**Total Points: 100 Due:** Week 7 in Lab

The project must be completed independently.

**Note:** I will be lecture in lab in Week 6, so this lab period will not be used to finish this project.

**Objectives**

* To gain practical understanding of basic linear algebra concepts and matrix operations.
* To gain practical understanding of MATLAB tools for solving simultaneous equations.
* To gain practical understanding of MATLAB tools for numerical differentiation.
* To gain practical understanding of MATLAB tools for numerical integration.

**Format Requirements**

* Complete the assignment in one script titled *lastname\_BE2200Proj3.m*.
* After *clear*, *close all*, and *clc*, in the comment line, include your name, project number and name, and the date of completion.
* Include a comment “% Part X” to separate individual sections of this assignment. For each assigned problem include a corresponding letter designation, e.g. “% Problem A”.
* Using an appropriate display command (e.g. disp, fprintf) display the output of each required calculation to the command window accompanied by an appropriate text explaining what is being displayed. **This is required for all problems.**
* Once completed, please publish this program to pdf and email it to Dr. Imas. For more information on linear algebra topics, please refer to the supplemental materials posted on Blackboard under Lecture Set for Numerical Methods. For MATLAB applications, please refer to Chapter 11 of your textbook.

**Part 1 (15 pts)**

1. **5 pts.** A = [3 4 -5 7 9] and B = [-7 3 0 -15 -4]. Using appropriate MATLAB command compute the **dot product** of vectors A and B, and assign the result to the variable of your choice. Before completing this computation, on your own, investigate how dot product is computed and what it represents. In the comment of your code, briefly explain how the dot product is calculated.
2. **5 pts.** Compute the **norm** of the vectors A and B, respectively. Assign the results to the variables of your choice. On your own, investigate what the vector norm represents and how it is calculated. In the comment of your code, briefly explain how the norm is calculated.
3. **5 pts.** X = [-1 4 -5] and Y = [-5 13 7]. Compute the **cross product** of X and Y using an appropriate MATLAB command. On your own, investigate how the cross product of a 3D vector is calculated and briefly explain it in the comment.

**Part 2 (20 pts.)**

Consider the matrices given below and perform the following calculations.

Bob = George =

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 3 |
| 2 | 4 | 5 |
| 3 | 5 | 6 |

|  |  |  |
| --- | --- | --- |
| -4 | 3 | -7 |
| 5 | 2 | 1 |
| 3 | 5 | 2 |

1. **3 pts.** Find the inverse matrix of Bob by using *inv* function.
2. **6 pts.** Find the inverse matrix of Bob by using *rref* function (Reduced Row Echelon Form). Please make sure to review your notes to understand the process. In addition to the *rref* function, you would need to create an augmented matrix, in which on the right side of the partition you would have to place an identity matrix (function *eye*). Also, note that the inverse matrix would exist as a subarray of the output matrix of *rref*. When executed, your code must display in the command window the inverse matrix only.
3. **3 pts.** Compute matrix and array products of matrices Bob and George.
4. **4 pts.** Using the function *det*, find the determinants of Bob and George, respectively.
5. **4 pts.** Using the function *rank*, find the ranks of Bob and George, respectively.

**Part 3 (40 pts.)**

1. The system of equations given below has the same number of equations and unknowns. It can be shown that only one solution exists. Solve the system of equations using each of the following MATLAB methods.
   1. **6 pts.** Partitioned Equations System: using *inv* function.
   2. **4 pts.** Partitioned Equations System: using “left divide” or “\”.
   3. **4 pts.** Using *linsolve* function
   4. **6 pts.** Using *rref*. Note that the final solutions matrix is a subarray of the output matrix of *rref*. In the command window, your code must display the solution matrix only.
2. **10 pts.** The following system of equations has the same number of equations and unknowns. It can be shown that an infinite number of solutions exists in this case.

Determine the appropriate MATALB technique to solve this system such that the best-fit solution is obtained. Implement this method. In the comment, briefly explain why this particular technique was chosen and how it works.

**Part 4 (25 pts.)**

1. **15 pts.** Calculate and plot an approximate derivatives of the function given below between the limits seconds with step sizes of 2, 1. 0.5, 0.1, 0.005, and 0.001. Use the function *diff* to perform numerical differentiation.

You should have six plots arranged in one figure containing six subplots. Make sure to appropriately label your figure and its axes. Do not forget units.

1. **5 pts.** Find the integral of the function given above between the limits of *t=*0 and *t=*20 seconds using *trapz* function. In other words, integrate over the entire signal (use the signal generated with a step of 0.001).
2. **5 pts.** Evaluate the same integral as in (b) but using *integral* function. Note that the input to this function is a function handle of *y(t)*. In the comment, state whether the results of (b) and (c) agree.