MATLAB assignment 2 Solution

Introduction to Linear Algebra (Week 2) **Fall, 2019**

1. (*2D Graphics in* MATLAB)

   (a) Draw graph of the polynomial

   $$p(x) = x^3 - x$$

   i. Construct a vector **x** which consists of equally-spaced points in $[-3, 3]$. To do this, use the MATLAB command *linspace* or the syntax $x_0 : \Delta x : x_n$.

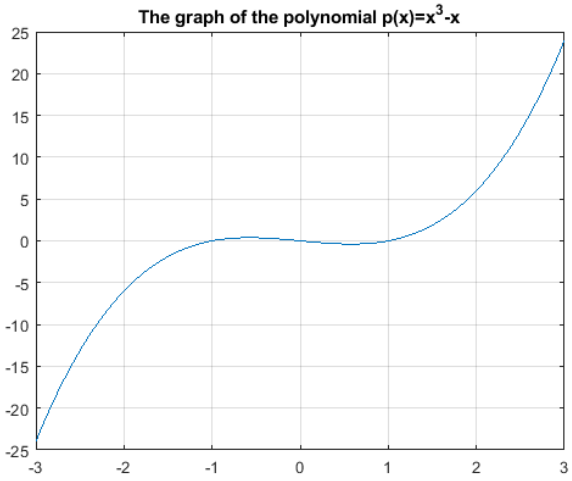
   ii. Construct a vector **p** whose i-th component is $p(x_i)$ where the x_i is i-th component of the vector **x**.

   iii. Make a new figure window by using the command *figure*.

   iv. Draw the graph of the given polynomial. You may use the MATLAB command *plot*.

   solution.

```
% assignment2_a

x = linspace(-3, 3, 500);    % Construct a vector x
p = x.^3 - x;                % Construct a vector p

figure;                      % Make a new figure
plot(x, p);                  % Draw the graph
grid on
```



(b) Use the MATLAB command *subplot* to produce four plots of the functions below over the specified range on the same figure.

i. $f(x) = |x - 1|$ for $-3 \leq x \leq 3$.

ii. $f(x) = \sqrt{|x|}$ for $-4 \leq x \leq 4$.

iii. $f(x) = e^{-x^2}$ for $-4 \leq x \leq 4$.

iv. $f(x) = \dfrac{1}{10x^2 + 1}$ for $-2 \leq x \leq 2$.

In this problem, use the MATLAB commands *abs*, *sqrt*, and *exp* for elementary functions.

solution.

```
% assignment2_b

figure;              % Open a new figure window.

%% i. f(x) = |x-1| for -3 <= x <= 3.
subplot(2, 2, 1);    % Make a subplot in a figure window.
x = -3 : 0.01 : 3;   % Construct a linearly-spaced vector x.
plot(x, abs(x-1));   % Plot the function f(x) over the specified
    domain x.
axis tight;          % Axis limits to the range of the data.
title('(1)');

%% ii. f(x) = sqrt(|x|) for -4 <= x <= 4.
subplot(2, 2, 2);
x = -4 : 0.01 : 4;
plot(x, sqrt(abs(x))); axis tight; title('(2)');

%% iii. f(x) = exp(-x^2) for -4 <= x <= 4.
subplot(2, 2, 3);
x = -4 : 0.01 : 4;
plot(x, exp(-x.^2)); axis tight; title('(3)');

%% iv. f(x) = 1/(10*x^2 + 1) for -2 <= x <= 2.
subplot(2, 2, 4);
x = -2 : 0.01 : 2;
plot(x, 1./(10*x.^2 + 1)); axis tight; title('(4)');
```

(c) Find the number of intersections of the polar system

$$\begin{cases} r = 1 + \cos(k\theta) \\ r = \cos(k\theta) \end{cases}, \qquad \text{where} \quad 0 \le \theta \le 2\pi,$$

by drawing the polar curves in MATLAB.

i. To draw a polar curve, you may use the MATLAB command *polar*.

ii. For a polar system, use the MATLAB command *hold* to graph two polar curves on the same set of axis.

iii. For $k = 1, 2, \cdots, 6$, graph the polar curves of each polar systems. You may use *for-loop*. Then, you will have 6 graphs because you have 6 polar systems.

