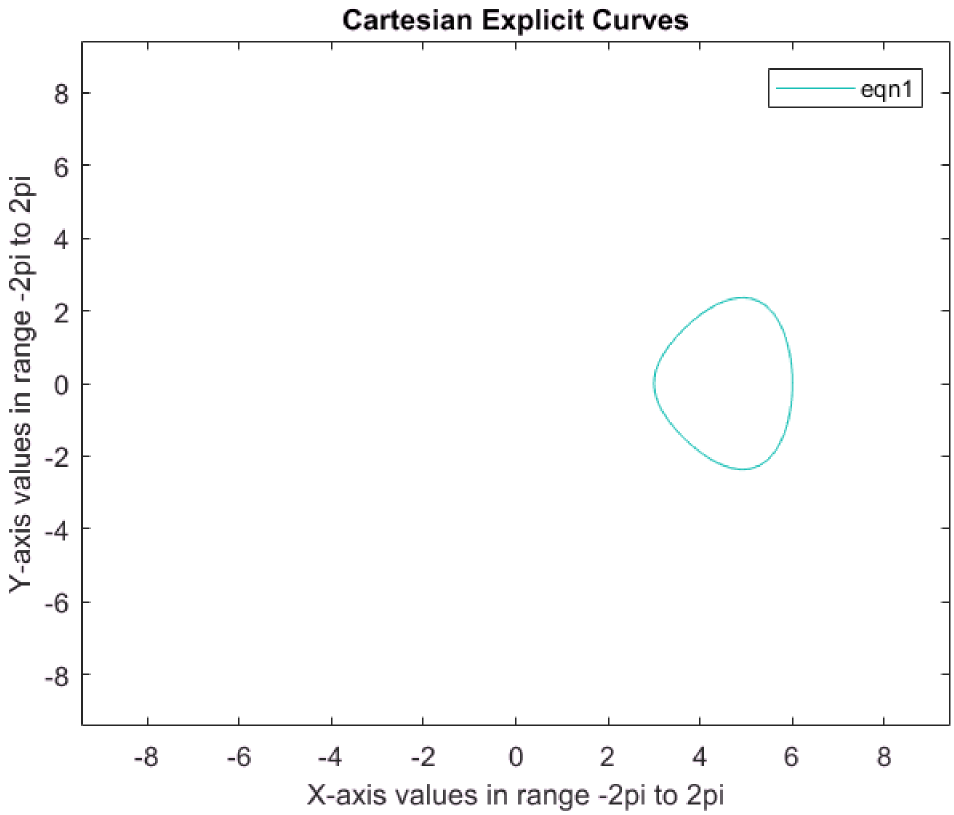
f = *function_handle with value:*

@(x,y,a)a.^2.*y.^2-x.^2.*(2*a-x).*(x-a)

```
ezplot(@(x,y)f(x,y,3))
```




```
% To plot curve with different limits thn given default limit of -2pi to 2pi, use following
ezplot(@(x,y)f(x,y,3),[-3*pi 3*pi])
% title, xlabel,ylabel and legend functions can be used to give title to graph,
% label X-axis and Y-axis, and show legends respectively.
% This can be applied to all other types of curves too.
xlabel('X-axis values in range -2pi to 2pi')
ylabel('Y-axis values in range -2pi to 2pi')
title('Cartesian Explicit Curves')
legend('eqn1')
```

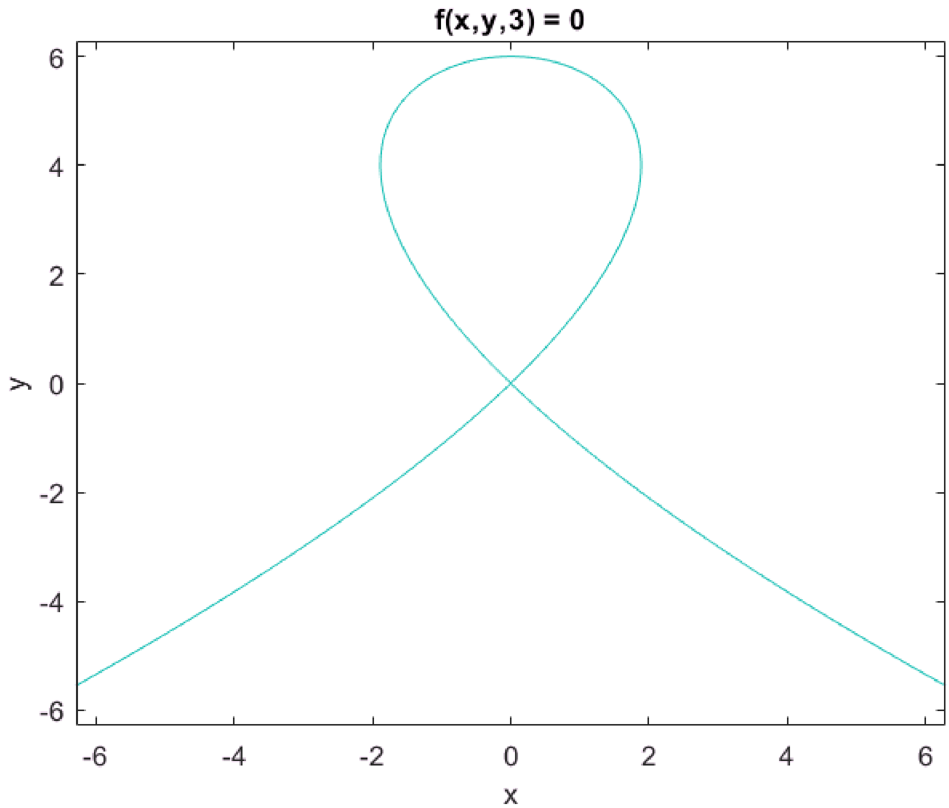


- $a^2x^2 = y^2(2a - y)$

```
f = @(x,y,a) a .^ 2.* x .^ 2 - y .^2 .* (2 * a - y)
```

```
f = function_handle with value:
    @(x,y,a)a.^2.*x.^2-y.^2.*(2*a-y)
```

```
ezplot(@(x,y)f(x,y,3))
```

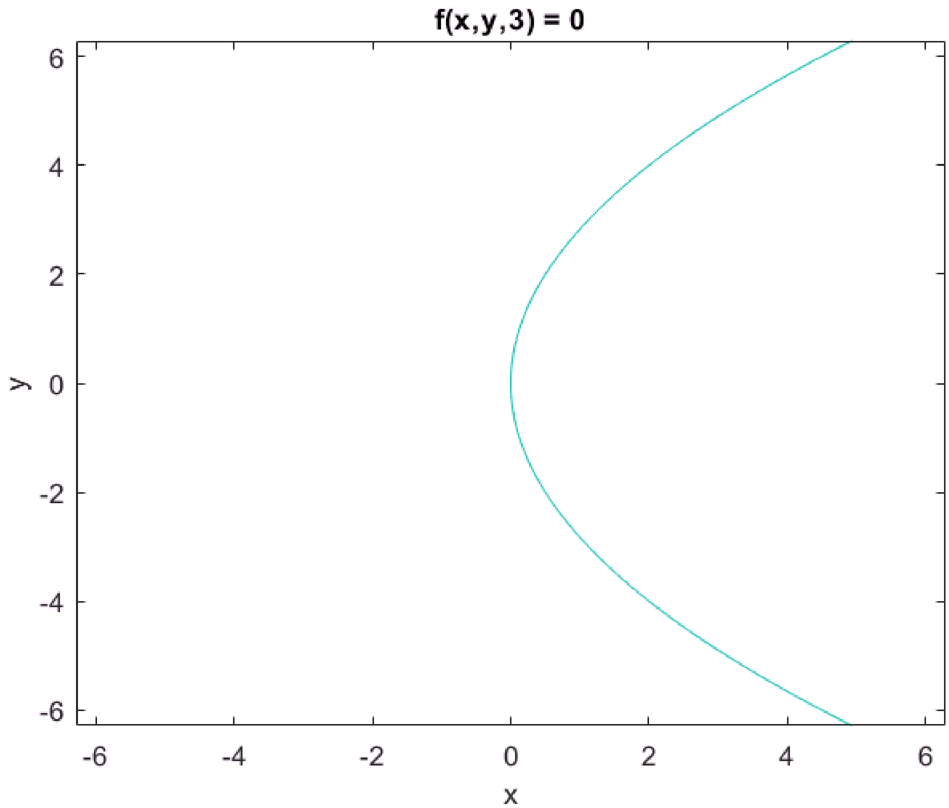


- $ay^2 = 4(x - 2a)$

```
f = @(x,y,a) a * y .^ 2 - 4 .* (x .* 2 * a)
```

```
f = function_handle with value:
    @(x,y,a)a*y.^2-4.*(x.*2*a)
```

```
ezplot(@(x,y)f(x,y,3))
```

