وزارة التعليـم العـالي
جـــامعة طيبـــــة
كليـــــة العلـــوم
قســم الريــاضيات

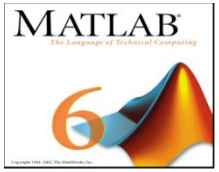
MATLAB Workshop
Department of Mathematics

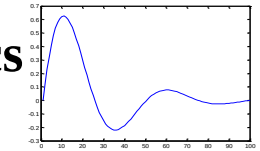
9/7/1436 (2015)

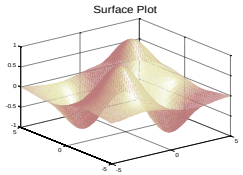
Meeting 2:
Matlab two and three dimensional graphics

Mostafa Zahri
Taibah University
Madinah

Matlab graphics

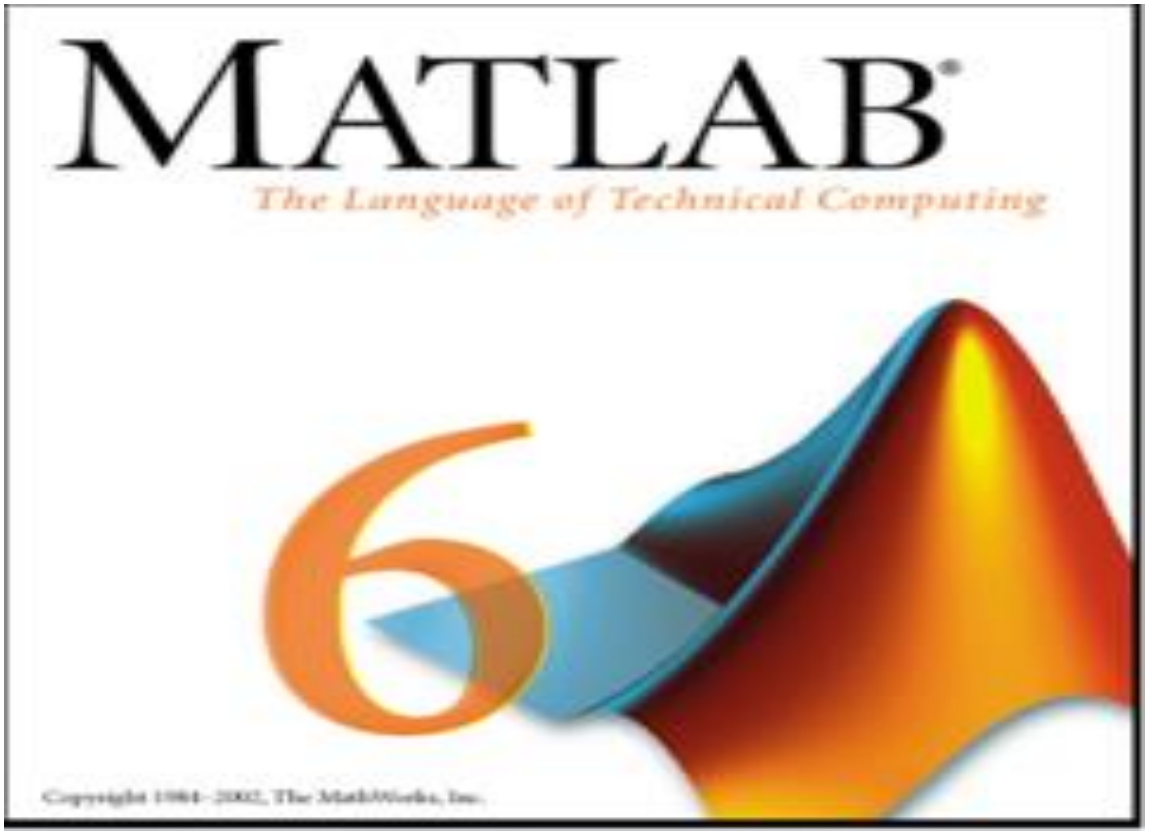
A. Introduction to Matlab graphics 

B. Two dimensional Graphics 

C. Three dimensional Graphics 

D. Image Manipulation 

Introduction to Matlab



الرسوم البيانية

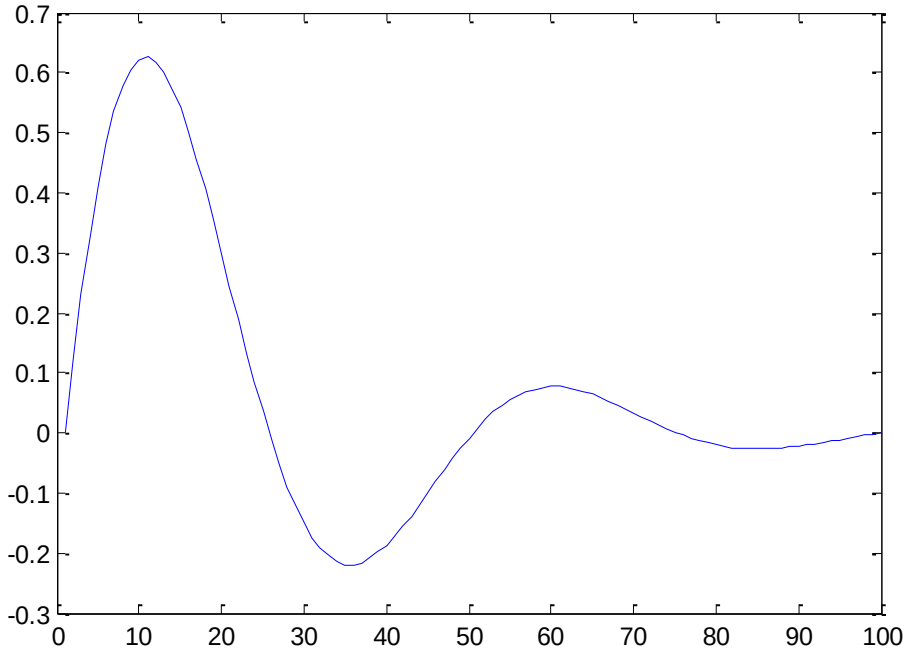
❖ MATLAB برنامج مزود بالعديد من الايعازات التي تظهر البيانات ثنائية اوثلاثية الأبعاد.

❖ الايعاز plot يقوم بإظهار البيانات على شكل ثنائي الأبعاد.

❖ الايعاز plot3 هو تمديد للايعاز plot إلى ثلاثي الأبعاد, وصيغته لها ثلاث مساقط بدلاً من مسقطين.

❖ الرسوم البيانية الجزئية **subplot**: تستطيع نافذة figure واحدة بإظهار اكثر من محور أو صورة, حيث يقسم subplot (m, n, p) نافذة الشكل الحالية الى مصفوفة mxn لرسم المناطق اما العدد p يحدد موقع الرسم البياني على المجموعة.

Two dimensional Graphics



Uniform Partition of Domains

(vi:step:vf) التجزيء المنتظم لفترة مغلقة للحصول على متجهة صف او عمود يتم باستعمال

```
>> x = (vi:step:vf);
 This command evaluate  the row vector x    %    >> x
x=
vi        vi+step        vi+2step        vi+3step        …        vf
```

```
>> x‘    %    This command evaluate  the column vector x
ans=
vi
vi+step
vi+2step
vi+3step
…
vf
```

التجزيء المنتظم الصفي أو العمودي متكافان في النتائج عند استعمال ماتلاب

Partition of Domains, intervals

Create an x-array (row-vector) of samples between 0 and 1

بفتح ماتلاب ندخل الاوامر التالية (0:Step:1) = x>> بحيث Step=0.5, 0.25, 0.2, 0.1

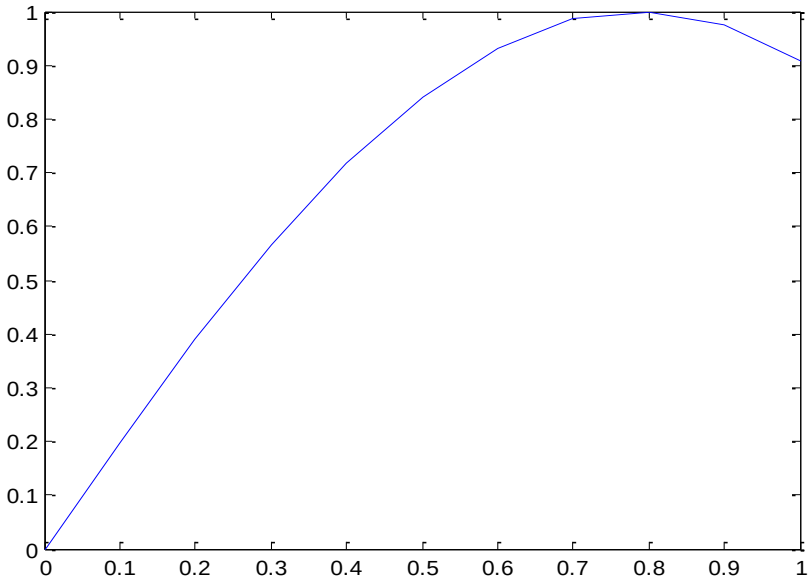
```
>> x = (0:0.5:1)
x =
    0    0.5000    1.0000
>> x = (0:0.25:1)
x =
    0    0.2500    0.5000    0.7500    1.0000
>> x = (0:0.2:1)
x =
    0    0.2000    0.4000    0.6000    0.8000    1.0000
>> x = (0:0.1:1)
x =
    0    0.1000    0.2000    0.3000    0.4000    0.5000    0.6000    0.7000    0.8000    0.9000    1.0000
```

Plot of One-dim function:plot(x,fx)

نعرف الدالة f(x)=sin(x) ثم ندخل الأوامر >>fx=sin(x) , >>plot(x, fx)

```
>> x = (0:0.1:1)
x =
0   0.1000   0.2000   0.3000   0.4000   0.5000   0.6000   0.7000   0.8000   0.9000   1.0000
>> fx=sin(x)
fx =
0   0.1987   0.3894   0.5646   0.7174   0.8415   0.9320   0.9854   0.9996   0.9738   0.9093
>> plot(x, fx)
```

The command plot(x, fx) draw the curve of the function f(x)=sin(x)



Uniform Partition of Domains, linspace

التجزيء المنتظم لفترة مغلقة للحصول على متجهة صف او عمود يتم باستعمال linspace:

x = linspace (vi,vf,n);

This command evaluate the row vector x , n is the number of points between v-initial and v-final

x %

x=

vi vi+1*(vf-vi)/(n-1) vi+2*(vf-vi)/ (n-1) vi+3*(vf-vi)/(n-1) ... vi+(n-2)* (vf-vi)/(n-1) vf

```
>> x=linspace (0,1,2)
x =
    0    1
>> x=linspace (0,1,5)
x =
         0    0.2500    0.5000    0.7500    1.0000
>> x=linspace (0,1,10)
x =
         0    0.1111    0.2222    0.3333    0.4444    0.5556    0.6667    0.7778    0.8889    1.0000
>> x=linspace (0,1,11)
x =
         0    0.1000    0.2000    0.3000    0.4000    0.5000    0.6000    0.7000    0.8000    0.9000    1.0000
```

Plot the function sin(x), plot(fx):default x-axis

رسم دالة باستعمال التجزيء المنتظم لفترة مغلقة :linspace

Create an x-array of 50 samples between 0 and 2π.

```
>>x=linspace(0,2*pi,50);
```

