7.3- Setting Axis Visibility:

You can use the axis command to make the axis visible or invisible.

```
axis on
```

makes the axis visible. This is the default.

```
axis off
```

makes the axis invisible.

7.4- Setting Grid Lines:

The grid command toggles grid lines on and off. The statement

```
grid on
```

turns the grid lines on and

```
grid off
```

turns them back off again.

8- Multiple Plots in One Figure

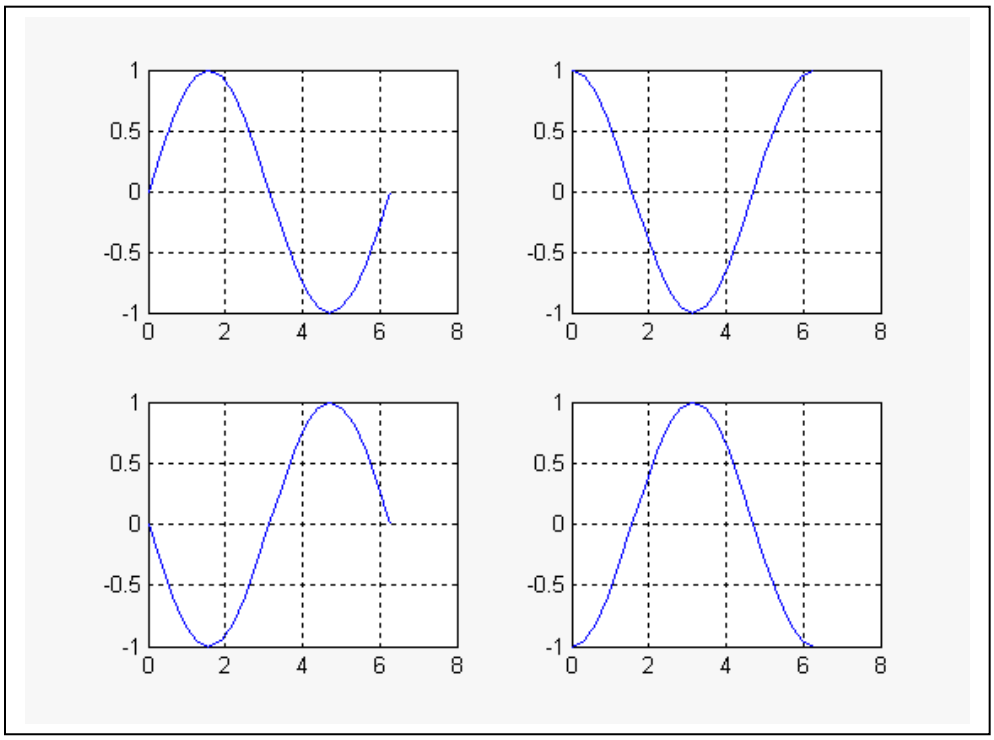
The subplot command enables you to display multiple plots in the same window or print them on the same piece of paper. Typing

```
subplot(m,n,p)
```

partitions the figure window into an m-by-n matrix of small subplots and selects the pth subplot for the current plot. The plots are numbered along first the top row of the figure window, then the second row, and so on. For example, these statements plot data in four different subregions of the figure window.

```
t = 0:pi/10:2*pi;
subplot(2,2,1),plot(t,sin(t)),grid
subplot(2,2,2),plot(t,cos(t)),grid
```

```
subplot(2,2,3),plot(t,sin(t+pi)),grid
subplot(2,2,4),plot(t,cos(t+pi)),grid
```



9- 3-D Plots

MATLAB has a variety of functions for displaying and visualizing data in 3-D, either as lines in 3-D (plot3 function), or as a wire frame (mesh function) and surfaces (surf function). This section provides a brief overview.

9.1- plot3 function:

