University of Puerto Rico
Department of Electrical and Computer Engineering
[INEL 5309-016] Digital Signal Processing
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ReadMe

DESIGN OF A MATLAB ENVIRONMENT TO DEMONSTRATE PROPERTIES OF THE DISCRETE FOURIER TRANSFORM (DFT)

Program Designed By:

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I. Project Overview

This MATLAB Environment is intended to demonstrate, in a scientific-pedagogical manner, the principal properties of the Discrete Fourier Transform (DFT), commonly known as the DFT. Such properties are presented in Figure 1.

THEOREM	LENGTH-N SEQUENCE	N-POINT DFT
Linearity	$\alpha g[n] + \beta h[n]$	$\alpha G[k] + \beta H[k]$
Circular Time-Shifting	$g[\langle n - n_0 \rangle_N]$	$W_N^{kn_0} G[k]$
Circular Frequency-Shifting	$W_N^{-k_0 n} g[n]$	$G[\langle k - k_0 \rangle_N]$
Duality	$G[n]$	$Ng[\langle -k \rangle_N]$
N-Point Circular Convolution	$\sum_{m=0}^{N-1} g[m]h[\langle n - m \rangle_N]$	$G[k]H[k]$
Modulation	$g[n]h[n]$	$\frac{1}{N}\sum_{m=0}^{N-1} G[m]H[\langle n - m \rangle_N]$
Parseval's Theorem	$\sum_{m=0}^{N-1} \lvert g[n] \rvert^2$	$\frac{1}{N}\sum_{m=0}^{N-1} \lvert G[k] \rvert^2$

Fig. 1 *Principal Properties of the DFT*

II. Basic Requirements

1. In order to be able to execute the designed MATLAB Environment, the program directory (INEL5309_S016_P2_MATLAB_Environment) must be opened.

   Open  -> INEL5309_S016_P2_MATLAB_Environment (Path)

2. The *DFT_Properties_Environment.m* file must be executed from MATLAB. To perform this operation, double click on the mentioned script and then press the run button:

