In this project you will learn how MATLAB can be used to generate standard matrices (such as the identity matrix, the zero matrix, etc.), to determine whether a linear system of equations is consistent, and to interpret linear systems geometrically.

**What you have to submit:** You must submit a printout of your MATLAB session following the instructions indicated in items (d) of TASK I, TASK II, and TASK III.

**Where you submit the assignment:** Drop your assignment into the box under your lab instructor’s name that is located in Cardwell Hall next to room 120.

**TASK I: Getting standard matrices with MATLAB.**

**Keywords:** zeros, ones, eye, rand, randn.

(a) Type in the following commands and observe what they do.

```
zeros(4,5)
zeros(7,1)
one(3,3)
one(2,5)
eye(4)
eye(3,4)
rand(5,4)
rand(3,7)
randn(6,2)
```

What do `rand` and `randn` do? How are they different? Use the help command to learn.

(b) Construct, with just one command, a matrix of size $8 \times 10$ with entries all equal to 6.

(c) Generate a random matrix of size $4 \times 7$ with entries between 1 and 100.

(d) What you have to submit for TASK I: A printout of all the commands typed and their outputs. Indicate which commands correspond to each item and explain what the commands in part (a) do.
**TASK II:** Determining whether a system is consistent. Finding solutions.

**Keywords:** *rref, rank.* Consult the online help for these MATLAB commands.

(a) Use MATLAB commands to find the rref and the rank of the following matrices.

\[
A = \begin{bmatrix}
2 & 4 & 2 & 4 & 2 & 4 \\
0 & 0 & 1 & -1 & -1 & 4 \\
2 & 4 & 3 & 3 & 3 & 4 \\
3 & 6 & 6 & 3 & 6 & 6
\end{bmatrix} \quad B = \begin{bmatrix}
2 & 8 & 4 \\
2 & 5 & 1 \\
4 & 10 & -1
\end{bmatrix}
\]

(b) Consider a system of linear equations whose augmented matrix is \([A|b]\), where \(A\) is as in part (a) and \(b\) is some column vector. Is this system always consistent, always inconsistent, or does consistency depend on the vector \(b\)? What is the answer to this question if instead of \(A\) we consider \(B\) of part (a)? Explain.

(c) Use MATLAB to determine whether the following systems are consistent. When the system is consistent find its solution(s).

\[
\begin{align*}
\begin{align*}
x + 2y + 3z &= 1 \\
3x + 2y + z &= 1 \\
x - y - 3z &= 1
\end{align*}
\quad \begin{align*}
\begin{align*}
4x_1 + 3x_2 + 2x_3 - x_4 &= 4 \\
5x_1 + 4x_2 + 3x_3 - x_4 &= 4 \\
-2x_1 - 2x_2 - x_3 + 2x_4 &= -3 \\
11x_1 + 6x_2 + 4x_3 + x_4 &= 11
\end{align*}
\end{align*}
\]

(d) What to submit for TASK II: Written solutions to all the problems. A printout of each of the commands typed and their outputs.

**TASK III:** Interpreting linear systems geometrically.

**Keywords:** *plot, grid on.* Consult online help for these MATLAB commands.

(a) The following commands will produce the graphs of the lines \(2y + x = 2\) and \(y + x = 3\) for \(-2 \leq x \leq 5\) on the same window. Press enter after typing each line.

\[
\begin{align*}
x &= -2:0.1:5; \\
y_1 &= 1-0.5\times x; \\
y_2 &= 3-x; \\
plot(x,y1,x,y2) \\
grid on;
\end{align*}
\]
(b) Determine whether the following systems are consistent. When the system is consistent find its solution(s).

\[
\begin{align*}
  x + 2y &= 1 \\
  2x + 3y &= 1 \\
  2x + 4y &= 3 \\
  3x + 6y &= 2 \\
  -2x + y &= 2 \\
  6x + y &= 6 \\
  2x + y &= 2
\end{align*}
\]

(c) For each system in part (b), use the commands in part (a) to plot the lines that its equations represent. In each case, choose the range of \( x \) conveniently and interpret geometrically your answers in part (b).

(d) What to submit for TASK III: Written solutions to all the problems. A printout of each of the commands typed and their outputs (graphs included).