The function plot3 is the 3-D version of plot. The command

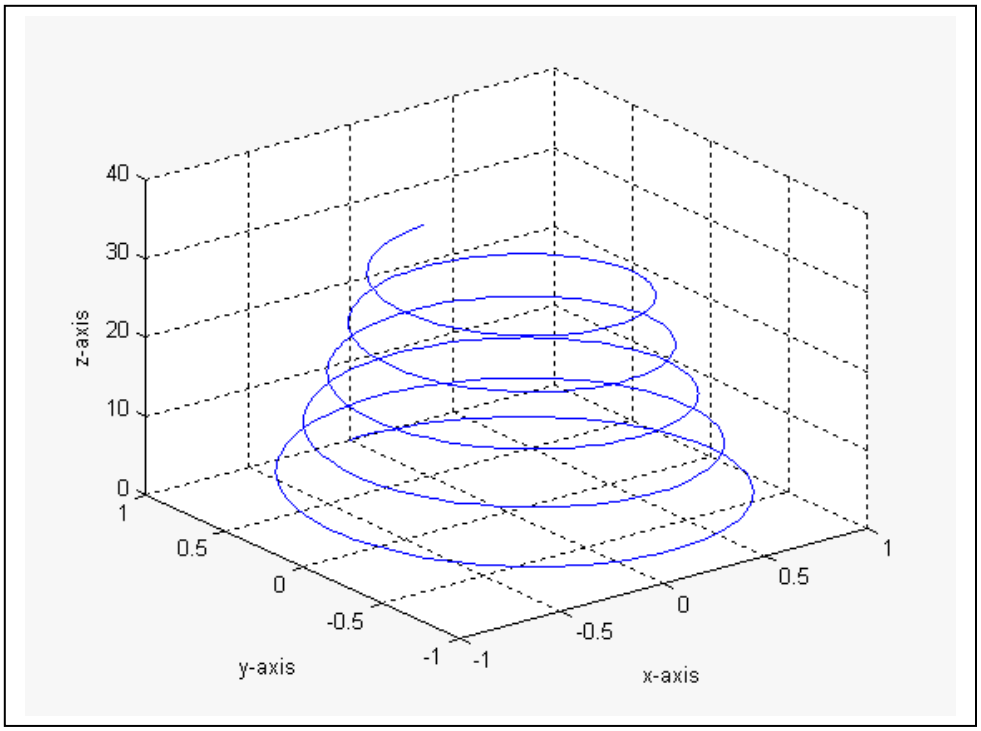
plot3 (x, y, z)

draws 2-D projection of a line in 3-D through the points whose coordinates are the elements of the vectors x, y, and z.

For example:

```
t = 0 : pi/50 : 10*pi ;
plot3 (exp(-0.02*t).* sin(t) , exp(-0.02*t).* cos(t) , t), …
xlabel ('x-axis'),ylabel ('y-axis') , zlabel ('z-axis') , grid
```

produce the inwardly spiraling helix shown below:



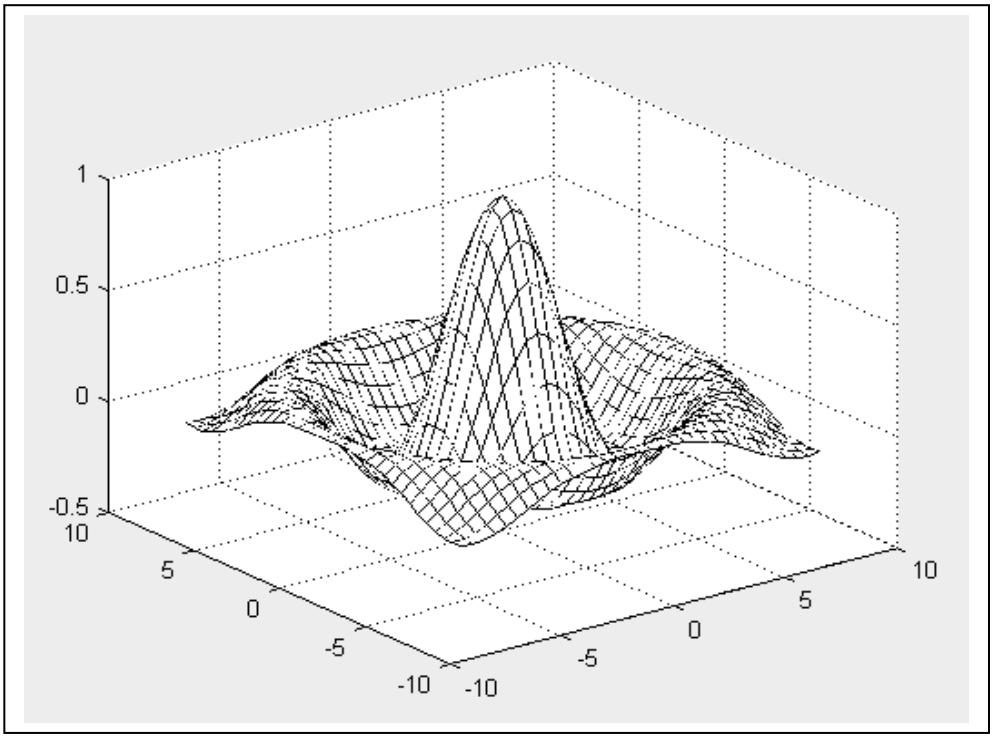
9.2- Visualizing functions of two variables (mesh function):

mesh function enable you to plot a 3-D mesh surface. The instruction mesh(z) displays a function of two variables, $z = f(x,y)$ after generating X and Y matrices consisting of repeated rows and columns, respectively, over the domain of the function.