   Editor -> Run 

3. A figure will appear with the main interphase of the program (Figure 2).

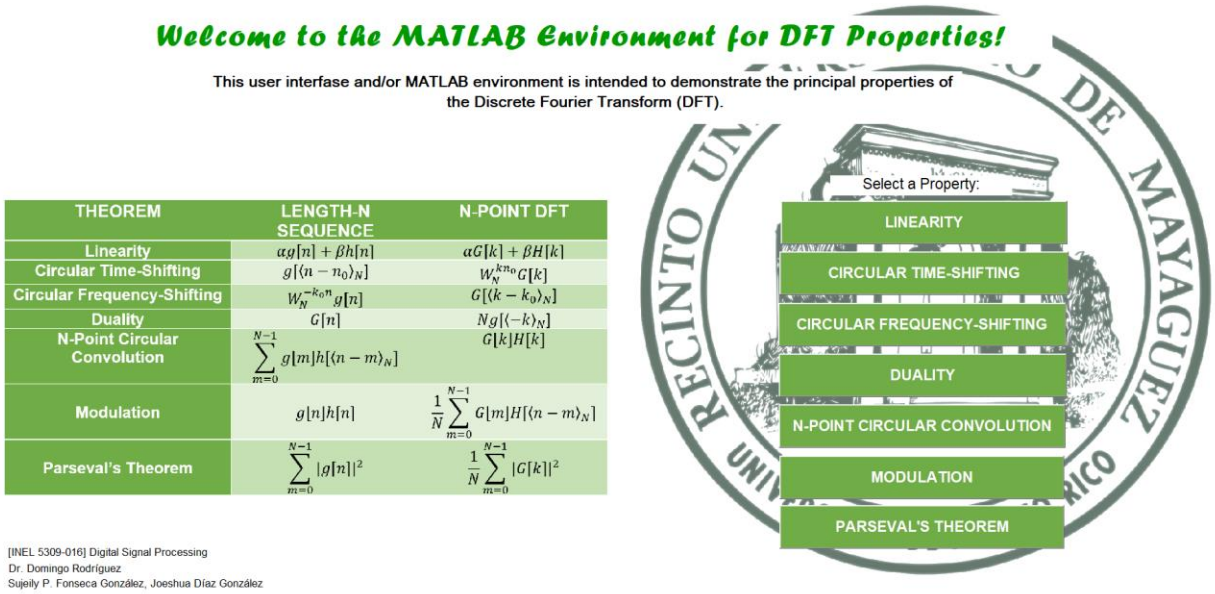

Fig. 2 *MATLAB Environment for DFT Properties*

The Figure 2 will present the DFT Properties available in the MATLAB Environment within a table. This to provide the definition for each of the mentioned properties.

III. Required Steps and Specifications

1. The user must select the desired property from the list presented in the main interphase.

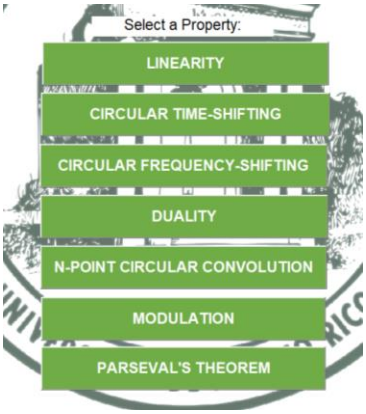

Fig. 3 *List of DFT Properties*

2. A new window will appear with the selected DFT Property.
3. If parameters are required, they must be indicated before uploading the file(s) corresponding to the input signal(s). Parameters must be written in the assigned field.
4. The file(s) of the input signal must be included. Function(s) or file(s) can be uploaded with the corresponding pushbutton(s)
5. The structure of an input function consists in a *.txt* file with the values placed in a row vector (horizontally). There are two files that can be used as example within the project directory (*g.txt* and *h.txt*).

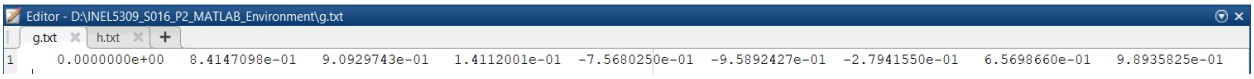

Fig. 4 *Structure of a Function (Input File)*

6. It is recommended that the length of the input signal(s) be between 16-64 points.
7. If a property needs more than one function, the *Done* button must be selected after completing the required fields.
8. If only one function is needed, after uploading it, results will appear.
9. After loading successfully the required fields, the program will make the necessary calculations and it will plot the real and imaginary parts of each sides of the property. Furthermore, the program will generate four files with the output signals. These files will be *.txt* files in *ascii,* and will be saved in the Outputs directory (*INEL5309_S016_P2_MATLAB_Environment\Outputs).*
10. The MATLAB project directory will contain the scripts for the figures, which can be used to understand the methodology and procedures followed.

