Lab Manual 5

Basic Plotting

Course Objective: understand the basic features and commands of MATLAB

Part A: Theory

`plot(x,y)`	plots y versus x with a solid line (the default line style),
`plot(x,y,'--')`	plots y versus x with a dashed line (more on this below), and
`plot(x)`	plots the elements of x against their row index.

Color Style-option		Line Style-option		Marker Style-option	
y	yellow	-	solid	+	plus sign
m	magenta	--	dashed	o	circle
c	cyan	:	dotted	*	asterisk
r	red	-.	dash-dot	x	x-mark
g	green	none	no line	.	point
b	blue			^	up triangle
w	white			s	square
k	black			d	diamond, etc.

Examples:

`plot(x,y,'r')`	plots y versus x with a red solid line,
`plot(x,y,':')`	plots y versus x with a dotted line,
`plot(x,y,'b--')`	plots y versus x with a blue dashed line, and
`plot(x,y,'+')`	plots y versus x as unconnected points marked by +.

When no style-option is specified, MATLAB uses a blue solid line by default.

Plots may be annotated with `xlabel`, `ylabel`, `title`, and `text` commands.

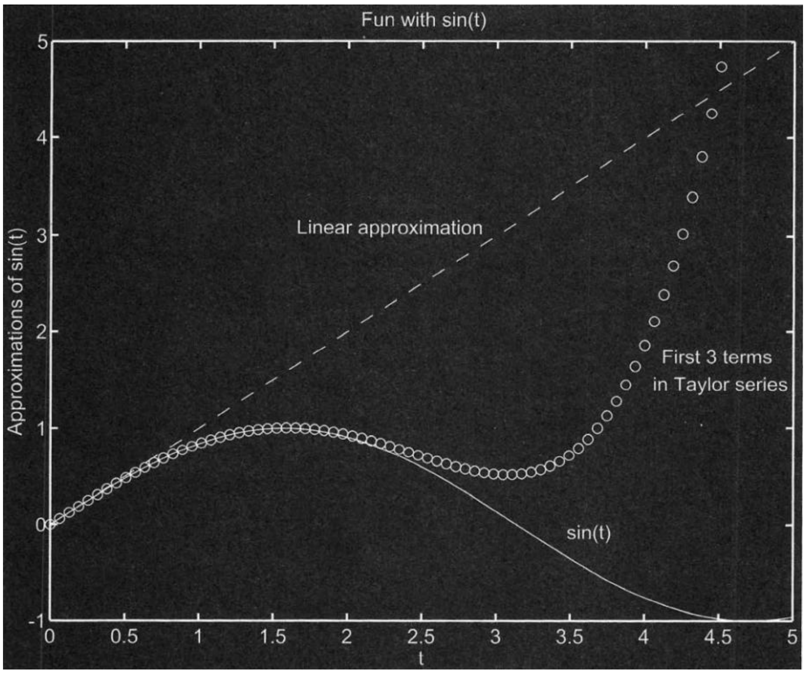
The first three commands take string arguments, whereas the last one requires three arguments—`text`(*x-coordinate, y-coordinate, 'text'*), where the coordinate values are taken from the current plot. Thus,

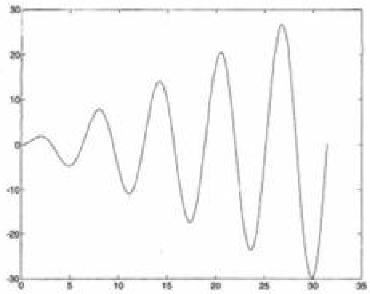
`xlabel('Pipe Length')`	labels the x-axis with `Pipe Length`,
`ylabel('Fluid Pressure')`	labels the y-axis with `Fluid Pressure`,
`title('Pressure Variation')`	titles the plot with `Pressure Variation`, and
`text(2,6,'Note this dip')`	writes "`Note this dip`" at the location (2.0,6.0) in the plot coordinates.

