MAS3114 MATLAB Assignment 1

Name: Samantha Bennett (enter you name here; -20 points if the info is incorrect/missing)

UF ID: ####-#### (enter your UF ID here; -20 points if the info is incorrect/missing)

```
clear
% Initialize the random number generator by typing the command
rng(########,'twister')
% where ######## must be your 8-digit UF ID number
% another -20 points if no UF ID or incorrect UF ID for the random number generator
```

Exercise 1 -- Creating Matrices

1A

```
% manually enter each entry for the 3 x 3  matrix A and separate each row by a semicolon
A = [1 2 3; 4 5 6; 7 8 9]
```

```
A = 3×3
     1     2     3
     4     5     6
     7     8     9
```

```
b = [1; -1; 1]
```

```
b = 3×1
     1
    -1
     1
```

```
c = [2, -2, 2]
```

```
c = 1×3
     2    -2     2
```

```
D = [1 2 3 4; -4 -3 -2 -1; 2 1 4 3]
```

```
D = 3×4
     1     2     3     4
    -4    -3    -2    -1
     2     1     4     3
```

```
% A(:,2) returns 2nd column
A(:,2)
```

```
ans = 3×1
     2
     5
     8
```

```
% D(3,:) returns return 3rd row
D(3,:)
```

```
ans = 1×4
     2     1     4     3
```

```
% [A b] returns augmented matrix [A b]
[A b]
```

```
ans = 3×4
     1     2     3     1
     4     5     6    -1
     7     8     9     1
```

```
% Give an explanation why and fix this command to get a 4 x 3 matrix in the
% output result.
%[A; c] returns 4x3 matrix with c added to the rows of A (not columns)
[A; c]
```

```
ans = 4×3
     1     2     3
     4     5     6
     7     8     9
     2    -2     2
```

[A c] is not the correct command because c is 4x1 so it cannot be added an extra column at the end of A since A is a 3x3.

1B

```
% eye(6) is a 6x6 matrix with pivot column with value = 1 in every column
eye(6)
```

```
ans = 6×6
     1     0     0     0     0     0
     0     1     0     0     0     0
     0     0     1     0     0     0
     0     0     0     1     0     0
     0     0     0     0     1     0
     0     0     0     0     0     1
```

```
% zeros(5,3) is a 5x3 matrix full of 0's
zeros(5,3)
```

```
ans = 5×3
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
```

```
% zeros(4) is a 4x4 matrix full of 0's
zeros(4)
```

```
ans = 4×4
     0     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0
```

```
% ones(4,3) is a 4x3 matrix full of 1's
ones(4,3)
```

```
ans = 4×3
     1     1     1
     1     1     1
     1     1     1
     1     1     1
```

```
% diag(c) is a 3x3 matrix with pivots columns with values from c in every column
diag(c)
```

```
ans = 3×3
     2     0     0
     0    -2     0
     0     0     2
```

1C

```
% randi([-8,8],3,6) is a 3x6 matrix filled with random numbers from -8 - 8
F = randi([-8,8],3,6)
```

```
F = 3×6
     6    -4     3     1     2    -1
    -4     5    -1     1     5     3
     2     2     3     4    -3    -1
```

```
% F(:, [2 4]) = F(:, [4 2]) returns F matrix with column 2 and 4 switched
F(:, [2 4]) = F(:, [4 2])
```

```
F = 3×6
     6     1     3    -4     2    -1
    -4     1    -1     5     5     3
     2     4     3     2    -3    -1
```

```
E = [A F]
```

```
E = 3×9
     1     2     3     6     1     3    -4     2    -1
     4     5     6    -4     1    -1     5     5     3
     7     8     9     2     4     3     2    -3    -1
```

```
% The command [m,n] = size(E), where
% m represents the number of rows and n represents the number of columns
[m,n] = size(E)
```

```
m = 3
n = 9
```

```
E(:, [3 6])
```

```
ans = 3×2
     3     3
     6    -1
     9     3
```

```
E(:, 3:6)
```

```
ans = 3×4
```

```
     3     6     1     3
     6    -4     1    -1
     9     2     4     3
```

Compare the commands E(:, [3 6]) and E(:, 3:6):

- E(:, [3 6]) returns the thrid and sixth column as a matrix
- E(:, 3:6) returns the 3rd - 6th column as a matrix

Exercise 2 -- Solving Ax = b

2A

```
[B, pivcol] = rref([A b])
```

```
B = 3×4
     1     0    -1     0
     0     1     2     0
     0     0     0     1
pivcol = 1×3
     1     2     4
```

The matrix B is the reduced row echelon form of [A b] and the pivcol is number of pivot columns and what column they're in in the matrix A.

The system Ax = b is inconsistent because there is pivot column in the last column.

2B

```
rank_comp(A, [A b])
```

```
rank([A]) does not equal to rank([A b])
```

The Rouch-Capelli Theorem states that if A and [A b] have the same rank, then they are consistent.

By Rouch-Capelli Theorem, the system Ax = b is inconsistent.

Compare your result with part A. Do you have the same conclusion? I have the same result as part A.