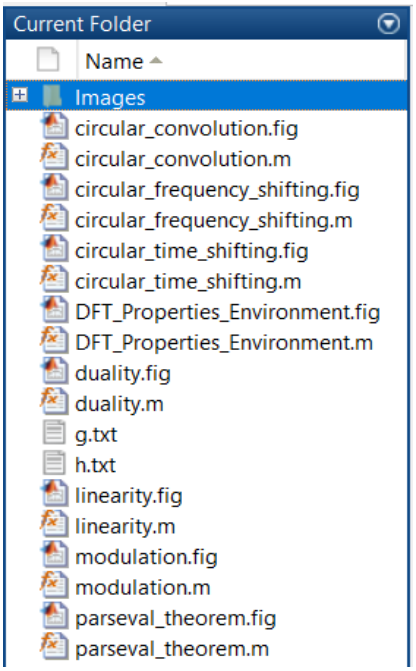

Fig. 5 *Project Directory*

IV. Program Modules

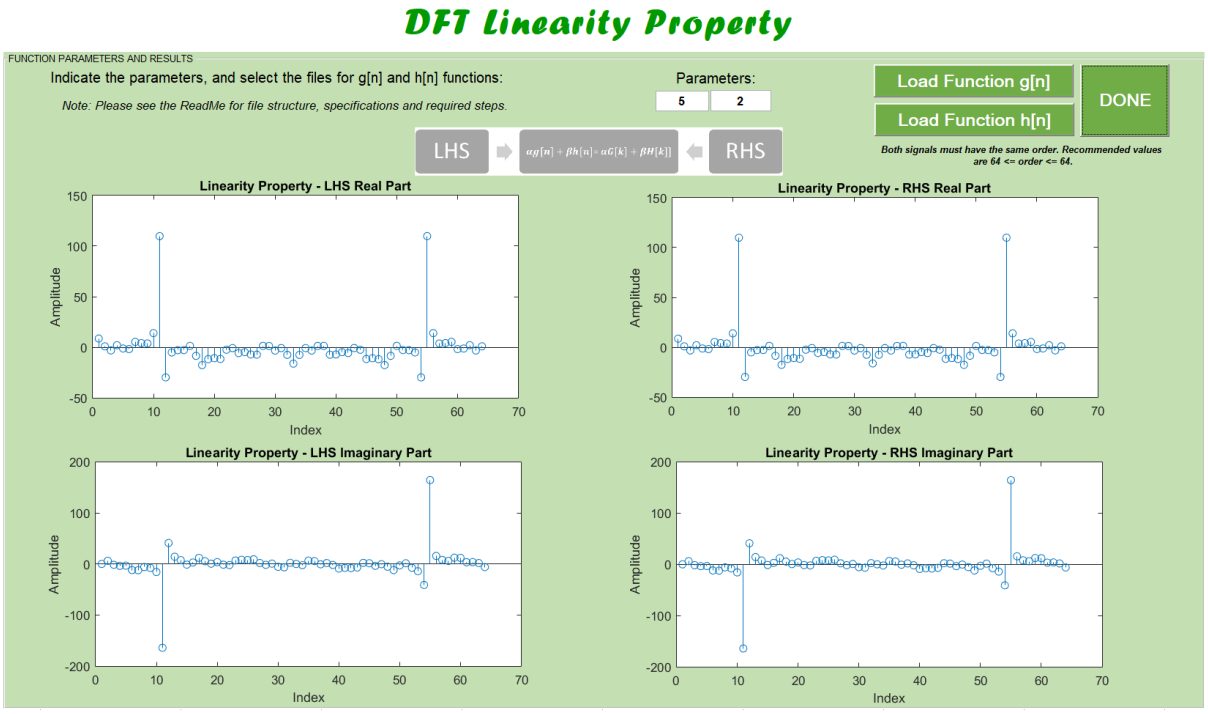

Fig. 6 *Example with the DFT Linearity Property*

