Homework 12 Problem 1

Dror Baron

Problem 1:

(a) We are asked to compute the 5-point DFT of several sequences. One approach to this question involves using Matlab. For example, for a sequence $x_1(n) = [2, 3, 2, 4, 2]$, the DFT can be computed in Matlab using the following commands.

```
x1=[2 3 2 4 2];
x1f=fft(x1)
```

Another approach would use the definition of the DFT,

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j2\pi kn/N}.$$

(b) We are asked to define $y_1(n)$ such that $Y_1(k) = X_1(k)X_2(k)$. One approach to do so uses Matlab, where we (*i*) compute $X_1(k)$ and $X_2(k)$ using the fft command, (*ii*) multiply them to form $Y_1(k)$, and (*iii*) compute $y_1(n)$ using the ifft command.

A second approach to compute $y_1(n)$ directly from $x_1(n)$ and $x_2(n)$ involves the circular convolution of x_1 and x_2.

A third approach relies on $x_2(n)$ having the simple form $[0, 0, 0, 1, 0]$, which implies that $x_1(n)$ is shifted in a cyclical way to the right by 3 units, or to the left by 2 units. Because $x_1(n) = [2, 3, 2, 4, 2]$, shifting it to the right by 3 units yields $y_1(n) = [2, 4, 2, 2, 3]$.

(c) We need to compute $x_3(n)$ such that $Y_2(k) = X_1(k)X_3(k)$. To do so, we compute $Y_2(k)$ and $X_1(k)$, for example using Matlab's fft command. Next, we derive $X_3(k)$ by dividing $Y_2(k)$ by $X_1(k)$. Finally, we compute $x_3(n)$ from $X_3(k)$, for example by applying the ifft command.