The meshgrid function transforms the domain specified by a single vector or two vectors x and y into matrices X and Y for use in evaluating functions of two variables. The rows of X are copies of the vector x and the columns of Y are copies of the vector y.

The following example evaluates and graphs the two-dimensional sinc function, sin(r)/r, between the x and y directions. R is the distance from origin, which is at the center of the matrix. Adding eps (a MATLAB command that returns the smallest floating-point number on your system) avoids the indeterminate 0/0 at the origin.

```
[X,Y] = meshgrid(-8:0.5:8, -8:0.5:8);
R = sqrt(X.^2 + Y.^2) + eps;
Z = sin(R)./R;
mesh(Z)
```

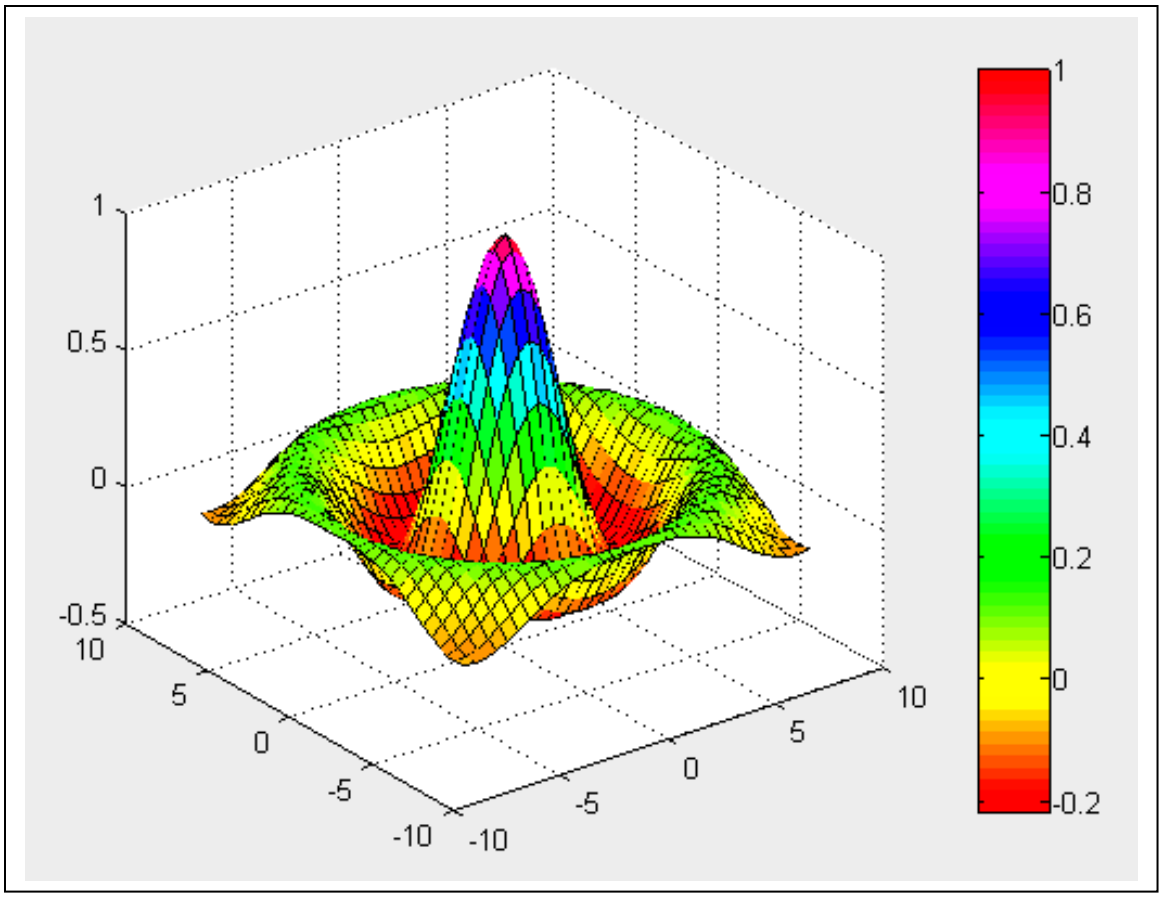


9.3- Colored Surface Plots (surf function):