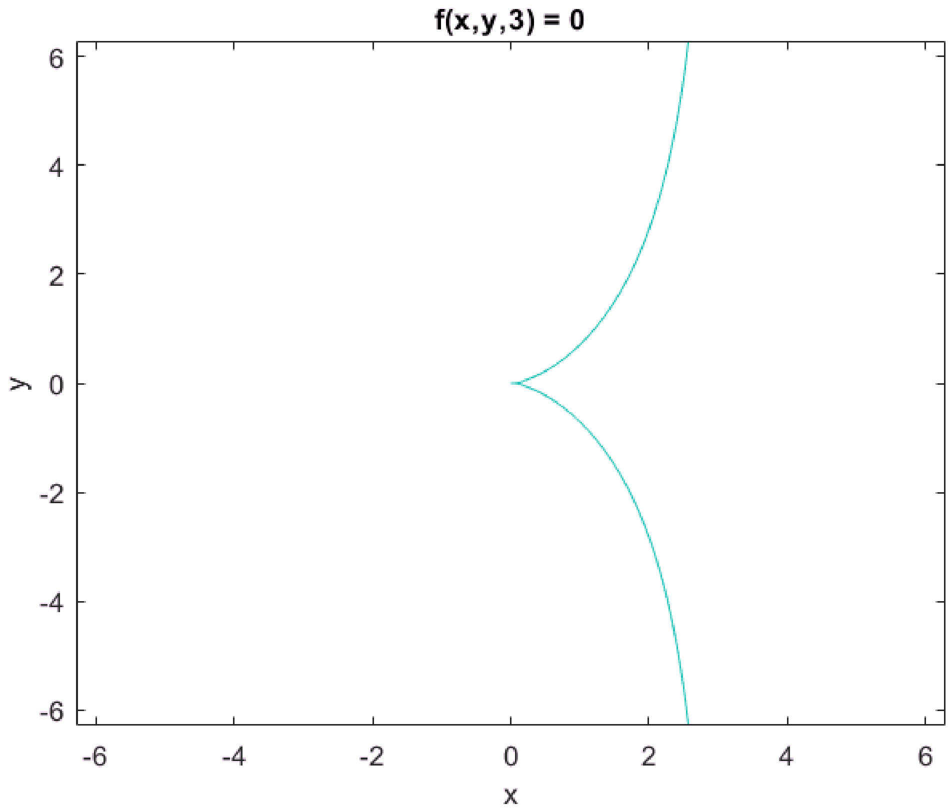


- $y^2(a - x) = x^3$

```
f = @(x,y,a)  y .^ 2 .*(a - x) -  (x .^ 3)
```

```
f = function_handle with value:
    @(x,y,a)y.^2.*(a-x)-(x.^3)
```

```
ezplot(@(x,y)f(x,y,3))
```

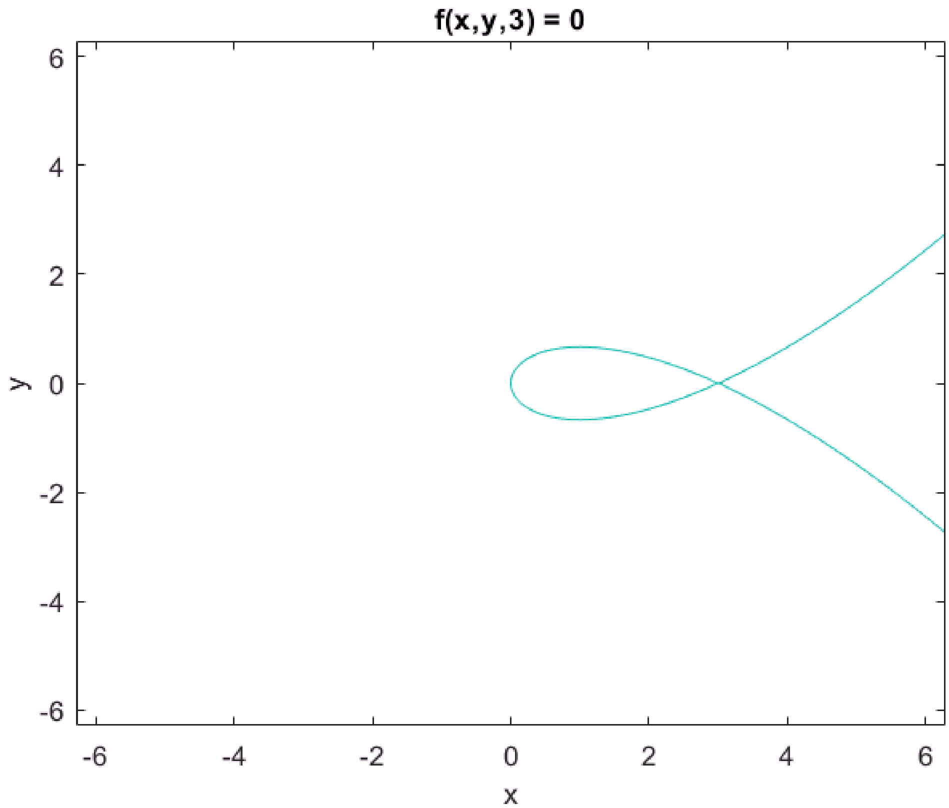


- $3ay^2 = x(x - a)^2$

```
f = @(x,y,a) 3 .* a * y .^ 2 - x .* (x - a) .^ 2
```

```
f = function_handle with value:
    @(x,y,a)3.*a*y.^2-x.*(x-a).^2
```

```
ezplot(@(x,y)f(x,y,3))
```

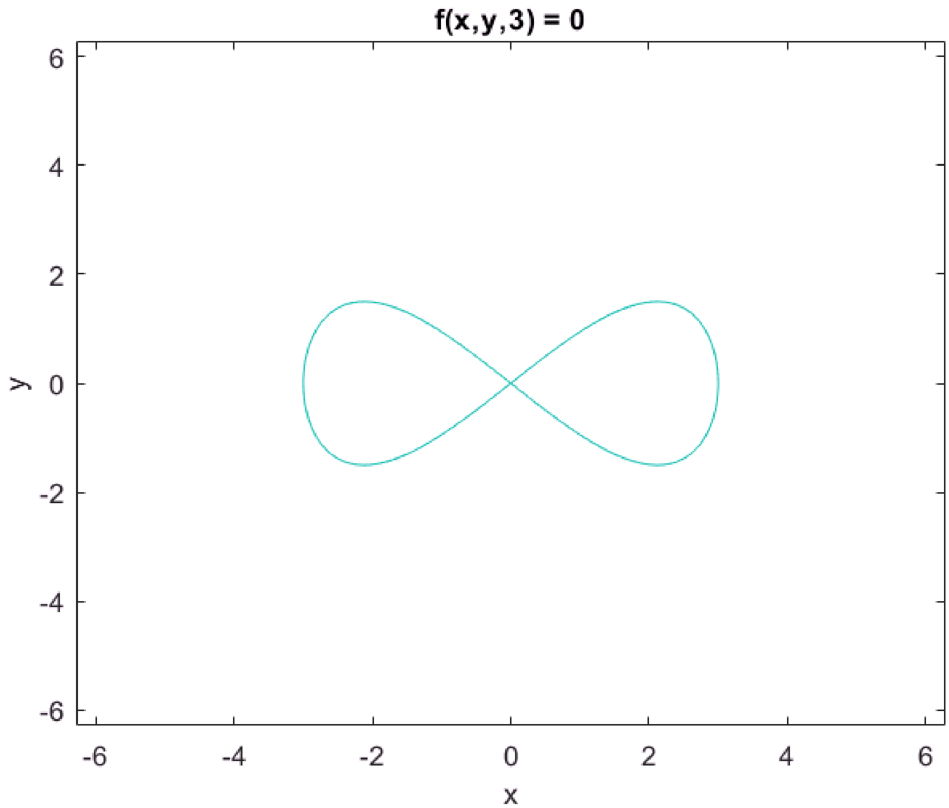


- $a^2 y^2 = x^2 \left(a^2 - x^2\right)$

```
f = @(x,y,a) a ^ 2 * y .^ 2 -x .^ 2 .* (a .^ 2 - x .^ 2)
```

```
f = function_handle with value:
    @(x,y,a)a^2*y.^2-x.^2.*(a.^2-x.^2)
```

```
ezplot(@(x,y)f(x,y,3))
```

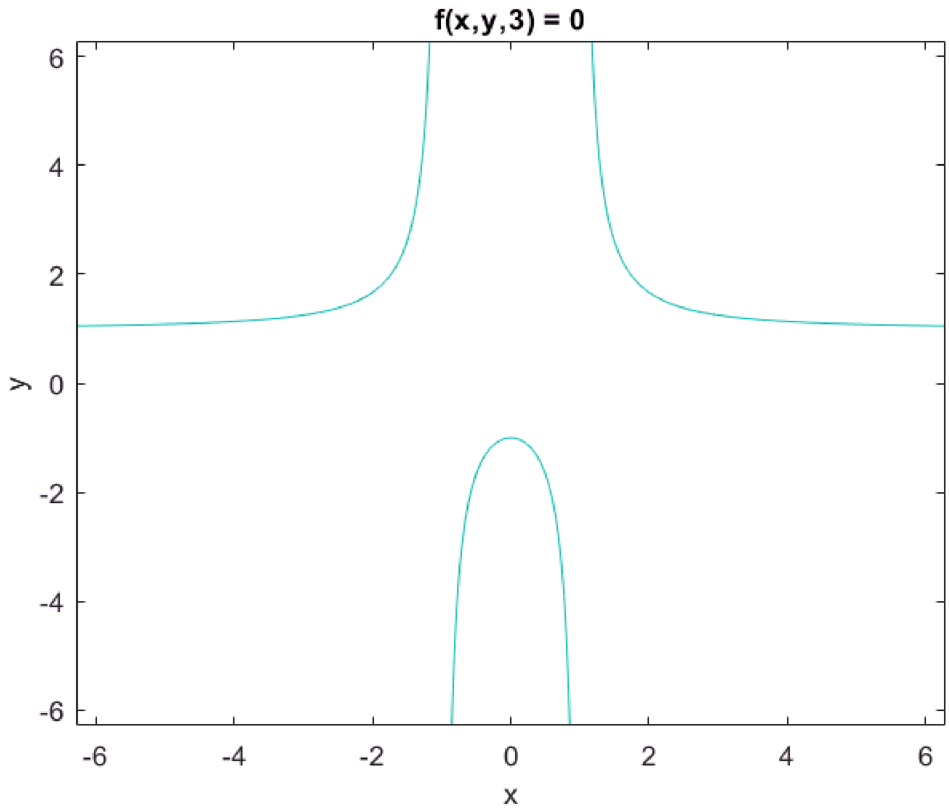


- $y(x^2 - 1) = (x^2 + 1)$

```
f = @(x,y,a) y .* (x .^ 2 - 1) - (x .^ 2 + 1)
```

```
f = function_handle with value:
    @(x,y,a)y.*(x.^2-1)-(x.^2+1)
```

```
ezplot(@(x,y)f(x,y,3))
```

