Electrical and Computer Engineering 434

Computer Exercise 1, Fall 2025

This assignment is due taps on Lesson 14.

Important: This is a paperless assignment; turn it in by submitting it via e-mail to your professor. Include your MATLAB m-file program (use file name **"cpx1lastname.m"**) and your report as an MS Word document or pdf (use file name **"cpx1lastname.docx" or "cpx1lastname.pdf"**).

Authorized resources: You may not use reports or data from previous offerings of this course. This assignment may be completed with the assistance of other students (remember to properly document any assistance received). However, each student must turn in an individual item that consists of their own work. Your matlab coding must not be copied and be your own work.

1. Introduction

For this exercise, use your judgment and the knowledge you've gained so far in ECE434 to analyze the spectrum of the given "mystery" signals, all using MATLAB. You can employ basic DSP techniques such as the DFT, zero padding, windowing, and any others with which you are familiar. You have no way to obtain any more data points for any of the given mystery signals. Be sure to include appropriate comments in your program code, including a good response to the "help" command. Your professor will run your MATLAB program, check your results for validity, examine your code for readability and programming style, and read your write-up. Your overall score will range from 100% for truly exceptional work to 0% for totally unacceptable work.

Mystery Signals: The mystery signals are provided in the binary data file named `cpx1.bin`, which will be emailed to you by your instructor. Bring the data into MATLAB by using the command: `load cpx1.bin -mat`. This data file contains the following:

Name	Description
`Fs`	the original sampling frequency in Hertz
`n2`	`n` index vector for `x2` (length of 128)
`n3`	`n` index vector for `x3` (length of 128)
`n4`	`n` index vector for `x4` (length of 8192)
`x2`	data vector for part 1 of the CPX1
`x3`	data vector for part 2 of the CPX1
`x4`	data vector for part 3 of the CPX1

If you have trouble loading this data file, let your professor know ASAP.

2. Requirements

There are three main parts to this computer exercise, along with a write-up described in Section 3. Your MATLAB program will be evaluated in terms of correctness of approach, programming technique, usefulness of comments, and clarity of output (such as plots). While you may choose to write this program as separate functions for each part of the exercise, you must submit only a single m-file program in the end, which accomplishes the stated objectives.

Your MATLAB program and the plots that it generates should support your answer(s) to each part below. Make sure your plots are clearly labeled and titled, and that subsequent plots don't overwrite each other. As appropriate, plots should be in the *time* and *frequency* domains, linear and log (dB), zoomed in and zoomed out, plots versus *time* and *frequency* are preferred over plots plotted versus *n* and *k*, respectively. For the frequency domain plots, the relative amplitudes are more meaningful than absolute amplitudes. A good practice is to scale all the frequency bins relative to the maximum value (thus for a linear plot, the maximum amplitude will be "1", and for a log (dB) plot, the maximum amplitude will be "0")

1. For data vector `x2`, determine how many (if any) sinusoidal frequencies of significant magnitude are present, and estimate their real-world frequency and relative amplitudes.
2. For data vector `x3`, determine how many (if any) sinusoidal frequencies of significant magnitude are present, and estimate their real-world frequency and relative amplitudes.
3. For data vector `x4`, describe the signal in general terms based on any methods of analysis, observation, or manipulation you wish to use. Do not attempt to determine the full frequency content of this signal, or you'll never finish. Does either the time or frequency domain representation give you any clue as to what type of signal this is? Can you identify this signal?

   More hints on signal x4:
   You should make an overall time plot and an overall frequency plot of this signal, to gain intuition as to what type of signal this is. Does this signal appear to be an audio signal? Use the MATLAB *Sound()* command to discover the contents of this signal. I'm interested in your intuition as to what you can learn in the time and frequency domain about this signal (before and after you know it's content). You should make a zoomed time and frequency plot of each of the three "parts" of this signal, interpreting what makes each part different and the same than the others in the time and frequency domain.
   Do any of the "parts" oscillate in time similar to another "part"?
   Do the "parts" occupy the same bandwidth?
   Are some "parts" high frequency, while others low frequency?

You can safely assume that the noise level in all three mystery data vectors is too low to cause any problems with your analysis and that there is no aliasing.

3 Write-Up Requirements

The write-up is not to be a dissertation—be concise but do address each part of the CPX1. This isn't meant to be a marathon writing assignment. *Please* don't misinterpret that to mean that you can just throw together a sloppy, incomplete write-up. Your write-up grade will be based on solution completeness, succinctness, organization, evidence of insight into DSP topics, and use of the English language. Pictures are worth a thousand words. Include your MATLAB plots in your write-up (export → jpg; then insert into word, or copy/paste) with proper Figure numbers and titles, AND refer to them as appropriate in your write-up. Plots plotted versus *time* and *frequency* are preferred over plots plotted versus *n* and *k*, respectively. These plots serve as the *evidence* to support your claims in answering the questions below.

1. For each of the three parts of the Computer Exercise that are specified in Section 2, write a few paragraphs addressing the following topics (you must address all the topics for full credit).

   (a) What did your spectral analysis and time domain analysis of the given data signal tell you about the signal?

   (b) What techniques did you try (what worked and what didn't—be specific)? Was smearing, SLL interference, or bias observed? [don't forget to define smearing, SLL interference and bias]

   (c) What significant thing(s) did you learn or observe?

2. After having completed the entire Computer Exercise, please summarize what you learned from this assignment.

3. See the grading rubric "CPX1 Grading Criteria for Students.pdf" to ensure your write-up addresses all these items.

Don't wait until the last minute to do this! Have fun...