

## MATLAB Assignment #1

This project is very simple. Its goal is to introduce you to Matlab. For an introduction to Matlab, you can consult the introduction posted on the class website. Whenever you use a new Matlab command, you can learn about it by using the **help** command; *e.g.*, type **help rref** to learn about the **rref** command.

For informations about Matlab tutoring and computers location, go to the Math. Dept. undergraduate resources web page:

<http://www-math.umd.edu/undergraduate/resources.html>

You should hand in your printed output. You can use the **diary** command to save your work: Type

```
>> diary project1
```

and Matlab will save all following outputs to a file called project1. Whenever you wish to stop saving, you may type

```
>> diary off
```

You should then edit the file project1 (with your favorite text editor) to include your name, the problem numbers, and the answers to any questions asked in the problems. Then print your file.

**Basic linear algebra commands:** You can enter a matrix into Matlab as follows:

```
>> A=[1 2 3;4 5 6;7 8 9]
```

Some useful commands to generate matrices include **diag**, **eye**, **ones**, **zeros** (you can use the **help** command to see how they are used).

In this project, we will generate matrices with random entries. You can generate a  $5 \times 7$  matrix with random entries between 0 and 1 by typing

```
>> A=rand(5,7)
```

The command **randi** can be used to generate random integers. For instance, you can generate a  $3 \times 4$  random matrix with integer entries between 3 and 11 with the command

```
>> A=randi([3,11],3,4)
```

Note that you can suppress Matlab printout of a result by ending the command with a semicolon. For instance

```
>> A=randi([3,11],3,4);
```

Use this as often as possible to reduce the size of your printout.

The  $(i, j)$ -entry of a matrix  $A$  is  $A(i, j)$ . For instance

```
>> A(2,3)
```

will return the entry on the second row and third column of  $A$ . You can also use

```
>> A(:,3)
```

to get the third column of  $A$ .

Finally, Matlab allows you to do various matrix operations easily. In particular, typing  $A+B$ ,  $A-B$  or  $A*B$  will return the sum, difference and product of two matrices, as defined in class.

**Problem 1.** Generate a random  $4 \times 6$  matrix  $A$  with entry integers between  $-5$  and  $5$ . Put it in reduced echelon form using the command `rref`. Are the columns of  $A$  linearly independent? What is the span of the columns of  $A$ ?

**Problem 2.** Generate a random vector  $\mathbf{u}$  in  $\mathbb{R}^6$  (remember that a vector is also a  $6 \times 1$  matrix). Calculate the product  $\mathbf{b} = A\mathbf{u}$ , using your matrix  $A$  from Problem 1. Use Matlab to solve  $A\mathbf{x} = \vec{b}$  by using the command

```
>> x=A\b
```

You know that  $\mathbf{u}$  is a solution of this equation. Did Matlab give you the solution  $\mathbf{u}$ ? Why? Find all solutions of  $A\mathbf{x} = \mathbf{b}$  (note that you can easily define the augmented matrix for this system by typing `[A b]`).

**Problem 3.** Generate random  $4 \times 4$  matrices  $A$  and  $B$  and test whether  $AB = BA$  (the best way to do this is to compute  $AB - BA$  and see if you get the zero matrix).

**Problem 4.** In a wind tunnel experiment, the force on a projectile due to the air resistance was measured at different velocities:

Velocity (100 ft/sec)	0	2	4	6	8	10
Force (100 lb)	0	2.90	14.8	39.6	74.3	119

Find an interpolating polynomial  $p(t) = a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + a_5t^5$  for these data (that is, find the coefficients  $a_0, a_1, \dots$  of such a polynomial, so that  $p(0) = 0, p(2) = 2.90, p(4) = 14.8\dots$ ).

What happens if you try to use a polynomial of degree less than 5?

**Problem 5.** Determine if the columns of the following matrix span  $\mathbb{R}^4$ :

$$\begin{bmatrix} 12 & -7 & 11 & -9 & 5 \\ -9 & 4 & -8 & 7 & -3 \\ -6 & 11 & -7 & 3 & -9 \\ 4 & -6 & 10 & -5 & 12 \end{bmatrix}$$

Find a column of the matrix that can be deleted and yet have the remaining matrix columns still span  $\mathbb{R}^4$ .

**Problem 6.** The matrix

$$\begin{bmatrix} 4 & -2 & 5 & -5 \\ -9 & 7 & -8 & 0 \\ -6 & 4 & 5 & 3 \\ 5 & -3 & 8 & -4 \end{bmatrix}$$

determines a linear transformation  $T$ .

Is  $T$  a one-to-one mapping? If not, find all  $\mathbf{x}$  such that  $T(\mathbf{x}) = \mathbf{0}$ .