

## ECE-178 Homework #4

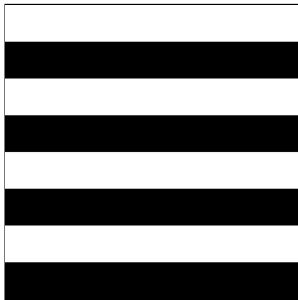
Due on Wednesday, November 6, 2024, 11:59 PM

Name:

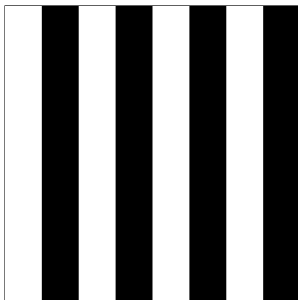
### 2D Fourier Transform Intuition (8 points)

- Derive the (Discrete) Fourier Transform for each of the following signals, assuming that each signal has a length of 8 samples. Sketch a plot of the resulting Fourier Transform including axis labels.
  - $p[n] = n \bmod 2$
  - $c[n] = 1$
  - $c[n] = 0$
- Sketch the 2D Fourier Transform of each of the following 8x8 images. For your convenience, you may report each pixel as being “dark” or “light” (white/black). *Hint: you shouldn't have to do any computations if you use the result from the previous question!*

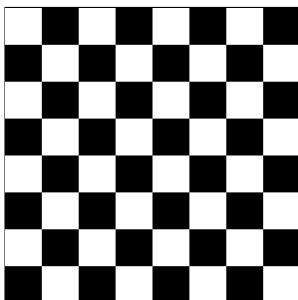
a.



b.



c.



- Explain the intuition behind the light pixels for 2a. What does a lit-up pixel represent? Create a general rule which applies to larger images.

### **[PROGRAMMING] Fast Convolution (7 points)**

**Unless otherwise stated, you may not use any library functions which compute convolution for this problem.**

1. Implement a function called `conv(x[n], y[n])` which returns the convolution of two 1D signals of identical length `x[n]` and `y[n]` using the formula from class.
2. Recall the relationship between convolution and the FFT. Use any `np.fft` to implement a faster `fastconv(x[n], y[n])` in numpy. Briefly explain why this implementation is faster.

**Bonus (not graded)** Convolution should work for signals of arbitrary length - not just signals of identical length. Implement `fastconv2(x[n], y[m])` using an FFT to improve your runtime where `x[n]` and `y[m]` don't necessarily have the same length.