

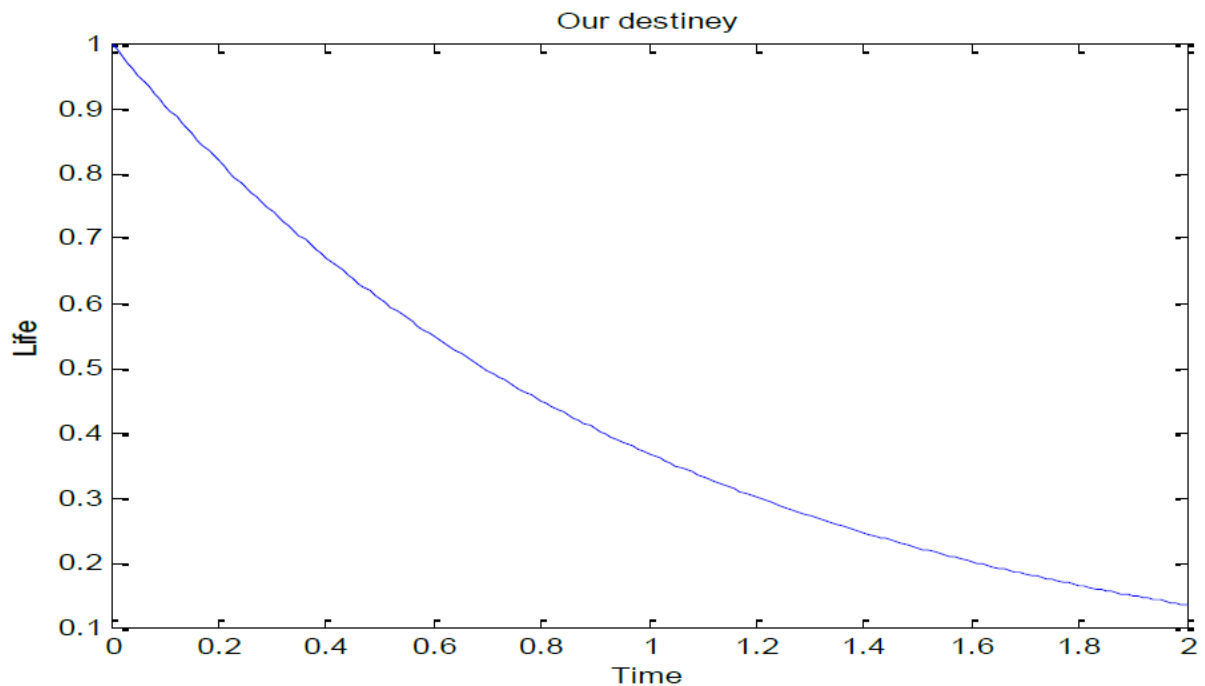
Experiment 2: Introduction to MATLAB II

1. Plotting

1.1 Basic Two-Dimensional Plot

MATLAB has extensive plotting capabilities. We will examine a simple two-dimensional plot and add features. The `'plot'` command graphs the numbers in one array versus the numbers in a second array of the same length. For example,

```
t=0:0.01:2;  
Temp=exp(-t);  
plot(t,Temp)  
xlabel('Time')  
ylabel('Life')  
title('Our destiny')
```

