

## Problem Set #11

Assigned: April 26, 2017  
Due Date: May 05, 2017

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### General Information

This problem set has two problems. It is worth ten points, five points for each problem. These points will be added to your grade on the final exam.

### Submission Instructions:

1. You should submit a write-up of both problems, and submit them as A SINGLE FILE by the due date.
2. As noted, the first problem must be typed, but may include scanned hand-drawn plots or figures. Your solution to the second problem may be hand-written.
3. The first page of your submission must be the TITLE PAGE (last page of this problem set) that is signed along with a scanned copy of your Mason ID.

### Important Notes:

1. Absolutely **no late submissions** will be accepted.
  2. You are NOT ALLOWED to discuss this assignment with other students in the class.
  3. Submitted work must be original and be your own work. If there is any collaboration or copying from other sources, it will be considered a direct violation of the George Mason honor code.
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### Problem 11.1★

(REFLECTION: Five Points)

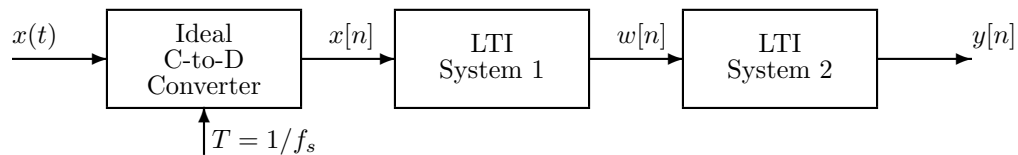
Write a 1-2 page summary of what you have learned in ECE 201 this semester. Your summary should include the major concepts that you learned, e.g., how sampling works, what convolution is and where it is used, the frequency response function and why it is useful. Your summary must be in your own words. Your summary should be typed, but you may include a hand-drawn diagram if you wish. The diagram should be scanned and included in your summary. Preparing this summary should help you review for the final exam.

### Problem 11.2★

(ANALYSIS: Five Points)

You have been assigned the task of recording notes from a new electronic musical instrument in order to determine whether or not it works according to its design specifications. This instrument can produce sounds at frequencies from 16 Hz to 7 kHz, which is approximately the same range of frequencies as a pipe organ. The instrument can produce pure sinusoids at user-specified frequencies, or it can produce a sinusoid plus a set of harmonics. For this problem, you may assume that the instrument is set to produce only one sinusoid at a time.

The microphone that is used for your recording is set up across the room from the instrument. Most of the walls of the room have acoustic foam on them that is designed to eliminate echoes, but there is still one spot that will produce an echo that will be picked up by your microphone and recorded by your equipment. An acoustics expert performed a set of measurements of the room and developed a system model for the room and your recording equipment. The model is shown below.



The sampling system (C/D) operates at a rate of 15 kHz. The acoustics expert says that the two LTI systems are defined by a frequency response (System 1) and a difference equation (System 2) as follows:

$$\text{SYSTEM 1 : } H(e^{j\hat{\omega}}) = e^{-j10\hat{\omega}}$$

$$\text{SYSTEM 2 : } y[n] = \frac{1}{2} (x[n] - x[n - 6])$$

Your job is to analyze whether the recording system operating in this environment is able to make accurate measurements of the sounds produced by the new musical instrument. In particular, suppose that you make 10-second recordings of each sinusoid the instrument can produce. If you play back these different recordings, will all of the sinusoidal signals sound equally loud? In other words, is the amplitude of the recorded sinusoid the same for all frequencies? Or are there some sinusoids that are quieter than others? Will the system be able to record every sinusoid, or will there be some sinusoids that cannot be heard in the recordings? Will changing the C/D converter to operate at a higher sampling rate help in the recording? What effect would a higher sampling rate have?

Provide a clear analysis and justification of your answers and analysis.

# Problem Set #11 Title Page

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Name: \_\_\_\_\_

G-Number: \_\_\_\_\_

## Honor Pledge

*I have neither given nor received aid on this exam.*

Signature: \_\_\_\_\_

COPY OF MASON ID

