Class Exercises for Chapter 10

1. Let the impulse response of a digital system be

$$h[n] = \{\underset{\substack{\uparrow \\ n=0}}{1}, 1, 1\}$$

   Is it a linear-phase system? Determine its magnitude and amplitude response. Find also the corresponding phase responses.

2. Let the impulse response of a digital system be

$$h[n] = \{\underset{\substack{\uparrow \\ n=0}}{\frac{1}{5}}, -\frac{1}{4}, \frac{1}{3}, -\frac{1}{2}, 1, 0, -1, \frac{1}{2}, -\frac{1}{3}, \frac{1}{4}\}$$

   Is it a linear-phase system? Why?

3. Compute the energy for $h_d[n]$:

$$h_d[n] = \frac{\omega_c}{\pi}\,\text{sinc}\left(\frac{\omega_c n}{\pi}\right), \qquad \omega_c = 0.1\pi$$

which is the impulse response of an ideal lowpass filter with cutoff frequency 0.1π.

4. Consider an ideal highpass filter whose frequency response in $(0, 2\pi)$ is given as:

$$H_d(e^{j\omega}) = \begin{cases} 1, \ 0.3\pi \le \omega \le 1.7\pi \\ 0, \ \text{otherwise} \end{cases}$$

Use the window method with rectangular window to design a length-21 casual linear-phase finite impulse response (FIR) filter that approximates $H_d(e^{j\omega})$.

5. Use the window method with rectangular window to design a length-21 casual linear-phase finite impulse response (FIR) filter that approximates an ideal lowpass filter. It is required that the sampled version of a continuous-time signal with frequency components of 500 Hz or below can pass through it with small attenuation. The sampling frequency is 8000 Hz.

6. Use the frequency sampling method to design a length 5 linear-phase FIR filter to approximate an ideal lowpass filter whose frequency response $H_d(e^{j\omega})$ in $(-\pi, \pi)$ is

$$H_d(e^{j\omega}) = \begin{cases} 1, & |\omega| < 0.5\pi \\ 0, & \text{otherwise} \end{cases}$$