7- Labwork - Fourier Series Coefficients & Gibbs Phenomenon

- You **cannot** use SYMBOLIC TOOLBOX.

In this lab, a matrix (matrix_Double.mat is the matrix form of the mri.tif image) will be manipulated to obtain a periodic signal and the approximations of this periodic signal will be calculated by using its Fourier series coefficients.

1) To define **one period of the periodic x(t) signal**, follow the steps below.

- Download "matrix_Double.mat" and "mri.tif" files and save them in where you save your "Name_surname_labx.m" file

Step 1: Write

```
load('matrix_Double.mat'); %load mat file
```

- in your Name_surname_labx.m file.

Step 2: Code written in Step 1 can define "matrix_Double" variable. Run your code and check!

Step 3: "matrix_Double" variable is in the form of a **matrix** consisting of rows and columns (2-Dimensional). By using **MATLAB's proper built in function**, transform it into 1-Dimensional **row** vector. The result(1-Dimensional row vector) will be **one period of the x(t) signal**.

2) Calculate the Fourier series coefficients (c_k) as calculated in the previous lab.

$$dt = 1 \; second$$
$$T = \; (length \; of \; x(t) signal) \; seconds$$
$$1 \leq t \leq (length \; of \; x(t) signal)$$
$$k = -2000: 1: 2000$$

3) Obtain **the approximations ($\hat{x}(t)$) of the x(t) signal** by using Equation 1. Use M values of 100, 500, 1000 and 2000. Use "real( )" function to remove the imaginary part of the $\hat{x}(t)$. Save calculated approximations for each M.

$$\hat{x}(t) = \sum_{k=-M}^{M} c_k e^{jkwt} \qquad (1)$$

4) Calculate the mean square error (MSE) of each approximation by using Equation 2 and plot errors for M values given in Part 3. Note that N represents the number of elements in the array.

$$MSE = \frac{1}{N}\sum_{t=1}^{T}(\hat{x}(t) - x(t))^2 \qquad (2)$$

5) Write the code below at the end of your m file. Replace the names of the "x_approximated" variables with the name of your approximated signals. Comment out the code to show the original image and each of your approximations in image format.

- Each figure shows an approximated version of "mri.tif" image
- If **Image Processing Toolbox** is not installed in MATLAB, write the code and replace proper variable names. But **do not comment out.**

```
%[row, column]=size(matrix_Double);
%figure
%image_original=uint8(real((reshape(x,[row column])))); %vector to matrix to
%image
%imshow(image_original)
%
%figure
%image_approximated=uint8(real((reshape(x_approximated1,[row column])))); %vector
%to matrix to image
%imshow(image_approximated)
%
%figure
%image_approximated=uint8(real((reshape(x_approximated2,[row column])))); %vector
%to matrix to image
%imshow(image_approximated)
%
%figure
%image_approximated=uint8(real((reshape(x_approximated3,[row column])))); %vector
%to matrix to image
%imshow(image_approximated)
%
%figure
%image_approximated=uint8(real((reshape(x_approximated4,[row column])))); %vector
%to matrix to image
%imshow(image_approximated)
```