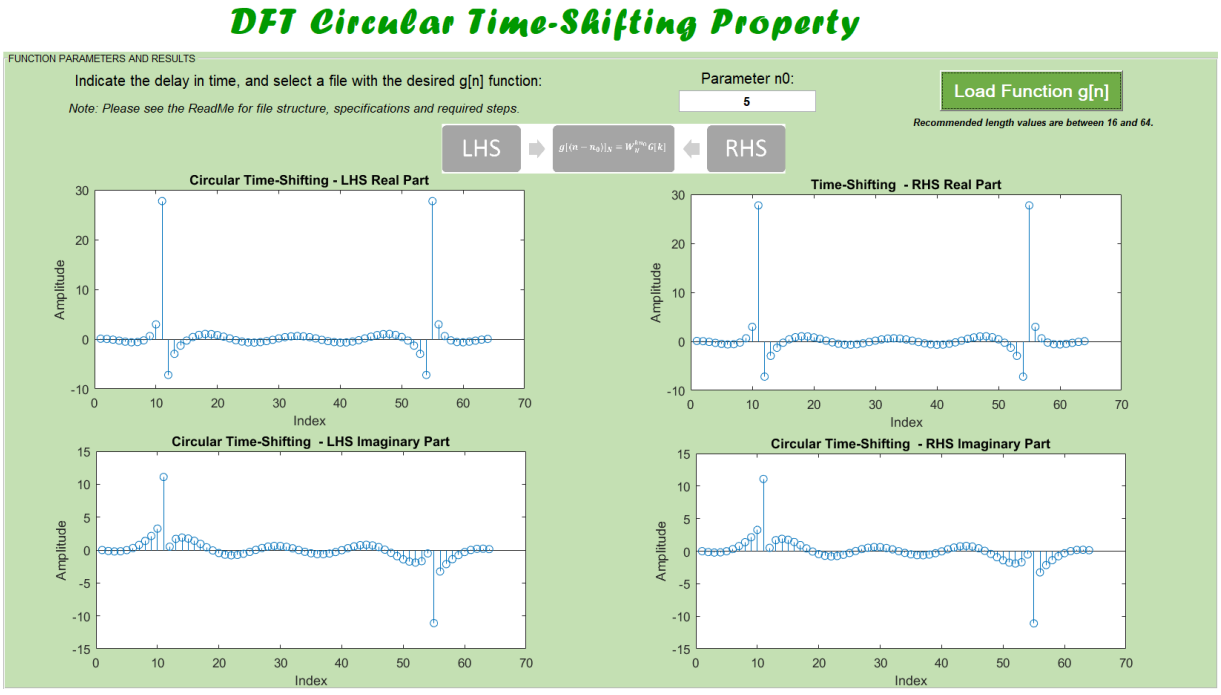

Fig. 7 *Example with the DFT Circular Time-Shifting Property*

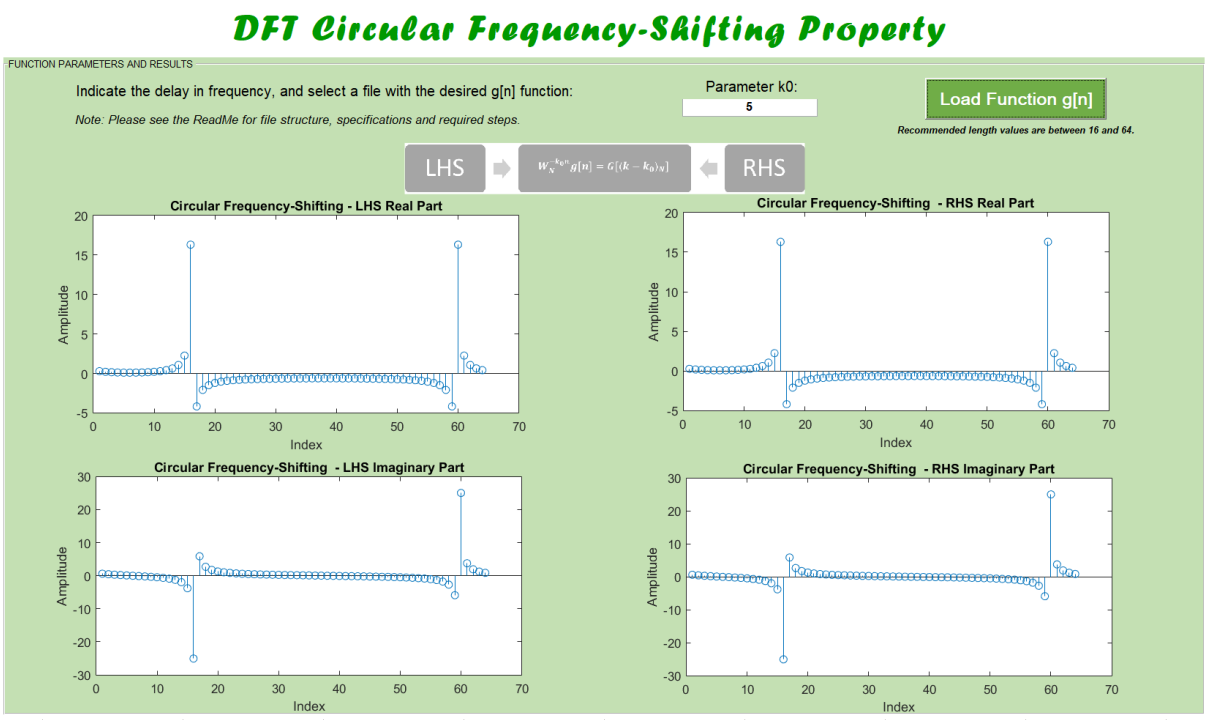