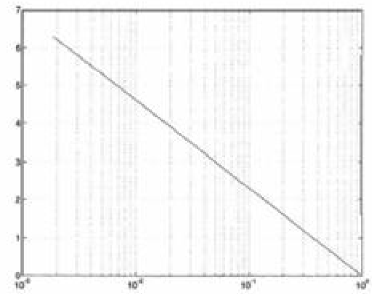
Part B: Practical

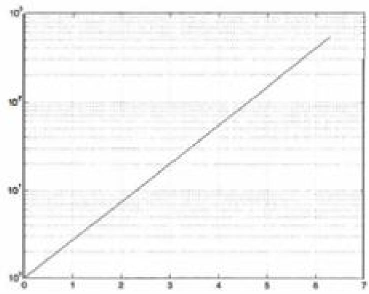
```
>> t=linspace(0,2*pi,100);                % Generate vector t
>> y1=sin(t);  y2=t;                      % Calculate y1, y2, y3
>> y3=t-(t.^3)/6+(t.^5)/120;
>> plot(t,y1,t,y2,'--',t,y3,'o')          % Plot (t,y1) with solid line
                                          %- (t,y2) with dashed line and
                                          %- (t,y3) with circles
>> axis([0 5 -1 5])                       % Zoom in with new axis limits
>> xlabel('t')                            % Put x-label
>> ylabel('Approximations of sin(t)')     % Put y-label
>> title('Fun with sin(t)')               % Put title
>> text(3.5,0,'sin(t)')                   % Write 'sin(t)' at point (3.5,0)
>> gtext('Linear approximation')
>> gtext('First 3 terms')
>> gtext('in Taylor series')
```

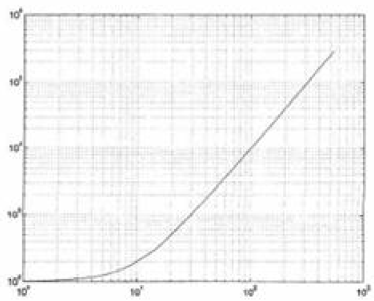
`gtext` writes the specified string at a location clicked with the mouse in the graphics window. So after hitting return at the end of `gtext` command, go to the graphics window and click a location.

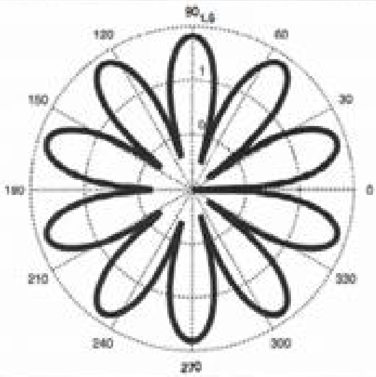


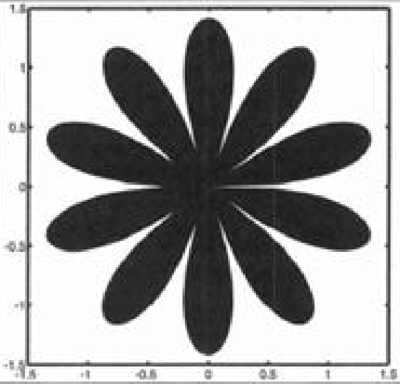
`fplot`	$f(t) = t \sin t, \;\; 0 \le t \le 10\pi$ `fplot('x.*sin(x)',[0 10*pi])` Note that the function to be plotted must be written as a function of x.	

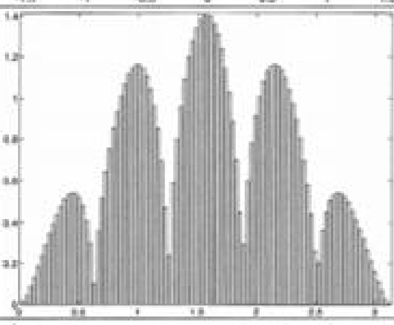
`semilogx`	$x = e^{-t}, \;\; y = t, \; 0 \le t \le 2\pi$
	`t = linspace(0,2*pi,200);`
	`x = exp(-t); y = t;`
	`semilogx(x,y), grid`
		

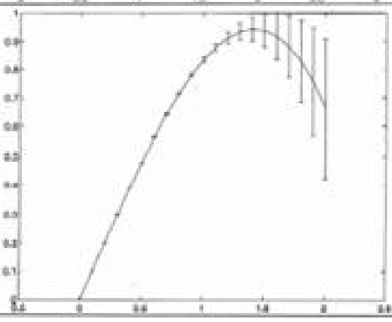
`semilogy`	$x = t, \; y = e^{t}, \;\; 0 \le t \le 2\pi$
	`t = linspace(0,2*pi,200);`
	`semilogy(t,exp(t))`
	`grid`
		

