EE 102: Signal Processing and Linear Systems

Instructor: Ayush Pandey

Homework #5: Introduction to the frequency domain

Name: _____ **Submission Date:** _____

Problem 1

Problem 2

Problem 3

Let $x[n]$ be a 1-D signal that represents grayscale colors as pixel intensities (0 is black and 255 is white):

$$x[n] = [\,50,\ 100,\ 240,\ 255,\ 200,\ 120,\ 80,\ 80,\ 90,\ 150,\ 220,\ 240\,], \qquad 0 \le n \le 11.$$

Assume causal zero-padding outside the given range, that is, $x[n] = 0$ for $n < 0$ or $n > 11$. Your goal is to compute $y[n]$ by hand and also using a for loop implementation (in Python or MATLAB) of the convolution sum. **You are not allowed to use external libraries to compute the convolution.**

Consider these physically meaningful impulse responses $h[\cdot]$ (all causal) of LTI systems:

(a) [12 points] A blurring system:

$$h[n] = \tfrac{1}{3}\,[\,\delta[n] + \delta[n-1] + \delta[n-2]\,]$$

(b) [12 points] A first-difference (edge detector):

$$h[n] = \delta[n] - \delta[n-1],$$

(c) [12 points] Exponential smoothing

$$h[n] = [\,0.6,\ 0.3,\ 0.1\,] \text{ for } n = 0, 1, 2, \text{ else } 0.$$

For each of the parts above,

1. By hand, write the convolution sum for $y[n]$ and compute numerically $y[n]$ at $n = 0, 1, 2$.
2. Implement a for loop that computes $y[n]$ for all n for system above. Make sure to plot the original $x[n]$ and each $y[n]$ on the same axes.
3. Apply repeated convolution to intensify the effect of the system. You can choose one of the systems above and experiment with repeated convolutions.

Problem 4

(a) [1 point] How long did this assignment take you to complete (this does not include the time spent in lectures or in labs, but it does include the time spent programming).