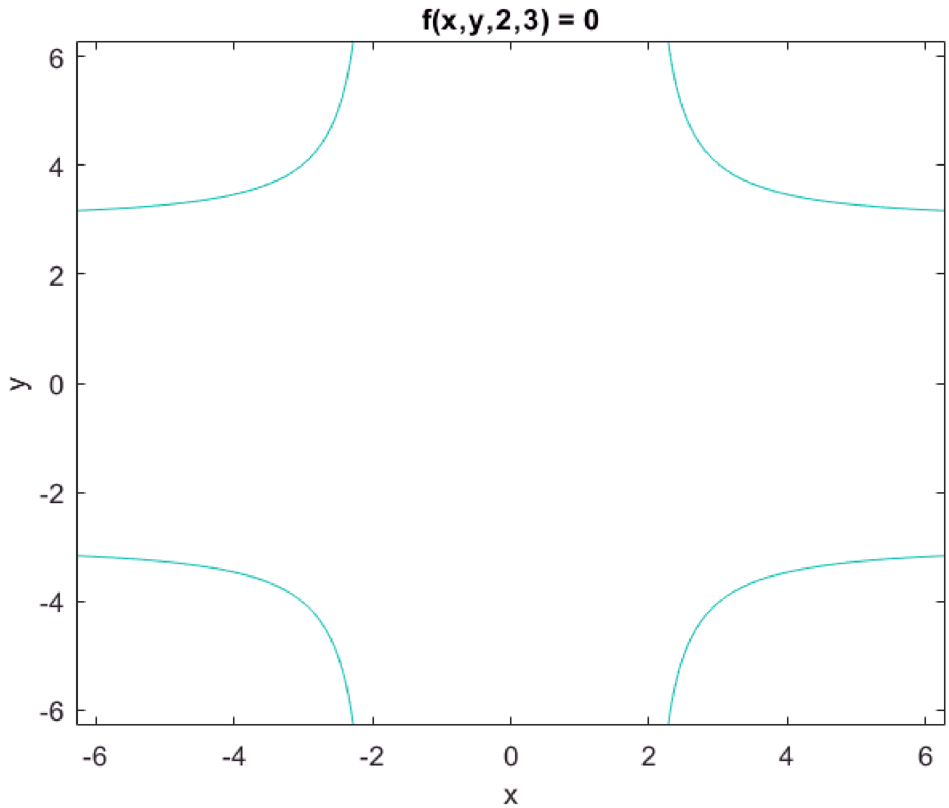


- $\left(x^2 - a^2\right)\left(y^2 - b^2\right) = a^2 b^2$

```
f = @(x,y,a,b) (x.^2 - a.^ 2) .* (y.^2 - b .^ 2) - (a ^2 * b^2)
```

```
f = function_handle with value:
    @(x,y,a,b)(x.^2-a.^2).*(y.^2-b.^2)-(a^2*b^2)
```

```
ezplot(@(x,y) f(x,y,2,3))
```

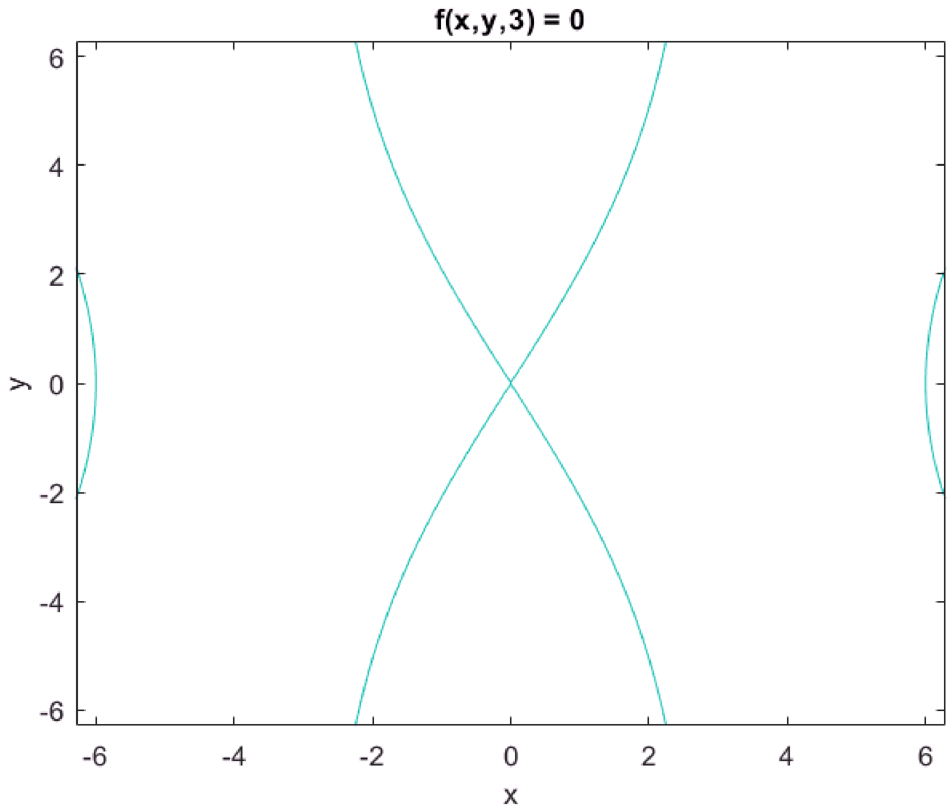


- $x^2\left(x^2 - 4a^2\right) = y^2\left(x^2 - a^2\right)$

```
f = @(x,y,a) x .^ 2 .* (x .^ 2 - 4 .* a .^ 2) - y .^2 .* (x.^ 2 - a^2)
```

```
f = function_handle with value:
    @(x,y,a)x.^2.*(x.^2-4.*a.^2)-y.^2.*(x.^2-a^2)
```

```
ezplot(@(x,y)f(x,y,3))
```

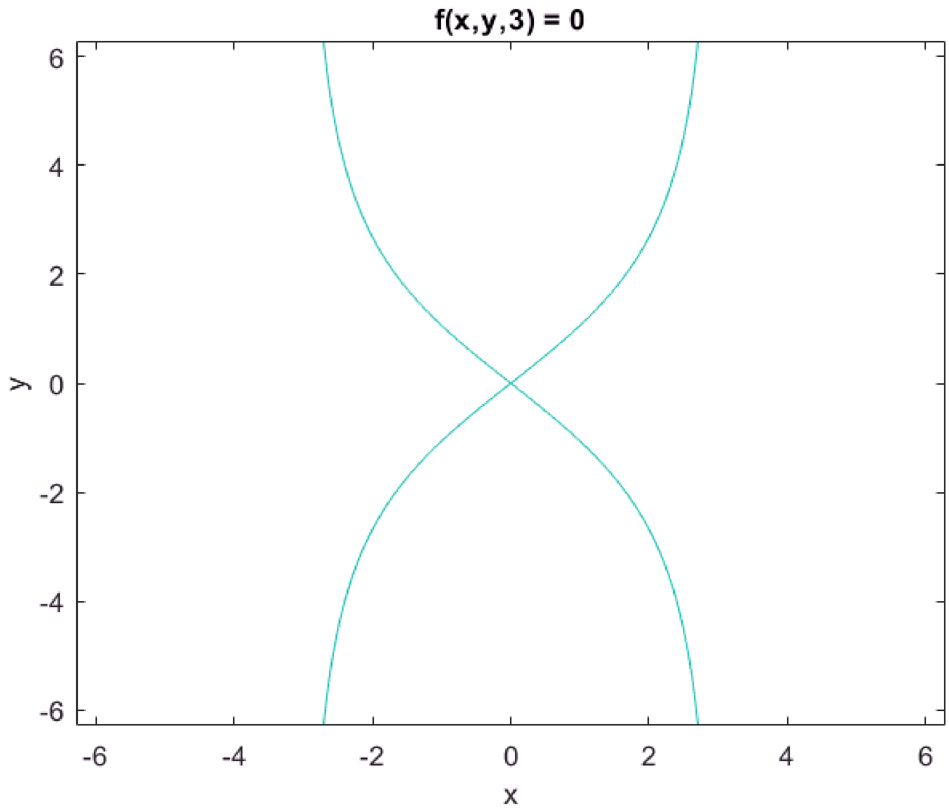


- $x^2y^2 = a^2\left(y^2 - x^2\right)$

```
f = @(x,y,a) x .^ 2 .* y .^ 2 - a .^ 2 .* (y .^ 2 - x .^ 2)
```

```
f = function_handle with value:
    @(x,y,a)x.^2.*y.^2-a.^2.*(y.^2-x.^2)
```

```
ezplot(@(x,y)f(x,y,3))
```