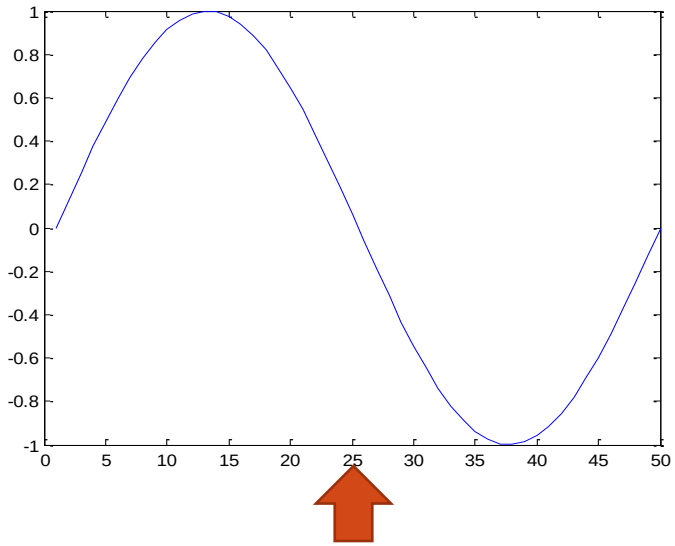
الرسم البياني للدالة **sin(x)**

Calculate sin(.) of the x-array

```
>>fx=sin(x);
```

Plot the fx-array

```
>>plot(fx)
```



x=linspace(0,2*pi,50= عدد النقاط); يظهر عدد النقاط المستعملة ليس القيم

Plot the function exp(-x/3)sin(x)

الرسم باستعمال التجزيء المنتظم لفترة مغلقة linspace والطريقة الصحيحة لضرب الدوال في ماتلاب

Create an x-array of 100 samples between 0 and 4π.

```
>>x=linspace(0,4*pi,100);
```

Calculate sin(.) of the x-array

```
>>y=sin(x);
```

Calculate $e^{-x/3}$ of the x-array

```
>>y1=exp(-x/3);
```

Multiply the arrays y and y1

```
>>y2=y*y1;
```

MatLab OUTPUT: ERROR

```
>> x=linspace(0,4*pi,100);
>> y=sin(x);
>> y1=exp(-x/3);
>> y2=y*y1;
??? Error using ==> mtimes
Inner matrix dimensions must agree.
```

mtimes Error is *
Inner matrix dimensions must agree:
The matrices y and y1 have different dimension. So How to do!!!

Plot the function exp(-x/3)sin(x)

الطريقة الصحيحة لضرب الدوال في ماتلاب هي استعمال الرمز " . " قبل " * "

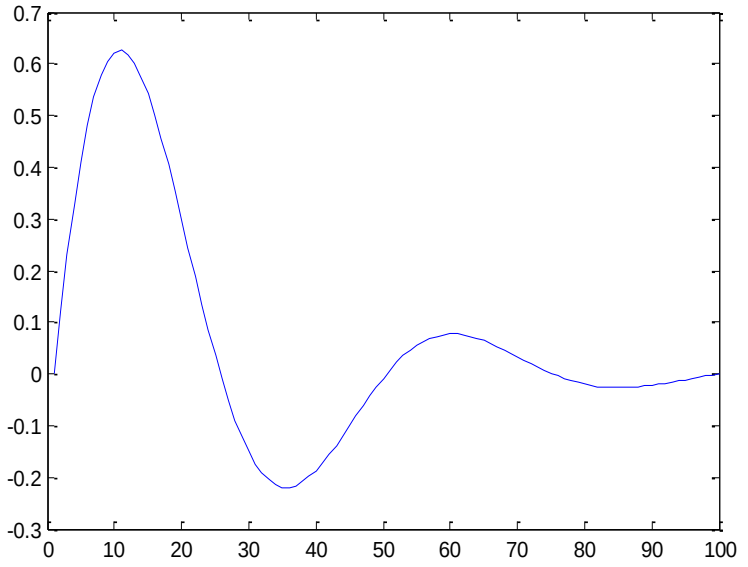
Multiply the arrays y and y1 **correctly**

```
>>y2=y.*y1;
```

Plot the y2-array

```
>>plot(y2)
```

الرسم البياني للدالة **exp(-x/3)sin(x)**



الرسم البياني يظهر قيم الدالة على المحور العمودي والنقاط 100 على المحور الافقي

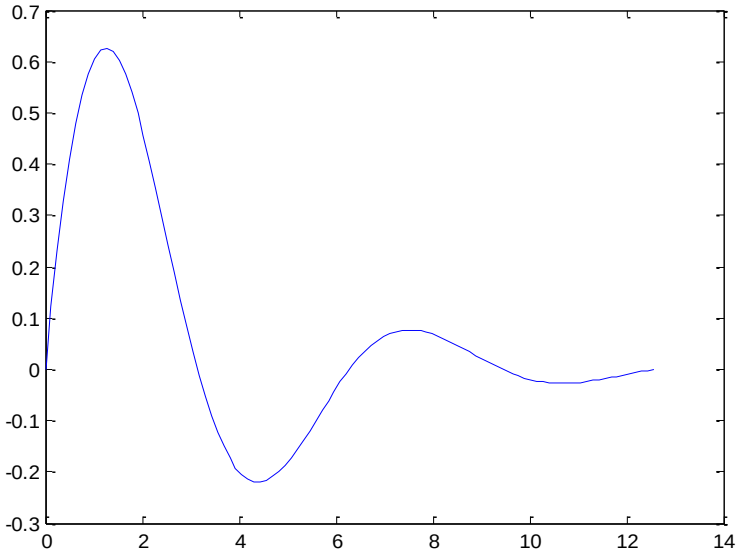
إذن كيف يمكن اظهار قيم النقاط المستعملة على محاور الرسم البياني !!!

Plot the function exp(-x/3)sin(x)

بدلا من ادخال >>plot(y2) يجب ادخال >>plot(x,y2)

>>plot(x,y2)

الرسم البياني للدالة exp(-x/3)sin(x)

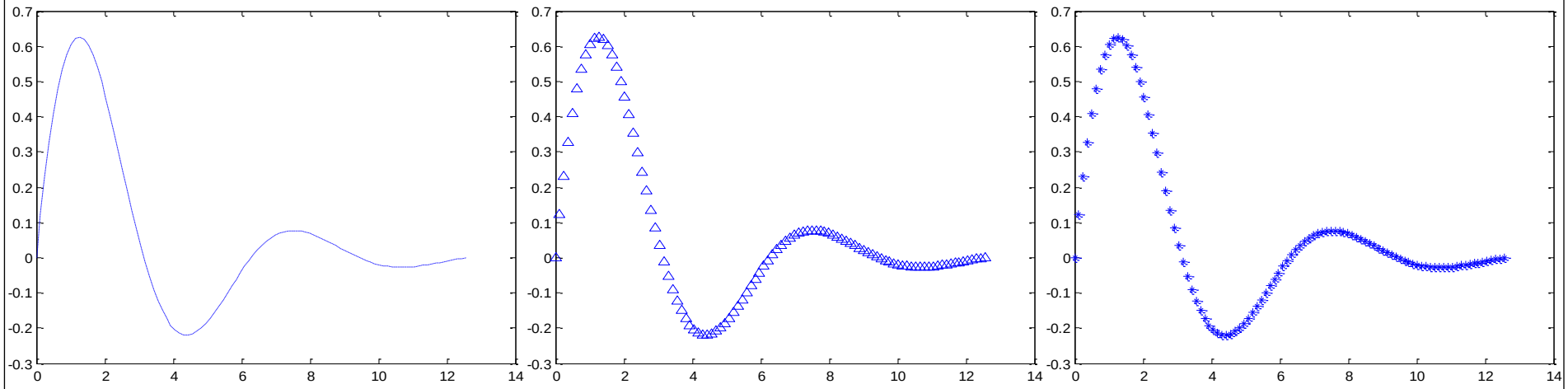


الرسم البياني يظهر القيم الحقيقية المستعملة
بمعنى اخر يظهر النقاط
(x, exp(-x/3)sin(x))
لكل
x=linspace(0,4*pi,100);

Editing of graphs, line type

```
>>x=linspace(0,4*pi,100);
>> y1=exp(-x/3);
>> y=sin(x);
>> y2=y.*y1;
>> figure(1);  plot(x,y2,'*');
>> figure(2);  plot(x,y2,'-.');
>> figure(3);  plot(x,y2,'^');
```

ادخال >>plot(x,y2,'line type')
يؤدي الى تغيير الخط المتصل في الرسم البياني الى خط متقطع او عبارة عن رمز يمثل احداثيات نقاط الدالة مثلا * او o او ...



Editing of graphs

The plot function is used to draw the relationship between x and y.
Format:
>>plot(x, y, 'Specifier')

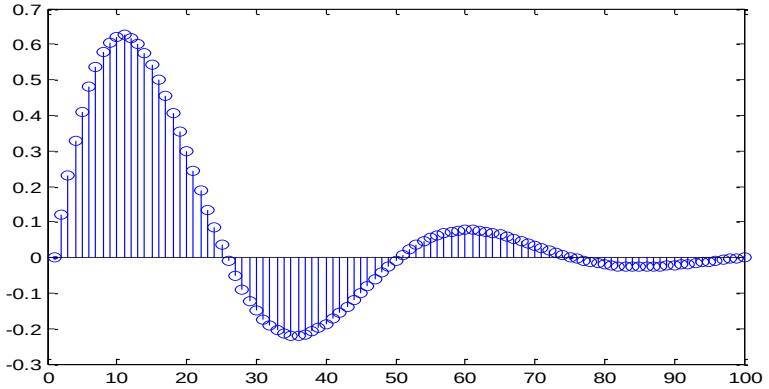
Specifier	Line Style
-	Solid line (default)
--	Dashed line
:	Dotted line
-.	Dash-dot line

Specifier	Marker Type
x	Cross
'square' or s	Square
'diamond' or d	Diamond
^	Upward-pointing triangle
v	Downward-pointing triangle
>	Right-pointing triangle
<	Left-pointing triangle
'pentagram' or p	Five-pointed star (pentagram)
'hexagram' or h	Six-pointed star (hexagram)

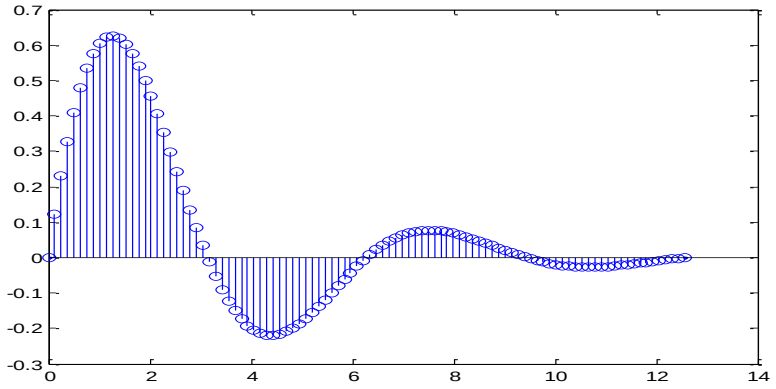
Specifier	Color
r	Red
g	Green
b	Blue
c	Cyan
m	Magenta
y	Yellow
k	Black
w	White

stem(.) & stairs functions

```
>>x=linspace(0,4*pi,100);
>> y1=exp(-x/3);  y=sin(x);
>> y2=y.*y1;
>>stem(y);
```

