MATLAB - TRANSFORMS

MATLAB provides command for working with transforms, such as the Laplace and Fourier transforms. Transforms are used in science and engineering as a tool for simplifying analysis and look at data from another angle.

For example, the Fourier transform allows us to convert a signal represented as a function of time to a function of frequency. Laplace transform allows us to convert a differential equation to an algebraic equation.

MATLAB provides the **laplace**, **fourier** and **fft** commands to work with Laplace, Fourier and Fast Fourier transforms.

The Laplace Transform

The Laplace transform of a function of time f*t* is given by the following integral −

$$L\{f(t)\} = \int_0^\infty f(t).e^{-st}dt$$

Laplace transform is also denoted as transform of f*t* to F*s*. You can see this transform or integration process converts f*t*, a function of the symbolic variable t, into another function F*s*, with another variable s.

Laplace transform turns differential equations into algebraic ones. To compute a Laplace transform of a function f*t*, write −

```
laplace(f(t))
```

Example

In this example, we will compute the Laplace transform of some commonly used functions.

Create a script file and type the following code −

```
syms s t a b w
laplace(a)
laplace(t^2)
laplace(t^9)
laplace(exp(-b*t))
laplace(sin(w*t))
laplace(cos(w*t))
```

When you run the file, it displays the following result −

```
ans =
 1/s^2

 ans =
 2/s^3

 ans =
 362880/s^10

 ans =
 1/(b + s)

ans =
 w/(s^2 + w^2)

ans =
```

```
 s/(s^2 + w^2)
```

The Inverse Laplace Transform

MATLAB allows us to compute the inverse Laplace transform using the command **ilaplace**.

For example,

```
ilaplace(1/s^3)
```

MATLAB will execute the above statement and display the result −

```
ans =
 t^2/2
```

Example

Create a script file and type the following code −

```
syms s t a b w
ilaplace(1/s^7)
ilaplace(2/(w+s))
ilaplace(s/(s^2+4))
ilaplace(exp(-b*t))
ilaplace(w/(s^2 + w^2))
ilaplace(s/(s^2 + w^2))
```

When you run the file, it displays the following result −

```
ans =
t^6/720

 ans =
 2*exp(-t*w)

 ans =
 cos(2*t)

 ans =
 ilaplace(exp(-b*t), t, x)

 ans =
 sin(t*w)

 ans =
 cos(t*w)
```

The Fourier Transforms

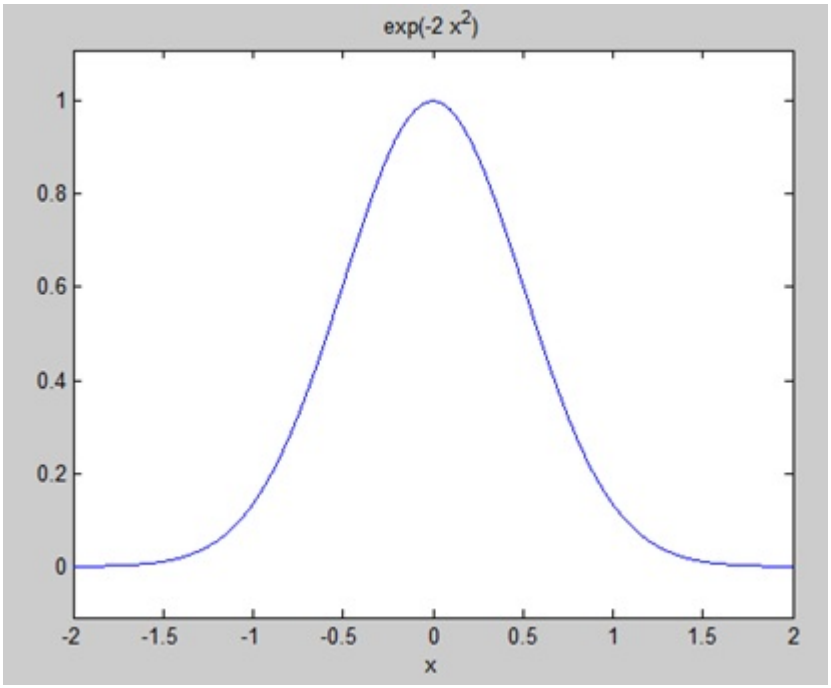
Fourier transforms commonly transforms a mathematical function of time, ft, into a new function, sometimes denoted by or F, whose argument is frequency with units of cycles/s *hertz* or radians per second. The new function is then known as the Fourier transform and/or the frequency spectrum of the function f.

Example

Create a script file and type the following code in it −

```
syms x
f = exp(-2*x^2);  %our function
ezplot(f,[-2,2])  % plot of our function
FT = fourier(f) % Fourier transform
```

When you run the file, MATLAB plots the following graph −



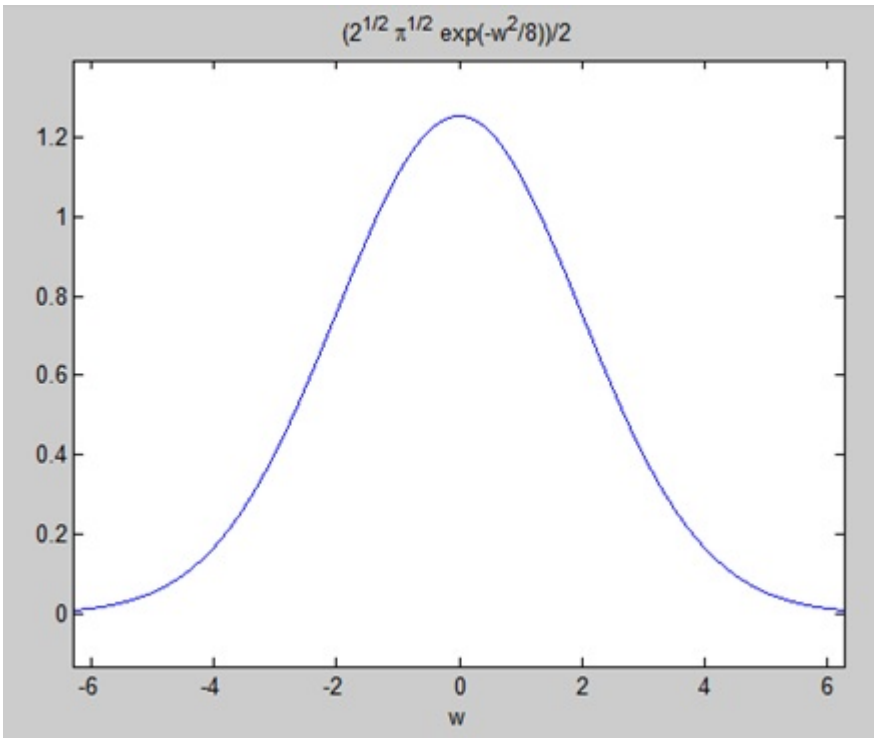
The following result is displayed −

```
FT =
 (2^(1/2)*pi^(1/2)*exp(-w^2/8))/2
```

Plotting the Fourier transform as −

```
ezplot(FT)
```

Gives the following graph −



Inverse Fourier Transforms

MATLAB provides the **ifourier** command for computing the inverse Fourier transform of a function. For example,

```
f = ifourier(-2*exp(-abs(w)))
```

MATLAB will execute the above statement and display the result −

```
f =
-2/(pi*(x^2 + 1))
```