Pop Quiz 1 [10 mins]

Name: ____________________________

Student ID: _______________________

1. An audio signal makes 250 cycles in its span (or has a frequency of 250Hz). How many samples do you need, at a minimum, to sample it correctly? [1]

500 samples (since Nyquist sampling needs to be at least twice the frequency)

2. If the number of bits is reduced, the quantization error ------increased------ [1]

Step size will be increased and hence quantization error is also increased.

3. Draw a 3x3 kernel that will take an image as input and output as image which has a quarter dimmed ghost to its bottom right. Make sure that the total energy is preserved. [3]

In Matlab notation, the kernel is [4/5,0,0;0,0,0;0,0,1/5]. The goal is to create the image plus itself at quarter brightness at the bottom right. Since we have to preserve energy, the sum of the fractions should add up to 1. Therefore, X + 1/4X = 1

From this we get, x = 4/5. And hence the kernel. Also, note that if we do not have no contribution or 0 value between the 4/5 and the 1/5 in the kernel, then it will become just another low pass filter where the contribution is spread to only one neighboring pixel (instead of two or four that we have done in class). Therefore, we need to have the second row to be completely 0. This will assure ghosting and not blurring.

4. Let us consider a signal x(t). Consider the operation \( ½(x(t)\delta(t) + x(t)\delta(t-1)) \). This is equivalent to [3]
   - low pass filtering of x
   - high pass filtering of x
   - band pass filtering of x

5. Calculate the convolution of the following signals. [2]

\[ h[t] = \delta[t + 1], \quad x[t] = \delta[t - a] + \delta[t + b] \]

Based on delay property of convolution we have

\[ x[t] \ast \delta[t + s] = x[t + s] \]

So we have

\[ (\delta[t - a] + \delta[t + b]) \ast \delta[t + 1] = \delta[t - a + 1] + \delta[t + b + 1] \]