**Department of Electrical Engineering**

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| **Faculty Member: Dr. Syed Ali Hassan** | **Dated: 13th September 2022** |
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| **Course/Section: DCS Group 2** | **Semester: 7th** |
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**EE355 Digital Communication Systems**

**Lab#1** **MATLAB Programming-A Quick Recap**

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|  |  | **PLO4-CLO3** | | **PLO5-CLO4** |
| **Name** | **Reg. No** | **Viva / Quiz / Lab Performance** | **Analysis of data in Lab Report** | **Modern Tool Usage** |
|  |  | **5 Marks** | **5 Marks** | **5 Marks** |
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**Lab1: MATLAB Programming-A Quick Recap**

**Objectives:**

The objective of this lab is to review the fundamentals of MATLAB with reference to communication systems.

* Dealing with the matrices, vectors, and mathematical operations in MATLAB
* Making functions in MATLAB
* Verifying the random number generation properties
* Simulating Gaussian noise.

**Lab Instructions**

* This lab activity comprises of following parts: Pre-lab, Lab Exercises, and Post-Lab Viva/Quiz session.
* The lab report shall be uploaded on LMS.
* Only those tasks that are completed during the allocated lab time will be credited to the students. Students are however encouraged to practice on their own in their spare time for enhancing their skills.

**Lab Report Instructions**

All questions should be answered precisely to get maximum credit. A lab report must ensure the following items:

* Lab objectives
* MATLAB codes
* Results (graphs/tables) duly commented and discussed
* Conclusion