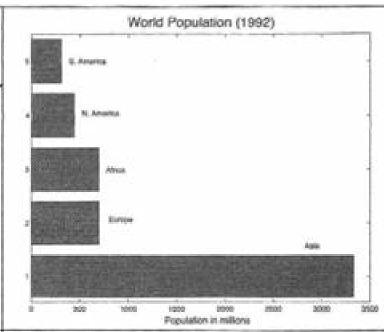
`loglog`	$x = e^{t}, \; y = 100 + e^{2t}, \;\; 0 \le t \le 2\pi$
	`t = linspace(0,2*pi,200);`
	`x = exp(t);`
	`y = 100 + exp(2*t);`
	`loglog(x,y), grid`
		

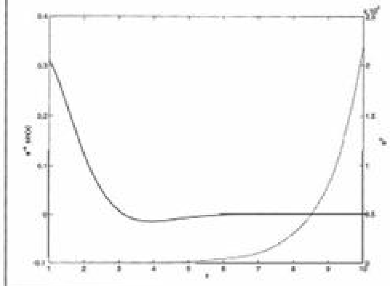
`polar`	$r^2 = 2\sin 5t,\ \ 0 \le t \le 2\pi$
	`t = linspace(0,2*pi,200);`
	`r = sqrt(abs(2*sin(5*t)));`
	`polar(t,r)`
		

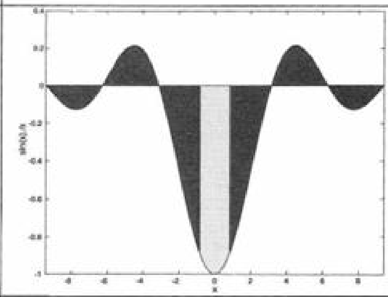
`fill`	$r^2 = 2\sin 5t,\ \ 0 \le t \le 2\pi$
	$x = r\cos t,\ \ y = r\sin t$
	`t = linspace(0,2*pi,200);`
	`r = sqrt(abs(2*sin(5*t)));`
	`x = r.*cos(t);`
	`y = r.*sin(t);`
	`fill(x,y,'k'),`
	`axis('square')`
		

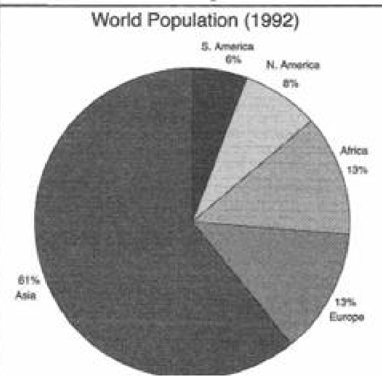
`bar`	$r^2 = 2\sin 5t,\ \ 0 \le t \le 2\pi$
	$y = r\sin t$
	`t = linspace(0,2*pi,200);`
	`r = sqrt(abs(2*sin(5*t)));`
	`y = r.*sin(t);`
	`bar(t,y)`
	`axis([0 pi 0 inf]);`
		

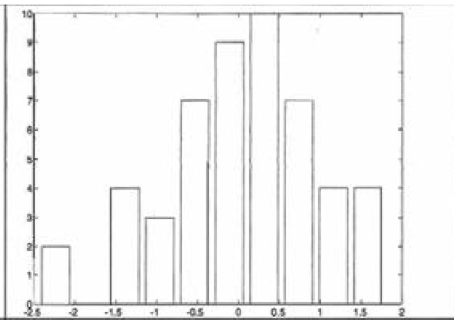
`errorbar`	$f_{\text{approx}} = x - \frac{x^3}{3!},\ \ 0 \le x \le 2$
	$error = f_{\text{approx}} - \sin x$
	`x = 0:.1:2;`
	`aprx2 = x - x.^3/6;`
	`er = aprx2 - sin(x);`
	`errorbar(x,aprx2,er)`
		