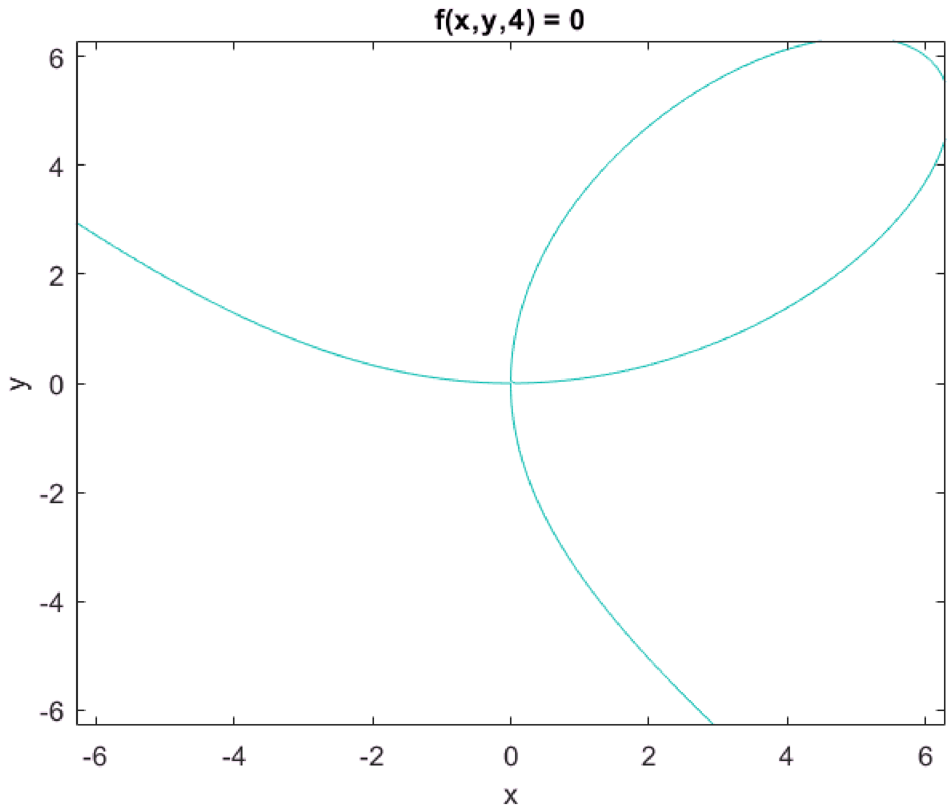
Cartesian Implicit Curves:

- $x^3 + y^3 = 3axy$

```
f = @(x,y,a) x .^ 3 + y .^ 3 - 3 .* a .* x .* y
```

```
f = function_handle with value:
    @(x,y,a)x.^3+y.^3-3.*a.*x.*y
```

```
ezplot(@(x,y) f(x,y,4))
```

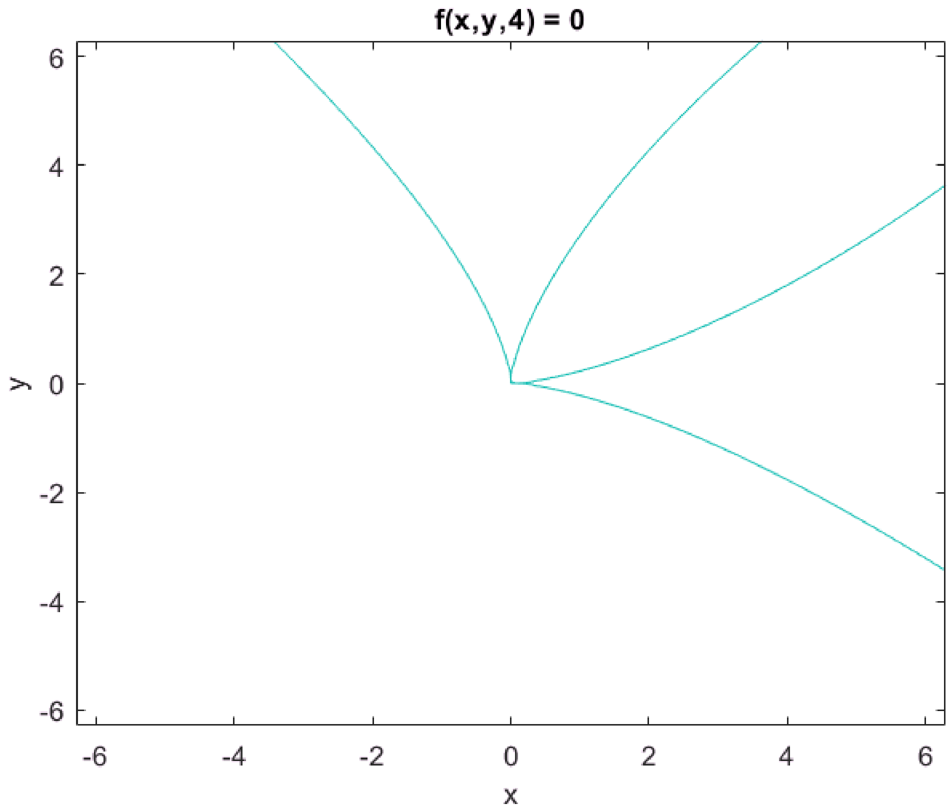


- $x^5 + y^5 = 5ax^2y^2$

```
f = @(x,y,a) x .^ 5 + y .^ 5 - 5 .* a .* x .^ 2 .* y .^ 2
```

```
f = function_handle with value:
    @(x,y,a)x.^5+y.^5-5.*a.*x.^2.*y.^2
```

```
ezplot(@(x,y) f(x,y,4))
```

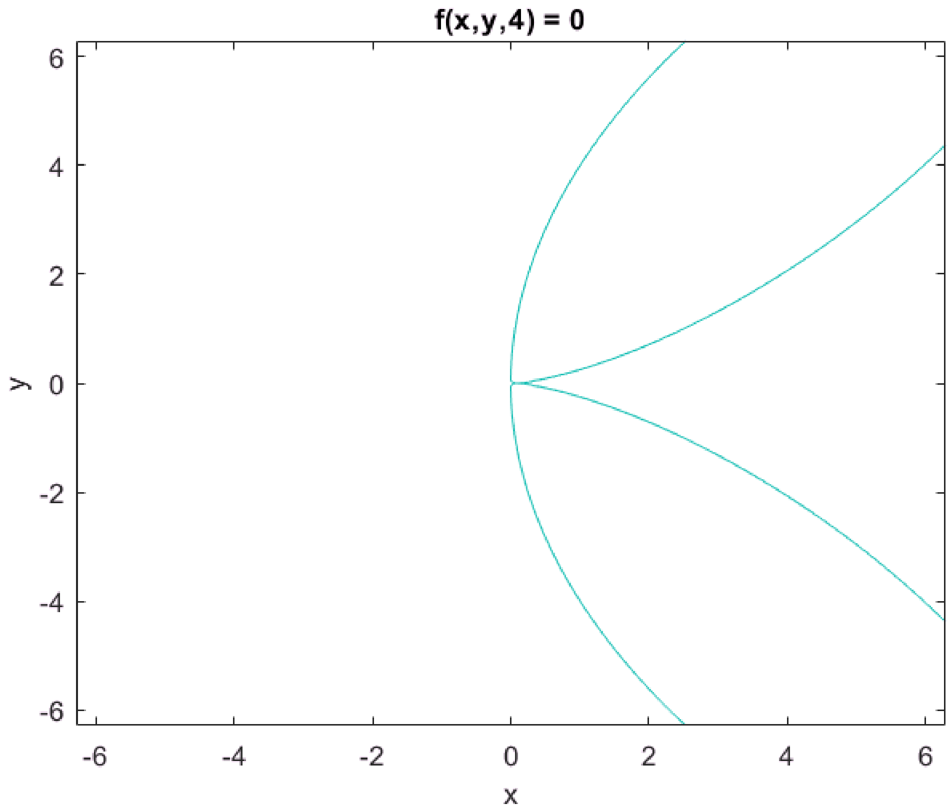


- $x^4 + y^4 = 4axy^2$

```
f = @(x,y,a) x .^ 4 + y .^ 4 - 4 .* a .* x .* y .^ 2
```

```
f = function_handle with value:
    @(x,y,a)x.^4+y.^4-4.*a.*x.*y.^2
```

```
ezplot(@(x,y) f(x,y,4))
```

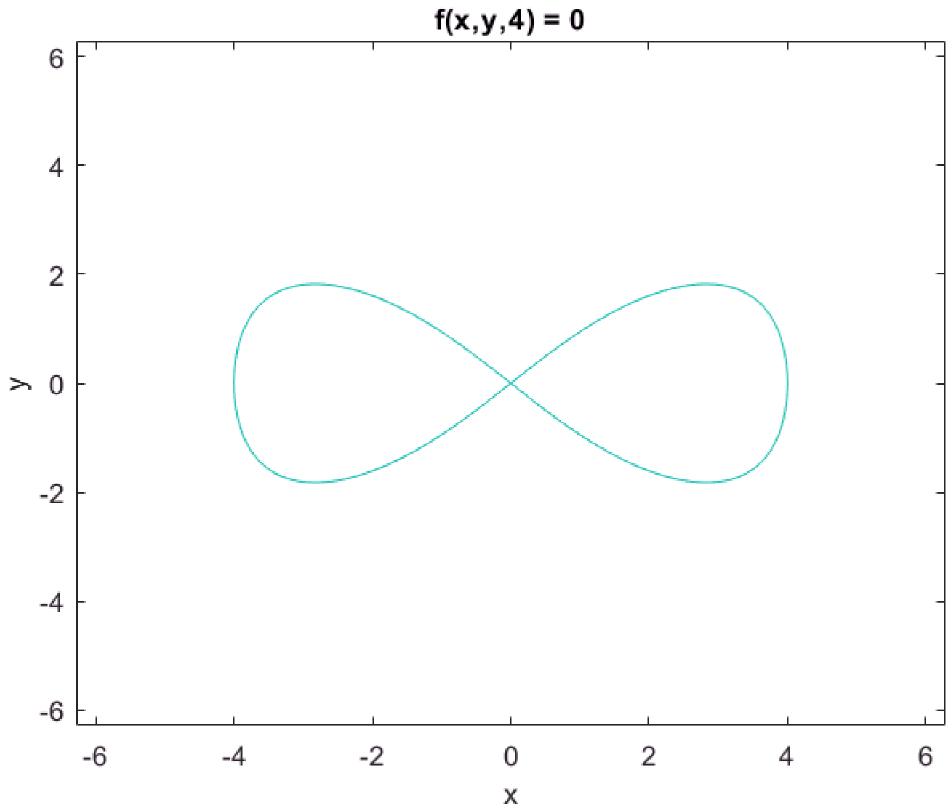


- $x^4 + y^4 = a^2(x^2 - y^2)$

```
f = @(x,y,a) x .^ 4 + y .^ 4 - a .^ 2 .* (x .^ 2 - y .^ 2)
```

```
f = function_handle with value:
    @(x,y,a)x.^4+y.^4-a.^2.*(x.^2-y.^2)
```

```
ezplot(@(x,y) f(x,y,4))
```