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| **Lab-01: MATLAB Programming-A Quick Recap** |
| **MATLAB Guide**  For getting familiar with MATLAB operations, matrices, arrays, loops, and plots, please refer to <https://www.mathworks.com/help/matlab/getting-started-with-matlab.html>.  **Task-1**  Generate a 3x3 matrix A.   1. Calculate the inverse of matrix A by using the inv() command. Get MATLAB help by typing help inv if you don’t know how to use the command/function.      1. Multiply A with its inverse and verify if it produces the identity matrix.      1. Generate another matrix A2=A\*A and repeat the above.      |  | | --- | | **Complete code of the MATLAB for task 1** | | %----------Task 1----------  clc  %This function genrate matrix of order 3x3 with randon number every time it  %will run  a=randi([0 50] ,[3 3])  %takng inverse  inv\_a=inv(a)  %taking product to get identity matrix  product=a\*inv\_a  %genrating another matrix by multiplying already genrated matrix a  a2=a\*a  %taking inverse  inv\_a2=inv(a2)  %taking product to get identity matrix  product2=a2\*inv\_a2 |   **Task-2**  **What is the function of rand()? (Find out by using MATLAB help.)**  This function return Uniformly distributed pseudorandom numbers.  R = rand(N) returns an N-by-N matrix containing pseudorandom values drawn from the standard uniform distribution on the open interval(0,1). rand(M,N) or rand([M,N]) returns an M-by-N matrix. rand(M,N,P,...) or rand([M,N,P,...]) returns an M-by-N-by-P-by-... array. rand returns a scalar. rand(SIZE(A)) returns an array the same size as A.     1. Generate five sequences of random numbers each of 100 elements and put them in a matrix of size 5x100.      1. Using the command mean(), find the average of each sequence. (Hint: you will have five average values).      |  | | --- | | **Complete code of the MATLAB for task 2** | | %------------Task 2-----------  %Genrating five sequence of random number from 0m to 100  seq1=rand(1,100);  seq2=rand(1,100);  seq3=rand(1,100);  seq4=rand(1,100);  seq5=rand(1,100);  %cancating the genrated sequence to form them in a order of 5x100  cantcated=[seq1;seq2;seq3;seq4;seq5];  %finding order ofd matrix to verify that it ius actually of order 5x100  order =size(cantcated);  %------part 2-------  mean1=mean(seq1)  mean2=mean(seq2)  mean3=mean(seq3)  mean4=mean(seq4)  mean5=mean(seq5) |   **Task-3**  Verification of random number generation properties.   1. Generate 100 random integers in the range [0,3] and calculate the frequency of each number and plot the histogram. (Hint: F(0)=20, F(1)=40, F(2)=25, F(3)=15)      1. Repeat for 1000, 10000, and 100000 samples. What do you observe/conclude?          |  | | --- | | **Complete code of part a and part b from task 3** | | %----------Task 3---------part 1----  num1=randi([0 3],[1,100]);  frequence\_for\_zero=numel(find(num1==0));  frequence\_for\_one=numel(find(num1==1));  frequence\_for\_two=numel(find(num1==2));  frequence\_for\_three=numel(find(num1==3));  figure (1)  h=histogram(num1,4);  title('Graph of 100 samples')  xlabel('Number')  ylabel('Frequency')  %----------Task 3---------part 2----  num1=randi([0 3],[1,1000]);  frequence\_for\_zero=numel(find(num1==0));  frequence\_for\_one=numel(find(num1==1));  frequence\_for\_two=numel(find(num1==2));  frequence\_for\_three=numel(find(num1==3));  figure (2)  h=histogram(num1,4);  title('Graph of 1000 samples')  xlabel('Number')  ylabel('Frequency')  %--------for 10000 samples-----  num1=randi([0 3],[1,10000]);  frequence\_for\_zero=numel(find(num1==0));  frequence\_for\_one=numel(find(num1==1));  frequence\_for\_two=numel(find(num1==2));  frequence\_for\_three=numel(find(num1==3));  figure (3)  h=histogram(num1,4);  title('Graph of 10000 samples')  xlabel('Number')  ylabel('Frequency')  %--------for 100000 samples-----  num1=randi([0 3],[1,100000])  frequence\_for\_zero=numel(find(num1==0))  frequence\_for\_one=numel(find(num1==1))  frequence\_for\_two=numel(find(num1==2))  frequence\_for\_three=numel(find(num1==3))  figure (4)  h=histogram(num1,4);  title('Graph of 100000 samples')  xlabel('Number')  ylabel('Frequency') |  1. Repeat (a) and (b) for random integers [0-7] and sample sizes of 100, 1000, 10000 and 100000. What do you observe from your results?          |  | | --- | | **Complete code of part c from task 3** | | %----------Task 3---------part 3----  num1=randi([0 7],[1,1000]);  frequence\_for\_zero=numel(find(num1==0));  frequence\_for\_one=numel(find(num1==1));  frequence\_for\_two=numel(find(num1==2));  frequence\_for\_three=numel(find(num1==3));  frequence\_for\_four=numel(find(num1==4));  frequence\_for\_five=numel(find(num1==5));  frequence\_for\_six=numel(find(num1==6));  frequence\_for\_seven=numel(find(num1==7));  figure (5)  h=histogram(num1,8);  title('Graph of 1000 samples')  xlabel('Number')  ylabel('Frequency')  %--------for 10000 samples-----  num1=randi([0 7],[1,10000]);  frequence\_for\_zero=numel(find(num1==0));  frequence\_for\_one=numel(find(num1==1));  frequence\_for\_two=numel(find(num1==2));  frequence\_for\_three=numel(find(num1==3));  frequence\_for\_four=numel(find(num1==4));  frequence\_for\_five=numel(find(num1==5));  frequence\_for\_six=numel(find(num1==6));  frequence\_for\_seven=numel(find(num1==7));  figure (6)  h=histogram(num1,7);  title('Graph of 10000 samples')  xlabel('Number')  ylabel('Frequency')  %--------for 100000 samples-----  num1=randi([0 7],[1,100000]);  frequence\_for\_zero=numel(find(num1==0))  frequence\_for\_one=numel(find(num1==1))  frequence\_for\_two=numel(find(num1==2))  frequence\_for\_three=numel(find(num1==3))  frequence\_for\_four=numel(find(num1==4))  frequence\_for\_five=numel(find(num1==5))  frequence\_for\_six=numel(find(num1==6))  frequence\_for\_seven=numel(find(num1==7))  figure (7)  h=histogram(num1,8);  title('Graph of 100000 samples')  xlabel('Number')  ylabel('Frequency') |   As we increase the number of samples the frequency of each number increase and almost get similar and each class of the histogram gets similar.  **Task-4**  Simulation of Gaussian noise.   1. Generate a real Gaussian noise sequence with zero mean and variance 1. Plot the histogram to verify the sequence has a Gaussian distribution. (Hint: randn() and hist())      1. Plot and compare it with the theoretical Gaussian function. (Hint: wgn())      1. What is the average symbol power of the sequence?   Average symbol power of the sequence is 0.001 dBW.   |  | | --- | | **Complete code of part a and part b from task 4** | | %------------task 4------------  norm=randn(100000,1)  mean1=mean(norm)  varirance=var(norm)  %Genral functin is Y= mean+var\*wgn(m,n,power)  Y=wgn(100000,1,0.001);  figure(2)  h1=histogram(norm);  title('Normal distributiuon using randn function')  figure(3)  h1=histogram(norm);  hold on  h2=histogram(Y)  title('Comparison of normal distributions '); |   **Task-5**  Plotting sinusoid.   1. Generate variable t=linspace(0,2\*pi,20). Calculate the sin values by using the sin() command. Plot them on a graph with t as the x-axis and sin(t) as the y-axis. Give labels properly for the x and y axes as t and sin(t), respectively. Set the marker to square, the line width of the graph to 3, and the line color to red. (pi=3.1415).      |  | | --- | | **Code of part a task 5** | | %----------Task 5---------  t=linspace(0,2\*pi,20);  tt=sin(t);  figure(4)  plot(t,tt,'--rs','LineWidth',3)  xlabel('x');  ylabel('sinx'); |  1. Create function sineplot.m that receives one argument n, k (n, k are scalars). This function will generate variable t which has n elements equispaced between 0 and 2\*pi. It will generate the values of sin(n\*k). The function will also plot the graph on MATLAB figure (using the plot() function). Label the x and y-axis of the graph.      |  | | --- | | **Code of part b task 5** | | function[t,sint]=sineplot(n,k)  t=linspace(0,2\*pi,n);  sint=sin(t\*k);  plot(t,sint,'--rs','LineWidth',3)  xlabel('t');  ylabel('sint'); |   **Task-6**  Complete the following two-hour “MATLAB on the ramp” course on MathWorks and upload your certificate with the report. Use your SEECS email ID to create an account on MathWorks so that you can have free access to the source   * https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted     **Conclusion:**  In this lab we get introduce to MATLAB. We get to know about the arrays and matrices multiplication and how to use random function to generates the random each time it will executes. Moreover Task 6 was quite helpful for completing all the tasks effectively. |
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