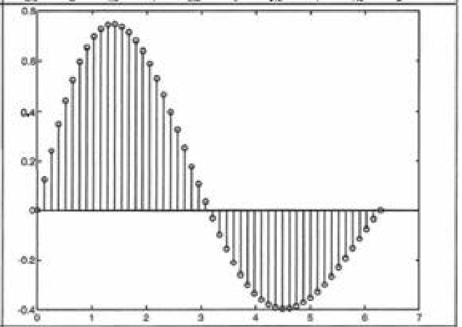
`barh`	World population by continents.
	`cont = char('Asia','Europe','Africa',...`
	`'N. America','S. America');`
	`pop = [3332;696;694;437;307];`
	`barh(pop)`
	`for i=1:5,`
	`gtext(cont(i,:));`
	`end`
	`xlabel('Population in millions')`
	`Title('World Population (1992)',`
	`'fontsize',18)`
		

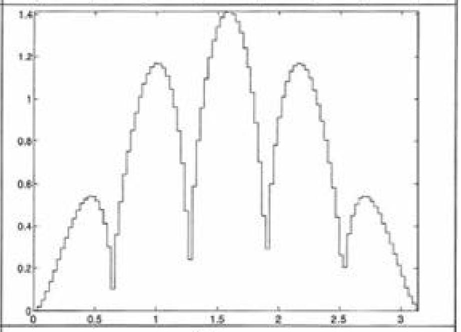
`plotyy`	$y_1 = e^{-x}\sin x,\ 0 \le t \le 10$
	$y_2 = e^x$
	`x = 1:.1:10;`
	`y1 = exp(-x).*sin(x);`
	`y2 = exp(x);`
	`Ax = plotyy(x,y1,x,y2);`
	`hy1 = get(Ax(1),'ylabel');`
	`hy2 = get(Ax(2),'ylabel');`
	`set(hy1,'string','e^-x sin(x)');`
	`set(hy2,'string','e^x ');`
		

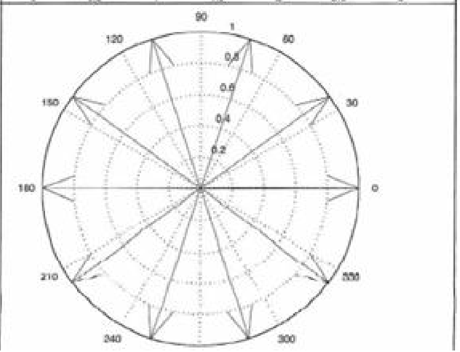
`area`	$y = \frac{\sin(x)}{x},\ -3\pi \le x \le 3\pi$
	`x = linspace(-3*pi,3*pi,100);`
	`y = -sin(x)./x;`
	`area(x,y)`
	`xlabel('x'), ylabel('sin(x)./x')`
	`hold on`
	`x1 = x(46:55); y1 = y(46:55);`
	`area(x1,y1,'facecolor','y')`
		

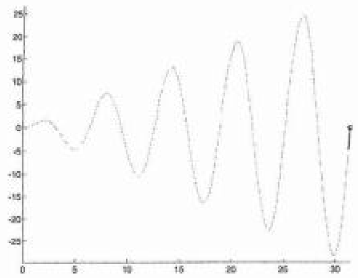
`pie`	World population by continents.
	`cont = char('Asia','Europe','Africa',...`
	`'N. America','S. America');`
	`pop = [3332;696;694;437;307];`
	`pie(pop)`
	`for i=1:5,`
	`gtext(cont(i,:));`
	`end`
	`Title('World Population (1992)',...`
	`'fontsize',18)`
		

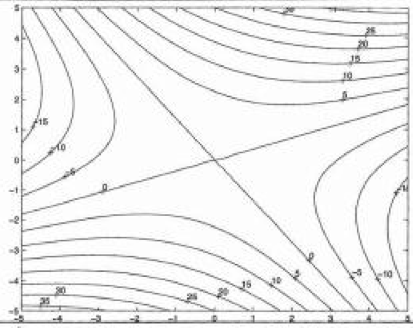
`hist`	Histogram of 50 randomly distributed numbers between 0 and 1.
	
