AESM1511

Assignment 1: Linear Time-Invariant systems and the Principle of Superposition

Introduction

You have now covered in the part Advanced Signal Analysis the principle of superposition. We will use it to start practicing some Matlab skills. At the same time, this assignment will also allow you to make use of the superposition principle to make simple manipulations on signals (functions), like summation and subtraction. If two signals are summed, a new signal is obtained. If you continue adding more and more signals to the original sum, you can, in principle, obtain any desired final signal, as long as you know what you want to obtain and what to sum to obtain it. You have seen that already in the lecture on Advanced Signal Analysis: when the different summed signals are sine functions, then one performs Fourier analysis. Here, we are going to use sine functions to build signals as a preparation for the future.

Tasks and questions

1. (Do not use for-LOOPS for this assignment. You can practice LOOPS in the following assignments.)
2. We are going to define six sinusoidal signals that are all 1257 points long. Let us suppose that these points are along the horizontal axis; then, the values of the signals are along the vertical axis. Let the values of a master signal start at $-\pi/2$ along the horizontal axis and end at $3\pi/2$. What is the sampling length of this signal along the horizontal axis (i.e., what is the distance between neighbouring points)? Define the sampling points of the master signal using the start value, the end value, and the sampling interval. Check that the length of the signal is indeed 1257 points. (Tip: If the length is different, round the sampling to the third digit after the decimal point.)
3. All six signals can be obtained by scaling the master signal $\sin(MasterSignalvalues)$. The scaling factors are the odd numbers from 1 to 11. The scaling can be written as
   $newsignal = \sin{(MasterSignalValues * scale)}/scale$.
   Note that the signal with scale 1 is equal to the master signal.
   Define a matrix with a dimension equal to the number of signals by the number of points. Put each of the six signals on a separate row.
4. Plot in one figure the first signal, the sum of the first two signals, the sum of the first three signals, the sum of the first four signals, the sum of the first five signals, and the sum of all six signals. Use a legend to show clearly which graph corresponds to which summed signals.
   What happens to the original master signal? How does it change after adding additional signals? What do you think the summed signal would look like if you continue adding more and more signals reaching, for example, 1000 summed signals? (No need to make an actual summation of 1000 signals, just give your informed opinion.)
5. Plot in a second figure the result of summing the even-number matrix rows, the result of summing the odd-number matrix rows, and the result of summing the two separate sums together. Use a legend to show clearly which graph corresponds to which summed signal.

6. Plot in a third figure the two final summed results from Tasks 4 and 5. Use a legend to show clearly which graph corresponds to which summed signal.
   Does the order of summation matter in obtaining the final result?
   Does the order of summation matter in obtaining intermediate results?
7. Make a flowchart of the complete program you have written.

Submitting your results

Submit your complete solution before 17.00 on September 26, 2022 in Brightspace under Assignments at the top of the course's webpage. Submit the results in the form of a zip file containing an executable .m file (or files if applicable) and a file with the flowchart. The name of the zip file should be

AESM1511_2022_matlab_a1_surname_studentnumber.zip

or

AESM1511_2022_matlab_a1_surname1_surname2_surname3.zip if you are working in a group. Working in groups is encouraged. Nevertheless, working in groups of more than 3-4 people is not effective and discouraged.