Fig. 8 *Example with the DFT Circular Frequency-Shifting Property*

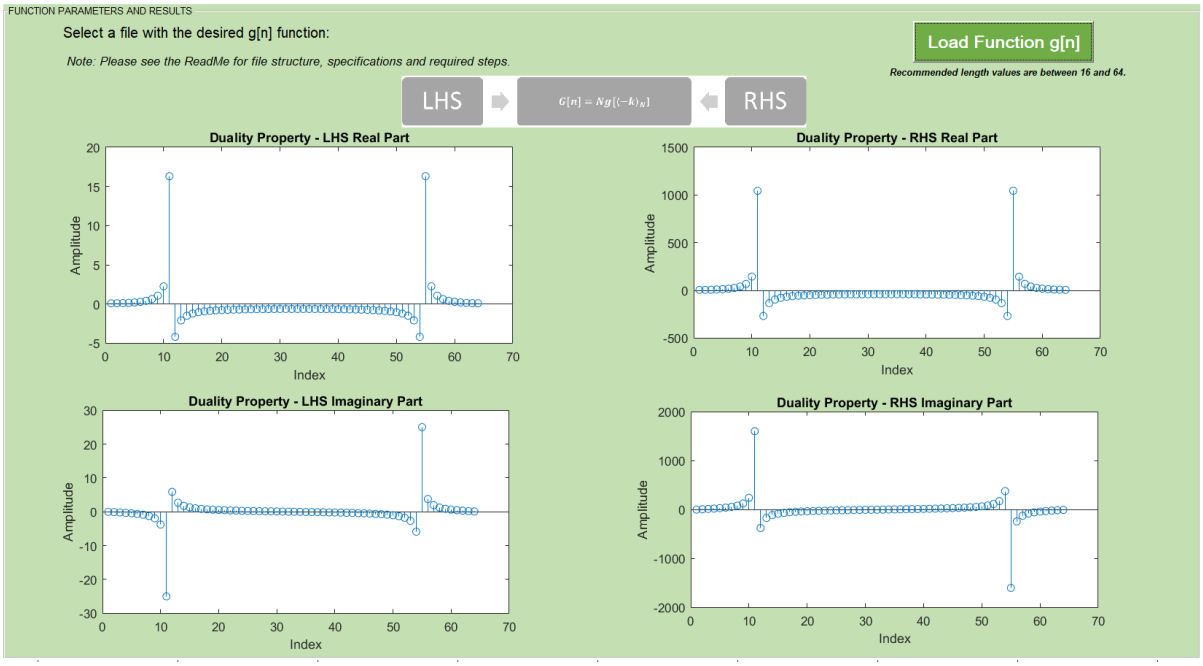

Fig. 9 *Example with the DFT Duality Property*