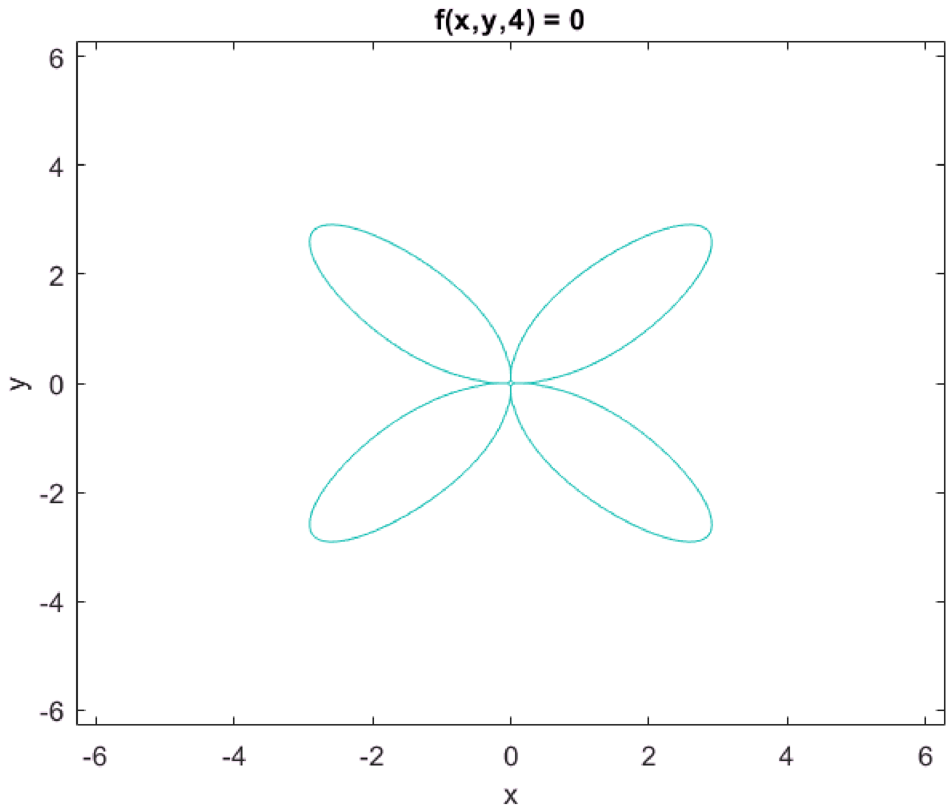


- $x^6 + y^6 = a^2x^2y^2$

```
f = @(x,y,a) x .^ 6 + y .^ 6 - a .^ 2 .* x .^ 2 .* y .^ 2
```

```
f = function_handle with value:
    @(x,y,a)x.^6+y.^6-a.^2.*x.^2.*y.^2
```

```
ezplot(@(x,y) f(x,y,4))
```

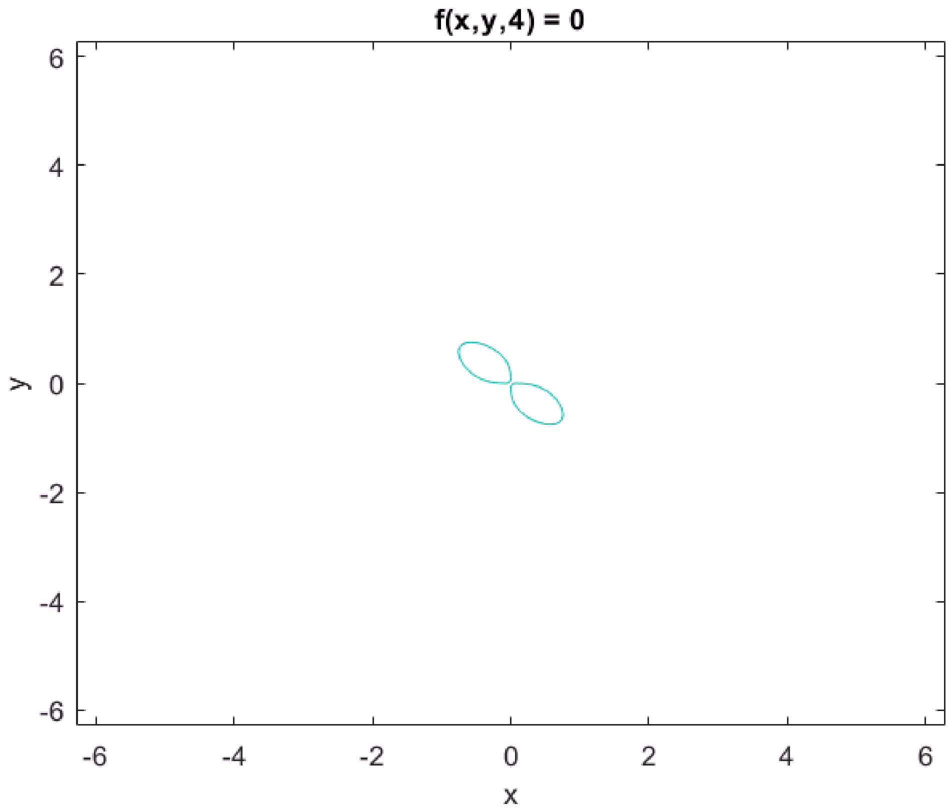


- $x^4 + y^4 + \text{xy} = 0$

```
f = @(x,y,a) x .^ 4 + y .^ 4 + x .* y
```

```
f = function_handle with value:
    @(x,y,a)x.^4+y.^4+x.*y
```

```
ezplot(@(x,y) f(x,y,4))
```

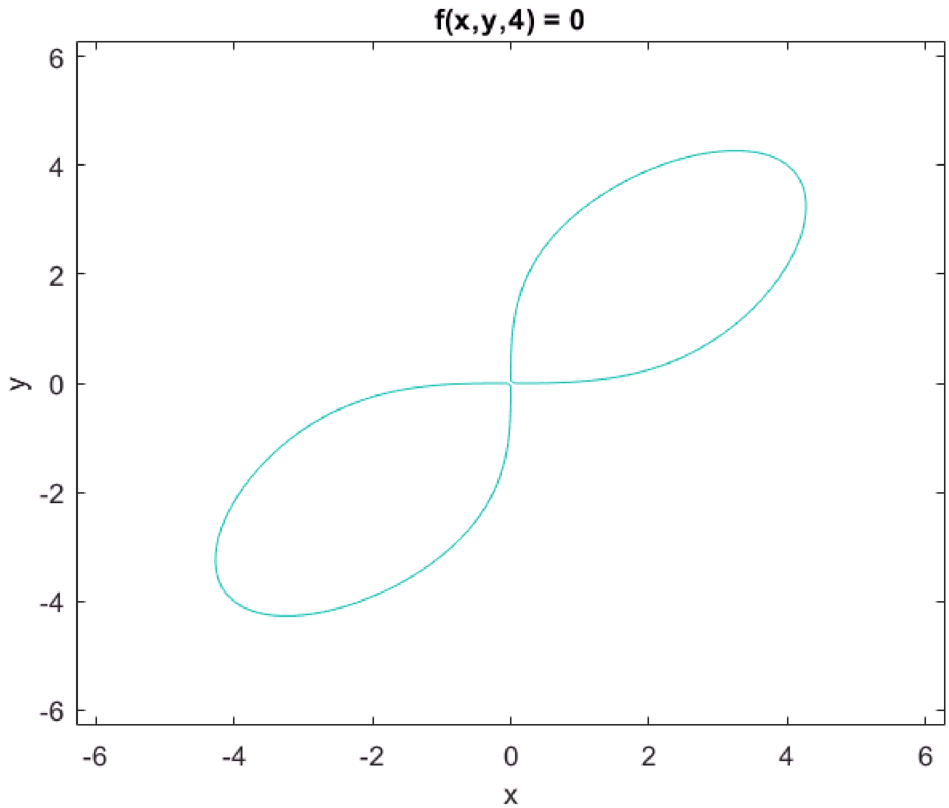


- $x^4 + y^4 = 2a^2\text{xy}$

```
f = @(x,y,a) x .^ 4 + y .^ 4 - 2 .* a .^ 2 .* x .* y
```

```
f = function_handle with value:
    @(x,y,a)x.^4+y.^4-2.*a.^2.*x.*y
```

```
ezplot(@(x,y) f(x,y,4))
```

