

Homework #1: Chapter 1 (due Sep. 7, 2012)

Preliminary

- All problems are worth +10 points unless otherwise noted.
- Download and review the Homework Format document
<http://www.ece.nmsu.edu/~pdeleon/Teaching/EE395/Homework/HomeworkFormat.pdf>
- Carefully read the *DSP Software Toolkit* Chapters 1 – 3
http://www.ece.nmsu.edu/~pdeleon/Teaching/EE395/DSP_Toolkit.pdf
- Download the CompanionFiles1.zip file
<http://www.ece.nmsu.edu/~pdeleon/Teaching/EE395/Homework/CompanionFiles1.zip>
This zip file contains source code for `singen.m` as an example and the main and function headers from *DSP Software Toolkit*. In addition, time-limited .p codes for this assignment are provided to assist you in developing and testing your codes and completing this assignment.
- Code the following tools from *DSP Software Toolkit* Chapter 4: **cosingen.m**, **cexpngen.m**, **plotdsig.m**, and **plotcsig.m**. Please follow the coding style of `singen.m`.
- Please attach at the *end* of your assignment printouts of **main1.m** (code to solve software problem 1), **main2.m** (code to solve software problem 2), etc... as well as any new tools developed in this assignment, i.e. **cosingen.m**, **cexpngen.m**, etc....

Software Problems

Use your software tools to solve the following problems.

1. Load the supplied speech file as follows.

```
[x,fs,bits] = wavread('dr1-fvmh0.wav');  
sound(x,fs);
```

What is the sample rate of the signal and the number of bits per sample? Use `plotdsig` (option = 1) to plot the section of the signal corresponding to the word 'oily.' Use `plotcsig` to plot the entire signal.

2. We showed in class that DT sinusoids with frequency, f are indistinguishable from DT sinusoids with frequency, $f + mf_s$ where m is an integer. Assume $f_1 = 60$ and $f_s = 200$, plot 50 samples of the following sequences and verify this result. You may use subplot to facilitate observation.

a $x(n) = \sin\left(\frac{2\pi f_1}{f_s}n\right)$, $x'(n) = \sin\left[\frac{2\pi(f_1+f_s)}{f_s}n\right]$, $x''(n) = \sin\left[\frac{2\pi(f_1+2f_s)}{f_s}n\right]$.

b $x(n) = \sin\left(\frac{2\pi f_1}{f_s}n\right)$, $x'(n) = \sin\left[\frac{2\pi(f_1+1.25f_s)}{f_s}n\right]$, $x''(n) = \sin\left[\frac{2\pi(f_1+2.5f_s)}{f_s}n\right]$.

3. In this problem we will code Example 1.4.3 in the textbook. Use `singen` with $f_s = 4$ Hz to create five different sampled sinusoids with frequencies $f_1 = -7$, $f_2 = -3$, $f_3 = 1$, $f_4 = 5$, and $f_5 = 9$ Hz. Plot 25 samples of each of these signals. The subplots should all be identical thus verifying Example 1.4.3. Comment.

4. In this problem we will code Example 1.4.4 in the textbook.

- a** Use `cosin` to generate 100 samples of

$$x(t) = 4 \cos(2\pi f_1 t) + 3 \cos(2\pi f_2 t) + 2 \cos(2\pi f_3 t) + \cos(2\pi f_4 t)$$

where f_1, f_2, f_3 , and f_4 , are given in the text and $f_s = 1.5$ kHz (undersampled). Plot the samples of the sequence (use `plotdsig`, option = 2).

- b** Use `cosin` to generate 100 samples of

$$x_a(t) = 4 \cos(2\pi f_{1a} t) + 3 \cos(2\pi f_{2a} t) + 2 \cos(2\pi f_{3a} t) + \cos(2\pi f_{4a} t)$$

where f_{1a}, f_{2a}, f_{3a} , and f_{4a} , are given in the text and $f_s = 1.5$ kHz. Plot the samples of the sequence (use `plotdsig`, option = 2).

- c** The sequences from (a) and (b) should be identical. Comment on why $x_a(nT) = x(nT)$ even though $x_a(t) \neq x(t)$.
- d** Given the sequences from (a) and (b), which signal is produced upon ideal reconstruction, $x(t)$ or $x_a(t)$?

5. If we assume the human auditory system can sense frequencies up to about 20 kHz (assuming no hearing damage), the Nyquist criterion would suggest a sample rate of at least $f_s = 40,000$ samples/s. Investigate and summarize the historical origin behind the compact disc audio rate of $f_s = 44,100$ samples/s. Hint: it has to do with clever engineers needing to store the digital samples somewhere—they had video tape but not magnetic or optical discs (that hadn't yet been invented).

Textbook Problems

1.1, 1.4, 1.5, 1.16