```
syms x y
eq1=x+y==5
```

eq1 = $x + y = 5$

```
eq2=x-y==-5
```

eq2 = $x - y = -5$

```
[x,y]=solve([eq1,eq2],[x,y])
```

x = 0

y = 5

```
x=cos(sqrt(5))
```

x = -0.6173

```
y=acos(1)
```

y = 0

```
z=asin(1)
```

z = 1.5708

```
syms x
eq1 = x^2 == 5
```

eq1 = $x^2 = 5$

```
solve(eq1,x)
```

ans =

$$\begin{pmatrix} \sqrt{5} \\ -\sqrt{5} \end{pmatrix}$$

```
%Not all equations can be solved algebraically
clear all
syms x
eq1 = x*cos(x)^2 == 5
```

eq1 = $x \cos(x)^2 = 5$

```
solve(eq1,x)
```

Warning: Unable to solve symbolically. Returning a numeric solution using vpasolve.

ans = $6.8268802918181824627200980859385$

```
clear all
syms x
eq1 = x*cos(x)^2 == 5
```

eq1 = $x\cos(x)^2 = 5$

```
vpasolve(eq1,x,[10,15])
```

ans = $11.707777831979465378395553925927$

```
%Matlab does not always give you all the solutions
% to an equation even if it can find them

syms x
eq1 = cos(x)^2 == 5
```

eq1 = $\cos(x)^2 = 5$

```
solve(eq1,x)
```

ans =

$$\begin{pmatrix} \mathrm{acos}(\sqrt{5}) \\ -\mathrm{acos}(\sqrt{5}) \end{pmatrix}$$

```


%This gives specific roots, but if you want to see them all,
% you have to use
clear all
syms x
eq1 = cos(x)^2 == 5
```

eq1 = $\cos(x)^2 = 5$

```
sols = solve(eq1,x,'Returnconditions',true)
```

```
sols = struct with fields:
             x: [2×1 sym]
    parameters: [1×1 sym]
    conditions: [2×1 sym]
```

```
sols.x
```

ans =

$$\begin{pmatrix} \mathrm{acos}(\sqrt{5}) + \pi\, k \\ \pi\, k - \mathrm{acos}(\sqrt{5}) \end{pmatrix}$$

```
sols.parameters
```

ans = k

```
sols.conditions
```

ans =

$$\begin{pmatrix} k \in \mathbb{Z} \\ k \in \mathbb{Z} \end{pmatrix}$$

```
syms x y a b z
eq1=x^2+y^2==a
```

eq1 = $x^2 + y^2 = a$

```
eq2=x-y==b
```

eq2 = $x - y = b$

```
[x,y]=solve([eq1,eq2],[x,y])
```

x =

$$\begin{pmatrix} \frac{b}{2} - \frac{\sqrt{2\,a - b^2}}{2} \\ \frac{b}{2} + \frac{\sqrt{2\,a - b^2}}{2} \end{pmatrix}$$

y =

$$\begin{pmatrix} -\frac{b}{2} - \frac{\sqrt{2\,a - b^2}}{2} \\ \frac{\sqrt{2\,a - b^2}}{2} - \frac{b}{2} \end{pmatrix}$$

```
x(1)
```

ans =

$$\frac{b}{2} - \frac{\sqrt{2\,a - b^2}}{2}$$

```
y(1)
```

ans =

$$-\frac{b}{2} - \frac{\sqrt{2\,a - b^2}}{2}$$

```
z=x-y
```

z =

$$\begin{pmatrix} b \\ b \end{pmatrix}$$

```
t=x+y
```

t =

$$\begin{pmatrix} -\sqrt{2\,a-b^2} \\ \sqrt{2\,a-b^2} \end{pmatrix}$$

```
s=x(2)+y(1)
```

s = 0

```
dotp=dot(x,y)
```

dotp =

$$\left(\frac{b}{2}+\frac{\sqrt{2\,a-b^2}}{2}\right)\left(\frac{\overline{\sqrt{2\,a-b^2}}}{2}-\frac{\overline{b}}{2}\right)-\left(\frac{b}{2}-\frac{\sqrt{2\,a-b^2}}{2}\right)\left(\frac{\overline{\sqrt{2\,a-b^2}}}{2}+\frac{\overline{b}}{2}\right)$$

```
simplify(dotp)
```

ans =

$$\frac{|b^2-2\,a|}{2}-\frac{|b|^2}{2}$$

Dot Product of vectors

```
syms x y a b z
assume(a, 'real')
assume(b,'real')
eq1=x^2+y^2==a
```

eq1 = $x^2+y^2=a$

```
eq2=x-y==b
```

eq2 = $x-y=b$

```
[x,y]=solve([eq1,eq2],[x,y])
```

x =

$$\begin{pmatrix} \frac{b}{2}-\frac{\sqrt{2\,a-b^2}}{2} \\ \frac{b}{2}+\frac{\sqrt{2\,a-b^2}}{2} \end{pmatrix}$$