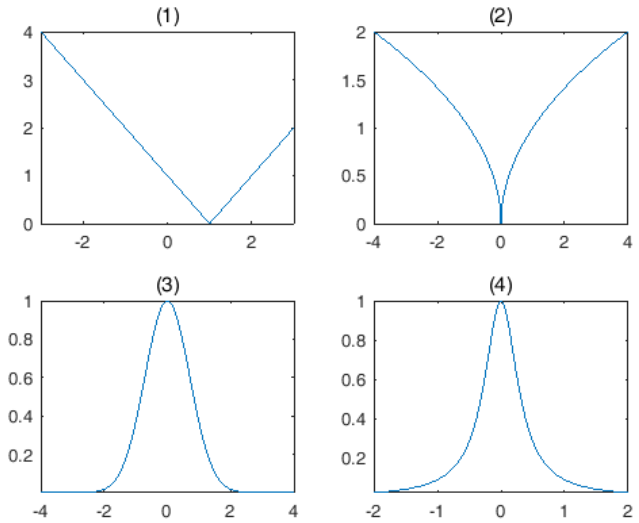
iv. Display your resulting images with 2×3 subplots in the same figure window.

How many intersections do you have for each system?

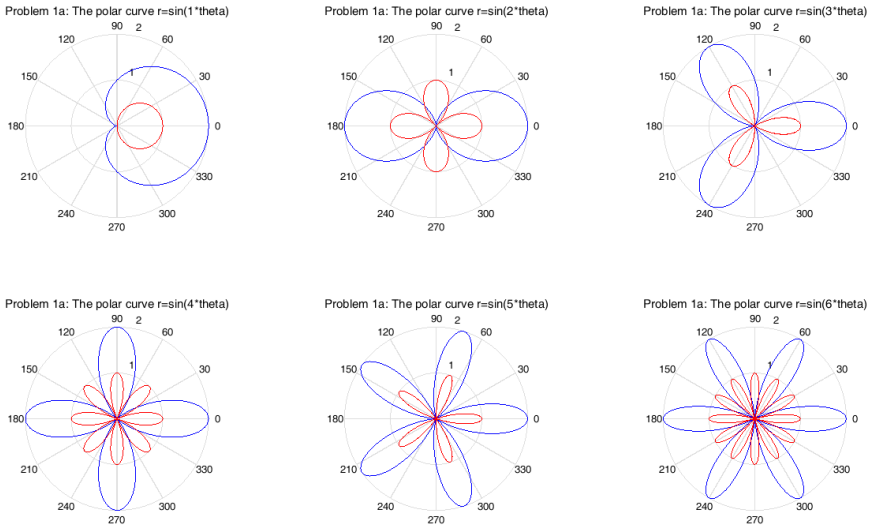
solution.

```
% assignment2_c

% Create a linearly-spaced vector of the parameter domain theta.
theta = linspace(0, 2*pi, 200);

figure(1); clf(1);      % Open a figure window.
for k=1:6
    r1=1+cos(k*theta);  % Calculate the values r1.
    r2=cos(k*theta);    % Calculate the values r2.
    subplot(2,3,k); polar(theta, r1, 'b'); % Draw the polar curve r
        .
    hold on;
    polar(theta, r2, 'r');
    title(sprintf('Problem 1a: The polar curve r=sin(%d*theta)', k)
        );
end
```

(b)


(1)
(2)
(3)
(4)

(c)


Problem 1a: The polar curve r=sin(1*theta)
Problem 1a: The polar curve r=sin(2*theta)
Problem 1a: The polar curve r=sin(3*theta)
Problem 1a: The polar curve r=sin(4*theta)
Problem 1a: The polar curve r=sin(5*theta)
Problem 1a: The polar curve r=sin(6*theta)