A surface plot is similar to a mesh plot except the rectangular faces of the surface are colored. The color of the faces is determined by the values of Z and the colormap (a colormap is an ordered list of colors). These statements graph the sinc function as a surface plot, select a colormap, and add a color bar to show the mapping of data to color.

```
[X,Y] = meshgrid(-8:0.5:8, -8:0.5:8);
R = sqrt(X.^2 + Y.^2) + eps;
Z = sin(R)./R;
surf(X,Y,Z)
```

colormap hsv
colorbar



Exercises:

1. Plot the following functions. Grid the plots, label the axis, and put a suitable title on the graphs.

a) y = tan(x) **$-3\pi/2 \le x \le 3\pi/2$** **step $\pi/100$.**
b) y = sinc(x) **$-4\pi \le x \le 4\pi$** **step $\pi/20$.**
c) y = e^x **$0 \le x \le 4$** **step 0.1.**
d) y = $\sin^{-1}(x)$ **$-\pi/2 \le x \le \pi/2$** **step $\pi/10$.**

2. Split the plotting window into four windows and place the plots you obtained in question-1 on each window.
3. Plot the inverse hyperbolic sine function and the inverse hyperbolic cosine function in the same graph (ranges from -10π to 10π in steps of π/10). Use a red dashed line for the first function and yellow plus line for the second function.
4. plot the below function in the range 0 to 3π in steps of π/20.

$$y(x) = \begin{cases} \sin(x) & \sin(x) \geq 0 \\ 0 & \sin(x) \leq 0 \end{cases}$$

5. Generate 10 normally distributed random points in 3-D space, and join them with lines in one 3-D graph.
6. Plot the surface $\mathbf{z = x^2 + y^2}$ with a finer mesh (of 0.25 units in each direction),using

   [x,y] = meshgrid (0:0.25:5 , 0:0.25:5).

7. The initial heat distribution over a steel plate is given by the function:

$$u(x, y) = 80 y^2 e^{-x^2 - 0.3y^2}$$

   Plot the surface ***u*** over the grid defined by:

$$-2.1 \leq x \leq 2.1 \ , \ -6 \leq y \leq 6$$

   where the grid width is 0.15 in both directions.

10- MATLAB Commands Review

axis Sets the axis limits for both 2-D and 3-D plots. Axis supports the arguments equal and square, which makes the current graphs aspect ratio 1.

contour Plots contour lines of a surface.

clear Clears all variables from the workspace.

clf Clears figure.

for Runs a sequence of commands a given number of times.

getframe Returns the pixel image of a movie frame.

help Online help.

hold on(off) Holds the plot axis with existing graphics on, so that multiple figures can be plotted on the same graph (release the hold of the axes).

if Conditional evaluation.

length Gives the length of an array.

load Loads data or variable values from previous sessions into current MATLAB session.

linspace Generates an array with a specified number of points between two values.

meshgrid Makes a 2-D array of coordinate squares suitable for plotting surface meshes.

mesh Plots a mesh surface of a surface stored in a matrix.

meshc The same as mesh, but also plots in the same figure the contour plot.

min Finds the smallest element of an array.

max Finds the largest element of an array.

mean Finds the mean of the elements of an array.

moviein Creates the matrix that contains the frames of an animation.

movie Plays the movie described by a matrix M.

orient Orients the current graph to your needs.

plot Plots points or pairs of arrays on a 2-D graph.

plot3 Plots points or array triples on a 3-D graph.

polar Plots a polar plot on a polar grid.

pol2cart Polar to Cartesian conversion.

print Prints a figure to the default printer.

quit or **exit** Leave MATLAB program.

rand Generates an array with elements randomly chosen from the uniform distribution over the interval [0, 1].

randn Generates an array with elements randomly chosen from the normal distribution function with zero mean and standard deviation 1.

subplot Partitions the graphics window into sub-windows.

save Saves MATLAB variables.

std Finds the standard deviation of the elements of an array.

stem Plots the data sequence as stems from the *x*-axis terminated with circles for the data value.

view Views 3-D graphics from different perspectives.

who Lists all variables in the workspace.

xlabel, ylabel, zlabel, title Labels the appropriate axes with text and title.

(x>=x1) Boolean function that is equal to 1 when the condition inside the arenthesis is satisfied, and zero otherwise.