MATLAB Project #3: Plotting in MATLAB and Subspaces

Purpose:
1. To learn MATLAB’s plotting function, a very useful feature of MATLAB.
2. To deepen your understanding of span, basis and dimension.


The `plot` command does 2-D plotting, and when you use it, a graph will appear in a Figure window. As the examples below show, you can specify a color and a symbol or line type when you use `plot`. To learn more, use `help plot`.

Exercise 1.
1. Try the following examples and make a sketch or write notes to describe what happened each time. Notice we use semicolons when creating the vectors here because each vector is quite long, and there is no reason to look at them.

```
>> x = 0:0.1:2*pi; si = sin(x); co = cos(x);
>> plot(x, si)
>> plot(x, si,'r')
>> plot(x, si,'-.')
>> plot(x, si,'*')
>> plot(x, co)
```

Here is one way to get more than one graph on the same axis system. Describe the result of each command:

```
>> plot(x, si, 'r*', x, co, 'b+')
>> P = [si; co]; plot(x, P)
```

2. Another way to get different graphs on the same axes is to use the `hold on` command. This causes the current graphics screen to be frozen, so the next plot command draws on the same axis system. The command stays in effect until you release it by typing `hold off`. Try the following commands, and describe the result of each:

```
>> plot(x, co, 'g--'), hold on
>> plot(x, si, 'ro')
>> hold off
```

3. It can be helpful to have grid lines displayed, and to set your own limits for the axes.

```
>> plot(x, si), grid
>> plot(x, si), axis([-8 8 -2 2])
```

4. The following MATLAB commands can be used to further polish your graph: `title`, `xlabel`, `ylabel`, `legend`. Properly use the above commands for your last `sin(x)` graph.
Part 2. Subspaces.

Exercise 2.1.
Use MATLAB to solve Problem 35 of Exercise 4.6 in Lay’s textbook.

Directions for Exercise 2.2:
Use the matrices $A$ and $B$ given below. Employ MATLAB to do whatever calculations you need and attach the results. Explain your methods briefly and why they work. No credit unless your methods and explanation are valid!

MATLAB functions that may be useful: rank, rref, and diary.

Exercise 2.2. For each of the following sets:

**Set 1.**
\[
A = \begin{bmatrix}
1 & 2 & 2 & 1 & 0 \\
1 & 3 & 3 & 1 & 2 \\
4 & 2 & 4 & 2 & 1 \\
2 & 3 & 5 & 0 & 2 \\
5 & 0 & 2 & 3 & 0
\end{bmatrix}, \quad B = \begin{bmatrix}
2 & 0 & 2 & 1 \\
1 & 2 & 1 & 3 \\
1 & 1 & 3 & 3 \\
1 & 2 & 3 & 2 \\
0 & 0 & 2 & 3
\end{bmatrix}
\]

**Set 2.**
\[
A = \begin{bmatrix}
1 & 2 & 2 & 1 & 3 \\
1 & 3 & 3 & 1 & 4 \\
4 & 2 & 4 & 2 & 4 \\
2 & 3 & 5 & 0 & 3 \\
5 & 0 & 2 & 3 & 3
\end{bmatrix}, \quad B = \begin{bmatrix}
2 & 2 & 2 & 2 \\
1 & 1 & 2 & 2 \\
1 & 3 & 1 & 3 \\
1 & 2 & 2 & 3 \\
2 & 1 & 2 & 1
\end{bmatrix}
\]

1. Verify that Col $A$ and Col $B$ have the same dimension.
2. Determine whether or not Col $A$ and Col $B$ are the same subspace of $\mathbb{R}^5$. Explain what you calculated and why it worked.

Question 1 is easy, but you will need to think how to answer question 2. Discuss it with each other — this can really help. Once you figure out a method it will not take long to do the calculations. Observe that Col $A$ and Col $B$ are obviously subspaces of $\mathbb{R}^5$.

Question 2 is not obvious. For example, if two subspaces of $\mathbb{R}^3$ each have dimension 1, each will be a line through the origin, but they might not be the same line. If each has dimension 2, they are planes through the origin, but they might not be the same plane. In general if two subspaces of $\mathbb{R}^n$ have the same dimension $k$, we can visualize each as looking like $\mathbb{R}^k$ -- but they might not be the same sets. Your job here is to figure out a way to decide if two subspaces of $\mathbb{R}^n$, which have the same dimension, are actually the same set of points, and apply your method to the subspaces Col $A$ and Col $B$. 