Math 451 ASSIGNMENT 7 **Due at 2 PM Wednesday, April 23rd**

- A **vector** is a list of numbers. When the numbers are listed horizontally we call the vector a **row vector**, and when the numbers are listed vertically the vector is a **column vector**.
- A **matrix** is a rectangular array of numbers. Each number in a matrix is called an **entry**.
- The **rows** and **columns** of a matrix should be self explanatory. The (i, j) entry of a matrix is the number in the ith row and the jth column.
- The **size** of a matrix is two numbers, called its **dimensions**. The first number is the number of rows in the matrix and the second number is the number of columns. Mathematically we write the size of a matrix with m rows and n columns as $m \times n$.
- A matrix with the same number of rows as columns is called a **square matrix**. The entries of a square matrix where the row number and column number are the same are called the **diagonal entries** of the matrix. All of them together, from upper left to lower right are called the diagonal of the matrix (so the diagonal is a vector).
- A matrix in which all of the entries not on the diagonal are zero is called a **diagonal matrix**. (Note that some or all of the diagonal entries may also be zero in a diagonal matrix.) A diagonal matrix in which all of the diagonal entries are one is called an **identity matrix**.
- If we consider the diagonal of a square matrix to be the "main" diagonal, then we can consider the entries in the diagonal immediately below the main diagonal. We'll refer to this as the **first sub-diagonal**; below that is the second sub-diagonal, and so on. The diagonal above the main diagonal we'll refer to as the **first super-diagonal**, and similarly for other super-diagonals.
- A square matrix in which all of the sub-diagonal entries are zeros is called an **upper triangular matrix**, and a square matrix in which all of the super-diagonal entries are zeros is called a **lower triangular matrix**

There are pretty good discussions of basic matrix/array manipulations in Section 1.2 of the textbook and at that *MATLAB* documentation center under *Language Fundamentals ¿ Matrices and Arrays*. For the latter, I find the "Examples and How To" section below the various functions to be the most useful.

NOTE: It is customary to use upper case letters for matrices, usually letters near the front of the alphabet. When discussing a general matrix we usually refer to it with the letter A, and its entries are $a_{i,j}$, where i is the row of the entry and j is the column.

1. Write what you would type at the command prompt to create the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$.

2. **Answer each of the following in words**, for a general matrix B that has been entered in *MATLAB*. Use the language presented above. When the answer is a vector, tell whether it is a column vector or a row vector.

   (a) What does `B(3,:)` return?

   (b) What does `B(3,2)` return?

   (c) What does `B(:,5)` return?

   (d) What does `diag(B)` return? (This is really only meaningful for square matrices, so try it there first. Then you should try it for a non-square matrix.)

(e) What does `diag(B,1)` return? (This is really only meaningful for square matrices, so try it there first. Then you should try it for a non-square matrix.)

(f) What does `sum(B(m,;))` return?

3. Describe (again, in words) the matrix created by each of the following commands for positive integers m and n. Be sure to include the size of the matrix and whether or not it is square.

   (a) `zeros(4,3)`

   (b) `ones(5)`

   (c) `eye(4)`

   (d) `3*eye(4)`

   (e) `diag(x)`, for a vector `x` that has already been created.

   (f) `diag(x,-1)`, for a vector `x` that has already been created.

   (g) `diag(x,2)`, for a vector `x` that has already been created.

4. Suppose that we wish to create the matrix A shown to the right *without typing it an entry at a time*. You should be able to use what you have discovered above to write A as the sum of three matrices created using some of the above commands. Give the sum in the space below.

$$A = \begin{bmatrix} 4 & -1 & 0 & 0 & 0 \\ -1 & 4 & -1 & 0 & 0 \\ 0 & -1 & 4 & -1 & 0 \\ 0 & 0 & -1 & 4 & -1 \\ 0 & 0 & 0 & -1 & 4 \end{bmatrix}$$

   $A =$

5. (a) Enter `M2=magic(4)`. What kind of matrix results? (One word.)

   (b) Try summing a few rows and columns using commands like `sum(M(3,:))`, and try summing the diagonal. What do you observe?