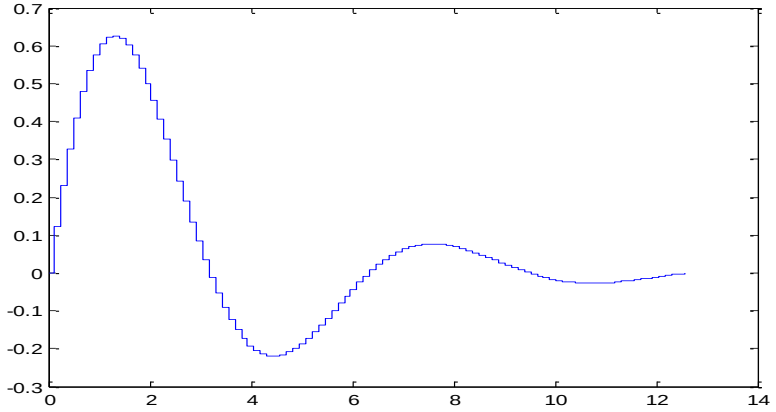



```
>>stem(x,y)
```



في الرسم البياني تظهر إحداثيات القيم باستعمال الرمز o وتربط بفترات تظهر قيمة الدالة.

```
>> x=linspace(0,4*pi,100);
>>y1=exp(-x/3);  y=sin(x);
>>y2=y.*y1;
>> stairs(x,y2)
```



Display Facilities, title and lables

عنونة الرسوم البيانية : عنوان الرسم : عنونة المحاور

xlabel(‘.’) for x-axis

```
>>xlabel('x (secs)')
```

Adding a ylabel(‘.’) for y-axis

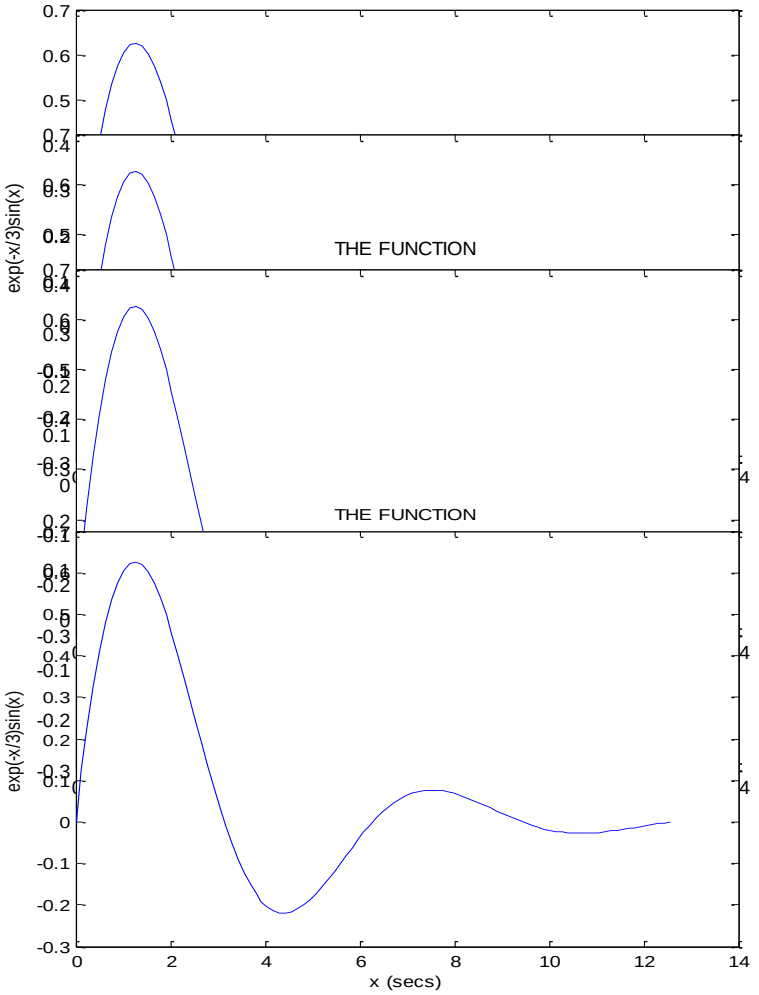
```
>>ylabel('exp(-x/3)sin(x)')
```

Adding a title(‘THE TITLE’)

```
>>title('THE FUNCTION')
```

All together

```
>>xlabel('x (secs)');
>>ylabel('exp(-x/3)sin(x)');
 >>title('THE FUNCTION');
```



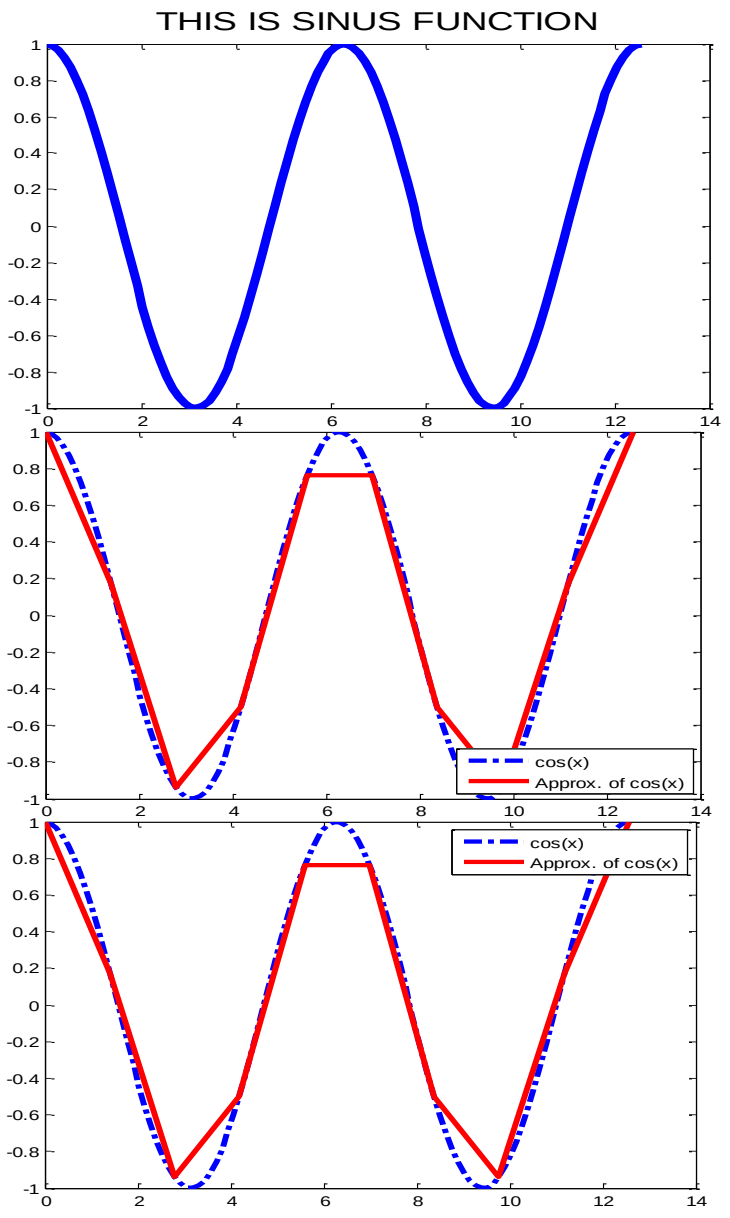
Display Facilities, Fonts and Size, Legend

لتغيير سمك المنحنى نستعمل 'LineWidth',5
الرقم 5 يمثل حجم المنحنى ولتغيير سمك الخط نستعمل
'FontSize',18 الرقم 18 يمثل حجم الخط

```
>> x=linspace(0,4*pi,100);
>> y=cos(x);
>> plot(x,y,'LineWidth',5);
>> title('THIS IS SINUS FUNCTION','FontSize',18);
```

```
>> x=linspace(0,4*pi,100);
>> y=linspace(0,4*pi,10);
>> fx=cos(x);
>> fy=cos(y);
>> plot(x,fx,'-.','LineWidth',3);
>> hold on; plot(y,fy,'r','LineWidth',3);
>> h = legend('cos(x)','Approx. of cos(x)',4);
```

```
>> h = legend('cos(x)','Approx. of cos(x)',1);
```

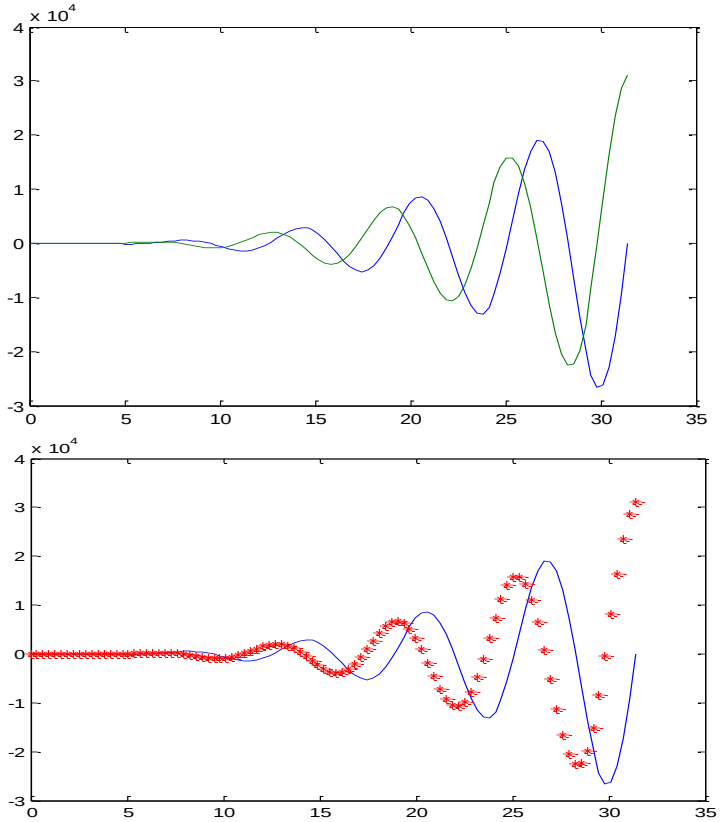


Plot of more than one function: plot(x, fx, y, fy)

اكثر من طريقة لرسم أكثر من دالة

Create an x-array and y-array of 100 samples between 0 and 10π, then we plot in the same figure using the command "**hold on**" the functions f(x) and f(y) using the solid line for the first one and the dotted plot for the second one.

```
>> y=linspace(0,10*pi,100);
>> x=linspace(0,10*pi,100);
>> fx=x.^3.*sin(x);
>> fy=y.^3.*cos(y);
>> plot(x,fx,y,fy)
```

