EEE321 Lab Work 1

(Clearly justify all answers.)

(Due 3 October 2024 for Sec.2 and 4 October 2024 for Sec.1)

Work on these questions as a homework first: answer the analytical parts of the questions and write the answers on a paper, write a MATLAB program (or many such programs) to perform the tasks that need computation, print your MATLAB code(s), print your computer outputs (numerical and graphic) whenever needed; the collection of all those will be your lab report. Be ready to run your computer codes during your on-line lab session. During your lab session, your TA will ask you questions, observe your results as you run them, and may go over your codes as needed. Based on your results, you may be asked to modify your lab report, including any modifications needed in your MATLAB codes, during the lab hours. Your on-line lab session will continue until your TA is satisfied with your results, during the allocated lab hours. You may upload your entire lab report during or right after your on-line lab session to MOODLE. If you need some more time to modify your report, you may do so, until the end of the day. Your report will get a grade based on your preparedness when you come to the lab session, performance of your codes during the lab session, (including any modifications done during the lab session) your answers to the oral questions during your demo(s), and the entire content of the submitted report.

****

A digital computer can only store and process digital signals. Digital signals are signals that are both discrete (in terms of its variable) and quantized (in terms of its value). Here in this lab practice, you will investigate discrete cosine signals. A discrete cosine signal is defined only over integers like any other discrete signal and given by the most general form, $x[n] = A\cos[\omega n+\phi]$, $n \in (-\infty, \infty)$. A is the amplitude, ω is the normalized frequency (in radians), and ϕ is the phase shift, also in radians. Note that the integer variable n in discrete signals is unitless; therefore, the frequency ω in discrete cosine signals has a unit which is just radians, and not radians per unit time as in continuous-time signals.

1- $x_1[n] = 3\cos[0.13\pi n + 0.5]$ for $n \in (-\infty, \infty)$. Generate and store in a file (the file must be visible in a directory when you exit MATLAB) a finite segment of this discrete cosine signal for $n \in [0, 127]$. Discuss the quantization associated with this $x_1[n]$ when it is generated and stored by a computer.

a) Retrive the file from the directory where it is stored, and read and print $x_1[3]$, $x_1[7]$, $x_1[114]$, $x_1[127]$.

b) Plot $x_1[n]$, $n \in [0, 127]$, adopting a graphic style which clearly shows the discrete nature of the signal. By the way, the default graph plotting style of MATLAB is not the best you can get: look at the discretee signal graphs in your textbook, and adopt a similar style. For example, do not use boxes, instead use horizontal and vertical axes as you ususally do when you plot a graph by hand. Use pin style for the values of the discrete-time function that you plot. Make sure that your graphs provide good enough information to whoever looks at them. Do not forget to label the axes of the graph properly. What is the value of ω?

2- Repeat (1) for $x_2[n] = \cos[2.2\pi n]$.

3- Repeat (1) for $x_3[n] = \cos[-1.8\pi n]$.

Compare (2) and (3) above, and comment on the results.

4- Repeat (1) for $x_4[n] = \cos[0.26\pi n]$.

5- Repeat (1) for $x_5[n] = \cos[0.26\pi n + 0.7]$.

Compare (4) and (5) above, and comment on the results.

6- Repeat (1) for $x_6[n] = \cos[0.01\pi n]$.

7- Repeat (1) for $x_7[n] = \cos[0.39\pi n]$.

8- Repeat (1) for $x_8[n] = \cos[\pi n]$.

9- Repeat (1) for $x_9[n] = \cos[1.08\pi n]$.

10- Repeat (1) for $x_{10}[n] = \cos[0.92\pi n]$.

Compare (9) and (10) above, and comment on the results.

11- Repeat (1) for $x_{11}[n] = \cos[n]$.

12- Repeat (1) for $x_{12}[n] = \cos[0.9n + 0.3]$.

A discrete signal $x[n]$ is said to be *periodic* if an integer N can be found, such that, $x[n + N] = x[n]$ for all n; in that case, N is a *period* of $x[n]$. Note that N, is not unique if it exists; minimum positive N is called the *fundamental period.* If a period cannot be found, as defined above, then the signal is not a periodic signal.

13- Using the above definition, find the fundamental period for each $x_i[n]$ given above; if the period does not exist (in other words, if the signal is not periodic), clearly justify the reason.

14- Write the most general property that ω must satisfy to have a periodic discrete cosine, and the corresponding fundamental period.

15- Compare and discuss the periodicity properties of discrete cosine signals with that of the continuous cosine signals.