ECE 6342 Fall 2016 HW 1 Due Thursday 09/01

Problems from Discrete-time Signal Processing - Oppenheim , 2nd edition , Chapter 2

Problem 1 : Oppenheim problem 2.1

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

(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given
(b) $T(x[n]) = \sum_{k=n_0}^{n} x[k]$
(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$
(d) $T(x[n]) = x[n - n_0]$
(e) $T(x[n]) = e^{x[n]}$
(f) $T(x[n]) = ax[n] + b$
(g) $T(x[n]) = x[-n]$
(h) $T(x[n]) = x[n] + 3u[n+1]$

Problem 2. Oppenheim problem 2.2

2.2. (a) The impulse response $h[n]$ of a linear time-invariant system is known to be zero, except in the interval $N_0 \le n \le N_1$. The input $x[n]$ is known to be zero, except in the interval $N_2 \le n \le N_3$. As a result, the output is constrained to be zero, except in some interval $N_4 \le n \le N_5$. Determine N_4 and N_5 in terms of N_0, N_1, N_2, and N_3.

(b) If $x[n]$ is zero, except for N consecutive points, and $h[n]$ is zero, except for M consecutive points, what is the maximum number of consecutive points for which $y[n]$ can be nonzero?

Problem 3. Oppenheim problem 2.4

2.4. Consider the linear constant-coefficient difference equation

$$y[n] - \tfrac{3}{4}y[n-1] + \tfrac{1}{8}y[n-2] = 2x[n-1].$$

Determine $y[n]$ for $n \ge 0$ when $x[n] = \delta[n]$ and $y[n] = 0$, $n < 0$.

Problem 4. Oppenheim problem 2.24

2.24. The impulse response of a linear time-invariant system is shown in Figure P2.24-1. Determine and carefully sketch the response of this system to the input $x[n] = u[n-4]$.

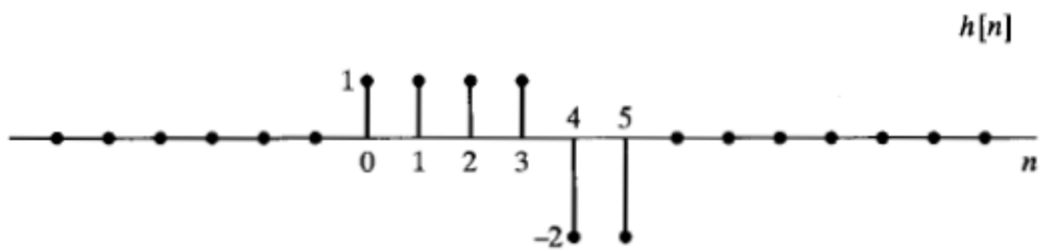

Figure P2.24-1

Problem 5 Oppenheim problem 2.29

2.29. A discrete-time signal $x[n]$ is shown in Figure P2.29-1.

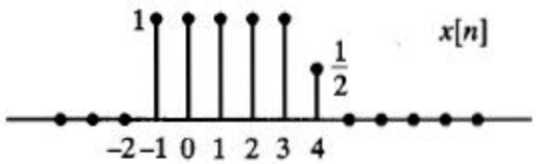

Figure P2.29-1

Sketch and label carefully each of the following signals:

(a) $x[n-2]$
(b) $x[4-n]$
(c) $x[2n]$
(d) $x[n]u[2-n]$
(e) $x[n-1]\delta[n-3]$

Problem 6. Oppenheim problem 2.30

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

(a) $T(x[n]) = (\cos \pi n)x[n]$
(b) $T(x[n]) = x[n^2]$
(c) $T(x[n]) = x[n]\sum_{k=0}^{\infty}\delta[n-k]$
(d) $T(x[n]) = \sum_{k=n-1}^{\infty}x[k]$

Problem 7. Oppenheim problem 2.39

2.39. Consider a system with input $x[n]$ and output $y[n]$. The input–output relation for the system is defined by the following two properties:

1. $y[n] - ay[n-1] = x[n]$,
2. $y[0] = 1$.

(a) Determine whether the system is time invariant.
(b) Determine whether the system is linear.
(c) Assume that the difference equation (property 1) remains the same, but the value $y[0]$ is specified to be zero. Does this change your answer to either Part (a) or Part (b)?

For more practice, some additional good problems to try out: 2.3, 2.5, 2.10, 2.12, 2.25