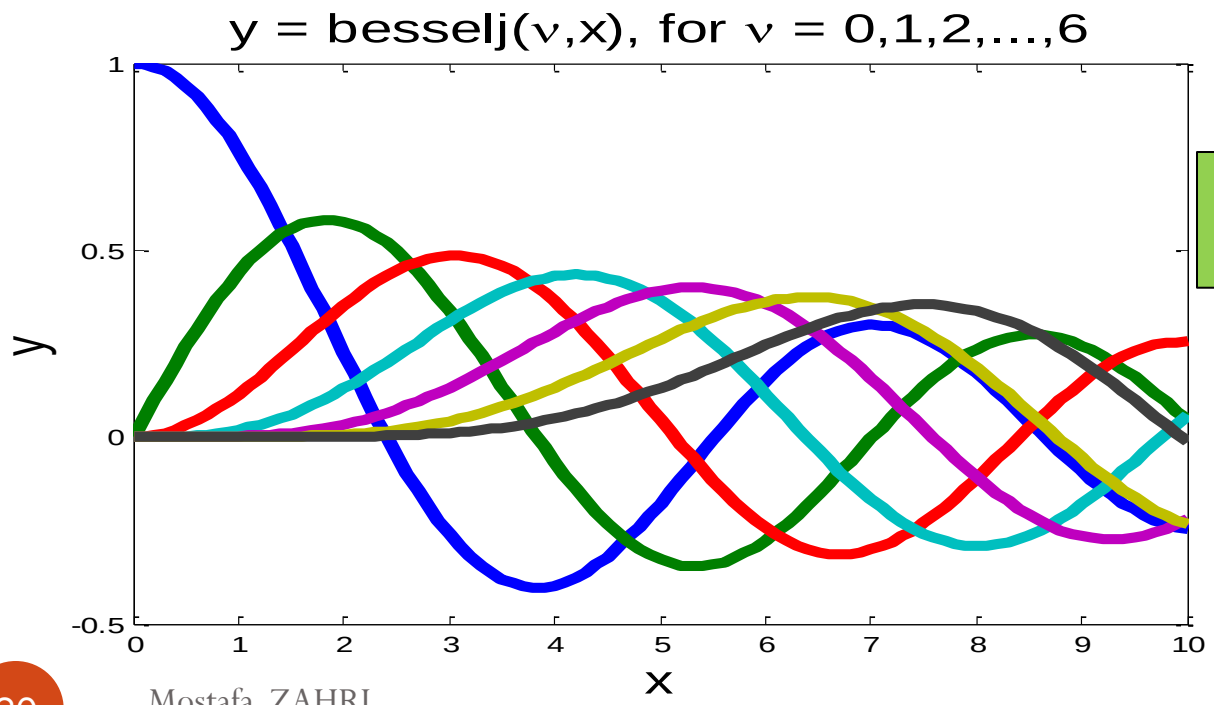



```
plot(x,fx); hold on; plot(y,fy,'r*');
```

Plot of more than one function: Bessel function

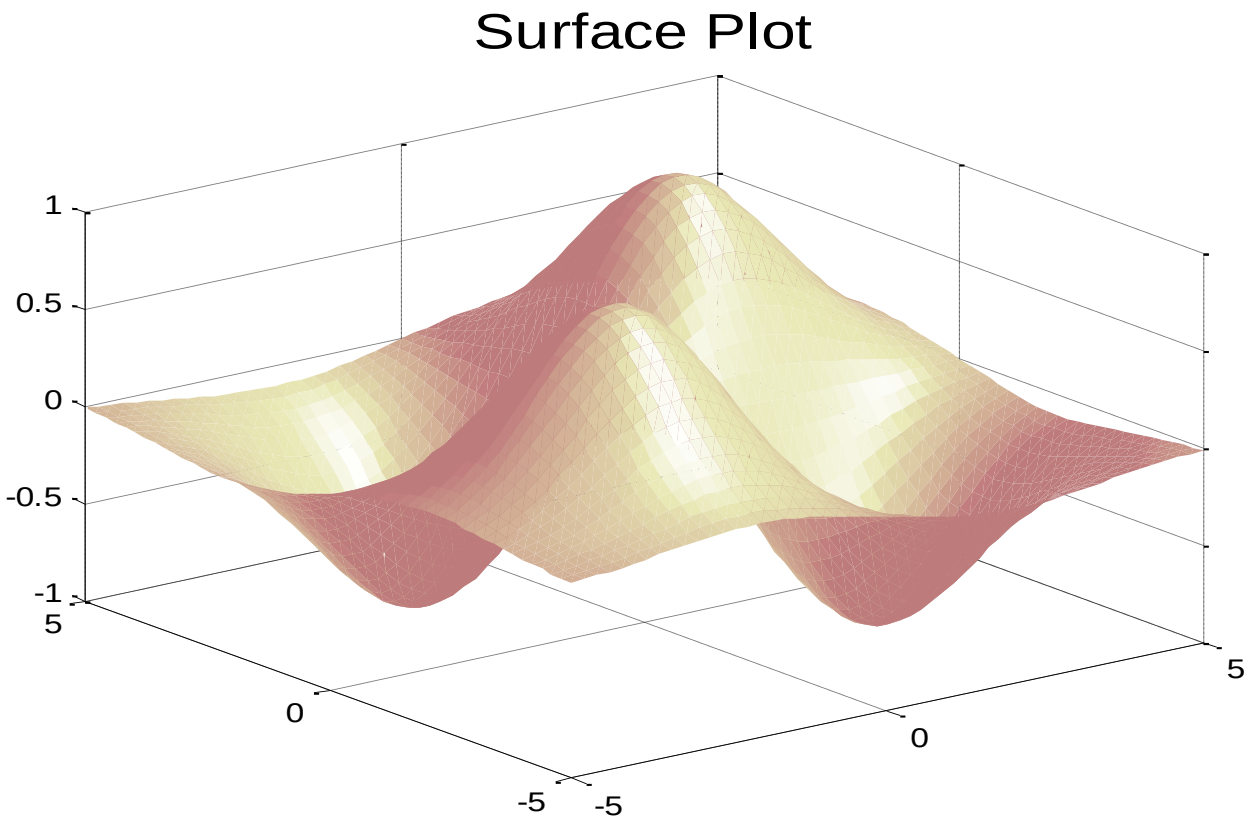
```
x = (0:0.1:10)';
 nu = 0:6;
y = besselj(nu,x); % Bessel function
plot(x,y,'LineWidth',5);
 xlabel('x','FontSize',18); ylabel('y','FontSize',18);
title('y = besselj(\nu,x), for \nu = 0,1,2,...,6','FontSize',18);
```

أكثر من طريقة لرسم أكثر من دالة



بهذه الطريقة يمكن رسم أكثر من دالة بسيل في مبيان واحد

Three dimensional Graphics

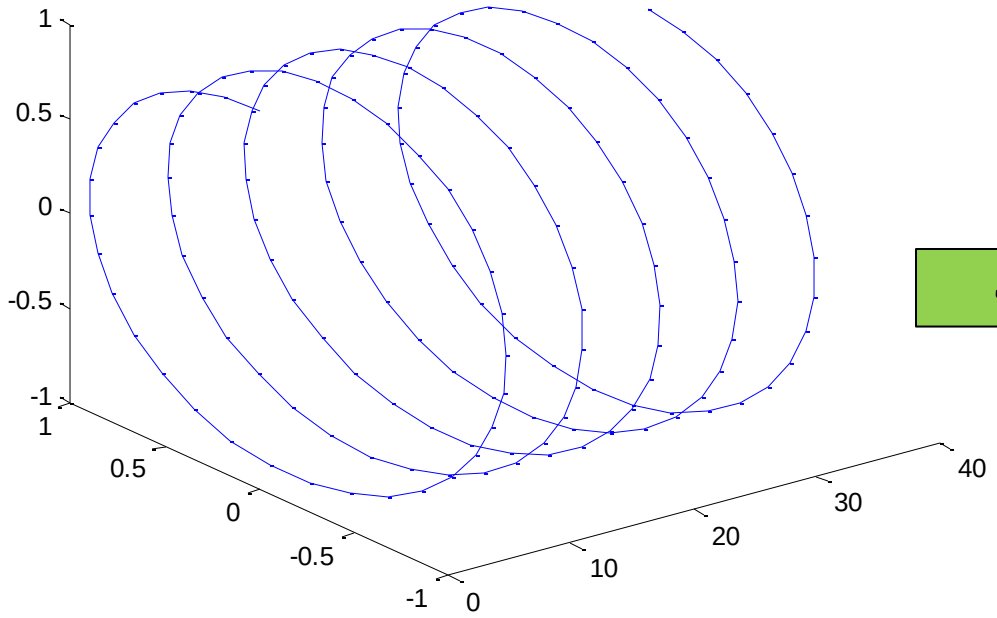


Curve in 3dim space

ادخل الأوامر التالية !!!

```
>> t=(0:0.2:10*pi);
>> x=sin(t);
>> y=cos(t);
>> plot3(t,x,y)
```

>> plot3(t,x,y) is in general used in the form plot3(vector , vector, vector) to draw a three dimensional coordinate system of points. Between these points Matlab interpolates the curve in the three dim space.

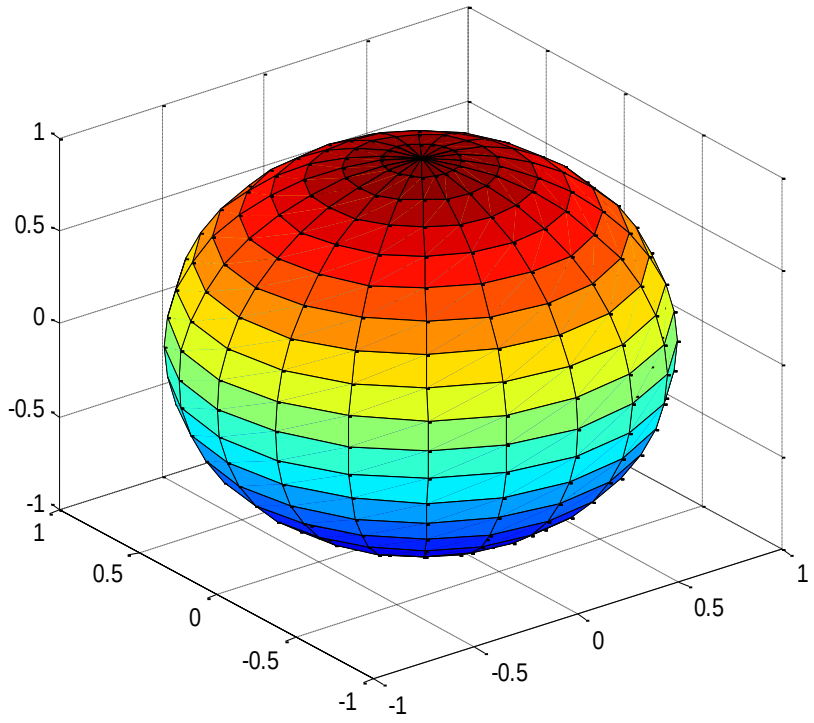


النتيجة هي منحنى ثلاثي الابعاد

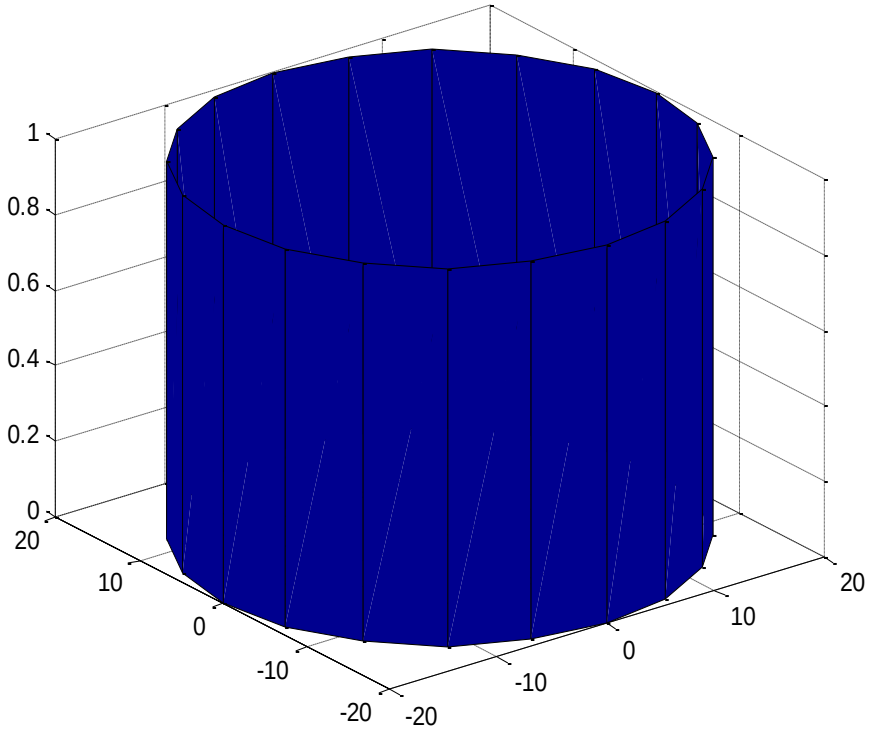
First 3dim surface plot

ادخل الأوامر التالية !!!

