Digital Signal Processing

Lab **CSE 4632**

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Lab 1

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General Instructions

For each task, make a separate file. For Matlab make a file such as **Task1.m, Task2.m,** and so on. For Python, you can either make separate files such as Task1.py, Task2.py, and so on, or you can make a single python colab/jupyter notebook containing all the tasks and output. For each graph or plot, you have to produce images as well using functions like "save fig" and save those images as **Task1_fig.png**, **Task2_fig.png**, and so on. After each weekly lab, you will be given some time to complete the rest of the tasks and prepare a report. The report includes the full code of each task, the solution explanations, and the figures. Then, you will have to upload the code files, the plot images, and the report pdf in google classroom. **(Do not Zip)**

Tasks

1. Write down the commands for each of the following operations: a. Create a row vector x of 5 equally spaced elements between 2 and 3 add 1 to the second element

   b. Create a second-row vector y of same dimension with elements equal to the successive even integers starting with 4.

   c. Create the matrix A, whose first row is equal to x, whose second row is a line of ones, and whose third row is equal to y.

   d. Define a row vector z, whose elements are equal to the mean value of the columns of A.

   e. Define a column vector zz, whose elements are the sum of the elements in each rows of A.

2. Create two matrices A and B:

$$A = \begin{pmatrix} 1 & 2 \\ 4 & -1 \end{pmatrix}, B = \begin{pmatrix} 4 & -2 \\ -6 & 3 \end{pmatrix}$$

a. Compute C_1 = A+B and C_2 = A-B

b. Compute the matrix products D_1 = AB and D_2 = BA

c. Using element wise operations, compute the matrix F whose elements are computed as follows, $f_{ij} = b_{ij} + a_{ij} b_{ij}^{1/4}$

d. In A, subtract from the second row, the first row multiplied by 4

3. Create a vector a with elements

$$a_n = \frac{(-1)^n \pi^{2n}}{(2n)!}, 0 \le n \le 100$$

Compute the sum of the elements of vector a

4. Given x = [7 6 1 2 0 -1 4 3 -2 0], what are the commands that will execute the following operations?

a. Sets the negative values of x to zero.

b. Extract the values of x greater than 3 in a vector y.

c. Add 3 to the values of x that are even.

d. Set the values of x that are less than the mean to zero.

e. Set the values of x those are greater than the mean to their difference with the mean.

5. In MATLAB, plot the functions x, x^3, e^x and e^{x^2} over the interval 0 < x < 5. Learn about the command **hold** and apply it. Use labels and titles for your plot.

6. Plot a discrete-time sinusoidal signal with $A = \frac{\pi}{6}$, $\omega = \frac{\pi}{3}$, $\phi = 10$ where -10 < n < 10. Here's a little bit of help for you, this is the general equation for a discrete-time sinusoidal signal.

$$x(n) = A\cos(\omega n + \phi)$$

7. Following is an equation which is used to calculate the growth of population of a certain country where t is the year in AD format (2013, 1921 etc.)

$$P(t) = 197273000/(1 + e^{-0.0313(t-1913.26)})$$

a. Write a MATLAB function that takes two values of t (t_1 and t_2) and plots the population in that range.

b. Verify your function by setting values of t_1 = 1810 and t_2 = 2013

c. What will be predicted population in the year 2021?

8. Check the help for "diag" and use it (may be more than once) to build the following 16x16 matrix:

$$D = \begin{bmatrix} -2 & 1 & 0 & 0 & \cdots & 0 & 1 \\ 1 & -2 & 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & -2 & 1 & 0 & \cdots & 0 \\ \vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 1 & -2 & 1 & 0 \\ 0 & 0 & \cdots & 0 & 1 & -2 & 1 \\ 1 & 0 & 0 & \cdots & 0 & 1 & -2 \end{bmatrix}$$