ECE315 - Signals and Systems, Spring 2017

Homework 1, Due 01/23/17

1. Determine whether each of the following signal is periodic. If the signal is periodic, find its fundamental period.
   (a) \( x(t) = 4 \), a constant signal.
   (b) Give an example to show the relationship between the fundamental period and fundamental frequency, \( F_0 = 1/T_0 \) does not hold for discrete-time signals.
   (c) \( x(t) = 28e^{j(400\pi t)} \)
   (d) \( x[n] = 28e^{j(400\pi n)} \)
   (e) \( x(t) = 10\sin(5t) - 4\cos(7t) \)
   (f) \( x[n] = 10\sin(5n) - 4\cos(7n) \)
   (g) \( x(t) = \cos\left(\frac{\pi}{2}t\right)\sin\left(\frac{\pi}{4}t\right) \)
   (h) \( x[n] = te^{j^t} \)
   (i) \( x[n] = e^{j(\pi n/\sqrt{2})} \)
   (j) \( x[n] = \cos\left(\frac{\pi}{8}n^2\right) \) (Pay attention to the square)
   (k) \( x[n] = \sum_{k=-\infty}^{\infty} \delta[n - k] \) (\( k \) is an integer)

2. MATLAB problems.
   (a) The following is a demo showing how to generate a tone (i.e., a sinusoid) in MATLAB and listen to it with the sound command. The frequency of your tone is 2 kHz, and the duration is 1 sec. The following lines of code should be saved in a file called mytone.m and run from the command line.

   Problem: 440Hz is a frequency of A above middle C on a musical scale. It is often used as the reference note for tuning purpose. Modify the code above to play the note A from your computer. Add a phase shift of \( \pi/6 \). Play with the parameter \( \text{sps} \). Following is what you need to submit for this problem:
% HW 1, ECE315, Spring 2017
% Play a tone
%
% Created by Hairong Qi
%
%
% clear the environment
clear ALL; % clear buffer
clf; % clear figure

% specify parameters
dur = 5.0; % duration
F = 2000; % fundamental frequency of the tone
sps = 30; % samples per second
A = 10; % amplitude

% generate the signal
t = 0:(1/F/sps):dur; % the time index
x = A*cos(2*pi*F*t); % the signal x(t)

% plot the signal
plot(t,x); % plot the signal
title('Sinusoidal signal x(t)');
xlabel('Time t (sec)');
ylabel('Amplitude');
grid on;

% play the signal
sound(x); % sound it out
• Comment on the effect of different values of sps.
• Submit both the code and the plot. Note that you probably cannot
tell anything from the plot because it’s too dense. Explore the
MATLAB command axis by help axis such that you only
print out a portion of the plot. Choose a range such that you can
tell it’s a sinusoid and can figure out the frequency and the phase.
• (+10 pts) Bonus: It is kind of inconvenient to have to go into the
code and modify parameters each time you want to explore some
new settings. Write a function in the form of function \[ x =
tone(F, \text{dur}, \text{sps}, A) \]. Play notes B and C. Note that we
will cover how to write and use a function in later homework.
But if you self-study it now, you get a bonus. Write a function
that plays a scale in C major using the function `tone`. Note that
you need to figure out the relationships between the frequencies of
each note on the scale.

(b) Plot the real part and imaginary part of the following signal on the same
figure. Explore MATLAB function `subplot`.

\[ x(t) = e^{j\pi/6t} \]

(c) On the same figure, plot the following four discrete-time real exponents-
tials \[ x[n] = z^n \] with \( z \) taking on four different values, \( z = 2, z =
1/2, z = -2, z = -1/2 \). Explore MATLAB function `stem` for DT
signal plots. Pay attention to the different looks of the curve when \( z \)
has different values.

(d) Plot the real and imaginary parts of the following complex exponential
\[ x(t) = A e^{\beta t} \] where \( A = 3e^{j\theta} \) and \( \theta = \pi/3, \beta = r+j\omega_0 =
-3+j\pi/4. \]