	`y = randn(50,1);`
	`hist(y)`
		

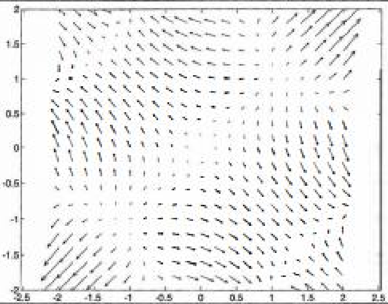
`stem`	$f = e^{-t/5}\sin t,\ 0 \le t \le 2\pi$
	
	`t = linspace(0,2*pi,200);`
	`f = exp(-.2*t).*sin(t);`
	`stem(t,f)`
		

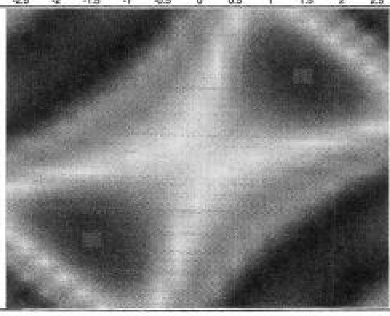
`stairs`	$r^2 = 2\sin 5t,\ 0 \le t \le 2\pi$
	$y = r\sin t$
	
	`t = linspace(0,2*pi,200);`
	`r = sqrt(abs(2*sin(5*t)));`
	`y = r.*sin(t);`
	`stairs(t,y)`
	`axis([0 pi 0 inf]);`
		

`compass`	$z = \cos\theta + i\sin\theta,\ -\pi \le \theta \le \pi$
	
	`th = -pi:pi/5:pi;`
	`zx = cos(th);`
	`zy = sin(th);`
	`z = zx + i*zy;`
	`compass(z)`
		

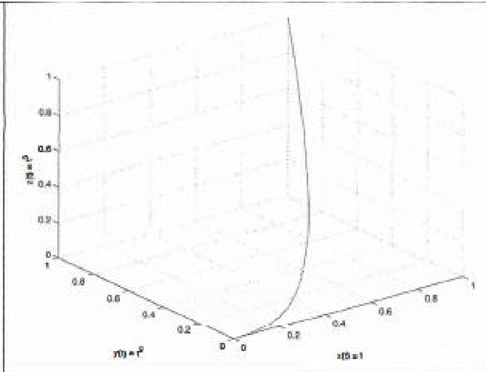
`comet`	$y = t \sin t, \;\; 0 \le t \le 10\pi$
	`q = linspace(0,10*pi,2000);`
	`y = q.*sin(q);`
	`comet(q,y)`
	(It is better to see it on screen.)
		

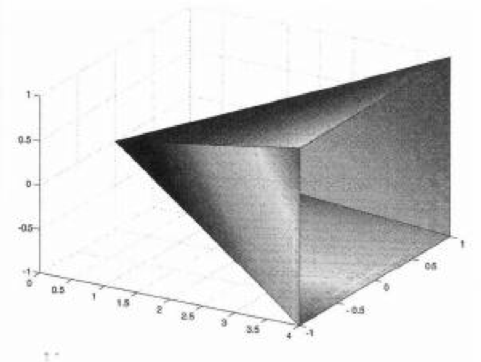
`contour`	$z \;=\; -\frac{1}{2}x^2 + xy + y^2$
	$\lvert x\rvert \le 5, \; \lvert y\rvert \le 5.$
	`r = -5:.2:5;`
	`[X,Y] = meshgrid(r,r);`
	`Z = -.5*X.^2 + X.*Y + Y.^2;`
	`cs = contour(X,Y,Z);`
	`clabel(cs)`
		

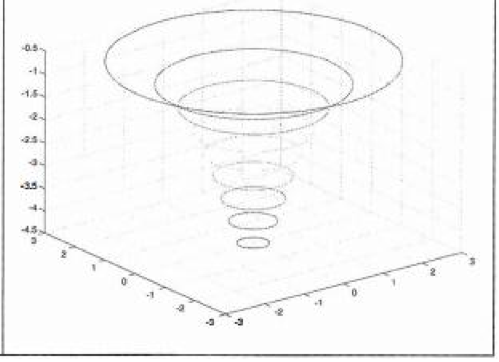
`quiver`	$z \;=\; x^2 + y^2 - 5\sin(xy)$
	$\lvert x\rvert \le 2, \; \lvert y\rvert \le 2.$
	`r = -2:.2:2;`
	`[X,Y] = meshgrid(r,r);`
	`Z = X.^2 - 5*sin(X.*Y) + Y.^2;`
	`[dx,dy] = gradient(Z,.2,.2);`
	`quiver(X,Y,dx,dy,2);`
		

