EE3701:Digital Signal Processing Lab

Labsheet 3: Properties of Signals, Systems, Convolution and Audio Processing

Pre-Lab Exercises

Revise the theory related to the signal and system based operations on all the four Lab exercises given below, and evaluate them analytically before you come to the lab.

Lab Exercises

1. Consider the following two discrete functions:

$$x[k] = \begin{cases} k+1 & 0 \leq k \leq 4 \\ 0 & \text{Otherwise} \end{cases} \qquad h[k] = \begin{cases} 1-k & 0 \leq k \leq 3 \\ 0 & \text{Otherwise} \end{cases}$$

   (a) Find the convolution of $x[k]$ and $h[k]$.
   (b) Find the convolution of $x[k]$ and $h[k-2]$.
   (c) Write, in brief, about your observations for both the convolutions.

2. Using MATLAB, find the odd and even part of the signal given below:

   (a) $x_1[n] = \begin{bmatrix} 5 & 4 & 6 & 7 & 3 & 2 \end{bmatrix}$
   (b) $x_2[n] = sin(2\pi fn) + cos(\pi fn)$

3. Using MATLAB, state whether the given system is linear and/or time invariant. Use $x_1[n] = u[n] - u[n-10]$ and/or $x_2[n] = \begin{cases} n & 0 \leq k \leq 10 \\ 0 & \text{Otherwise} \end{cases}$ as an input signals.

   (a) $y_1[n] = x[n-3] * x[n-2]$
   (b) $y_2[n] = x[n+2]$
   (c) $y_3[n] = sin(x[n])$

4. Given the impulse response of the system, plot the impulse response and state whether the system is causal and/or stable.

   (a) $h_1[n] = \begin{cases} 1-k & 0 \leq k \leq 3 \\ 0 & \text{Otherwise} \end{cases}$
   (b) $h_2[n] = \begin{cases} sin(\frac{2\pi k}{50}) & -10 \leq k \leq 30 \\ 0 & \text{Otherwise} \end{cases}$
   (c) $h_4[n] = sin(2\pi fn)u[n+2]$

Experimental Exercises:

1. Generate and play the following basic signals:

   (a) sinusoidal signal of length 2 seconds with frequency 500Hz, sampled at 22100Hz.
   (b) square wave of length 2 seconds with appropriate frequency sampled at 22100Hz
   (c) chirp signal by using MATLAB `chirp` function
   (d) dual tone signal by adding two sinusoidal signals of length 0.5 seconds and different frequencies.

2. Use `audiorecorder` and `audioplayer` functions of MATLAB to record and play the audio activity of your surroundings. Take alternate samples out of your signals and play with same sampling frequency. Write, in brief, your observations.