y =

$$\begin{pmatrix} -\frac{b}{2}-\frac{\sqrt{2\,a-b^2}}{2} \\ \frac{\sqrt{2\,a-b^2}}{2}-\frac{b}{2} \end{pmatrix}$$

```
z=dot(x,y)
```

z =

$$-\left(\frac{b}{2}-\frac{\sqrt{2\,a-b^2}}{2}\right)\left(\frac{b}{2}+\frac{\sqrt{2\,a-b^2}}{2}\right)-\left(\frac{b}{2}+\frac{\sqrt{2\,a-b^2}}{2}\right)\left(\frac{b}{2}-\frac{\sqrt{2\,a-b^2}}{2}\right)$$

```
simplify(z)
```

ans =

$$\frac{|b^2-2\,a|}{2}-\frac{b^2}{2}$$

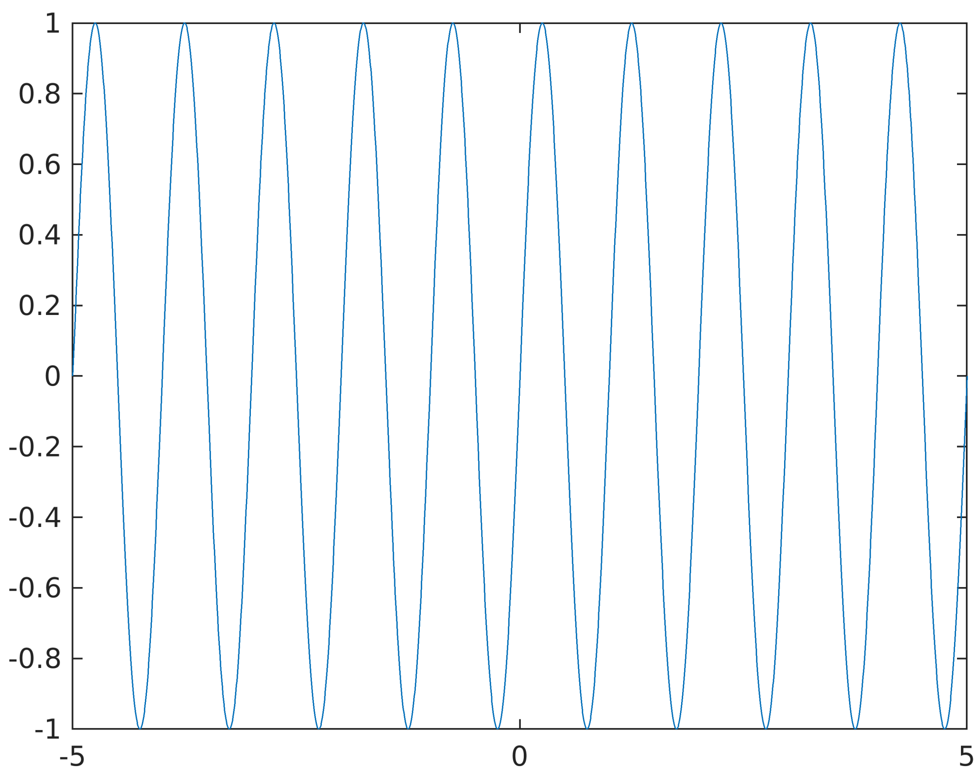
```
syms x d
d=diff(x^3,x)
```

d = $3\,x^2$

```
%functions plotting
syms f(t,k) t k
f(t,k) = sin(k*t)
```

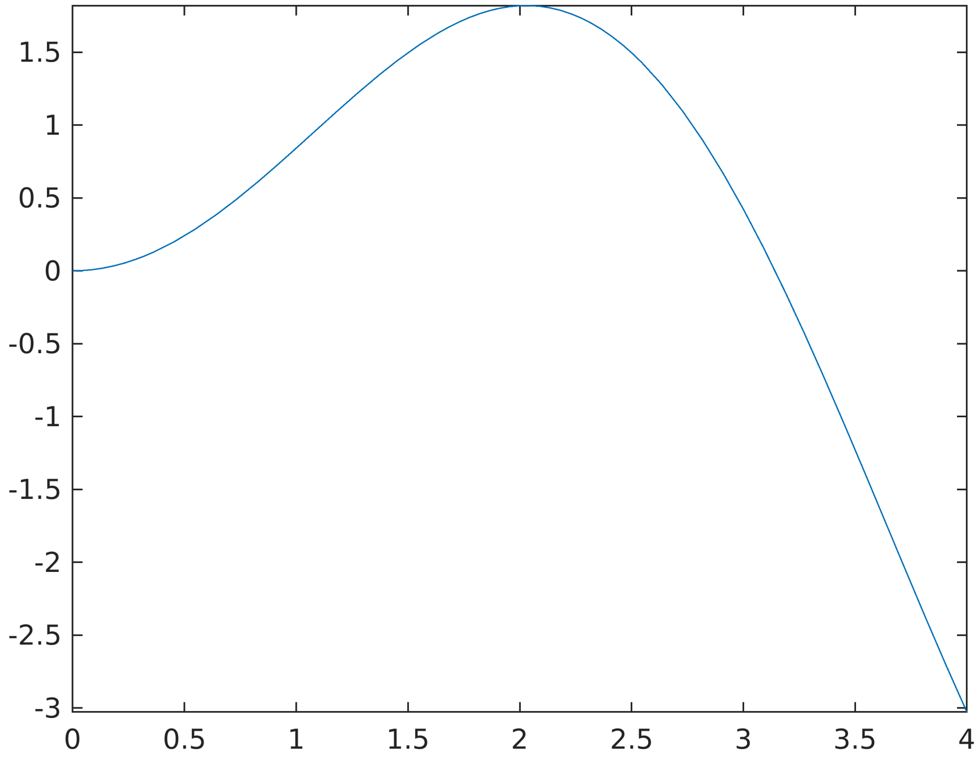
f(t, k) = $\sin(k\,t)$

```
fplot(f(t,2*pi),[-5,5])
```




```
figure
```

```
syms x
fplot(x*sin(x),[0,4])
```




```
%calculus
syms x deriv
deriv = diff(x^2,x)
```

deriv = $2\,x$

```
int(deriv)
```

ans = x^2

```
syms x f dfdx d2fdx2 dfdx_n f_n
f = x*sin(x)^2*cos(x)^2
```

f = $x\cos(x)^2\sin(x)^2$

```
dfdx = diff(f,x)
```

dfdx = $2\,x\cos(x)^3\sin(x)+\cos(x)^2\sin(x)^2-2\,x\cos(x)\sin(x)^3$

```
d2fdx2 = diff(f,x,2)
```

d2fdx2 = $2\,x\cos(x)^4+4\cos(x)^3\sin(x)-12\,x\cos(x)^2\sin(x)^2-4\cos(x)\sin(x)^3+2\,x\sin(x)^4$

```
%pde
clear all
syms f x y
f = sqrt(x^2+y^2)
```

f = $\sqrt{x^2+y^2}$

```
dfdx=diff(f,x)
```

dfdx =

$$\frac{x}{\sqrt{x^2+y^2}}$$