>>sphere(20)



>>cylinder(20)



Generating a meshgrid and plot of 3dim function

```
>> [X,Y] = meshgrid(-5:2:5, -5:2:5)
```

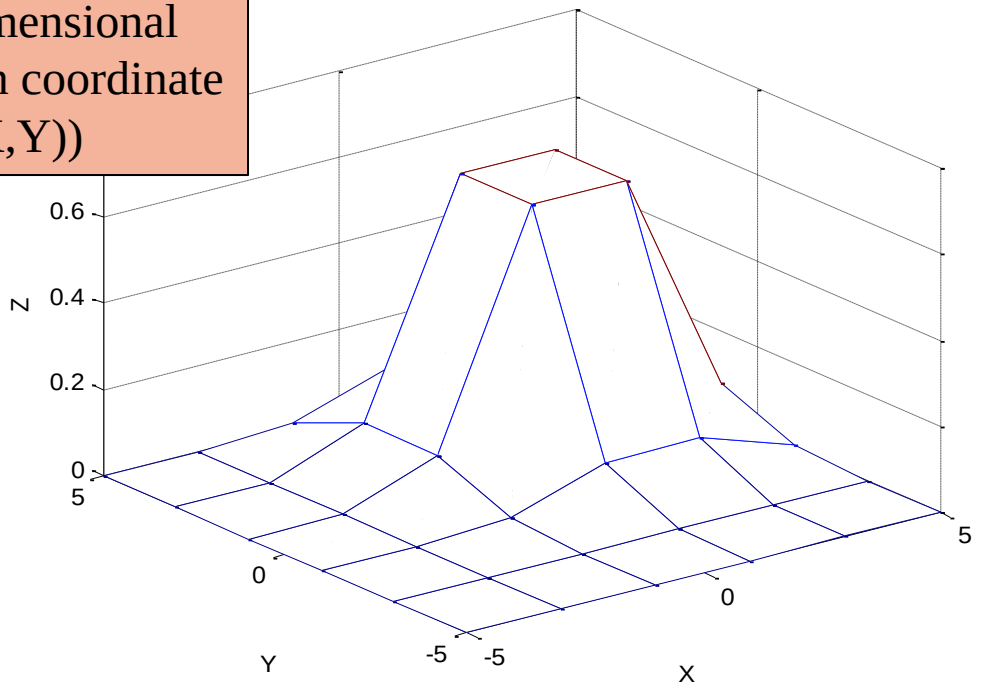
```
X =
    -5    -3    -1     1     3     5
    -5    -3    -1     1     3     5
    -5    -3    -1     1     3     5
    -5    -3    -1     1     3     5
    -5    -3    -1     1     3     5
    -5    -3    -1     1     3     5
Y =
    -5    -5    -5    -5    -5    -5
    -3    -3    -3    -3    -3    -3
    -1    -1    -1    -1    -1    -1
     1     1     1     1     1     1
     3     3     3     3     3     3
     5     5     5     5     5     5
```

```
Z = exp(-((X-2).^2+(Y-2).^2)/4)
```

```
Z =
    0.0111    0.0819    0.0710   -0.0710   -0.0819   -0.0111
    0.0819    0.6035    0.5231   -0.5231   -0.6035   -0.0819
    0.0710    0.5231    0.4535   -0.4535   -0.5231   -0.0710
   -0.0710   -0.5231   -0.4535    0.4535    0.5231    0.0710
   -0.0819   -0.6035   -0.5231    0.5231    0.6035    0.0819
   -0.0111   -0.0819   -0.0710    0.0710    0.0819    0.0111
```

The mesh plot create a three dimensional graph with coordinate (X, Y, F(X,Y))

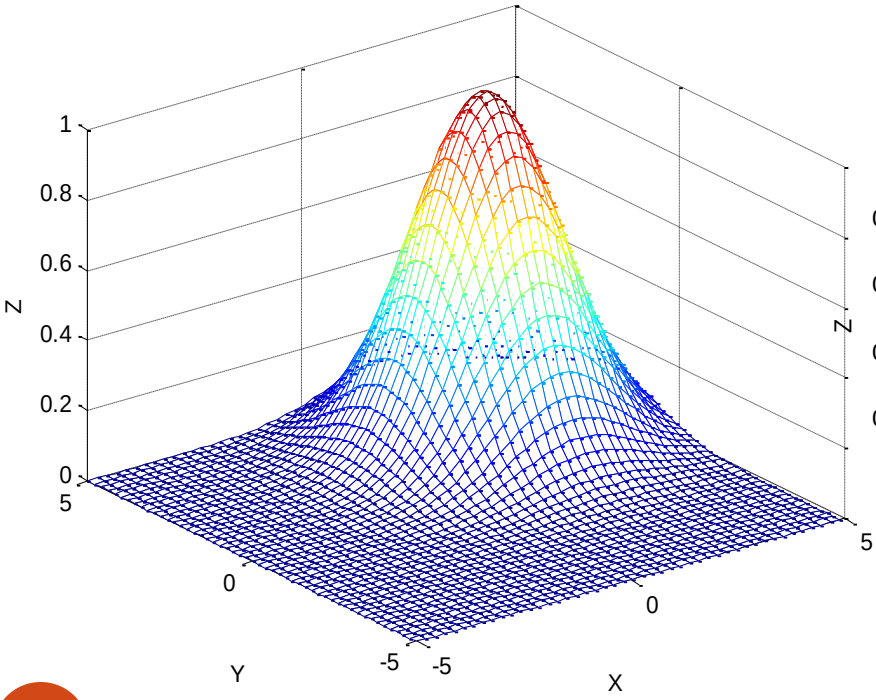
```
>> mesh(X,Y,Z)
>> xlabel('X');ylabel('Y');zlabel('Z');
```

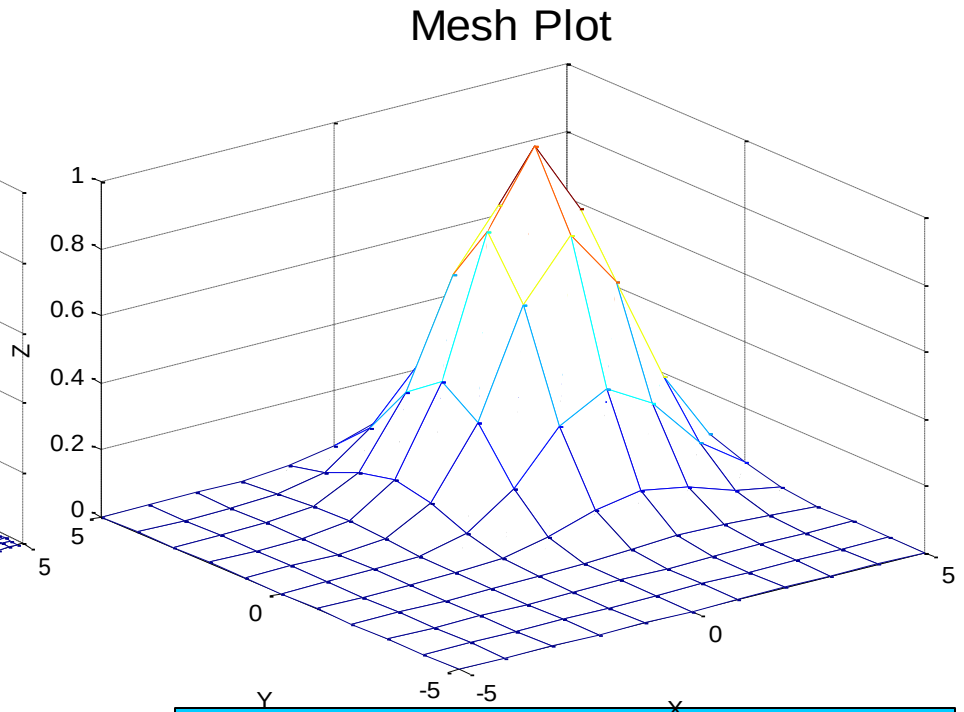


Generating a meshgrid and plot of 3dim function

```
>> [X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);
>>Z = exp(-((X-2).^2+(Y-2).^2)/4);
>>mesh(X,Y,Z);
>> xlabel('X');ylabel('Y');zlabel('Z');
```

نكبر عدد النقاط الشبكة المستعملة حيث عوضا عن 0.2 ناخد 2 ثم الدالة Z ونرسم >>mesh(X,Y,Z);



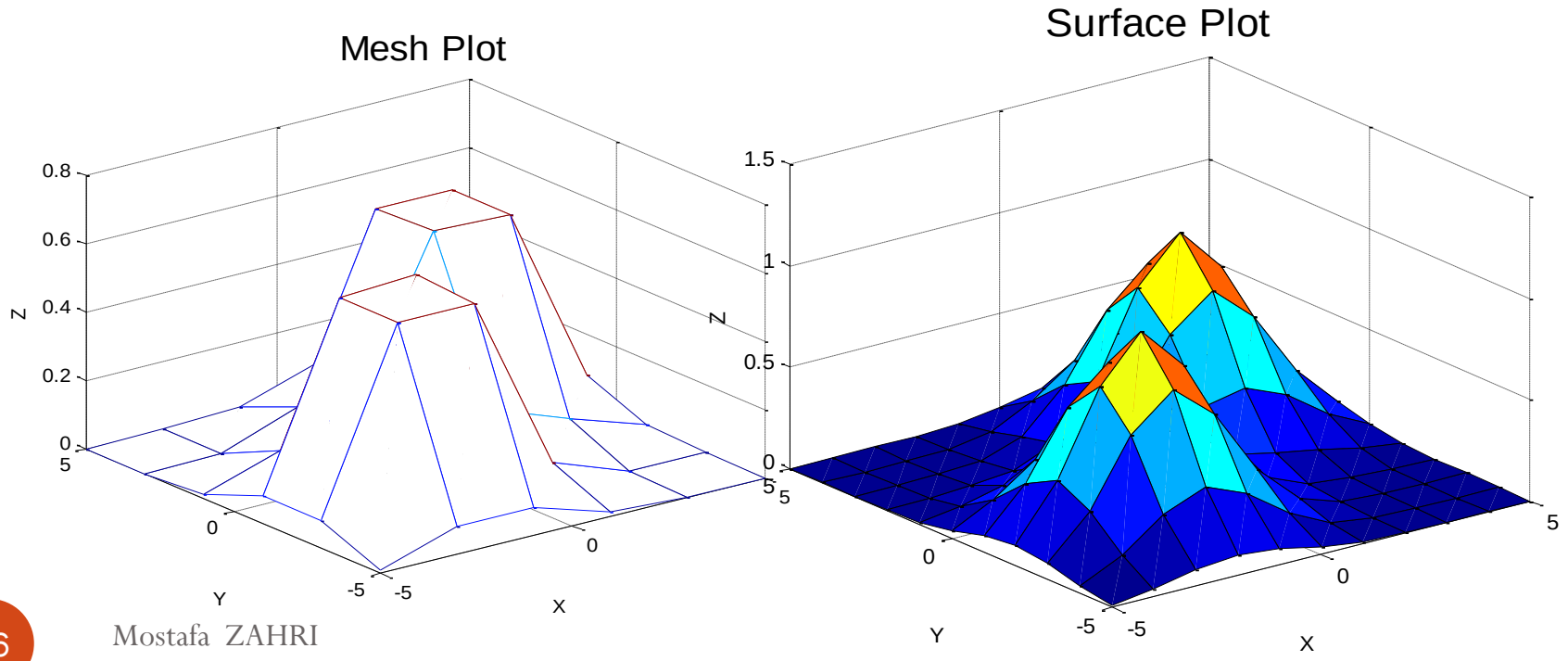



```
>> [X,Y] = meshgrid(-5:1:5, -5:1:50)
```