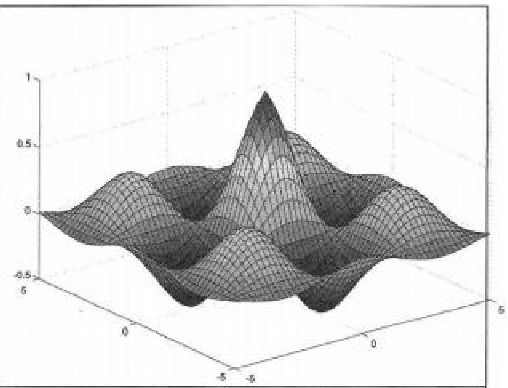
`pcolor`	$z \;=\; x^2 + y^2 - 5\sin(xy)$
	$\lvert x\rvert \le 2, \; \lvert y\rvert \le 2.$
	`r = -2:.2:2;`
	`[X,Y] = meshgrid(r,r);`
	`Z = X.^2 - 5*sin(X.*Y) + Y.^2;`
	`pcolor(Z), axis('off')`
	`shading interp`
		

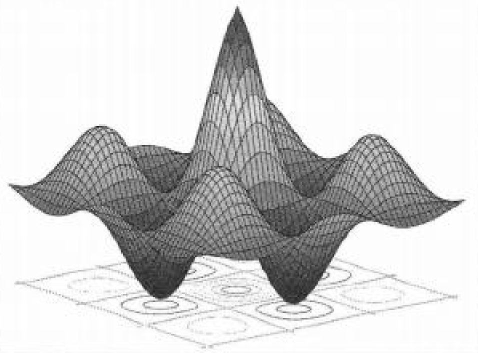
Plot 3D

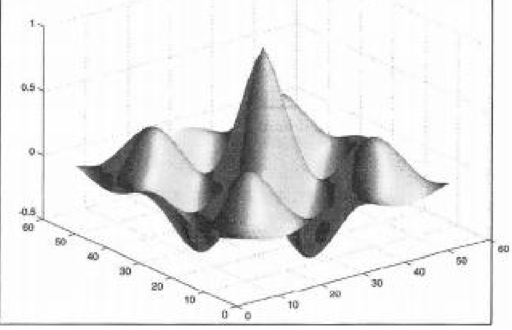
`plot3`	Plot of a parametric space curve:
	$$x(t) = t,\ y(t) = t^2,\ z(t) = t^3.$$
	$$0 \leq t \leq 1.$$
	`t = linspace(0,1,100);`
	`x = t; y = t.^2; z = t.^3;`
	`plot3(x,y,z), grid`
	`xlabel('x(t) = t')`
	`ylabel('y(t) = t^2')`
	`zlabel('z(t) = t^3')`
		

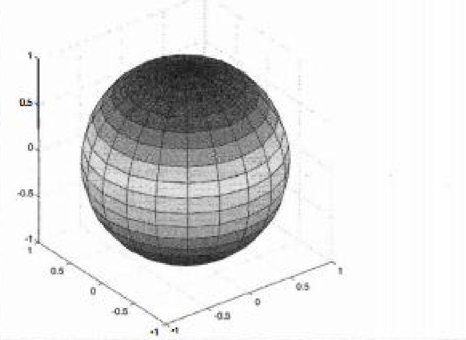
`fill3`	Plot of four filled polygons
	with three vertices each.
	`X = [0 0 0 0; 1 1 -1 1;`
	`   1 -1 -1 -1];`
	`Y = [0 0 0 0; 4 4 4 4;`
	`   4 4 4 4];`
	`Z = [0 0 0 0; 1 1 -1 -1;`
	`   -1 1 1 -1];`
	`fillcolor=rand(3,4);`
	`fill3(X,Y,Z,fillcolor)`
	`view(120,30)`
		

