Digital Signal Processing EE 351M
Prof. Haris Vikalo HW #1
January 24, 2019 Due: 01/31/19

Homework Set #1

1. (**4 pts**) *For each of the following systems, determine whether the system is (1) stable, (2) causal, (3) linear, (4) time invariant, and (5) memoryless:*

   (a) $T(x[n]) = e^{x[n]} + 3$

   (b) $T(x[n]) = 4x[-n] + u[n+1]$

2. (**3 pts**) *Determine which of the following signals is periodic. If a signal is periodic, determine its period.*

   (a) $x[n] = \sin(\pi n/7)$

   (b) $x[n] = e^{jn}$

   (c) $x[n] = (n+1)e^{j\pi n}$

3. (**4 pts**) *Consider a system S with input $x[n]$ and output $y[n]$ related according to the block diagram in Figure 1.*

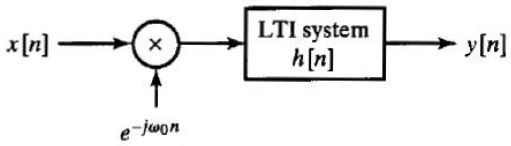


Figure 1: An LTI system.

The input $x[n]$ is multiplied by $e^{-jw_0 n}$, and the product is passed through a stable LTI system with impulse response $h[n]$.
(a) *Is the system S linear? Justify your answer.*
(b) *Is the system S time invariant? Justify your answer.*
(c) *Is the system S stable? Justify your answer.*
(d) *Specify a system C such that the block diagram in Figure 2 represents an alternative way of expressing the input-output relationship of the system S. (Note: The system C does not have to be an LTI system.)*

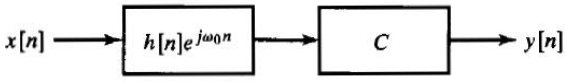


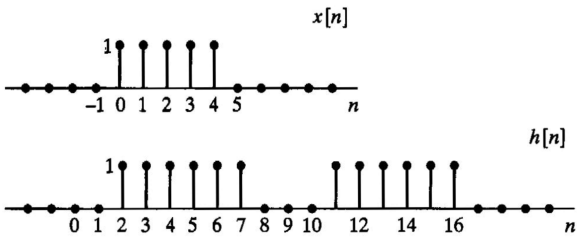
Figure 2: An alternative system.

4. (**3 pts**) Which of the following discrete-time signals could be eigenfunctions of any stable LTI system?

   (a) $e^{j3\omega n}$
   (b) $e^{j\omega n} + e^{j4\omega n}$
   (c) $4^n u[n]$

5. (**4 pts**) (Programming assignment.)

   (a) Write a simple code (preferably in Python) that uses discrete convolution to find the response to the input $x[n]$ of an LTI system with the impulse response $h[n]$ (see figure below). Plot the response. Submit your code, print out and submit the response.



   (b) Plot the magnitude and phase of the frequency response of the LTI system given by

$$H(e^{j\omega}) = \frac{0.008 - 0.033e^{-j\omega} + 0.05e^{-2j\omega} - 0.033e^{-3j\omega} + 0.008e^{-4j\omega}}{1 + 2.37e^{-j\omega} + 2.7e^{-2j\omega} + 1.6e^{-3j\omega} + 0.41e^{-4j\omega}}.$$

   Hint: "numpy.convolve" and "scipy.signal.freqz" are Python functions useful for (a) and (b), respectively.