```
dfdy=diff(f,y)
```

dfdy =

$$\frac{y}{\sqrt{x^2+y^2}}$$

```
%Maximizing a function
syms f x a dfdx xatmax
f = x/(a+x^2)
```

f =

$$\frac{x}{x^2+a}$$

```
dfdx = diff(f,x);
xatmax = solve(dfdx==0,x)
```

xatmax =

$$\begin{pmatrix} -\sqrt{a} \\ \sqrt{a} \end{pmatrix}$$

```
subs(f,x,xatmax)
```

ans =

$$\begin{pmatrix} -\frac{1}{2\sqrt{a}} \\ \frac{1}{2\sqrt{a}} \end{pmatrix}$$

```
%Taylor Series
syms f x
f = exp(x);
taylor(f,x,0,'Order',5)
```

ans =

$$\frac{x^4}{24}+\frac{x^3}{6}+\frac{x^2}{2}+x+1$$

```
%Vector
syms v w a b c d e f
v = [a, b, c]
```

v = $\begin{pmatrix} a & b & c \end{pmatrix}$

```
w = [d e f]
```

w = $\begin{pmatrix} d & e & f \end{pmatrix}$

```
uxv=cross(v,w)
```

uxv = $\begin{pmatrix} b\,f-c\,e & c\,d-a\,f & a\,e-b\,d \end{pmatrix}$

```
uv=dot(v,w)
```

uv = $d\,\overline{a}+e\,\overline{b}+f\,\overline{c}$

```
v+w
```

ans = $\begin{pmatrix} a+d & b+e & c+f \end{pmatrix}$

```


%Vector Calculus
syms f x y z v
f = sqrt(x^2+y^2+z^2)
```

f = $\sqrt{x^2+y^2+z^2}$

```
v = gradient(f,[x,y,z])
```

v =

$$\begin{pmatrix} \frac{x}{\sqrt{x^2+y^2+z^2}} \\ \frac{y}{\sqrt{x^2+y^2+z^2}} \\ \frac{z}{\sqrt{x^2+y^2+z^2}} \end{pmatrix}$$

```
curl(v)
```

ans =

$$\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$