2C

```
[m,n] = size(A);
LS_solution(n, A, [A b])
```

```
Ax = b is inconsistent and it has no solution
```

Exercise 3 -- Underdetermined and Overdetermined Systems

3A

```
% create a 2x3 matrix A1 with random entries between -8 and 8
A1 = randi([-8,8],2,3);
% create a 2x1 vector b with random entries between -8 and 8
```

```
b = randi([-8,8],2,1);
% display the augmented matrix [A1 b] and
% call LS_solution for the system A1x=b to determine the number of solutions of the system
[m,n] = size(A1);
[A1 b]
```

```
ans = 2×4
    -8     8     5    -2
     3    -2     8    -7
```

```
LS_solution(n, A1, [A1 b])
```

```
Ax = b is consistent and it has infinitely many solutions
```

```
% create 2x3 matrices A2 and A3, and repeat the process for the systems A2x=b and A3x=b
A2 = randi([-8,8],2,3);
b = randi([-8,8],2,1);
[m,n] = size(A2);
[A2 b]
```

```
ans = 2×4
    -6    -5    -6     7
    -3    -1    -2     2
```

```
LS_solution(n, A2, [A2 b])
```

```
Ax = b is consistent and it has infinitely many solutions
```

```

A3 = randi([-8,8],2,3);
b = randi([-8,8],2,1);
[m,n] = size(A3);
[A3 b]
```

```
ans = 2×4
    -6    -3     4     5
     0     6    -7     2
```

```
LS_solution(n, A3, [A3 b])
```

```
Ax = b is consistent and it has infinitely many solutions
```

3B We expect most underdeterminded systems to have infinitely many solutions because they have more variables than equations. This makes it harder to find unique solutions for each variable.

- Can an underdetermined linear system have a unique solution? Why or why not?

It cannot because an underdetermined linear system have either have no solution or infinitely many solutions. When the linear system does have a solution, it must be infinitely many solutions because there are columns that are not pivot columns not including the last column. Therefore, the solution would include variables without solutions. For example,

$$\begin{matrix} 1 & 2 & 0 & 4 \\ 0 & 1 & 3 & 3 \end{matrix} \qquad \begin{aligned} x + 2y &= 4 \\ y + 3z &= 3 \end{aligned}$$

In this example, z does not have a unique solution. Therefore, the whole linear system is infinitely many solutions.

- Can an underdetermined linear system have no solution? If yes, give an example where A is 2x3.

An understeremined linear system can have no solution. For example,

$$\begin{matrix} 1 & 2 & 0 & 4 \\ 0 & 0 & 0 & 9 \end{matrix} \qquad \begin{aligned} x + 2y &= 4 \\ 0 &= 9 \end{aligned}$$

In this example, there is a pivot column in the last column, so this linear system has no solution.

(Use the "INSERT" to add math equations in your example)

3C

```
% create a 3x2 matrix A1 with random entries between -8 and 8
A1 = randi([-8,8],3,2);
% create a 3x1 vector b with random entries between -8 and 8
b = randi([-8,8],3,1);
% display the augmented matrix [A1 b] and
[A1 b]
```

```
ans = 3×3
    -5    -1    -5
    -8    -5     7
     8     5    -6
```

```
% call LS_solution for the system A1x=b to determine the number of solutions of the system
[m,n] = size(A1);
LS_solution(n, A1, [A1 b])
```

```
Ax = b is inconsistent and it has no solution
```

```
% create 3x2 matrices A2 and A3, and repeat the process for the systems A2x=b and A3x=b
A2 = randi([-8,8],3,2);
b = randi([-8,8],3,1);
[A2 b]
```

```
ans = 3×3
    -2    -5     2
    -6     7    -8
     8    -1     2
```

```
[m,n] = size(A2);
LS_solution(n, A2, [A2 b])
```

```
Ax = b is inconsistent and it has no solution
```

```

A3 = randi([-8,8],3,2);
b = randi([-8,8],3,1);
[A3 b]
```

```
ans = 3×3
```

```
     1    -1     0
     7    -2    -7
     0     5     0
```

```
[m,n] = size(A3);
LS_solution(n, A3, [A3 b])
```

```
Ax = b is inconsistent and it has no solution
```

3D We expect most overdeterminded systems to be inconsistent because the matrix has to work out perfectly to not be inconsistent. It has to have 2 pivot columns in the 2 left-most columns (with a 3x2 matrix). If the pivot column is in the last column, then it is inconsistent.

An overdetermined linear system can have one solution or infinitely many solutions. For example,

- one solution -- give an example where A is 3x2

$2x = 3y + 1$
$3x = 2y + 4$
$x = y + 1$

(Use the "INSERT" to add math equations in your example)

- infinitely many solutions -- give an example where A is 3x2 (DO NOT give three identical equations as an example)

$x + 6y = 6 \qquad 1 \quad 6 \quad 6$
$0x + 0y = 0 \qquad 0 \quad 0 \quad 0$
$0x + 0y = 0 \qquad 0 \quad 0 \quad 0$

(Use the "INSERT" to add math equations in your example)