ECE 113: Digital Signal Processing
Homework 1
Due Jan 12, 11pm, 2022

Chapter 1

Motivation

1. **Problem 1.2.** For each of the following signals, classify them as continuous-time, discrete-time, or digital:

   (a) Speech signal captured by a microphone.

   (b) Text file saved on your computer.

   (c) Air pressure as a function of altitude.

   (d) The number of male voters in every election cycle.

2. **Problem 1.14.** Consider the setting of Prob 1.13. Assume it takes about 2.1 seconds to transmit an amount of data from location A to location B. Approximately, how many samples of $x(n)$ are transmitted during this operation?

3. **Problem 1.17.** Consider the sequences

$$x(n) = \begin{cases} (\frac{1}{2})^n, & 0 \leq n \leq 3, \\ 0, & \text{otherwise.} \end{cases}$$

$$y(n) = \begin{cases} (\frac{1}{4})^{n-1}, & 0 \leq n \leq 5, \\ 0, & \text{otherwise.} \end{cases}$$

   (a) Plot the samples of $x(n)$.

   (b) Plot the samples of $y(n)$.

   (c) Plot the samples of the sequence $z(n) = x(n)y(n)$, which are obtained from the point–wise product of the samples of $x(n)$ and $y(n)$.

4. **Problem 1.19.** The energy of a real-valued sequence is defined as the sum of the squares of its samples:

$$\mathcal{E}_x \triangleq \sum_{n=-\infty}^{\infty} x^2(n)$$

   What is the energy of the sequences $x(n), y(n)$, and $z(n)$ defined in Prob. 1.17.

Chapter 2

Fundamental Sequences

1. **Problem 2.7.** Let
$$x(n) = \left(\frac{1}{2}\right)^n . e^{j(\frac{\pi}{3}n+\frac{\pi}{4})} . \left(\frac{1}{2} + j\frac{\sqrt{3}}{2}\right)$$
and denote its polar representation by $x(n) = \rho(n)e^{j\theta(n)}$, where both $\rho(n)$ and $\theta(n)$ are functions of n.
   (a) Determine $\rho(n)$ and $\theta(n)$.
   (b) Determine the even and odd parts of $\rho(n)$.
   (c) Determine the even and odd parts of $\theta(n)$.

2. **Problem 2.37.** Given the sequence $x(n) = 0.5^n u(n)$, plot the sequences $x(2n)$ and $x(n/2)$. Find the energies of the latter sequences as well. How do the even and odd components of $x(2n)$ and $x(n/2)$ relate to those of $x(n)$?

3. Evaluate the following series:
   (a)
$$\mathcal{S} = \sum_{n=0}^{\infty} n(0.5)^n$$
   (a)
$$\mathcal{S} = \sum_{n=3}^{\infty} n(0.5)^{2n}$$