Surface and Mesh Plot

```
>> [X,Y] = meshgrid(-5:2:5, -5:2:5);
>> Z = exp(-((X-2).^2+(Y-2).^2)/4)+...
        exp(-((X+2).^2+(Y+2).^2)/4);
>> mesh(X,Y,Z);
>> xlabel('X');ylabel('Y');zlabel('Z');
>>title('Mesh Plot');
```

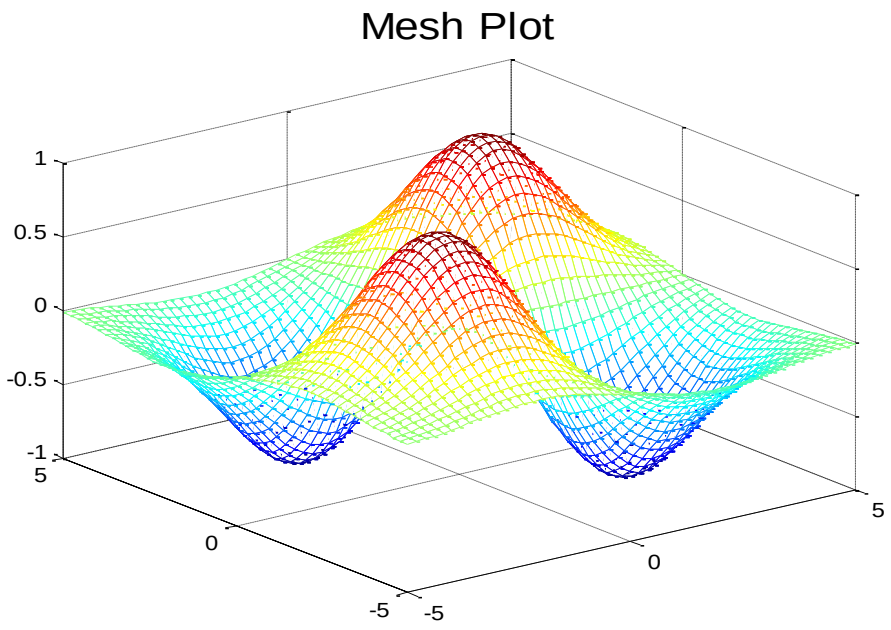
```
>> [X,Y] = meshgrid(-5:1:5, -5:1:5);
>> Z = exp(-((X-2).^2+(Y-2).^2)/4)+...
        exp(-((X+2).^2+(Y+2).^2)/4);
>> surf(X,Y,Z);
>> xlabel('X');ylabel('Y');zlabel('Z');
>>title('Surface Plot');
```

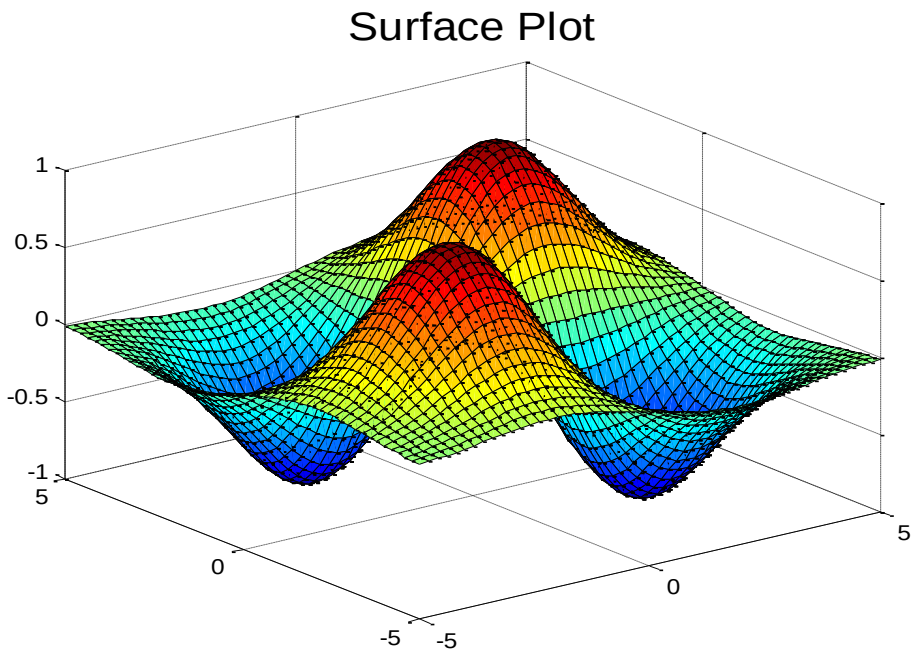


Mesh and Surface Plot

```
[X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);
Z = exp(-((X-2).^2+(Y-2).^2)/4)+...
    exp(-((X+2).^2+(Y+2).^2)/4)-...
    exp(-((X-2).^2+(Y+2).^2)/4)-...
    exp(-((X+2).^2+(Y-2).^2)/4);
mesh(X,Y,Z);grid on;
title('Mesh Plot','Fontsize',18);
```

```
...
mesh(X,Y,Z);grid on;
title('Mesh Plot','Fontsize',18);
```

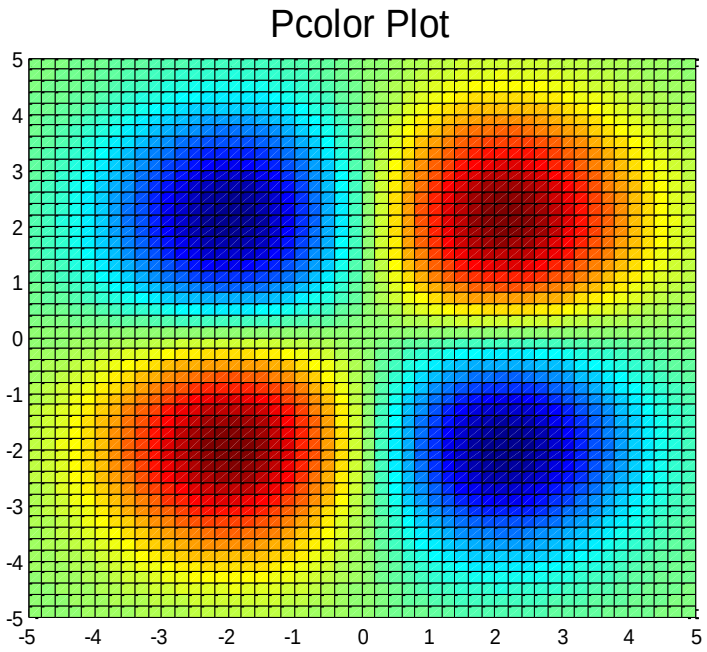




pcolor plot

The use of the pcolor plot command:
pcolor(Matrix,Matrix,Matrix);

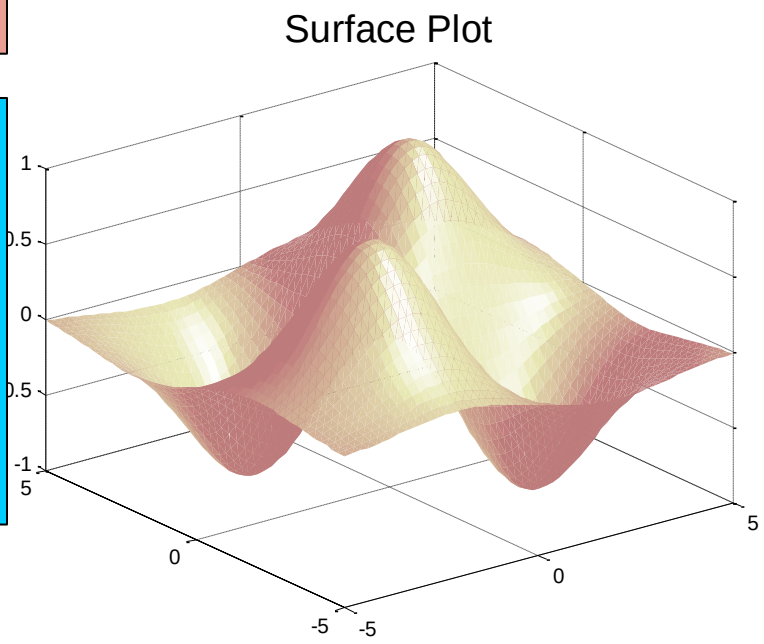
```
[X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);
Z = exp(-((X-2).^2+(Y-2).^2)/4)+…
      exp(-((X+2).^2+(Y+2).^2)/4)-…
      exp(-((X-2).^2+(Y+2).^2)/4)-…
      exp(-((X+2).^2+(Y-2).^2)/4);
pcolor(X,Y,Z);
title('Pcolor Plot','Fontsize',18)
```



Surface plot with shading and colormap

The use of the surfl plot command:
surfl(Matrix,Matrix,Matrix);

```
[X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);
Z = exp(-((X-2).^2+(Y-2).^2)/4)+…
    exp(-((X+2).^2+(Y+2).^2)/4)-…
    exp(-((X-2).^2+(Y+2).^2)/4)-…
    exp(-((X+2).^2+(Y-2).^2)/4);
surfl(X,Y,Z); shading interp; colormap(pink);
title('Surface Plot','Fontsize',18)
```

