

## EE1330: Digital Signal Processing, Spring 2017

Indian Institute of Technology Bhilai

HW 1, Assigned: 02.03.2017, Due: 08.03.2017.

1. Are the following signals periodic? If so, state their period.

(a)  $x[n] = e^{(j\pi n/6)}$ . (1)

(b)  $x[n] = e^{(j3\pi n/4)}$ . (1)

(c)  $x[n] = [\sin(\pi n/5)]/(\pi n)$ . (1)

2. For each of the following systems, determine whether the system is (1) stable, (2) causal, (3) linear, (4) time invariant, and (5) memoryless. Credit will be given only if you show your work.

(a)  $T\{x[n]\} = \sum_{k=n_0}^n x[k]$ . (5)

(b)  $T\{x[n]\} = ax[n] + b$ . (5)

(c)  $T\{x[n]\} = x[n] + 3u[n+1]$ . (5)

3. For a linear time-invariant system, show that causality implies  $h[n]$  is zero for  $n < 0$ . (5)

4. Use discrete convolution to determine the output of the linear time invariant system mentioned below for the given input.

(a)  $x[n] = 2\delta[n] - 1\delta[n-1]; h[n] = -\delta[n] + 2\delta[n-1] + \delta[n-2]$ . (2)

(b)  $x[n] = \delta[n+2] + 2\delta[n+1] + \delta[n] + \delta[n-1]; h[n] = \delta[n] - \delta[n-1] + \delta[n-4] + \delta[n-5]$ . (3)

5. Determine which of the following LTI systems are stable:

(a)  $h[n] = 4^n u[n]$ . (1)

(b)  $h[n] = u[n] - u[n-10]$ . (1)

(c)  $h[n] = 3^n u[-n-1]$ . (1)

(d)  $h[n] = (3/4)^{|n|} \cos(\pi n/4 + \pi/4)$ . (1)

(e)  $h[n] = 2u[n+5] - u[n] - u[n-5]$ . (1)

6. Given that the output of an LTI system to an input  $x_0[n] = \delta[n+1] + 2\delta[n] + \delta[n-1]$  is  $y_0[n] = -\delta[n+2] - 2\delta[n+1] + 2\delta[n-1] + \delta[n-2]$ . Find the following:

(a) The output of the system to an input  $x_1[n] = \delta[n-1] + 2\delta[n-2] + 3\delta[n-3] + 4\delta[n-4] + 3\delta[n-5] + 2\delta[n-6] + \delta[n-7]$ . (2)

(b) The impulse response of the system. (3)

7. Write a program in Python to implement linear convolution. Verify that your code works by using the input-sample response pairs given in problem 4. Make your implementation a function so that it can be reused in future homeworks. Plot the input, sample response and output for each case. Clearly comment your code. (10)