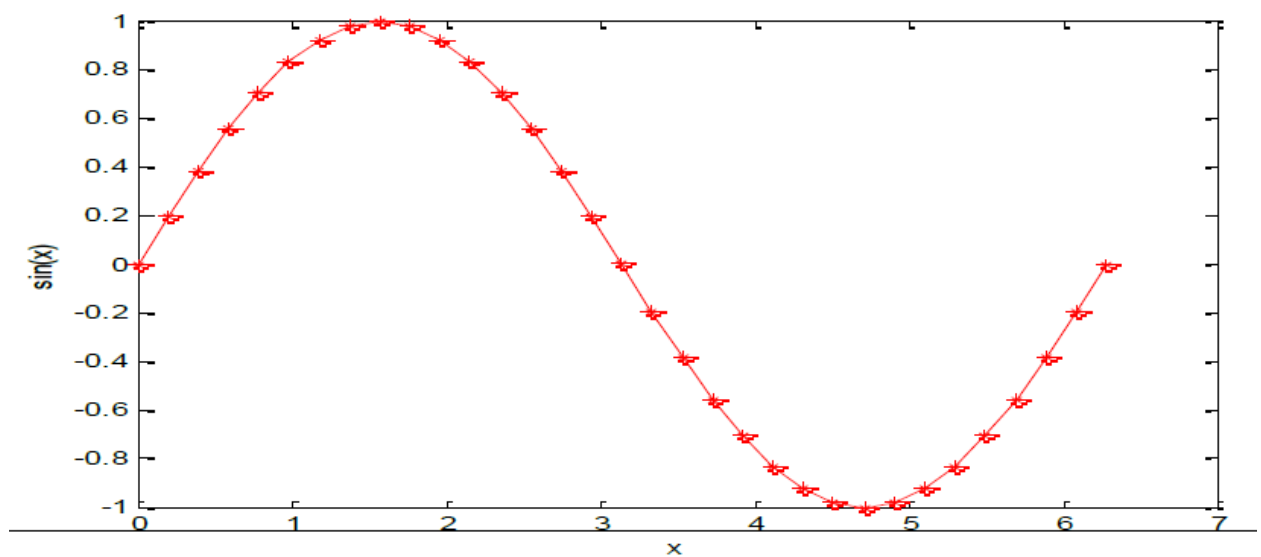


1.2 Colors, Symbols and Line Types

Short name	Long name
y	Yellow
m	Magenta
c	Cyan
r	Red
g	Green
b	Blue
w	White
k	black

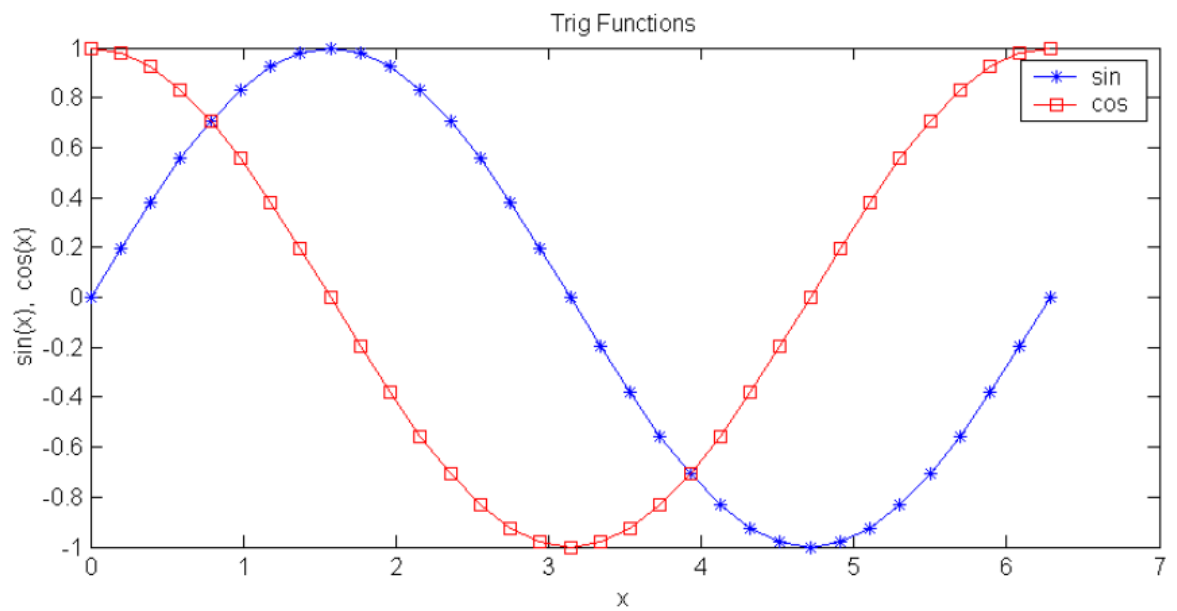
You can change colors, symbols and line types as demonstrated below

```
x=0:pi/16:2*pi;  
y=sin(x);  
plot(x,y,'r *--')  
xlabel('x')  
ylabel('sin(x)')
```