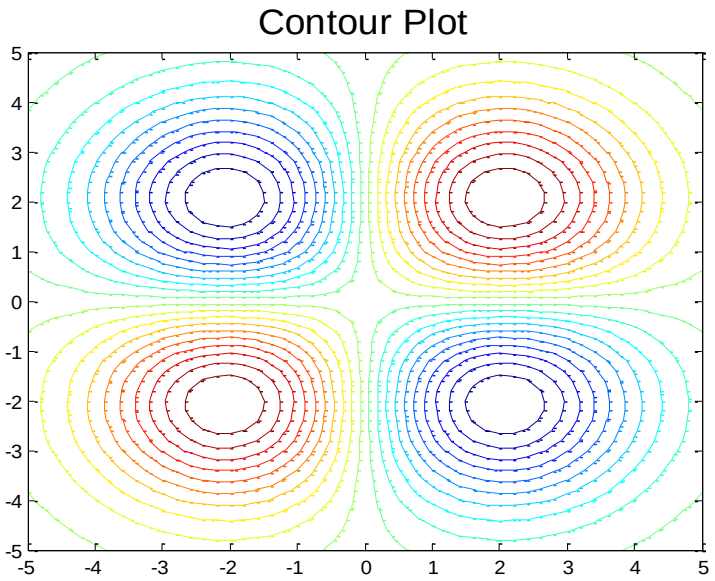


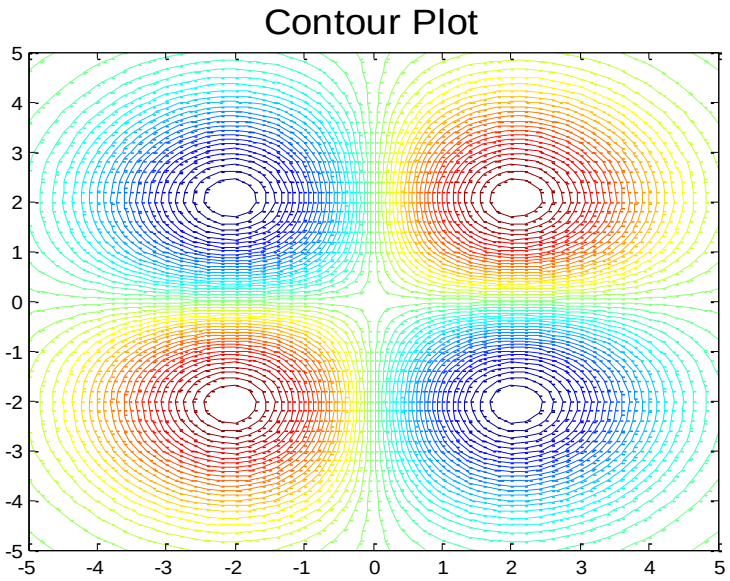
contour plot

The use of the contour plot command:
contour(Matrix,Matrix,Matrix,'NumberOflines');

```
[X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);
Z = exp(-((X-2).^2+(Y-2).^2)/4)+…
    exp(-((X+2).^2+(Y+2).^2)/4)-…
    exp(-((X-2).^2+(Y+2).^2)/4)-…
    exp(-((X+2).^2+(Y-2).^2)/4);

figure(1);contour(X,Y,Z,20);
title('Contour Plot','Fontsize',18);
figure(2);contour(X,Y,Z,50);
title('Contour Plot','Fontsize',18)
```





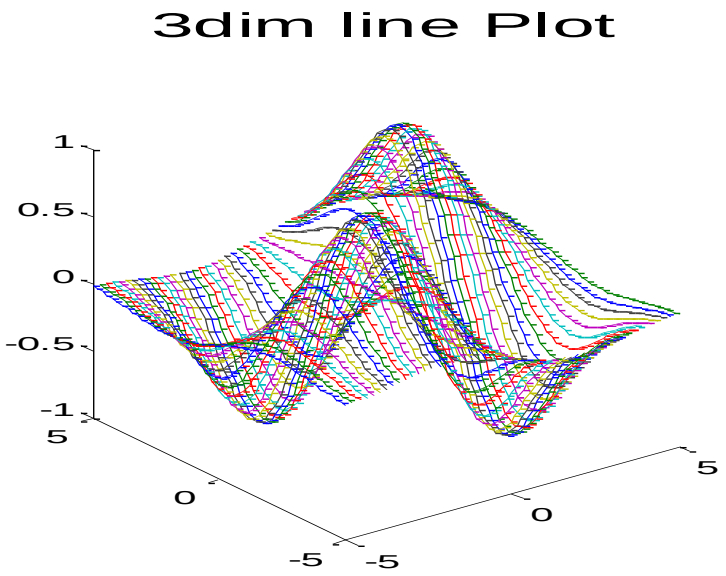
Plot3, plot, three dimensional plot

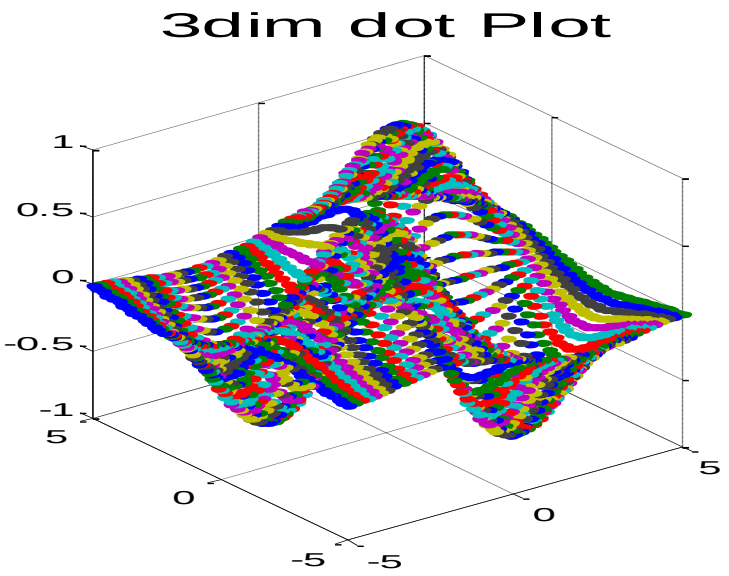
The use of the plot3 plot command:
plot3(Matrix,Matrix,Matrix,'Options');

```
[X,Y] = meshgrid(-5:0.2:5, -5:0.2:5);

Z = exp(-((X-2).^2+(Y-2).^2)/4)+...
      exp(-((X+2).^2+(Y+2).^2)/4)-...
      exp(-((X-2).^2+(Y+2).^2)/4)-...
      exp(-((X+2).^2+(Y-2).^2)/4);
```

```
figure(1);subplot(1,2,1);plot3(X,Y,Z);
grid off;
title('3dim line Plot','Fontsize',18)
figure(1);subplot(1,2,2);plot3(X,Y,Z,'.');
grid on;
title('3dim dot Plot','Fontsize',18)
```





Subplot of a sphere

How to use the command:
subplot(number of rows,number of colums, position of the graph)

```
subplot(2,3,1)
sphere;
axis square;
shading flat;
title('Flat Shading','FontSize',20);
%--------This a comment line --------
subplot(2,3,2)
sphere;
axis square;
shading faceted;
title('Faceted Shading','FontSize',20);
% --------This a comment line --------
subplot(2,3,3)
sphere;
axis square;
shading interp;
title('Interpolated Shading','FontSize',20);
```

```
subplot(2,3,4);
sphere(50);
axis square
shading flat
title('Flat Shading','FontSize',20);
 %--------This a comment line --------
subplot(2,3,5)
sphere(50);
axis square;
shading faceted;
title('Faceted Shading','FontSize',20);
 %--------This a comment line --------
subplot(2,3,6);
sphere(50);
axis square;
shading interp;
title('Interpolated Shading','FontSize',20);
```