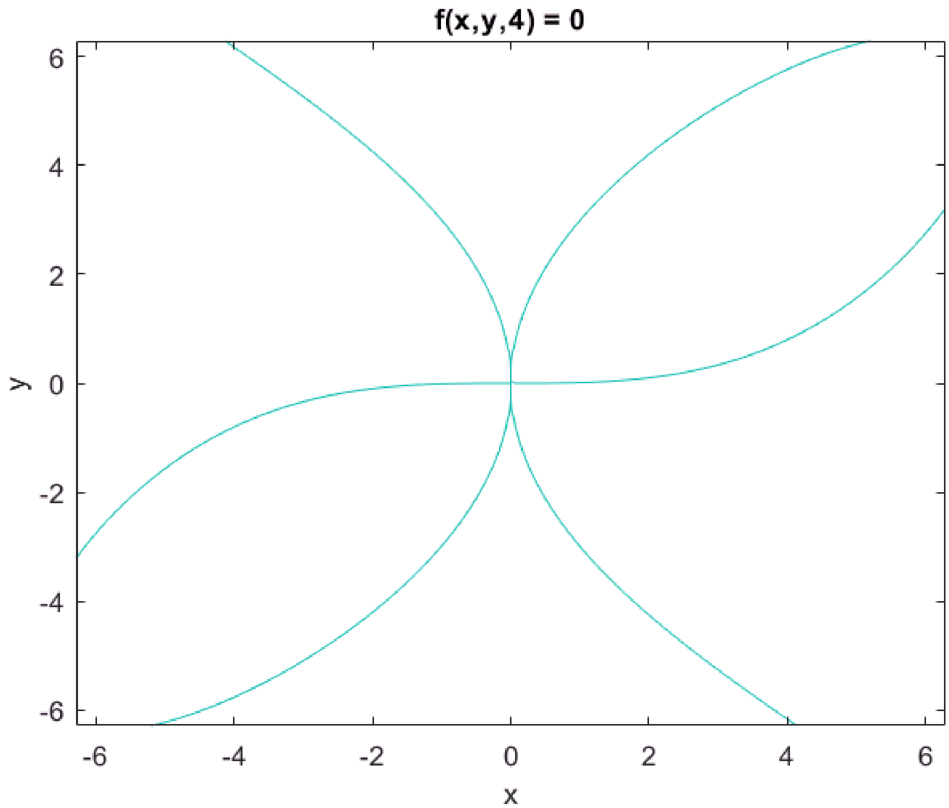


- $x^5 + y^5 = 5a^2x^2y$

```
f = @(x,y,a) x .^ 5 + y .^ 5 - 5 .* a .^ 2 .* x .^ 2 .* y
```

```
f = function_handle with value:
    @(x,y,a)x.^5+y.^5-5.*a.^2.*x.^2.*y
```

```
ezplot(@(x,y) f(x,y,4))
```



Parametric Curves: (Use fplot for parametric curves)

- $x = a\cos^3\theta, y = b\sin^3\theta$

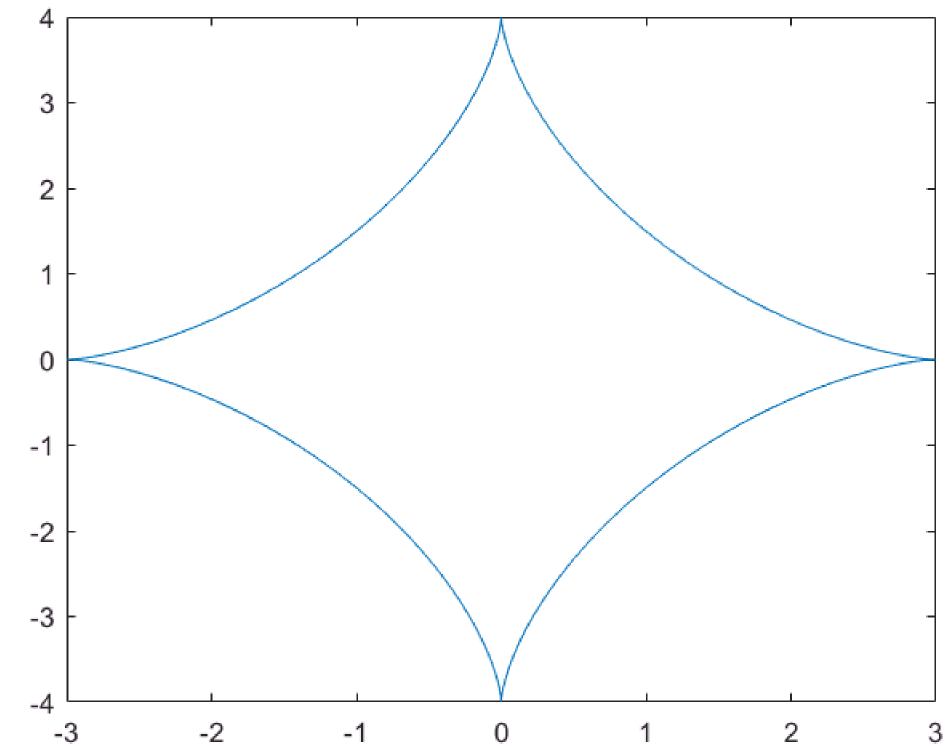
```
clear
x = @(a,theta) a .* cos(theta).^3
```

```
x = function_handle with value:
    @(a,theta)a.*cos(theta).^3
```

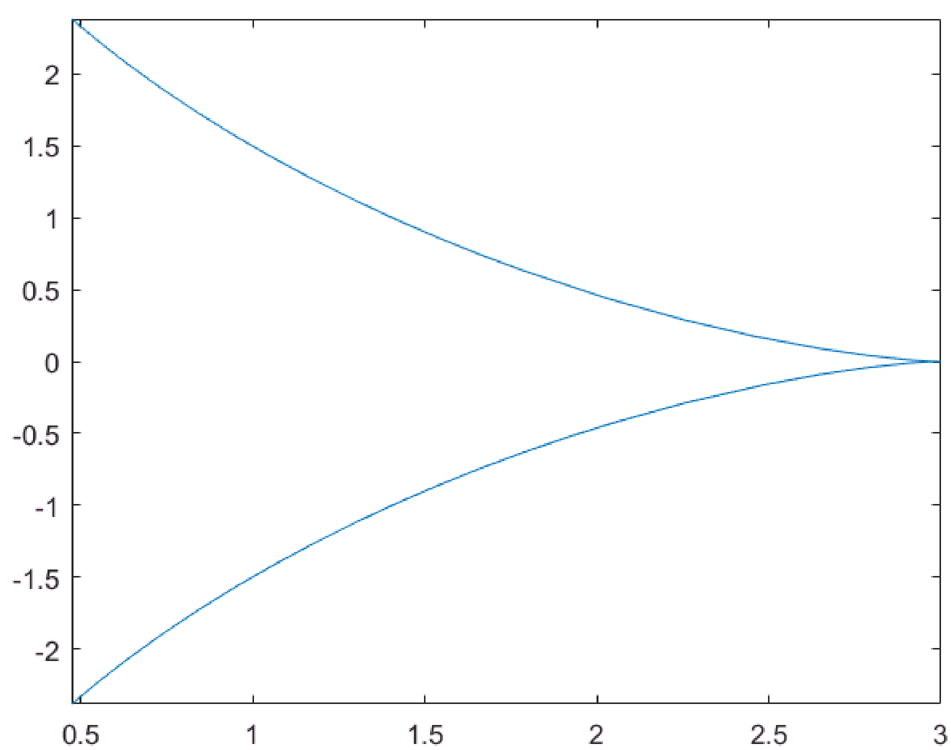
```
y = @(b,theta) b .* sin(theta).^3
```

```
y = function_handle with value:
    @(b,theta)b.*sin(theta).^3
```

```
fplot(@(theta) x(3,theta),@(theta) y(4,theta))
```




```
% To plot curve with different limits thn given default limit of -5 to 5, use following
fplot(@(theta) x(3,theta),@(theta) y(4,theta),[-1 1])
```



- $x = a(\theta + \sin\theta),\ y = b(1 + \cos\theta)$

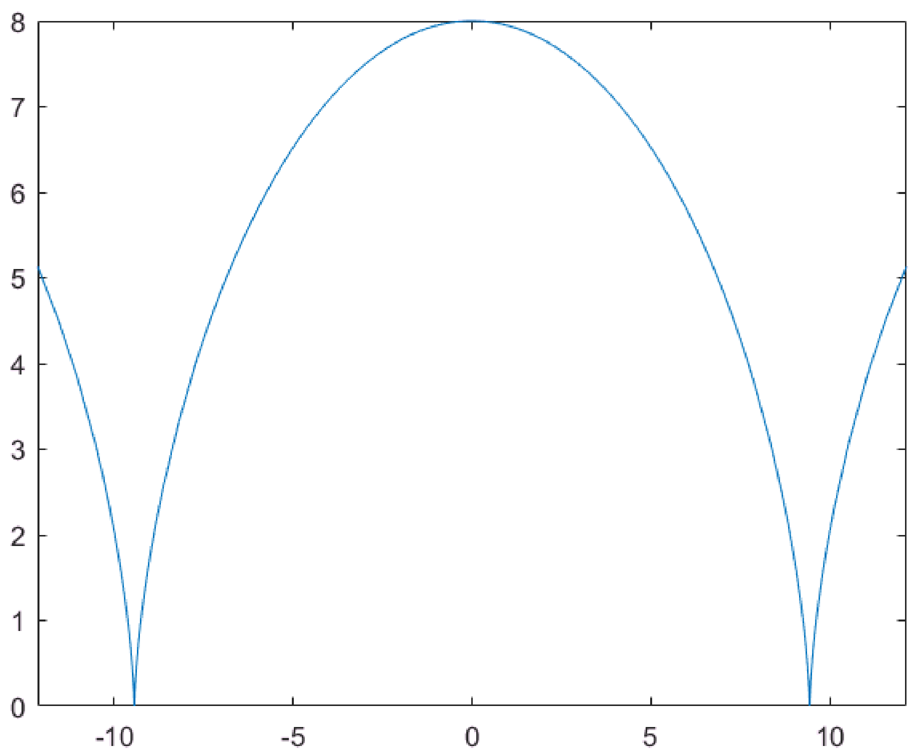
```
x = @(a,theta) a .* (theta + sin(theta))
```

```
x = function_handle with value:
    @(a,theta)a.*(theta+sin(theta))
```

