Plotting functions and curves

Instructor: Pei-Chiang Shao (邵培強)

Department of Mathematics, National Central University
Jhongli District, Taoyuan City 32001, Taiwan (R.O.C.)

E-mail: shaopj823@gmail.com

Plotting mathematical functions

Plot the function $f(x) = 2 + \sin x$ for $x \in [0, 2\pi]$.

```
% Matlab code
f = @(x) 2+sin(x);
f(0)
f([0 pi/2 pi])
x1 = linspace(0, 2*pi, 10);
y1 = f(x1);
x2 = linspace(0, 2*pi, 20);
y2 = f(x2);
figure; plot(x1, y1);
figure; plot(x2, y2);
```

Plotting mathematical functions

Plot the function $f(x) = 2 + \frac{\sin x}{e^x}$ for $x \in [0, 2\pi]$.

```
% Matlab code
f = @(x) 2 + sin(x)./exp(x);
f(0)
f([0 pi/2 pi])
x = linspace(0, 2*pi, 100);
y = f(x);
figure; plot(x,y);
```

Plotting curves

Plot circles with center (c_1, c_2) and radius r, i.e., $(x - c_1)^2 + (y - c_2)^2 = r^2$. (Hint: parameterize the circle using $x(t) = r\cos t$ and $y(t) = r\sin t$ for $t = 0, \cdots, 2\pi$.)

```
% Matlab code
r = 5;
c = [1, 2];
t = linspace(0, 2*pi, 100);
x = r*cos(t);
y = r*sin(t);
figure; plot(x+c(1), y+c(2));
hold on; plot(c(1), c(2), '*');
axis equal
```

Plotting 3D curves

Plot the 3D curve $x(t) = 5\cos t$, $y(t) = 3\sin t$, $z(t) = t$.

```
% Matlab code
t = 0: pi/50 : 6*pi;
x = 5*cos(t);
y = 3*sin(t);
z = t;
figure;
plot3(x, y, z);
```

Plotting surfaces

Plot the surface $f(x, y) = x^2 + y^2$ for $-2 \leq x \leq 2$ and $0 \leq y \leq 4$.

```
% Matlab code
f = @(x,y) x.^2 + y.^2;
x = linspace(-2,2,10);
y = linspace(0,4,10);
[X, Y] = meshgrid(x,y);
Z = f(X,Y);
figure; mesh(X,Y,Z);
figure; surf(X,Y,Z);
```

Plotting contours

Plot the contour (level lines) of $f(x, y) = \sin(y \cos(x))$ for $-\pi \leq x \leq \pi$ and $0 \leq y \leq 2\pi$.

```
% Matlab code
f = @(x,y) sin(y*cos(x));
x = linspace(-pi,pi,100);
y = linspace(0,2*pi,100);
[X, Y] = meshgrid(x,y);
Z = f(X,Y);
figure; contour(X,Y,Z);
figure; mesh(X,Y,Z);
```

Plotting ellipses

Plot an ellipse centered at origin with its main axis having an angle of 45 degree with the x-axis. Hint: use $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and the rotation matrix $Q = [\cos\theta - \sin\theta; \sin\theta \cos\theta]$.

```
% Matlab code
a = 5;
b = 3;
c = pi/4;
t = linspace(0,2*pi,100);
x = a*cos(t);
y = b*sin(t);
u = x*cos(c)-y*sin(c);
v = x*sin(c)+y*cos(c);
figure; plot(u,v);
```

Quiz

Reproduce the following plot which shows two ellipses embeded in a circle.