Subplot of a sphere

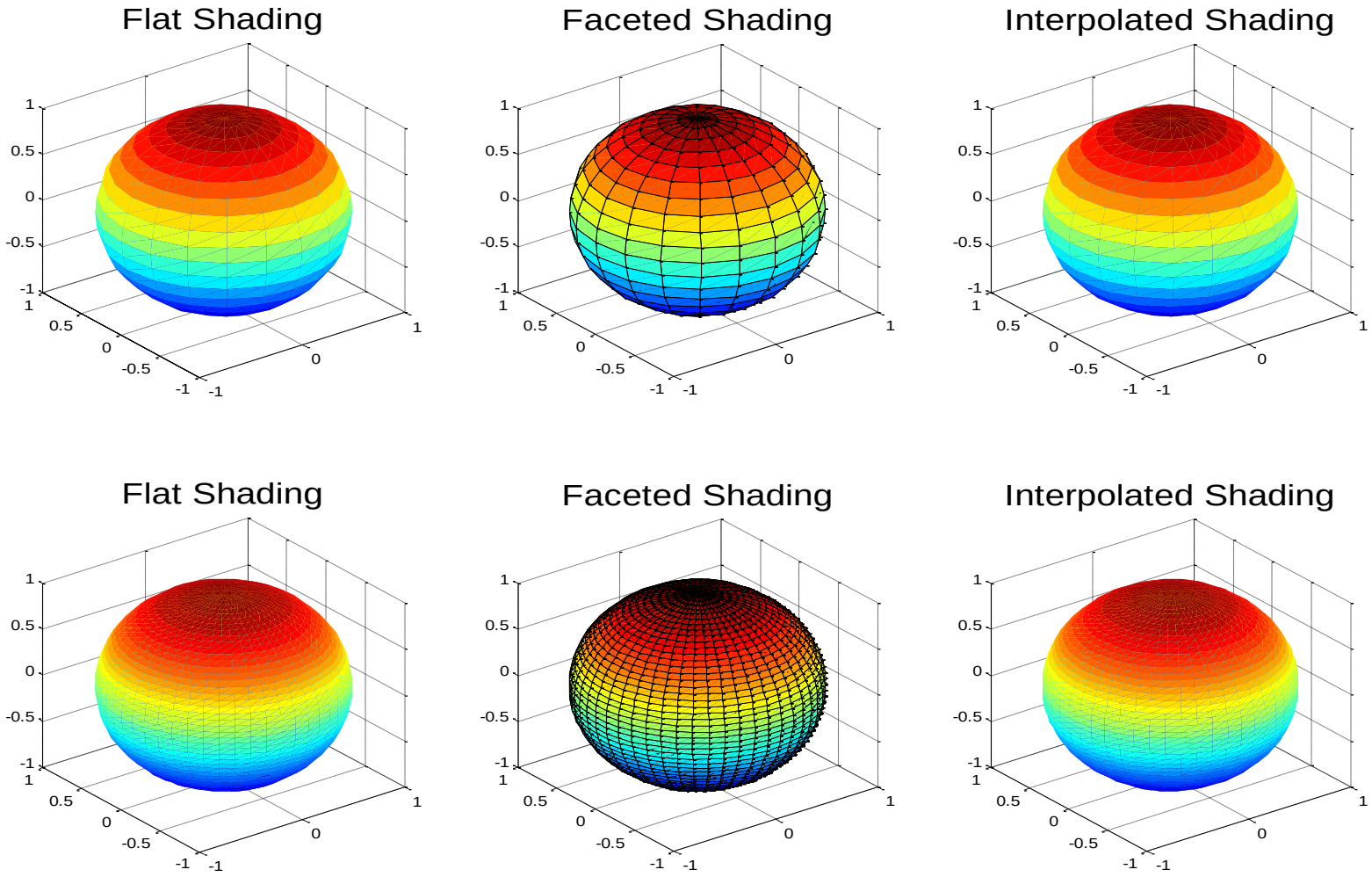


Image Manipulation

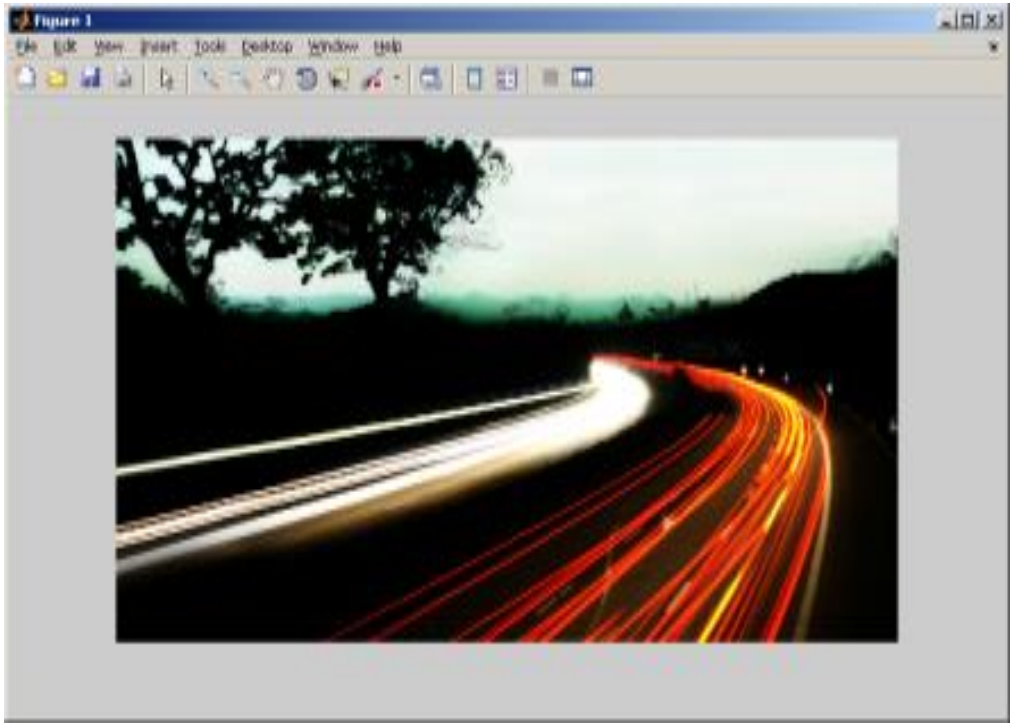


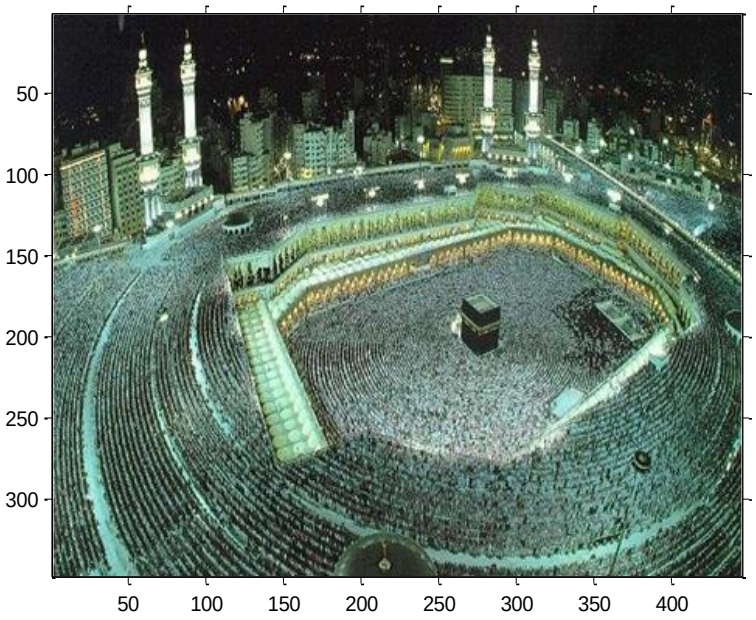
Image Manipulation

To read an image, use the imread command.
Example: read an image file named 'c:\test.jpg' and store it in matrix A.

>>A = imread('haram.jpg');
To display an image, use the following command

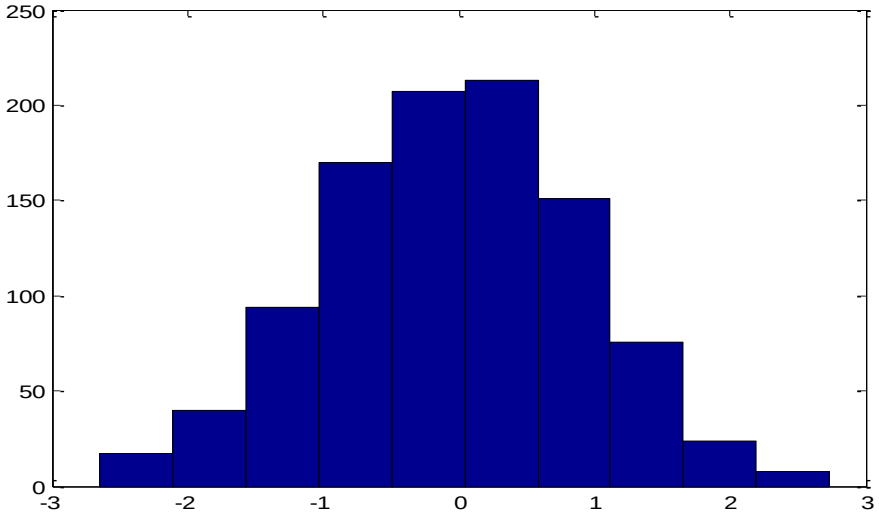
>> imshow(A);

```
>> A = imread('haram1.jpg');
>> imshow(A);
```



النتيجة هي ظهور صورة الحرم المكي على الواجهة الرسومية لماتلاب

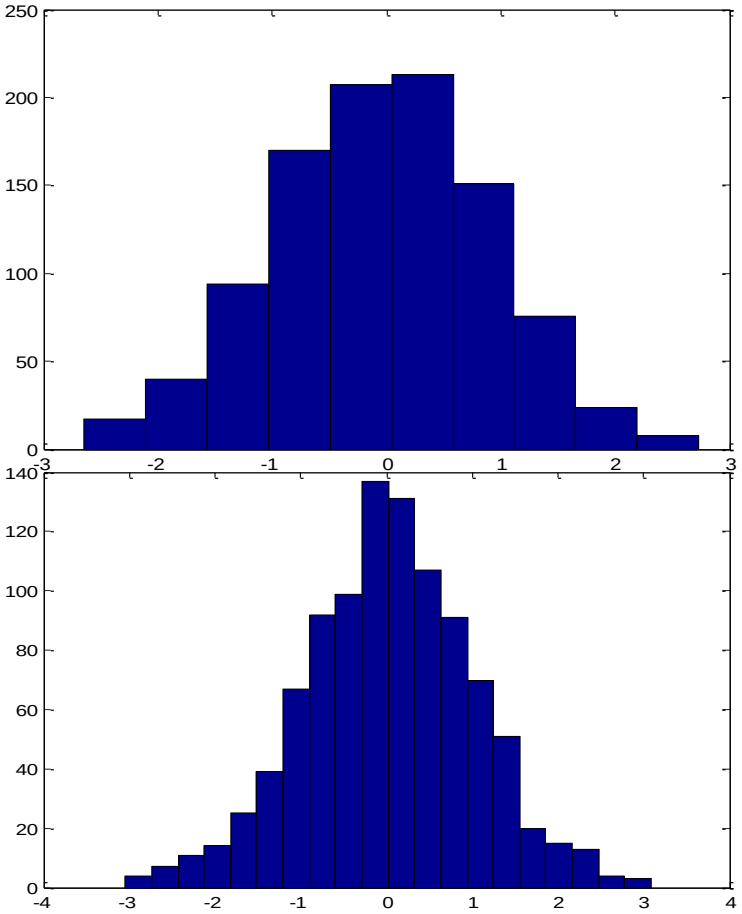
Statistics with Matlab



Histogram

Generate an vector of 1000 normally distributed random Numbers and the hist(y) command draw a Histogram with 10 classes

```
>>y = randn(1000,1);
>>hist(y);
```



hist command draw a Histogram with 20 classes

```
>>y = randn(1000,1);
>>hist(y, 20);
```

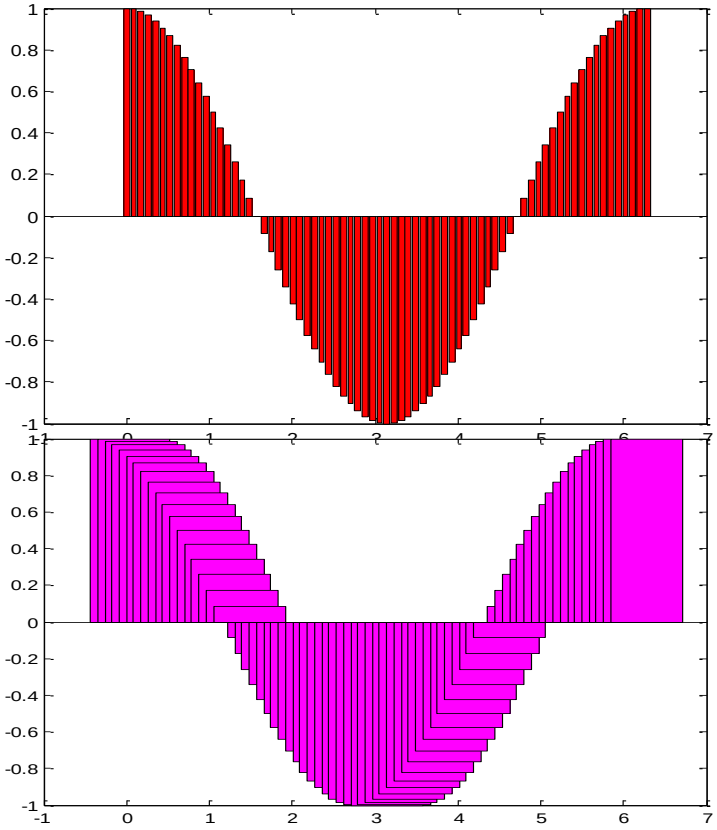
Bar Graphs

The following program is used for Drawing a default Bar Graphs using red color

```
>> x = (0:pi/36:2*pi);
>> y = cos(x);
>> bar(x,y,'r');
```

The following program is used for Drawing a Bar Graphs using megenta color and bar style

```
>> x = (0:pi/36:2*pi);
>> y = cos(x);
>> bar(x,y,10,'m');
```



Learning More : Plotting - General Commands

1. >>figure	1. creates a new figure window
2. >>subplot	2. defines multiple plots on a single page
3. >>title	3. defines plot title text
4. >>xlabel	4. x axes label text
5. >>ylabel,zlabel	5. y or z axes label text
6. >>text	6. puts text at specified coordinates
7. >>axis	7. defines the axis limits
8. >>colorbar	8. creates a colorbar
9. >>shading	9. defines type of shading (faceted, flat, interp)
10.>>set	10. use to define properties of the axis or figure
11.>>gca	11. returns handle to current plot axis
12.>>gcf	12. returns handle to current figure

Learning More 2: D Graphics Functions

1. >> plot	1. linear plot of lines, points or symbols
2. >> fill	2. filled 2D polygons
3. >> loglog	3. log-log scale plot
4. >> semilogx	4. log (x-axis) - linear (y-axis) plot
5. >> semilogy	5. log (y-axis) - linear (x-axis) plot
6. >> bar	6. bar plot
7. >> errorbar	7. Linear plot with error bars
8. >> fplot	8. Function plot
9. >> hist	9. histogram
10.>> polar	10. polar coordinate plot
11.>> rose	11. angular histogram plot
12.>> stairs	12. stairstep plot

Learning More: More 3D Graphics Functions

```
1. >> plot3
2. >> fill3
3. >> contour,contour3
4. >> pcolor
5. >> quiver, quiver3
6. >> stream, stream3
7. >> mesh, meshc, meshz

8. >> surf, surfc, surfl
9. >> surfnorm
10.>> cylinder, sphere
```

1. Plot lines and points in 3D space
2. Filled 3D polygons in 3D space
3. contour data in 2D or 3D space
4. checkerboard color plot in 2D
5. vector plot in 2D or 3D
6. Stream lines in 2D or 3D
7. Mesh surface in 3D, with contours or zero plane.
8. Shaded surface in 3D
9. Display surface normal vectors.
10. Generate a cylinder or sphere.

Learning More: Help

Remember the help command

MATLAB help pages:

- describe how to use functions and gives examples
- provides theory behind more complex functions

Getting Started

- MATLAB Functions Listed by Category
- MATLAB Functions Listed Alphabetically

MATLAB Reference Guide, User's Guide

Thanks