Cairo University
Faculty of Engineering
Electronics & Communication Department

ELC3253B 3rd year
2023 – 2024

Assignment 3

1.1 Gram-Schmidt Orthogonalization:

- Write a Matlab function "[phi1,phi2]=GM_Bases(s1,s2)"
  - The function calculates the Gram-Schmidt orthonormal bases functions (phi1 & phi 2) for two input signals (s1 & s2)
  - The inputs s1 and s2: are two $1\times N$ vectors that represent the input signals
  - The outputs phi1 & phi2: are two $1\times N$ vectors that represent the two orthonormal bases functions (using Gram-Schmidt). If s1 & s2 have one basis function, then phi2 is $1\times N$ zero vector

1.2 Signal Space representation:

- Write a matlab function "[v1,v2]=signal_space(s, phi1,phi2)"
  - The function calculates the signal space representation of input signal s over the orthonormal bases functions (phi1 & phi 2)
  - The inputs s: is a $1\times N$ vectors that represent the input signal
  - The inputs phi1 & phi2: are two $1\times N$ vectors that represent the two orthonormal bases functions .
  - The output [v1,v2]: is the projections (i.e. the correlations) of s over phi1 and phi2 respectively.

1.3 Effect of AWGN on signal space representation

Now consider the signals

$r_1(t) = s_1(t) + w(t); \qquad r_2(t) = s_2(t) + w(t)$

Where $w(t)$ is a zero mean AWGN with variance σ^2

1.4 Requirements

1. Use your "GM_Bases" function to get the bases functions of $s_1(t)$ & $s_2(t)$ Figure 1.1. Plot the obtained bases functions

2. Use your "signal_space" function (along with the bases from 1) to get the signal space representation of $s_1(t)$ & $s_2(t)$ in Figure 1.1. Plot the signal space representation

3. Generate samples of $r_1(t)$ and $r_2(t)$ using $s_1(t)$ & $s_2(t)$ in Figure 1.1 and random noise samples (for example 50 or 100 sample). Use your "signal_space" function (along with the bases from 1) to plot the signal points of the generated samples of $r_1(t)$ and $r_2(t)$ at $\frac{E}{\sigma^2} = -5$ dB, 0 dB, 10 dB (each $\frac{E}{\sigma^2}$ in a different figure), where E is the energy of $s_1(t)$ or $s_2(t)$ (**use "scatter" in Matlab**)
4. How does the noise affect the signal space? Does the noise effect increase or decrease with increasing σ^2?

Notes: ***Each figure should have a legend and the axes should be properly labelled with proper font size. All curves should have line width of 2.***
The signal points in the scatter plots in 3 should be clear and visible. Use different colours for the points of $r_1(t)$ and $r_2(t)$

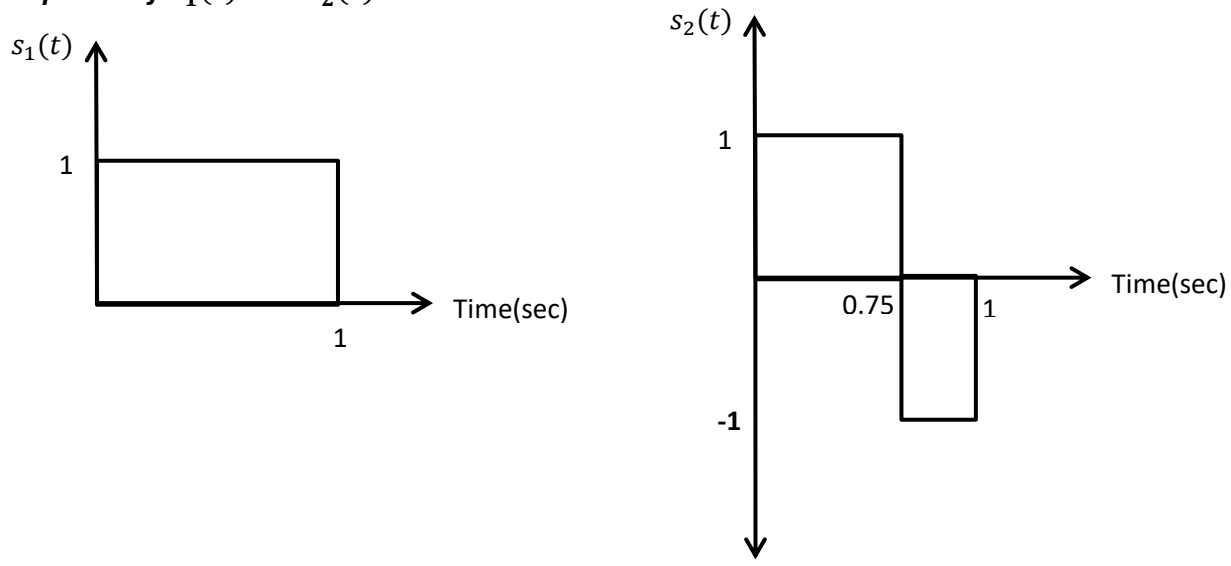

Figure 1.1

Submission Requirements

1. You should submit a .pdf report that **fulfils the requirements of all parts (in the same order of the requirements).** The report should include:
    - **a)** All the required results, comments, and answers to questions
    - **b)** All the required figures
    - **c)** All the required sketches and theoretical analysis
    - **d)** All codes as appendices (with comments that clearly explain the code and variables).
2. The figures in your report should be **clear**. **All figures** should have **a clear legend and the axes should be properly labelled with proper font size.**
3. Your comments and answers should be clearly typed not scanned. They should be **"concise"** and do not exceed 3 lines (each)**.**
4. Please keep your report **neat, clean, and organized**.
5. **You are responsible** for the clarity and visibility of your figures, analysis, comments, code, etc.

Plagiarism: Students must not copy any material from any reference (without proper citation) or any another project. Plagiarism check shall be carried and the project will be considered invalid (fail) in case of plagiarism.