1.3 Multiple Plots on a Single Graph

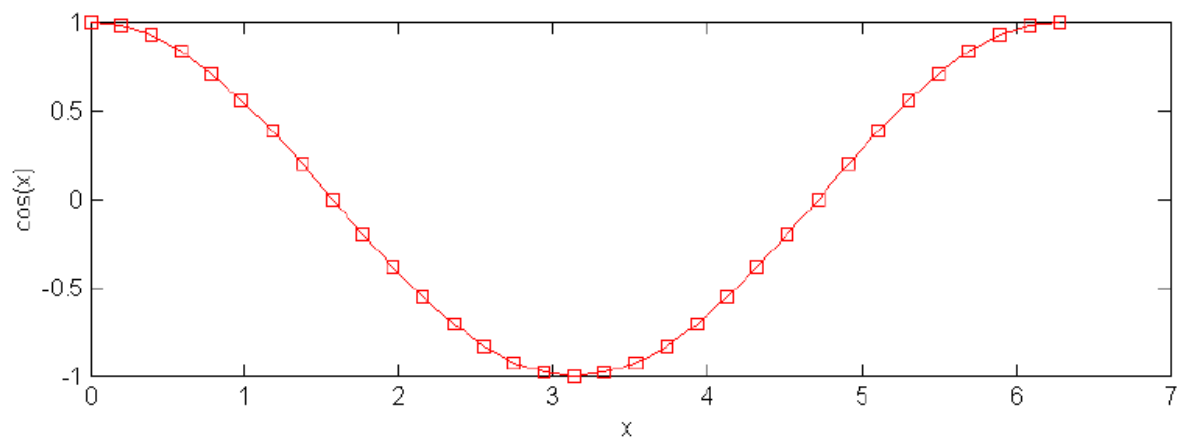
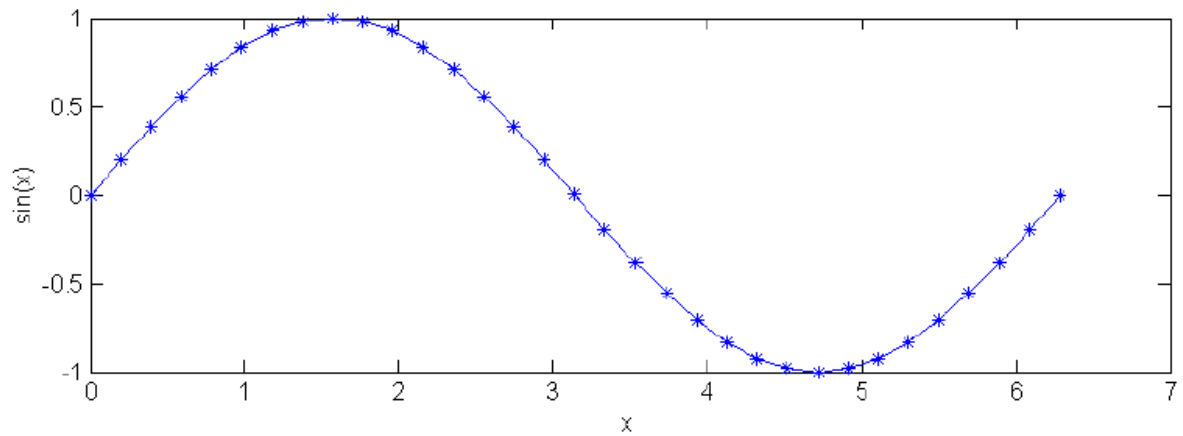
```
x=0:pi/16:2*pi;  
y1=sin(x);  
y2=cos(x);  
plot(x,y1,'* -',x,y2,'r s -')  
xlabel('x')  
ylabel('sin(x), cos(x)')  
title('Trig Functions')  
legend('sin','cos')
```



1.4 Subplots

You can create graphics arrays using the 'subplot' command.

```
x=0:pi/16:2*pi;  
y1=sin(x);  
y2=cos(x);  
  
subplot(2,1,1)  
plot(x,y1,'* -')  
xlabel('x')  
ylabel('sin(x)')  
subplot(2,1,2)  
plot(x,y2,'r s -')  
xlabel('x')  
ylabel('cos(x)')
```



2.Vector, Matrix and Array Commands

Some of MATLAB functions operate essentially on a vector (row or column), and others on and m-by-n matrix ($m \geq 2$).

