UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering

ECE 310 Digital Signal Processing – Fall 2023

Homework 2

Profs. Do, Moustakides, Snyder **Due: Fri, Sep 8, 2023 on Gradescope**

---

1. Compute the convolution $(x * h)$ for the x and h given below. **Note**: The arrow indicates $n = 0$, $\delta[n]$ denotes unit impulse signal, and $u[n]$ denotes the unit step signal.

   (a) $x = \{\underset{\uparrow}{1}, 1, 1, 1, 2, 2, 2, 2\}$, and $h = \{\underset{\uparrow}{1}, -1\}$

   (b) $x[n] = (1/2)^n u[n]$, and $h = \{\underset{\uparrow}{1}, 1\}$

   (c) $x = \{\underset{\uparrow}{0}, 0, 2\}$, and $h[n] = (1/2)^n u[n]$

   (d) $x[n] = \delta[n-4]$, and $h[n] = u[n] - u[n-4]$

2. Suppose that S is a linear shift-invariant (LSI, or LTI for linear time-invariant) system. Furthermore, suppose that we obtain the output signal $y = g$ for input signal $x = \{\underset{\uparrow}{0}, 2\}$. Find the impulse response h of the system S in terms of g.

3. Consider an LSI system characterized by

$$y[n] = x[n] + 2x[n-1], \quad \text{for } n \in \mathbb{Z}.$$

   (a) Find the impulse response h. That is, determine y when $x[n] = \delta[n]$.

   (b) Use the impulse response to find the output y when $x[n] = u[n] - u[n-4]$.

4. Consider a linear constant coefficient difference equation (LCCDE) system characterized by

$$y[n] = \frac{1}{2}y[n-1] + x[n] + 2x[n-1], \quad \text{for } n = 0, 1, 2, \ldots,$$

   and assuming zero initial conditions (i.e. $y[-1] = 0$).

   (a) Find the impulse response h. That is, determine y when $x[n] = \delta[n]$.

   (b) Use the impulse response to find the output y when $x[n] = u[n] - u[n-4]$.