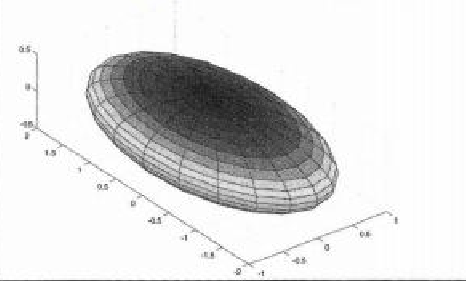
`contour3`	Plot of 3-D contour lines of
	$$z = -\frac{5}{1+x^2+y^2},$$
	$$\lvert x\rvert \leq 3, \lvert y\rvert \leq 3.$$
	`r = linspace(-3,3,50);`
	`[x,y] = meshgrid(r,r);`
	`z = -5./(1 + x.^2 + y.^2);`
	`contour3(x,y,z)`
		

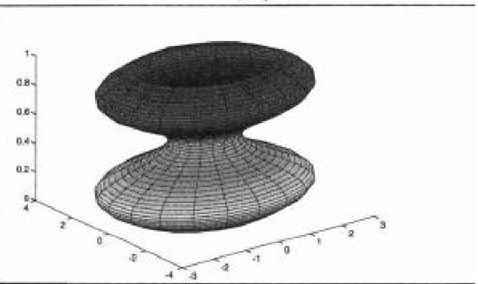
`surf`	$z = \cos x \cos y \, e^{\frac{-\sqrt{x^2+y^2}}{4}}$
	$\lvert x\rvert \le 5, \quad \lvert y\rvert \le 5$
	
	`u = -5:.2:5;`
	`[X,Y] = meshgrid(u, u);`
	`Z = cos(X).*cos(Y).*...`
	`    exp(-sqrt(X.^2 + Y.^2)/4);`
	`surf(X,Y,Z)`
		

`surfc`	$z = \cos x \cos y \, e^{\frac{-\sqrt{x^2+y^2}}{4}}$
	$\lvert x\rvert \le 5, \quad \lvert y\rvert \le 5$
	
	`u = -5:.2:5;`
	`[X,Y] = meshgrid(u, u);`
	`Z = cos(X).*cos(Y).*...`
	`    exp(-sqrt(X.^2 + Y.^2)/4);`
	`surfc(Z)`
	`view(-37.5,20)`
	`axis('off')`
		

`surfl`	$z = \cos x \cos y \, e^{\frac{-\sqrt{x^2+y^2}}{4}}$
	$\lvert x\rvert \le 5, \quad \lvert y\rvert \le 5$
	
	`u = -5:.2:5;`
	`[X,Y] = meshgrid(u, u);`
	`Z = cos(X).*cos(Y).*...`
	`    exp(-sqrt(X.^2 + Y.^2)/4);`
	`surfl(Z)`
	`shading interp`
	`colormap hot`
		

`sphere`	A unit sphere centered at the origin and generated by three matrices x, y, and z of size 21×21 each.
	
	`sphere(20)`
	`axis('square')`
	or
	`[x,y,z] = sphere(20);`
	`surf(x,y,z)`
	`axis('square')`
		

`ellipsoid`	An ellipsoid of radii $rx = 1$, $ry = 2$, and $rz = 0.5$, centered at the origin.
	
	`cx = 0; cy = 0; cz = 0;`
	`rx = 1; ry = 2; rz = 0.5;`
	`ellipsoid(cx,cy,cz,rx,ry,rz)`
	`axis('equal')`
		

`cylinder`	A cylinder generated by
	$r = \sin(3\pi z) + 2$
	$0 \le z \le 1, \quad 0 \le \theta \le 2\pi.$
	
	`z = [0:.02:1]';`
	`r = sin(3*pi*z) + 2;`
	`cylinder(r), axis square`
		

`slice`	Slices of the volumetric function $f(x, y, z) = \cos^2 x + cos^2 y - z^2$ $\lvert x\rvert \le 3$, $\lvert y\rvert \le 3$, $\lvert z\rvert \le 3$ at $x = -2$ and 2, $y = 2$, and $z = -2.5$ and 0.
	
	`v = [-3:.2:3];`
	`[x,y,z] = meshgrid(v,v,v);`
	`f = (cos(x).^2 + sin(y).^2-z.^2);`
	`xv = [-2 2.5]; yv = 2;`
	`zv = [-2.5 0];`
	`slice(x,y,z,f,xv,yv,zv);`
	
	The value of the function is indicated by the color intensity.