DFT N-Point Circular Convolution Property

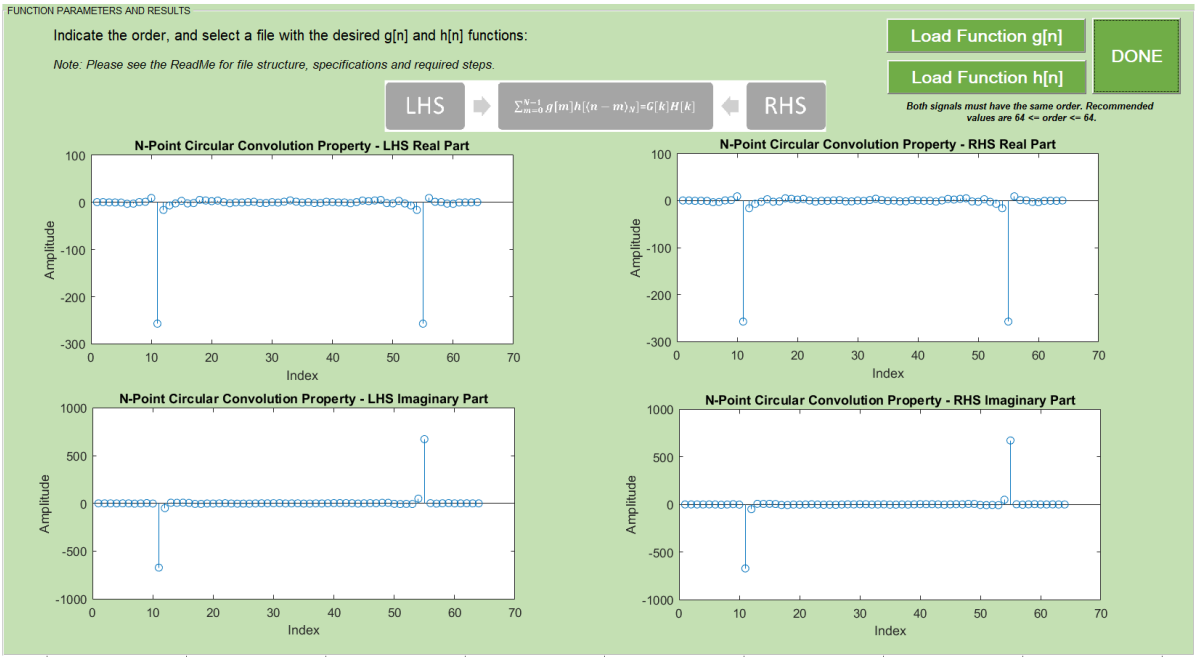

Fig. 10 *Example with the DFT Convolution Property*

DFT Modulation Property