Array	Commands
find	Finds indices of nonzero elements.
length	Computers number of elements.
linspace	Creates regularly spaced vector. 
logspace	Creates logarithmically spaced vector. 
max	Returns largest element.
min	Returns smallest element.
prod	Product of each column. 
reshape	Change size 
size	Computes array size.
sort	Sorts each column.
sum	Sums each column.

```
>> X = [1 0 4 -3 0 0 0 8 6];
indices = find(X)
indices =
     1     3     4     8     9
>> indices = find(X>2)
indices =
     3     8     9

>> length(X)
ans =
     9
>> max(X)
ans =
     8
>> min(X)
ans =
    -3
> sort(X)
ans =
    -3     0     0     0     0     1     4     6     8
>> sum(X)
ans =
    16
```

```
>> sum(X,2)
ans =
    16
>> sum(X,1)
ans =
     1     0     4    -3     0     0     0     8     6
>>
```

Create a vector of 4 linearly spaced numbers from 1 to 12:

```
>> A = linspace(1,12,4)
A =
    1.0000    4.6667    8.3333   12.0000
```

3. Calculus

The Symbolic Math Toolbox provides functions to do the basic operations of calculus; differentiation, limits, integration, summation, and Taylor series expansion. The following sections outline these functions.

3.1 Differentiation

diff(f)

differentiates f with respect to its symbolic variable (in this case x)

Let's create a symbolic expression.

```
>>syms a x
f = sin(a*x)
diff(f)
f =
sin(a*x)
ans =
a*cos(a*x)
```

To calculate the second derivatives with respect to x and a , respectively, type

```
diff(f,2)
```

or

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

which return

```
ans =
```

```
-sin(a*x)*a^2
```

3.2 Limits

The fundamental idea in calculus is to make calculations on functions as a Variable “gets close to” or approaches a certain value. Recall that the definition of the derivative is given by a limit

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

provided this limit exists. The Symbolic Math Toolbox allows you to compute the limits of functions in a direct manner.

```
>>syms h n x
limit( (cos(x+h) - cos(x))/h,h,0 )
ans =
-sin(x)
```

Mathematical Operation	MATLAB command
$\lim_{x \rightarrow 0} f(x)$	Limit(f)
$\lim_{x \rightarrow a} f(x)$	Limit(f,x,a)
$\lim_{x \rightarrow a^-} f(x)$	Limit(f,x,a,'left')
$\lim_{x \rightarrow a^+} f(x)$	Limit(f, x,a,'right')

3.3 Integration

If f is a symbolic expression, then the integration of f is `int(f)`

$$\int x^2 dx$$

We can do this in (at least) three different ways. The shortest is:

```
>>int('x^2')
ans =
1/3*x^3
```

Alternatively, we can define x symbolically first, and then leave off the single quotes in the `int` statement.

```
>>syms x
>>int(x^2)
ans =
1/3*x^3
```

Mathematical Operation	MATLAB Command
$\int x^n dx = \frac{x^{n+1}}{n+1}$	<code>int(x^n)</code> or <code>int(x^n,x)</code>
$\int_0^{\pi/2} \sin(2x) dx = 1$	<code>>>int(sin(2*x),x,0,pi/2)</code> <code>ans =</code> <code>1</code>
$g = \cos(at + b)$ $\int g(t) dt = \sin(at + b)/a$	<code>>> g = 'cos(a*t + b)'</code> <code>g =</code> <code>cos(a*t + b)</code> <code>>>int(g)</code> <code>ans =</code> <code>sin(b + a*t)/a</code>

4 .Linear algebra in MATLAB

□ Solving Equation

One of the most important problems in technical computing is the solution of simultaneous linear equations. In matrix notation, this problem can be stated as follows.

we may need to find x_1 , x_2 , and x_3 so that

$$\begin{aligned} X_1 + 2X_2 - X_3 &= 1 \\ -2X_1 - 6X_2 + 4X_3 &= -2 \\ -X_1 - 3X_2 + 3X_3 &= 1 \end{aligned}$$

The problem can be rewritten in matrix-vector notation. We introduce a matrix A and a vector b by

$$A = \begin{bmatrix} 1 & 2 & -1 \\ -2 & -6 & 4 \\ -1 & -3 & 3 \end{bmatrix} ; \quad b = \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}$$

```
A = [ 1 2 -1; -2 -6 4; -1 -3 3 ]
b = [ 1; -2; 1 ]
x = A\b
```

Matlab should give the solution

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \\ 2 \end{bmatrix}$$