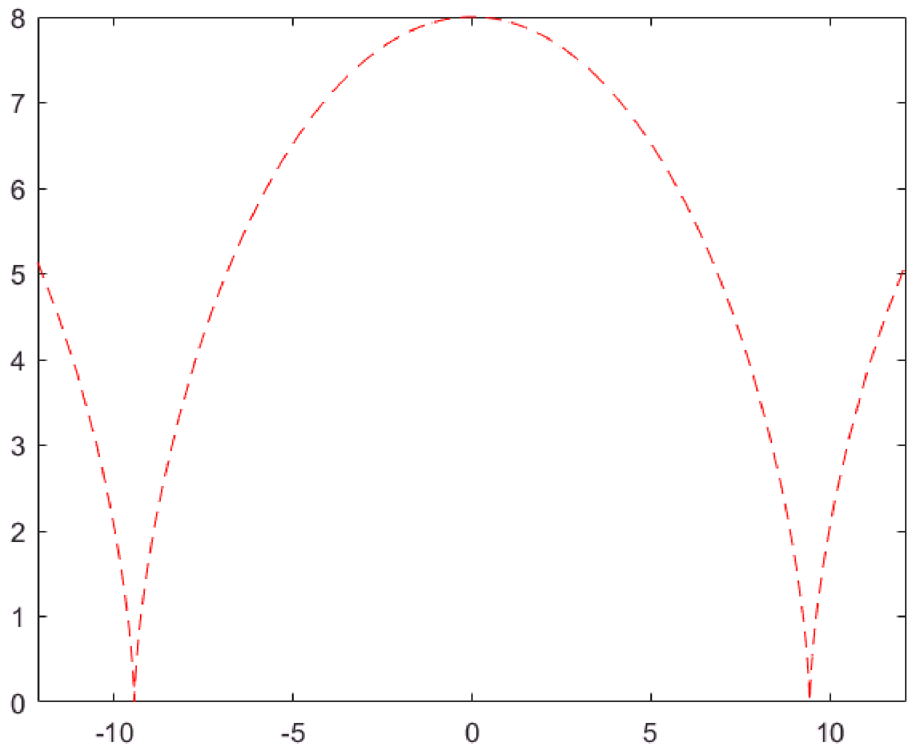
```
y = @(b,theta) b .* (1 + cos(theta))
```

```
y = function_handle with value:
    @(b,theta)b.*(1+cos(theta))
```

```
fplot(@(theta) x(3,theta),@(theta) y(4,theta))
```




```
% To change color and marker style,
fplot(@(theta) x(3,theta),@(theta) y(4,theta),'r--')
```




```
% r represents red color and '--' represents marker style.
% For more styles, see documentation of plot using "doc plot" command
```

- $x = a(\theta - \sin\theta), y = a(1 - \cos\theta)$

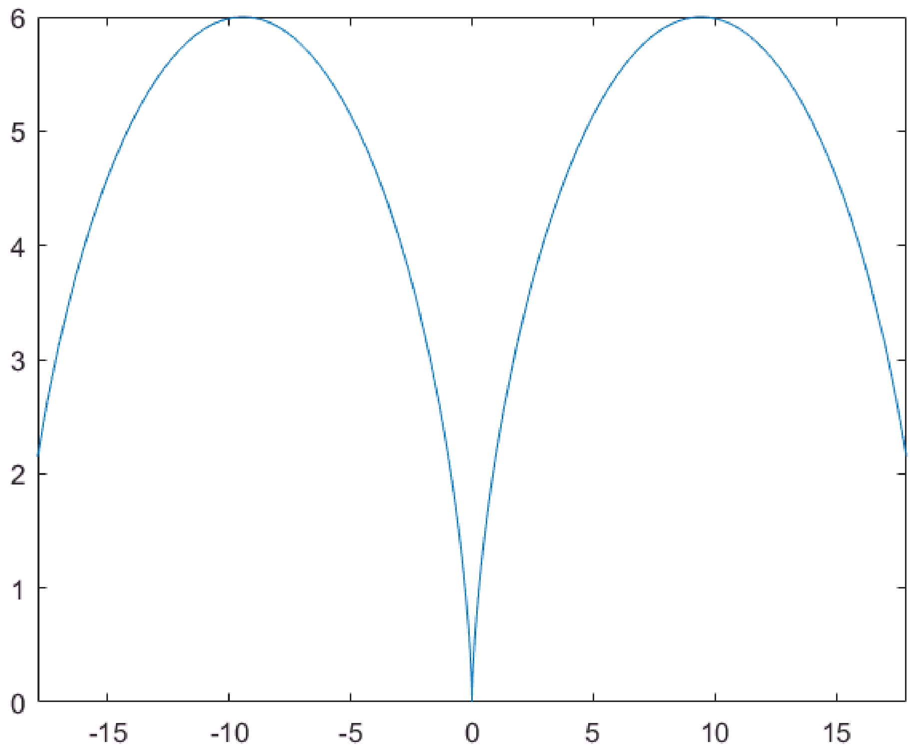
```
x = @(a,theta) a .* (theta - sin(theta))
```

```
x = function_handle with value:
    @(a,theta)a.*(theta-sin(theta))
```

```
y = @(a,theta) a .* (1 - cos(theta))
```

```
y = function_handle with value:
    @(a,theta)a.*(1-cos(theta))
```

```
fplot(@(theta) x(3,theta),@(theta) y(3,theta))
```



- $x = a(\theta - \sin\theta)$, $y = a(1 + \cos\theta)$

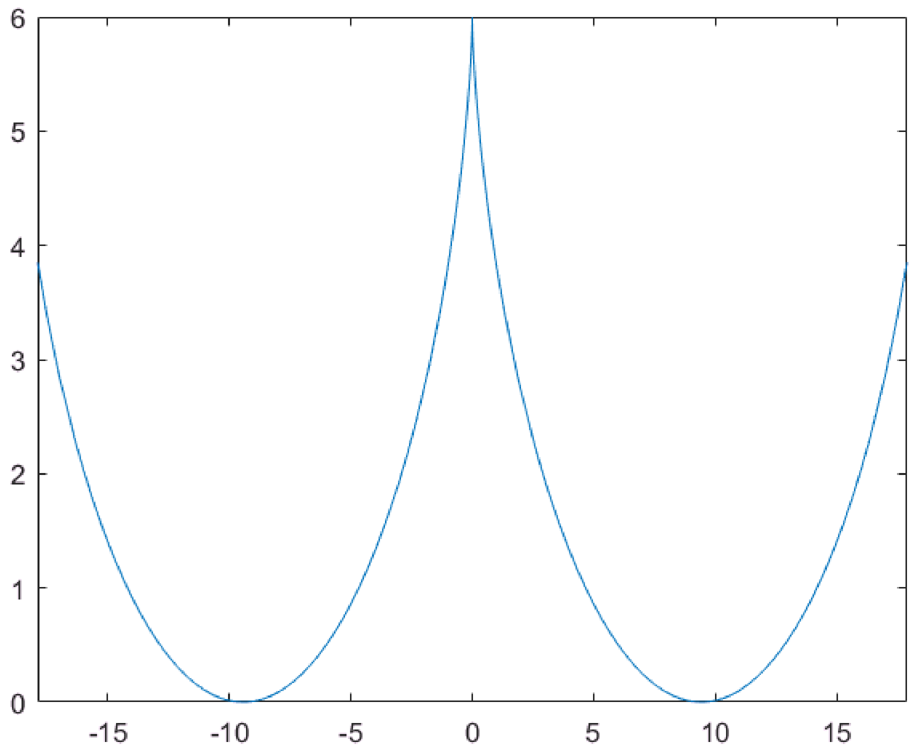
```
x = @(a,theta) a .* (theta - sin(theta))
```

```
x = function_handle with value:
    @(a,theta)a.*(theta-sin(theta))
```

```
y = @(a,theta) a .* (1 + cos(theta))
```

```
y = function_handle with value:
    @(a,theta)a.*(1+cos(theta))
```

```
fplot(@(theta) x(3,theta),@(theta) y(3,theta))
```