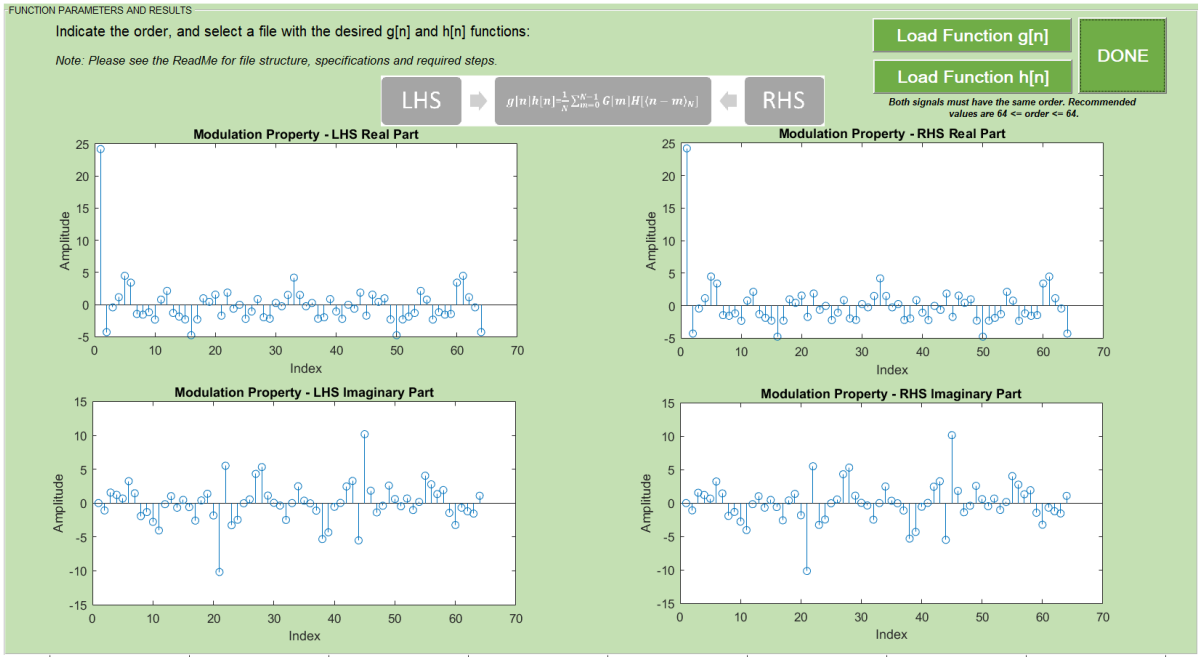

Fig. 11 *Example with the DFT Modulation Property*

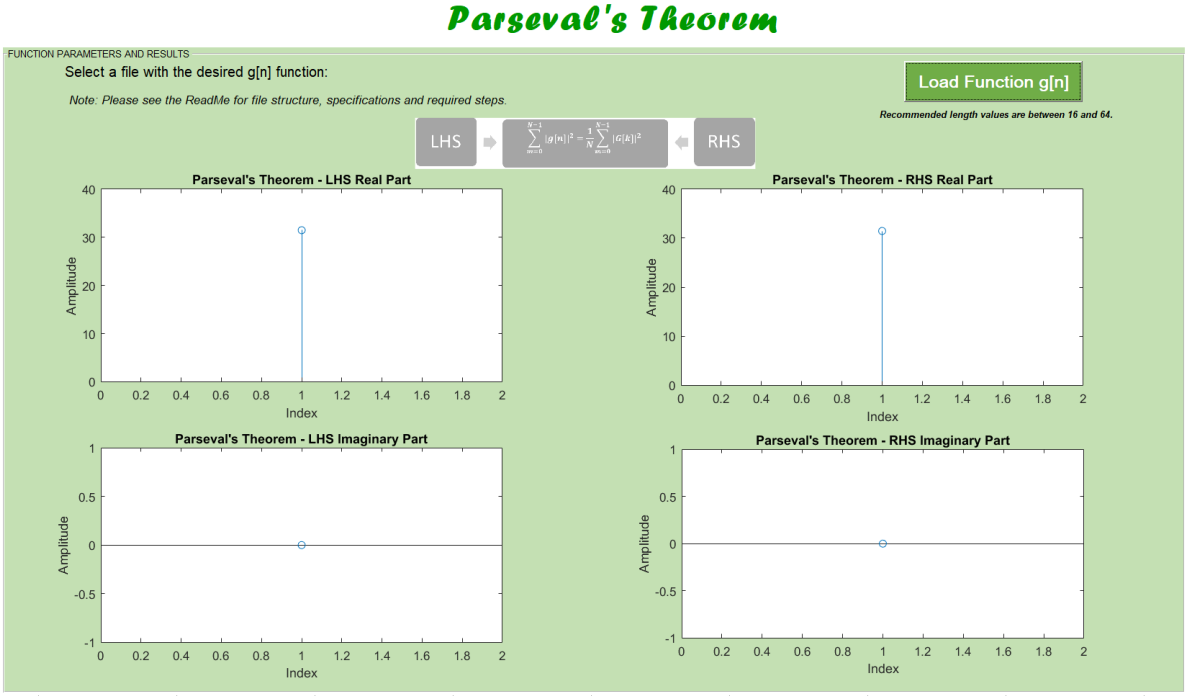

Fig. 12 *Example with the Parseval's Theorem*