HW2 DSP Review

Problem 1 30 points

(a) Let $x(t) = \cos(2\pi(t-4)) + \sin 5\pi t$ and determine the **period** of each term in seconds.

(b) Determine if $x(t)$ is periodic and determine the fundamental period.

(c) If $x1(t) = \cos[2\pi 500\ (t - 0.5 * 10^{-3})]$, what is the phase shift in radians for the cos term?

Problem 2 20 points
Let $x(t) = 4\sin(20\pi t)$.

(a) Determine the period in seconds and the frequency in Hertz.

(b) To obtain 10 samples per cycle of the signal, what is the time interval between samples?

Problem 3 10 points for Part a
Sampling and Aliasing Suppose that $x[n] = \cos(2\pi n F_0 + \theta)$ is a sampled cosine signal.

(a) **Prove** that the signal $\cos(2\pi n(F_0 + m) + \theta)$ where m and n are integers is again $x[n]$. That is, discrete sinusoids are **periodic** in frequency and sinusoids at frequencies $F_0 \pm m$ are identical.

(b) **Example** A sinusoid that is not sampled at a rate at least $S \geq 2f_0$[1] is aliased and the resulting frequency of the aliased sinusoids are

$$f_a = f_0 \pm MS$$

where fa is the aliased frequency, f_0 is the analog frequency of the sampled signal and M is an integer. For example, if the 100 Hz sinusoid

$$x(t) = \cos(200\pi t + \theta)$$

is sampled at S=140 Hz (samples/second) it is aliased to the frequency

$$f_a = 100 - 140 = -40 \text{ Hz}.$$

If negative frequencies bother you $\cos(-80\pi t + \theta) = \cos(80\pi t - \theta)$.

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[1]Note that the units of S is actually samples/second but this is the same number as 2 f_0 in cycles/second (Hertz). Using S in Hz is convenient to compare to analog frequencies f in Hz.

Problem 4 30 points
Calculate the aliasing if any for the signal $x(t) = \cos(200\pi t + \theta)$ sampled at the following rates:

(a) 200 Hz

(b) 90 Hz

(c) 35 Hz

Problem 5 10 points
View Oppenheim's Introduction video again. Then view his video on Sampling, Aliasing and Frequency Response. Pay attention to the aliasing example and the change of frequencies. Outline what was in the video in short sentences.

http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-1-introduction/

http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/demonstration-1-sampling-aliasing-and-frequency-response-part-1/

REMEMBER THE HOMEWORK RULES

A. -10 POINTS FOR EACH DAY LATE
B. For all Problems: (-10 points if violated)
1. Briefly describe the problem to be solved before attempting the solution.
2. Show all work.
3. Turn in problems in order
4. Make the results clear (Circle answers, explain results, etc.)
5. When an explanation of the results is requested, the numerical solution will not be suff
MATLAB Problems (-10 or more if violated)
1. Write the equations to be solved
2. Describe the solution method (flowchart, description, etc)
3. Comment the MATLAB code
4. Turn in the code and the results (Plots, etc.)
Be Neat -- if I cannot read the solution -- no credit!!