- $x = a(\theta + \sin\theta), y = a(1 - \cos\theta)$

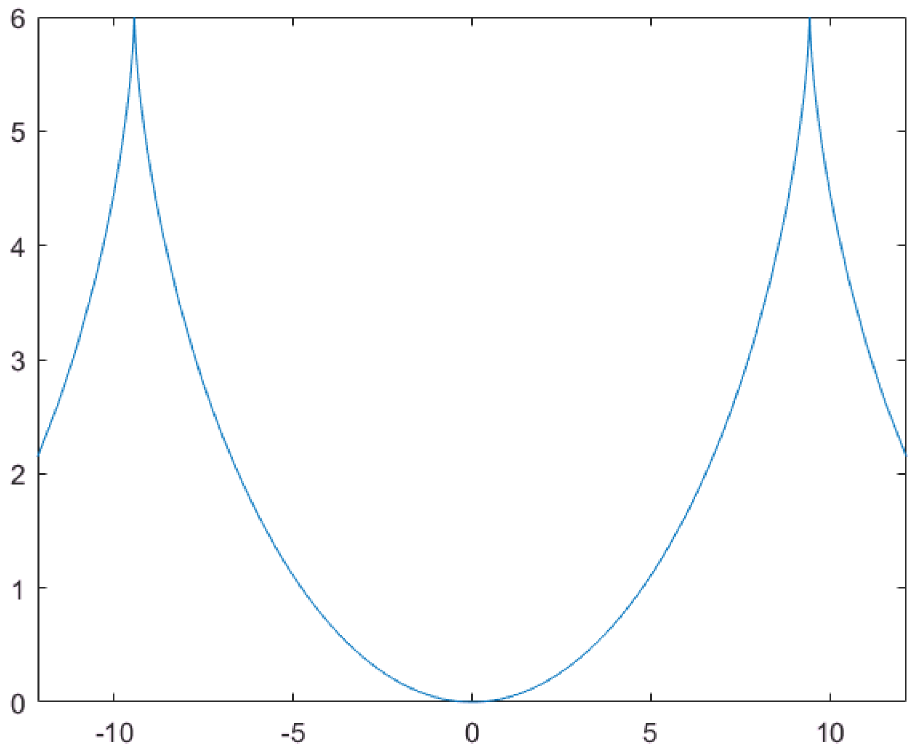
```
x = @(a,theta) a .* (theta + sin(theta))
```

```
x = function_handle with value:
    @(a,theta)a.*(theta+sin(theta))
```

```
y = @(a,theta) a .* (1 - cos(theta))
```

```
y = function_handle with value:
    @(a,theta)a.*(1-cos(theta))
```

```
fplot(@(theta) x(3,theta),@(theta) y(3,theta))
```



- $x = t^2, y = t - \dfrac{t^3}{3}$

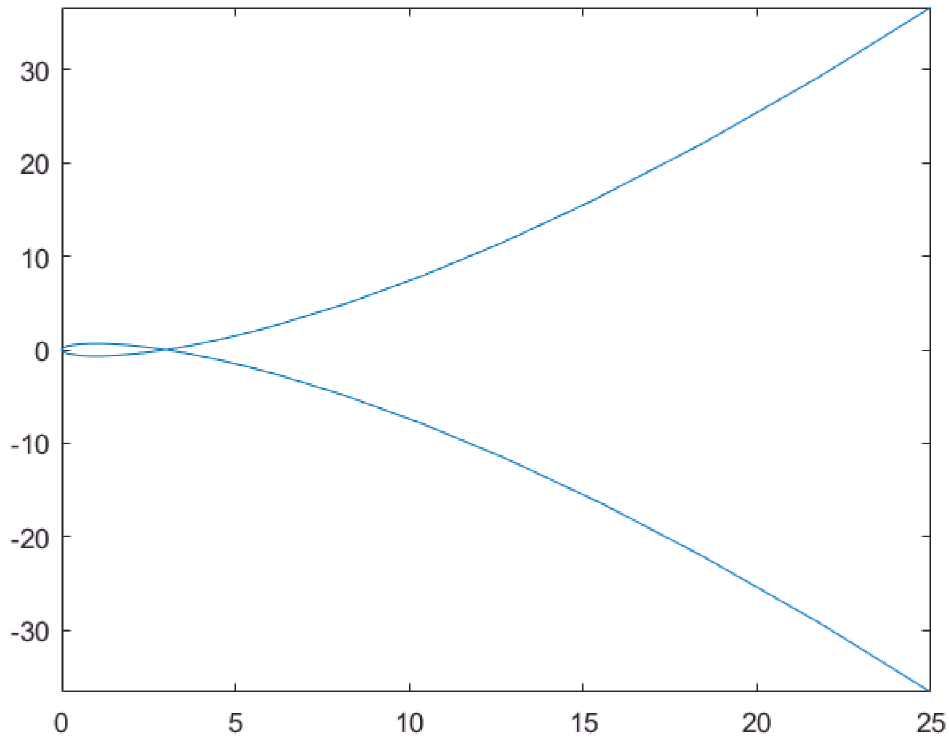
```
x = @(t) t .^ 2
```

```
x = function_handle with value:
    @(t)t.^2
```

```
y = @(t) t - (t .^ 3 /3)
```

```
y = function_handle with value:
    @(t)t-(t.^3/3)
```

```
fplot(@(t) x(t),@(t) y(t))
```



- $x = \text{at}, y = \dfrac{a}{t^2}$

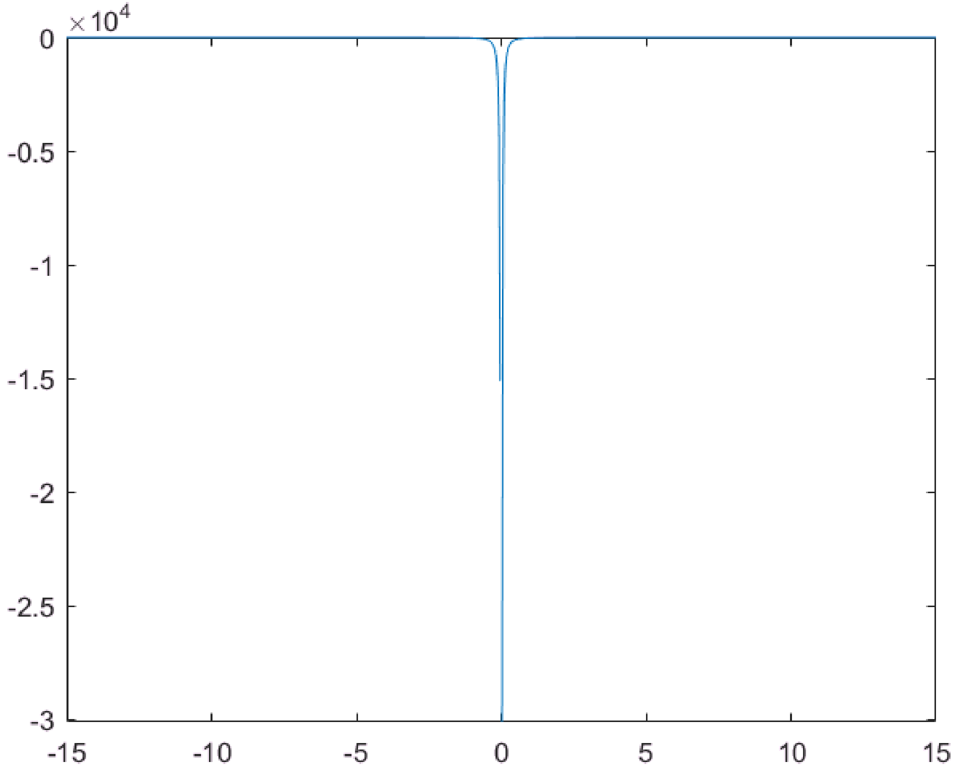
```
x = @(t,a) a .* t
```

```
x = function_handle with value:
    @(t,a)a.*t
```

```
y = @(t,a) a ./ t .^ 2
```

```
y = function_handle with value:
    @(t,a)a./t.^2
```

```
fplot(@(t) x(t,-3),@(t) y(t,-3))
```



- $x = a\left(\cos\theta + \frac{1}{2}\log\tan^2\frac{\theta}{2}\right), y = a\sin\theta$

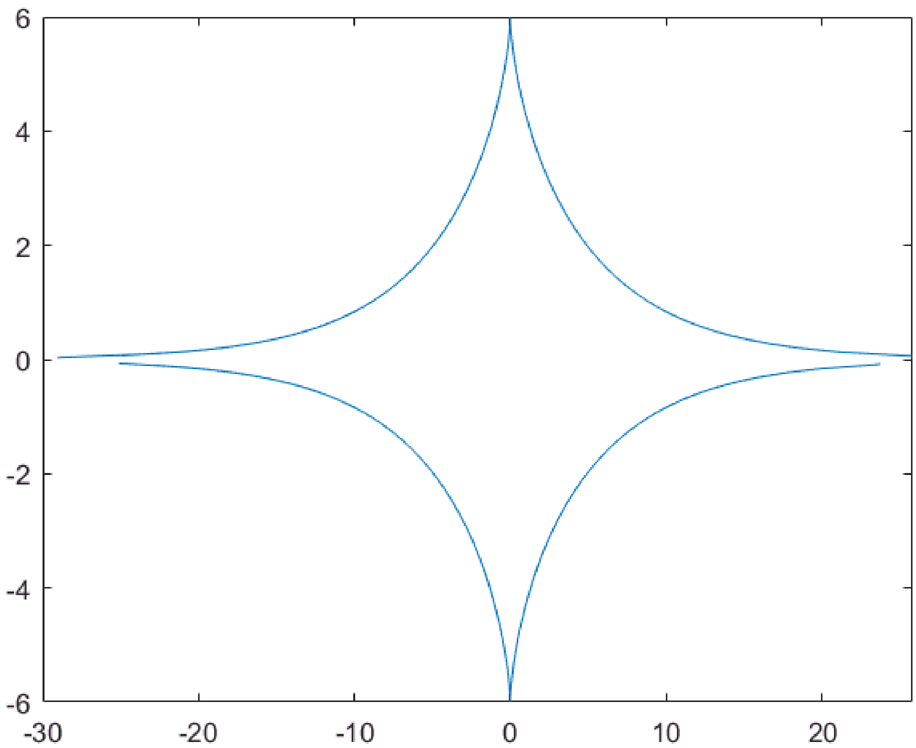
```
x = @(a,theta) a .* (cos(theta) + 1/2 .*(log(tan(theta./2).^2)))
```

```
x = function_handle with value:
    @(a,theta)a.*(cos(theta)+1/2.*(log(tan(theta./2).^2)))
```

```
y = @(a,theta) a.* sin(theta)
```

```
y = function_handle with value:
    @(a,theta)a.*sin(theta)
```

```
fplot(@(theta) x(-6,theta),@(theta) y(-6,theta))
```


6
4
2
0
-2
-4
-6
-30
-20
-10
0
10
20