ZHEJIANG UNIVERSITY - UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ECE 310 DIGITAL SIGNAL PROCESSING

Homework 2

Prof. Zhi-Pei Liang

the output:

1. Two systems are specified by the following input-output relations, where x[n] is the input and y[n]

Due: January 29, 2021

(a)
$$y[n] = y[n-5] + x[n] + 10x[n-1]$$

(b)
$$y[n-2] + 2y[n] = \cos(\frac{\pi}{6}n)x[n]$$

For each system, determine if it is: (a) linear or non-linear, (b) time-invariant or time-varying. Justify your answers with proofs or counter-examples.

- 2. The output, y[n], of a given system is always related to its input x[n] by y[n] = h[n] * x[n], where h[n] is the system's unit pulse response. Show that the system must be LSI.
- 3. Express the output y[n] of an LSI system with unit pulse response h[n] in terms of its step response g[n] = h[n] * u[n] and the input x[n]. **Hint:** Try to represent $\delta[n]$ in terms of shifted versions of u[n].
- 4. Assume that the zero-state response of an LSI system to input $x[n] = 3^{(-n)}u[n]$ is $y[n] = \frac{1}{5^n}u[n-1]$. Use the system's properties (linearity and shift-invariance) to find h[n], the system's unit pulse response.
- 5. Compute the convolution x[n] * h[n] for the x[n] and h[n] given below. **Note**: The arrow indicates n = 0.

(a)
$$x[n] = \{-1, 0, 1\}, h[n] = \{1, 2, 3, 4, 5\}$$

(b)
$$x[n] = 3^{(-n)}u[n], h[n] = \{0, 1, 2\}$$

(c)
$$x[n] = u[n], h[n] = n(u[n] - u[n-4])$$

(d)
$$x[n] = (-1)^{(-n)}u[n], h[n] = e^{(-n)}u[n]$$